Initial Safety Factor Assessment
Lawrence Energy Center
Inactive Units - Ash Pond Area 2, Ash Pond Area 3, and Ash Pond 4

Prepared for:

Westar Energy

Lawrence Energy Center

Lawrence, Kansas

Prepared by:

APTIM Environmental & Infrastructure, Inc.

April 2018

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Plan Review/Amendment Log §257.73(e)

Date of Review	Reviewer Name	Sections Amended and Reason	Version

CCR Regulatory Requirements

USEPA CCR Rule Criteria 40 CFR 257.73	Jeffrey Energy Center (JEC) Safety Factor Assessments
§257.73(e)(1)(i-iv) stipulates: *(e) Periodic safety factor assessments. (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations:* *(i) The calculated static factor of safety under long-term, maximum storage pool loading condition must equal or exceed 1.50;* *(ii) The calculated safety factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40;* *(iii)The calculated seismic factor of safety must equal or exceed 1.00;* *(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20;*	Section 4.0

USEPA CCR Rule Criteria 40 CFR 257.73	Jeffrey Energy Center (JEC) Safety Factor Assessments
§257.73(e)(2) stipulates: *(2) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment specified in paragraph (e)(1) of this section meets the requirements of this section.*	Section 5.0
§257.73(f)(1) stipulates: *(f) Timeframes for periodic assessments –* *(1) Initial Assessments. Except as provided by paragraph (f)(2) of this section, the owner or operator of the CCR unit must complete the initial assessments required by paragraphs (a)(2), (d), and (e) of this section no later than October 17, 2016. The owner or operator has completed an initial assessment when the owner or operator has placed the assessment required by paragraphs (a)(2), (d), and (e) of this section in the facility's operating record as required by §257.105(f)(5), (10), (12).*	Not applicable. See §257.100
§257.73(f)(2) stipulates: *(2) Use of a previously completed assessment(s) in lieu of the initial assessment(s). The owner or operator of the CCR unit may elect to use a previously completed assessment ot serve as the initial assessment required by paragraphs (a)(2), (d), and (e) of this section provided that the previously completed assessments(s):* *(i) Was completed no earlier than 42 months prior to October 17, 2016; and* *(ii) Meets the applicable requirements of paragraphs (a)(2), (d) and (e) of this section.*	Not Applicable for this Report.

USEPA CCR Rule Criteria 40 CFR 257.73	Jeffrey Energy Center (JEC) Safety Factor Assessments
§257.73(f)(3) stipulates: *(3) Frequency for conducting periodic assessments. The owner or operator of the CCR unit must conduct and complete the assessments required by paragraphs (a)(2), (d), (e) of this section every five years. The date of completing the initial assessment is the basis for establishing the deadline to complete the first subsequent assessment. If the owner or operator elects to use a previously completed assessment(s) in lieu of the initial assessment as provided by paragraph (f)(2) of this section, the date of the report for the previously completed assessment is the basis for establishing the deadline to complete the first subsequent assessment. The owner or operator may complete any required assessment prior to the deadline provided the owner or operator places the completed assessment(s) into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent assessments is based on the date of completing the previous assessment. For purposes of this paragraph (f)(3), the owner or operator has completed an assessment when the relevant assessment(s) required by paragraphs (a)(2), (d), and (e) of this section has been placed in the facility's operating record as required by §257.105(f)(5), (10), and (12).*	An assessment will be completed every five years and placed into the operating record.
§257.73 (g) stipulates: *(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(f), the notification requirements specified in §257.106(f), and the internet requirements specified in §257.107(f).*	Section 5.0

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USEPA CCR Rule Criteria 40 CFR 257.73	Jeffrey Energy Center (JEC) Safety Factor Assessments
§257.100 stipulates (a): *(a) Inactive CCR surface impoundments are subject to all of the requirements of this subpart applicable to existing CCR surface impoundments.*	Section 5.0
§257.100 stipulates (e)(1): *(e) Timeframes for certain inactive CCR surface impoundments. (1) An inactive CCR surface impoundment for which the owner or operator has completed the actions by the deadlines specified in paragraphs (e)(1)(i) through (iii) of this section is eligible for the alternative timeframes specified in paragraphs (e)(2) through (6) of this section. The owner or operator of the CCR unit must comply with the applicable recordkeeping, notification, and internet requirements associated with these provisions. For the inactive CCR surface impoundment:* *(i) The owner or operator must have prepared and placed in the facility's operating record by December 17, 2015, a notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to §257.105(i)(1);* *(ii) The owner or operator must have provided notification to the State Director and/or appropriate Tribal authority by January 19, 2016, of the intent to initiate closure of the inactive CCR surface impoundment pursuant to §257.106(i)(1); and* *(iii) The owner or operator must have placed on its CCR Web site by January 19, 2016, the notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to §257.107(i)(1).*	Section 5.0

USEPA CCR Rule Criteria 40 CFR 257.73	Jeffrey Energy Center (JEC) Safety Factor Assessments
§257.100(e)(3) stipulates: (e)(3) Design criteria. The owner or operator of the inactive CCR surface impoundment must: (v) No later than April 17, 2018, complete the initial hazard potential classification, structural stability, and safety factor assessments as set forth by §257.73(a)(2), (b), (d), (e), and (f).	Report completed by April 17, 2018.

1.0 INTRODUCTION

APTIM Environmental and Infrastructure, Inc. (APTIM, f/k/a CB&I Environmental & Infrastructure Inc., CB&I) has prepared this Safety Factor Assessment (Assessment) at the request of Westar Energy (Westar) for the inactive Ash Pond Area 2 (Area 2 Ponds), Ash Pond Area 3 (Area 3 Ponds), and the Scrubber Supply Pond (Area 4 Pond) located at Lawrence Energy Center (LEC) in Lawrence, Kansas.

The Area 2, 3, and 4 Ponds have been deemed to be regulated, inactive CCR units by the United States Environmental Protection Agency (USEPA), through the Disposal of Coal Combustion Residuals from Electric Utilities Final Rule (CCR Rule) 40 CFR §257 and §261. On July 26, 2016 the USEPA extended the CCR Rule requirements for certain inactive CCR surface impoundments. Westar is currently in the process of conducting closure by removal of CCR (per §257.100(b)) within the inactive Area 2, 3, and 4 Ponds to prepare for construction of a Kansas National Pollutant Discharge Elimination System (NPDES) regulated pond system. All facility water containing CCR material is managed in settling tanks. CCR material from the Area 2, 3, and 4 Ponds is being disposed of in Industrial Landfill No. 847. Westar intends to complete closure of the Area 2, 3, and 4 Ponds in 2018.

In support of compliance with the CCR Rule, APTIM has conducted an Assessment of the Pond and reviewed the relevant portions of the facility’s operating record, permit application, and previous stability analyses and inspections. This Assessment meets the requirements set forth within 40 CFR §257.73(e) and §257.100(a) and (e) based on the review of available information and visual observation.

2.0 AREA 2, AREA 3, AND AREA 4 PONDS OVERVIEW

Westar owns and operates a series of clarifying ponds for process water at LEC in Douglas County, Kansas. LEC is located approximately 3 miles northwest of Lawrence, Kansas, is bounded by the Kansas River and resides in Sections 13 and 14, Township 12 South, Range 19 East. The locations of the Area 2, Area 3, and Area 4 Ponds are depicted in **Figure 1.**

The ponds are separated into three "areas", termed Areas 2, 3, and 4, as noted below:

- **Area 2 Ponds**
  - Pond 501 (CCR removed and operating)
  - Pond 502 (CCR removed and operating)
  - Pond 503 (CCR removed and operating)
  - Clear Pond (a.k.a. West Pond, in the process of being dewatered and CCR removed and operating)
  - Laydown Area (in the process of being dewatered, CCR removed, and incorporated into the Storm Water Settling Pond)
  - Storm Water Settling Pond (in the process of being dewatered and CCR removed

- **Area 3 Ponds**
  - Pond 401 (CCR removed and operating)
  - Pond 402 (CCR removed and incorporated into Pond 404)
  - Pond 403 (CCR removed and incorporated into Pond 404)
  - Pond 404 (CCR removed and operating)

- **Area 4 Pond** – Scrubber Supply Pond (certified CCR removed in May 2017 and removed from service)

The Area 2, 3, and 4 Ponds are regulated impoundments under the CCR Rule and stopped receiving CCR prior to October 2015. Historically the Area 2, 3, and 4 Ponds received CCR material from the plant. The CCR material was deposited in the Area 2, 3, and 4 Ponds while overflow water was discharged to the Kansas River via Outfall 001BV, in line with Kansas NPDES Permit No. I-KS-31-PO09. As each pond was progressively filled, the ponds were dewatered and the CCR material was excavated and placed in Industrial Landfill No. 847. CCR material was distributed to different ponds within each area depending on the availability of capacity.

A perimeter impoundment dike was constructed to surround the LEC ponds and ties into the natural grades near the southern portion of the Area 2 Pond and the eastern portion of the Area 4 Pond. The crest of the perimeter dike is at approximately 839 feet Mean Sea Level (ft MSL) with side slopes at 3H:1V, providing a maximum height of 15 feet located in the northwest section. The crest width is approximately 30 feet. The perimeter dike was originally constructed of silty clay, which was obtained by excavation of existing grades in the area.

Currently a reconfiguration of the Area 2, 3, and 4 Ponds is being undertaken. With the Area 4 Pond closed, plant process water flows from the Area 2 Ponds (with the exception of Ponds 502 and 503) to the Area 3 Ponds prior to discharge to the Kansas River through Outfall 001BV. Site topography prior to closure of the Area 2, 3, and 4 Ponds is depicted in **Figure 2**.

2.1 Existing Conditions and Operations

The original design of the LEC ponds included four areas through which stormwater and contact water moved before being discharged to the Kansas River. Following the adoption and establishment of the CCR Rule, the LEC ponds have been renamed and reconfigured. Currently, closure by removal of CCR is ongoing at the LEC ponds and is anticipated to be completed in 2018, in accordance with §257.102(c). Most of the configurations and flow patterns of the Area 2, Area 3, and Area 4 Ponds will be maintained. The Laydown Area will be reconfigured into the northern portion of the Storm Water Settling Pond. Pond 402 and Pond 403 will be reconfigured into the eastern portion of Pond 404. Closure consists of the removal of CCR material and existing clay liner, with the installation of an 18-in. clay liner, rip-rap, and aggregate base at the top of each berm. Contact water and process water is currently managed within the LEC Pond network, allowing for proper management of water during the ongoing construction process. As each pond is progressively dewatered, CCR material will be excavated and placed in the Industrial Landfill No. 847.

Following the completion of the closure activities, stormwater will continue to be directed to the Storm Water Settling Pond where it is discharged to Baldwin Creek. Contact water and process water will be directed to Pond 501, 502, and 503. From Pond 502, contact water and process water is discharged to the West Pond (Clear Pond), then Pond 404 and 401. From Pond 401, water is discharged through conveyance pipes to the Kansas River through Outfall 001BV or recycled into the plant.

