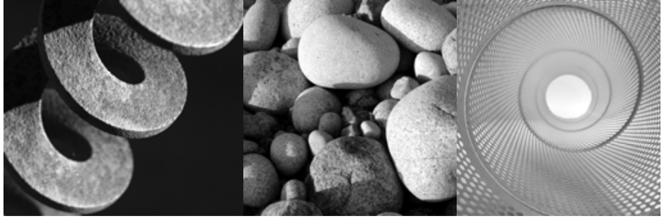

GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

DRAFT

Specific Site Assessment for Coal Ash Impoundments at PacifiCorp Energy

Jim Bridger Power Station

Point of Rocks, Wyoming

Submitted to:
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Project 091330

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1.0 Introduction

1.1 Purpose

This report presents the results of a specific site assessment of the dam safety of Flue Gas Desulphurization (FGD) Pond 1 embankment dam FGD Pond 2 embankment dam at the PacifiCorp Energy Jim Bridger Power Station in Point of Rocks, Wyoming. The specific site assessment was conducted on June 9 and 10, 2009.

1.2 Scope of Work

The scope of work between GEI and Lockheed-Martin Corporation for the specific site assessment is summarized in the following tasks:

1. Acquire and review existing reports and drawings relating to the safety of the project provided by the United States Environmental Protection Agency (EPA) and Owners.

2. Conduct detailed physical inspections of the project facilities. While on-site, fill out Field Assessment Check Lists provided by EPA for each management unit being assessed.

3. Review and evaluate stability analyses of the project's coal combustion waste impoundment structures.

4. Review the appropriateness of the inflow design flood (IDF), and adequacy of ability to store IDF, provision for any spillways, including considering the hazard potential in light of conditions observed during the inspections or to the downstream channel.

5. Review existing performance monitoring programs and recommend any additional monitoring required.

6. Review existing geologic assessments for the projects.

7. Submit draft and final reports.

1.3 Authorization

GEI Consultants, Inc., performed the coal combustion waste impoundment assessment for the EPA as a subcontractor to Lockheed Martin who is a contractor to the EPA. This work was authorized by Lockheed-Martin under P.O. No.: 7100052068; EAC #0-381 between Lockheed-Martin and GEI Consultants, Inc. (GEI), dated June 5, 2009.

1.4 Project Personnel

The scope of work for this task order was completed by the following personnel from GEI:

Stephen G. Brown, P.E.	Project Manager/Task Leader
Amber L. Misgen	Staff Geotechnical Engineer

The Program Manager for the EPA was Stephen Hoffman. The Program Manager for Lockheed-Martin Corporation was Dennis Miller.

1.5 Limitation of Liability

This report summarizes the assessment of dam safety of the FGD Pond 1 and FGD Pond 2 coal combustion waste impoundments at the PacifiCorp Energy Jim Bridger Power Station, Point of Rocks, Wyoming. The purpose of each assessment is to determine the structural integrity of the impoundments and provide summaries and recommendations based the available information and on engineering judgment. GEI used a professional standard of practice to review, analyze, and apply pertinent data. No warrantees, express or implied, are provided by GEI. Reuse of this report for any other purpose, in part or in whole, is at the sole risk of the user.

1.6 Prior Inspections

FGD Pond 1 and FGD Pond 2 embankment dams are inspected every 5 years by the Wyoming State Engineer's Office (SEO). The SEO last inspected the FGD Pond 1 and FGD Pond 2 dams in June of 2004. The SEO was on site to inspect all Jim Bridger Power Station Impoundments concurrently with the assessment on June 9, 2009. SEO provided copies of the Wyoming Dam Inspection Reports for FGD Pond 1, FGD Pond 2, and the Evaporation Pond for the 2009 and 2004 inspections. The last reported inspection of FGD Pond 1 and FGD Pond 2 by PacifiCorp personnel was February 2009; the last inspection by outside consulting engineers was performed in March 2009.

2.0 Description of Project Facilities

2.1 General

Jim Bridger Power Station is a coal-fired power plant consisting of 4 units that generate about 2,110 megawatts (MW). The Jim Bridger Power Station is located 25 miles East of Rock Springs in Point of Rocks, Sweetwater County, Wyoming, see Figure 1. The power plant is located approximately 4 miles north of the Point of Rocks I-80 exit 130. FGD Pond 1 and FGD Pond 2 are located to the northwest of the power plant. PacifiCorp Energy (PacifiCorp) and Idaho Power Inc. own the power plant, which is operated by PacifiCorp. The first unit went online in 1974. FGD Pond 1 first went into service in 1979 and was expanded in 1989. FGD Pond 2 first went into service in 1990 and was expanded in 2002-2003.

2.2 Impoundment Dams and Reservoirs

FGD Pond 1 and FGD Pond 2 embankments are classified by the SEO Dam Safety Bureau as Significant Hazard potential structures because of their height and storage capacity and economic risk to property. The hazard classification is further discussed in Sections 6 and 10. Both impoundments are located in Sections 25, 26, 35, and 36 Township 21 North Range 101 West.

2.2.1 FGD Pond 1

The maximum height of FGD Pond 1 is 32.5 feet at the main dam (Dike A). The main dam has a cross-valley configuration and the saddle dike (Dike B) is configured as a perimeter dike. FGD Pond 1 has a storage capacity of about 1,340 acre-feet and its surface area is approximately 93 acres. FGD Pond 1 is currently in process of closure as the storage capacity of the impoundment has been reached. An interim cover has been constructed using 74 acre-feet of bottom ash to control fugitive dust during the permit closure process.

