Intended for

Dynegy Midwest Generation, LLC

Date

May 24, 2023

Project No.

1940102653

GROUNDWATER MODELING REPORT, REVISION 1

BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

DRAFT

GROUNDWATER MODELING REPORT, REVISION 1
BALDWIN POWER PLANT BOTTOM ASH POND

Project Name	**Baldwin Power Plant Bottom Ash Pond**
Project No.	**1940102653**
Recipient	**Dynegy Midwest Generation, LLC**
Document Type	**Groundwater Modeling Report**
Revision	**FINAL DRAFT Revision 1**
Date	**May 24, 2023**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Jake J. Walczak, PG
Senior Hydrogeologist

Brian G. Hennings, PG
Senior Managing Hydrogeologist

CONTENTS

TABLES (IN TEXT)

TABLES (ATTACHED)

FIGURES (ATTACHED)

APPENDICES

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternate Source Demonstration
BAP	Bottom Ash Pond
BPP	Baldwin Power Plant
CCR	coal combustion residuals
CIP	closure in place
cm/s	centimeters per second
Cooling Pond	Baldwin Lake
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
FAPS	Fly Ash Pond System
ft/day	feet/foot per day
ft/ft	feet per foot/feet
Geosyntec	Geosyntec Consultants, Inc.
GMP	Groundwater Monitoring Plan
GMR	Groundwater Modeling Report
gpm	gallons per minute
GWPS	Groundwater Protection Standard
HCR	Hydrogeologic Site Characterization Report
HELP	Hydrologic Evaluation of Landfill Performance
HUC	Hydrologic Unit Code
ID	Identification
IEPA	Illinois Environmental Protection Agency
Kd	distribution coefficient
Kh/Kv	vertical anisotropy
mg/L	milligrams per liter
mL/g	milliliters per gram
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRT	Natural Resource Technology, Inc.
Phase II	Groundwater Quality Assessment and Phase II Hydrogeologic Investigation
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
Site	combined area including the BAP, FAPS, Secondary Pond, Tertiary Pond, and Cooling Pond
SDA	spray dry absorption
SSR	sum of squared residuals

S_y	specific yield
TDS	Total Dissolved Solids
TVD	total-variation-diminishing
UA	uppermost aquifer
UGU	Upper Groundwater Unit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UU	Upper Unit

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Modeling Report (GMR) on behalf of the Baldwin Power Plant (BPP), operated by Dynegy Midwest Generation, LLC (DMG), in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments. This document presents the results of predictive groundwater modeling simulations for the proposed closure scenario for the Bottom Ash Pond (BAP). The BAP (coal combustion residuals [CCR] unit Identification [ID] number [No.] 601, Illinois Environmental Protection Agency [IEPA] ID No. W1578510001-06, and National Inventory of Dams [NID] No. IL50721) is the only active CCR unit present on the BPP property. The Fly Ash Pond System (FAPS) is a closed CCR unit on the BPP property (CCR unit ID 605; IEPA ID Nos. W1578510001-01, W1578510001-02, and W1578510001-03; and NID No. IL50721).

The BPP is located in Baldwin, Illinois (**Figure 1-1**). The BPP property is situated in an agricultural area. The BPP property is bordered to the west by the Kaskaskia River; to the east by Baldwin Road, farmland, and strip-mining areas; to the southeast by the Village of Baldwin; to the south by the Illinois Central Gulf railroad tracks, scattered residences, and State Route 154; and to the north by farmland (**Figure 1-2**).

A detailed summary of site conditions was provided in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021c). Hydrogeologic data collected after submittal of the HCR in 2021 as part of the 2022 Hydrogeologic Site Investigation were also used to establish a conceptual site model (CSM) for this GMR and is summarized herein. Three distinct water-bearing units have been identified in the vicinity of the BAP based on stratigraphic relationships and common hydrogeologic characteristics. The units are described as follows from the surface downward:

- **CCR**: CCR, consisting primarily of fly ash, bottom ash, and boiler slag. Also includes earthen fill deposits of predominantly clay and silt materials from on-site excavations that were used to construct berms and roads surrounding the various impoundments across the Site.
- **Upper Unit (UU)**: Predominantly clay with some silt and minor sand, silt layers, and occasional sand lenses. Includes the lithologic layers identified as the Cahokia Formation, Peoria Loess, Equality Formation, and Vandalia Till. This unit is composed of unlithified natural geologic materials and extends from the upper saturated materials to the bedrock. Thin sand seams and the interface (contact) between the UU and bedrock have been identified as potential migration pathways (PMPs). No continuous sand seams were observed within or immediately adjacent to the BAP; however, the sand seams may act as a PMP due to relatively higher hydraulic conductivities. The acronym UU and the materials it contains is synonymous with Upper Groundwater Unit (UGU) used in previous documents.
- **Bedrock Unit**: This unit is considered the uppermost aquifer (UA). Pennsylvanian and Mississippian-aged bedrock is composed of interbedded shale and limestone bedrock, which underlies and is continuous across the entire Site.

The extent of sand and gravel aquifers in the region are primarily found along the Kaskaskia River Valley where sand and gravel deposits are highly permeable, thick, and extensive. Outside of the Kaskaskia River Valley, the unlithified materials in upland areas are predominantly clay, which generally provide a low probability of encountering sand and gravel layers for dependable groundwater supply. Although some thin sand seams and layers occur intermittently within the Vandalia Till in localized areas around the BPP, most groundwater supplies in upland areas are obtained from large diameter shallow bored wells. Typical water wells in the vicinity of the BPP are between 25 and 55 feet deep, 36 to 48 inches in diameter, and collect groundwater through slow percolation into the wells, which are large diameter to allow for greater water storage to compensate for the low rate of groundwater infiltration (Ramboll, 2021c).

The shallow bedrock is the only water-bearing unit that is continuous across the Site. Groundwater in the bedrock mainly occurs under semi-confined to confined conditions with the overlying unlithified unit behaving as the upper confining unit to the UA. Shallow sandstone and creviced limestone may yield small supplies in some areas, but water quality becomes poorer (*i.e.*, highly mineralized) with increasing depth.

Data collected from previous field investigations, as well as the lithologic contact and groundwater elevation data from the 2022 Hydrogeologic Site Investigation, were used to develop a groundwater model for the BAP. The MODFLOW model was used to evaluate a closure scenario: CCR consolidation and closure in place (CIP) using information provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec Consultants, Inc. [Geosyntec], 2022a).

The CIP closure scenario was predicted to reduce total flux in and out of the BAP CCR by greater than 90 percent within 30 days following implementation of the CIP closure scenario. This was determined by comparing the post-construction movement of water in and out of the consolidated BAP CCR to pre-construction conditions. The reduction in total flux in and out of the consolidated BAP CCR is predicted to exceed 90 percent reduction for the remaining model timeframe. In general, the greatest predicted reduction in heads among the proposed BAP compliance monitoring wells takes place within approximately 93 years following implementation of the CIP closure scenario, at which time total flux in and out are predicted to reduce by 95 and 93 percent respectively. Due to the low hydraulic conductivity of the UU and UA materials, heads are not predicted to stabilize at all proposed BAP compliance monitoring wells until approximately 482 years following implementation of the CIP closure scenario, at which time total flux in and out are predicted to reduce by approximately 96 percent.

A monitoring well network was included in a proposed BAP Groundwater Monitoring Plan (GMP) (Ramboll 2021a) to satisfy requirements of 35 I.A.C. § 845 and was submitted as part of the operating permit application for the BAP in 2021. Additional wells completed in 2022 will be included in a revision to the proposed GMP that will be included as part of the final construction permit application for submittal to IEPA no later than August 1, 2023. A review and summary of data collected from 2015 through completion of eight independent groundwater sampling events collected at wells identified in the revised BAP GMP will be included in the revised HCR.

Quarterly monitoring under 35 I.A.C. § 845.650(b) will commence no later than the second quarter of 2023. At the time the groundwater modeling was completed, quarterly monitoring had not been initiated. As such, comparisons of groundwater contaminant concentrations to the Groundwater Protection Standard (GWPS) in this report are considered potential exceedances. Potential exceedances of the GWPS are presented in the attached revision to the History of Potential Exceedances (**Appendix A**) and discussed in **Section 3** of this report. Based on statistical analysis, evaluation of subsequent potential exceedances of the GWPS, and intention to pursue Alternate Source Demonstrations (ASDs), it has been determined there are no potential exceedances of applicable groundwater standards attributable to the BAP.

Groundwater contaminant transport modeling was completed to demonstrate how the proposed CIP closure plan will maintain compliance with the applicable GWPS. Boron is commonly used as an indicator parameter for contaminant transport modeling for CCR because it is commonly present in coal ash leachate and it is mobile (*i.e.*, has low rates of sorption or degradation) in groundwater. The revised History of Potential Exceedances did not identify boron as a potential exceedance of the GWPS; however, boron has been detected in BAP porewater and groundwater; therefore, groundwater transport modeling was completed using boron.

The model domain for evaluating boron transport following closure of the BAP includes the closed FAPS which is present along the eastern and southern boundaries of the BAP. The FAPS completed IEPA approved closure activities in November of 2020, and it is another potential source of boron within the model domain. The closure plan for the FAPS also included groundwater modeling of boron transport. Boron transport within the current BAP model was compared to the results from the previous FAPS closure plan modeling and found that simulated flow and transport associated with the FAPS are consistent between the two models. As described in this report, proposed BAP compliance wells PZ-182, OW-257, and MW-382 are located in the direction of groundwater flow from the north central area of the FAPS between the FAPS (East Fly Ash Pond) and the surface water drainage feature near the west end of the BAP. Because these wells are downgradient of the FAPS which is an alternate source of boron, and groundwater quality at these wells is not attributable to the BAP, these wells were not included in the evaluation of BAP compliance with the GWPS following implementation of the CIP scenario.

Additionally, a BAP closure by removal (CBR) closure scenario prediction model was completed to evaluate the difference in post-construction boron concentrations simulated at PZ-182, OW-257, and MW-382 under both CIP and CBR conditions. Concentrations are predicted to increase above the GWPS for boron (2 milligrams per liter [mg/L]) following implementation of both BAP CIP and CBR closure scenarios in these three wells. Maximum concentrations within the modeling timeframes at these wells are predicted to be on the same order of magnitude for both BAP CIP and CBR closure scenarios. Since concentrations at proposed BAP compliance monitoring wells PZ-182, OW-257, and MW-382 increase to concentrations above the GWPS following implementation of the CBR closure scenario, after BAP source concentrations have been removed, the source for predicted post-construction concentrations within the model domain can only be attributable to the closed FAPS. These results support the conclusion that wells PZ-182, OW-257, and MW-382 should not be included in the evaluation of BAP compliance with the GWPS following implementation of the CIP scenario.

Results of groundwater fate and transport modeling conservatively estimate that groundwater boron concentrations at the proposed BAP compliance wells that are not influenced by the FAPS will remain below the GWPS following implementation of the CIP scenario at the BAP.

1. INTRODUCTION

1.1 Overview

In accordance with requirements of 35 I.A.C. § 845, Ramboll has prepared this GMR on behalf of the BPP, operated by DMG. This report applies specifically to the CCR unit referred to as the BAP (**Figure 1-1**). The BAP is a 177-acre unlined CCR surface impoundment (SI) used to manage CCR and non-CCR waste streams at the BPP. This GMR presents and evaluates the results of predictive groundwater modeling simulations for a proposed CIP closure scenario which includes: CCR removal from the western areas of the BAP, consolidation to the southeast, and eventually northeastern portions of the BAP, and construction of a cover system over the remaining CCR following initial corrective action measures (removal of free liquids from the BAP).

1.2 Site Location and Background

The BPP is located in southwest Illinois in Randolph and St. Clair Counties. The Randolph County portion of the BPP is located within Sections 2, 3, 4, 9, 10, 11, 14, 15, and 16 of Township 4 South and Range 7 West. The St. Clair County portion of the property is located within Sections 33, 34, and 35 of Township 3 South and Range 7 West. The BAP is approximately one-half mile west-northwest of the Village of Baldwin (**Figure 1-1**).

The BPP property is bordered to the west by the Kaskaskia River; to the east by Baldwin Road, farmland, and strip-mining areas; to the southeast by the Village of Baldwin; to the south by the Illinois Central Gulf railroad tracks, scattered residences, and State Route 154; and to the north by farmland. The St. Clair/Randolph County Line crosses east-west at approximately the midpoint of Baldwin Lake (*i.e.,* Cooling Pond). **Figure 1-1** shows the location of the BPP; **Figure 1-2** is a site map showing the location of the BAP (a 35 I.A.C. § 845 regulated CCR unit and the subject of this GMR), FAPS (an IEPA closed CCR unit), Secondary Pond, Tertiary Pond, and Cooling Pond. The combined area including the BAP, FAPS, Secondary Pond, Tertiary Pond, and Cooling Pond will hereinafter be referred to as the Site.

1.3 Site History and Unit Description

The BPP is a coal-fired electrical generating plant that began operation of its first unit in 1970; two additional generating units were put into service in 1973 and 1975. The plant initially burned bituminous coal from Illinois and switched to subbituminous coal in 1999. Total plant generating capacity is approximately 1,892 megawatts.

The BAP is classified as an existing, unlined CCR SI and covers an area of approximately 177 acres in the southern portion of the BPP property (**Figure 1-2**). The BAP is surrounded by a perimeter road and is bounded to the north by the Cooling Pond, and to the east and south by the closed FAPS CCR Multi-Unit. The BAP is also bounded to the west by the easternmost wooded area that surrounds the Secondary and Tertiary Ponds. The BAP is being used to store and dispose of sluiced bottom ash, some of which is mined for beneficial use, to temporarily store spray dry absorption (SDA) waste, and to clarify plant process water, including other non-CCR station process wastewaters, prior to discharge in accordance with the BPP's National Pollutant Discharge Elimination System (NPDES) permit (AECOM, 2016b; IEPA, 2016).

The FAPS at the BPP is a closed CCR Multi-Unit consisting of three unlined SIs: Old East Fly Ash Pond (IEPA Unit ID W1578510001-01), the East Fly Ash Pond (IEPA Unit ID W1578510001-02), and West Fly Ash Pond (IEPA Unit ID W1578510001-03), with a combined surface area of approximately 232 acres (**Figure 1-2**). During operation, the FAPS discharged water to the BAP. The receiving water bodies for the BAP were the Secondary Pond, and in turn the Tertiary Pond, which ultimately discharges towards a tributary of the Kaskaskia River, south of the Cooling Pond intake structure. A Groundwater Quality Assessment and Phase II Hydrogeologic Investigation (Phase II; Natural Resource Technology, Inc. [NRT], 2014a) was followed by a Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan dated March 31, 2016 (NRT, 2016a) with revised pages included in the response to IEPA July 13, 2016 comments in the technical memorandum dated August 8, 2016 (NRT, 2016b) to define the hydrogeology and to assess the groundwater impacts related to the FAPS. Groundwater models were also completed to assess the groundwater impacts associated with closure of the FAPS and predict the fate and transport of CCR leachate components, as well as estimate the time required for hydrostatic equilibrium of groundwater beneath the FAPS (NRT, 2014b; NRT, 2014c; NRT, 2016c). Based on these assessments, a Closure and Post-Closure Care Plan (AECOM, 2016a), which included a groundwater monitoring program sufficient for long-term, post-closure monitoring, was developed and approved by IEPA in a letter to the Dynegy Operating Company dated August 16, 2016. Closure activities, which included constructing a final cover system to control the potential for water infiltration into the closed CCR unit, were completed, and FAPS closure was completed November 17, 2020. The approximate dates of construction of each successive stage of the BAP and FAPS are summarized in **Table A** below (AECOM, 2016b).

Table A. History of Construction

Date	Event
1969	Construction of Old East Fly Ash Pond, East Fly Ash Pond, and West Fly Ash Pond external perimeter embankment
1979	Construction of East Fly Ash Pond and West Fly Ash Pond northern embankment
1989	Raise inboard perimeter of the entire East Fly Ash Pond and West Fly Ash Pond
1995	Construction of interior dike between the East Fly Ash Pond and West Fly Ash Pond
1999	Raise of interior dike between the East Fly Ash Pond and West Fly Ash Pond; replacement of outlet pipe from the West Fly Ash Pond to the Secondary Pond
2012	Modification of BAP embankment (original construction date unknown)
2016	Closure Plan completed for the FAPS and approved by IEPA
2020	FAPS closure activities, including construction of a final cover system, and FAPS closure completed

2. SITE GEOLOGY AND HYDROGEOLOGY

BAP hydrogeologic data presented in the HCR (Ramboll, 2021c) and BAP hydrogeologic data collected after submittal of the HCR in 2021 as part of the 2022 Hydrogeologic Site Investigation were used to establish a CSM for this GMR and is summarized below. Refer to the HCR (Ramboll, 2021c) for more details of regional and local site characteristics. BAP hydrogeologic data collected as part of the 2022 Hydrogeologic Site Investigation will be presented in a revised HCR to be included in a construction permit application for submittal to IEPA no later than August 1, 2023. Surface elevations range from approximately 415 feet North American Vertical Datum of 1988 (NAVD88) in the east side of the BAP to 450 feet NAVD88 in the west side of the BAP. Topographic maps drawn prior to construction indicate the areas of the BAP were generally between 400 and 430 feet National Geodetic Vertical Datum of 1929 (NGVD29), which included a drainage feature near the west end of the BAP (Figure 2-2 of the HCR). Topography in the vicinity of the Site (**Figure 1-1**) ranges from approximately 370 feet NAVD88 along the Kaskaskia River southwest of the Site to 450 feet NAVD88 towards the south and east. The principal surface drainage for the region is the Kaskaskia River.

There are five principal types of unlithified materials above the bedrock in the vicinity of the BAP, these include the following in descending order:

- Fill, predominantly coal ash (fly ash, bottom ash, and slag) within the CCR units, but also including general fill within constructed levees around the Cooling Pond, constructed berms around the Site, and constructed railroad embankments south of the Site;
- Alluvial clay, sandy clay, and clayey sand of the Cahokia Formation (ranging in thickness at the BAP from 13 to 27 feet);
- Silt and silty clay of the Peoria Loess (ranging in thickness at the BAP from 2 to 23 feet);
- Clay and sandy clay of the Equality Formation (ranging in thickness at the BAP from 8 to 37 feet), with occasional sand seams and lenses; and
- Clay and sandy clay diamictons of the Vandalia Till (ranging in thickness at the BAP from 11 to 37 feet) with intermittent and discontinuous sand lenses.

Depth to bedrock ranges from approximately 28.4 feet towards the west end of the BAP (MW-370) to approximately 57 feet immediately north of the BAP (MW-393).

Three distinct water-bearing units have been identified in the vicinity of the BAP based on stratigraphic relationships and common hydrogeologic characteristics. The units are described as follows from the surface downward:

- **CCR**: CCR, consisting primarily of fly ash, bottom ash, and boiler slag. Also includes earthen fill deposits of predominantly clay and silt materials from on-site excavations that were used to construct berms and roads surrounding the various impoundments across the Site. The overall (geometric mean) horizontal and vertical hydraulic conductivity for the CCR determined during the Phase II and 2022 Hydrogeologic Site Investigations are 1.5×10^{-2} centimeters per second (cm/s) and 4.1×10^{-5} cm/s, respectively. Horizontal and vertical hydraulic conductivities for this unit determined during the Phase II and 2022 Hydrogeologic Site Investigations ranged from 8.1×10^{-4} to 1.1×10^{-1} cm/s and 5.6×10^{-7} to 6.5×10^{-4} cm/s, respectively.

- **UU**: Predominantly clay with some silt and minor sand, silt layers, and occasional sand lenses. Includes the lithologic layers identified as the Cahokia Formation, Peoria Loess, Equality Formation, and Vandalia Till. This unit is composed of unlithified natural geologic materials and extends from the upper saturated materials to the bedrock. As observed in the field, one or more of these four lithologic units may be present at a particular soil boring location; and, the observed lithologic unit(s) may or may not be saturated depending on location at the Site. Given that these units are not consistently in contact with groundwater, this unit was renamed from UGU used in previous reports to UU. The term UU is synonymous with UGU used in previous documents. The overall (geometric mean) horizontal and vertical hydraulic conductivities for this unit determined during the Phase II and 2022 Hydrogeologic Site Investigations are 2.9 x 10^{-5} cm/s and 3.5 x 10^{-7} cm/s, respectively. Horizontal and vertical hydraulic conductivities for this unit determined during the Phase II and 2022 Hydrogeologic Site Investigations ranged from 3.5 x 10^{-7} to 6.8 x 10^{-4} cm/s and 6.3 x 10^{-9} to 4.2 x 10^{-4} cm/s, respectively. Thin sand seams and the interface (contact) between the UU and bedrock have been identified as PMPs. No continuous sand seams were observed within or immediately adjacent to the BAP; however, the sand seams may act as a PMP due to relatively higher hydraulic conductivities (on the order of 10^{-4} cm/s) than the surrounding clays (on the order of 10^{-5} cm/s). The contacts between the unlithified material and bedrock have also been identified as PMPs where horizontal hydraulic conductivity data in Site monitoring wells with screens and/or filter packs across or immediately above the bedrock range from 3 x 10^{-7} to 6 x 10^{-4} cm/s and have a geometric mean horizontal hydraulic conductivity of 2 x 10^{5} cm/s.
- **Bedrock Unit**: This unit is composed of interbedded shale and limestone bedrock, which underlies and is continuous across the entire Site and has been identified as the UA. The horizontal hydraulic conductivity for this unit determined during the Phase II and 2022 Hydrogeologic Site Investigations ranges from 2.4 x 10^{-7} to 3.5 x 10^{-5} cm/s with a geometric mean of 1.9 x 10^{-6} cm/s (Ramboll, 2021c).

In general, the UU consists of low permeability clays and silts. Within the UU, only thin and intermittent sand lenses are present within predominantly clay deposits; thus, the unlithified materials do not represent a continuous aquifer unit. Thin, non-continuous sandy deposits (*i.e.,* PMPs) that exist across the Site do not appear to extend to the FAPS and BAP as evidenced by soil borings adjacent to the CCR units in which no sand was observed.

The extent of sand and gravel aquifers in the region are primarily found along the Kaskaskia River Valley where sand and gravel deposits are highly permeable, thick, and extensive. Outside of the Kaskaskia River Valley, the unlithified materials in upland areas are predominantly clay, which generally provide a low probability of encountering sand and gravel layers for dependable groundwater supply. Although some thin sand seams and layers occur intermittently within the Vandalia Till in localized areas around the BPP, most groundwater supplies in upland areas are obtained from large diameter shallow bored wells. Typical water wells in the vicinity of the BPP are between 25 and 55 feet deep, 36 to 48 inches in diameter, and collect groundwater through slow percolation into the wells, which are large diameter to allow for greater water storage to compensate for the low rate of groundwater infiltration (Ramboll, 2021c).

The underlying bedrock at the Site is Pennsylvanian and Mississippian bedrock, mainly limestone and shale. A bedrock low is present at the southwest corner of the Site and extends northeastward. The Tertiary Pond in the southwest corner of the Site corresponds to the lowest observed bedrock surface elevation (372.6 feet NAVD88). Higher bedrock elevations are present east of the BPP and FAPS as observed at MW-358 (428.6 feet NAVD88). The bedrock in the vicinity of the BAP yields small amounts of water from interconnected pores, cracks, fractures, crevices, joints, and bedding planes. The shallow bedrock is the only water-bearing unit that is continuous across the Site. Shallow sandstone and creviced limestone may yield small supplies in some areas, but water quality becomes poorer (*i.e.,* highly mineralized) with increasing depth. The Pennsylvanian and Mississippian rocks generally have low porosities and permeabilities, are not a reliable source of groundwater, and the quality varies considerably (Pryor, 1956). Limestones intercepted at the Site are generally light to dark gray, fine-grained, thin bedded, banded, argillaceous, and competent except where weathered. Weathering of the limestone produces a calcareous clay. Limestone layers are often interbedded with thin shale layers and are sometimes fossiliferous or sandy. The shale layers are generally weathered, competent, silty, slightly micaceous, fissile, and dark gray. Where highly weathered shale (*i.e.,* decomposed bedrock) was encountered, the shale was non-fissile and resembled an unlithified stiff clay with medium to high plasticity.

The locations of groundwater monitoring wells are provided on **Figure 2-1**. Based on elevation measurements, lateral groundwater flow in the shallow unlithified materials and bedrock is generally to the west and southwest across the Site (**Figure 2-2**) toward the Kaskaskia River. Groundwater flow in bedrock is toward the northwest in the east and central areas of the BAP, and southwest to northwest on the east area of the FAPS until groundwater reaches the bedrock valley feature underlying the Secondary and Tertiary Ponds west of the BAP and FAPS, at which point the flow direction veers towards this bedrock surface low. Groundwater elevations across the Site vary seasonally, generally less than 7 feet, and range between approximately 370 and 450 feet NAVD88, although flow directions are generally consistent. Additional potentiometric surface maps are located in Figures 3-2 to 3-9 of the HCR (Ramboll, 2021c) and will be included as part of the revised HCR.

In the western area of the FAPS, average horizontal hydraulic gradients in the shallow unlithified materials and bedrock were 0.015 feet per foot/feet (ft/ft) and 0.016 ft/ft, respectively, as groundwater flowed from east to west across the FAPS. Average groundwater velocities in the shallow unlithified materials and bedrock in the western area of the FAPS were 0.0082 and 0.0003 feet per day (ft/day), respectively. In general, flow velocities in the vicinity of the FAPS are consistent, varying only 0.0019 ft/day in the shallow unlithified materials and 0.0002 ft/day in the bedrock.

Between monitoring wells in the northeastern portion of the BAP, average horizontal hydraulic gradients in the shallow unlithified materials and bedrock were 0.004 and 0.003 ft/ft, respectively, as groundwater flowed southeast to northwest across the BAP. Average groundwater velocities in the shallow unlithified materials and bedrock in the northeast portion of the BAP were 0.0023 and 0.0001 ft/day, respectively. Between monitoring wells in the western portion of the BAP average horizontal hydraulic gradients in the shallow unlithified materials and bedrock were 0.011 and 0.017 ft/ft, respectively, as groundwater flowed northeast to southwest across the BAP. Average groundwater velocities in the west area of the BAP in shallow unlithified materials and bedrock were 0.0058 and 0.0003 ft/day, respectively. In general, flow velocities are consistent, varying only 0.001 ft/day in shallow unlithified materials and 0.0001 ft/day in bedrock in the vicinity of the BAP.

Groundwater in the Pennsylvanian and Mississippian-aged bedrock mainly occurs under semi confined to confined conditions as demonstrated with vertical hydraulic gradient calculations presented in the HCR (Ramboll, 2021c), with the overlying unlithified unit behaving as the upper confining unit to the UA (Bedrock Unit). The relatively flat horizontal groundwater gradient beneath the Site, and the mostly upward vertical gradients, inconsistent upward/downward vertical gradients or flowing artesian conditions observed in the UU and UA, suggests the BAP and neighboring ponds are not areas of increased recharge or infiltration (Ramboll, 2021c). These findings are further supported by the results of the 2022 Hydrogeologic Site Investigation, which will be included as part of a revised HCR.

In 2022, additional wells were installed as part of the 2022 Hydrogeologic Site Investigation, after the initial HCR was completed (Ramboll, 2021c), for further hydrogeologic investigation and water quality evaluation. The results of the 2022 Hydrogeologic Site Investigation and water quality evaluation will be included in a revised HCR. A summary of monitoring well locations and construction details for wells used in this GMR are included in **Table 2-1** and the locations are depicted on **Figure 2-1**. Groundwater elevation readings and lithologic contact information from the wells completed in 2022 have been incorporated into this GMR. Groundwater elevation data from 48 of the 78 total monitoring wells included in **Table 2-1** and depicted on **Figure 2-1**, were utilized as groundwater model flow calibration targets as summarized in **Table 2-2** and described in **Sections 5.2 and 5.2.2**. Boron concentration data from 50 of the 78 total monitoring wells included in **Table 2-1** and depicted on **Figure 2-1**, were utilized as transport model calibration targets as summarized in **Table 2-2** and described in **Sections 5.2 and 5.2.3**. Complete documentation of the 2022 Hydrogeologic Site Investigation activities at the BAP including boring logs, monitoring well and piezometer construction forms, and summary tables of testing results (*e.g.,* groundwater analytical results, horizontal and vertical gradient calculations, and single well aquifer test results), will be provided in a revised HCR after completion of eight independent groundwater sampling events.

3. GROUNDWATER QUALITY

The classification of groundwater at the Site was addressed in the Phase II investigation (NRT, 2014a). Field hydraulic conductivity tests performed on the UU materials (*i.e.,* Cahokia Formation, Equality Formation, and Vandalia Till) and Bedrock Unit materials (*i.e.,* Mississippian and Pennsylvanian bedrock) as part of the Phase II and 2022 Hydrogeologic Site Investigations had geometric mean hydraulic conductivities of 2.9 x 10^{-5} cm/s and 1.9 x 10^{-6} cm/s, respectively.

Geologic material with a hydraulic conductivity of less than 1 x 10^{-4} cm/s which does not meet the provisions of 35 I.A.C. § 620.210 (Class I), 35 I.A.C. § 620.230 (Class III), or 35 I.A.C. § 620.240 (Class IV), meets the definition of a Class II – General Resource Groundwater (35 I.A.C. § 620.220). Based on the detailed geologic information provided for the unlithified materials and bedrock at BPP, along with the hydrogeologic data, the groundwater in both the unlithified deposits and underlying bedrock at the Site is classified as Class II - General Resource Groundwater.

Bedrock was intercepted at 42 borings/well locations installed during the Phase II Investigation, the investigation for Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan, and the 2022 Hydrogeologic Site Investigation. The UA at the Site is the shallow Pennsylvanian and Mississippian-aged bedrock that immediately underlies the unlithified deposits. The shallow bedrock yields water through interconnected secondary porosity features (*e.g.* cracks, fractures, crevices, joints, bedding planes, and other secondary openings). The shallow bedrock is the only water-bearing unit that is continuous across the Site. Groundwater in the Pennsylvanian and Mississippian-aged bedrock mainly occurs under semi-confined to confined conditions with the overlying unlithified unit behaving as the upper confining unit to the UA. Off-site, immediately upgradient and downgradient of the BPP property boundaries, both the shallow glacial deposits and the shallow bedrock have served as a source of water supply (see water well survey in Section 5.1 of the HCR; Ramboll, 2021c). The shallow unlithified deposits off-site have yielded water through intermittent, discontinuous sand lenses and, in the bedrock, through fractured sandstone and limestone. However, within the boundaries of the Site, only thin and intermittent sand lenses are present within predominantly clay deposits; thus, the unlithified materials do not represent a continuous aquifer unit. Based on the above, the Bedrock Unit is the only viable aquifer in the vicinity of the Site and was designated as the UA in the Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan (NRT, 2016b), consistent with the United States Environmental Protection Agency (USEPA) definition in Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.53.

Water quality in the UA (*i.e.,* Pennsylvanian and Mississippian-aged bedrock) decreases with increasing depth as water becomes increasingly mineralized. Further, the ability of the unit to store and transmit water is dependent on the density of bedrock features that contribute to secondary porosities and whether those features are interconnected enough to yield water. Therefore, the lower limit of the UA is the depth at which either the groundwater is mineralized to a point that it is no longer a useable water source, or the secondary porosities do not yield a sufficient volume of groundwater to produce a useable water supply.

A monitoring well network was included in a proposed BAP GMP (Ramboll 2021a) to satisfy requirements of 35 I.A.C. § 845 and was submitted as part of the operating permit application for the BAP in 2021. Additional wells completed in 2022 will be included in a revision to the proposed GMP that will be included as part of the construction permit application for submittal to IEPA no later than August 1, 2023. A review and summary of data collected from 2015 through completion of eight independent groundwater sampling events collected at wells identified in the revised BAP GMP will be included in the revised HCR. A draft revision to the History of Potential Exceedances was completed by comparing groundwater results collected through April 2023 to the applicable GWPS in accordance with the proposed groundwater monitoring plan and methodologies provided in the operating permit application for the BAP (an initial History of Potential Exceedances was submitted as part of the operating permit application for the BAP in 2021 [Ramboll, 2021b]). For completeness, groundwater data collected through April 2023 from wells installed in 2022 (after the operating permit application was submitted) were also compared to the GWPS using the methodologies provided in the operating permit application. The Draft Determination of Potential Exceedances (Table 1 of **Appendix A**) and Draft Summary of Potential Exceedances (Table 2 of **Appendix A**) indicate the following potential exceedances:

- Chloride at wells MW-370, MW-392, MW-393, and MW-394
- Cobalt (unconfirmed) at well PZ-170
- Fluoride at well MW-393
- Lithium at well MW-370
- Total Dissolved Solids (TDS) at wells MW-370, and MW-394

An ASD (**Appendix B**) was prepared by Ramboll (2023) to further evaluate potential GWPS exceedances. The results of the evaluation demonstrated that the potential GWPS exceedance of lithium in well MW-370 was not related to the BAP based on several lines of evidence presented in the ASD. Since potential GWPS exceedances for lithium are not related to the BAP, lithium will not be discussed further in this GMR.

Cobalt (total) has only been tested once in groundwater sampled from well PZ-170; a confirmation sample will be collected. If the potential exceedance is confirmed, an ASD will be pursued. As indicated by the porewater results presented in the HCR (Ramboll, 2021c), very little cobalt has been detected in the porewater samples collected at the BAP, and the concentrations of cobalt detected in porewater are lower than those observed in the sample collected from PZ-170. Since this potential exceedance has not been confirmed and an ASD will be pursued, cobalt will not be discussed further in this GMR.

ASDs will be pursued for potential exceedances of chloride, fluoride, and TDS. Additional data is being collected to support multiple lines of evidence for presentation in a memorandum following commencement of quarterly monitoring. Since ASDs are being pursued, chloride, fluoride, and TDS will not be discussed further in this GMR.

Quarterly monitoring under 35 I.A.C. § 845.650(b) will commence no later than the second quarter of 2023. At the time the groundwater modeling was completed, quarterly monitoring had not been initiated. As such, comparisons of groundwater contaminant concentrations to the GWPS in this report are considered potential exceedances. Potential exceedances of the GWPS are presented in the attached revision to the History of Potential Exceedances (**Appendix A**). Based on statistical analysis, evaluation of subsequent potential exceedances of the GWPS, and intention to pursue ASDs, it has been determined there are no potential exceedances of applicable groundwater standards attributable to the BAP.