2.2 Current Dimensions and Capacities

The Area 2, 3, and 4 Ponds incorporate a total area of approximately 47.4 acres with a storage capacity of approximately 683.5 acre-ft. The maximum and minimum depths of impounded water varied depending on plant operations, stormwater conditions and the closure schedule. Historically, CCR material has been distributed to different cells within each area depending on the availability of space. This made the amount of CCR material in each pond vary from minimal to almost at capacity. Due to current closure construction operations there is no CCR material volume within the Area 4 Pond and portions of the Area 2 and 3 Ponds. All ponds are being constructed during closure to have 3H:1V sideslopes.

2.3 Instrumentation

There are no instrumentation devices associated with the hydraulic structures, impoundment embankments, perimeter dike, or slope performance has been installed at or near the Area 2, 3, and 4 Ponds.

3.0 REVIEW OF PREVIOUS INVESTIGATIONS/INSPECTIONS

The available information for the Area 2, 3, and 4 Ponds was provided to and reviewed by APTIM for this Assessment:

- ❑ Annual Inspection Report Lawrence Energy Center Inactive Units – Ash Pond Area 2, Ash Pond Area 3, Ash Pond 4, CB&I, June 2017.
- ❑ Coal Combustion Waste Impoundment Round 7 – Dike Assessment Report, Dewberry & Davis, LLC, March 2011.
- ❑ LEC Survey, Professional Engineering Consultants (PEC), June 2016.
- ❑ NPDES Permit No. I-KS-31-PO09

Based on the available information and the site visit conducted May 15, 2017 by Richard Southorn, a professional engineer with APTIM, the following Assessment has been conducted to evaluate the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices in accordance with 40 CFR §257.73(d).

3.1 Summary of Previous Stability Assessment

A stability assessment was conducted in December 2009 by Golder Associates, Inc. in response to a 2009 EPA Request for Information. The stability assessment evaluated if the perimeter dike would remain stable under maximum loading conditions. The analysis included a visual inspection and stability modeling using SLIDE, by Rocscience, Inc.

3.1.1 Visual Inspection

A site visit was conducted prior to modeling during an October 2009 site visit. Based on the recorded visual observations, it was determined there were no signs of structural deficiencies on the perimeter dike side slopes or crest. This includes signs of cracking, sloughing, and settlement, seepage of water from the downstream face, severe erosional features, and distress in and around piping. It was noted there were signs of heavy vegetation on the downstream slope but that is not unexpected given the dike is a natural slope rather than an engineered structure.

3.2.2 Geotechnical Site Assessment

Four soil borings along the perimeter dike crest were completed and used in the 2009 stability assessment by Golder Associates. The depths of borings range from 18 to 24 feet. From the borings it was determined that the perimeter dike was generally comprised of asphalt with a bottom ash road base in the top 1 to 5 feet and was underlain by firm to stiff silty clays and clays until the base of the borehole. The stratigraphy was fairly consistent from borehole to borehole. Groundwater was not observed in any boreholes.

3.1.3 Stability Assessment Model

Golder Associates analyzed two cross sections through the perimeter dike and into Pond 404, which were thought to represent the typical construction of the berm. The cross sections were based on the site topography, visual assessment, and boring data and were analyzed under the maximum anticipated loading conditions. This included assuming the CCR material in the Pond 404 was two feet below the crest of the perimeter dike and the water level was at the berm crest. The phreatic surface was assumed to be linear connection between the upstream and downstream elevations. The model was run under static and seismic conditions. A seismic acceleration of 0.05g was applied based on the USGS seismic hazard map corresponding to a two percent chance of exceedance in 50 years.

The material and strength properties used in the analysis were based on field sampling, previous experience, and lab results from the material samples obtained from the borings. Lab testing included moisture density testing, consolidated-undrained triaxial testing, and grain size analyses.

The required factors of safety were determined to be 1.5 and 1.1 for static and seismic conditions, respectively. The computed factors of safety computed static conditions ranged from 3.0 to 3.1 and the seismic conditions ranged from 2.5 to 2.7. Therefore, the calculated factors of safety were determined to meet the required factors of safety of 1.5 and 1.1. It was concluded from this assessment that the perimeter dike was capable of performing its intended function under maximum loading conditions. It was recommended that downstream slope protection be added to prevent erosion due to wave action, and that the quarterly inspections be performed.

3.3 Summary of Previous Visual Inspection Reports

In addition to the visual inspection conducted by Golder Associates in 2009 for the stability assessment, the visual inspection conducted by Dewberry & Davis LLC in 2010 and the annual inspection conducted by CB&I in 2017 were reviewed.

3.3.1 2010 Visual Inspection

Dewberry & Davis LLC conducted field observations on September 24, 2010 on behalf of the EPA to verify no visible parts of the embankments had signs of overstress, significant settlement, shear failure, or other signs of instability. There were no indications of unsafe conditions or conditions needing remedial action and the dike appeared to be structural sound. The thick vegetation at the site inhibited their observations in some areas of the perimeter dike. It was recommended that portions of large vegetative growth be removed to prevent potential seepage paths in the perimeter dike and allow for easier inspection.

3.3.2 2017 Annual Inspection

Based on a review of the 2017 Annual Inspection Report, it was determined that the Area 2, 3, and 4 Ponds were in good working order. At the time of inspection, there were no signs of distress or malfunction that would indicate actual or potential structural weakness. It was noted that woody vegetation had been removed from the perimeter impoundment dike as previously recommended, allowing for a full visual examination. No erosion or sloughing was observed along the perimeter dike. See **Appendix A** for the photo log from the May 2017 site visit.

During the inspection it was noted that Westar started the process of conducting closure by removal of CCR within the inactive Area 2, 3, and 4 Ponds to prepare for construction of an NPDES regulated pond system. The Area 4 Pond and Ponds 502 and 503 were dewatered and under construction at the time of inspection. Therefore, the hydraulic structures and stormwater conveyance systems at the Area 4 Pond and Ponds 502 and 503 were not in operation. The remaining Area 2 and 3 Ponds were in the process of being dewatered. There was no indication that closure activities at the Area 2, 3, and 4 Ponds have disrupted or have the potential to disrupt safety or operations.

Based on the on-site inspection performed on May 15, 2017, CB&I recommend the following actions:

- Continue to perform typical maintenance activities on the Area 2, 3, and 4 Ponds and perimeter dike; and
- Continue to monitor and maintain erosion controls.

4.0 INITIAL SAFETY FACTOR ASSESSMENT (§257.73(e))

An initial and periodic safety factor assessment is required to be conducted for CCR impoundments per §257.73(e)(1). This includes determining if the factor of safety for a critical cross section of the perimeter dike is greater than the required factor of safety for each of the four loading conditions shown in **Table 1** below.

Table 1
Initial Safety Factor Assessment Requirements

Analysis	Required Minimum Factor of Safety (§257.73(e))
Long-term, maximum storage pool loading	≥1.50
Maximum surcharge pool loading	≥1.40
Seismic Loading	≥1.00
Soil Liquefaction[1]	≥1.20

Notes:
(1) Soil liquefaction must be analyzed for dikes constructed of soils susceptible to liquefaction

APTIM performed a safety factor analysis to ensure the stability of the perimeter dike during current operating conditions (see **Table 1**). A critical cross section was developed and used to determine the minimum factor of safety for each scenario in SLIDE – 2D Limit Equilibrium Slope Stability Analysis (SLIDE), version 6.038, developed by Rocscience, Inc. See **Appendix B** for each model result and see Section 4.4 for the summary table.

4.1 Critical Cross-Section Location

Cross section A-A' is a schematic, critical cross-section which incorporates the section of the perimeter dike most susceptible to structural failure, as required by §257.73(e)(1). It conservatively captures the area with the highest potential for failure based on the embankment geometry, water levels, and subsurface soil conditions. The cross-section is based on the cross-sections used in the 2009 stability assessment, 2009 boring data, elevations and conditions from the 2016 survey, and the proposed reconfiguration design created by Black & Veatch. The cross-section is characterized by the following features:

- ❑ Peak perimeter dike crest of 840 ft MSL;
- ❑ Upstream side slope of 3H:1V;
- ❑ Downstream toe elevation of 815 ft MSL; and
- ❑ Upstream toe elevation of 824 ft MSL.

The phreatic surface was conservatively modeled to be a linear connection between the upstream water surface elevation and the downstream water surface elevation. See **Figure 4** for an approximate cross-section location.

4.2 Layer Properties

APTIM reviewed the material and strength properties for the perimeter dike previously used in the 2009 stability assessment. It was concluded that the values previously used were conservative and appropriately determined from field soil classification, lab data, therefore the same properties were used in this analysis for the geologic layers. The clay liner properties were estimated based on lab results for a re-compacted natural clay liner at a landfill at LEC. The property values can be seen in the summary **Table 2** below.

Table 2 **SLIDE Model Material Properties**			
Material Layer	**Unit Weight (pcf)**	**Cohesion (psf)**	**Friction Angle (degrees)**
Clay Liner	120	400	24
Clay Foundation PI=39	116	260	26
Clay Foundation PI=50	116	410	28

The clay liner was modeled with a unit weight of 120 pcf, a cohesion of 400 psf, and a friction angle of 24 degrees, as determined from laboratory data for a re-compacted natural clay liner at a LEC landfill. The perimeter dike is founded on and comprised of silty clay and clay soil. Golder Associates assigned properties to the dike and foundation materials based on plasticity index (PI). Unit weights were assigned to the clay layers based on density testing of undisturbed soil sample testing. Shear strength parameters were assigned based on the laboratory results of consolidated-undrained triaxial testing of undisturbed samples.

4.3 Model Analyses

Safety factor analyses were performed using the critical cross-section and material properties previously described in the SLIDE software for the following modeled scenarios required by §257.73(e)(1):

- ❑ Long-term Maximum Storage Loading;
- ❑ Maximum Surcharge Loading;
- ❑ Seismic Conditions; and
- ❑ Drawdown conditions.

The scenarios were run under current operating conditions to fulfill the CCR Rule Requirements, even though the Area 2, 3, and 4 Ponds are have not received CCR material since 2015 and are being repurposed.

The limit equilibrium analysis methods used in the SLIDE model analyses included the Bishop Simplified Method, the Janbu Corrected Method, the Spencer Method, and the GLE (Generalized Limit Equilibrium) / Morgenstern-Price Method. The lowest factor of safety from the four methods used is reported on the SLIDE plot for each modeled scenario (see **Appendix B**) and on the summary table in Section 4.4.4. Additional information regarding each scenario is described in the following subsections.