The FGD Pond 1 main dam crest is 22 feet wide and both upstream and downstream slopes have an approximate 3H:1V slope. The maximum height of the main dam is 32.5 feet. There is a 12 foot wide berm along the downstream toe. The embankment is zoned with a shale and silty clay core, silty sand shells, and a processed sand chimney and blanket drain. A clay pond liner extends 10 feet under the upstream embankment shell.

The maximum height of Dike B is 11 feet. The FGD Pond 1 Dike B is a homogenous silty sand or siltstone/sandstone embankment with a 12 foot wide crest and having upstream and downstream slopes at an approximate 3H:1V slope. The upstream side of the upstream slope has a 9 foot wide shale or silty clay low permeability zone, except at one section where the dike embankment is above the planned maximum water surface El. 6697.

The FGD Pond 1 does not have a spillway. A drop inlet decant structure with a 36-inch diameter concrete encased corrugated metal pipe (CMP) outlet conveys fluid from FGD Pond 1 to FGD Pond 2. Dewatering wells have been installed to dewater FGD Pond 1. Water collected by the wells is pumped to the decant inlet structure where it flows by gravity into FGD Pond 2.

2.2.2 FGD Pond 2

The maximum height of FGD Pond 2 is 42 feet, which includes a 28 foot raise that was constructed in 2002-2003. The dam is configured as a long U-shaped perimeter dike. FGD Pond 2 has a storage capacity of about 11,534 acre-feet and its surface area is approximately 392 acres. As of March 13, 2009, 2,958 acre-feet of FGD solids and water is stored in FGD Pond 2. Plant operations maintain a maximum of 2 feet of free liquid above the FGD solids. The level of free liquid varies seasonally depending on evaporation rate and precipitation.

FGD Pond 2 dam crest is 18 feet wide and both upstream and downstream slopes have an approximate 3H:1V slope. The dam is made up of silty sand shell material, and lean to fat clay core material. Four different types of foundation preparation were specified in the design drawings based on conditions encountered in the field. As-built drawings provided do not reflect the foundation-embankment geometries constructed in the field.

A cement-bentonite seepage cutoff wall is provided along the centerline of the dam and extends 15 to 20 feet below the key trench. Where upstream shell of the embankment is founded on pond solids a heavy duty woven geotextile was placed on top of the pond solids before placing the embankment raise.

A pump back system with a series of well points is used to control underground seepage and mitigate surface water contamination along the northeastern boundary of FGD Pond 2. Collected water is returned to FGD Pond 2. FGD Pond 2 has a bird hazing system to protect local and migratory birds.

FGD Pond 2 does not have a liner, spillway, or outlet structure. FGD Pond 2 inlet structure is the former outlet structure of FGD Pond 1.

Table 2.1: Impoundment Dam Parameters Summary

Parameter	Value		
Dam	FGD Pond 1 (Dike A)	FGD Pond 1 (Dike B)	FGD Pond 2
Height (ft)	32.5	11	42
Length (ft)	Approx. 2,200	1,800	Approx. 9,780
Crest Width (ft)	22	12	18
Crest Elevation (ft)	El. 6702.5	6701.5	El. 6702
Side Slopes (_H:1V)	3	3	3
Current Ash/Pool El. (ft)	6702.5	6701.5	6674
Storage Capacity (ac-ft)	1,340		11,534
Surface Area (acres)	93		392

2.3 Vicinity Map

The Jim Bridger Power Station is located 25 miles East of Rock Springs in Point of Rocks, Sweetwater County, Wyoming, see Figure 1. The power plant is located approximately 4 miles north of the Point of Rocks I-80 exit 130. FGD Pond 1 and FGD Pond 2 are located just northwest of the power plant. The site is in a semi-arid high plains region characterized by cactus, sagebrush, and sparse grasses.

2.4 Standard Operational Procedures

The facility is manned full-time (24 hours a day and 7 days a week) and personnel perform daily inspections of ash pond facilities. There have been no known spills or unpermitted releases for either FGD Pond 1 or FGD Pond 2 in the past 10 years. FGD Pond 1 is currently in the closure process and is not receiving coal combustion waste materials. A closure Corrective Action Plan has been submitted to the Wyoming Department of Environmental Quality. The planned impoundment closure includes a bottom ash cover, dewatering of impounded materials, a soil cover, and an evapo-transpiration cover to keep water from infiltrating to the waste materials.

Water is pumped approximately 41 miles from the Green River and stored on site for plant blowdown water. The plant relies on two nearby mines, Bridger Coal mine and Black Butte Mine, to supply coal for its operations.

Typically 90 percent of the generated fly ash is sold commercially as Class F pozzolanic fly ash for use in concrete. Waste bottom ash is dewatered and disposed of in an industrial landfill located to the north of FGD Pond 2. Water-borne coal combustion waste that consists primarily of flue gas desulphurization solids is pumped from the plant via two above-ground pipes around FGD Pond 1 to the FGD Pond 1 concrete outlet structure, which now functions solely as the inlet structure for FGD Pond 2. No water-borne coal combustion waste is placed in FGD Pond 1.

The site receives an average of approximately 7 inches of rain annually and the pan evaporation rate is 30 to 36 inches annually.