4. GROUNDWATER MODEL

4.1 Overview

Data collected from previous field investigations, as well as the lithologic contact, groundwater elevation, and boron concentration data from 2022 Hydrogeologic Site Investigation and subsequent groundwater sampling events, were used to develop a groundwater flow and transport model for the BAP. The MODFLOW (flow) and MT3DMS (transport) models were used to evaluate one closure scenario: CCR consolidation and CIP using information provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a). The results of the MODFLOW and MT3DMS modeling of the CIP closure scenario are summarized in this GMR. Associated model files are included as **Appendix C.** Contaminant transport modeling was completed in 2023 following the collection of additional groundwater samples from the monitoring wells installed in 2022. Transport modeling results are provided in this revised GMR and will be included in a construction permit application for submittal to IEPA no later than August 1, 2023.

4.2 Conceptual Site Model

The HCR (Ramboll, 2021c) is the foundation document for the site setting and CSM that describes groundwater flow at the Site. Additional hydrogeologic data was collected after submittal of the HCR during the 2022 Hydrogeologic Site Investigation and included in this GMR to support the CSM and develop the model. The BAP overlies the recharge area for the underlying geologic media (*i.e.,* low permeability clays of the UU). Groundwater enters the model domain vertically via recharge. Groundwater may also enter or exit the model through the Cooling Pond, Secondary and Tertiary Ponds, the Kaskaskia River, or the many tributary streams located within the model domain. Groundwater may also exit the model through surface water management features within the BAP. Groundwater in the unlithified materials consistently flows east to west towards the Kaskaskia River. Groundwater flow in bedrock is northwest in the east and central areas of the BAP, and southwest to northwest on the east area of the FAPS until groundwater reaches the bedrock valley feature underlying the Secondary and Tertiary Ponds west of the BAP and FAPS, at which point the flow direction veers towards this bedrock surface low at the southwestern corner of the Site.

Groundwater contaminant transport modeling was completed to demonstrate how the proposed CIP closure scenario will maintain compliance with the applicable GWPS. Boron is commonly used as an indicator parameter for contaminant transport modeling for CCR because it is commonly present in coal ash leachate and it is mobile (*i.e.*, has low rates of sorption or degradation) in groundwater. The Draft Revision to the History of Potential Exceedances (**Appendix A**) did not identify boron as a potential exceedance of the GWPS; however, boron has been detected in BAP porewater and groundwater. Therefore, groundwater transport modeling was completed using boron. The BAP and FAPS were modeled as sources of boron within the model domain. The BAP and FAPS are constructed over low permeability clays of the UU. Mass (boron) is added to groundwater via vertical recharge through CCR, and horizontal groundwater flow through CCR where it is in contact with the water table. Boron mass flows with groundwater (onsite groundwater flow directions described above). The primary transport pathway is the UA which underlies the BAP and is continuous across the entire Site. The UU also contains PMPs in the form of thin discontinuous sand seams within the UU or at the interface (contact) between the UU and bedrock where hydraulic conductivities are relatively higher.

4.3 Model Approach

A three-dimensional groundwater flow and transport model was calibrated to represent the conceptual flow system described above. Initial steady state flow modeling was performed to represent current Site conditions in 2022 following closure of the FAPS in 2020. This flow model was calibrated to match median groundwater elevations for recent groundwater elevation data. The calibrated steady state flow model was used to develop a calibrated transient flow and transport model to match recent boron concentrations observed at each monitoring well. The calibrated model was then used to evaluate the effectiveness of the CIP closure scenario. The start of the transient flow and transport model was initiated in 1970 (model year 0) when the BPP began operation and the BAP and FAPS were active (initial conditions model) through 2020 (51 model years) when closure at the FAPS was complete. Three models were included for the closure prediction simulation. The first model simulated an extended period of current conditions, 2021 to 2024 (4 model years). The second model simulated a period for the removal of free liquids, 2025 to 2027 (3 model years). The third model simulated the final closure conditions, 2028 to 3027 (1,000 model years). The prediction modeling timeline for the CIP closure scenario is illustrated in **Figure 4-1**.

Three model codes were used to simulate groundwater flow and contaminant transport:

- Groundwater flow was modeled in three dimensions using MODFLOW 2005
- Contaminant transport was modeled in three dimensions using MT3DMS
- Percolation (recharge) after consolidation of CCR and cover system construction was modeled using the results of the Hydrologic Evaluation of Landfill Performance (HELP) model.

5. MODEL SETUP AND CALIBRATION

5.1 Model Descriptions

For the construction and calibration of the numerical groundwater flow model for the Site, Ramboll selected the model code MODFLOW, a publicly available groundwater flow simulation program developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system—given user-supplied inputs of hydraulic conductivity, aquifer/layer thickness, recharge, wells, and boundary conditions. The program also calculates water balance at wells, rivers, and drains.

Major assumptions of the MODFLOW code are: (i) groundwater flow is governed by Darcy's law; (ii) the formation behaves as a continuous porous medium; (iii) flow is not affected by chemical, temperature, or density gradients; and (iv) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988). MODFLOW 2005 was used for these simulations with Groundwater Vistas 8 software for model pre- and post- processing tasks (Environmental Simulations, Inc., 2018).

MT3DMS (Zheng and Wang, 1998) is an update of MT3D. It calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay, and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods, and the higher-order finite-volume total-variation-diminishing (TVD) method for the solution schemes. The finite difference solution has numerical dispersion for low-dispersivity transport scenarios but conserves good mass balance. The particle-tracking method avoids numerical dispersion but was not accurate in conserving mass. The TVD solution is not subject to significant numerical distribution and adequately conserves mass, but is numerically intensive, particularly for long-term models such as developed for the BAP. The finite difference solution was used for this simulation.

Major assumptions of MT3DMS are: (i) changes in the concentration field do not affect the flow field; (ii) changes in the concentration of one solute do not affect the concentration of another solute; (iii) chemical and hydraulic properties are constant within a grid cell; and (iv) sorption is instantaneous and fully reversible, while decay is not reversible.

The HELP model was developed by the USEPA. HELP is a one-dimensional hydrologic model of water movement across, into, through, and out of a landfill or soil column based on precipitation, evapotranspiration, runoff, and the geometry and hydrogeologic properties of a layered soil and waste profile. For this modeling, results of the HELP model, HELP Version 4.0 (Tolaymat and Krause, 2020), were used to estimate the hydraulic conditions beneath consolidation areas.

5.2 Flow and Transport Model Setup

The modeled area was approximately 11,125 feet (445 rows) by 16,375 feet (655 columns) with the BAP located in the east-central portion of the model. The western edge of the model is bounded by the Kaskaskia River. The north, east, and south edges of the model were selected to maintain sufficient distance from the BAP to reduce boundary interference with model calculations, while not extending too far past the extent of available calibration data. The model area is displayed in **Figure 5-1**.

The MODFLOW model was calibrated to median groundwater elevation collected from December 2015 to June 2022. The flow model calibration targets are presented in **Table 2-2**. MT3DMS was run on the calibrated flow model and model-simulated concentrations were calibrated to the range of observed boron concentration values at the monitoring wells from December 2015 to December 2022 presented in **Table 2-2**. Multiple iterations of MODFLOW and MT3DMS calibration were performed to achieve an acceptable match to observed flow and transport data. For the BAP, the calibrated flow and transport models were used in predictive modeling to evaluate the CIP closure scenario by consolidating CCR and using HELP modeled recharge values to simulate changes proposed in the closure scenario.

5.2.1 Grid and Boundary Conditions

A six-layer, 445 x 655 node grid was established with 25-foot grid spacing in the vicinity of the BAP and BPP property. The grid increases gradually to a maximum 450-foot row spacing and 225-foot column spacing near the edges of the model. The model grid and boundary conditions are illustrated in **Figures 5-2 through 5-7**. All edges of the model are no-flow (*i.e.,* Neumann) boundaries in all layers of the model with the exceptions of the western edge in layer 4, where a river (mixed) boundary was placed to simulate the mean flow conditions of the Kaskaskia River, and vary between no-flow (*i.e.,* Neumann) and river (*i.e.,* mixed) boundaries on the northern edge in layers 2 through 4, where a river (*i.e.,* mixed) boundary was placed to simulate the Cooling Pond, and the southern edge in layers 2 through 4, where river (*i.e.,* mixed) boundary was placed to simulate the southernmost tributary. The limits of the model domain approximate the limits of the Kaskaskia River subwatershed (Hydrologic Unit Code [HUC] boundary) in which the BPP and BAP reside. The top of the model was a time-dependent specified flux (*i.e.,* Neumann) boundary, with specified flux rates equal to the recharge rate. Surface water features within the active BAP were simulated in the model as constant head boundaries.

5.2.2 Flow Model Input Values and Sensitivity

Flow model input values and sensitivity analysis results are presented in **Table 5-1** and described below.

The modeled well location layers and flow model calibration targets (*i.e.*, median groundwater elevations from December 2015 to June 2022 [or November 2022 groundwater elevations for wells constructed or reoccupied in 2022] and target well locations) are summarized in **Table 2-2**. Anomalous groundwater elevations (*e.g.,* groundwater elevations that do not represent static groundwater conditions, groundwater elevation outliers, or groundwater elevations measured in error) monitored between December 2015 and June 2022 were removed from the median groundwater elevation calculations used as flow calibration targets. UU wells MW-151, MW-154, MW-252, and MW-253 are screened just above or at the interface between the UU and decomposed bedrock of the UA and may be hydraulically connected to multiple hydrostratigraphic units (*i.e.,* multiple modeled layers). In the flow calibration model, flow calibration targets for UU wells MW-151, MW-154, MW-252, and MW-253 were placed in the decomposed bedrock model layer, which exhibited heads more representative of the groundwater observations in these wells.

Sensitivity analysis was conducted by changing input values and observing changes in the sum of squared residuals (SSR). Horizontal conductivity, vertical conductivity, and river conductance terms were all varied between one-tenth and ten times calibrated values. Recharge terms were varied between one-half and two times calibrated values. River stage for river reach 0 (*i.e.,* Cooling Pond) and river reach 1 (*i.e.,* Kaskaskia River) were varied between 98.5 and 101.5 percent of calibrated values. River stage for river reaches 2 through 8 and constant head reaches 0 and 1 were varied between 99.5 and 100.5 percent of calibrated values. When the calibrated model was tested, SSR was 1,210.53. Sensitivity test results were categorized into negligible, low, moderate, moderately high, and high sensitivity based on the change in SSR as summarized in the notes in **Table 5-1**.

5.2.2.1 Model Layers

All available boring log data included in the HCR (Ramboll, 2021c) and lithologic contacts from the 2022 Hydrogeologic Site Investigation activities were used to develop surfaces utilizing Surfer® software for each of the three distinct water-bearing units described in **Section 2**. Layer 1 (**Figure 5-8**) modeled only CCR material within the limits of the BAP and FAPS; no flow cells were used outside the limits of the CCR units. The approximate base of ash surface in the BAP was provided by Geosyntec, which was developed using historic pre-construction topographic maps and incorporated base of ash data collected by Ramboll from borings within the BAP completed in 2022. The approximate base of ash surface in the FAPS was developed using historic pre-construction topographic maps. The modeled UU was split into three modeled layers, where model layer 2 (**Figure 5-9**) represented the upper silty clay of the UU, model layer 3 (**Figure 5-10**) represented a discontinuous transmissive zone within the UU (this unit is considered a PMP) or represented the approximate top of Vandalia Till/lower silty clay of UU in absence of a transmissive zone, and model layer 4 (**Figure 5-11**) represented the lower silty clay of the UU. Model layer 5 (**Figure 5-12**) represented the decomposed bedrock of the UA near the contact between the UU and UA. Model layer 6 (**Figure 5-13**) represented the deeper more competent bedrock of the UA. The bottom elevation of the UA (*i.e.,* bedrock) in layer 6 was flat lying and assumed to be an elevation of 200 feet NAVD88. The resulting surfaces were imported as layers into the model to represent the distribution and change in thickness of each water-bearing unit across the model domain.

5.2.2.2 Hydraulic Conductivity

Hydraulic conductivity values and sensitivity results are summarized in **Table 5-1**. When available, these values were derived from field or laboratory measured values reported in the HCR (Ramboll, 2021c) and collected during the 2022 Hydrogeologic Site Investigation, to be representative of site-specific conditions. The sources of the hydraulic conductivity values are summarized in **Table 5-1**. Conductivity zones that did not have representative site data were determined through model calibration. No horizontal anisotropy was assumed. Vertical anisotropy (presented as Kh/Kv in **Table 5-1**) was applied to conductivity zones to simulate preferential flow in the horizontal direction in the UU and UA.

The spatial distribution of the hydraulic conductivity zones in each layer (**Figures 5-14 through 5-19**) simulates the distribution of hydraulic conductivity as reported in the HCR (Ramboll, 2021c) and determined from hydrogeologic data collected during the 2022 Hydrogeologic Site Investigation. All hydraulic conductivity zones were laterally continuous within the model with the exception of the CCR hydraulic conductivity zones Old East Fly Ash Pond, East Fly Ash Pond, West Fly Ash Cell, and BAP (zones 2, 3, 4, and 7); the fill at the BAP and FAPS boundary (zone 16), the river alluvium hydraulic conductivity zone (zone 12); and the PMP hydraulic conductivity zone (zone 14). The limits of the ash fill were determined from data presented in the HCR (Ramboll, 2021c) and determined from hydrogeologic data collected during the 2022 Hydrogeologic Site Investigation. The ash fill extent was propagated through all related ash fill property zones (*i.e.*, recharge, storage, specific yield [S_Y], and effective porosity). Conductivity zone 100 (identified on figures as "Above River BC") was placed above river cells to improve communication between the river and the groundwater in layers above the layer in which the river boundary condition was placed.

The model had a high sensitivity to changes in horizontal conductivity in zone 9 (*i.e.,* UA), and a moderate sensitivity in zone 1 (*i.e.,* UU), zone 7 (*i.e.,* BAP), and zone 14 (*i.e.,* PMP); the model had a low or negligible sensitivity to changes in horizontal conductivity in the remaining hydraulic conductivity zones. The model had a moderate sensitivity to changes in vertical conductivity in zone 1 (*i.e.,* UU) and zone 9 (*i.e.,* UA), while the model exhibited a negligible sensitivity in the remaining hydraulic conductivity zones.

5.2.2.3 Recharge

Recharge rates (**Table 5-1**) were determined through calibration of the model to median groundwater elevation collected from December 2015 to June 2022, as presented in **Table 2-2**. The spatial distribution of recharge zones was based on the location and type of material present at land surface (**Figure 5-20**). Seven different zones were created to simulate recharge in the model area. A single silty clay zone (zone 1) was used to simulate ambient recharge over the upper silty clay of the UU outside the limits of the CCR units. Zones 5 and 6 were used to simulate recharge over the upper silty clay of the UU in the area of the Secondary Pond and Tertiary Pond, respectively. The recharge occurring through the ash fill placed in the FAPS and BAP was split into four different values, where recharge was varied based upon the historical use of each ash fill area and the response of flow calibration target heads. Post-closure FAPS recharge rates for the Old East Ash Pond, East Fly Ash Pond, and West Fly Ash Cell (zones 2, 3, and 4) were consistent with previous prediction modeling values used for the proposed cover system at the FAPS (NRT, 2014b). The BAP was simulated with a single zone (zone 7) which also had the greatest recharge value within the model domain.

The model had low sensitivity to changes in recharge in all zones, with the exception of zones 5 (Secondary Pond) and 6 (Tertiary Pond), where sensitivity was negligible.

5.2.2.4 Storage and Specific Yield

The calibration model did not use these terms because it was run at steady state. For the transport model, which was run in transient, no field data defining these terms were available so published values were used consistent with Fetter (1988). S_Y was set to equal effective porosity values described in **Section 5.2.3.3**. The spatial distribution of the storage and S_Y zones were consistent with those of the hydraulic conductivity zones. The sensitivity of these parameters was tested by evaluating their effect on the transport model as described in **Section 5.2.3.4**.

5.2.2.5 River Parameters

River reaches are illustrated in **Figure 5-1**. The Kaskaskia River was simulated using head-dependent flux nodes in modeled river reach 1 that required inputs for river stage, width, bed thickness, and bed hydraulic conductivity (**Table 5-1**). River width, bed thickness, and bed hydraulic conductivity parameters were used to calculate a conductance term for the boundary node. This conductance term was determined by adjusting hydraulic conductivity during model calibration. The calibrated hydraulic conductivity value was set at 5.17 ft/day. The length of the modeled river extends from the northernmost extent of the model domain to the southernmost extent of the model domain using river reach 1. The modeled river stage in the calibration model was based on available Kaskaskia River stage data at Red Bud, Illinois (USGS 05595240) and at New Athens, Illinois (USGS 05595000) gaging stations in 2021 and 2022. No slope was applied to the upstream and downstream modeled river stage as calculated gradients between the two gaging stations were determined to be negligible across the length of the model domain. The river boundary was placed in layer 4 corresponding with simulated river elevation (**Figure 5-5**).

The Cooling Pond was simulated using head-dependent flux nodes in modeled river reach 0 (**Table 5-1**). The conductance term was determined by adjusting hydraulic conductivity during model calibration. The calibrated hydraulic conductivity value was set at 3.8 ft/day. The river stage in the calibration model approximated the elevation at which the Cooling Pond is maintained (Ramboll, 2021c). The river boundary was placed in layers 2 through 4 corresponding with simulated river elevation (**Figures 5-3 through 5-5**).

The Secondary and Tertiary ponds were simulated using head-dependent flux nodes in modeled river reach 8 (**Table 5-1**). The conductance term was determined by adjusting hydraulic conductivity during model calibration. The calibrated hydraulic conductivity value was set at 0.26 ft/day. The river stage in the calibration model approximated historic groundwater elevations measured in monitoring well TPZ-165 placed within the limits of the Secondary Pond (**Figure 2-1**) (NRT, 2014a). The bottom of the river boundary was estimated using historic topographic maps and placed in layers 2 through 6 corresponding with simulated river elevation (**Figures 5-3 through 5-7**).

The remaining tributaries were simulated using head-dependent flux nodes in modeled river reaches 2 through 5 and reach 7 (**Table 5-1**). The conductance terms were determined by adjusting hydraulic conductivity during model calibration. Calibrated hydraulic conductivity values by tributary river reach are shown in **Table 5-1**. The river stage in the calibration model approximated local topography for each reach. The river boundaries were placed in layers 2 through 5 corresponding with simulated river elevation (**Figures 5-3 through 5-6**).

The model had moderate and high sensitivity to changes in river stage at reach 0 (Cooling Pond) and reach 1 (Kaskaskia River), respectively. The model had high sensitivity at reach 7 (northeast stream [east of Cooling Pond]) and moderate to moderately high sensitivity at reach 3 (south stream [between reach 2 and reach 4]) and reach 4 (south stream [adjacent to FAPS]) (**Table 5-1**). The remaining river reaches had low to negligible sensitivity to changes in river stage. The model had negligible sensitivity to changes in river conductance.

5.2.2.6 Constant Head Boundary Parameters

Surface water features within the active BAP were simulated in the model as constant head boundaries. The constant head boundaries required inputs for head at the boundaries (elevation).

These constant head boundary features act as discharge features within the BAP, which is consistent with stormwater management practices within the active BAP (AECOM, 2016b). The head at the boundaries for reaches 0 and 1 estimated water surface elevation within the BAP. The constant head boundaries were placed in layer 1 within the BAP (**Figure 5-2**).

The model had negligible sensitivity to changes in head in reach 0 (BAP constant head west) and reach 1 (BAP constant head central).

5.2.3 Transport Model Input Values and Sensitivity

MT3DMS input values are listed in **Table 5-2** and described below. Sensitivity of the transport model is summarized in **Table 5-3**.

Groundwater transport was calibrated to groundwater boron concentration ranges at each well as measured from the monitoring wells between December 2015 and December 2022. The transport model calibration targets are summarized in **Table 2-2**.

Sensitivity analysis was conducted by changing input values and observing percent change in boron concentration at each well from the calibrated model boron concentration. Effective porosity was varied by decreasing and increasing calibrated model values by 0.05. Storage values were multiplied and divided by a factor of 10, and S_y by a factor of 2. High S_y sensitivity was not analyzed for zone 100 (identified on figures as "Above River BC") since the calibration value was already near upper limits of acceptable values for S_y (0.5).

5.2.3.1 Initial Concentrations

No initial concentrations were placed in the calibration model. The flow model was run as transient, and concentration was added to the model through recharge and constant concentration cells starting at the same time as the flow simulation. Two models (Calibration Model 1 and Calibration Model 2) run in series were used to calibrate concentrations to current observations and simulate changes in CCR unit operations at the Site from construction (1970) to present day (2022 [*i.e.,* current conditions]). The first model (Calibration Model 1) started at the time of BAP and FAPS construction (1970) and ended in 2020 (51-year calibration model period) when the FAPS was closed. The second model (Calibration Model 2) started in 2021 and ended in 2022 (2-year calibration model period) following the FAPS closure and included reduced recharge in the FAPS consistent with estimated closed FAPS recharge values in the 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c), and removal of constant head cells in the West Ash Pond that were used to simulate stormwater management operations in the active FAPS in Calibration Model 1 to simulate the reduced activity in this area of the pond. The transport model timeline is illustrated in **Figure 4-1**.

5.2.3.2 Source Concentrations

Five concentration sources in the form of vertical percolation (recharge zones) through CCR were simulated in layer 1 for calibration (**Figure 5-20 and Table 5-2**) (recharge zones in order of greatest to least simulated recharge): (i) percolation through CCR in the active BAP (zone 7, BAP [West]; zone 8, BAP [East]), and (ii) percolation through CCR in the FAPS (zone 2, Old East Fly Ash Pond; zone 3, East Fly Ash Pond; zone 4, West Fly Ash Pond) active 1970 to 2020 (Calibration Model 1) and closed 2020 to 2022 (Calibration Model 2). All five sources were simulated by assigning concentration to the recharge input. Recharge rates in the active BAP were consistent across zone 7 (BAP [West]) and zone 8 (BAP [East]) which approximately bisect the active BAP; however, concentrations applied to recharge zones 7 and 8 were 4 and 1.5 mg/L, respectively, to reflect concentrations of boron observed at CCR porewater wells in each side of the active BAP.

The CCR sources were also simulated with constant concentration cells placed in layer 1 to simulate saturated ash conditions (see constant concentration cell reaches described in **Table 5-2**). From the model perspective, this means that when the simulated water level is above the base of these cells, water that passes through the cell will take on the assigned concentration. The spatial distributions of source concentrations applied to constant concentration cell reaches (saturated ash cells) are consistent with the spatial distributions of concentrations applied to the recharge zones. All source concentrations were calibrated in the transport model to the boron concentration data collected from December 2015 to December 2022.

Because these are the sources of concentration in the model, the model will be highly sensitive to changes in the input values. For that reason, sensitivity testing was not completed for the source values.

5.2.3.3 Effective Porosity

Effective porosity for each modeled zone were derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983), for each material modeled then adjusted during model calibration and presented in **Table 5-2**. The spatial distribution of the effective porosity zones was consistent with those of the hydraulic conductivity zones.

Sensitivity testing was completed on all wells and the results are provided in **Table 5-3**. Monitoring locations where the calibrated and tested concentrations were below 0.1 mg/L boron are not included in the following discussion of model sensitivity to boron transport. The model had a negligible to moderately high sensitivity to decreases in porosity values, with exception of MW-382 where sensitivity was high. The model had a negligible to moderate sensitivity to increases in porosity values, with exception of three monitoring locations where sensitivity was moderately high (*i.e.,* MW-382, MW-385, and MW-390).

5.2.3.4 Storage and Specific Yield Sensitivity

Sensitivity testing was completed on all wells and the results are provided in **Table 5-3**. Monitoring locations where the calibrated and tested concentrations were below 0.1 mg/L boron are not included in the following discussion of model sensitivity to boron transport. The transport model had a negligible to moderate sensitivity to decreases in storage and S_Y, with exception of seven monitoring locations where sensitivity was moderately high (i.e., MW-151, MW-366, MW-375, MW-382, MW-384, MW-385, and MW-390). The transport model had a negligible to moderately high sensitivity to increases in storage and S_Y, with exception of three monitoring locations where sensitivity was high (i.e., MW-382, MW-385, and MW-390).

5.2.3.5 Dispersivity

Physical attenuation (dilution and dispersion) of contaminants is simulated in MT3DMS. Dispersion in porous media refers to the spreading of contaminants over a greater region than would be predicted solely from the average groundwater velocity vectors (Anderson, 1979; Anderson, 1984). Dispersion is caused by both mechanical dispersion, a result of deviations of actual velocity at a microscale from the average groundwater velocity, and molecular diffusion driven by concentration gradients. Molecular diffusion is generally secondary and negligible compared to the effects of mechanical dispersion and only becomes important when groundwater velocity is very low. The sum of mechanical dispersion and molecular diffusion is termed hydrodynamic dispersion, or simply dispersion (Zheng and Wang, 1998).

Dispersivity values were applied to the entire model domain and determined during calibration. Longitudinal dispersivity was set at 5 feet. The transverse and vertical dispersivity were set at 1/10 and 1/100 of longitudinal dispersivity. These input values were determined during model calibration. With travel distances of less than 100 feet for groundwater from the source to the majority of the monitoring points, the model is not expected to be sensitive to dispersivity inputs and the sensitivity of the model to dispersivity was not tested.

5.2.3.6 Retardation

It was assumed that boron would not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 milliliters per gram [mL/g]) which is a conservative estimate for estimating contaminant transport times. Boron transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.*, adsorption and/or precipitation reactions as well as dilution and dispersion). Further assessment of these processes and how they affect boron transport at the Site will be completed as part of future remedy selection evaluations. For the purposes of this GMR, and as mentioned at the beginning of this section, no retardation was applied to boron, a surrogate for lithium in the groundwater model as described in **Section 4.3**, transport in the model (*i.e.,* Kd was set to 0).

5.3 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions were made while developing this model:

- Following closure of the FAPS in 2020, the groundwater flow system can be simulated as steady state for calibration to current conditions.
- Natural recharge is constant over the long term.
- Fluctuations in river stage do not affect groundwater flow over the long term.
- Hydraulic conductivity is consistent within each material (hydraulic conductivity zone) modeled.
- The approximate base of ash surface in the BAP was provided by Geosyntec, which was developed using historic pre-construction topographic maps and incorporated base of ash data collected by Ramboll from borings within the BAP completed in 2022. The approximate base of ash surface in the FAPS was developed using historic pre-construction topographic maps.
- Constant head cells were used to simulate surface water management features during operation of the CCR units.
- Recharge rates were modified, and constant head cells were removed after 2020 in the area of the FAPS to simulate closure.
- Source concentrations are assumed to remain constant over time. Only recharge rate was modified after 2020 to simulate FAPS closure.
- Boron is not adsorbed and does not decay; mixing and dispersion are the only attenuation mechanisms.

The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. Since data used for calibration are near the BAP and FAPS, model predictions of transport distant spatially and temporally from the calibrated conditions at the CCR units will not be as reliable as predictions closer to the CCR units and concentrations observed between 2015 and 2022.

5.4 Calibration Flow and Transport Model Results

Results of the MODFLOW modeling are presented below. Electronic copies of the model files are attached to this report (**Appendix C**).

Observed and simulated heads are presented in **Figure 5-21 through Figure 5-28**. The mass balance error for the flow model was 0.02 percent and the ratio of the residual standard deviation to the range was 5.4 percent. The mass balance error for the flow model was within the target for the criteria of 1 percent and the ratio of the residual standard deviation to the range was within the target for the criteria of 10 percent. Another flow model calibration goal is that residuals are evenly distributed such that there is no bias affecting modeled flow. The observed heads are plotted versus the simulated heads and identified by layer in **Figure 5-21**. The near-linear relationship between observed and simulated values indicates that the model adequately represents the calibration dataset. The residual mean was -1.33 feet; in general, the simulated values were evenly distributed above and below the observed values. This is also illustrated by layer in the observed versus residuals plot **Figure 5-22**. Some simulated values were overpredicted (negative values on **Figure 5-22**), where the most significant overpredicted values (exceeding 10 feet) were primarily within the UA (bedrock) of layer 6, largely at lower groundwater elevations near the Secondary and Tertiary Ponds, near the southwest boundary of the West Ash Pond of the FAPS, or in bedrock wells screened below the decomposed bedrock. These residuals plot in the lower left quadrant of **Figure 5-22**.

The range of observed boron concentrations between December 2015 and December 2022 for the fifty (50) transport calibration locations are summarized in **Table 2-2**. The goals of the transport model calibration were to have predicted concentrations fall within the range of observed concentrations, and/or have predicted concentrations above and below the GWPS for boron (2 mg/L) match observed concentrations above or below the standard at each well. Twenty (20) transport calibration locations had observed boron concentrations that ranged above and below the GWPS for boron (2 mg/L); for these locations the goal of transport model calibration was to have predicted concentrations above and below the GWPS for boron match observed median concentrations above or below the standard at each well (for example, if the median observed concentration for a well was above the GWPS, the goal is to have predicted concentrations above the GWPS at the well). One or more of these goals were achieved at all but five of the transport calibration location wells, specifically MW-150, MW-151, MW-356, MW-385, and MW-394, where concentrations were underpredicted with the exception of MW-151, where concentrations were overpredicted (**Figure 5-29**). Deviations from the observed boron concentrations are discussed below.

- MW-150, MW-356, and MW-394 were underpredicted transport calibration locations and had observed boron concentrations that ranged above and below the GWPS for boron (2 mg/L) with median observed concentrations only slightly above the GWPS for boron at 2.12, 2.01, and 2.02 mg/L, respectively.

- UU well MW-150 is nested with MW-350 at the southwest corner of the Site near the Tertiary Pond. The MW-150/MW-350 well nest was observed to have generally downward vertical gradients in the HCR (Ramboll, 2021c); however, other nested wells near the Secondary and Tertiary ponds indicate the presence of upward gradients between the UA and UU. The model calibration resulted in upward vertical gradients in these areas including the MW-150/MW-350 wells nest. The modeled gradients at this well nest likely inhibit the downward migration of simulated boron concentrations to MW-150. Nested well MW-350 has low observed boron concentrations and met the model calibration criteria discussed above.
- In general, the model under-predicts boron concentrations in bedrock locations like MW-356 and MW-394 where the range of concentrations observed (1.79 to 2.92 mg/L and 1.87 to 2.23 mg/L, respectively) are near the range of observed boron concentrations in upgradient bedrock wells like MW-304, where concentrations range from 1.27 to 2.16 mg/L. Since no initial concentrations were placed in the calibration model to represent the presence of boron observed in background wells, it is expected that the model may under-predict boron concentrations within the range of observed background.
- MW-385 is an under-predicted bedrock well identified as a UA well in the HCR (Ramboll, 2021c). MW-385 was installed in December 2015 on the former berm that was located between the active FAPS East Ash Pond and West Ash Pond. MW-385 was abandoned shortly after installation in February 2016, after collection of only one boron concentration data point. Since the data available for this well is limited, the usefulness of this location as a transport calibration point is also limited as the single data point may not be representative of current conditions. Like MW-385, MW-386 was abandoned shortly after installation, after collection of only one boron concentration data point, and was also located on the berm between the active FAPS East Ash Pond and West Ash Pond. Simulated boron concentrations at MW-386 met the calibration criteria discussed above; however, since the data available for this well is limited, like MW-385, the usefulness of this location as a transport calibration point is also limited as the single data point may not be representative of current conditions.
- MW-151 is identified as a UU well in the HCR (Ramboll, 2021c). MW-151 was constructed with a filter pack that extends from the UU into the weathered bedrock. This well was modeled in layer 5 which represents the decomposed bedrock rather than UU layers 2 through 4. Boron concentrations are over-predicted by the model at this location which may be associated with the well being screened across multiple model layers.

The remaining calibration locations had predicted concentrations that met one or more of the following goals of the transport model calibration: to have predicted concentrations fall within the range of observed concentrations; to have predicted concentrations above and below the GWPS for boron (2 mg/L) match observed concentrations observed above or below the standard at each well; and/or to have predicted concentrations above and below the GWPS for boron match observed median concentrations above or below the standard at each well. In other words, there was a very good match between predicted and observed boron concentrations relative to wells with concentrations above and below the GWPS. For example, UA well MW-391, located west of the FAPS, where the highest UA bedrock boron concentrations were observed, was calibrated near the median concentration of the observed values from December 2015 to December 2022. Similarly, UU well OW-157 located north of the East Ash Pond of the FAPS, where the highest concentrations in the UU were observed, had the highest predicted boron concentrations on Site. The calibration result for wells MW-391 and OW-157 indicate the transport calibration model was able to simulate the highest observed concentrations in both the UA and UU, respectively. The simulated boron concentrations at porewater wells within the BAP also approximated the median of the observed boron concentrations, with the exception of XPW01 which was simulated as dry, indicating the simulated BAP boron source concentrations were representative. The distribution of boron concentrations in the calibrated model are presented on **Figure 5-30 through Figure 5-35**.

6. SIMULATION OF CIP CLOSURE SCENARIO

6.1 Overview and Prediction Model Development

Prediction simulations were performed to evaluate the effects of closure (source control) measures (CCR consolidation and CIP closure scenario) for the BAP on the groundwater quality following initial corrective action measures, which includes removal of free liquids from the BAP. As discussed in **Section 5.2.3.5**, physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in MT3DMS, which captures the physical process of natural attenuation as part of corrective actions for the closure scenario simulated. No retardation was applied to boron transport in the model (*i.e.,* Kd was set to 0) as discussed in **Section 5.2.3.6**. The following methods were used to develop the prediction models and simulate the CIP closure scenario:

- Extend the modeled existing conditions (calibration conditions) approximately 2 years prior to applying initial corrective action measures to allow time for IEPA coordination, approvals, and permitting; as well as the final design and bid process according to the schedule in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).
- Define CCR removal and consolidation areas based on designs provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).
- Apply several constant head cell areas to the BAP for the dewatering period (approximately 3 years) to remove free liquids within the BAP (initial corrective action measures).
- Apply drains (drain input parameters approximated designs provided in the CCR Surface Impoundment Final Closure Plan [Geosyntec, 2022a]) to simulate storm water management within CCR removal areas following closure.
- Apply no flow cells and remove recharge in the CCR removal areas to simulate the absence of material in model layer 1 following consolidation and cover system construction.
- Remove source concentrations within the CCR removal areas (source concentrations associated with recharge zones and saturated ash cells [constant concentration cells]).
- Apply reduced recharge in the consolidated CIP areas to simulate the effects of the cover system on the groundwater flow system (HELP calculated percolation rates were developed based on cover system construction materials and designs provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).