4.3.1 Long-Term Maximum Storage Loading

According to Section E.3.b.ii.b of the preamble in the CCR Rule, the maximum storage pool loading is “the maximum water level that can be maintained that will result in full development of a steady-state seepage condition.” The current outlet piping for Pond 404 is located at 829.5 ft MSL and leads to Pond 401. Therefore the long-term maximum storage pool loading surface elevation was modeled at this elevation. The water surface elevation for Baldwin Creek was conservatively assumed to be 822.5 ft MSL. A linear connection connecting the water surface in Pond 404 and the water surface in Baldwin Creek was used as the phreatic surface within the perimeter dike.

The minimum factor of safety determined by SLIDE for this scenario is 2.366, which is greater than the required factor of safety of 1.50 as stated in §257.73(e)(1)(i).

4.3.2 Maximum Surcharge Loading

The maximum surcharge pool loading condition is meant to ensure that the impoundment can withstand a temporary rise in the pool elevation above the maximum storage pool elevation under inflow design flood stage. Therefore this scenario was modeled with upstream water elevation approximately three feet lower than the perimeter dike crest. This was found to be appropriate considering maintaining 3 feet of freeboard is a standard in the industry.

The calculated static factor of safety is 2.208 for the perimeter dike and meets the requirement for the maximum surcharge pool condition (1.40), per §257.73(e)(1)(ii).

4.3.3 Seismic Loading

As discussed in the preamble of the CCR Rule, all CCR surface impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. Specifically, it must be assessed to withstand "a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located". Therefore the long-term maximum loading scenario was analyzed under a peak ground acceleration of 0.0462 g. The seismic acceleration is based on the USGS seismic hazard map for a 2 percent probability of exceedance in 50 years (see **Figure 5**).

The calculated static factor of safety is 2.065 for the perimeter dike and meets the requirement for the seismic loading (1.0), per §257.73(e)(1)(iii).

4.3.4 Soil Liquefaction

Based on 40 CFR §257.73(e)(1)(iv), a soil liquefaction analysis must be conducted for dikes constructed of soils that have a susceptibility to liquefaction. Liquefaction of soils typically occurs in loose, saturated, sandy soils that undergo a loss of strength during a seismic event. The perimeter dike and foundation are constructed of clay soils. Clayey soils are not typically susceptible to liquefaction and therefore a liquefaction analysis was not conducted. Additionally, no groundwater was observed in any of the boreholes from the perimeter dike.

4.3.5 Drawdown Conditions

40 CFR §257.73 does not require that drawdown conditions are modeled. However for CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, it is required that the slopes that will maintain structural integrity in events of drawdown of the adjacent water body. Therefore, a drawdown scenario was created where the stabilizing force of the water from Baldwin Creek is removed and Pond 404 is operating at the estimated maximum water level (829.5 ft MSL). The calculated static factor of safety is 2.115 for the perimeter dike, which is determined to be acceptable by industry standards.

4.4 Summary of Findings

Table 3 below summarizes the initial safety factor assessment results for the perimeter dike and Area 2, 3, and 4 Ponds. It confirms that the calculated factors of safety meet or exceed the required factors of safety by 40 CFR §257.73(e). All four cases were calculated for both circular and block slip surfaces.

The Area 2 and 3 Ponds are currently in the process of being dewatered and closed. The Area 2, 3, and 4 Ponds are not required by the CCR Rule to be assessed during closure conditions.

Table 3
Initial Safety Factor Assessment Results

Analysis	Calculated Minimum Factor of Safety		Required Minimum Factor of Safety (§257.73(e))
	Circular	Block	
Long-term, maximum storage pool loading	2.366	2.411	≥1.50
Maximum surcharge pool loading	2.208	2.242	≥1.40
Seismic Loading	2.115	2.065	≥1.00
Soil Liquefaction	N/A[1]	N/A[1]	≥1.20
Drawdown Conditions	2.115	2.128	N/A[2]

Notes:
(1) Perimeter dike is not constructed of soils that are susceptible to liquefaction (i.e. typically saturated granular soils).
(2) Analysis not required and therefore there is no minimum factor of safety that needs to be met, however it has been assumed that a factor of safety of 1.3 should be met based on industry standards.

5.0 RECORDS RETENTION AND MAINTENANCE (§257.100(g))

5.1 Incorporation of Assessment into Operating Record

§257.105(g) of 40 CFR Part 257 provides record keeping requirements to ensure that the Assessment must be placed in the facility's operating record. Specifically, §257.105(f) stipulates:

> §257.105(f) stipulates*: "(f) Design Criteria. The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record: (5)The initial and periodic hazard potential classification assessments as required by §§257.73(a)(2) and 257.74(a)(2)."*

This Assessment will be placed within the Facility Operating Record upon Westar's review and approval.

5.2 Notification Requirements

§257.106(f) of 40 CFR Part 257 provides guidelines for the notification of the availability of the initial and periodic Assessment. Specifically, §257.106(f) stipulates:

> §257.106(f) stipulates: "*(f) Design criteria. The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must: (4) Provide notification of the availability of the initial and periodic hazard potential classification assessments specified under §257.05(f)(5)"*

The State Director and appropriate Tribal Authority will be notified upon placement of this Assessment in the Facility Operating Record.

§257.107(f) of 40 CFR Part 257 provides publicly accessible Internet site requirements to ensure that the Assessment is accessible through the Westar webpage. Specifically, §257.107(f) stipulates:

> §257.107(f) stipulates: *"(f) Design criteria. The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site: (4) The initial and periodic hazard potential classification assessments specified under §257.105(f)(5)."*

This Assessment will be uploaded to Westar's CCR compliance reporting website upon Westar's review and approval.

6.0 PROFESSIONAL ENGINEER CERTIFICATION (§257.73(e)(2))

The undersigned registered professional engineer is familiar with the requirements of the CCR Rule and has visited and examined LEC or has supervised examination of LEC by appropriately qualified personnel. The undersigned registered professional engineer attests that this Assessment has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and meets the requirements of §257.73 and §257.100. This certification was prepared as required by §257.73(e)(2).

Name of Professional Engineer: Richard Southorn

Company: APTIM

Signature: ______________________

Date: 04/16/18

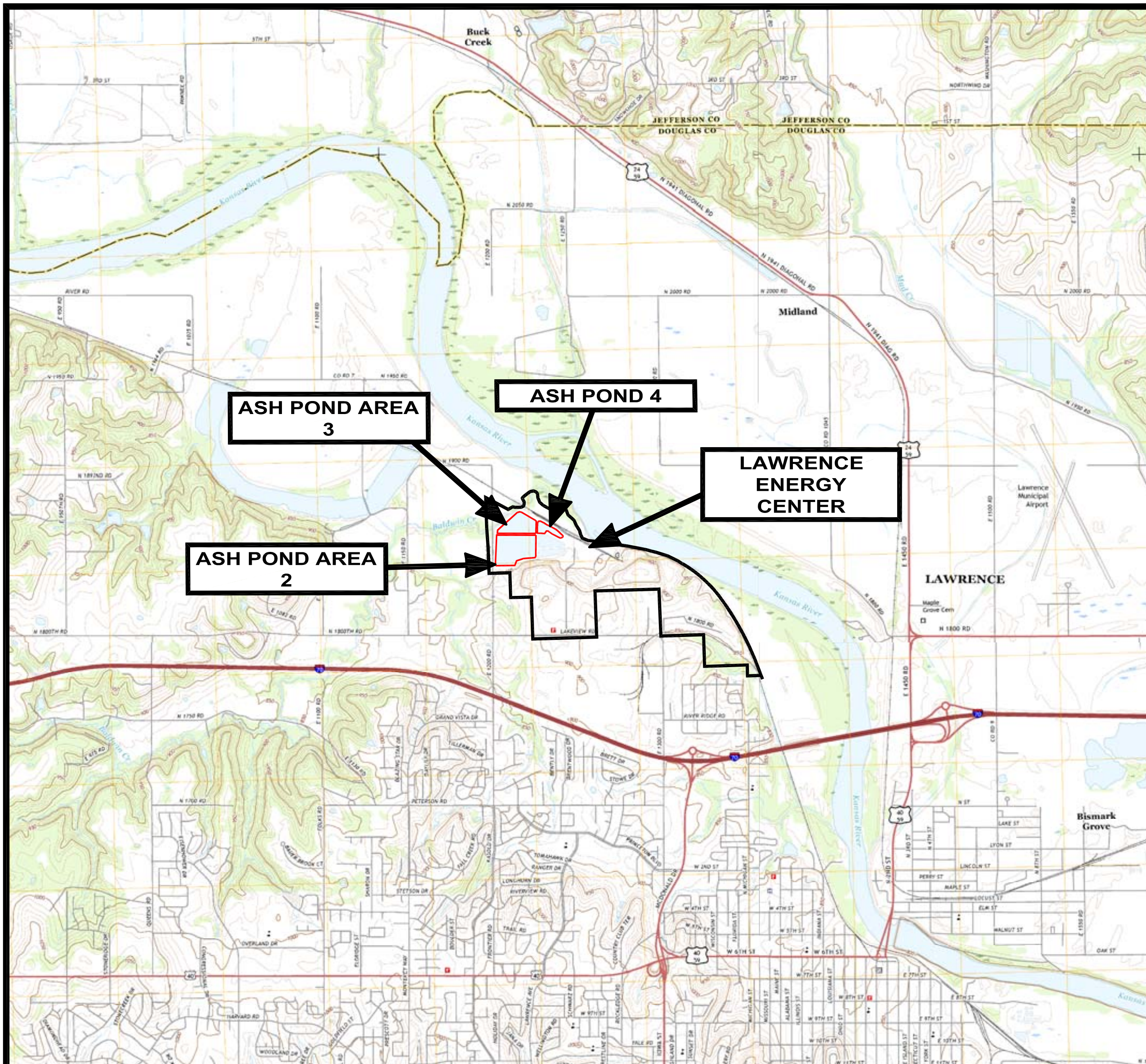
PE Registration State: Kansas

PE Registration Number: PE25201

Professional Engineer Seal:

FIGURES

APTIM



LEGEND

LAWRENCE ENERGY CENTER FACILITY BOUNDARY

CCR UNIT BOUNDARY

NOTES

1. AERIAL TOPO OBTAINED FROM USGS 7.5-MINUTE SERIES, LAWRENCE EAST, LAWRENCE WEST, MIDLAND AND WILLIAMSTOWN QUADRANGLE, KANSAS, 2014.