3.0 Summary of Construction History and Operation

The Jim Bridger Power Station went online in 1972. The surge pond, which stores river water pumped from the Green River for the cooling towers, was built in the early 1970s and was raised in the 1990s. FGD Pond 1 was put into service in 1979 and was raised in the 1989. Dike B was raised 3 feet to El. 6701.5, and Dike A was filled to achieve a level crest at El. 6702.5. FGD Pond 2 was originally an evaporation pond. Construction of the FGD Pond 2 expansion was completed in 2003 and involved a 28-foot raise of the existing dikes. The expansion increased the storage capacity of the pond to serve the plant for approximately 40 years. PacifiCorp considers the life of FGD Pond 2 as nominally 30 years.

FGD Pond 2 expansion raised the existing dikes by 28 feet. The raise was completed using onsite borrow materials except for imported granular drain material. The resulting dike is approximately 9,700 feet long and varies from 10 feet to 40 feet in height. A cement-bentonite cutoff wall was excavated from the key trench for the length of the dam and has a minimum depth of 15 feet and width of 2 feet.

FGD Pond 1 has been filled to capacity and is currently out-of-service awaiting closure. The current liquid elevation in FGD Pond 2 is El. 6674, with a current freeboard of 28 feet. At the end of its service life, the highest water elevation in FGD Pond 2 will be El. 6699 with an operating freeboard of 3 feet.

Effluent is conveyed to FGD Pond 1 via two 12-inch overland pipes. The current outlet structure in FGD Pond 1 will continue to be used to convey effluent to FGD Pond 2 until FGD Pond 1 has been closed.

A diversion channel has been constructed at the western end of FGD Ponds 1 and 2 to divert surface water up to the 100 year flood event around the impoundments.

The foundation conditions at FGD Pond 2 vary over the length of the expanded dike. Generally subgrade preparation consisted of stripping topsoil and preparing a suitable subgrade. From station 11+00 to 25+00, subgrade preparation included the re-construction of the Evaporation Pond 3 tailwater berm, and stabilization using geotextiles. In areas where the upstream shell material was designed to cover existing pond solids, a layer of granular material with woven-geotextiles above and below was used to stabilize the pond solids to enable construction of the overlying dam embankment fill. Light duty woven-geotextiles were used as field conditions required based on the 4 different subgrade preparation types specified. Existing pond solids located beneath the embankment core material were removed to a varying depth down to the key excavation.

4.0 Geologic and Seismic Considerations

The site is situated along the northeastern flank of the Rock Springs Uplift. This north-south trending structural anticline formed during the Laramide Orogeny. The sedimentary beds dip northeasterly at approximately 5 degrees. Formations found at the site include the upper Cretaceous Fox Hills, Lewis, and Almond Formations. These formations are made up of sandstones, siltstones, shales, clays, and coal beds.

Geologic maps of the site show the Almond Sandstone outcropping along the southern boundary of FGD Pond 1. The Lewis/Almond contact outcrops at the western end of FGD 1 and underlies the western quarter of the pond.

Surface stream flow is mostly ephemeral during the spring and early summer months. Potash Wash is located north of FGD 2. Potash Wash flows east towards Deadmans Wash which joins with Bitter Creek. Bitter Creek is a tributary to Green River. Deadmans Wash flows from northwest to southeast at a distance of approximately 1,200 feet east of the impoundments.

Embankment stability studies at the site have used a peak ground acceleration of 0.10g for 95 percent probability of ground motion not being exceeded in a 50-year period. According to the United States Geological Survey National Seismic Hazard Mapping Project the peak ground motion for this site is on the order of 0.05g for a similar return period. The previous stability models for design of FGD Pond 2 used an acceptably conservative seismic coefficient of 0.10g for the pseudo-static stability analysis.

5.0 Instrumentation

FGD Pond 1 and FGD Pond 2 do not have any embankment monitoring instrumentation. FGD Pond 1 has a downstream gravel trench to collect seepage through the left abutment and a sump pump to return the seepage to the impoundment. FGD Pond 2 has a series of well points and a pump station to collect seepage from the north side of the Pond and return it to FGD Pond 2.

At the time of our site visit, the FGD Pond 1 sump was nearly full of water, but the pump-back system had been disconnected. Site personnel advised this water is from the Evaporation Pond and is not seepage from FGD Pond 1 based on the color of the water.

The as-built drawings for FGD Pond 2 indicate that plans for installing settlement monuments and up to 8 piezometers were not implemented from the original design.

There are 56 wells installed on site for groundwater quality observation and an associated program of groundwater sampling and monitoring. Twelve of the wells are monitored quarterly. Thirty-two of the wells are monitored semiannually. These wells are not associated with monitoring the performance of the embankments or the seepage collection system.

6.0 Field Assessment

6.1 General

Field observations of the FGD Pond 1 and FGD Pond 2 Impoundments were made on June 9, 2009, by Stephen G. Brown, P.E. and Amber L. Misgen, of GEI. The field assessment was attended by Joe Byron of the United States Environmental Protection Agency, Jeff Tucker of PacifiCorp Energy, and Michael Meyer, P.E. and Paul Falhsing, P.E. of PacifiCorp Energy Jim Bridger Power Station. The State of Wyoming was represented by Larry Stockdale, P.E. Safety of Dams Engineer and Louis Harmon, P.E., P.G., Water and Wastewater Program Manager. The Wyoming agency personnel conducted a separate inspection of the facilities and departed the site at the completion of their inspection.

The weather during the field assessment was generally overcast, windy, and a high temperature of 61 degrees. The site had received rain during the several days prior to the site visit and, as a result, ponded water was present at several locations.

A copy of the field checklists are provided in Appendix B and photographs are provided in Appendix C. Sections 6.2 and 6.3 describe observations made during the inspection relative to key project features. Section 6.4 presents specific observations.