HELP modeling input and output values are summarized in **Table 6-1** and described in detail below. Prediction simulations were performed to evaluate changes in the groundwater flow system from the CIP closure scenario. The following simplifying assumptions were made during the simulations:

- In the CIP closure scenario, HELP-calculated average annual percolation rates were developed from a 30-year HELP model run. This 30-year HELP-calculated percolation rate remained constant over duration of the closure scenario prediction model run following closure.
- Changes in recharge resulting from dewatering, CCR removal, consolidation, construction of the cover system, and final grading (recharge rates are based on HELP-calculated average annual percolation rates) have an instantaneous effect on recharge and percolation through surface materials.

- The geocomposite drainage layer and geomembrane liner placed over the ash consolidation area were assumed to have good field placement and assumed to have the same slope as the final grade of the overlying cover materials based on the design drawings provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).
- CCR removal areas were assumed to have the same topography as the former approximated base of ash surface in the BAP.

6.2 HELP Model Setup and Results

HELP (Version 4.0; Tolaymat and Krause, 2020) was used to estimate percolation through the top and slopes of the BAP CIP Consolidation area. HELP files are included electronically (**Appendix C**), and outputs are attached to this report (**Appendix D**).

HELP input data and results are provided in **Table 6-1**. All scenarios were modeled for a period of 30 years. Climatic inputs were synthetically generated using default equations developed for Belleville Scott Air Force Base, Illinois (the closest weather station included in the HELP database). Precipitation, temperature, and solar radiation was simulated based on the latitude of the BAP. Thickness and type of the geosynthetic drainage layer, geotextile protective cushion layer, geomembrane liner, soil backfill, and soil runoff input parameters were developed for the ash consolidation scenario using data provided the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).

HELP model results (**Table 6-1**) indicated 0.000239 inches of percolation per year through the top of the BAP CIP consolidation and cover system area, and 0.000007 inches of percolation per year through the slopes of the BAP consolidation and cover system areas. The differences in HELP model runs for each area included the type of lateral drainage layer or cushion, soil runoff slope, and the soil runoff slope length; all other HELP model input parameters were the same for each simulated area. Two additional HELP model simulations were completed to support the *Proposed Alternative Final Protective Layer Equivalency Demonstration* (Geosyntec, 2022b) which is an appendix to the Construction Permit Application to which this report is also attached. Results of these two additional HELP simulations were not incorporated in the MODFLOW simulations for closure. Simulation inputs and output results are presented in **Appendix D**.

6.3 Simulation of CIP Closure Scenario

The calibrated model was used to evaluate the effectiveness of the CIP closure scenario by defining CCR removal and consolidation areas, reducing head to simulate a dewatering period (approximately 3 years), removing source concentrations within the removal areas, applying drains to simulate storm water management within CCR removal areas following closure, applying no flow cells and removing recharge in the CCR removal areas to simulate the absence of material in model layer 1 following closure, and applying reduced recharge in the consolidation and CIP areas to simulate the effects of the cover system on transport.

As discussed in the model approach **Section 4.3** and illustrated on **Figure 4-1**, the start of the transient flow and transport model was initiated in 1970 (model year 0), when the BPP began operation and the BAP and FAPS were active (initial conditions model), through 2020 (51 model years) when closure at the FAPS was complete. Three models were included for the closure prediction simulation. The first model simulated an extended period of current conditions, 2021 to 2024 (4 model years). The second model simulated a period for the removal of free liquids, 2025 to 2027 (3 model years). The third model simulated the final closure conditions, 2028 to 3027 (1,000 model years). The prediction model input values are summarized in **Table 6-2**.

6.3.1 CIP Closure Scenario Groundwater Flow System and Predicted Boron Concentrations

The design for CIP includes an initial 3-year dewatering period to remove free liquids followed by CCR removal from the western areas of the BAP, consolidation to the southeast, and eventually northeastern portions of the BAP, and construction of a cover system over the remaining CCR (**Figure 6-1**).

Post-construction heads decrease at monitoring wells surrounding the CCR removal and consolidated CIP areas of the BAP following dewatering and implementation of CIP. In general, the greatest predicted reduction in heads among the proposed BAP compliance monitoring wells (MW-192, MW-193, MW-356, MW-369, MW-370, MW-382, MW-392, MW393, MW-394, OW-256, OW-257, PZ-170, and PZ-182) takes place within approximately 93 years following implementation of the CIP closure scenario. The heads at these wells continue to decrease until they are predicted to stabilize (approximate hydraulic steady state); however, due to the low hydraulic conductivity of the UU and UA materials, heads are not predicted to stabilize at all proposed BAP compliance monitoring wells until approximately 482 years following implementation of the CIP closure scenario. Groundwater flow directions are predicted to remain consistent with current flow directions.

Evaluations of post-construction water flux through the consolidated and covered BAP CCR were completed using data obtained from the CIP closure scenario prediction model when simulated post-construction heads in the proposed BAP compliance monitoring wells reached their most significant reduction in heads at approximately 93 years following implementation of the CIP closure scenario. The pre-construction (calibration model) and post-construction CIP closure scenario prediction model simulated water flux values are summarized in **Appendix E** and discussed below. Data export files used for flux evaluations are found along with model files in **Appendix C**.

Figure 6-2 is a plot showing the changes in flux reduction (shown as negative percentage) over time, starting from implementation of the CIP closure scenario through approximately 100 years following implementation. The CIP closure scenario was predicted to reduce total flux in and out of the BAP CCR by greater than 90 percent within 30 days following implementation of the CIP closure scenario. This was determined by comparing the post-construction movement of water in and out of the consolidated BAP CCR to pre-construction conditions. The reduction in total flux in and out of the consolidated BAP CCR is predicted to exceed 90 percent reduction for the remaining model timeframe. In general, the greatest predicted reduction in heads among the proposed BAP compliance monitoring wells takes place within approximately 93 years following implementation of the CIP closure scenario, at which time total flux in and out are predicted to reduce by 95 and 93 percent, respectively (**Figure 6-3**). Flux in and out are predicted to reduce by approximately 96 percent after approximately 482 years following implementation of the CIP closure scenario when heads are predicted to stabilize at the BAP compliance wells. Prior to construction (*i.e.*, current existing conditions) the total groundwater flux into the CCR is 10.90 gallons per minute (gpm) versus a total flux out of 10.77 gpm (**Appendix E**). Total flux out includes flux through the CCR (3.39 gpm) and the modeled constant head cells (7.38 gpm) used to simulate surface water management within the active BAP. Approximately 93 years following implementation of the CIP closure scenario, the groundwater flux into and out of the CCR is equal at approximately 0.56 and 0.70 gpm, respectively, with no surface water management within the CIP area.

An evaluation of simulated boron plumes greater than the GWPS (2 mg/L for boron) in both pre-construction calibration models and post-construction prediction models indicated several proposed BAP compliance monitoring wells (PZ-182, OW-257, MW-382) to be potentially influenced by boron concentrations associated with the closed FAPS. The model domain for evaluating boron transport following closure of the BAP includes the closed FAPS, which is present along the eastern and southern boundaries of the BAP. The FAPS completed IEPA approved closure activities in November of 2020, and it is another potential source of boron within the model domain. The closure plan for the FAPS also included groundwater modeling of boron transport. The evaluation included a review of maximum plume extents associated with the FAPS presented in the 2014 FAPS groundwater modeling reports (NRT, 2014b; NRT, 2014c) (completed as part of the FAPS Closure Plan Report [AECOM, 2016a]), as well as a review of simulated groundwater flow directions and simulated boron concentrations in both the BAP pre-construction calibration and BAP post-construction prediction models. Groundwater elevations and boron concentrations at FAPS closure monitoring wells were calibrated during development of the current BAP flow and transport model and the simulation period was extended to 1,000 years to verify consistent results with the 2014 FAPS groundwater modeling reports. Changes in FAPS operations were incorporated into the current BAP modeling (utilizing similar changes in recharge used to simulate closure in the previous 2014 model). Boron transport within the current BAP model was compared to the results from the previous FAPS closure plan modeling and found that simulated flow and transport associated with the FAPS are consistent between the two models. Proposed BAP compliance wells PZ-182, OW-257, and MW-382 are located in the direction of groundwater flow from the north central area of the FAPS between the FAPS (East Ash Pond) and the surface water drainage feature near the west end of the BAP. Because these wells are downgradient of the FAPS, which is an alternate source of boron, these wells were not included in the evaluation of BAP compliance with the GWPS following implementation of the CIP closure scenario.

Simulated boron concentrations at the remaining proposed BAP compliance monitoring wells (PZ-170, OW-256, MW-192, MW-193, MW-370, MW-369, MW-392, MW-393, and MW-394) were below the GWPS (2 mg/L for boron) during the pre-construction period (calibration model), and prediction modeling results indicated these proposed BAP compliance monitoring wells would continue to remain below the GWPS for the post-construction modeling timeframe following dewatering and consolidation (**Figure 6-4**). The maximum extent of the plume above the GWPS for boron (2 mg/L) at 93 years following implementation of the CIP closure scenario, when simulated post-construction heads in the proposed BAP compliance monitoring wells reached their most significant reduction in heads, is illustrated in **Figure 6-5,** where boron exceedances are within the footprint of the former BAP except where source concentrations are potentially associated with the closed FAPS.

Additionally, a BAP CBR closure scenario prediction model was completed to evaluate the difference in post-construction boron concentrations simulated at PZ-182, OW-257, and MW-382 under both CIP and CBR conditions. The CBR closure scenario was simulated by: (i) extending the initial 3-year dewatering period to remove free liquids used in the CIP prediction model to an initial 9-year dewatering period, as the CBR construction timeframe is longer than CIP (see information provided in the CCR Surface Impoundment Final Closure Plan [Geosyntec, 2022a] which is an appendix to the Construction Permit Application to which this report is also attached); (ii) applying no flow cells and removing recharge in the entire BAP footprint to simulate the absence of material in model layer 1 following CBR; and, (iii) removing all source concentrations within the BAP footprint following CBR (source concentrations associated with recharge zones and saturated ash cells [constant concentration cells]). A timeseries plot of predicted boron concentrations following implementation of the BAP CIP and CBR closure scenarios at proposed BAP compliance monitoring wells PZ-182, OW-257, and MW-382 is provided in **Figure 6-6**. As illustrated in **Figure 6-6**, concentrations are predicted to increase above the GWPS for boron (2 mg/L) following implementation of both BAP CIP and CBR closure scenarios in these three wells. Maximum concentrations within the modeling timeframes at these wells are predicted to be on the same order of magnitude for both BAP CIP and CBR closure scenarios.

The differences in predicted concentrations between CIP and CBR illustrated on **Figure 6-6** are likely due to slightly lower heads simulated at PZ-182, OW-257, and MW-382 in the CBR scenario, which increases the hydraulic gradient beneath the BAP which drives more rapid predicted arrival of boron in these wells from the FAPS. Since concentrations at proposed BAP compliance monitoring wells PZ-182, OW-257, and MW-382 increase to concentrations above the GWPS following implementation of the CBR closure scenario when BAP source concentrations have been removed, the source for predicted post-construction concentrations within the model domain must be the closed FAPS. These results support the conclusion that wells PZ-182, OW-257, and MW-382 should not be included in the evaluation of BAP compliance with the GWPS following implementation of the CIP closure scenario.

Although predicted boron concentrations at proposed BAP compliance wells PZ-182 and MW-382 are influenced by the FAPS, simulated boron concentrations at these wells started below the GWPS during the pre-construction period (calibration model) and an initial decrease in predicted concentrations was observed immediately following implementation of the BAP CIP closure scenario (**Figure 6-4**). The initial decrease in predicted boron concentrations is followed by a predicted increase in concentrations at approximately 14 and 80 years in wells PZ-182 and MW-382, respectively, following implementation of the CIP closure scenario as simulated concentrations associated with the FAPS begin to influence predicted boron concentrations in wells further along the flow path between the FAPS (East Ash Pond) and the drainage feature near the west end of the BAP.

Results of groundwater fate and transport modeling conservatively estimate that groundwater boron concentrations at the proposed BAP compliance wells that are not influenced by the FAPS will remain below the GWPS following implementation of the CIP closure scenario at the BAP. The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. Since data used for calibration are near the BAP and FAPS, model predictions of transport distant spatially and temporally from the calibrated conditions at the CCR units will not be as reliable as predictions closer to the CCR units and concentrations observed between 2015 and 2022.

7. CONCLUSIONS

This GMR has been prepared to evaluate the groundwater flow system and transport of boron concentrations at the BAP and how the proposed CIP closure scenario will reduce total flux in and out of the CCR and maintain compliance with the GWPS for boron (2 mg/L) in the post-construction BAP. Groundwater elevation data collected from sampling events from December 2015 to June 2022 (or November 2022 groundwater elevations for wells constructed or reoccupied in 2022) and boron concentration data collected from sampling events from December 2015 to December 2022 were used to develop a groundwater flow and transport model for the BPP BAP and surrounding area. The MODFLOW and MT3DMS models were then used to evaluate the CIP closure scenario which includes: CCR removal from the western areas of the BAP, consolidation to the southeast, and eventually northeastern portions of the BAP, and construction of a cover system over the remaining CCR following initial corrective action measures (removal of free liquids from the BAP) using information provided in the CCR Surface Impoundment Final Closure Plan (Geosyntec, 2022a).

The CIP closure scenario was predicted to reduce total flux in and out of the BAP CCR by greater than 90 percent within 30 days following implementation of the CIP closure scenario. This was determined by comparing the post-construction movement of water in and out of the consolidated BAP CCR to pre-construction conditions. The reduction in total flux in and out of the consolidated BAP CCR is predicted to exceed 90 percent reduction for the remaining model timeframe. In general, the greatest predicted reduction in heads among the proposed BAP compliance monitoring wells takes place within approximately 93 years following implementation of the CIP closure scenario, at which time total flux in and out are predicted to reduce by 95 and 93 percent, respectively. Due to the low hydraulic conductivity of the UU and UA materials, heads are not predicted to stabilize at all proposed BAP compliance monitoring wells until approximately 482 years following implementation of the CIP closure scenario, at which time total flux in and out are predicted to reduce by approximately 96 percent.

The model domain for evaluating boron transport following closure of the BAP includes the closed FAPS which is present along the eastern and southern boundaries of the BAP. The FAPS completed IEPA approved closure activities in November of 2020, and it is another potential source of boron within the model domain. The closure plan for the FAPS also included groundwater modeling of boron transport. Boron transport within the current BAP model was compared to the results from the previous FAPS closure plan modeling and found that simulated flow and transport associated with the FAPS are consistent between the two models. As described in this report, proposed BAP compliance wells PZ-182, OW-257, and MW-382 are located in the direction of groundwater flow from the north central area of the FAPS between the FAPS (East Ash Pond) and the surface water drainage feature near the west end of the BAP. Because these wells are downgradient of the FAPS which is an alternate source of boron, and groundwater quality at these wells is not attributable to the BAP, these wells were not included in the evaluation of BAP compliance with the GWPS following implementation of the CIP closure scenario.

Additionally, a BAP CBR closure scenario prediction model was completed to evaluate the difference in post-construction boron concentrations simulated at PZ-182, OW-257, and MW-382 under both CIP and CBR conditions. Concentrations are predicted to increase above the GWPS for boron (2 mg/L) following implementation of both BAP CIP and CBR closure scenarios in these three wells. Maximum concentrations within the modeling timeframes at these wells are predicted to be on the same order of magnitude for both BAP CIP and CBR closure scenarios. Since concentrations at proposed BAP compliance monitoring wells PZ-182, OW-257, and MW-382 increase to concentrations above the GWPS following implementation of the CBR closure scenario, after BAP source concentrations have been removed, the source for predicted post-construction concentrations within the model domain can only be attributable to the closed FAPS. These results support the conclusion that wells PZ-182, OW-257, and MW-382 should not be included in the evaluation of BAP compliance with the GWPS following implementation of the CIP closure scenario.

Results of groundwater fate and transport modeling conservatively estimate that groundwater boron concentrations at the proposed BAP compliance wells that are not influenced by the FAPS will remain below the GWPS following implementation of the CIP closure scenario at the BAP.

8. REFERENCES

AECOM, 2016a. Closure and Post-Closure Care Plan for the Baldwin Fly Ash Pond System at Dynegy Midwest Generation, LLC Baldwin Energy Complex, Baldwin, Illinois. March.

AECOM, 2016b. RE: History of Construction, USEPA Final Rule, 40 C.F.R. § 257.73 (c), Baldwin Energy Complex, Baldwin, Illinois. October.

Anderson, M.P., 1979. *Using models to simulate the movement of contaminants through groundwater flow systems*. CRC Critical Rev. Environ. Control., 9(2), p. 97-156.

Anderson, M.P., 1984. *Movement of contaminants in groundwater: groundwater transport -- advection and dispersion*. Groundwater Contamination. National Academy Press, Washington, D.C. p. 37-45.

Environmental Simulations, Inc., 2018. Groundwater Vistas 8 Software.

Fetter, C.W., 1988. Applied Hydrogeology. Merrill Publishing Company, Columbus, Ohio.

Geosyntec Consultants, Inc. (Geosyntec), 2022a. CCR Surface Impoundment Final Closure Plan, Baldwin Power Plant, Bottom Ash Pond, Baldwin, Illinois. December 12.

Geosyntec Consultants, Inc. (Geosyntec), 2022b. Construction Permit Application, Baldwin Power Plant, Bottom Ash Pond, Baldwin, Illinois. November 14.

Heath, R.C., 1983. Basic Groundwater Hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p.

Illinois Environmental Protection Agency (IEPA), 2016. Dynegy Midwest Generation, Inc. – Baldwin Energy Complex: Baldwin Fly Ash Pond System Closure – NPDES Permit No. IL000043, letter from William Buscher (IEPA) to Rick Diericx (Dynegy Operating Company). August 16.

McDonald, M.G., and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations, Techniques of Water-Resources of the United States Geological Survey. Book 6, Chapter A1.

Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p.

Natural Resource Technology, Inc. (NRT), 2014a. Groundwater Quality Assessment and Phase II Hydrogeologic Investigation, Baldwin Ash Pond System. June 11.

Natural Resource Technology, Inc. (NRT), 2014b. Groundwater Model and Simulation of Closure Alternatives, Baldwin Ash Pond System. June 18.

Natural Resource Technology, Inc. (NRT), 2014c. Groundwater Model and Simulation of Closure Alternatives, Model Report Addendum Baldwin Ash Pond System. September 30.

Natural Resource Technology, Inc. (NRT), 2016a. Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan, Baldwin Fly Ash Pond System, Baldwin, Illinois. Prepared for Dynegy Midwest Generation, LLC by Natural Resource Technology, Inc. March 31.

Natural Resource Technology, Inc. (NRT), 2016b. Technical Memorandum: Baldwin Energy Complex Ash Pond Closure and Post-Closure Plan – Response to Illinois EPA Comments. August 8.

Natural Resource Technology, Inc. (NRT), 2016c. Hydrostatic Modeling Report, Baldwin Fly Ash Pond System Baldwin Energy Complex, Baldwin, Illinois. March 31.

Pryor, Wayne A., 1956. Groundwater Geology in Southern Illinois: A Preliminary Geologic Report.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. Groundwater Monitoring Plan. Bottom Ash Pond, Baldwin Power Plant, Baldwin, Illinois. October 25.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. History of Potential Exceedances. Bottom Ash Pond, Baldwin Power Plant, Baldwin, Illinois. October 17.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. Hydrogeologic Site Characterization Report. Bottom Ash Pond, Baldwin Power Plant, Baldwin, Illinois. October 25.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2023. Alternate Source Demonstration. Baldwin Power Plant, Bottom Ash Pond, CCR Unit 601. April 30.

Tolaymat, T. and Krause, M, 2020. Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual. United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219.

Zheng, Z., and P.P. Wang, 1998. *MT3DMS, a Modular Three-Dimensional Multispecies Transport Model.* Model documentation and user's guide prepared by the University of Alabama Hydrogeology Group for the United States Army Corps of Engineers (USACE).

TABLES

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
MW-104SR	UU	2011-08-01	455.54	455.54	Top of PVC	452.52	4.80	14.80	447.80	437.70	15.00	437.50	10	2	38.188355	-89.853434
MW-104DR	UU	2011-08-01	455.62	455.62	Top of PVC	452.62	23.20	28.20	429.40	424.40	28.50	417.60	5.1	2	38.188344	-89.853434
MW-116	UU	1991-09-30	457.97	547.97	Top of PVC	454.90	15.00	25.00	439.90	429.90	25.00	429.90	10	2	--	--
MW-126	UU	2009-06-19	469.84	469.84	Top of PVC	466.84	9.95	19.31	456.89	447.53	19.31	446.87	9.36	2	--	--
MW-150	UU	2010-09-01	396.54	396.54	Top of PVC	393.84	15.00	24.70	378.80	369.20	25.20	368.70	9.6	2	38.189401	-89.878468
MW-151	UU	2010-09-01	399.96	399.96	Top of PVC	397.22	6.10	15.80	391.10	381.40	16.30	380.90	9.6	2	38.188449	-89.872354
MW-152	UU	2010-09-01	424.99	424.99	Top of PVC	422.18	7.50	16.70	414.70	405.50	17.20	405.00	9.3	2	38.187569	-89.866764
MW-153	UU	2010-09-01	445.67	445.67	Top of PVC	442.77	10.40	20.00	432.40	422.80	20.50	422.30	9.6	2	38.185884	-89.86101
MW-154	UU	2010-09-01	387.76	387.76	Top of PVC	384.99	7.50	12.20	377.50	372.80	12.70	372.30	4.6	2	38.196555	-89.883732
MW-155	UU	2010-09-01	393.55	393.55	Top of PVC	390.62	10.30	19.90	380.30	370.70	20.50	370.20	9.6	2	38.193312	-89.882878
MW-158R	UU	2022-10-08	456.24	456.24	Top of PVC	453.56	8.00	18.00	445.56	435.56	18.00	435.56	10	2	38.195275	-89.849411
MW-161	UU	2013-08-01	431.27	431.27	Top of PVC	428.74	23.30	32.80	405.40	396.00	33.40	384.00	9.5	2	38.19631	-89.879159
MW-162	UU	2013-08-01	433.20	433.20	Top of PVC	430.83	15.90	25.30	415.00	405.50	25.90	404.90	9.5	2	38.192595	-89.879221
MW-192	UU	2022-09-27	436.94	436.94	Top of PVC	434.04	20.00	30.00	414.04	404.04	30.00	400.04	10	2	38.199203	-89.866927
MW-193	UU	2022-10-04	438.06	438.06	Top of PVC	434.51	22.00	32.00	412.51	402.51	32.00	402.51	10	2	38.199173	-89.862658
MW-194	UU	2022-10-05	438.20	438.20	Top of PVC	435.43	18.00	28.00	407.43	397.43	28.00	405.43	10	2	38.199138	-89.858653
MW-203	UA	--	457.53	457.53	Top of PVC	455.66	67.00	77.00	388.66	378.66	78.00	377.67	10	2	--	--
MW-204	UA	1991-09-30	456.02	456.02	Top of PVC	453.30	68.00	78.00	385.30	375.30	79.00	79.00	10	2	--	--
MW-252	UU	2010-09-01	425.07	425.07	Top of PVC	422.27	44.40	49.00	377.90	373.20	49.50	372.70	4.6	2	38.187563	-89.866745
MW-253	UU	2010-09-01	445.84	445.84	Top of PVC	442.70	29.90	34.50	412.80	408.20	35.00	407.70	4.6	2	38.185885	-89.861026
MW-258	UA	2022-10-07	456.12	456.12	Top of PVC	453.50	40.00	50.00	413.59	403.59	50.00	390.50	10	2	38.195276	-89.849429
MW-262	UU	2013-08-01	433.21	433.21	Top of PVC	430.86	42.10	46.60	388.70	384.20	47.20	379.90	4.5	2	38.192605	-89.87922
MW-304	UA	2015-10-20	455.49	455.49	Top of PVC	453.03	45.00	55.00	408.00	398.00	55.00	317.60	10	2	38.188332	-89.853441

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
MW-306	UA	1991-09-25	453.17	453.17	Top of PVC	450.91	72.70	87.70	378.20	363.20	87.70	361.20	15	2	38.20114	-89.846756
MW-307	UA	1991-09-16	436.66	436.66	Top of PVC	434.00	57.00	72.00	377.00	362.00	74.00	333.00	15	2	--	--
MW-350	UA	2010-09-01	396.80	396.80	Top of PVC	394.11	41.60	46.20	352.50	347.90	46.60	347.40	4.6	2	38.189416	-89.878477
MW-352	UA	2010-09-01	425.04	425.04	Top of PVC	422.36	67.90	72.50	354.50	349.80	73.00	348.60	4.6	2	38.187554	-89.866729
MW-355	UA	2010-09-01	393.69	393.69	Top of PVC	390.82	27.40	32.00	363.40	358.80	32.50	358.20	4.6	2	38.193305	-89.882865
MW-356	UA	2015-10-01	427.60	427.60	Top of PVC	425.18	56.00	66.00	369.20	359.20	66.00	290.20	10	2	38.198963	-89.869578
MW-358	UA	2022-10-08	455.73	455.73	Top of PVC	453.59	80.00	90.00	373.73	363.73	90.00	363.59	10	2	38.195275	-89.849417
MW-366	UA	2015-12-04	425.08	425.08	Top of PVC	422.54	42.00	52.00	380.50	370.50	52.00	368.20	10	2	38.192191	-89.872345
MW-369	UA	2015-11-19	422.71	422.71	Top of PVC	420.49	56.00	66.00	364.50	354.50	66.00	349.80	10	2	38.196986	-89.870258
MW-370	UA	2015-11-25	420.85	420.85	Top of PVC	418.67	53.00	63.00	365.70	355.70	63.00	352.70	10	2	38.195603	-89.869669
MW-373	UA	2015-10-28	391.32	391.32	Top of PVC	388.80	20.00	30.00	368.80	358.80	30.00	293.70	10	2	38.190726	-89.879258
MW-374	UA	2015-11-10	400.91	400.91	Top of PVC	398.41	30.00	40.00	368.40	358.40	40.00	356.10	10	2	38.189682	-89.877242
MW-375	UA	2015-11-06	423.05	423.05	Top of PVC	420.50	57.00	67.00	363.50	353.50	67.00	335.80	10	2	38.189045	-89.873514
MW-377	UA	2015-11-02	421.36	421.36	Top of PVC	418.75	46.00	56.00	372.80	362.80	56.00	360.50	10	2	38.188386	-89.869742
MW-382	UA	2015-11-23	431.19	431.19	Top of PVC	428.67	56.00	66.00	372.70	362.70	66.00	358.10	10	2	38.19454	-89.868044
MW-383	UA	2015-12-21	459.49	459.49	Top of PVC	457.18	58.00	68.00	399.20	389.20	68.00	384.20	10	2	38.194913	-89.858286
MW-384	UA	2015-12-18	458.95	458.95	Top of PVC	456.70	60.50	70.50	396.20	386.20	70.50	362.60	10	2	38.191789	-89.860699
MW-385	UA	2015-12-16	454.56	454.56	Top of PVC	454.82	80.00	90.00	374.80	364.80	90.00	361.80	10	2	38.191729	-89.86847
MW-386	UA	2015-12-11	454.17	454.17	Top of PVC	454.67	76.00	86.00	378.70	368.70	86.00	365.70	10	2	38.189441	-89.866991
MW-387	UA	2015-11-18	426.63	426.63	Top of PVC	424.01	48.00	58.00	376.00	366.00	58.00	362.70	10	2	38.190905	-89.874773
MW-388	UA	2015-12-12	408.92	408.92	Top of PVC	406.28	33.00	43.00	373.30	363.30	43.00	361.10	10	2	38.191785	-89.87773
MW-389	UA	2015-12-01	419.90	419.90	Top of PVC	417.30	42.00	52.00	375.30	365.30	52.00	361.60	10	2	38.193679	-89.877076
MW-390	UA	2016-03-04	428.06	428.06	Top of PVC	425.98	50.00	65.00	376.00	361.00	65.00	358.00	15	2	38.192956	-89.869793
MW-391	UA	2016-03-10	426.63	426.63	Top of PVC	424.24	55.00	70.00	369.20	354.20	70.00	349.80	15	2	38.190869	-89.874759

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
MW-392	UA	2022-09-26	437.02	437.02	Top of PVC	434.07	74.00	84.00	360.07	350.07	84.00	350.07	10	2	38.199203	-89.866934
MW-393	UA	2022-10-04	437.86	437.86	Top of PVC	434.59	75.00	85.00	359.59	349.59	85.00	349.59	10	2	38.199174	-89.862666
MW-394	UA	2022-10-05	438.29	438.29	Top of PVC	435.51	73.00	83.00	362.51	352.51	83.00	350.51	10	2	38.199136	-89.85866
OW-156	UU	2010-09-01	427.87	427.87	Top of PVC	425.14	7.90	17.20	417.30	407.90	17.70	407.40	9.3	2	38.198969	-89.869592
OW-157	UU	2010-09-01	432.64	432.64	Top of PVC	429.90	7.80	17.10	422.10	412.80	17.60	412.30	9.3	2	38.19384	-89.867384
OW-256	UU	2013-08-01	427.70	427.70	Top of PVC	425.20	28.00	32.50	397.20	392.70	33.10	389.20	4.5	2	38.198966	-89.86961
OW-257	UU	2013-08-01	431.02	431.02	Top of PVC	428.17	34.00	38.50	394.20	389.70	39.10	388.60	4.5	2	38.193865	-89.867456
PZ-169	UU	2015-07-28	422.60	422.60	Top of PVC	420.01	31.50	41.50	388.50	378.50	41.50	378.00	10	2	38.196962	-89.870253
PZ-170	UU	2015-07-29	421.43	421.43	Top of PVC	418.58	21.10	31.10	397.50	387.50	31.10	387.50	10	2	38.195585	-89.869632
PZ-171	UU	2015-07-31	434.15	434.15	Top of PVC	431.54	28.00	38.00	403.50	393.50	38.00	393.50	10	2	38.194595	-89.879189
PZ-172	UU	2015-08-03	412.95	412.95	Top of PVC	410.22	16.00	26.00	394.20	384.20	26.00	384.00	10	2	38.191491	-89.879283
PZ-173	UU	2015-08-03	391.46	391.46	Top of PVC	388.43	3.50	13.50	384.90	374.90	13.50	374.30	10	2	38.1907	-89.879247
PZ-174	UU	2015-08-04	401.92	401.92	Top of PVC	398.97	14.50	24.50	384.50	374.50	24.50	374.30	10	2	38.189682	-89.877209
PZ-175	UU	2015-08-07	423.01	423.01	Top of PVC	419.87	40.00	50.00	379.90	369.90	50.00	369.70	10	2	38.189032	-89.873481
PZ-176	UU	2015-08-06	406.44	406.44	Top of PVC	403.46	18.10	28.10	385.40	375.40	28.60	374.90	10	2	38.188565	-89.871623
PZ-177	UU	2015-08-06	420.90	420.90	Top of PVC	417.93	20.50	30.50	397.40	387.40	30.50	387.20	10	2	38.188361	-89.869736
PZ-178	UU	2015-08-05	431.26	431.26	Top of PVC	428.45	33.00	43.00	395.50	385.50	43.00	385.00	10	2	38.188076	-89.867868
PZ-182	UU	2015-07-30	431.61	431.61	Top of PVC	428.47	24.00	34.00	404.50	394.50	34.00	394.50	10	2	38.194512	-89.86801
TPZ-158	UU	2013-08-01	456.26	456.26	Top of PVC	453.26	9.20	18.30	444.00	435.00	18.90	434.30	9.1	1.3	38.195308	-89.849428
TPZ-159	UU	2013-08-01	447.64	447.64	Top of PVC	444.69	20.00	29.00	424.70	415.70	29.60	394.70	9.1	1.3	38.199022	-89.862558
TPZ-160	UU	2013-08-01	431.49	431.49	Top of PVC	428.59	9.80	18.80	418.80	409.80	19.40	393.60	9.1	1.3	38.19896	-89.875586
TPZ-163	CCR	2013-08-01	458.41	458.41	Top of PVC	455.51	8.60	18.10	446.90	437.40	18.70	410.50	9.5	2	38.19274	-89.857249
TPZ-164	CCR	2013-08-01	435.10	435.10	Top of PVC	432.50	5.20	9.70	427.30	422.80	10.30	422.20	4.5	2	38.195586	-89.862797
TPZ-165	UU	2013-08-01	398.85	398.85	Top of PVC	396.10	7.80	16.80	388.30	379.30	17.40	378.70	9.1	1.3	38.193174	-89.874746

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
TPZ-166	UU	2013-08-01	425.18	425.18	Top of PVC	422.33	15.30	24.70	407.10	397.60	25.30	396.80	9.5	2	38.1922	-89.872297
TPZ-167	CCR	2013-08-01	441.38	441.38	Top of PVC	438.63	21.40	30.90	417.20	407.70	31.50	389.90	9.5	2	38.190478	-89.869723
TPZ-168	CCR	2013-08-01	457.53	457.53	Top of PVC	454.93	15.80	25.30	439.20	429.70	25.80	384.90	9.5	2	38.188681	-89.863954
XPW01	CCR	2022-09-23	437.66	437.66	Top of PVC	435.12	7.00	12.00	428.12	423.12	12.00	421.12	5	2	38.197522	-89.864474
XPW02	CCR	2022-09-24	437.92	437.92	Top of PVC	434.86	6.00	11.00	428.86	423.86	11.00	420.86	5	2	38.197894	-89.86188
XPW04	CCR	2022-09-24	434.58	434.58	Top of PVC	430.59	6.50	16.50	424.09	414.09	16.50	410.59	10	2	38.194698	-89.863819
XPW05	CCR	2022-09-24	437.27	437.27	Top of PVC	434.12	18.00	28.00	416.12	406.12	28.00	404.12	10	2	38.196233	-89.862366
XPW06	CCR	2022-09-22	417.72	417.72	Top of PVC	418.06	5.00	10.00	412.99	407.99	10.00	402.06	5	2	38.196967	-89.868954

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BGS = below ground surface
CCR = coal combustion residuals
ft = foot or feet
HSU = Hydrostratigraphic Unit
PVC = polyvinyl chloride
UA = uppermost aquifer
UU = upper unit
generated 01/09/2023, 11:09:49 AM CST

TABLE 2-2. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, IL

Well ID	Monitored Hydrogeologic Unit	Modeled Target Location (Layer Number)	Flow Model Target Groundwater Elevation (Modified Median Value December 2015 to June 2022 [feet NAVD88][1])	Transport Model Target Total Boron Concentrations December 2015 to December 2022 (mg/L)		
				Minimum	Median	Maximum
MW-104DR	UU	3	445.01	0.0191	0.02	0.05
MW-104SR	UU	2	446.42	0.04	0.128	0.237
MW-116	UU	4	449.61 [2]	0.023	0.024	0.025
MW-126	UU	2	459.57 [2]	0.0092	0.0106	0.012
MW-150	UU	3	377.70	0.31[3]	2.12[3]	4.29[3]
MW-151	UU	5	395.62	0.217[3]	0.267[3]	0.507[3]
MW-152	UU	3	419.87	0.015[3]	9.92[3]	29[3]
MW-153	UU	2	432.69	0.009[3]	0.02[3]	21.5[3]
MW-154	UU	5	379.61	0.018[3]	0.02[3]	0.056[3]
MW-155	UU	3	373.98	0.0114[3]	0.02[3]	0.05[3]
MW-158R	UU	2	442.63 [2]	0.0254	0.0347	0.061
MW-192	UU	2	428.57 [2]	0.0525	0.0537	0.0686
MW-193	UU	3	429.02 [2]	0.0473	0.059	0.0645
MW-194	UU	3	431.32 [2]	0.019	0.022	0.023
MW-203	UA	6	No Target	0.907	0.907	0.907
MW-204	UA	6	442.82 [2]	1.02	1.03	1.35
MW-252	UU	5	424.93	0.12[3]	0.144[3]	1.47[3]
MW-253	UU	5	434.66	0.0333[3]	0.0604[3]	0.24[3]
MW-258	UA	5	441.95 [2]	1.03	1.27	1.35
MW-304	UA	6	445.93	1.27	1.685	2.16
MW-306	UA	6	435.63	0.025	0.2	0.634
MW-307	UA	6	431.10 [2]	1.2	1.47	1.63
MW-350	UA	6	374.27	0.541	0.652	0.9
MW-352	UA	6	423.42	0.76[3]	1.82[3]	2.09[3]
MW-355	UA	6	370.39	0.02[3]	0.024[3]	0.05[3]
MW-356	UA	6	424.92	1.79	2.01	2.92
MW-358	UA	6	No Target	1.1	1.25	1.67
MW-366	UA	6	409.99	1.19	1.66	2.7
MW-369	UA	6	413.31	0.592	1.55	2.4
MW-370	UA	6	402.35	1.56	1.82	2.67
MW-374	UA	6	388.62	No Target		
MW-375	UA	6	392.00	0.979	1.37	2.06
MW-377	UA	6	416.56	1.54	1.74	2.01
MW-382	UA	5	414.96	1.6	1.75	2.57
MW-383	UA	6	441.03	1.26	1.42	2.05
MW-384	UA	6	445.34	1.26	1.48	2.26
MW-385	UA	6	No Target	2.45	2.45	2.45
MW-386	UA	6	No Target	1.34	1.34	1.34
MW-388	UA	6	393.34	No Target		
MW-389	UA	6	400.58	No Target		
MW-390	UA	6	423.44	0.175	0.546	2.3
MW-391	UA	6	No Target	1.3	3.25	8.91
MW-392	UA	6	428.08 [2]	1.57	1.72	2.33
MW-393	UA	6	429.29 [2]	1.53	1.83	2.04
MW-394	UA	6	432.69 [2]	1.87	2.02	2.23
OW-156	UU	2	421.74	0.02[3]	0.024[3]	0.03[3]
OW-157	UU	2	426.61	44.6[3]	45.2[3]	45.3[3]
TPZ-164	CCR	1	431.14	1.09	1.47	2.04
XPW01	CCR	1	426.15 [2]	0.93	0.942	1.03
XPW02	CCR	1	433.52 [2]	1.18	1.2	1.52
XPW04	CCR	1	426.56 [2]	1.15	1.28	1.38
XPW05	CCR	1	432.43 [2]	1.02	1.16	1.25
XPW06	CCR	1	415.07 [2]	2.29	3.86	4.64

[O: EGP 1/3/23, C: JJW 1/4/23, U: JJW 5/2/23, C: EGP 5/16/23]

Notes:

[1] Target groundwater elevations represent modified median groundwater elevations from December 2015 to June 2022. Anomalous groundwater elevations (e.g., groundwater elevations that do not represent static groundwater conditions, groundwater elevation outliers, or groundwater elevations measured in error) monitored between December 2015 and June 2022 were removed from the median groundwater elevation calculations used as flow calibration targets.