2. ALL BOUNDARIES ARE APPROXIMATE.

N

0 5000'

GRAPHIC SCALE

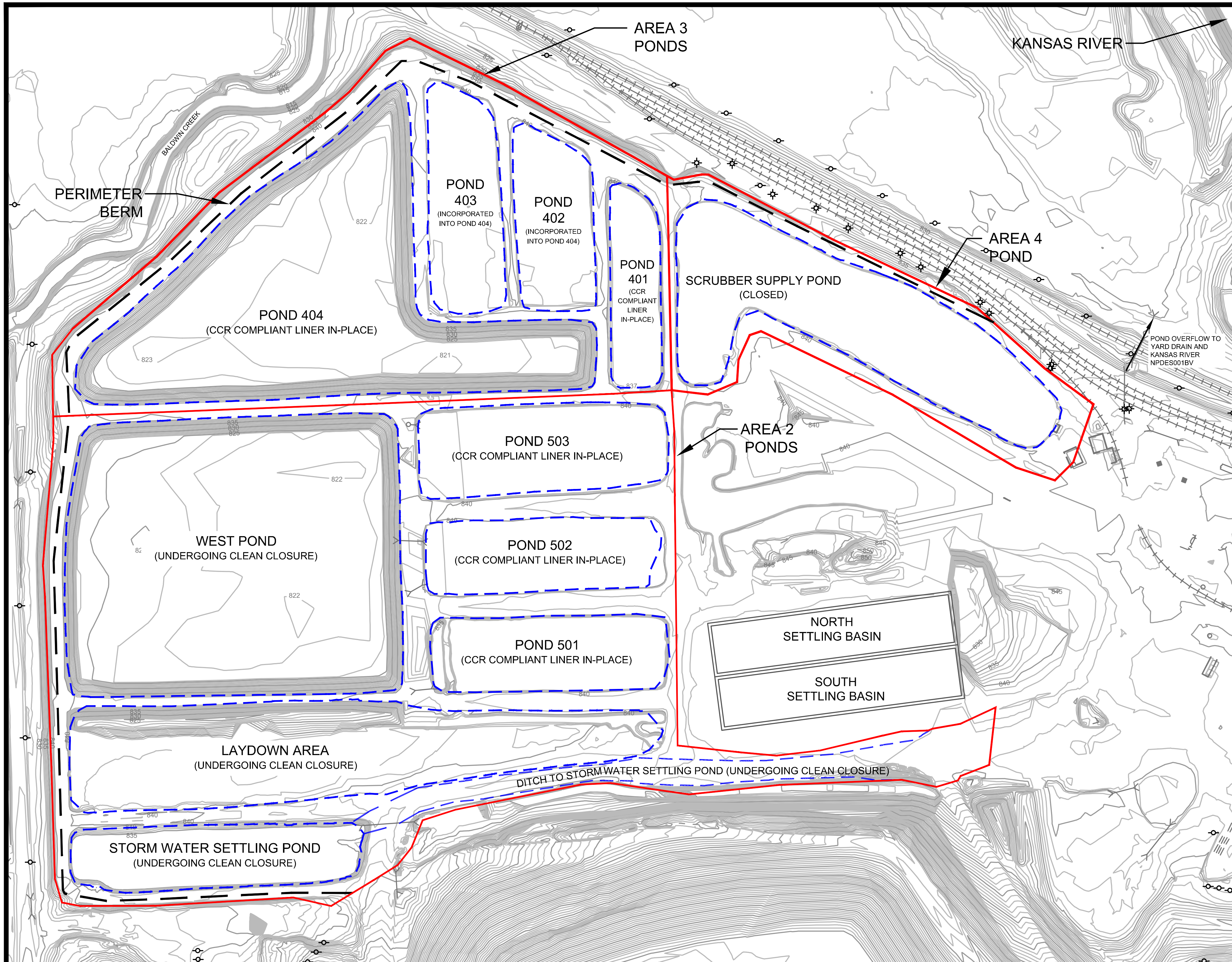
APTIM Environmental & Infrastructure, Inc.

APTIM

LAWRENCE ENERGY CENTER
1250 N. 1800 RD., LAWRENCE, KS.

FIGURE 1
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
SITE LOCATION PLAN

APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018



N

0 225'

GRAPHIC SCALE

LEGEND

(red line)	APPROXIMATE POND AREA BOUNDARY
(blue dashed line)	APPROXIMATE POND BOUNDARY
(black dashed line)	APPROXIMATE PERIMETER DIKE LOCATION

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY PEC IN JUNE 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. ALL BOUNDARIES AND FEATURE LOCATIONS ARE APPROXIMATE.

REV. NO.	DATE	DESCRIPTION

Westar Energy®

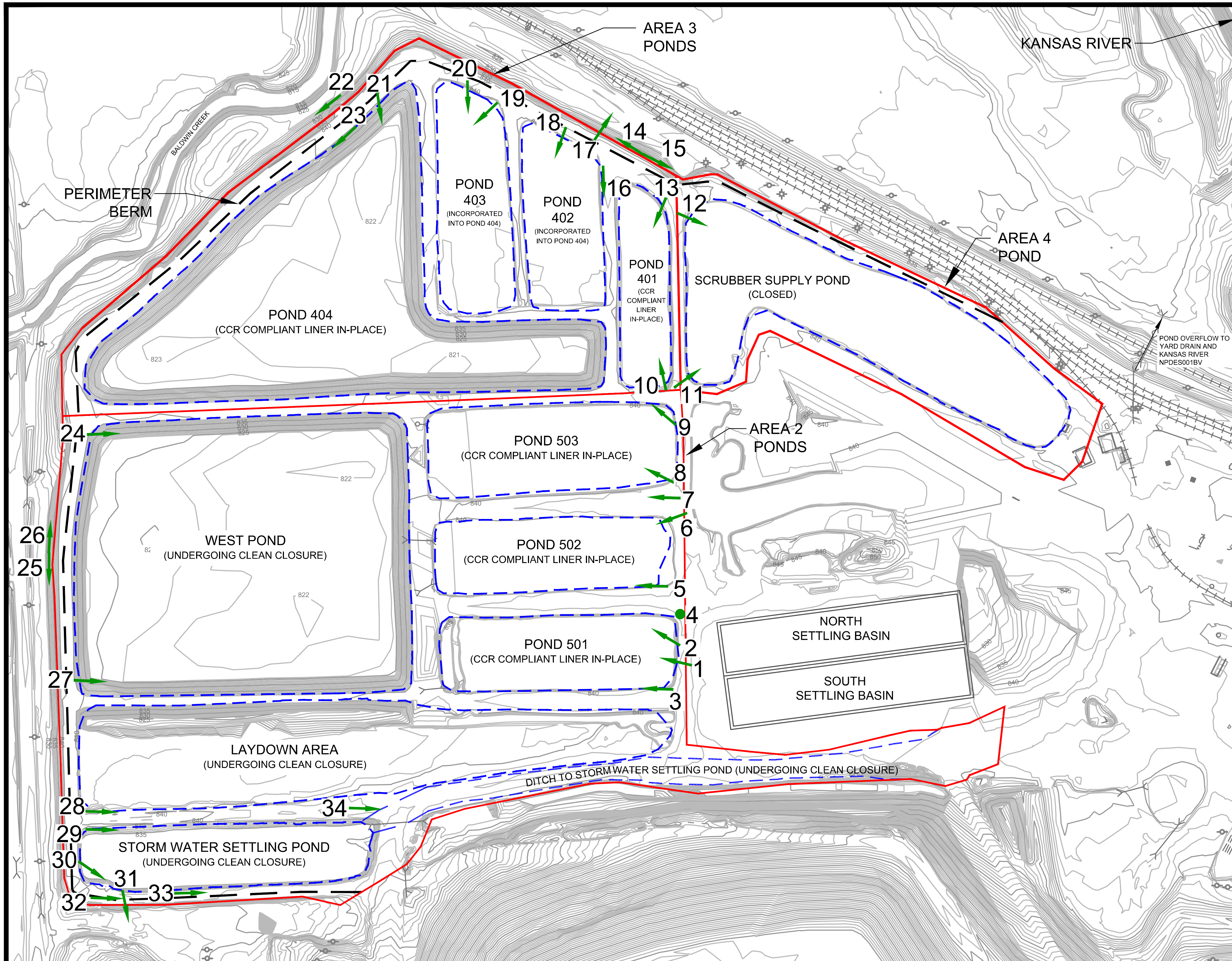
APTIM

APTIM Environmental & Infrastructure, Inc.

LAWRENCE ENERGY CENTER
1250 N 1800 RD. LAWRENCE, KANSAS

FIGURE 2
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
SITE TOPOGRAPHY PRIOR TO CLOSURE

DRAWN BY:	ORC	APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018



N

0 225'

GRAPHIC SCALE

LEGEND

- APPROXIMATE AREA BOUNDARY
- APPROXIMATE POND BOUNDARY
- APPROXIMATE PERIMETER DIKE LOCATION

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY PEC IN JUNE 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

REV. NO.	DATE	DESCRIPTION

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APTIM

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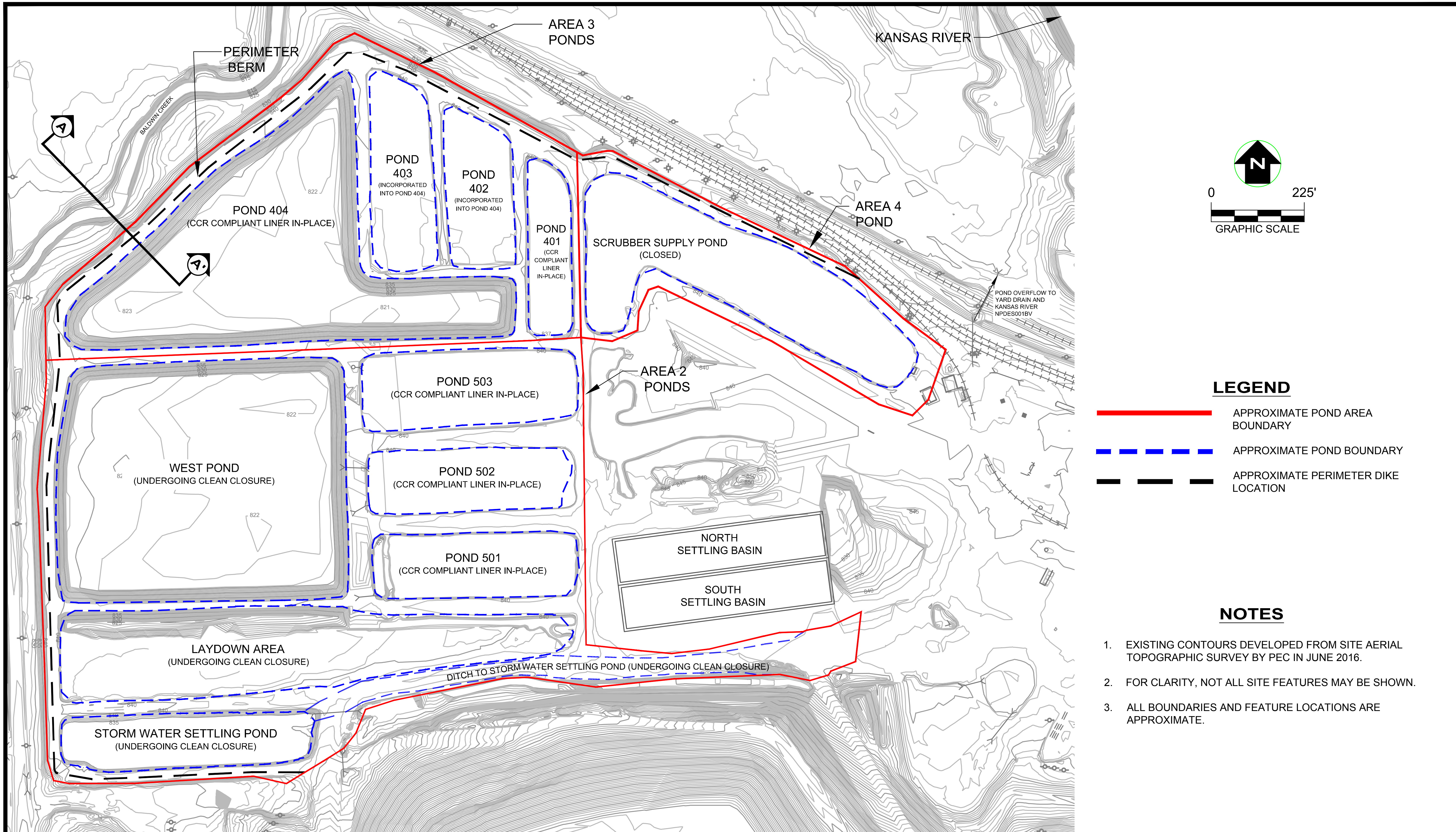
FIGURE 3
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4 PHOTO LOG