6.2 FGD Pond 1

FGD Pond 1 is formed by the main dam (Dike A) at the south and a saddle dike, (Dike B) at the northeast. FGD Pond 1 is currently full and has an interim covering consisting of bottom ash. This impoundment is in the process of being closed. Wells have been installed to dewater the permanently stored material prior to construction of the permanent cover. The crest, abutments, and downstream slope were assessed during the June 9, 2009 inspection. The June 2009 will be the last SEO inspection of this impoundment according to the state inspectors.

6.2.1 Dam Crest

The dam crest appears to be in good condition. We saw no obvious signs of settlement or displacement, see photos 1 and 5.

6.2.2 Upstream Slope

The upstream slope of the dam was not observed because it is covered with settled FGD solids and a temporary bottom ash cover. See photo 1, 2, 5, and 6.

6.2.3 Downstream Slope

The downstream slope of the dam, which consists of processed sand used for the dam shells, does not have additional erosion protection. Ponded water was observed near the downstream toe in a low area of an access road. This water was considered to be ponded rainwater from the recent thunderstorms.

Seepage from the left abutment FGD Pond 1 is collected in a gravel-filled trench drain that is located approximately 300 feet downstream. Seepage collected by the trench drain flow to a sump and is then pumped to FGD Pond 1. The sump has been disconnected and is no longer in use since FGD Pond 1 has been filled and the dewatering system installed. The seepage from FGD Pond 1 is reported to be greatly reduced since the liquid levels in FGD Pond 1 have been lowered by the dewatering well system.

The downstream slope and toe berm are covered with thick mature sagebrush, grasses, and bushes. This vegetation should be removed to enable visual inspection of the dam and prevent roots from penetrating the dam. See photos 3 and 4. Except for the excessive vegetation, the downstream slope was observed to be in generally good condition.

6.2.4 Outlet Works

The concrete decant inlet structure in FGD Pond 1 currently receives pumped effluent from the plant and effluent dewatered from the FGD Pond 1 well points. This structure currently serves as the inlet to FGD Pond 2 and no coal combustion waste is placed in FGD Pond 1.

The structure is missing the west and north safety railing. Surface soil and rock appears to be sloughing into the structure from the north. A few cobble sized rocks are present atop a metal screening and dead tumbleweed is present in the structure. The concrete appears to be in good condition considering the age of the outlet. See photo 25.

6.2.5 Emergency Spillway

There is no emergency spillway associated with FGD Pond 1.

6.2.6 Internal Drains or Toe Drains

FGD Pond 1 Dike A has a processed sand blanket and chimney drain on the downstream side of the core. There is no collection sump for seepage through the blanket drain. No seepage was observed at the downstream toe of the embankment.

Design drawings for FGD Pond 1 Dike B show that a pit-run gravel and sand toe drain was part of the design but was not part of the contract associated with the 1979 as-built drawings and was apparently not constructed.

6.3 FGD Pond 2

FGD Pond 2 is formed by a dam along the east and north, small saddle dikes on its northern and southern boundaries. A cement–bentonite cutoff wall is provided to reduce foundation seepage along the dam centerline and extends 15 to 20 feet below the key trench. Field observations of FGD Pond 2 included the dam crest, upstream face, and downstream face.

6.3.1 Dam Crest

The dam crest was generally level and in good condition with exception of a rutted area along the crest between FGD Pond 1 and Pond 2 that is attributed to vehicle activity on a wet area caused by snow melt. We saw no obvious signs of settlement or displacement. See photos 9, 12, 22, 30, and 36.

6.3.2 Upstream Slope

There was no visual evidence of slumps or bulges on the slope that would be indicative of stability issues. There are several of areas that are experiencing erosion. Near Station 46+00 in the groin, there are erosion rills that run from the crest to the water surface. Near Stations 73+00 and 84+00 where a pipe penetrates the dam near the crest there is erosion from mid-slope to the water surface. The pipes exit the upstream slope below the crest and they lay directly on the embankment. The pipes frequently freeze causing plant operations staff to cut openings into the pipes, see photos 15 to 20. These intentional openings allow fluid to spill out of the pipes and erode the embankment. Near Station 3+00 the ground shows significant erosion in a ramp constructed on natural ground, see photos 33 and 34. The erosion issues present on the upstream slope are repairable and at this time to not pose a dam safety issue.

There is localized wave cutting present on the eastern embankment (Stations 10+00 to Station 40+00). The upstream face of the dam does not have slope protection, see photo 35. This wave cutting could be alleviated with the addition of riprap armament, however, the anticipated loss due to wave erosion was considered in the design of the raise as negligible because it would be replaced by settled FGD solids. This assumption was justified in the design by citing the less than 2-foot height of free liquid and the annual infilling of about a foot of solids. The pond solids that infill the area would not be expected to have the same strength properties as the original compacted embankment. The report recommends addressing isolated areas of erosion by discharging effluent at multiple/varying points to allow for immediate infilling of the affected areas. Currently, PacifiCorp did not indicated that they plan on discharging at multiple points.

Except for localized slope erosion and the wave erosion, the upstream slope was observed to be in good condition.

6.3.3 Downstream Slope and Toe

The downstream slope of the dam does not have additional erosion protection. It is currently grass covered. Near Station 59+00 a 24-inch-diameter CMP culvert was observed at the downstream toe that penetrates beneath the toe of the downstream slope, see photo 40. From the subsequent review of design documents, it appears that this culvert was associated with former saddle Dike III. Based on the drawings, the culvert extends from the downstream toe of Dike III a distance of approximately 225 feet to the north. The culvert should be removed or properly abandoned by grouting full and the affected embankment repaired as necessary. Prior to removing/abandoning the culvert the length and condition of the culvert should be confirmed.