[2] Target groundwater elevation used most recent measurement (November 2022) for wells constructed or reoccupied in 2022
[3] Target boron concentration used dissolved boron data from November 2010 to December 2022
ID = identification
mg/L = milligrams per liter
NAVD88 = North American Vertical Datum of 1988

Hydrogeologic Unit:
CCR = coal combustion residuals
UA = uppermost aquifer
UU = upper unit

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Zone	Zone Description	Materials	ft/d	cm/s	Kh/Kv	Value Source	Sensitivity[1]
Horizontal Hydraulic Conductivity			**Calibration Model**				
1	UU	silty clay	0.07	2.47E-05	NA	Calibrated - Near Geomean Hydraulic Conductivity Field Test Results for Wells Screened in the Upper Unit (Ramboll, 2021; 2022 HSI)	Moderate
2	Old East Fly Ash Pond	CCR	0.5	1.76E-04	NA	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Negligible
3	East Fly Ash Pond	CCR	0.5	1.76E-04	NA	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Low
4	West Fly Ash Pond	CCR	0.5	1.76E-04	NA	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Low
7	Bottom Ash Pond	CCR	1.5	5.29E-04	NA	Calibrated - Near Minimum Hydraulic Conductivity Field Test Results for Wells Screened in BAP (Ramboll, 2021; 2022 HSI)	Moderate
8	UA (Decomposed Bedrock)	bedrock	0.05	1.76E-05	NA	Calibrated - Within Range of Hydraulic Conductivity Field Test Results for Wells Screened in Bedrock (Ramboll, 2021; 2022 HSI)	Low
9	UA	bedrock	0.05	1.76E-05	NA	Calibrated - Within Range of Hydraulic Conductivity Field Test Results for Wells Screened in Bedrock (Ramboll, 2021; 2022 HSI)	High
10	UU (Top of Vandalia)	silty clay	0.07	2.47E-05	NA	Calibrated - Near Geomean Hydraulic Conductivity Field Test Results for Wells Screened in the Upper Unit (Ramboll, 2021; 2022 HSI)	Low
12	River Alluvium	silty clay	0.6	2.12E-04	NA	Calibrated	Low
14	PMP	sand seams	0.3	1.06E-04	NA	Calibrated - Near Geomean Hydraulic Conductivity Field Test Results for Wells Screened Across Upper Unit Sands (Ramboll, 2021)	Moderate
16	Fill at BAP & FAPS Boundary	fill	0.5	1.76E-04	NA	Calibrated	Negligible
100	Above River Boundary Condition	NA	500	1.76E-01	NA	Calibrated - Conductivity Value to Allow Groundwater Flow to River Boundary Conditions	Negligible
Vertical Hydraulic Conductivity			**Calibration Model**				
1	UU	silty clay	0.007	2.47E-06	10	Calibrated - Within Range of Upper Unit Vertical Hydraulic Conductivity Laboratory Test Results (Ramboll, 2021; 2022 HSI)	Moderate
2	Old East Fly Ash Pond	CCR	0.5	1.76E-04	1	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Negligible
3	East Fly Ash Pond	CCR	0.5	1.76E-04	1	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Negligible
4	West Fly Ash Pond	CCR	0.5	1.76E-04	1	Calibrated - Near Geomean of Vertical Hydraulic Conductivity Laboratory Test Results from FAPS Wells (Ramboll, 2021)	Negligible
7	Bottom Ash Pond	CCR	1.5	5.29E-04	1	Calibrated - Near BAP Well TPZ-164 Vertical Hydraulic Conductivity Laboratory Test Results (Ramboll, 2021)	Negligible
8	UA (Decomposed Bedrock)	bedrock	0.01	3.53E-06	5	Calibrated	Low

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Zone	Zone Description	Materials	ft/d	cm/s	Kh/Kv	Value Source	Sensitivity[1]
Vertical Hydraulic Conductivity			**Calibration Model**				
9	UA	bedrock	0.005	1.76E-06	10	Calibrated	Moderate
10	UU (Top of Vandalia)	silty clay	0.007	2.47E-06	10	Calibrated - Within Range of Upper Unit Vertical Hydraulic Conductivity Laboratory Test Results (Ramboll, 2021; 2022 HSI)	Low
12	River Alluvium	silty clay	0.6	2.12E-04	1	Calibrated	Negligible
14	PMP	sand seams	0.3	1.06E-04	1	Calibrated - Near Geomean Hydraulic Conductivity Field Test Results for Wells Screened Across Upper Unit Sands (Ramboll, 2021)	Negligible
16	Fill at BAP & FAPS Boundary	fill	0.5	1.76E-04	NA	Calibrated	Negligible
100	Above River Boundary Condition	NA	500	1.76E-01	1	Calibrated - Conductivity Value to Allow Groundwater Flow to River Boundary Conditions	Negligible
Recharge			**Calibration Model**				
1	Silty Clay	silty clay	1.00E-05	0.04	NA	Calibrated	Low
2	Old East Fly Ash Pond	CCR	6.80E-05	0.30	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	Low
3	East Fly Ash Pond	CCR	6.80E-05	0.30	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	Low
4	West Fly Ash Pond	CCR	6.80E-05	0.30	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	Low
5	Secondary Pond	silty clay	1.00E-05	0.04	NA	Calibrated	Negligible
6	Tertiary Pond	silty clay	1.00E-05	0.04	NA	Calibrated	Negligible
7	Bottom Ash Pond	CCR	1.80E-04	0.79	NA	Calibrated	Low
Storage							
1	UU	silty clay	*Not used in steady-state calibration model*				
2	Old East Fly Ash Pond	CCR					
3	East Fly Ash Pond	CCR					
4	West Fly Ash Pond	CCR					
7	Bottom Ash Pond	CCR					
8	UA (Decomposed Bedrock)	bedrock					
9	UA	bedrock					
10	UU (Top of Vandalia)	silty clay					
12	River Alluvium	silty clay					
14	PMP	sand seams					
16	Fill at BAP & FAPS Boundary	fill					
100	Above River Boundary Condition	NA					

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

River Parameters

	Relative Location	Stage of River (feet)	Sensitivity	River Bottom Elevation (feet)	Hydraulic Conductivity (ft/d)	Average River Conductance (ft^2/d)	Sensitivity
Reach 0	Cooling Pond	429	Moderate	410	3.80	3.80E+04	Negligible
Reach 1	Kaskaskia River	370	High	365	5.17	5.17E+04	Negligible
Reach 2	South Stream (Southern Limit of Model Domain)	456.03-370	Negligible	452.03-365.54	2.08	2.08E+04	Negligible
Reach 3	South Stream (Between Reach 2 and Reach 4)	449.98-370.06	Moderate	447.98-368.06	2.05	2.05E+04	Negligible
Reach 4	South Stream (Adjacent to FAPS)	445-368	Moderately High	443-366	0.36	3.60E+03	Negligible
Reach 5	Northwest Stream (West of Cooling Pond)	410.66-370	Negligible	408.66-368	3.89	3.89E+04	Negligible
Reach 7	Northeast Stream (East of Cooling Pond)	454.75-427	High	452.75-425	2.60	2.60E+04	Negligible
Reach 8	Secondary and Tertiary Pond	396	Low	394.99-376.17	0.26	2.60E+03	Negligible

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

River Parameters

Value Source	NA	Calibrated - Cooling Pond Stage (Reach 0) Approximates Elevation at which Pond is Maintained; Kaskasia River Stage (Reach 1) at Baldwin Power Plant Based on Interpolated Stage Data Provided at New Athens, Illinois (USGS 5595000) and Red Bud (USGS 5595240); River Stage at Reaches 2 through 7 Approximate Topography; River Stage at Reach 8 Based on Historic Groundwater Elevation within Secondary and Tertiary Ponds at TPZ-165	NA	Calibrated	Calibrated	Calibrated	NA

Constant Head Parameters

	Relative Location	Head at Boundary (feet)	Sensitivity
Reach 0	BAP Constant Head West	415	Negligible
Reach 1	BAP Constand Head Central	425	Negligible
Value Source	NA	Calibrated - Head at Boundary Based on Estimated Water Surface Elevation within BAP	NA

[O: JJW 2/17/2023 ; C: EGP 5/18/23]

Notes:

[1] Sensitivity Explanation:
Negligible - SSR changed by less than 1%
Low - SSR change between 1% and 10%
Moderate - SSR change between 10% and 50%
Moderately High - SSR change between 50% and 100%
High - SSR change greater than 100%

SSR = sum of squared residuals
- - - = not tested
BAP = bottom ash pond
FAPS = fly ash pond system
cm/s = centimeters per second
ft/d = feet per day
ft^2/day = feet squared per day
HSI = Hydrogeologic Site Investigation
in/yr = inches per year
Kh/Kv = anisotropy ratio
NA = not applicable

Hydrogeologic Unit:
CCR = coal combustion residuals
PMP = potential migration pathway
UA = uppermost aquifer
UU = upper unit

References:

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. Hydrogeologic Site Characterization Report. Bottom Ash Pond. Baldwin Power Plant. Baldwin, Illinois.
Natural Resource Technology, Inc. (NRT), 2014b. Groundwater Model and Simulation of Closure Alternatives, Baldwin Ash Pond System. June 18.
Natural Resource Technology, Inc. (NRT), 2014c. Groundwater Model and Simulation of Closure Alternatives, Model Report Addendum Baldwin Ash Pond System. September 30.

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

			Calibration Model						
	Hydrostratigraphic Unit	**Materials**	**Calibration Model 1 Dates: 1970-2020 Recharge (ft/d)**	**Calibration Model 2 Dates: 2021-2022 Recharge (ft/d)**	**Boron Concentration (mg/L)**	**Calibration Model 1 Dates: 1970-2020 Constant Head (feet)**	**Calibration Model 2 Dates: 2021-2022 Constant Head (feet)**	**Value Source**	**Sensitivity**
Initial Concentration									
Entire Domain	NA	NA	NA	NA	0	NA	NA	NA	- - -
Source Concentration (recharge)									
Zone 2	Old East Fly Ash Pond	CCR	4.00E-04	6.80E-05	38	NA	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	- - -
Zone 3	East Fly Ash Pond	CCR	8.00E-04	6.80E-05	79	NA	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	- - -
Zone 4	West Fly Ash Pond	CCR	6.00E-04	6.80E-05	47	NA	NA	calibrated - 2021-2022 recharge at FAPS consistent with estimated closed FAPS recharge values in 2014 FAPS groundwater modeling report (NRT, 2014b; NRT, 2014c)	- - -
Zone 7	Bottom Ash Pond (West)	CCR	1.80E-04	1.80E-04	4	NA	NA	calibrated	- - -
Zone 8	Bottom Ash Pond (East)	CCR	1.80E-04	1.80E-04	1.5	NA	NA	calibrated	- - -
Source Concentration (constant concentration cells) and Stormwater Management (constant head cells)									
Reach 2	Old East Fly Ash Pond	CCR	NA	NA	38	NA	NA	calibrated	- - -
Reach 3	East Fly Ash Pond	CCR	NA	NA	79	NA	NA	calibrated	- - -
Reach 4	West Fly Ash Pond Constant Head	CCR	NA	NA	47	424.3	NA	calibrated - head at boundary consistent with stormwater management practices within the active FAPS (AECOM, 2016b)	- - -
Reach 14	West Fly Ash Pond (Berm)	CCR	NA	NA	47	NA	NA	calibrated	- - -
Reach 0	BAP Constant Head West	CCR	NA	NA	4	415	415	calibrated - head at boundary based on estimated water surface elevation within BAP	- - -
Reach 1	BAP Constand Head Central	CCR	NA	NA	4	425	425	calibrated - head at boundary based on estimated water surface elevation within BAP	- - -
Reach 7	Bottom Ash Pond (West)	CCR	NA	NA	4	NA	NA	calibrated	- - -
Reach 8	Bottom Ash Pond (East)	CCR	NA	NA	1.5	NA	NA	calibrated	- - -

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Storage, Specific Yield and Effective Porosity

Zone	Hydrostratigraphic Unit	Materials	Storage	Specific Yield	Effective Porosity	Value Source	Sensitivity
1	UU	silty clay	0.003	0.15	0.15	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
2	Old East Fly Ash Pond	CCR	0.003	0.2	0.2	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
3	East Fly Ash Pond	CCR	0.003	0.2	0.2	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
4	West Fly Ash Pond	CCR	0.003	0.2	0.2	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
7	Bottom Ash Pond	CCR	0.003	0.25	0.25	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
8	UA (Decomposed Bedrock)	bedrock	0.003	0.15	0.15	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
9	UA	bedrock	0.003	0.3	0.3	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
10	UU (Top of Vandalia)	silty clay	0.003	0.15	0.15	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
12	River Alluvium	silty clay	0.003	0.15	0.15	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
14	PMP	sand seams	0.003	0.25	0.25	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
16	Fill at BAP & FAPS Boundary	fill	0.003	0.2	0.2	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3
100	Above River Boundary Condition	NA	0.003	0.5	0.5	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Calibrated - Effective Porosity Estimated from Literature (Fetter, 1988; Morris and Johnson, 1967; Heath, 1983; Walton, 1988)	see Table 5-3

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Dispersivity						
Applicable Region	**Hydrostratigraphic Unit**	**Materials**	**Longitudinal (feet)**	**Transverse (feet)**	**Vertical (feet)**	**Sensitivity**
Entire Domain	NA	NA	5	0.5	0.05	- - -

[O: JJW 5/5/2023, C:EGP 5/22/23]

Notes:
[1] The concentrations from the end of the calibrated transport model were imported as initial concentrations for the prediction model runs.
- - - = not tested
ft/d = feet per day
mg/L = milligrams per liter
NA = not applicable

Hydrogeologic Unit:
CCR = coal combustion residuals
PMP = potential migration pathway
UA = uppermost aquifer
UU = upper unit

References:
AECOM, 2016b. RE: History of Construction, USEPA Final Rule, 40 C.F.R. § 257.73 (c), Baldwin Energy Complex, Baldwin, Illinois. October.
Fetter, C.W., 1988, Applied Hydrogeology, Merrill Publishing Company, Columbis, Ohio.
Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p.
Heath, R.C., 1983. Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p.
Walton, W.C., 1988. Practical Aspects of Groundwater Modeling. National Water Well Association, Worthington, Ohio.
Natural Resource Technology, Inc. (NRT), 2014b. Groundwater Model and Simulation of Closure Alternatives, Baldwin Ash Pond System. June 18.
Natural Resource Technology, Inc. (NRT), 2014c. Groundwater Model and Simulation of Closure Alternatives, Model Report Addendum Baldwin Ash Pond System. September 30.

TABLE 5-3. TRANSPORT MODEL INPUT VALUES (SENSITIVITY)
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well ID	Calibration Concentration (mg/L)	Storage and Specific Yield				Effective Porosity			
		File Name		File Name		File Name		File Name	
		BAL_Conc_324_T_A _s_sy_low.gwv BAL_Conc_324_T_B_2_s_sy_low.gwv		BAL_Conc_324_T_A _s_sy_high.gwv BAL_Conc_324_T_B_2_s_sy_high.gwv		BAL_Conc_324_T_A_por_low.gwv BAL_Conc_324_T_B_2_por_low.gwv		BAL_Conc_324_T_A_por_high.gwv BAL_Conc_324_T_B_2_por_high.gwv	
		Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]
MW-116	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-126	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-158R	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-192	2.3E-02	2.2E-02	low	2.3E-02	low	2.5E-02	moderate	2.0E-02	moderate
MW-193	0.2	0.3	moderate	0.2	low	0.3	moderate	0.2	moderate
MW-194	1.3	1.2	low	1.3	negligible	1.4	low	1.2	low
MW-203	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-204	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-258	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-304	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-306	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-307	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-350	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-356	5.0E-06	3.0E-06	moderate	6.0E-06	moderate	9.0E-06	moderately high	3.0E-06	moderate
MW-358	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-366	1.5	0.6	moderately high	2.4	moderately high	2.0	moderate	1.1	moderate
MW-369	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-370	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-375	1.3	0.5	moderately high	1.9	moderate	1.8	moderate	0.9	moderate
MW-377	4.9E-03	0.0	high	3.0E-02	high	1.2E-02	high	1.4E-03	moderately high
MW-382	0.3	4.44E-03	moderately high	1.5	high	0.7	high	0.2	moderately high
MW-383	4.6E-02	1.2E-02	moderately high	4.2E-02	low	9.0E-02	moderately high	2.4E-02	moderate
MW-384	0.2	0.1	moderately high	0.1	moderately high	0.3	moderately high	0.1	moderate
MW-385	0.2	2.62E-03	moderately high	0.7	high	0.3	moderately high	0.1	moderately high
MW-386	4.0E-02	0.0	high	1.3E-01	high	9.1E-02	high	1.5E-02	moderately high
MW-390	0.2	4.48E-03	moderately high	0.5	high	0.3	moderately high	0.1	moderately high
MW-391	3.5	2.7	moderate	3.8	low	4.1	moderate	2.9	moderate
MW-392	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-393	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-394	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
TPZ-164	1.5	1.5	negligible	1.5	negligible	1.5	negligible	1.5	negligible
XPW01	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
XPW02	1.5	1.5	negligible	1.5	negligible	1.5	negligible	1.5	negligible
XPW04	1.5	1.5	negligible	1.5	negligible	1.5	negligible	1.5	negligible
XPW05	1.5	1.5	negligible	1.5	negligible	1.5	negligible	1.5	negligible
XPW06	4.0	4.0	negligible	4.0	negligible	4.0	negligible	4.0	negligible

TABLE 5-3. TRANSPORT MODEL INPUT VALUES (SENSITIVITY)

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Well ID	Calibration Concentration (mg/L)	Storage and Specific Yield				Effective Porosity			
		File Name		File Name		File Name		File Name	
		BAL_Conc_324_T_A _s_sy_low.gwv BAL_Conc_324_T_B_2_s_sy_low.gwv		BAL_Conc_324_T_A _s_sy_high.gwv BAL_Conc_324_T_B_2_s_sy_high.gwv		BAL_Conc_324_T_A_por_low.gwv BAL_Conc_324_T_B_2_por_low.gwv		BAL_Conc_324_T_A_por_high.gwv BAL_Conc_324_T_B_2_por_high.gwv	
		Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]
MW-104SR	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-104DR	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-150	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-151	6.1	2.8	moderately high	10.3	moderately high	9.7	moderately high	3.1	moderate
MW-152	2.5	2.9	moderate	1.1	moderately high	3.7	moderate	1.6	moderate
MW-153	9.0E-06	0.0	high	3.0E-06	moderately high	1.0E-04	high	1.0E-06	moderately high
MW-154	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-155	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-252	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
MW-253	0.0	0.0	negligible	0.0	negligible	6.00E-06	negligible	0.0	negligible
MW-352	1.0E-06	2.1E-05	high	0.0	high	0.0	high	1.0E-06	negligible
MW-355	0.0	0.0	negligible	0.0	negligible	0.0	negligible	0.0	negligible
OW-156	0.7	0.7	negligible	0.7	low	0.7	low	0.6	low
OW-157	14.8	19.4	moderate	7.3	moderately high	20.0	moderate	11.3	moderate
		S*0.1 Sy*0.5		S*10 Sy*2[2]		Porosity-0.05		Porosity+0.05	

[O: JJW 5/22/23; C: EGP 5/23/23]

Notes:

[1] Sensitivity Explanation:
Negligible = concentration changed by less than 1%
Low = concentration change between 1% and 10%
Moderate = concentration change between 10% and 50%
Moderately High = concentration change between 50% and 100%
High = concentration change greater than 100%

[2] High specific yield sensitivity not analyzed for zone 100 (Above River Boundary Conditions) since the calibration value was already near upper limits of acceptable values for specific yield

ID = identification
mg/L = milligrams per liter
S = storativity
Sy = specific yield

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Closure Scenario Number (Drainage Length)	BAP CIP - Consolidation Area (Top)	BAP CIP - Consolidation Area (Slopes)	Notes
Input Parameter			
Climate-General			
City	Baldwin, IL	Baldwin, IL	Nearby city to the Site within HELP database
Latitude	38.18	38.18	Site latitude
Evaporative Zone Depth	18	18	Estimated based on geographic location (Illinois) and uppermost soil type (Tolaymat, T. and Krause, M 2020)
Maximum Leaf Area Index	4.5	4.5	Maximum for geographic location (Illinois) (Tolaymat, T. and Krause, M, 2020)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity	Belleville Scott Air Force Base, IL	Belleville Scott Air Force Base, IL	Nearby city to the Baldwin Ash Pond within HELP database
Number of Years for Synthetic Data Generation	30	30	
Temperature, Evapotranspiration, and Precipitation	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 38.18/ -89.85	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 38.18/ -89.85	
Soils-General			
% where runoff possible	100	100	
Area (acres)	53.73	21.39	CIP - Consolidation and Cover System Area based on construction drawing for Baldwin Ash Pond
Specify Initial Moisture Content	No	No	
Surface Water/Snow	Model Calculated	Model Calculated	
Soils-Layers			
1	Vegetative Soil Layer (HELP Final Cover Soil [topmost layer])	Vegetative Soil Layer (HELP Final Cover Soil [topmost layer])	Layers details for CIP areas based on grading plans, construction drawings, and cover system design for Baldwin BAP
2	Protective Soil Layer (HELP Vertical Percolation Layer)	Protective Soil Layer (HELP Vertical Percolation Layer)	
3	Geotextile Protective Layer (Custom)	Geocomposite Drainage Layer (HELP Geosynthetic Drainage Net)	
4	Geomembrane Liner	Geomembrane Liner	
5	Unsaturated CCR Material (HELP Waste)	Unsaturated CCR Material (HELP Waste)	
Soil Parameters--Layer 1			
Type	1	1	Vertical Percolation Layer (Cover Soil)
Thickness (in)	6	6	Layer 1 thickness is the average thickness of unsaturated backfill material
Texture	26	26	Default used for CIP Consolidation area
Description	Silty Clay Loam (Moderate)	Silty Clay Loam (Moderate)	
Saturated Hydraulic Conductivity (cm/s)	1.90E-06	1.90E-06	Default used for CIP Consolidation area
Soil Parameters--Layer 2			
Type	1	1	Vertical Percolation Layer (BAP)
Thickness (in)	18	18	design thickness

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Closure Scenario Number (Drainage Length)	**BAP CIP - Consolidation Area (Top)**	**BAP CIP - Consolidation Area (Slopes)**	**Notes**
Texture	28	28	Defaults used
Description	Silty Clay (Moderate)	Silty Clay (Moderate)	
Saturated Hydraulic Conductivity (cm/s)	1.20E-06	1.20E-06	Defaults used
Soil Parameters--Layer 3			
Type	2	2	Lateral Drainage Layer
Thickness (in)	0.175	0.2	design thickness
Texture	43	20	Custom used for the top area of the CIP and a Default used for the slopes
Description	16 oz Nonwoven Geotextile	Geosynthetic Drainage Net	
Saturated Hydraulic Conductivity (cm/s)	3.00E-01	1.00E+01	Custom used for the top area of the CIP and a Defaults used for the slopes
Soil Parameters--Layer 4			
Type	4	4	Flexible Membrane Liner
Thickness (in)	0.04	0.04	design thickness
Texture	36	36	Defaults used
Description	LDPE Membrane	LDPE Membrane	
Saturated Hydraulic Conductivity (cm/s)	4.00E -13	4.00E -13	Defaults used
Soil Parameters--Layer 5			
Type	1	1	Vertical Percolation Layer (Waste)
Thickness (in)	545.28	231.72	design thickness
Texture	83	83	Custom used for CCR material
Description	Unsaturated CCR Material (HELP Waste)	Unsaturated CCR Material (HELP Waste)	
Saturated Hydraulic Conductivity (cm/s)	5.29E-04	5.29E-04	Custom used for CCR material from HCR average
Soils--Runoff			
Runoff Curve Number	89.8	91.1	HELP-computed curve number
Slope	2.00%	25.00%	Estimated from construction design drawings
Length (ft)	600	150	estimated maximum flow path
Vegetation	fair	fair	fair indicating fair stand of grass on surface of soil backfill
Execution Parameters			
Years	30	30	
Report Daily	No	No	
Report Monthly	No	No	
Report Annual	Yes	Yes	
Output Parameter			
Unsaturated Percolation Rate (in/yr)	**0.000239**	**0.000007**	

Notes:

[O: EGP 12/15/22, C: LCA 12/16/22]

% = percent
ft = feet
HELP = Hydrologic Evaluation of Landfill Performance
in = inches
in/yr = inches per year
Lat = latitude
Long = longitude
CBR = Closure By Removal
CIP = Closure In Place
HCR = Hydrogeologic Characterization Report

References:

Tolaymat, T. and Krause, M, 2020. Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual . United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219.
Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. Hydrogeologic Site Characterization Report. Newton Primary Ash Pond. Newton Power Plant. Newton, Illinois.