DRAWN BY:	ORC	APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018



LEGEND

- APPROXIMATE POND AREA BOUNDARY
- APPROXIMATE POND BOUNDARY
- APPROXIMATE PERIMETER DIKE LOCATION

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY PEC IN JUNE 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. ALL BOUNDARIES AND FEATURE LOCATIONS ARE APPROXIMATE.

REV. NO.	DATE	DESCRIPTION

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1250 N 1800 RD. LAWRENCE, KANSAS

FIGURE 4
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
APPROXIMATE CROSS-SECTION LOCATION

DRAWN BY: ORC	APPROVED BY: RDS	PROJ. NO.: 631232565	DATE: APRIL 2018

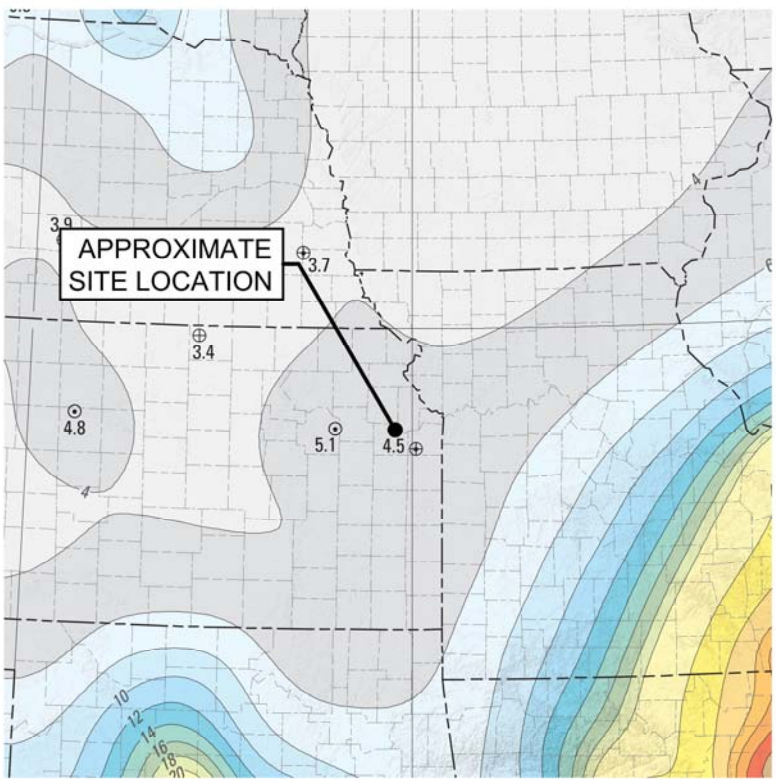
USGS
science for a changing world
Earthquake Hazards Program

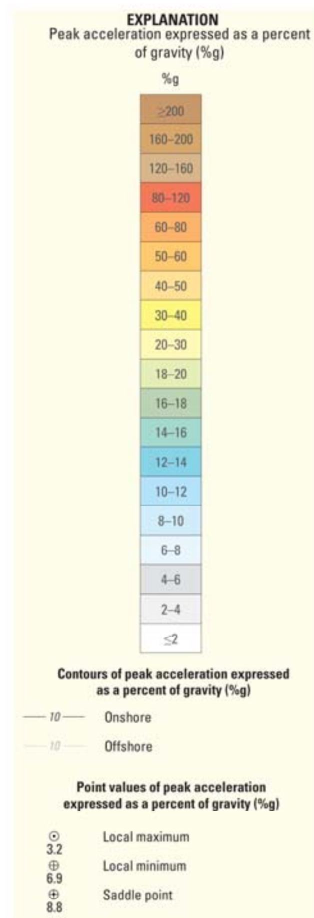
LOCATION 39.003 Lat. -95.258 Long.

The interpolated probabilistic ground motion values, in %g, at the requested point are:

P.E. %	Exp. Time (years)	Ground Motion (g)
2	50	0.0462

U.S. NATIONAL SEISMIC HAZARD MAPS: Peterson, M.D., et al, 2014





Peak Horizontal Acceleration with 2% Probability of Exceedance in 50 Years

NOTES

1. Information obtained from the United States Geological Survey website.

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FIGURE 5
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
MAP OF HORIZONTAL ACCELERATION

APPROVED BY: RDS	PROJ. NO.: 631232565	DATE: APRIL 2018

APPENDICES

APPENDIX A

2017 Photo Log

Photograph No. 1	
Date: May 15, 2017 **Direction:** Northwest	
Description: Observing Pond 501. Some vegetation is present on the side slopes. Site road is in good condition.	

Photograph No. 2	
Date: May 15, 2017 **Direction:** Northwest	
Description: Observing Pond 501. Erosion is present within pond, but does not impact stability of impoundment.	

Photograph No. 3 **Date:** May 15, 2017 **Direction:** West	
Description: Pond 501 interior side slopes contain some vegetation. Erosion is present, but does not affect stability of regulated impoundment.	

Photograph No. 4 **Date:** May 15, 2017 **Direction:** South of the Pond 501	
Description: Manhole inlet where process water enters impounded pond network.	

Photograph No. 5 **Date:** May 15, 2017 **Direction:** West	
Description: Clean closure activities ongoing in Pond 502. Side slopes appear stable. Site road is in good condition.	

Photograph No. 6 **Date:** May 15, 2017 **Direction:** Southwest	
Description: Clean closure activities ongoing in Pond 502. Site roads surrounding Pond 502 are in stable condition.	

Photograph No. 7 **Date:** May 15, 2017 **Direction:** Northwest	
Description: Pond 503 has been dewatered and will be undergoing clean closure in the future. Knife-gate inlet structure shown.	

Photograph No. 8 **Date:** May 15, 2017 **Direction:** Northwest	
Description: Dewatered Pond 503. Will begin process of closure in near future.	

Photograph No. 9

Date:
May 15, 2017

Direction:
Northwest

Description:
Culvert connection Pond 503 and Pond 401 that is no longer in use due to closure of Pond 503. Site roads are in stable condition.

Photograph No. 10

Date:
May 15, 2017

Direction:
Northwest

Description:
Observing Pond 401. Side slopes are stabilized with rip-rap. Piping connecting Pond 401 to Pond 503 is shown. Pond 401 underwent clean closure and construction for receipt of process water.

Photograph No. 11 **Date:** May 15, 2017 **Direction:** Northeast	
Description: Closed Scrubber Supply Pond (Area 4 Pond). Appropriate vegetative growth present.	

Photograph No. 12 **Date:** May 15, 2017 **Direction:** Southeast	
Description: Former Scrubber Supply Pond (Area 4 Pond) that was cleaned, filled with soil fill, and vegetated.	

Photograph No. 13 **Date:** May 15, 2017 **Direction:** Southwest	
Description: Pond 401 outlet structure. Rip-rap stabilized side slopes present. Pond 401 underwent clean closure and construction for receipt of process water.	

Photograph No. 14 **Date:** May 15, 2017 **Direction:** Northwest	
Description: Impoundment outer northern side slope (north of Pond 401). Very good condition - significant vegetative growth present. No erosion present.	

Photograph No. 15 **Date:** May 15, 2017 **Direction:** Southeast **Description:** Impoundment outer northern side slope (north of Pond 401). Very good condition - significant vegetative growth present. No erosion present.	

Photograph No. 16 **Date:** May 15, 2017 **Direction:** South **Description:** Berm separating Pond 401 (left) and 402 (right). Mild vegetation present on side slopes of both Ponds. Site road is in stable condition.	

Photograph No. 17 **Date:** May 15, 2017 **Direction:** Northeast	
Description: Stormwater ditch at bottom of impoundment on northern slope a rock check dam as shown. Appropriate vegetative growth and no erosion present. Good condition.	

Photograph No. 18 **Date:** May 15, 2017 **Direction:** Southwest	
Description: Pond 402 inlet. Mild to moderate vegetation present on side slopes. Moderate erosion within pond, but does not impact stability of impoundment.	

Photograph No. 19 **Date:** May 15, 2017 **Direction:** Southwest **Description:** Pond 402 outlet structure between Pond 402 (left) and Pond 403 (right). Site road is in stable condition.	

Photograph No. 20 **Date:** May 15, 2017 **Direction:** South **Description:** Pond 403 inlet. Moderate erosion and mud cracking within pond, but does not impact stability of impoundment.	

Photograph No. 21 **Date:** May 15, 2017 **Direction:** Southeast	
Description: Pond 404 inlet. Healthy vegetation present on the side slopes.	

Photograph No. 22 **Date:** May 15, 2017 **Direction:** Southwest	
Description: Outer slope of impoundment (near Pond 404). Well vegetated, no erosion. Good condition.	

Photograph No. 23 **Date:** May 15, 2017 **Direction:** Southwest	
Description: Pond 404 side slope and outfall. Rip-rap and mild to moderate vegetation present on side slopes. No significant erosion present.	

Photograph No. 24 **Date:** May 15, 2017 **Direction:** East	
Description: West Pond outlet to Pond 404. Rip-rap and mild vegetation present on side slopes. No observed erosion.	

Photograph No. 25 **Date:** May 15, 2017 **Direction:** South	
Description: Outer slope of impoundment (near West Pond). Good condition, well vegetated, no erosion observed.	

Photograph No. 26 **Date:** May 15, 2017 **Direction:** North	
Description: Outer slope of impoundment (near West Pond). Moderate to significant vegetation present. No significant erosion present.	