The downstream slope and toe was observed to be in generally good condition.

6.3.4 Emergency Spillway

There is no emergency spillway for FGD Pond 2.

6.3.5 Outlet Works

There is no outlet works for FGD Pond 2.

6.3.6 Internal Drains or Toe Drains

Seepage was being collected and pumped back into Pond 2 from the toe drain located between Station 80+00 and 91+75.

6.4 Field Assessment Observations

6.4.1 Settlement

No evidence of significant settlement of FGD Pond 1 and FGD Pond 2 embankments was observed.

6.4.2 Movement

No evidence was observed to indicate differential movement of the FGD Pond 1 and FGD Pond 2 dams or the FGD Pond 1 concrete decant inlet structure.

6.4.3 Erosion

Erosion observed on FGD Pond 2 is generally minor, its source is apparent, and easily could be repaired. The more significant erosion feature discussed above should be repaired and the cause of the erosion addressed to prevent.

6.4.4 Seepage

No evidence of significant seepage through FGD Pond 1 or FGD Pond 2 dam embankments. Seepage through both embankments has been mitigated with pump back systems. At FGD Pond 1 a collector trench and sump had been used in the past. Seepage at FGD Pond 1 is expected to continue to decline as the pond is dewatered and the sump pump is not in service any longer. Seepage and/or groundwater, was observed in the sump as it is continuing to flow and be collected by the trench drain. At FGD Pond 2, well points collect seepage and then the effluent is pumped back into FGD Pond 2.

6.4.5 Cracking

No cracks were observed in the upstream or downstream slopes or the crests of the dams.

6.4.6 Deterioration

No significant deterioration of FGD Pond 1 and FGD Pond 2 dams and structures was observed.

6.4.7 Geologic Conditions

The geology of FGD Pond 1 and FGD Pond 2 project features is consistent with descriptions in the available reports. There have been no studies or events (landslide, earthquake, etc.) that would result in changes to the description of local geologic conditions.

6.4.8 Foundation Deterioration

No signs of foundation deterioration were observed for the FGD Pond 1 and FGD Pond 2 dams.

6.4.9 Condition of Spillway and Outlet Works

There is no spillway at FGD Pond 1 or FGD Pond 2. FGD Pond 1 outlet structure was observed to be in acceptable condition. The decant structure trashrack should be cleaned of debris and safety railings should be replaced, see photo 25. There is no outlet at FGD Pond 2 and water is only removed by evaporation.

6.4.10 Reservoir Rim Stability

No reservoir rim stability issues were observed.

6.4.11 Uplift Pressures on Structures, Foundations, and Abutments

There are no significant structures associated with the two impoundments. No evidence of uplift pressure issues was observed.

6.4.12 Other Significant Conditions

No other conditions were observed that would affect the safety of the project structures.

7.0 Structural Stability

7.1 Visual Observations

The inspection team saw no visible signs of instability associated with the FGD Pond 1 and FGD Pond 2 dams during the June 9, 2009, site assessment.

7.2 Field Investigations

A Geotechnical Analysis Report for the FGD Pond 2 expansion was prepared by Maxim Technologies Inc. in 2001. Subsurface investigations performed at the site consisted of:

- In 2001, Maxim drilled 24 soil borings to depths ranging from approximately 20 to 66 feet below grade. Standard Penetration Tests (SPT) data was recorded in the field. Laboratory tests consisted of gradation, Atterberg Limits, moisture content, dry density, direct shear, swell/consolidation, moisture-density relationship, specific gravity, and resistivity and pH. Temporary casings were installed in select borings to allow ground water level monitoring. Field permeability tests were performed in the bedrock.
- The 2001 Maxim report references previous laboratory testing completed by Bechtel in 1973. This design document was not reviewed.

The stability analyses performed for the FGD Pond 1 construction and raise were not received for this review. While FGD Pond 1 Dike A and B have shown no signs of stability issues over the years, an analysis of FGD Pond 1 Dikes A and B would be advisable to address the loading conditions for the planned closure.

FGD Pond 1 Dike B poses little risk to property or life as a failure would release materials into FGD Pond 2, which contains similar materials. As FGD Pond 2 fills with solids, it will act as a toe berm to increase the stability of Dike B.

The design report for FGD Pond 1 Dikes A and B was not provided for this assessment. As-built drawings for Dikes A and B were provided but did not provide any documentation of the stability analyses completed for design.

7.3 Discussion of Stability Analysis

7.3.1 FGD Pond 1

No stability analyses were provided to GEI from the design of FGD Pond 1. GEI completed a representative static-steady seepage analysis for the maximum section of Dike A using material properties developed for the FGD Pond 2 analyses.

7.3.2 FGD Pond 2

The 2001 study was completed to evaluate the stability of the proposed FGD Pond 2 embankment expansion by evaluating five cross section locations. Using STABL version 6, developed by Purdue University, stability under steady seepage conditions and end of construction conditions were evaluated using the Modified Bishop Method. For the seismic case, an equivalent acceleration of 0.1g was applied as a pseudostatic coefficient to the embankment. It was noted that a ground acceleration of 0.05g is appropriate for the region.