TABLE 6-2. PREDICTION MODEL INPUT VALUES

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Scenario: CIP (CCR removal from the western areas of the Bottom Ash Pond, consolidation to the eastern areas of the Bottom Ash Pond, and construction of a cover system over the remaining CCR)

Prediction Model	Model Years	Zone Description	Recharge Zone	Boron Recharge Concentration (mg/L)	Recharge (ft/day)	Recharge (in/yr)	Source Concentration (constant concentration cells) and Stormwater Management (constant head cells) Description	Reach Number	Constant Head (feet)	Constant Concentration (mg/L)
Initial Conditions	51	Old East Fly Ash Pond	2	38	4.00E-04	1.75	Old East Fly Ash Pond	2	--	38
Initial Conditions	51	East Fly Ash Pond	3	79	8.00E-04	3.50	East Fly Ash Pond	3	--	79
Initial Conditions	51	West Fly Ash Cell	4	47	6.00E-04	2.63	--	--	--	--
Initial Conditions	51	--	--	--	--	--	West Fly Ash Pond Constant Head	4	424.3	47
Initial Conditions	51	--	--	--	--	--	West Fly Ash Pond (Berm)	14	--	47
Initial Conditions	51	--	--	--	--	--	BAP Constant Head West	0	415.0	4
Initial Conditions	51	--	--	--	--	--	BAP Constand Head Central	1	425.0	4
Initial Conditions	51	Bottom Ash Pond (West)	7	4	1.80E-04	0.79	Bottom Ash Pond (West)	7	--	4
Initial Conditions	51	Bottom Ash Pond (East)	8	1.5	1.80E-04	0.79	Bottom Ash Pond (East)	8	--	1.5
Exisiting Conditions	4	Old East Fly Ash Pond (Post-Closure)	2	38	6.80E-05	0.30	Old East Fly Ash Pond	2	--	38
Exisiting Conditions	4	East Fly Ash Pond (Post-Closure)	3	79	6.80E-05	0.30	East Fly Ash Pond	3	--	79
Exisiting Conditions	4	West Fly Ash Cell (Post-Closure)	4	47	6.80E-05	0.30	--	--	--	--
Exisiting Conditions	4	--	--	--	--	--	West Fly Ash Pond Constant Head	4	--	47
Exisiting Conditions	4	--	--	--	--	--	West Fly Ash Pond (Berm)	14	--	47
Exisiting Conditions	4	--	--	--	--	--	BAP Constant Head West	0	415.0	4
Exisiting Conditions	4	--	--	--	--	--	BAP Constand Head Central	1	425.0	4
Exisiting Conditions	4	Bottom Ash Pond (West)	7	4	1.80E-04	0.79	Bottom Ash Pond (West)	7	--	4
Exisiting Conditions	4	Bottom Ash Pond (East)	8	1.5	1.80E-04	0.79	Bottom Ash Pond (East)	8	--	1.5
Dewatering	3	Old East Fly Ash Pond (Post-Closure)	2	38	6.80E-05	0.30	Old East Fly Ash Pond	2	--	38
Dewatering	3	East Fly Ash Pond (Post-Closure)	3	79	6.80E-05	0.30	East Fly Ash Pond	3	--	79
Dewatering	3	West Fly Ash Cell (Post-Closure)	4	47	6.80E-05	0.30	--	--	--	--
Dewatering	3	--	--	--	--	--	West Fly Ash Pond Constant Head	4	--	47
Dewatering	3	--	--	--	--	--	West Fly Ash Pond (Berm)	14	--	47
Dewatering	3	--	--	--	--	--	BAP Constant Head West	0	415.0	4
Dewatering	3	--	--	--	--	--	BAP Constand Head Central	1	425.0	4
Dewatering	3	Bottom Ash Pond (West)	7	4	1.80E-04	0.79	Bottom Ash Pond (West)	7	--	4
Dewatering	3	Bottom Ash Pond (East)	8	1.5	1.80E-04	0.79	Bottom Ash Pond (East)	8	--	1.5
Dewatering	3	--	--	--	--	--	CIP Area Dewater Constant Head (Northeast)	26	433	1.5
Dewatering	3	--	--	--	--	--	CIP Area Dewater Constant Head (West Central)	23	420	1.5
Dewatering	3	--	--	--	--	--	CIP Area Dewater Constant Head (Southeast)	24	433	1.5
CIP	1000	Old East Fly Ash Pond (Post-Closure)	2	38	6.80E-05	0.30	Old East Fly Ash Pond	2	--	38
CIP	1000	East Fly Ash Pond (Post-Closure)	3	79	6.80E-05	0.30	East Fly Ash Pond	3	--	79
CIP	1000	West Fly Ash Cell (Post-Closure)	4	47	6.80E-05	0.30	--	--	--	--

TABLE 6-2. PREDICTION MODEL INPUT VALUES

GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Scenario: CIP (CCR removal from the western areas of the Bottom Ash Pond, consolidation to the eastern areas of the Bottom Ash Pond, and construction of a cover system over the remaining CCR)

Prediction Model	Model Years	Zone Description	Recharge Zone	Boron Recharge Concentration (mg/L)	Recharge (ft/day)	Recharge (in/yr)	Source Concentration (constant concentration cells) and Stormwater Management (constant head cells) Description	Reach Number	Constant Head (feet)	Constant Concentration (mg/L)
CIP	1000	--	--	--	--	--	West Fly Ash Pond Constant Head	4	--	47
CIP	1000	--	--	--	--	--	West Fly Ash Pond (Berm)	14	--	47
CIP	1000	--	--	--	--	--	BAP Constant Head West	0	415.0	4
CIP	1000	--	--	--	--	--	BAP Constand Head Central	1	425.0	4
CIP	1000	Removal Area - Bottom Ash Pond (Post-Closure)	7	--	0	0	--	--	--	--
CIP	1000	CIP Top - Bottom Ash Pond (Post-Closure)	8	4	5.46E-08	2.39E-04			--	--
CIP	1000	CIP Slopes - Bottom Ash Pond (Post-Closure)	9	4	1.60E-09	7.01E-06			--	--
CIP	1000	--	--	--	--	--	CIP Area - Bottom Ash Pond (Post-Closure)	20	--	4

Prediction Model	Construction Period (years)	Zone Description	Hydraulic Conductivity Zone	Horizontal Hydraulic Conductivity (ft/d)	Horizontal Hydraulic Conductivity (cm/s)	Vertical Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (cm/s)
Initial Conditions	51	Bottom Ash Pond	7	1.5	5.29E-04	1.5	5.29E-04
Exisiting Conditions	4	Bottom Ash Pond	7	1.5	5.29E-04	1.5	5.29E-04
Dewatering	3	Bottom Ash Pond	7	1.5	5.29E-04	1.5	5.29E-04
CIP	1000	CIP Top - Bottom Ash Pond (Post-Closure)	18	1.5	5.29E-04	1.5	5.29E-04
CIP	1000	CIP Slopes - Bottom Ash Pond (Post-Closure)	19	1.5	5.29E-04	1.5	5.29E-04

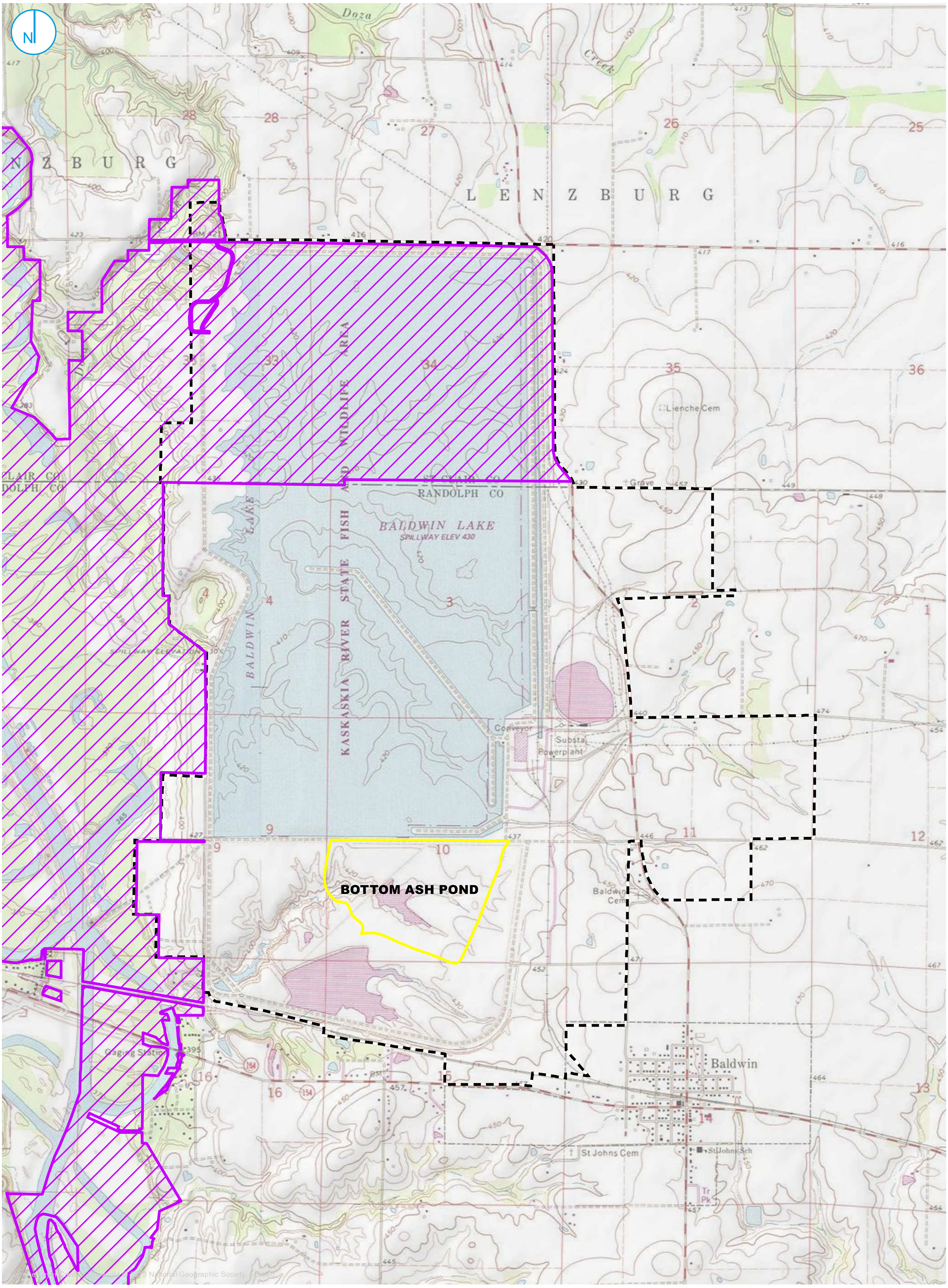
Prediction Model	Construction Period (years)	Drain Reach	Relative Location	Stage of Drain (feet)	Thickness of Drain Bed (feet)	Hydraulic Conductivity (ft/d)	Drain Conductance (ft^2/d)
CIP	1000	10	BAP Drain West	410	1	6.00	6.00E+04

[O: JJW 1/6/23; EGP 5/22/23]

Notes:

-- = boundary condition or property zone not included in prediction model
CCR = coal combustion residuals
CIP = Closure In Place
ft^2/day = feet squared per day
ft/day = feet per day
in/yr = inches per year
cm/s = centimeters per second

FIGURES



▢ BOTTOM ASH POND BOUNDARY
⬚ PROPERTY BOUNDARY
▨ KASKASKIA RIVER STATE FISH AND WILDLIFE AREA

SOURCE NOTE
I-View, Prairie State Conservation Coalition accessed via Illinois Department of Natural Resources Division of Natural Heritage Website
https://www2.illinois.gov/sites/naturalheritage/DataResearch/Pages/Access-Our-Data.aspx

0 1,000 2,000 Feet

SITE LOCATION MAP

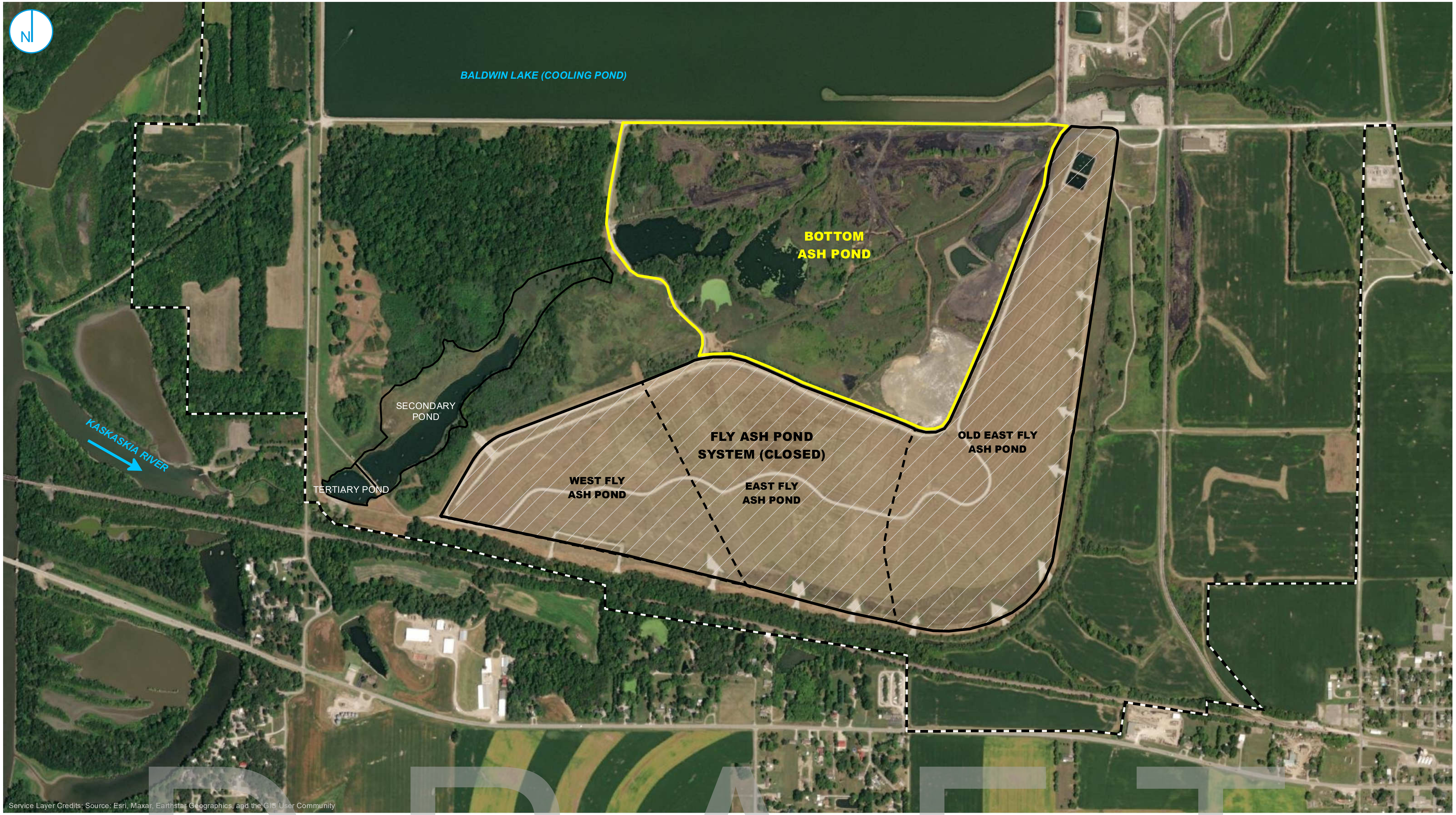
FIGURE 1-1

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\Model_Figures\Baldwin\Figure 1-2_Base Map.mxd

PROJECT: 169000XXXX | DATED: 5/23/2023 | DESIGNER: GALARNMC



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

🟨 35 I.A.C. § 845 REGULATED UNIT (SUBJECT UNIT)

▨ LIMITS OF FINAL COVER

☐ SITE FEATURE

☐ FLY ASH POND SYSTEM (CLOSED)

☐ PROPERTY BOUNDARY

0 400 800 Feet

SITE MAP

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 1-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Baldwin\BAP\Groundwater_Modeling_Report\Figure 2-1_Monitoring Well Location Map.mxd

PROJECT: 169000XXXX | DATED: 5/3/2023 | DESIGNER: GALARNMC

🟨 35 I.A.C. § 845 REGULATED UNIT (SUBJECT UNIT)
▨ LIMITS OF FINAL COVER
☐ SITE FEATURE
☐ FLY ASH POND SYSTEM (CLOSED)
⬚ PROPERTY BOUNDARY
■ MONITORING WELL
🟩 PORE WATER WELL

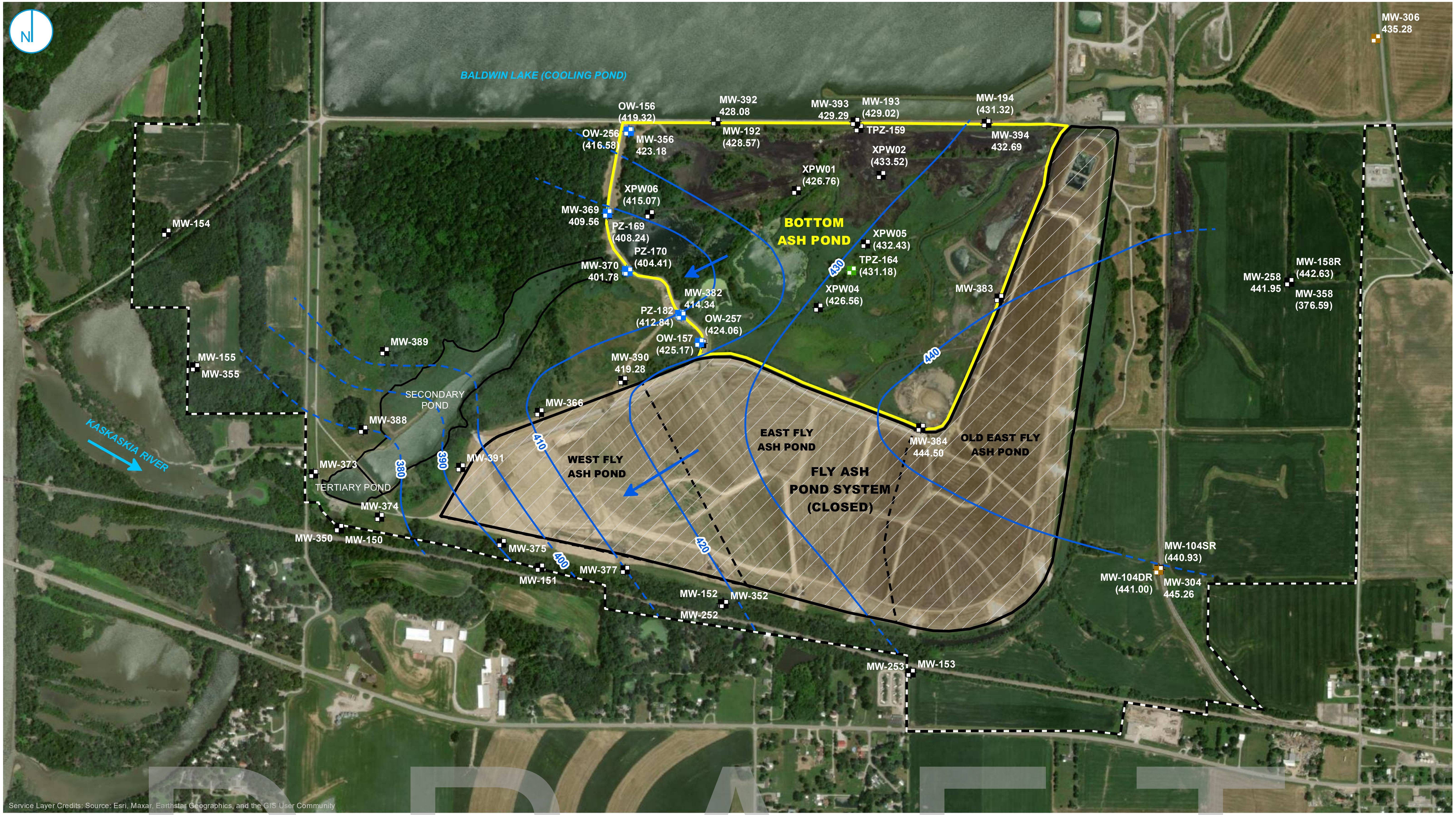
0 500 1,000 Feet

MONITORING WELL LOCATION MAP

FIGURE 2-1

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

🟧 BACKGROUND WELL
🟦 COMPLIANCE WELL
🟩 PORE WATER WELL
⬛ MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (10-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

35 I.A.C. § 845 REGULATED UNIT (SUBJECT UNIT)
FLY ASH POND SYSTEM (CLOSED)
SITE FEATURE
CAPPED AREA
PROPERTY BOUNDARY

0 400 800 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

BEDROCK POTENTIOMETRIC SURFACE MAP
NOVEMBER 14, 2022

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

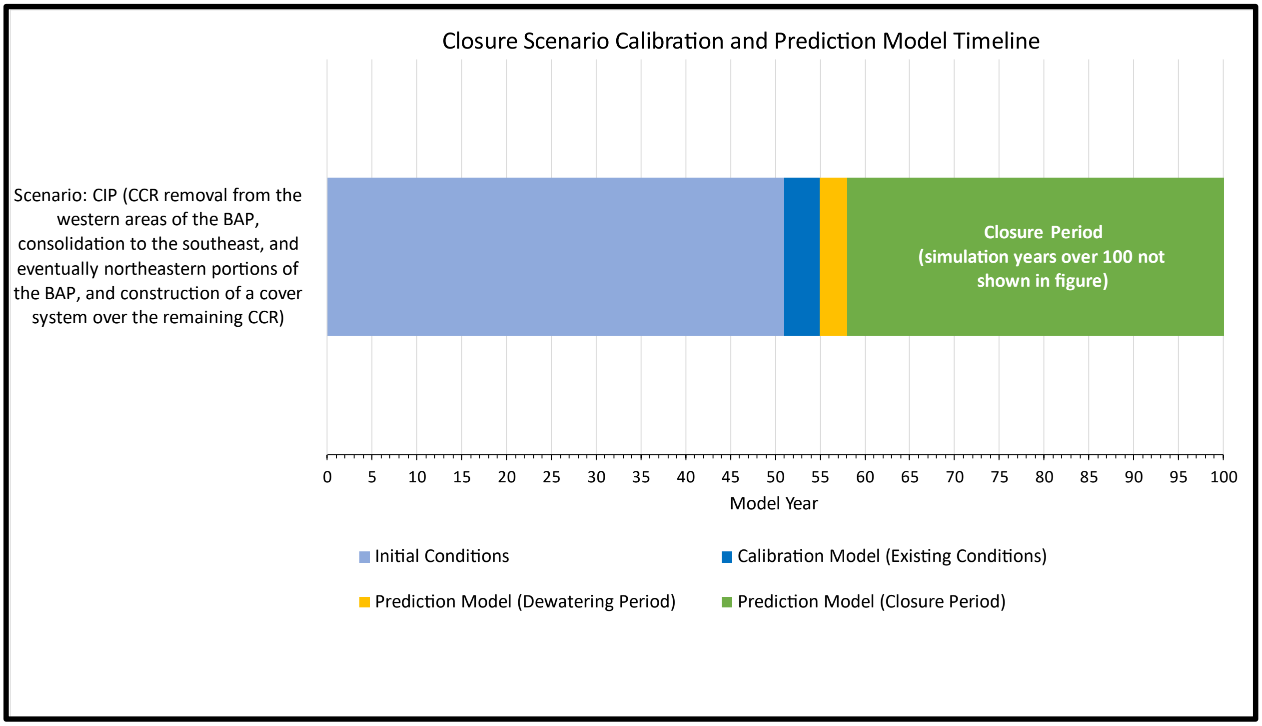
FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Baldwin\BAP\Groundwater_Modeling_Report\Figure 2-2_Pot Surface 20221114.mxd

PROJECT: 169000XXXX | DATED: 1/6/2023 | DESIGNER: galammc



CLOSURE SCENARIO CALIBRATION AND PREDICTION MODEL TIMELINE

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

- 🟨 35 I.A.C. § 845 REGULATED UNIT (SUBJECT UNIT)
- ☐ FLY ASH POND SYSTEM (CLOSED)
- ▨ LIMITS OF FINAL COVER
- ☐ SITE FEATURE
- ⬚ MODEL DOMAIN
- ▨ NO FLOW AREA
- ∼ RIVER
- ● WATERBODY

0 1,250 2,500
Feet

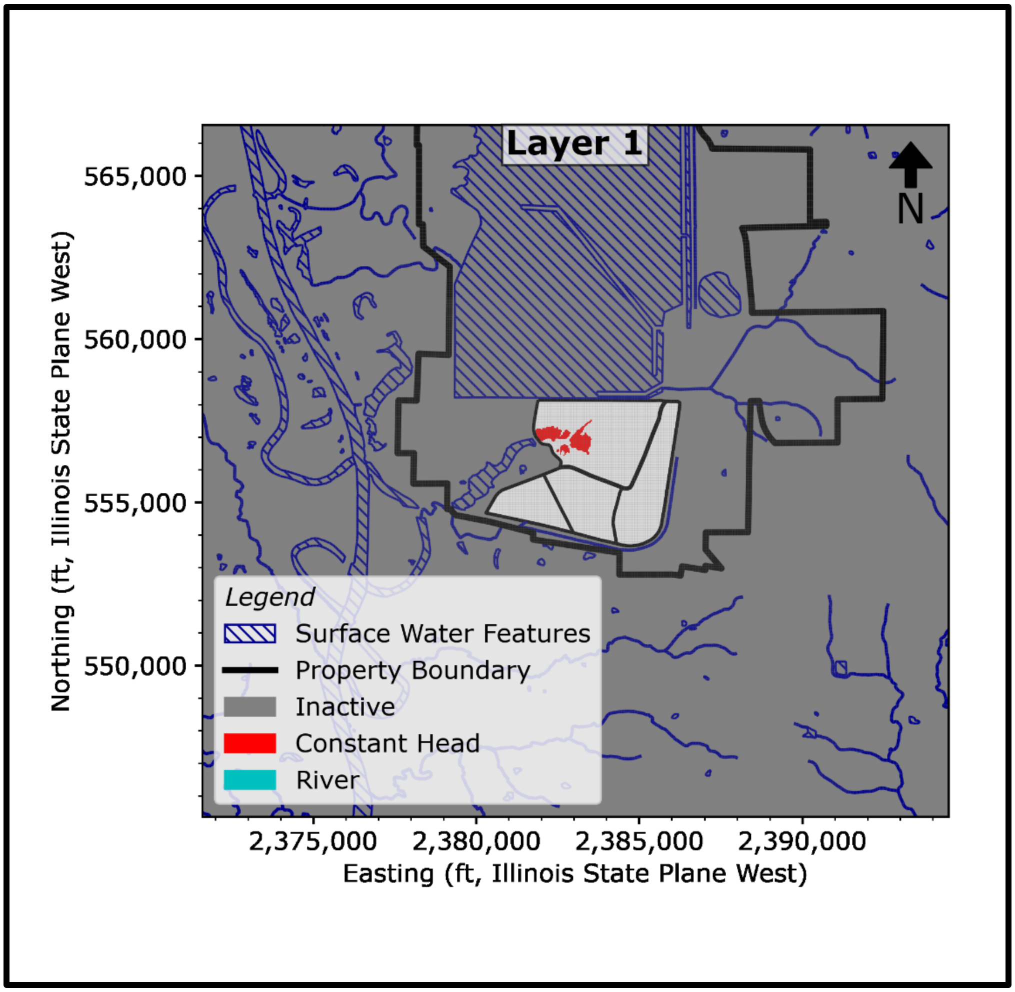
MODEL AREA MAP

FIGURE 5-1

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

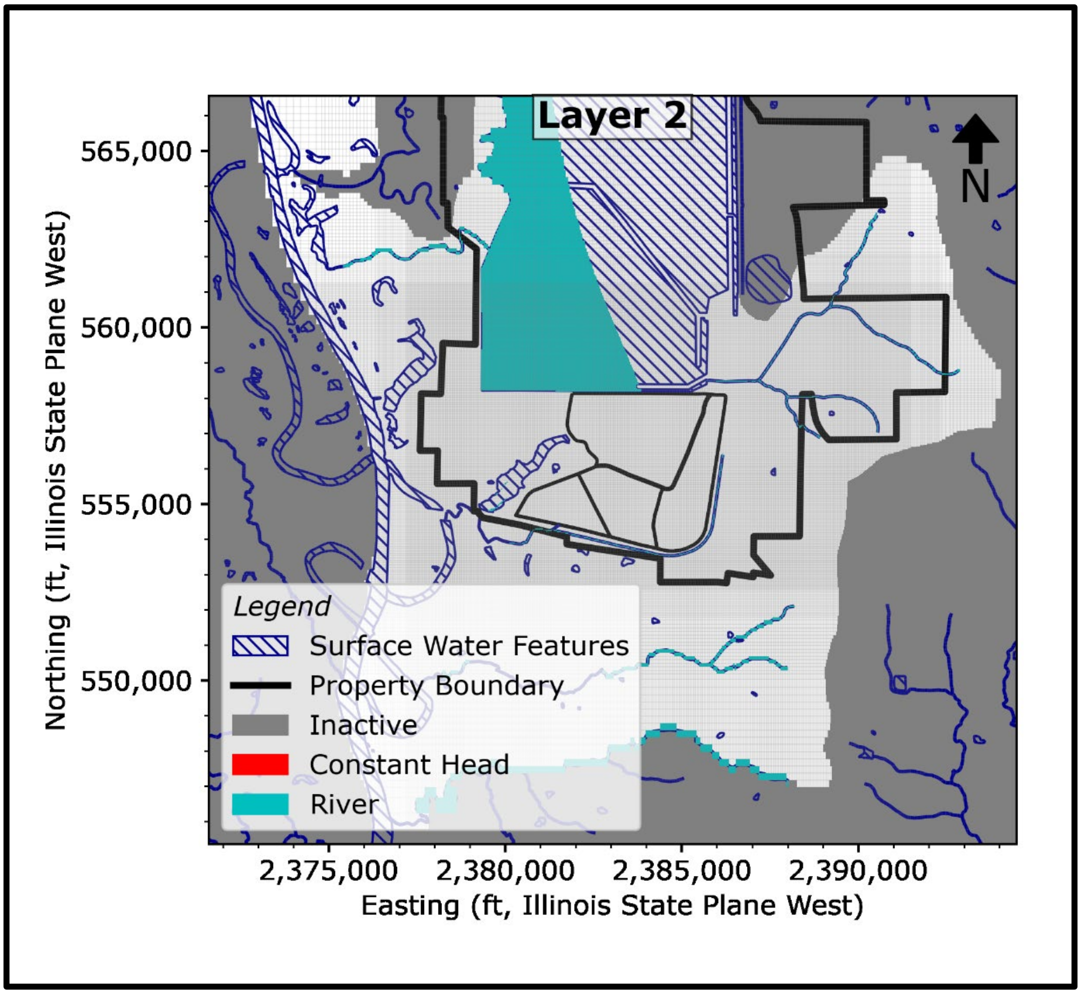
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



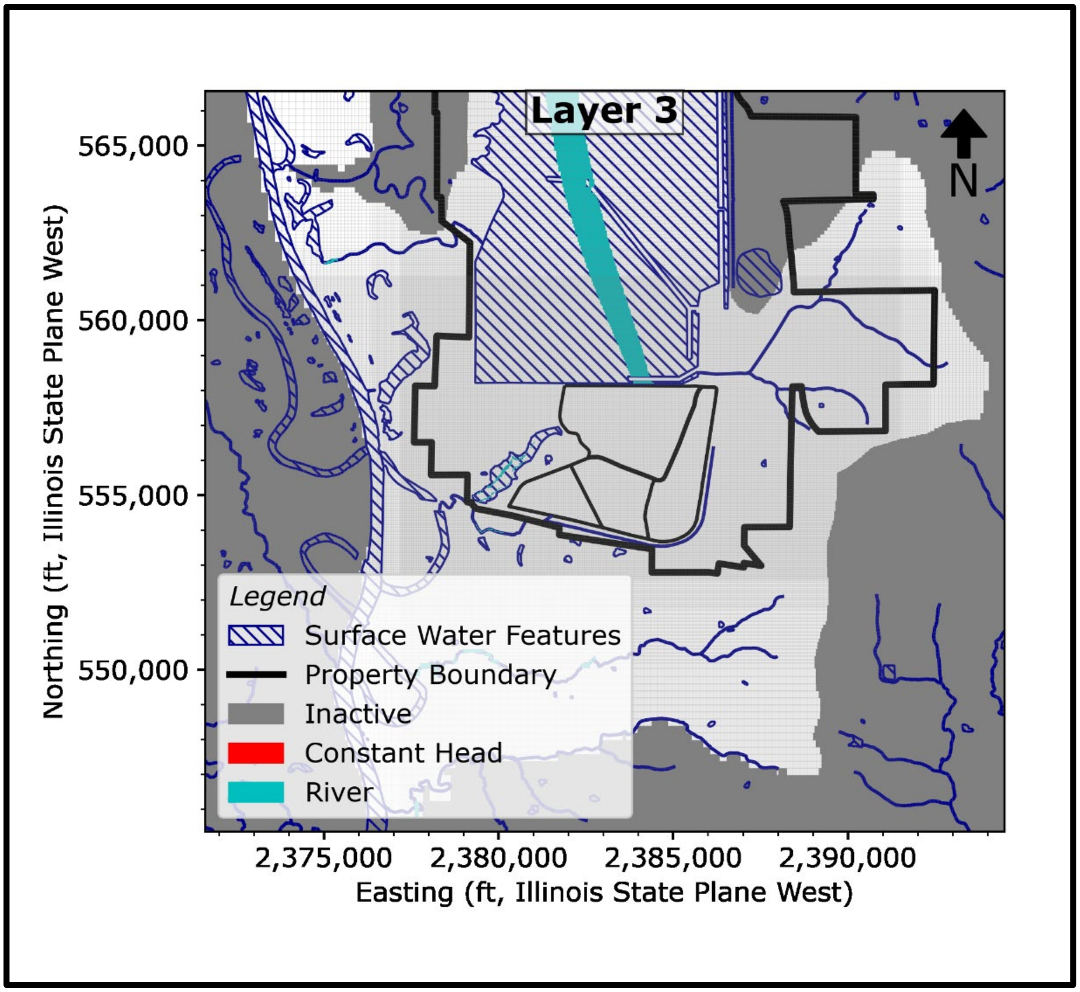
BOUNDARY CONDITIONS FOR LAYER 1 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



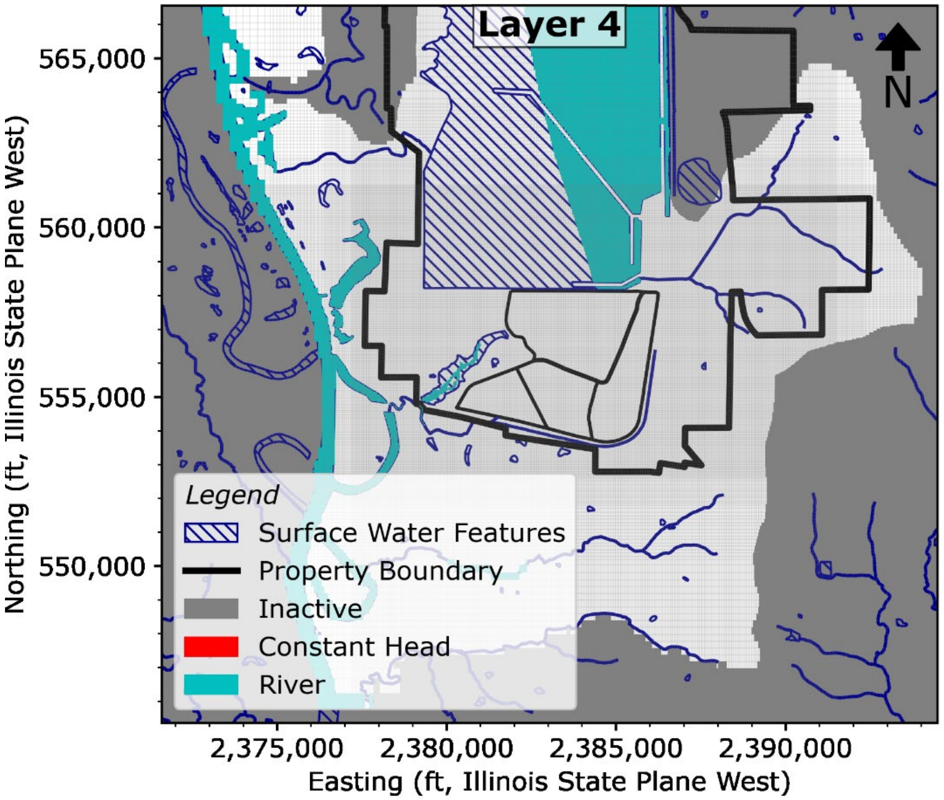
BOUNDARY CONDITIONS FOR LAYER 2 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



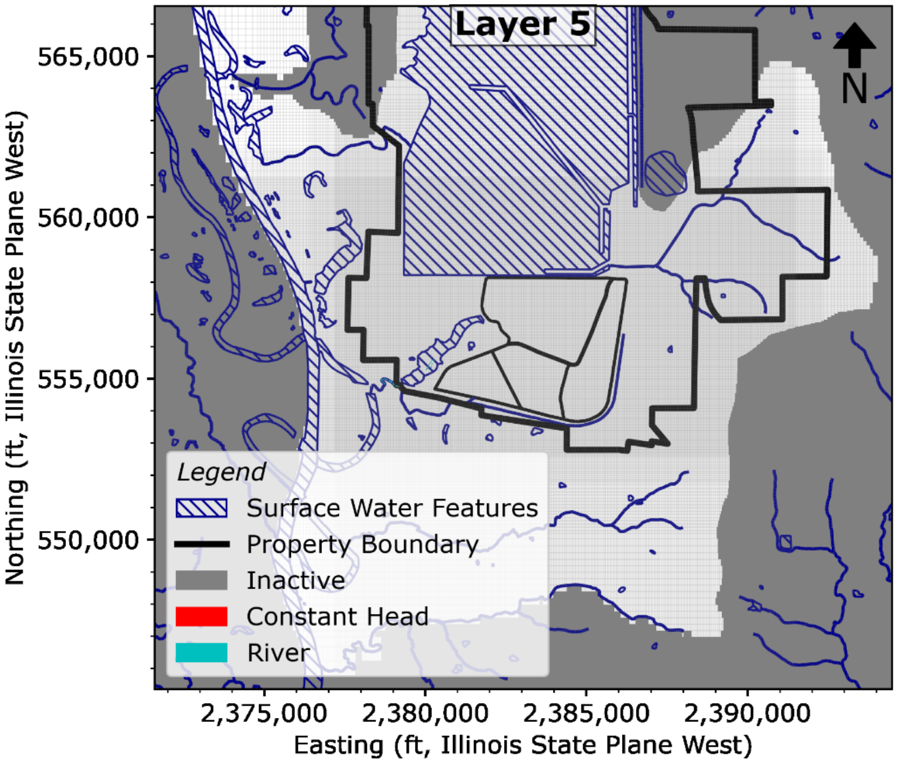
BOUNDARY CONDITIONS FOR LAYER 3 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