Photograph No. 27 **Date:** May 15, 2017 **Direction:** East	
Description: Berm separating the West Pond and Laydown Area. West Pond slope is stabilized with rip-rap. Vegetation present.	

Photograph No. 28 **Date:** May 15, 2017 **Direction:** East	
Description: Berm separating the Laydown Area and the Storm Water Settling Pond. Mild erosion present on side slope of Laydown Area, which does not impact stability of impoundment.	

Photograph No. 29 **Date:** May 15, 2017 **Direction:** East	
Description: Berm separating the Laydown Area and the Storm Water Settling Pond.	

Photograph No. 30 **Date:** May 15, 2017 **Direction:** Southeast	
Description: Outfall of Storm Water Settling Pond. Mild to moderate vegetation present. No significant erosion present.	

Photograph No. 31 **Date:** May 15, 2017 **Direction:** Southeast	
Description: Outfall 007A on south side of Storm Water Settling Pond. Healthy vegetation present near outfall.	

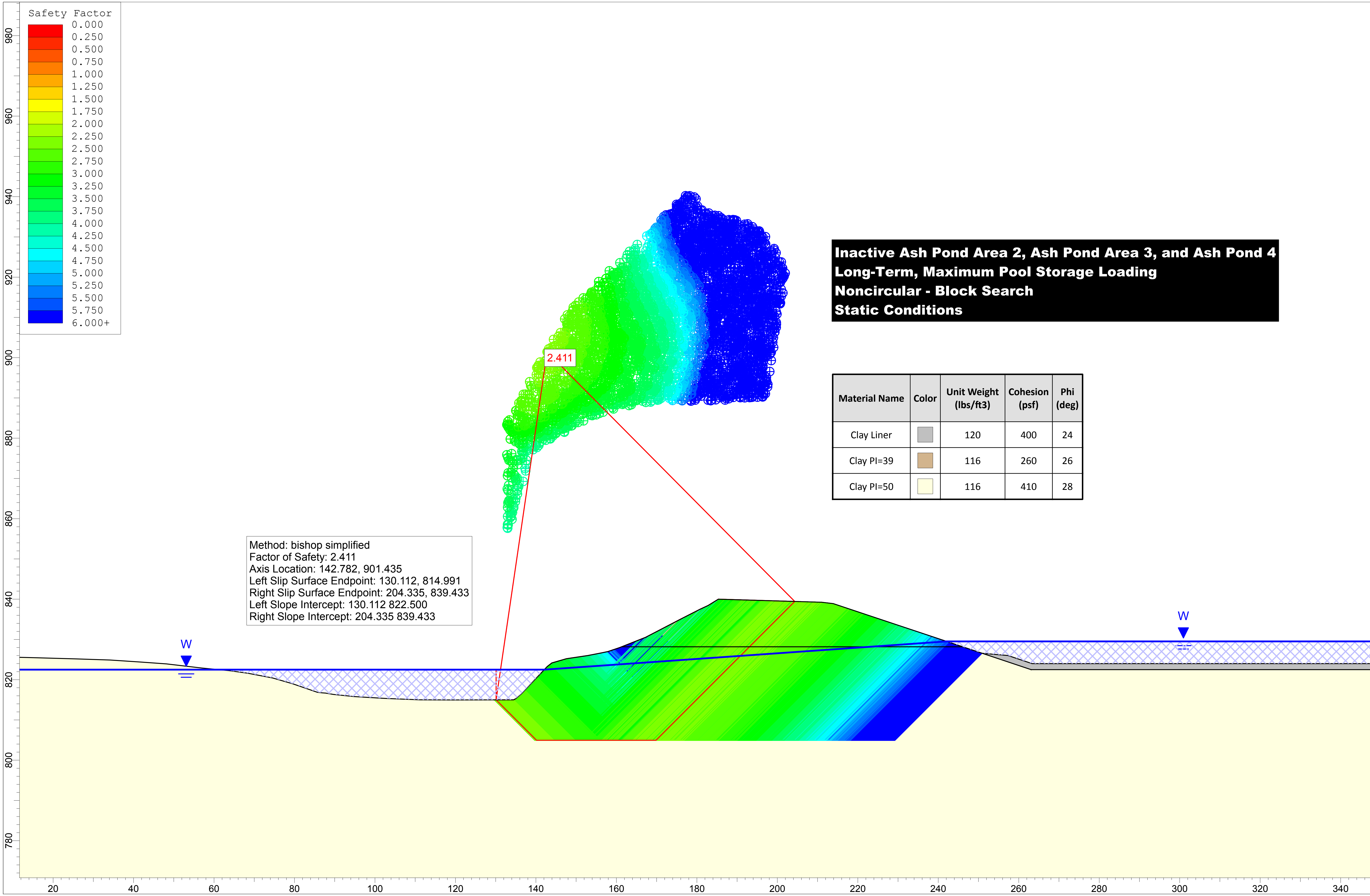
Photograph No. 32 **Date:** May 15, 2017 **Direction:** East	
Description: Outfall 007A on south side of Storm Water Settling Pond. Moderate to significant vegetation present near outfall. Outfall is well maintained.	

Photograph No. 33 **Date:** May 15, 2017 **Direction:** East	
Description: Perimeter dike on south side of Storm Water Settling Pond is in stable condition. Mild to moderate vegetation present on side slope of Pond.	

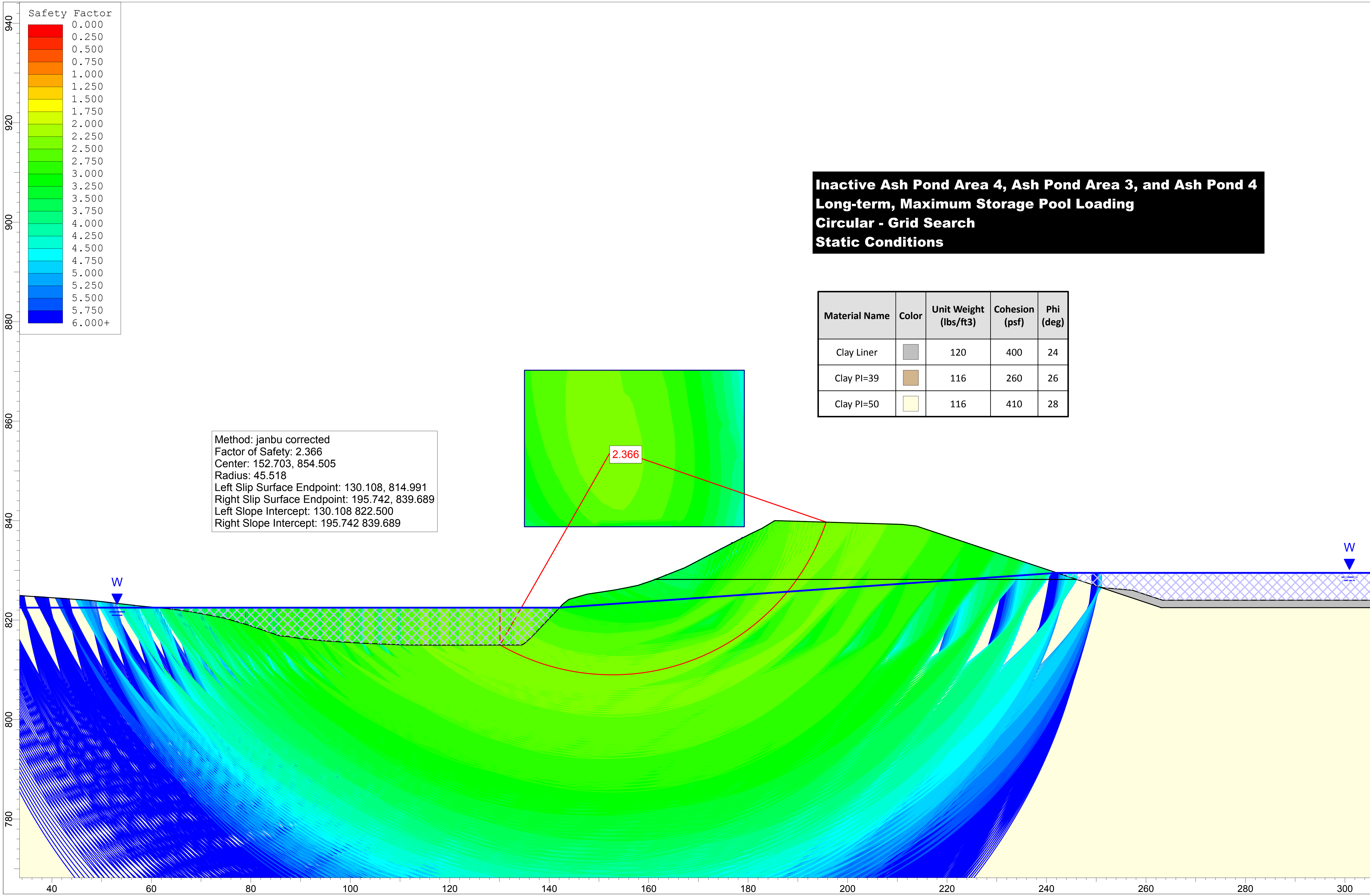
Photograph No. 34 **Date:** May 15, 2017 **Direction:** East	
Description: Recently regraded stormwater ditch. Good condition.	