The material properties used in the stability modeling were based on laboratory testing of site-specific materials and engineering judgment. The modeled sections were based on the design geometry. The five sections evaluate stability at the most critical sections of the embankment. Areas where pond solids or other weak foundation conditions were stabilized by a layer of granular fill and geotextiles were not included in the stability models, which implies the design considered the strength of the stabilized material to be equal to or higher than the surrounding dam and foundation materials. Similarly, the stability analyses did not include the cutoff wall, which implies the design considered the strength of the cement-bentonite cutoff wall to be equal to or higher than the strength of the surrounding foundation materials.

Old dike materials that underlie some parts of the embankment were not modeled in the pertinent stability cross-sections. The old dike materials were primarily removed where key trench was excavated and remain in some locations beneath the dam shells. The original dikes and the new dam embankment were constructed of onsite borrow materials and this similarity in materials may explain why different embankment material properties were not assigned.

The phreatic surface used in the models was based on seepage output from the SEEP2D software developed by the United States Army Engineer Waterways Experiment Station. Input and output data was visualized using GMS, a graphical user interface program developed by Brigham Young University. Hydraulic conductivity values were based on field tests, laboratory tests, and engineering judgment. Seepage analyses were completed for a full reservoir of water El. 6699, which neglects the benefits of a longer seepage path as the impoundment fills with solids.

7.4 Factors of Safety

7.4.1 FGD Pond 1

No stability analyses were provided to GEI from the design of FGD Pond 1. GEI completed a representative static-steady seepage analysis for the maximum section of Dike A and using material properties developed for the FGD Pond 2 analyses. The phreatic surface was estimated based on engineering judgment. Upstream slope protection material was ignored and the core was modeled as a single material type. The resulting factor of safety exceeds the minimum FERC requirement of 1.5. GEI performed a sensitivity analysis of modeling the impoundment at the high water elevation of 6694 and at the crest elevation of 6702.5. Factors of safety exceeded the minimum FERC requirements in all cases modeled (see Appendix E.1).

7.4.2 FGD Pond 2

We reviewed the computed factors of safety for the embankment design contained in the 2001 report. The report indicates the factors of safety for static steady-seepage, earthquake (pseudostatic), and end of construction loading conditions meet or exceed the required minimum factors of safety as defined by the FERC and the SEO Dam Safety Bureau. The criteria are minimum factors of safety of 1.5 for steady-state seepage, 1.0 for pseudostatic seismic stability, and 1.1 for end of construction.

However, GEI was unable to reproduce the factors of safety reported in the 2001 Design Report (see Appendix E.2). The check analyses by GEI yielded factors of safety lower than those reported in the 2001 Design Report. The *steady seepage with a cutoff wall* analysis at Section 8+00 resulted in a factor of safety of 1.33, which is lower than the 1.5 factor of safety reported in 2001 for this section and lower than the minimum required FERC factor of safety of 1.5.

GEI completed a sensitivity analysis in an attempt to replicate the Design Reports stability results. The resulting factors of safety were still lower than presented in the Design Report. The *steady seepage with a cutoff wall* analysis at Section 8+00 was found to meet FERC guidelines if the reservoir head was assumed to be completely dissipated by the core, which would be a very un-conservative assumption.

GEI's review analyses were completed with GeoStudio 2007 v. 7.14 stability module SLOPE/W, by GEO-SLOPE International, Ltd. As indicated in Table 7.1, the minimum calculated factor of safety of the review static – steady seepage analyses is less than required.

Table 7.1: Stability Factors of Safety for FGD Pond 2 and Guidance Values

Loading Condition	Min. Calculated FOS (2001 Report)	Min. Calculated FOS (GEI Review)	Min. Required FOS
Full Reservoir – Static-Steady Seepage	1.5	1.33 (at Station 8+00)	1.5
Full Reservoir – SS with pseudostatic earthquake (0.1g)	1.1	1.18	1.0
End Of Construction	1.4	1.23	1.1

7.5 Seismic Stability - Liquefaction Potential

The liquefaction potential was not analyzed for the expansion of FGD Pond 2. Liquefiable soils were not encountered during the soil investigation performed for FGD Pond 2 and are also not expected to be present in FGD Pond 1.

7.6 Summary of Results

7.6.1 FGD Pond 2

The stability analyses that have been performed for FGD Pond 2 appear to include the most critical sections of the embankment.

The structural stability of four of the five embankment sections evaluated for FGD Pond 2 meets or exceeds the minimum required factors of safety in accordance with FERC guidelines. Check analyses completed by GEI show the factor of safety for steady seepage conditions is 1.33 at FGD Pond 2 Station 8+00, which is below the FERC minimum required criteria of 1.5. A factor of safety of 1.33 is substantially below the required factor of safety, however it does not indicate impending instability. All of the check analyses performed by GEI resulted in lower calculated factors of safety than reported in the 2001 Design Report. It is concerning that the design stability analyses are not reproducible.

The 2001 design stability analyses are not fully representative of the as-constructed conditions. The cement-bentonite slurry wall is not included in the stability cross-sections, however the strength of the cement-bentonite wall is expected to be equal or higher than the surrounding materials. At several locations, the FGD Pond 2 dam embankment is constructed on top of old dike materials or pond solids. The strength properties of these underlying materials is not discussed or accounted for in the 2001 design report, except that these materials may have been considered to have equivalent properties to the engineered fill of the new embankment and did not need to be distinguished in the analysis, which may not be a conservative approach.

A filter compatibility evaluation was not included in the design report for the granular stabilization material beneath the upstream and downstream shells of the dam. The filter compatibility for the toe drain should also be reviewed.