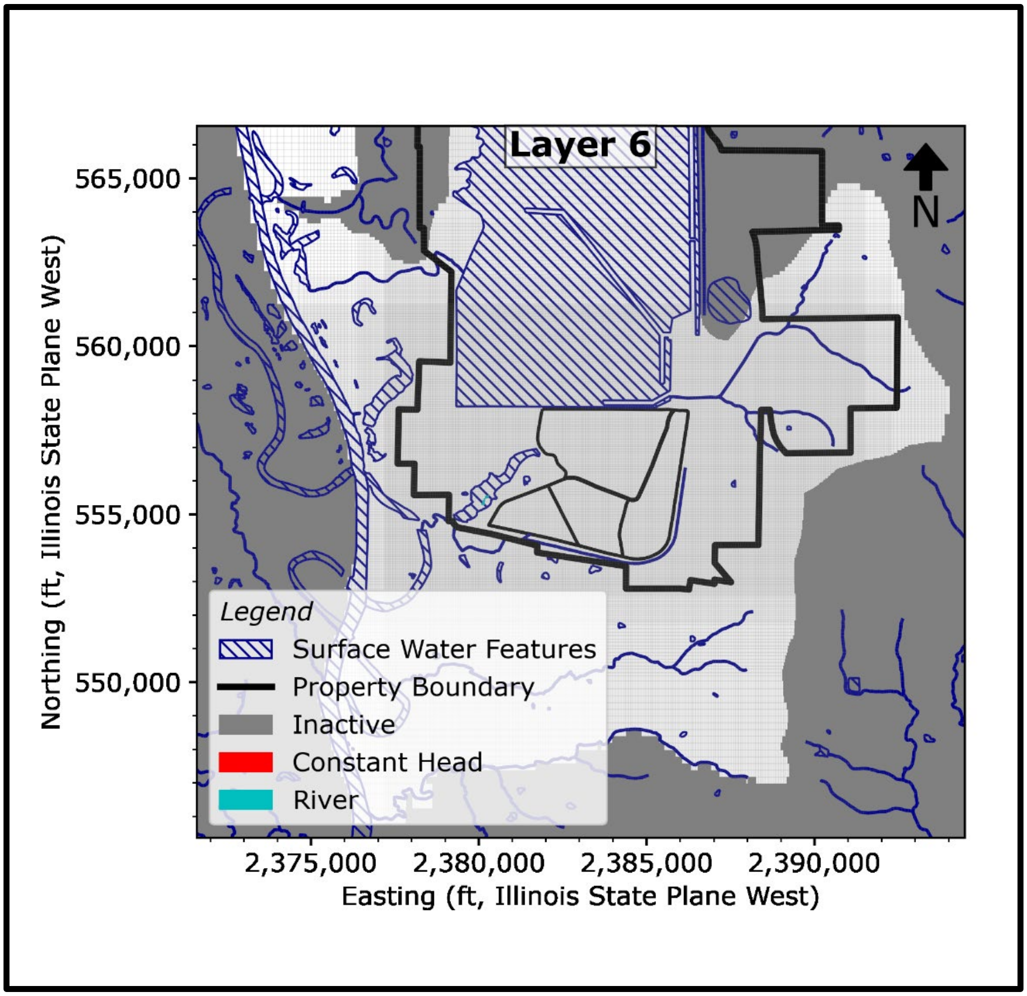
BOUNDARY CONDITIONS FOR LAYER 4 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



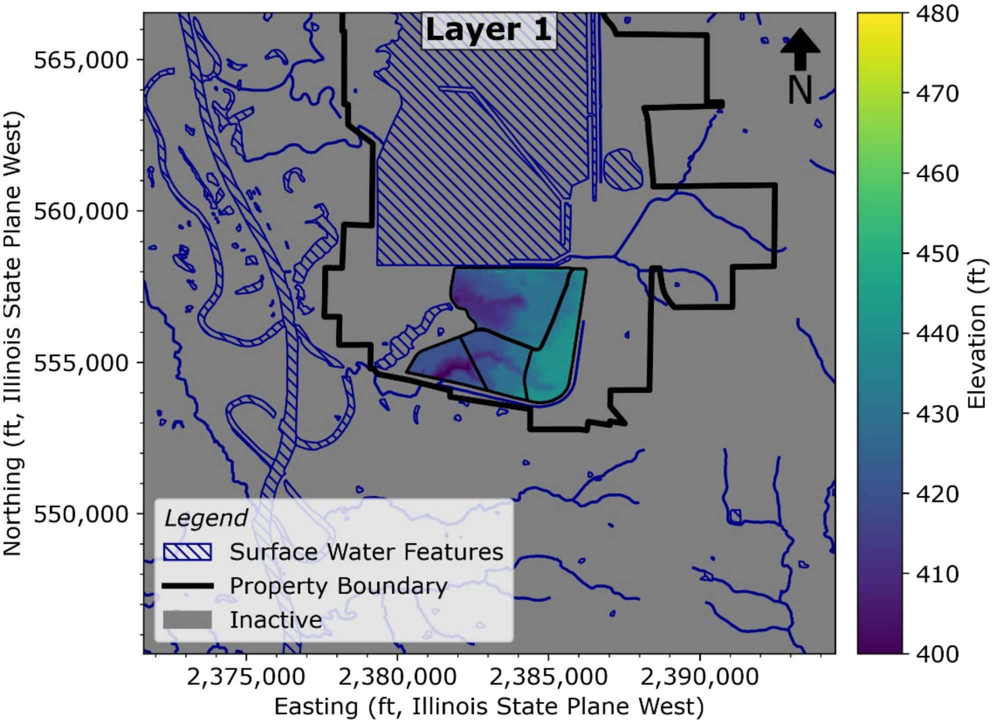
BOUNDARY CONDITIONS FOR LAYER 5 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



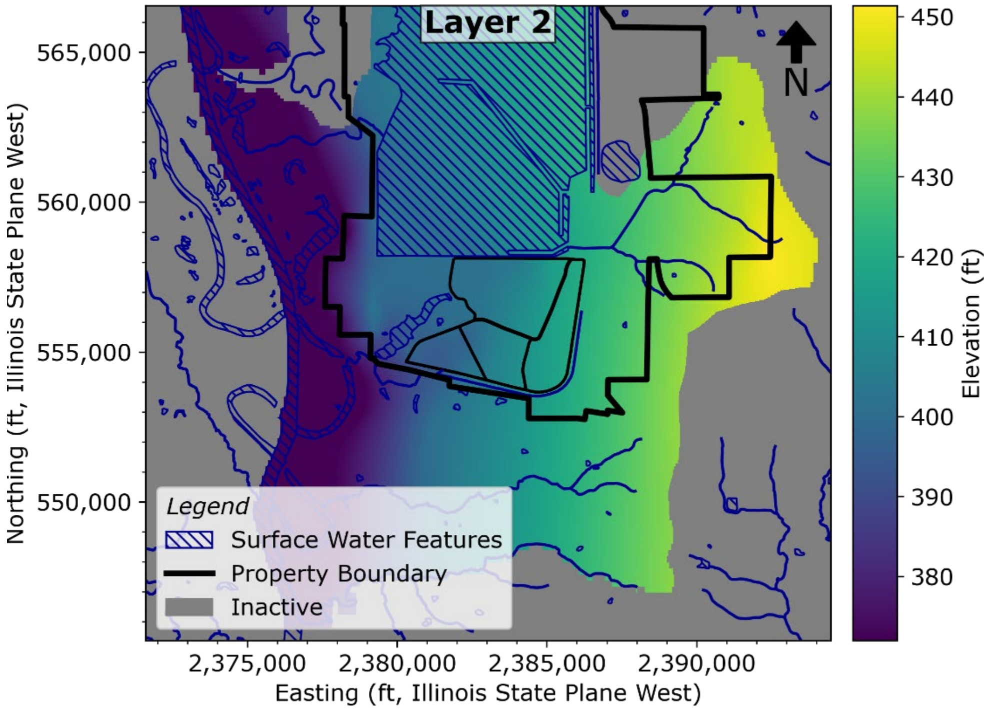
BOUNDARY CONDITIONS FOR LAYER 6 OF THE CALIBRATED NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



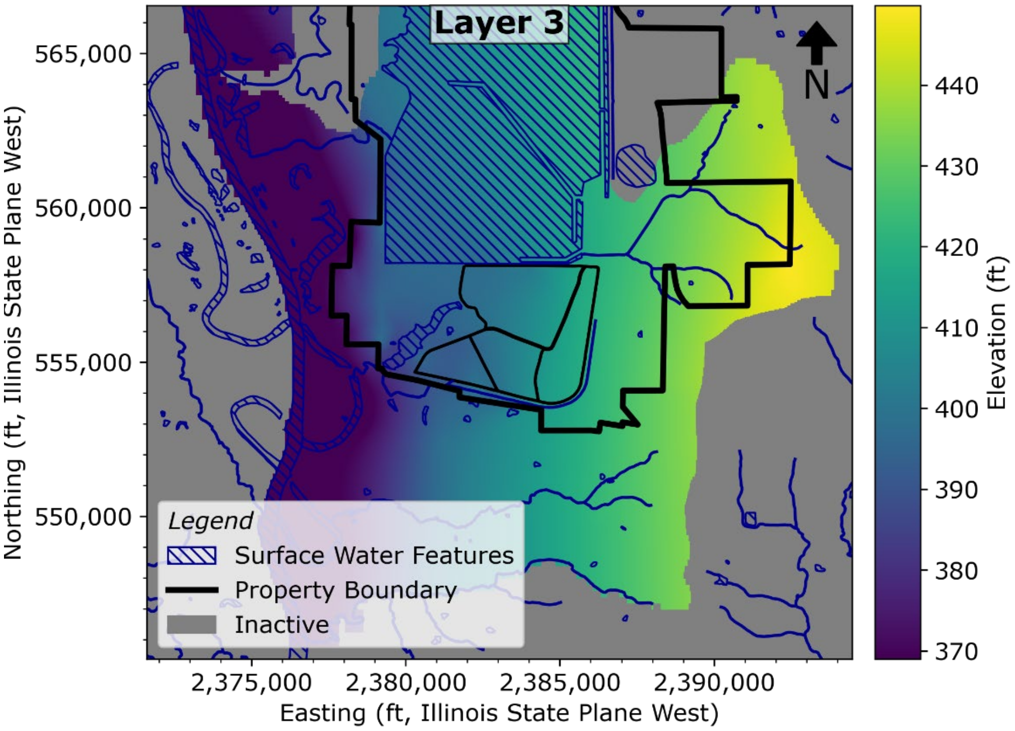
BOTTOM ELEVATION OF MODEL LAYER 1

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



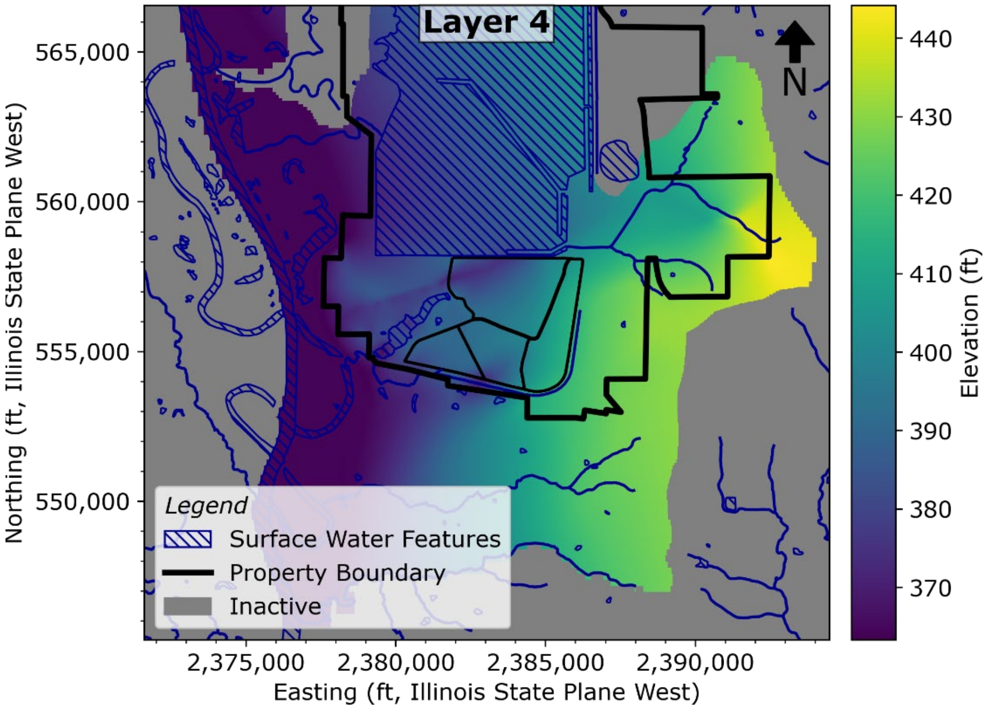
BOTTOM ELEVATION OF MODEL LAYER 2

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



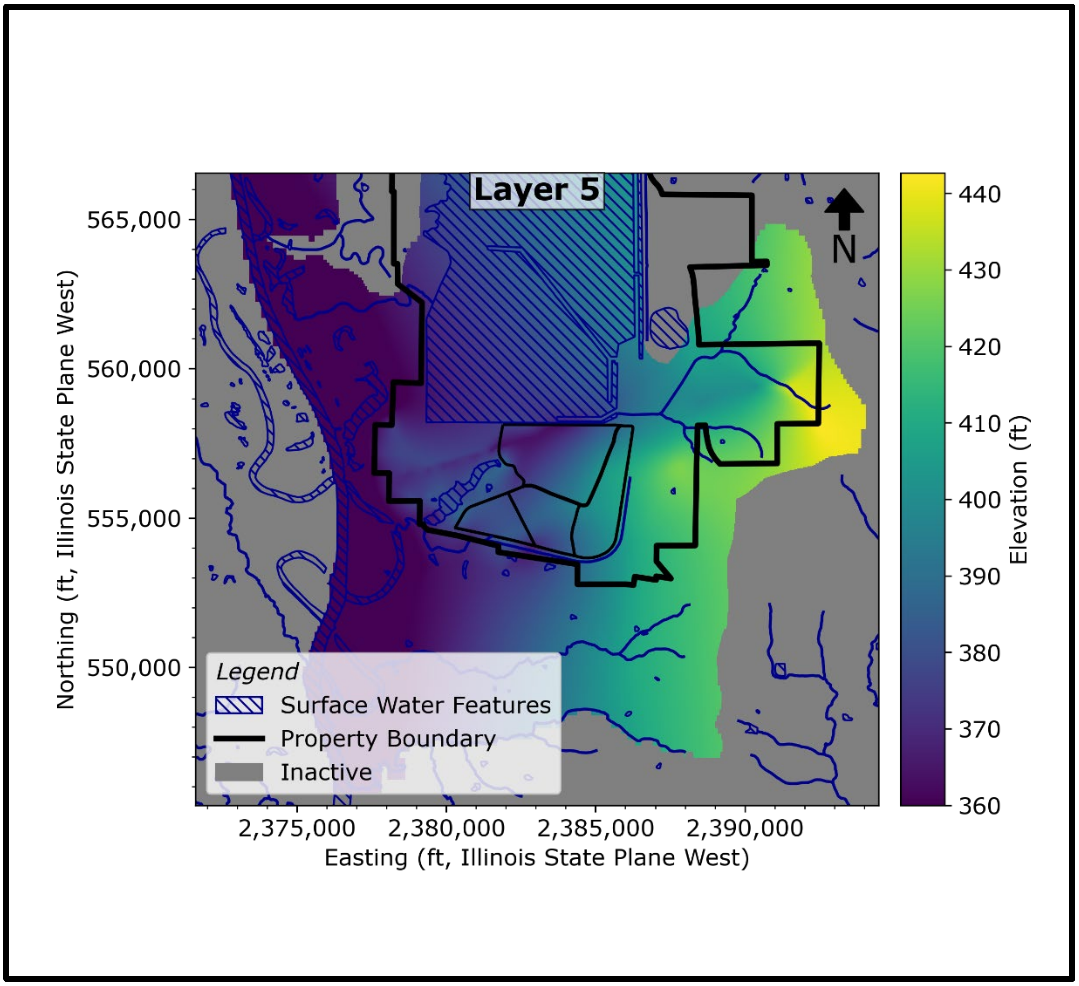
BOTTOM ELEVATION OF MODEL LAYER 3

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



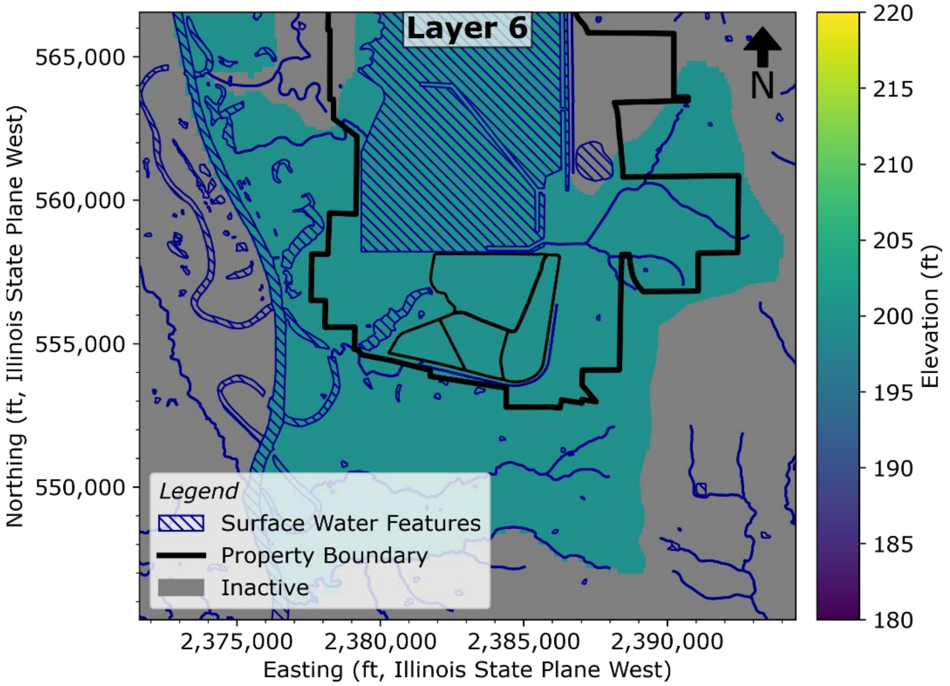
BOTTOM ELEVATION OF MODEL LAYER 4

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



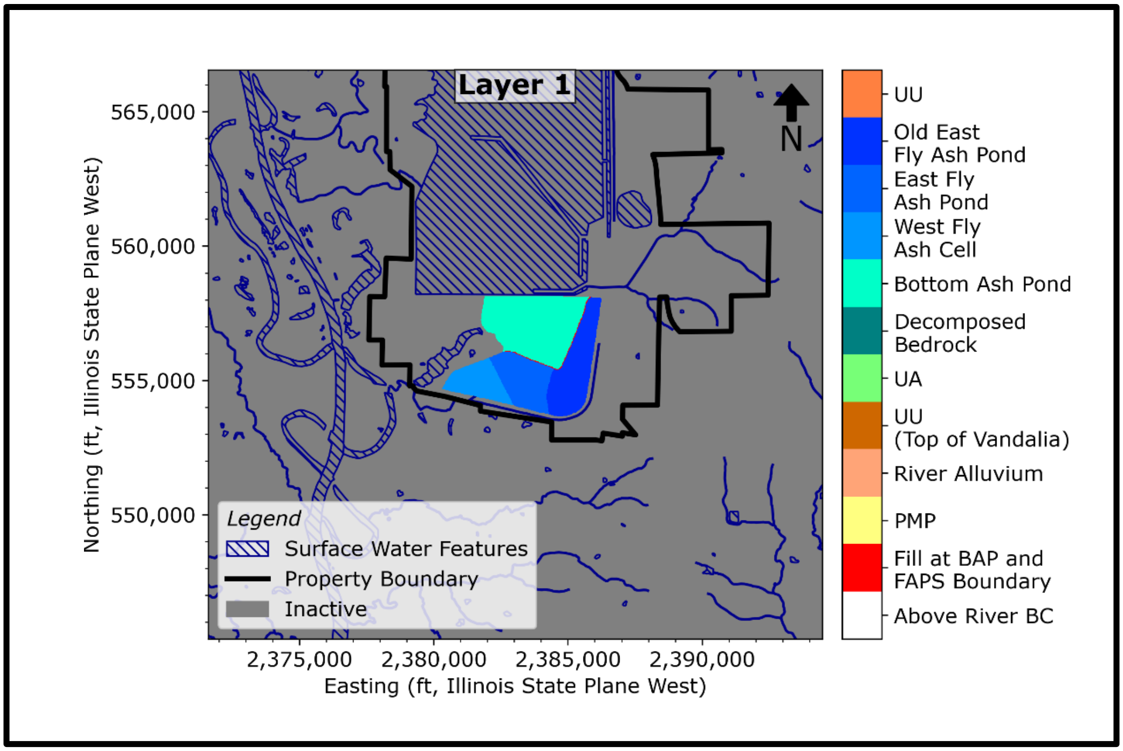
BOTTOM ELEVATION OF MODEL LAYER 5

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



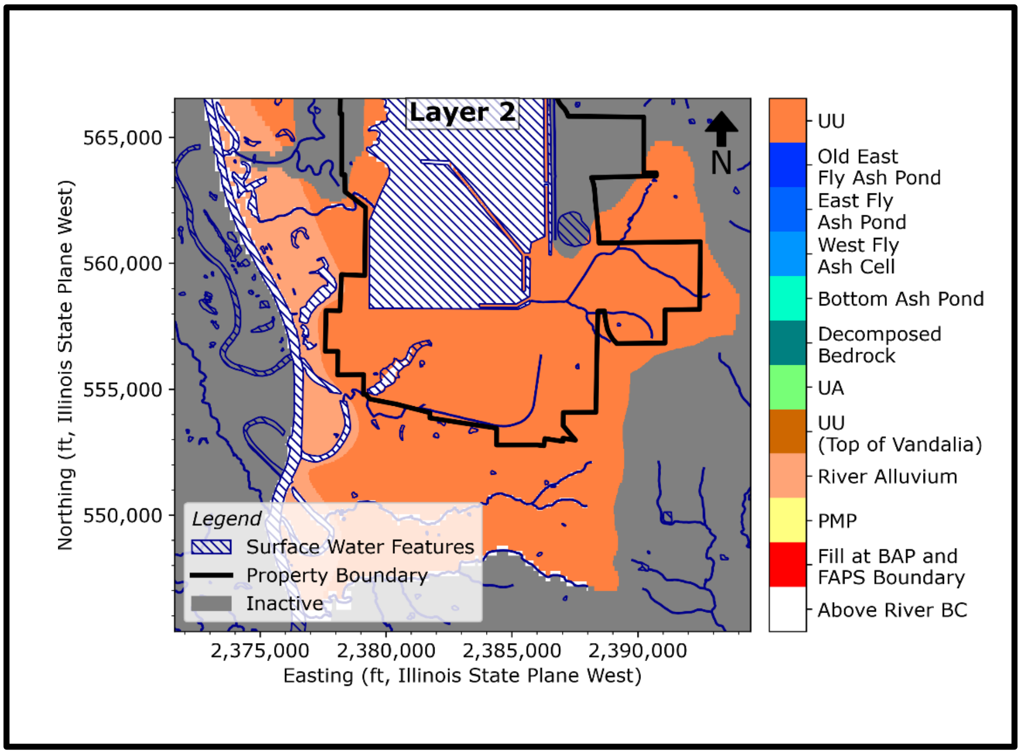
BOTTOM ELEVATION OF MODEL LAYER 6

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



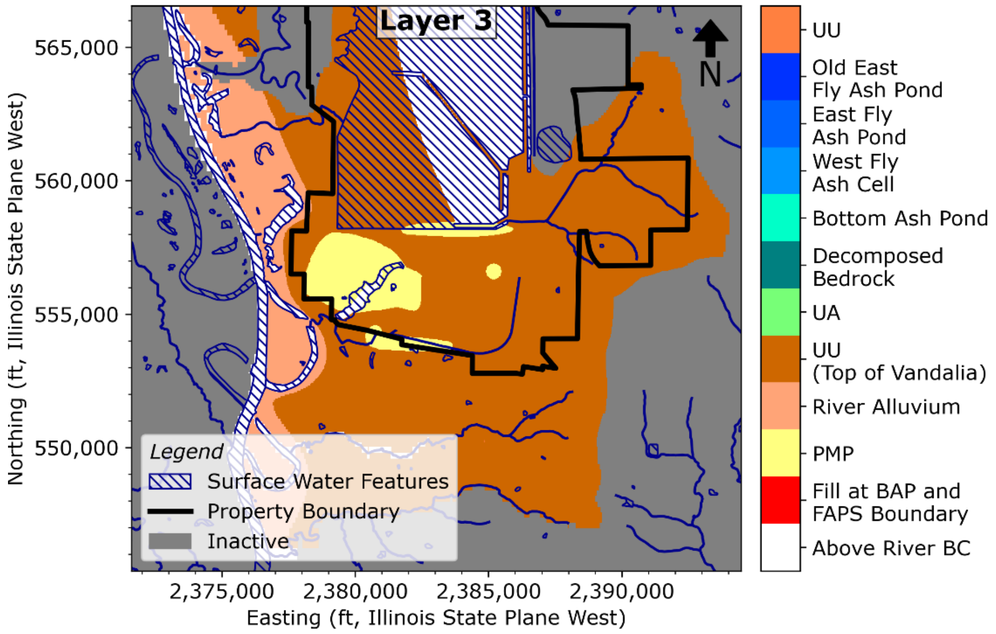
SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 1 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



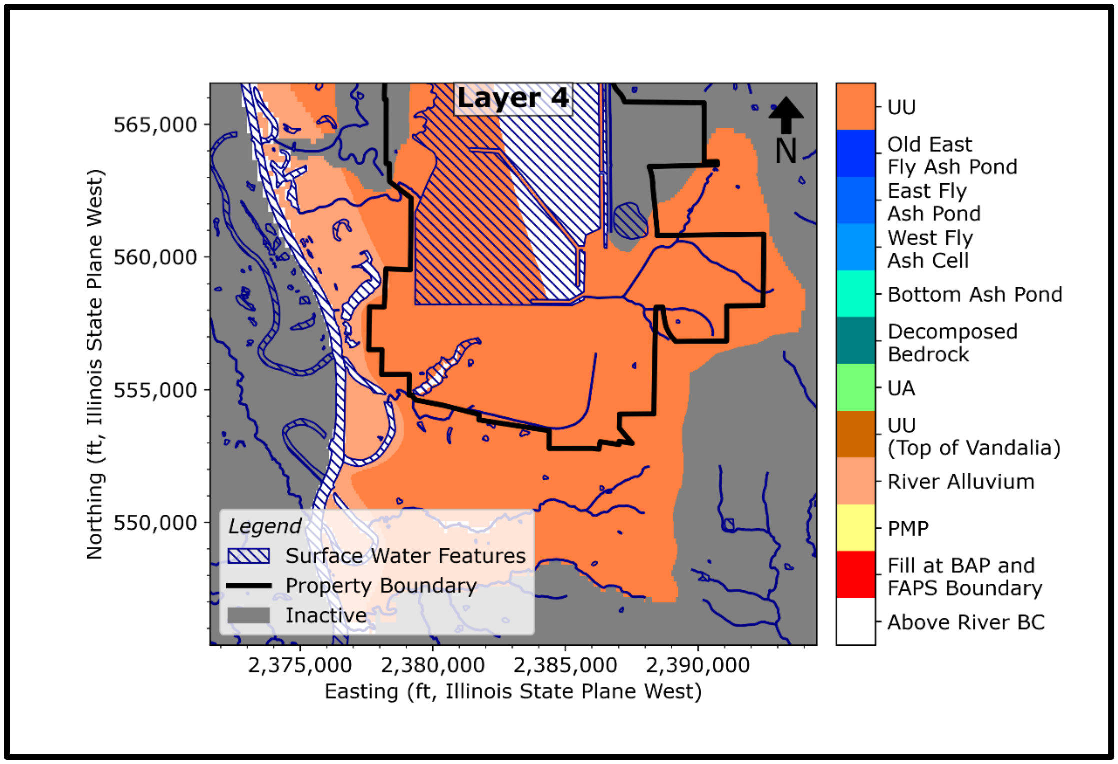
SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 2 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



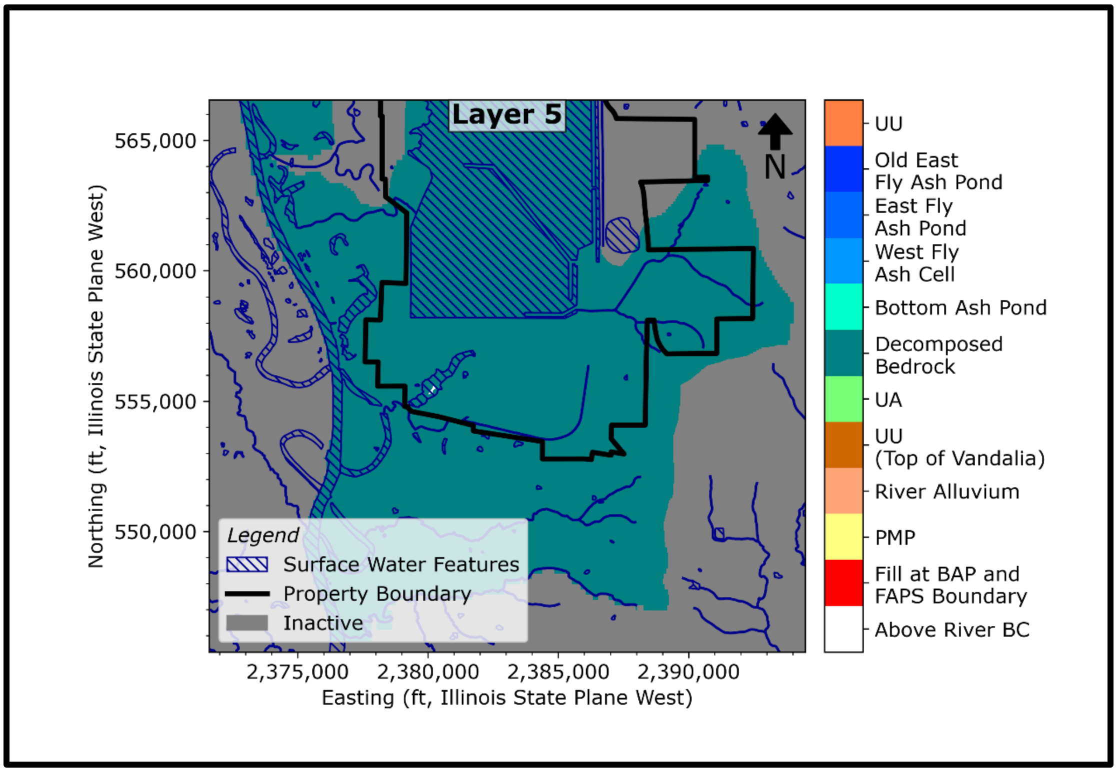
SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 3 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 4 IN THE NUMERICAL MODEL

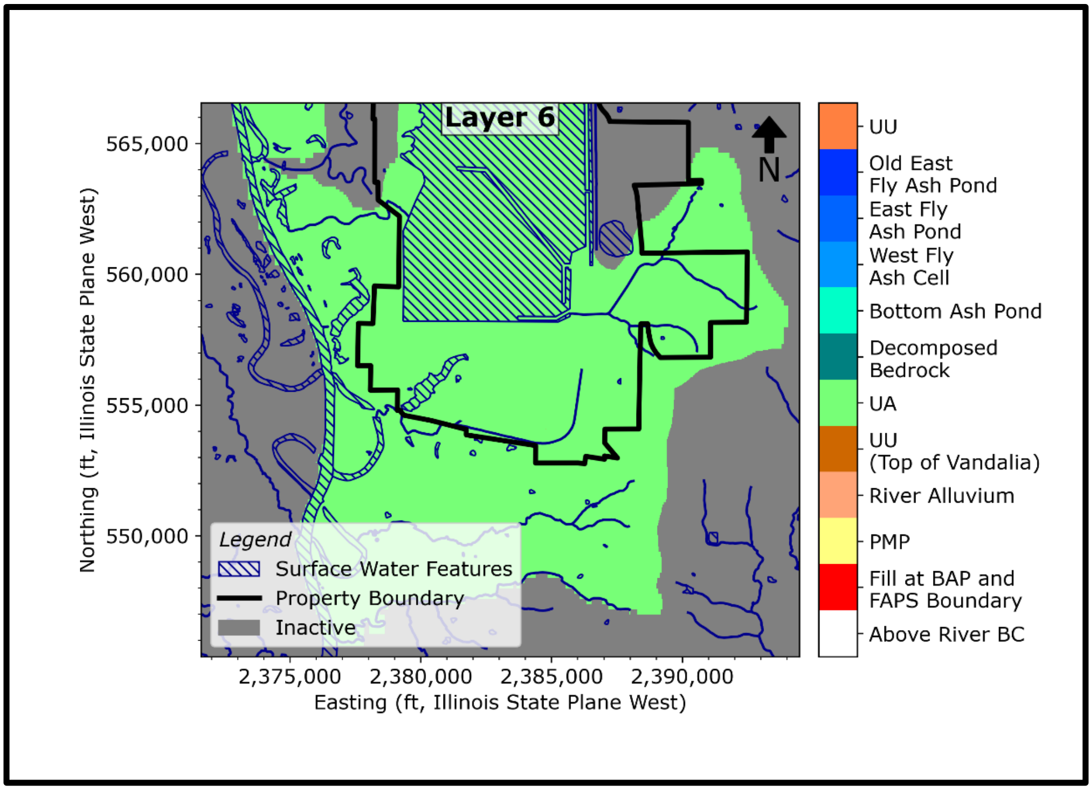
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 5 IN THE NUMERICAL MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