APPENDIX B

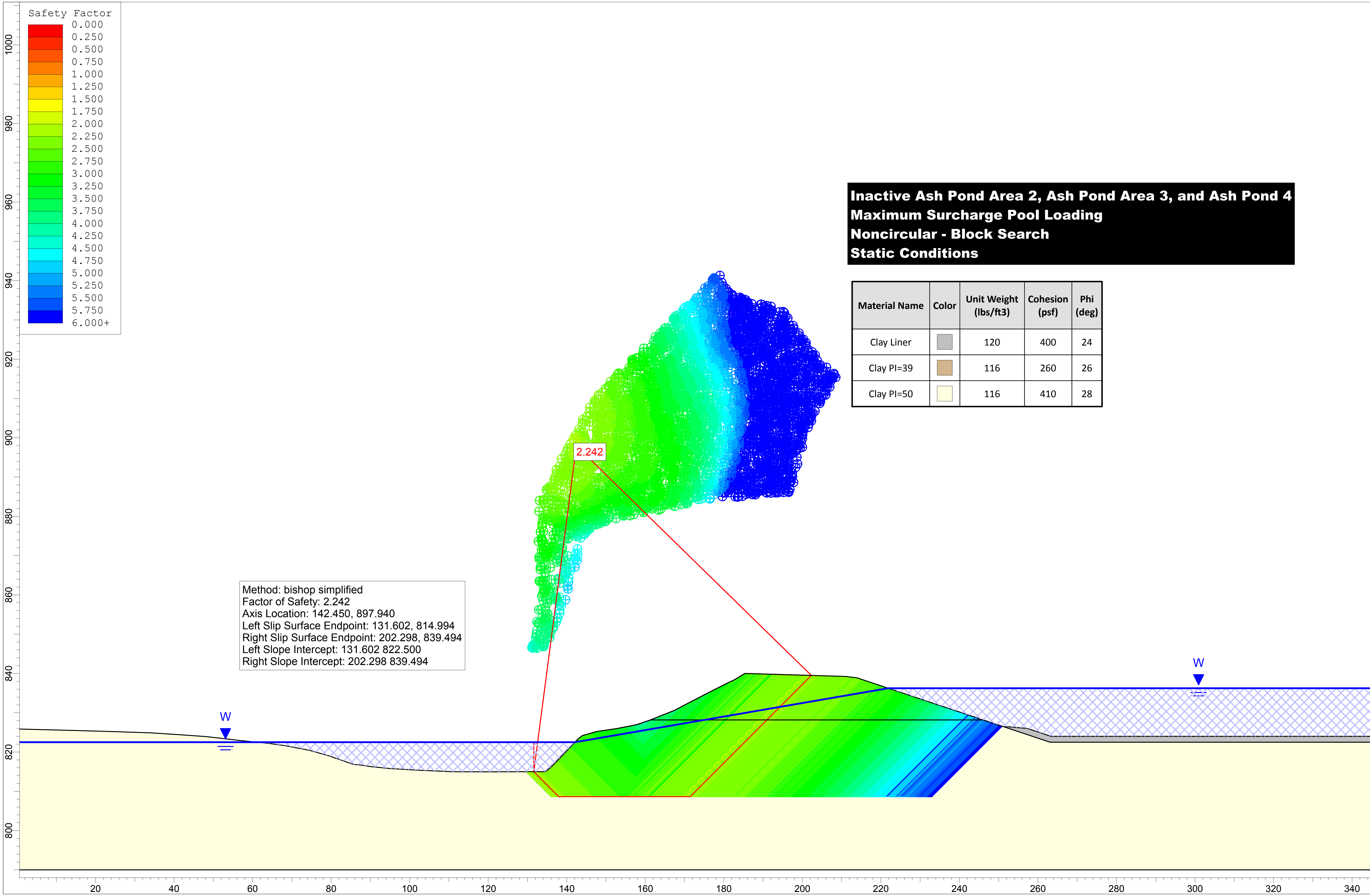
Safety Factor Assessment Models



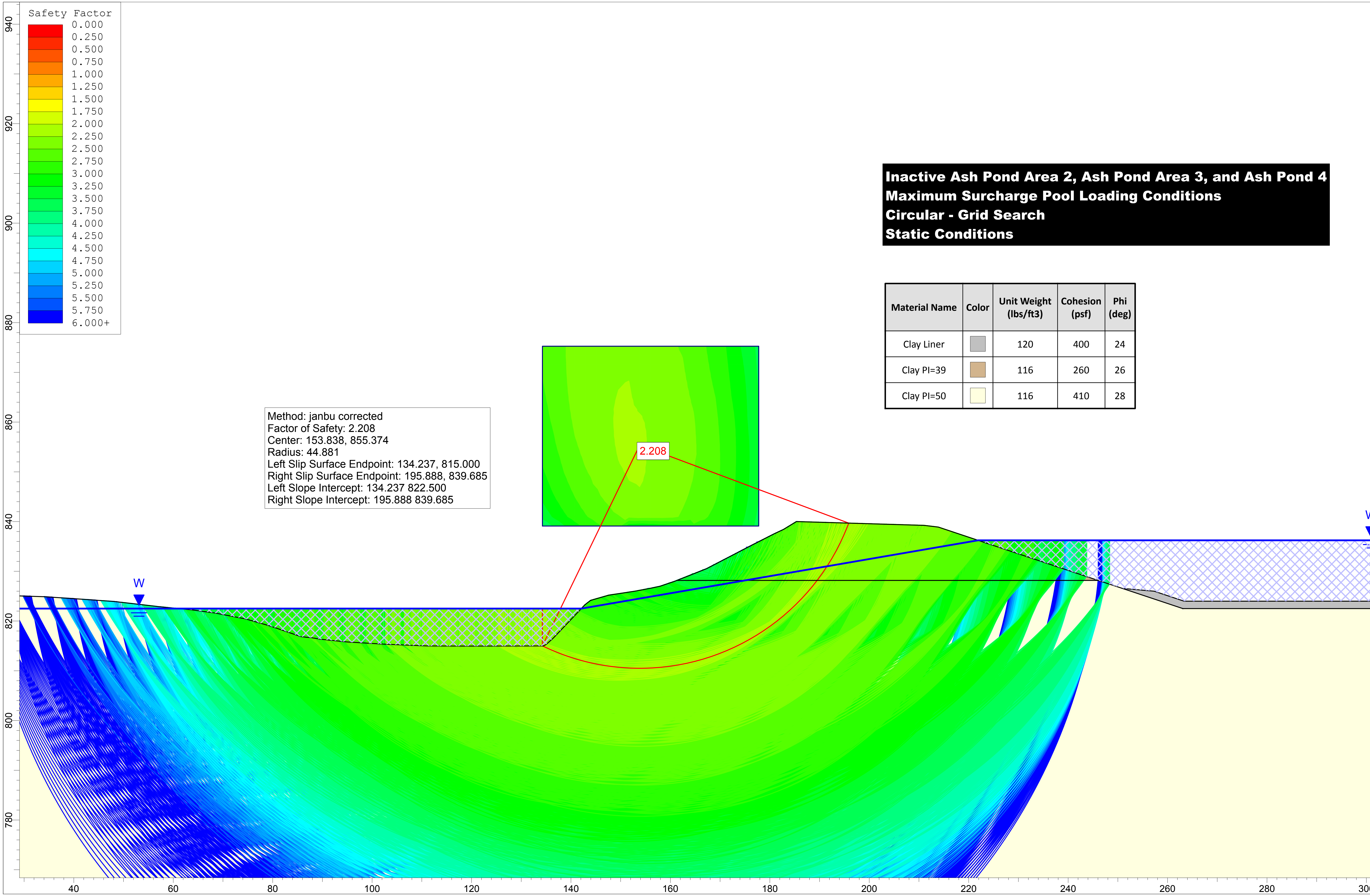
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



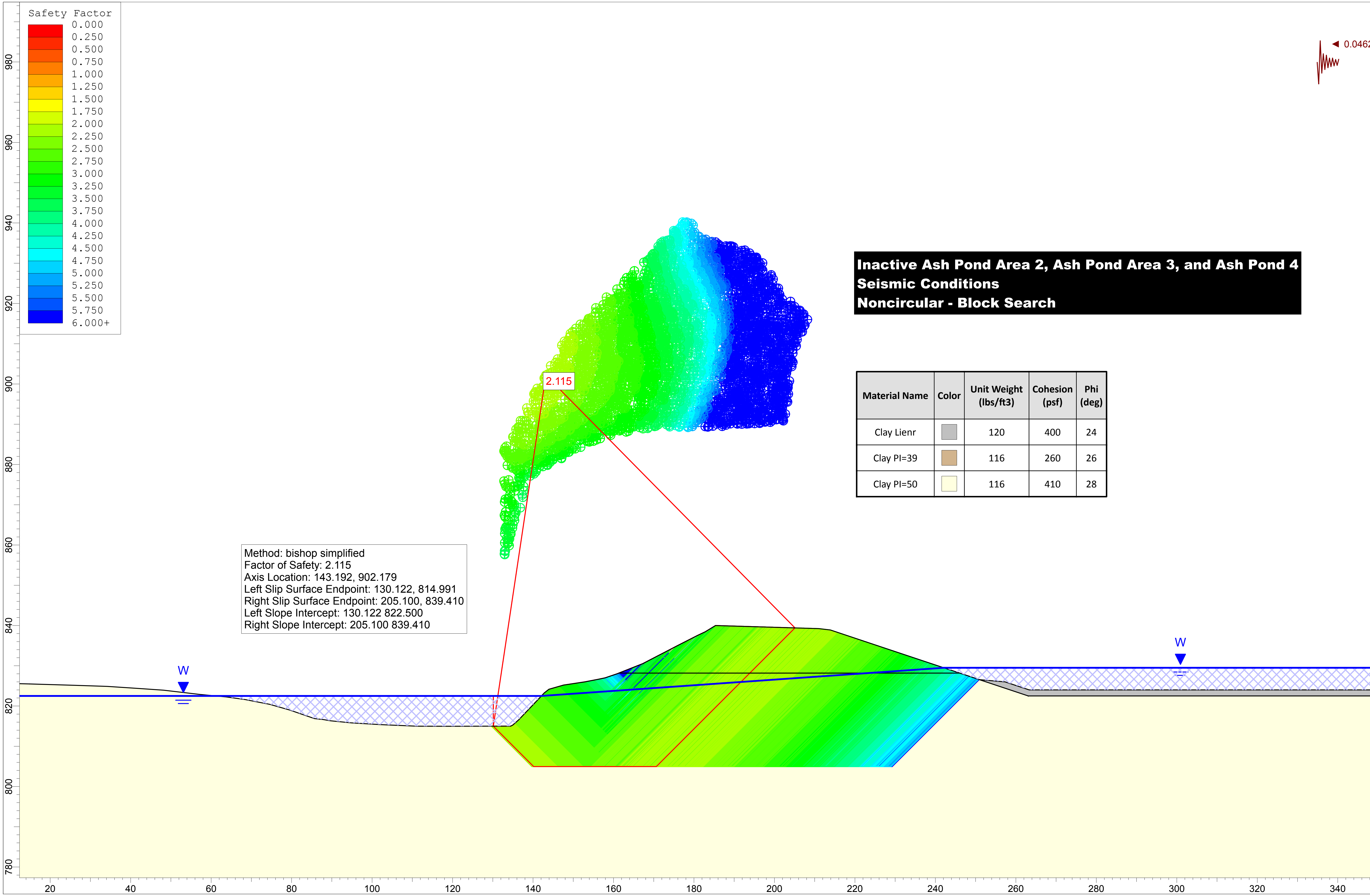
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Inactive Ash Pond Area 2, Ash Pond Area 3, and Ash Pond 4
Seismic Conditions
Noncircular - Block Search