8.0 Spillway Adequacy

8.1 Floods of Record

Floods of record have not been evaluated for the ponds at the Jim Bridger facility.

8.2 Inflow Design Floods

Inflow design flood information was included in the FGD Pond 2 Design Report and consisted of back-to-back 100 year events over the basin plus a 100-year event occurring on the pond area. This inflow design flood was approved by the Wyoming SEO and resulted in a 1 foot flood surcharge on the pond area. The inflow design flood for a Significant Hazard Dam would generally be one-half the Probable Maximum Flood (PMF) based on FERC guidelines and federal dam practice.

8.2.1 Determination of the PMF

The PMF was not evaluated in the design of FGD Ponds 1 and 2. For the purpose of this review, a preliminary estimate of the Probable Maximum Precipitation (PMP) hydrology of the basin is discussed below.

A 24-hour, 10 square mile PMP is estimated to be 18 inches and the ½ PMP would be 9 inches or 0.75 feet.

FGD Pond 1 would receive 9 inches falling directly on its surface plus water from an estimated additional 123 acres of contributing basin area. FGD Pond 1 has an upstream diversion ditch that is sized for the 100 year, but is considered to convey ¼ of the 100 year before the ditch fails for this analysis. The resulting inflow to the pond is 0.35 feet of surcharge in the pond. The total for the Probable Maximum Flood (PMF) is 1.1 feet of surcharge on the pond. FGD Pond 1 has no freeboard as it is full of ash. Based on the interim cover grading plan this flood would run-off over Dike B into FGD Pond 2.

Similarly, FGD Pond 2 would receive 9 inches falling directly on its surface plus runoff from an estimated 1,148 acres of total contributing basin area, which includes the pond area. FGD Pond 2 has an upstream diversion ditch that is sized for the 100 year, but is considered to convey ¼ of the 100 year before the ditch fails for this analysis. Adjusting the volume by deducting the flood captured by the diversion ditch before the ditch fails results in an inflow flood of an estimated 798 acre-feet into a 392 acre pond, which results in a 2 foot surcharge on the pond.

Additionally, there is a potential to add 0.25 feet for runoff from FGD Pond 1, as discussed above, for a total of 2.25 foot surcharge on FGD Pond 2. FGD Pond 2 was designed for 3 feet of freeboard and can store the ½ PMF.

8.2.2 Freeboard Adequacy

The freeboard at FGD Pond 1 is not adequate because the freeboard has been eliminated by filling the pond to the dam crest with solids. Large, rare, storm inflow floods to FGD Pond 1 are expected to runoff over Dike B and into FGD Pond 2 with a potential to damage Dike B.

The available freeboard at FGD Pond 2 is adequate based on the design inflow flood and for the ½ PMF.

8.2.3 Dam Break Analysis

Dam break analyses have not been performed for the Pond embankments. FGD Ponds 1 and 2 are currently classified as Significant Hazard and we concur with this rating as a minimum. However, visual inspection of the drainage way indicates the potential for a breach flood to overtop Interstate 80. At the location where the main drainage meets I-80, the drainage is restricted, I-80 and the railroad embankment terminate the drainage with a potentially small storage capacity, and the available culverts appear undersized for the anticipated flow. If I-80 is overtopped there would be a high potential for loss of life. We recommend a dam break analyses and inundation mapping for these ponds be performed.

8.3 Spillway Rating Curves

There are no spillways associated with either FGD Pond 1 or FGD Pond 2.

9.0 Adequacy of Maintenance and Methods of Operation

9.1 Procedures

Currently there is no formal Operation & Maintenance Manual in use at the Jim Bridger Plant. Engineering staff is currently considering formalizing the standard operational procedures to inspect, maintain, report, and operate the system. Several of the plant engineers and operating personnel have been with the facility for many years. The power plant is manned 24 hours a day, seven days a week. There is a daily equipment check performed by plant personnel.

9.2 Maintenance of Impoundments

Maintenance of the two impoundments is performed by Jim Bridger Plant staff under the guidance of PacifiCorp managers and engineers.

9.3 Surveillance

The impoundments are patrolled by plant personnel. Plant personnel are available at the power plant and on 24-hour call for any emergencies that may arise. There are no automatic alarm systems at the impoundments.

10.0 Emergency Action Plan

An Emergency Action Plan (EAP) and inundation mapping has not been developed for the Significant Hazard dams at this site and is not required as part of the dam safety program in Wyoming.

11.0 Conclusions

11.1 Assessment of Dams

11.1.1 Field Assessment

The FGD Pond 1 and FGD Pond 2 embankments were generally found to be in satisfactory condition.

11.1.2 Stability Analysis (Adequacy of Factors of Safety)

The check stability analyses completed by GEI for FGD Pond 2 embankment expansion meet the minimum required factors of safety criteria according to SEO and the FERC guidance, except the steady seepage analysis at Station 8+00 yields a factor of safety of 1.33, which is lower than required. These analyses generally include use of appropriate material properties and loading conditions, however, potential weaker materials underlying parts of the dam shells were not explicitly addressed in the models. While the review analysis factor of safety for FGD Pond 2 Station 8+00 is substantially below the required minimum, it does not indicate impending instability of the dam.

All check analyses performed by GEI resulted in lower factors of safety than the 2001 design analyses. While some variance in stability model results can be expected, the difference between the results or our check analyses and those reported in the 2001 design is significant. The factors of safety reported in the design report are not reproducible based on the information provided in Appendix D of the 2001 Design Report.