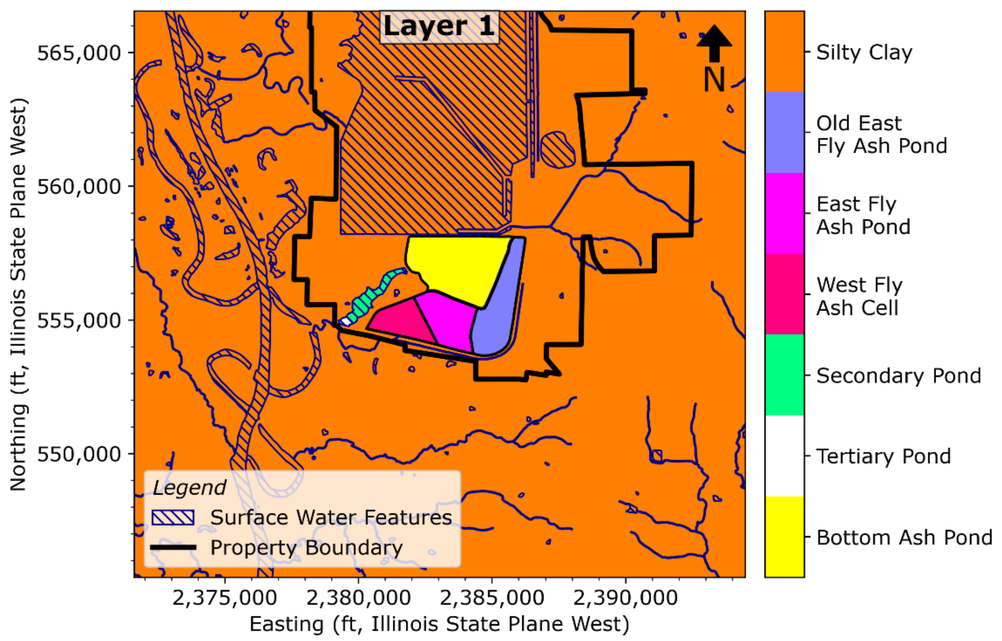
RAMBOLL



SPATIAL DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 6 IN THE NUMERICAL MODEL

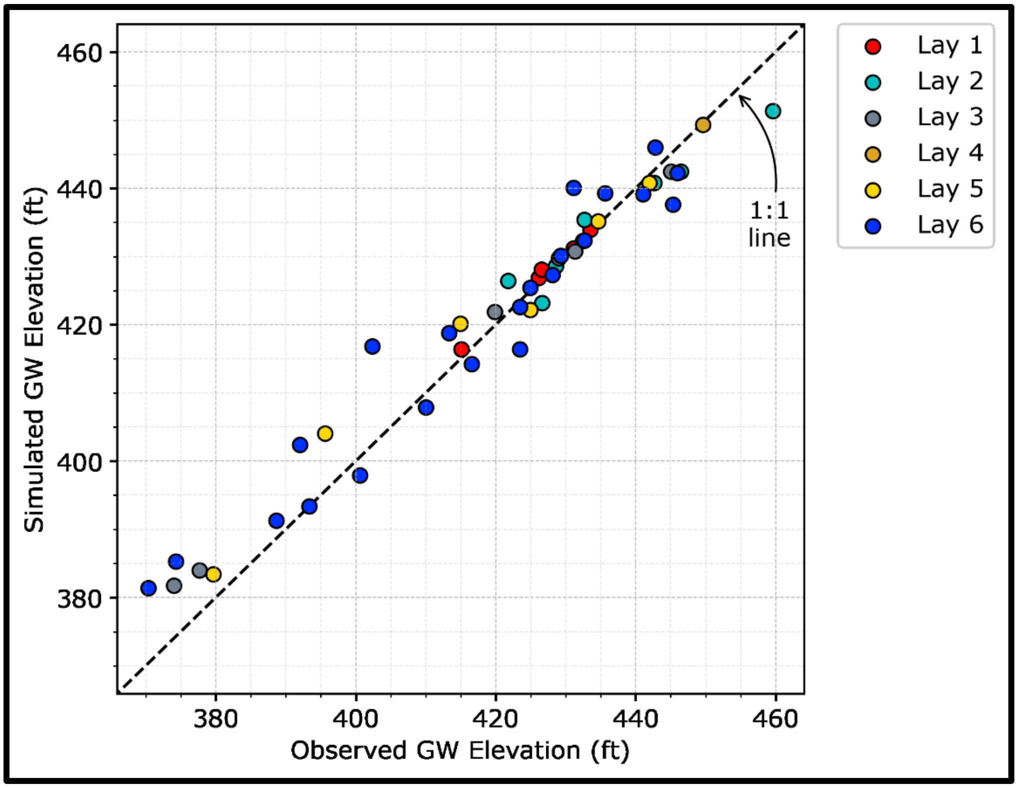
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 5-20



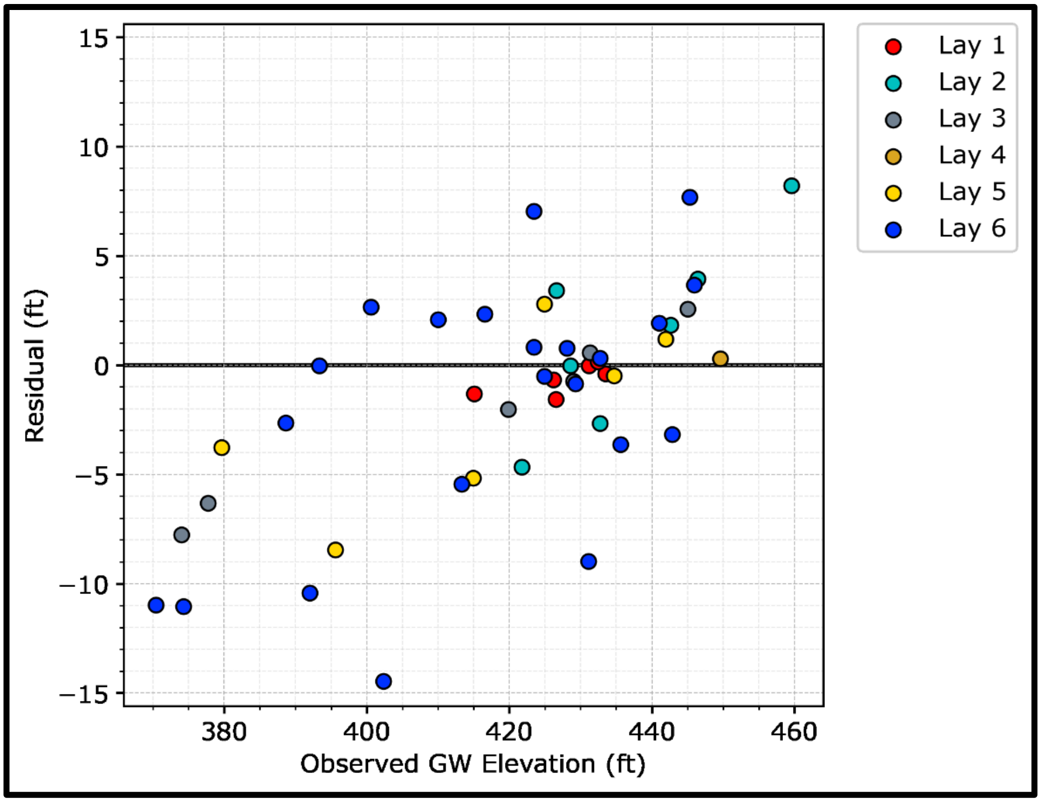
MODEL RECHARGE DISTRIBUTION (STEADY STATE CALIBRATION MODEL)

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



OBSERVED VERSUS SIMULATED STEADY STATE GROUNDWATER LEVELS FROM THE CALIBRATION MODEL

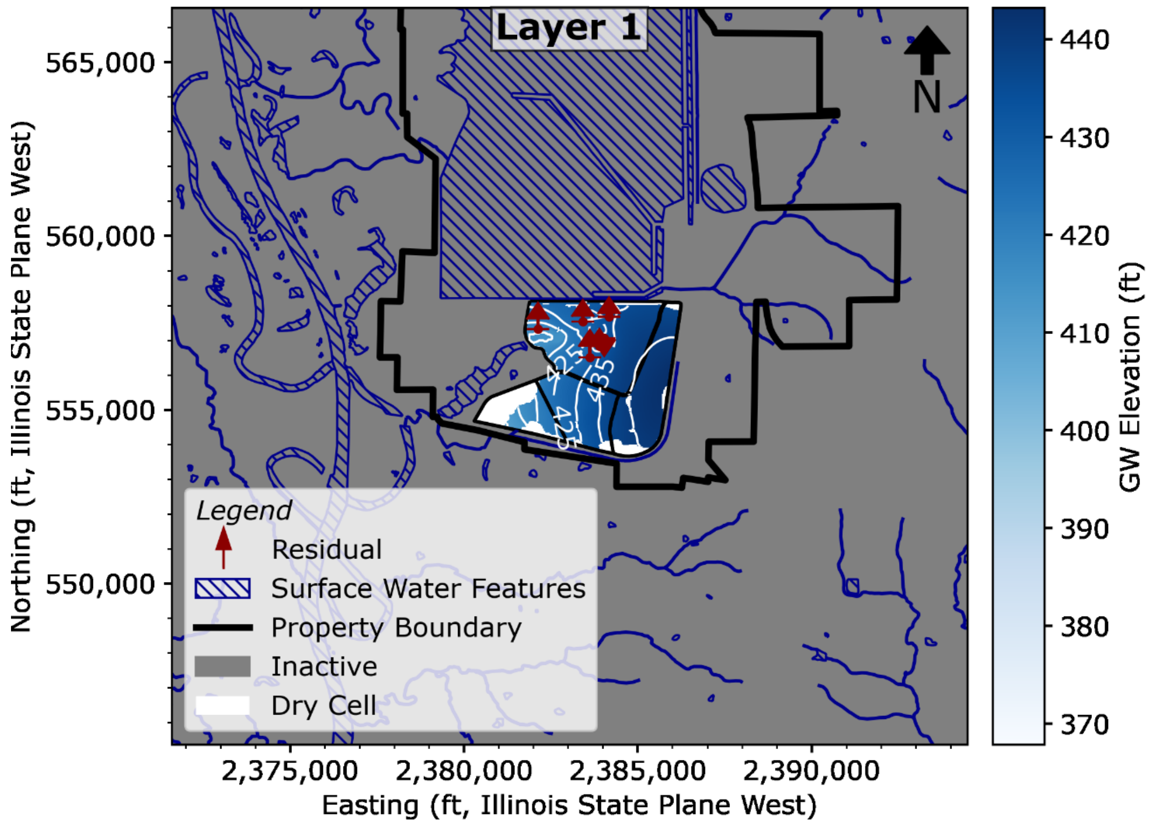
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



SIMULATED GROUNDWATER LEVEL RESIDUALS FROM THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

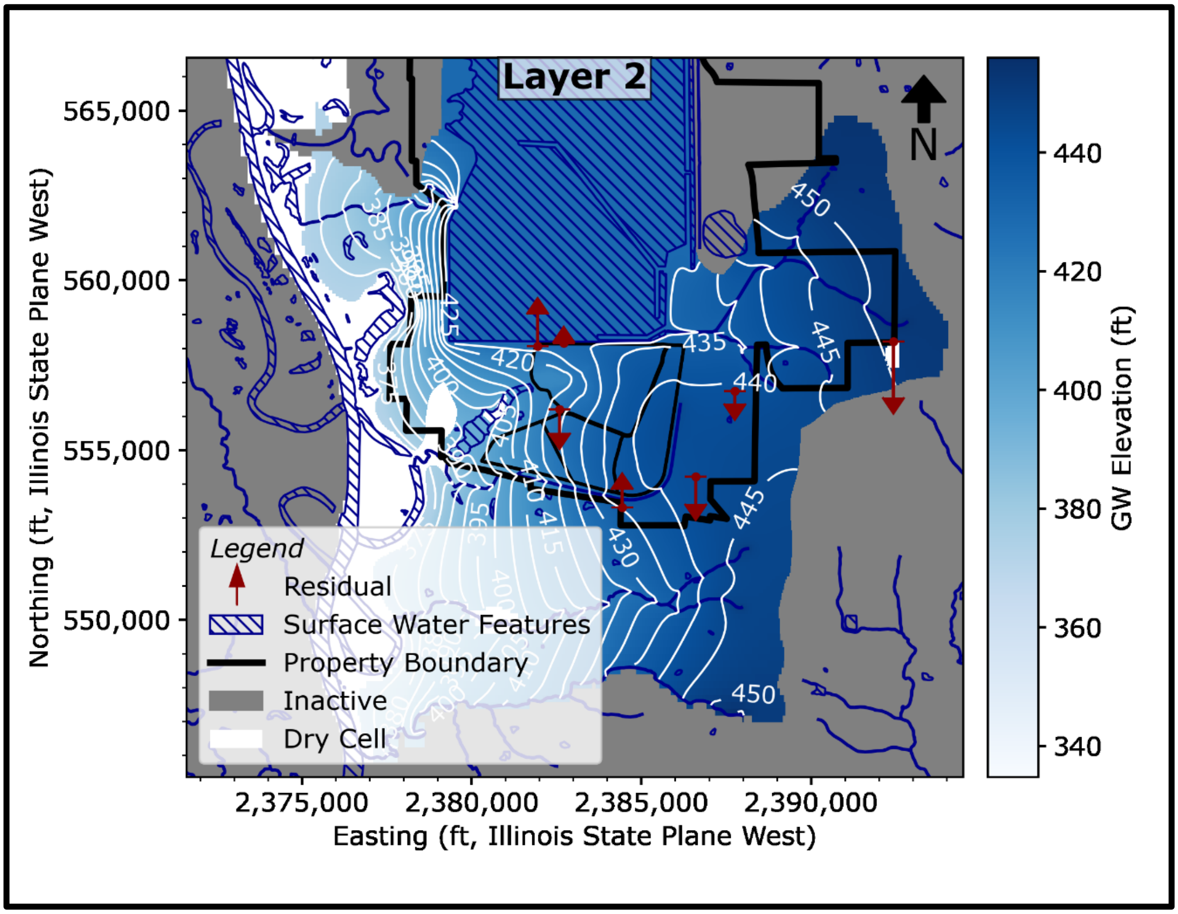
FIGURE 5-23



NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 1 OF THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

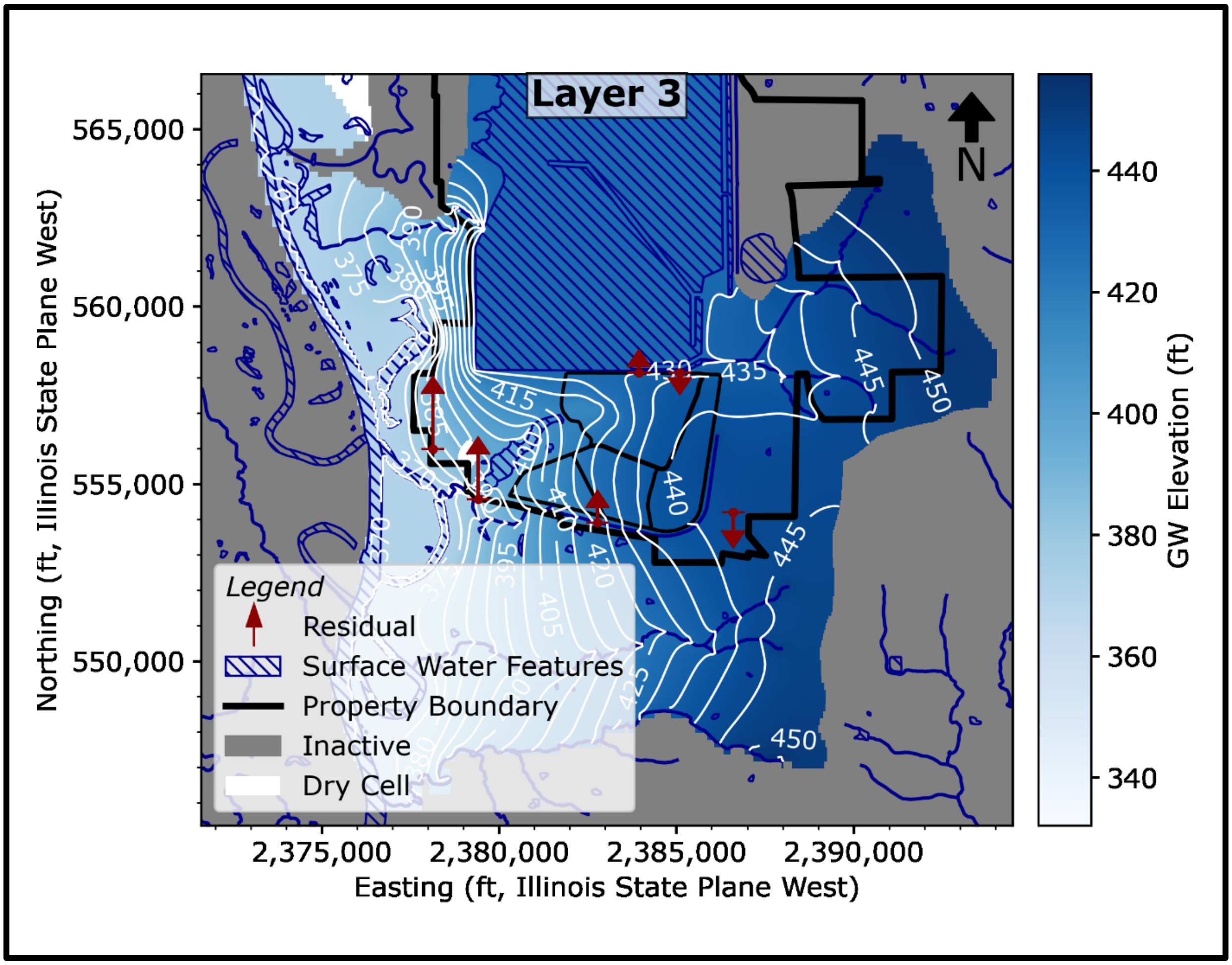


NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 2 OF THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

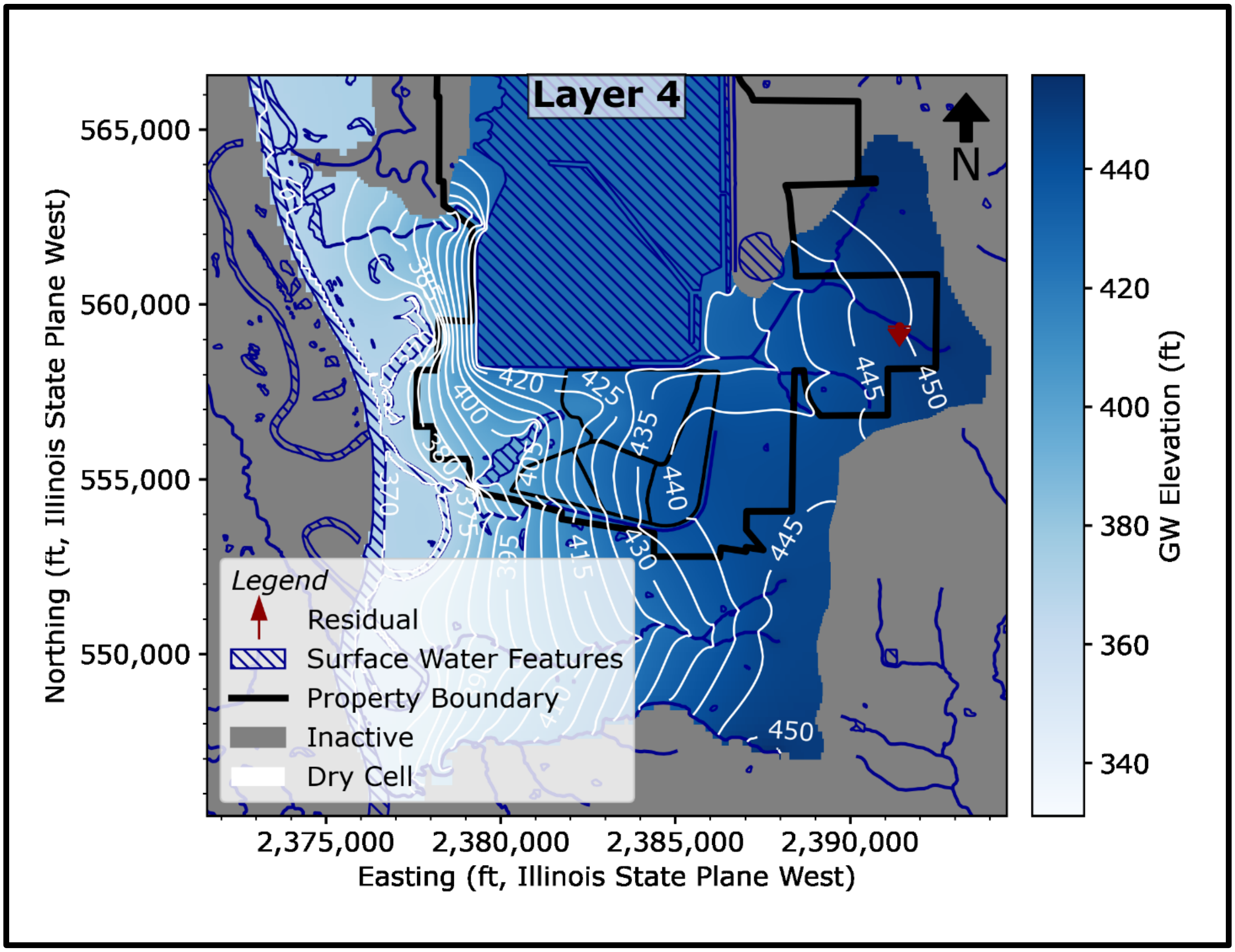
FIGURE 5-25



NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 3 OF THE CALIBRATED MODEL

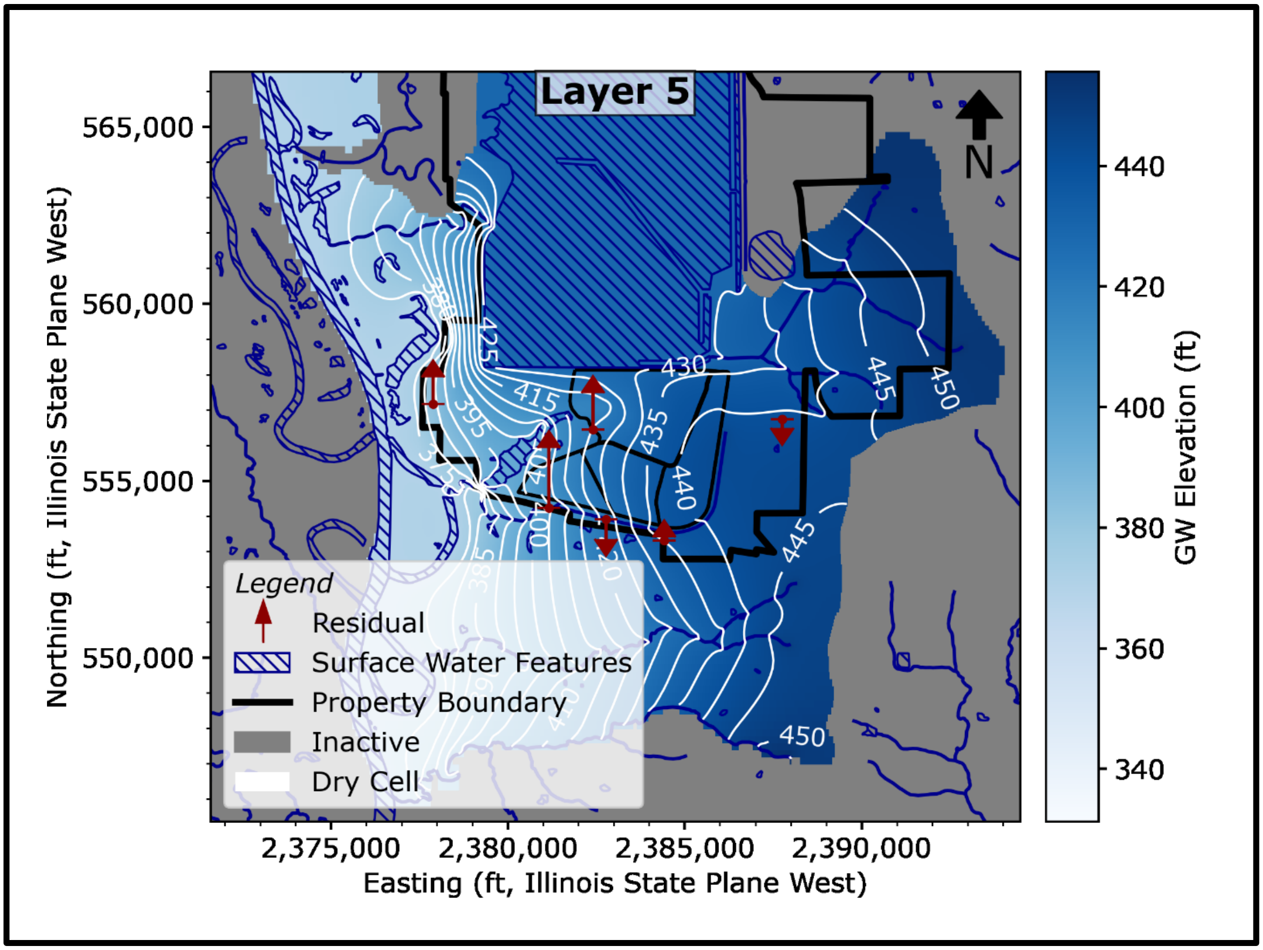
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 4 OF THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

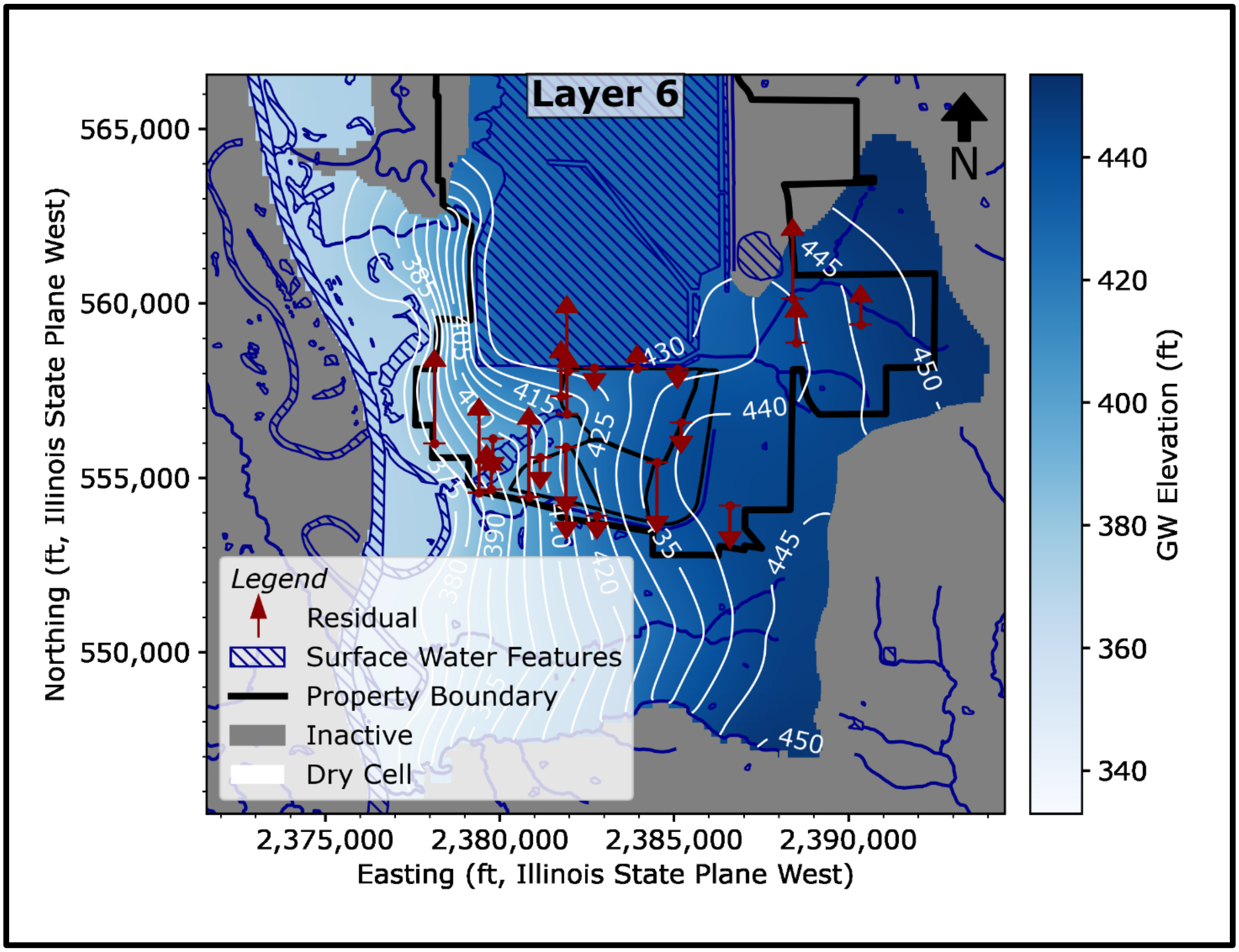


NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 5 OF THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

RAMBOLL



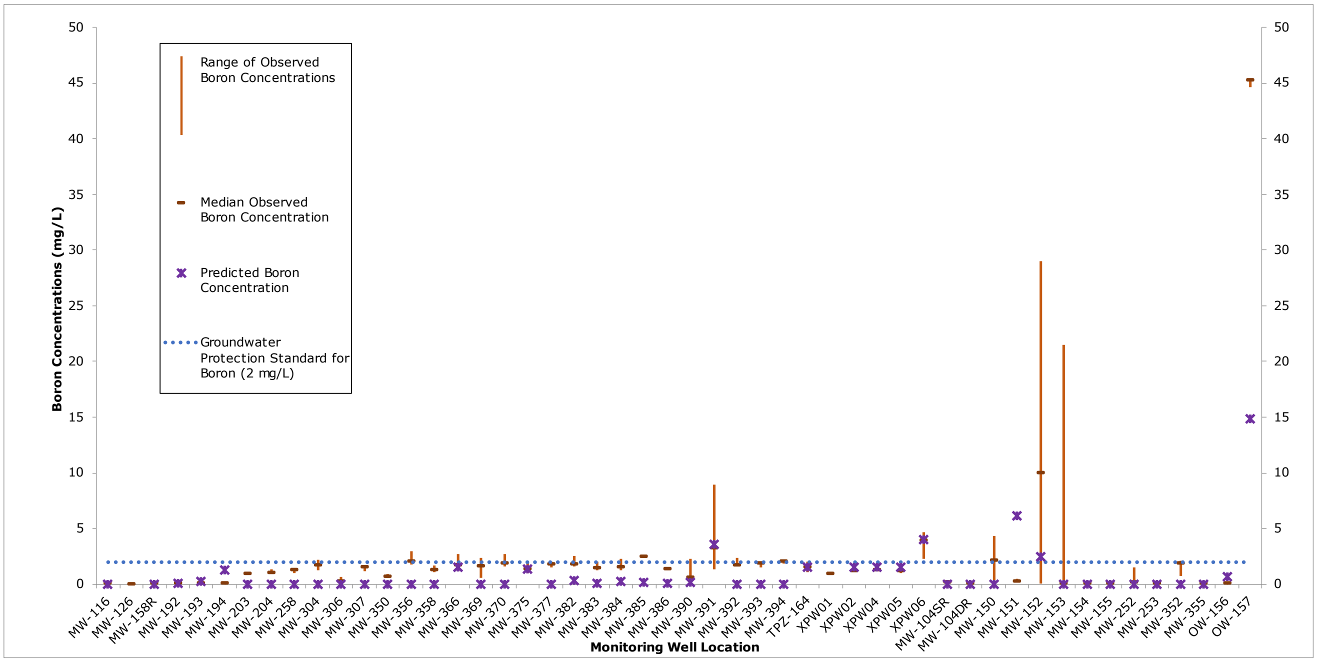
NOTE: RED DOTS INDICATE WELLS AND ARROW DIRECTION INDICATES BIAS IN SIMULATED GROUNDWATER LEVEL (NORTH ARROW = OVERESTIMATION, SOUTH ARROW = UNDERESTIMATION)

SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM LAYER 6 OF THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