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
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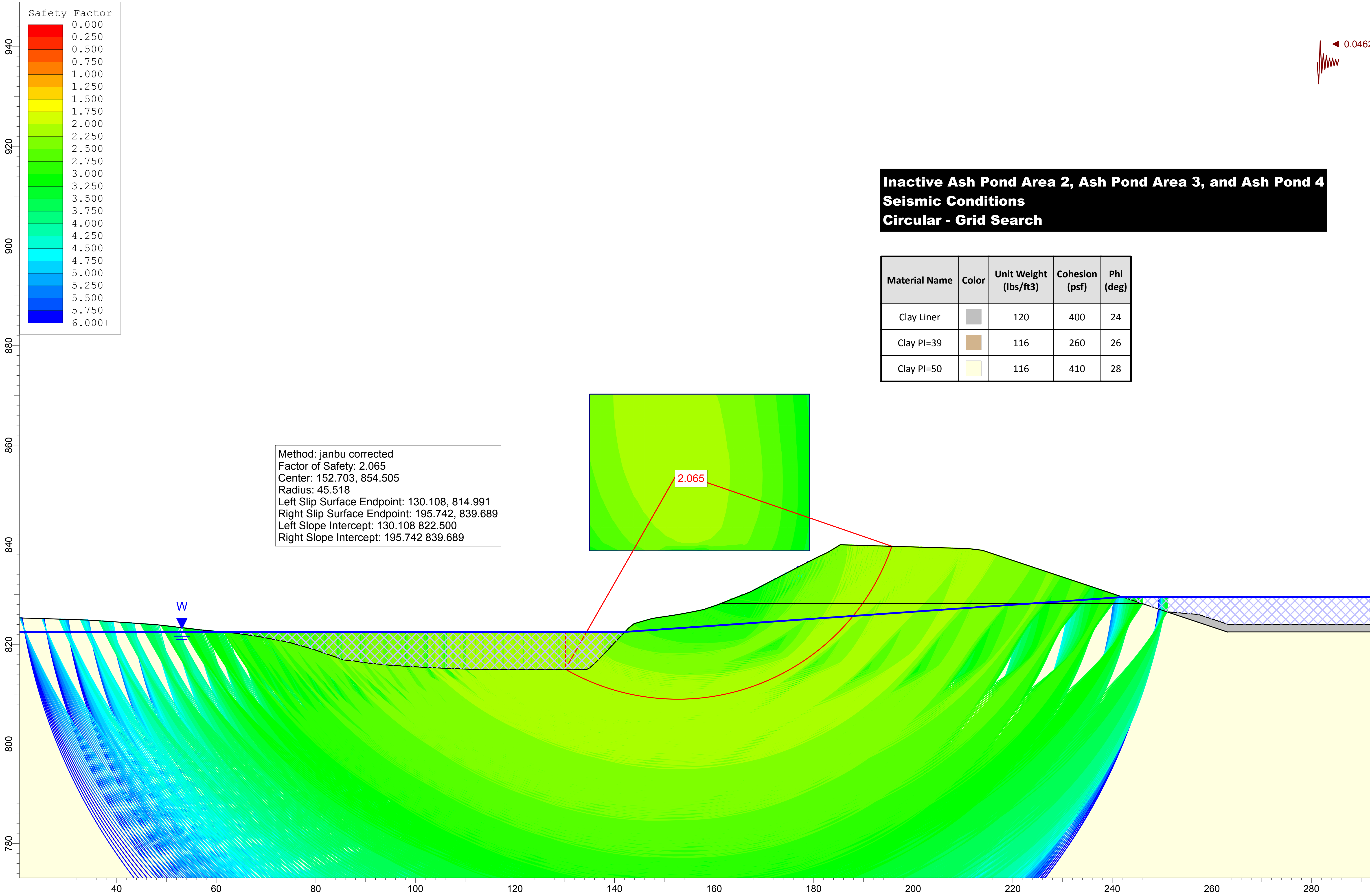
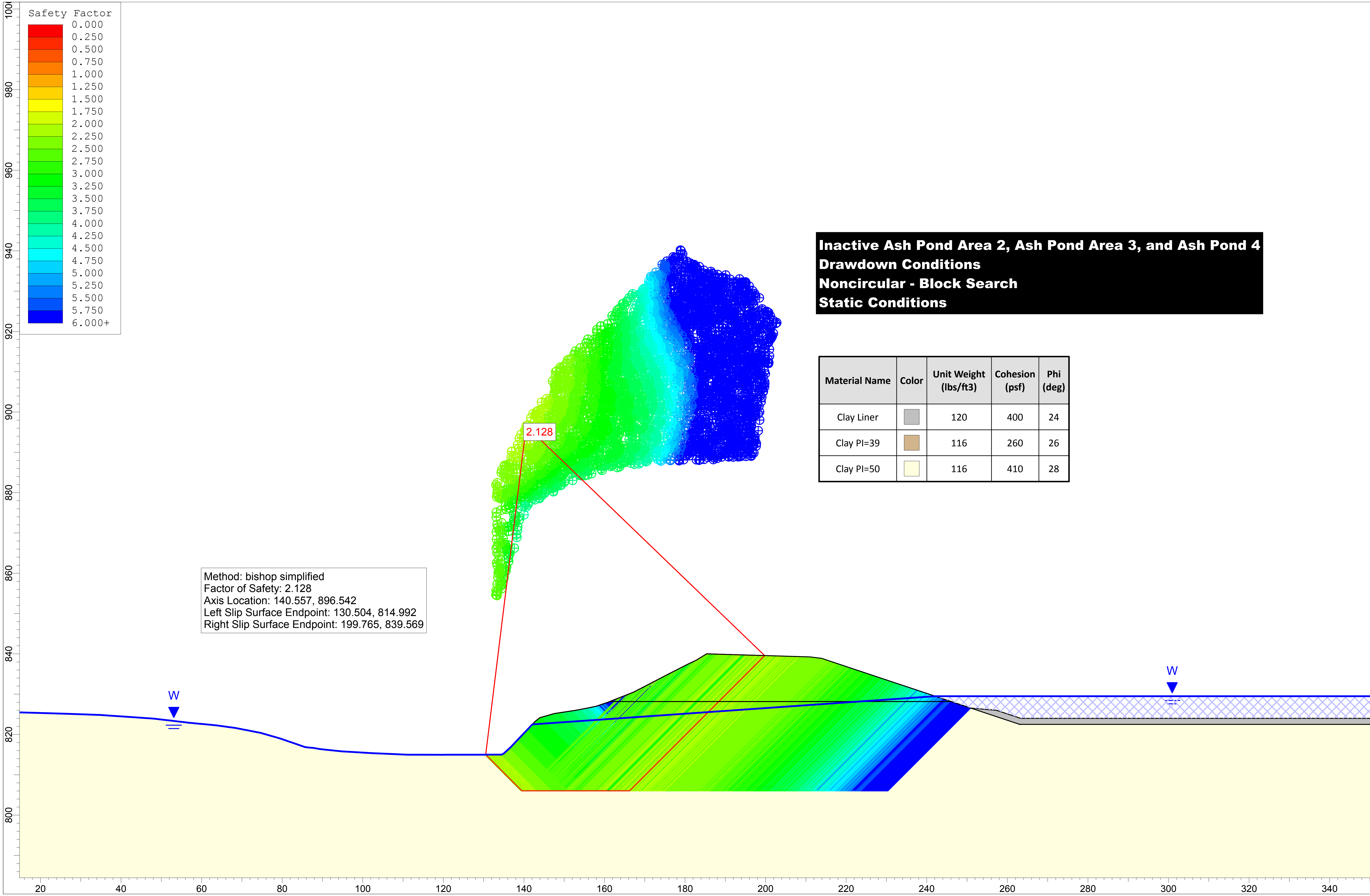
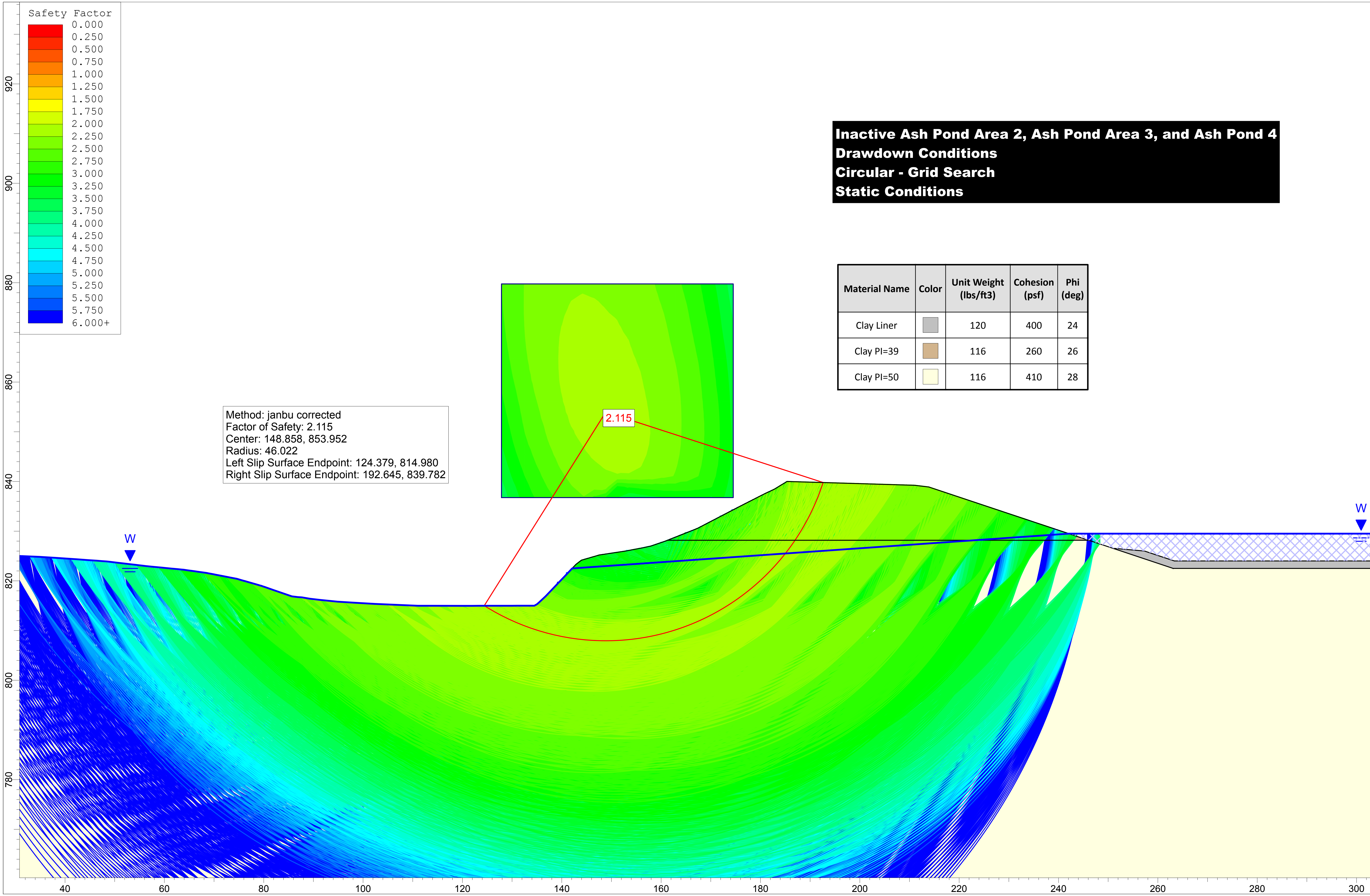
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Clay Liner		120	400	24
Clay PI=39		116	260	26
Clay PI=50		116	410	28