11.1.3 Embankment Settlement at Station 54+00

The revised design report discusses a concern for soils that exhibit collapse potential in the foundation near Station 54+00. It was advised in the revised design appendix that this area should be observed at least once every three months for the first year and once every year thereafter for cracking and/or settlement. While no obvious signs of settlement or cracking were observed in this area during our site visit, the monitoring advised by the design report is sound and should a documented part of operations. Particular attention to monitoring this area should be made as the embankment and foundation become saturated.

11.1.4 Spillway Adequacy and Outlet Works

Neither FGD Pond 1 nor FGD Pond 2 has emergency spillways. FGD Pond 1 is full of solids and has no freeboard. Therefore, large floods would be assumed to runoff and given the current grading plan this runoff would primarily be into FGD Pond 2. Runoff from Pond 1 will need to be managed to avoid erosion damage to the main dam or, more likely, to Dike B.

FGD Pond 2 was designed to have 3 feet of operating freeboard, which is sufficient to store the ½ PMF for Pond 2 as well as runoff for the ½ PMF from Pond 1. The available storage in FGD Pond 2 exceeds the requirement to safely store the ½ PMF in accordance with general federal engineering practice for Significant Hazard dams. A preliminary estimate of the PMP was made for purposes of this report.

FGD Pond 1 decant outlet structure functions adequately as the inlet for FGD Pond 2. The inlet receives pumped effluent from the plant and the water from FGD Pond 1 dewatering well points.

11.2 Adequacy of Maintenance and Surveillance

FGD Pond 1 and Pond 2 have acceptable maintenance and surveillance programs, except for instrumentation and vegetation. Instrumentation is lacking for both Pond 1 and Pond 2. The excessive vegetation on Pond 1 main dam should be controlled. Evaluate the CMP identified at the downstream toe of FGD Pond 2 near Station 59+00, and, if it serves no useful purpose or penetrates beneath the dam, either abandon by grouting full or remove the CMP. A formalized inspection process would be appropriate for Significant Hazard class impoundments.

12.0 Recommendations

12.1 Corrective Measures for the Structures

12.1.1 FGD Pond 1

1. Provide erosion protection for Dike B against runoff from large, rare flood events during the interim period until the final cover is installed and closure is completed. Evaluate if erosion protection is also needed for the main dam.

12.1.2 FGD Pond 2

1. The calculated factor of safety at Station 8+00 of 1.33 for static steady-seepage is below the state and federal guidance of 1.5. Re-evaluate this loading condition at Station 8+00 and, if the issue cannot be resolved by analysis, implement measures to improve the stability to achieve a factor of safety of 1.5. Also, the 2001 stability results could not be reproduced in check analyses. Revisit and revise the 2001 stability analysis as necessary to provide proper documentation of the design.

2. Protect embankment crest from developing soft spots that result in vehicle ruts by restricting vehicle traffic or upgrading the crest surface in problem areas.

3. Settlement monitoring near Station 54+00 should be a documented part of operations. This monitoring should include documentation of embankment conditions at, and around, Station 54+00, and a surveyed crest settlement monument.

4. Abandon the CMP at Station 59+00 in-place by grouting full or remove the CMP if it is found to serve no useful purpose or if it penetrates beneath the dam.

12.1.3 FGD Pond 1 Outlet Structure – FGD Pond 2 Inlet Structure

1. Repair structures designed safety precautions, stabilize surrounding soils, and clear foreign debris from the structure.

12.2 Corrective Measures Required for Maintenance and Surveillance Procedures

1. Address the excessive sage brush vegetation on FGD Pond 1 main dam.

2. Monitor and repair the minor surface erosion and wave erosion.

3. Implement an instrumentation and monitoring program for the dams.

4. Document inspections using a checklist for consistency.

12.3 Corrective Measures Required for the Methods of Operation of the Project Works

None.

12.4 Any New or Additional Monitoring Instruments, Periodic Observations, or Other Methods of Monitoring Project Works or Conditions That May Be Required

1. Install instrumentation to monitor the performance of the dams and dikes and implement a program of regular readings and engineering evaluation of the data.

2. Continue monitoring seepage at the downstream toe of FGD Pond 2 northern embankment for any changes in seepage quantity and flow rate or evidence that the flow is carrying soil/ash particles from the embankment.

12.5 Acknowledgement of Assessment

I acknowledge that the management unit(s) referenced herein was personally inspected by me and was found to be in the following condition**:**

SATISFACTORY

FAIR

POOR

UNSATISFACTORY

DEFINITIONS FOR ASSESSMENT

SATISFACTORY
No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria. Minor maintenance items may be required.

FAIR
Acceptable performance is expected under all required loading conditions (static, hydrologic, seismic) in accordance with the applicable safety regulatory criteria. Minor deficiencies may exist that require remedial action and/or secondary studies or investigations

POOR
A management unit safety deficiency is recognized for any required loading condition (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Remedial action is necessary. POOR also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.

UNSATISFACTORY
Considered unsafe. A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution. Reservoir restrictions may be necessary.

I acknowledge that the management unit referenced herein:

Has been assessed on June 9 and 10, 2009 (date)

Signature: ______________________________

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13.0 References

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Figures

Appendix A

Instrumentation Data – (No instrumentation data available)

Appendix B

Inspection Checklist

June 9, 2009

Appendix C

Inspection Photographs

June 9, 2009

Appendix D

Reply to Request for Information Under Section 104(e)

Appendix E

Stability Check Analyses

E.1 FGD Pool 1

E.2 FGD Pool 2