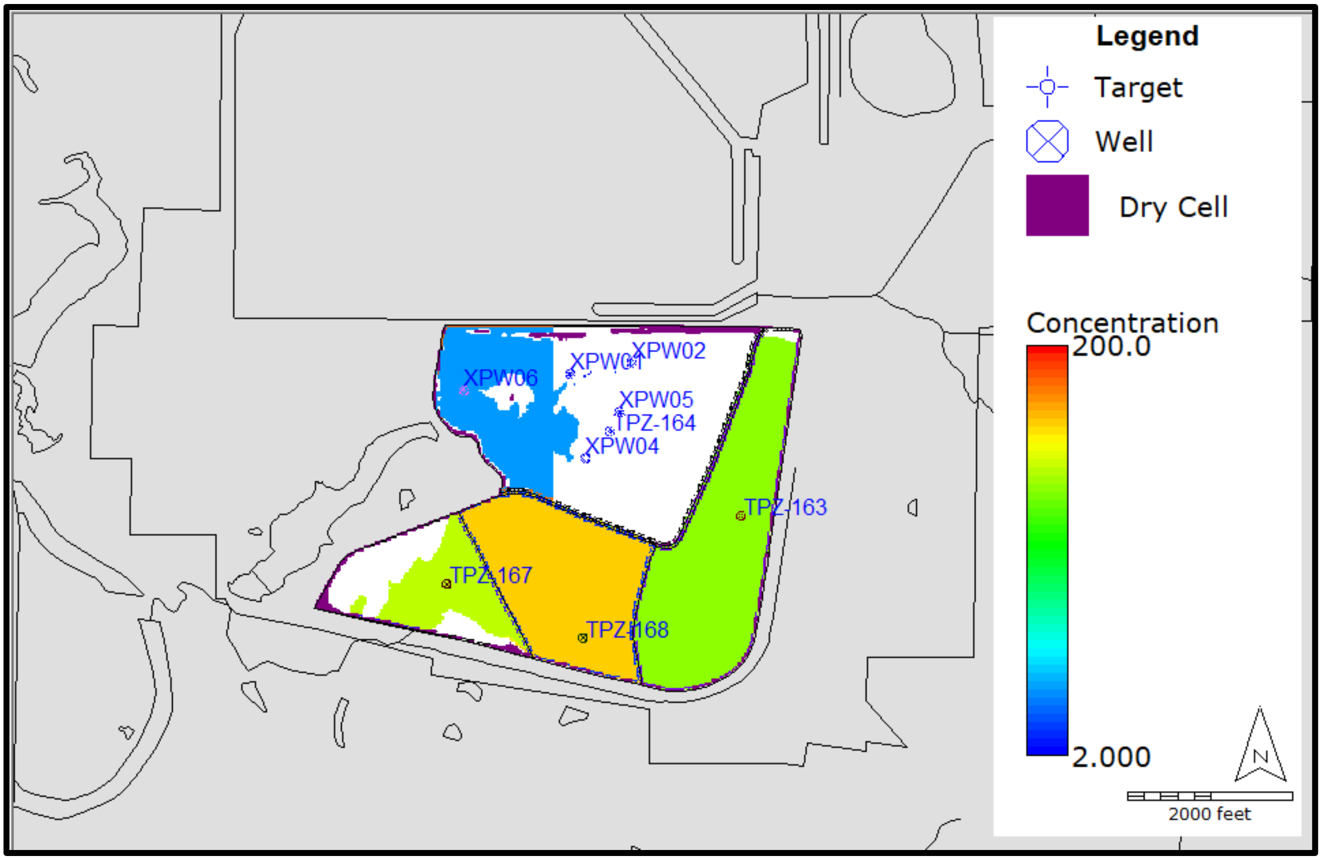
RAMBOLL

FIGURE 5-29



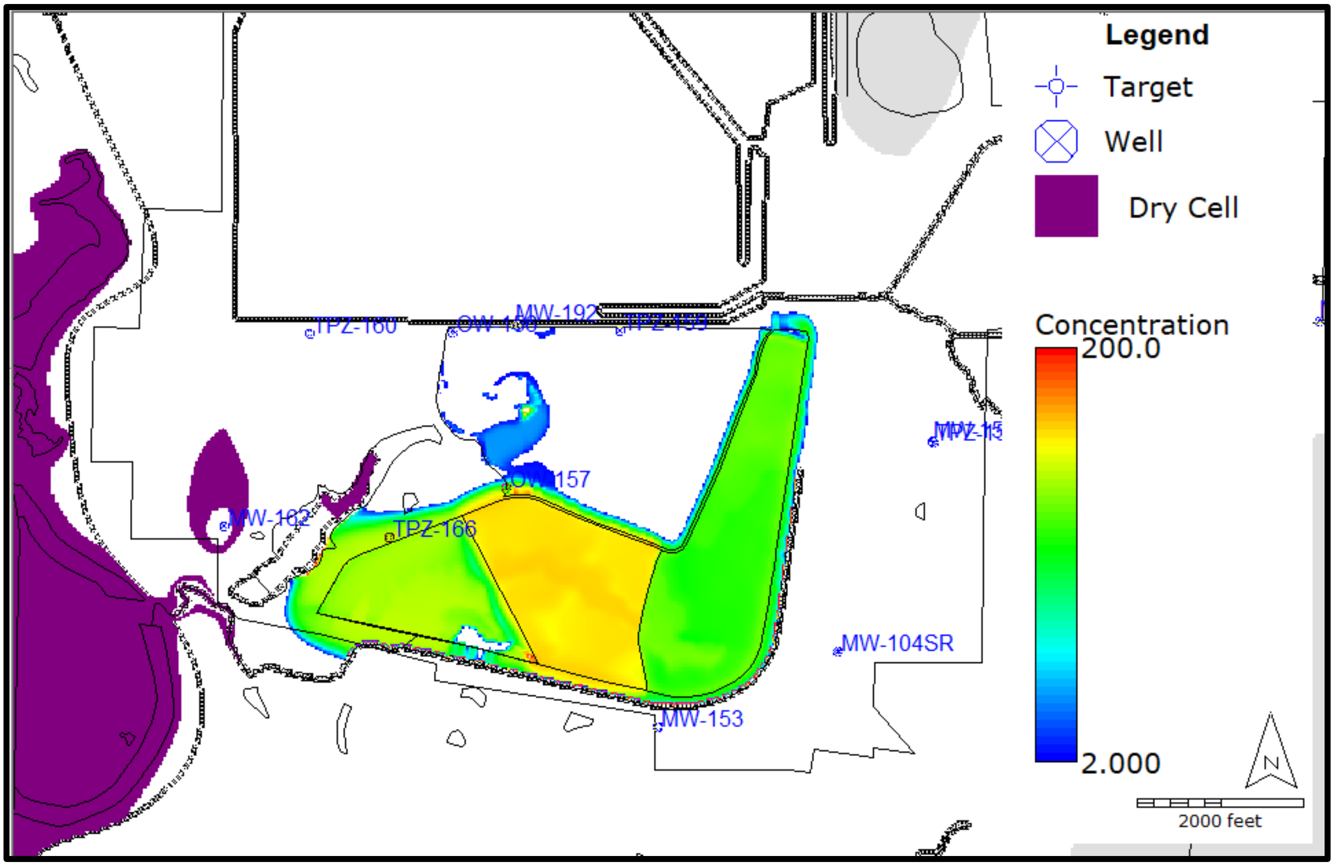
OBSERVED AND SIMULATED BORON CONCENTRATIONS (mg/L)

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



LAYER 1 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL (CCR)

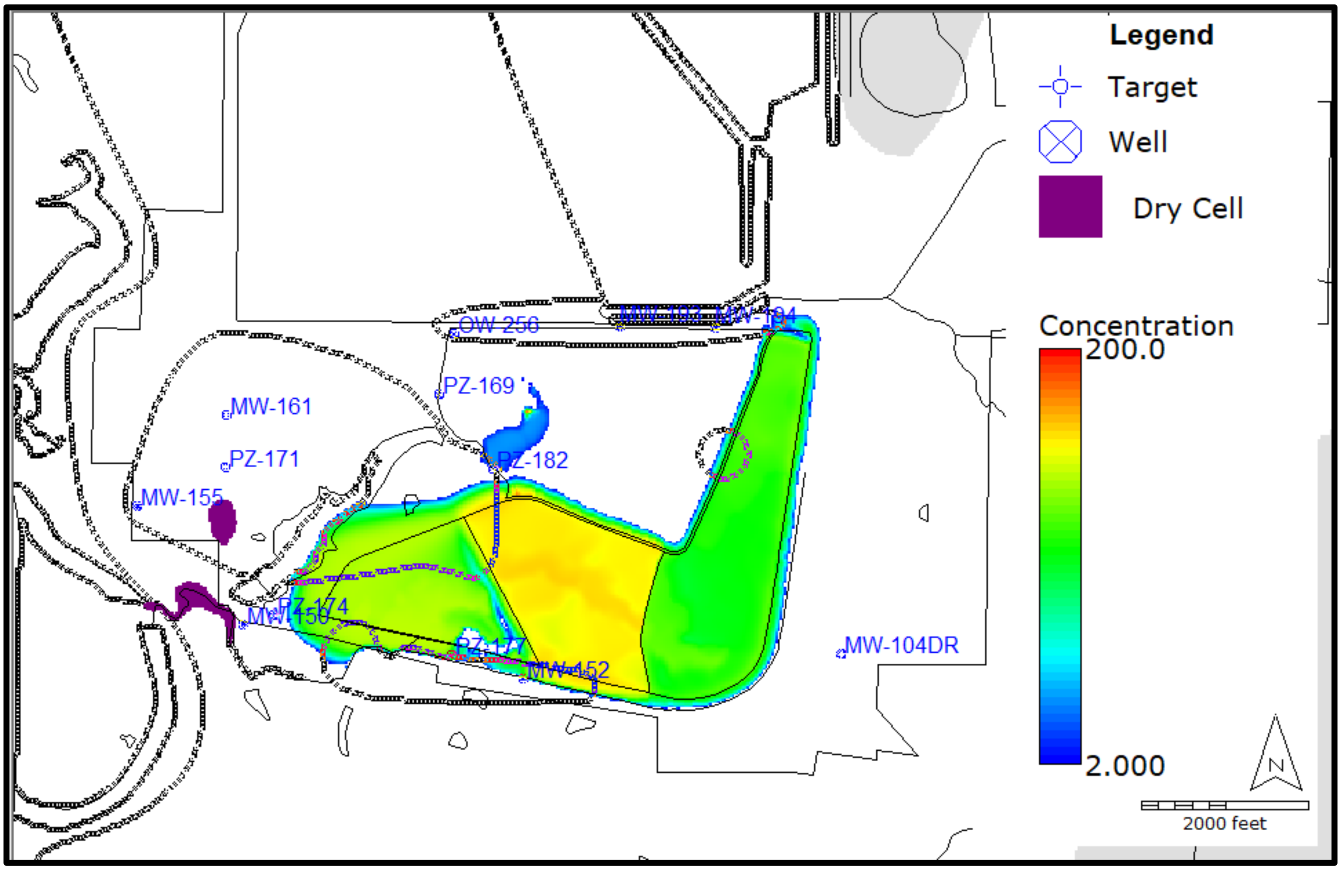
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



LAYER 2 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL (UU [UPPER SILTY CLAY])

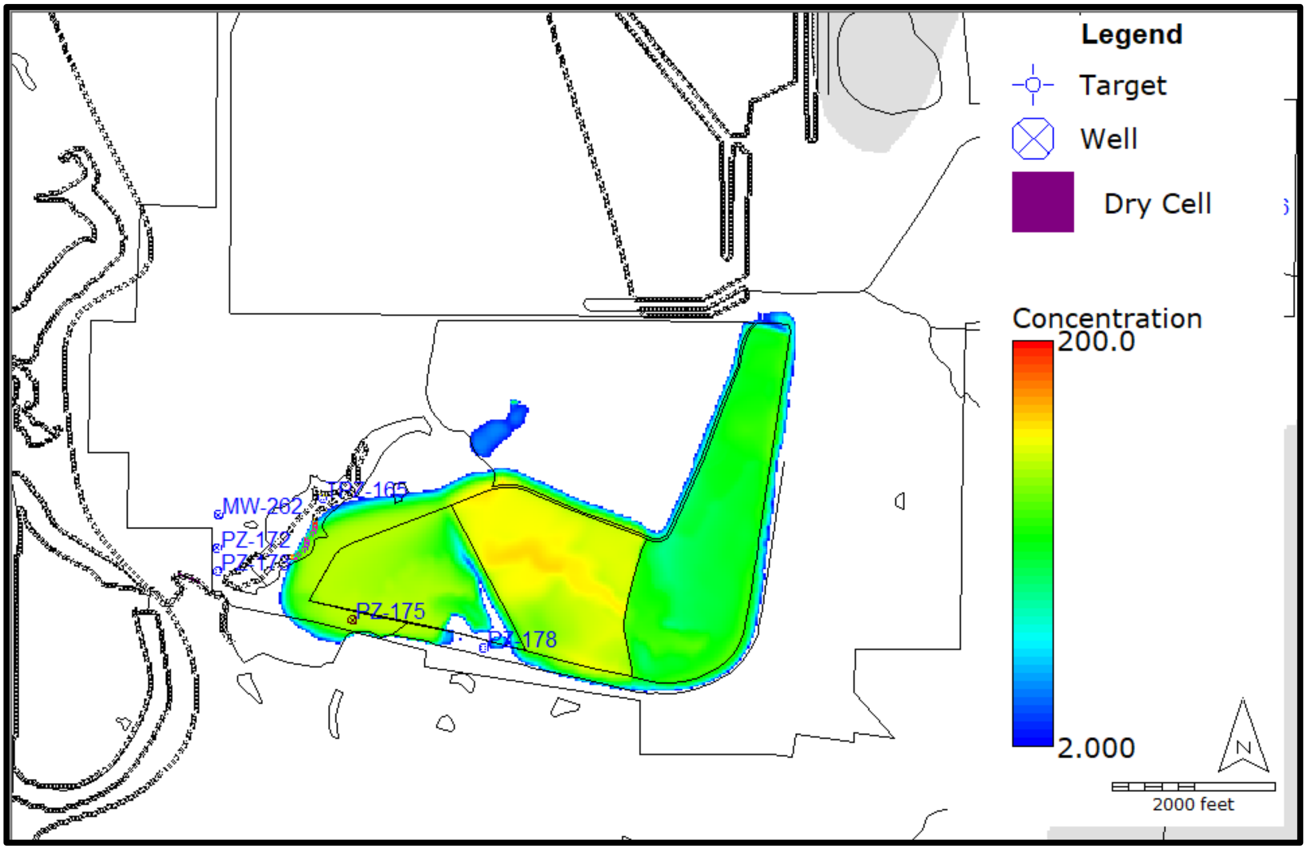
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 5-32



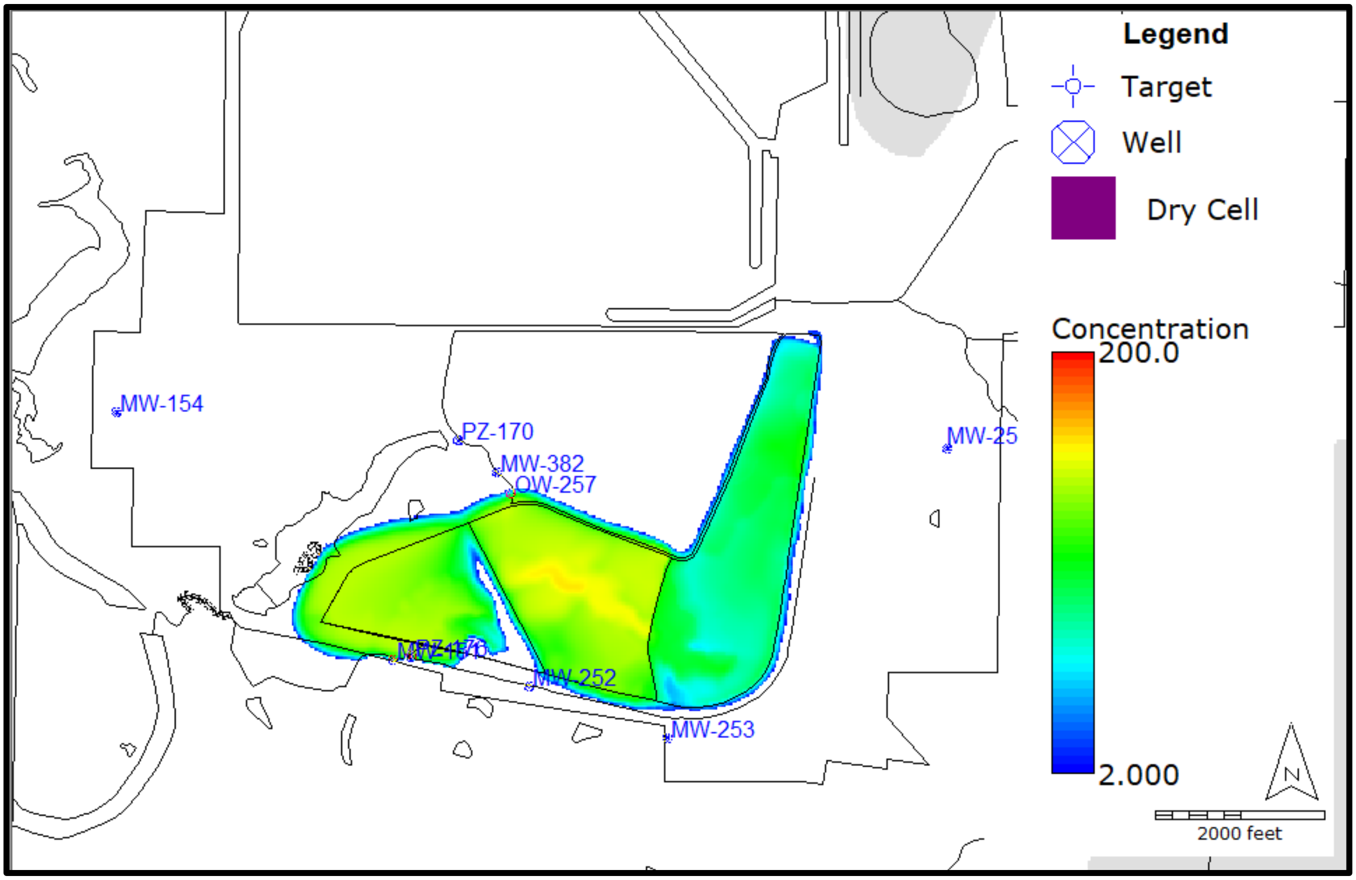
LAYER 3 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL
(UU [PMP/TOP OF VANDALIA])

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



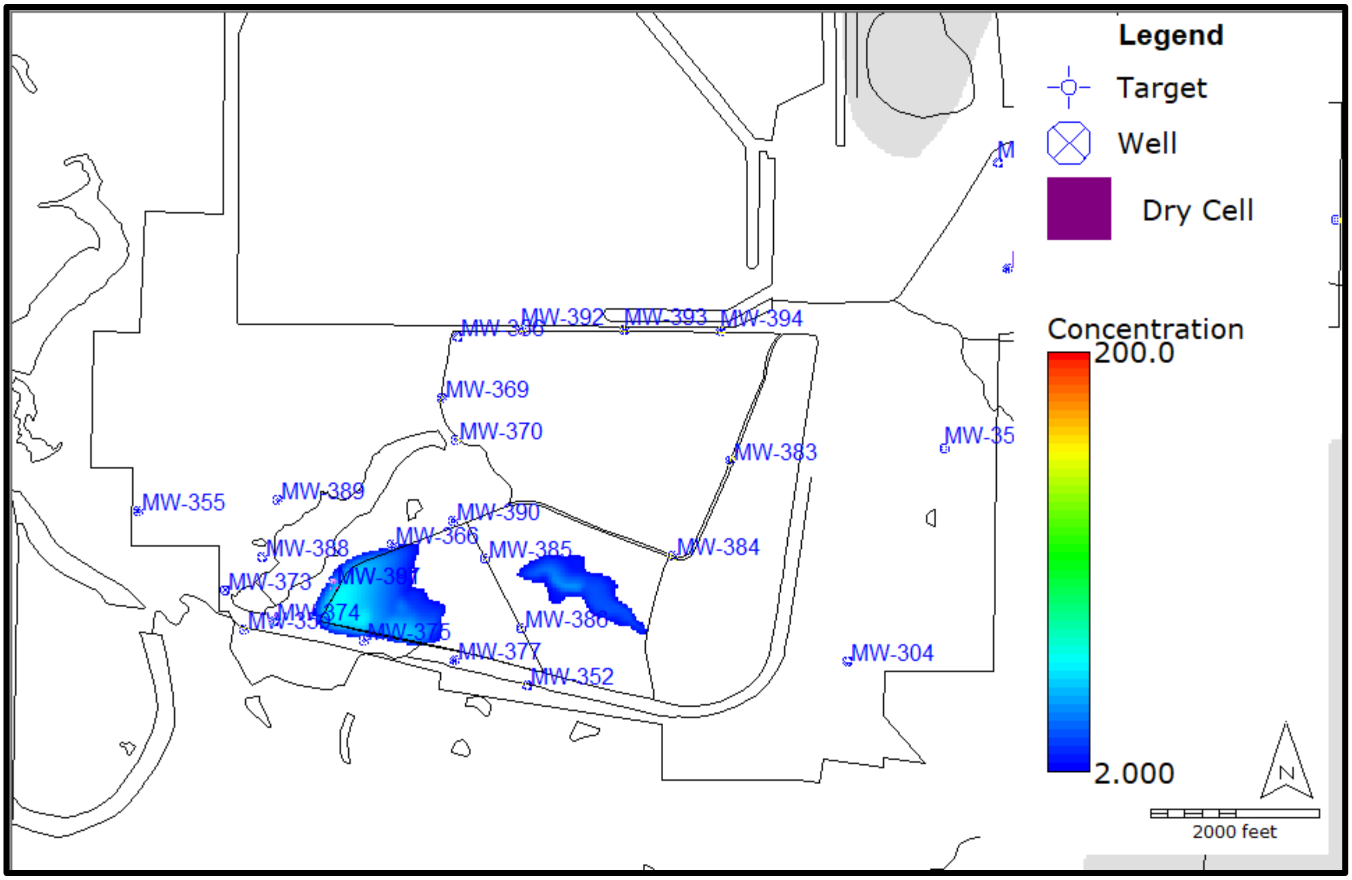
LAYER 4 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL (UU [LOWER SILTY CLAY])

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



LAYER 5 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL (UA [DECOMPOSED BEDROCK])

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

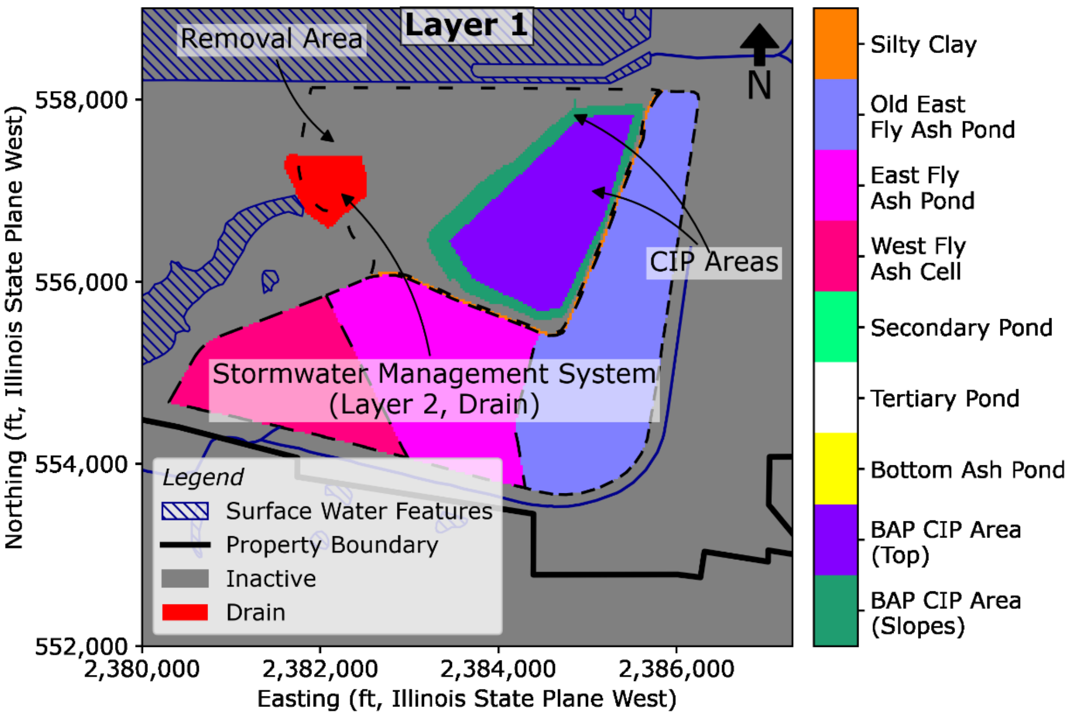


LAYER 6 DISTRIBUTION OF BORON CONCENTRATIONS (mg/L) IN THE CALIBRATED MODEL (UA)

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

RAMBOLL

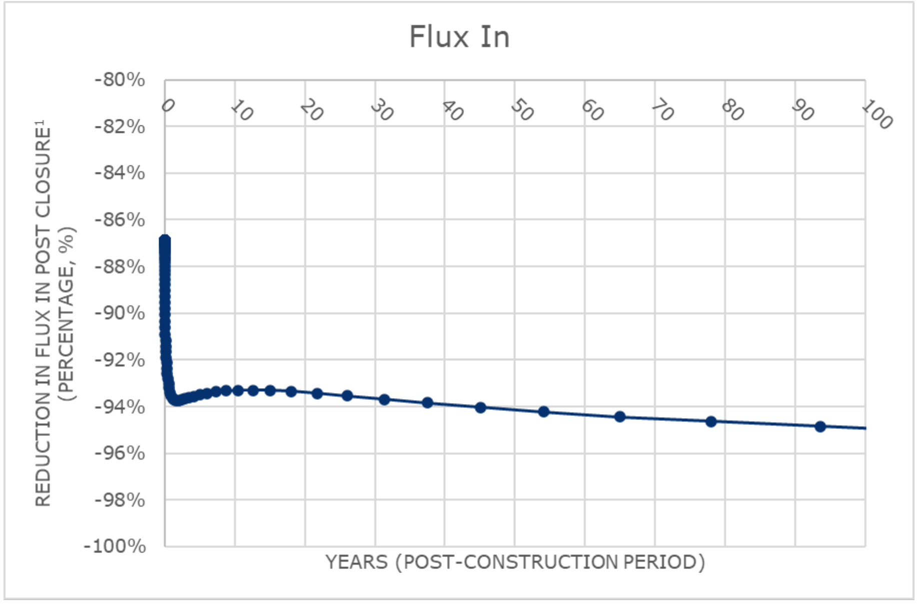
FIGURE 6-1



RECHARGE AND STORMWATER MANAGEMENT MODIFICATIONS FOR CLOSURE IN PLACE

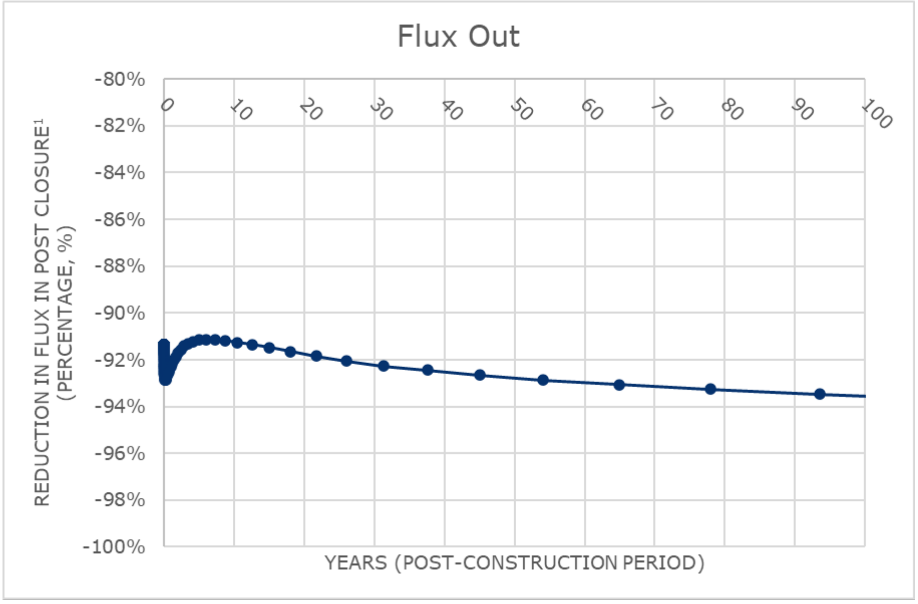
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 6-2



Flux In

Notes:
1. Reduction in flux in as compared to flux in at the end of calibration model (model period of 53 years). Reduction in flux in are expressed as negative percentages to illustrate decreases in flux over time

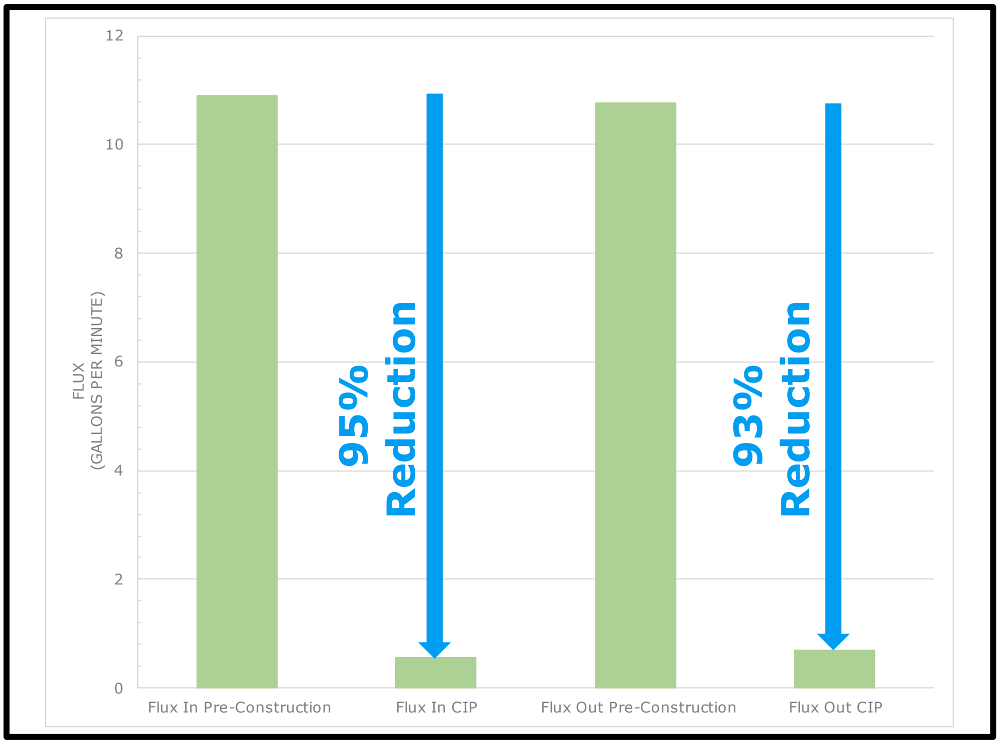


Flux Out

Notes:
1. Reduction in flux in as compared to flux out at the end of calibration model (model period of 53 years). Reduction in flux out are expressed as negative percentages to illustrate decreases in flux over time

REDUCTIONS IN TOTAL FLUX IN AND OUT OF CCR FOLLOWING IMPLEMENTATION OF THE CIP CLOSURE SCENARIO

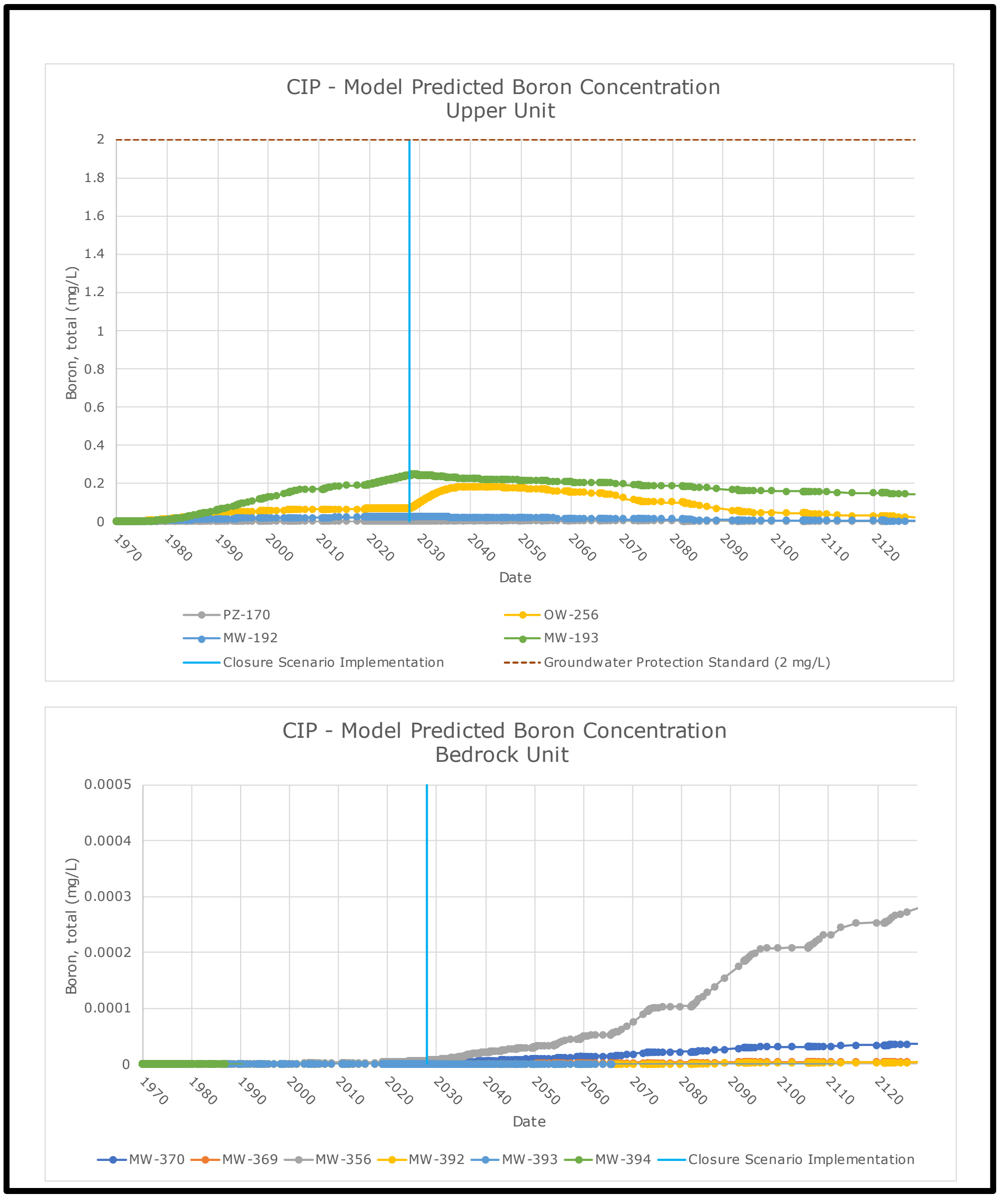
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



REDUCTIONS IN TOTAL FLUX IN AND OUT OF CCR 93 YEARS FOLLOWING IMPLEMENTATION OF THE CIP CLOSURE SCENARIO

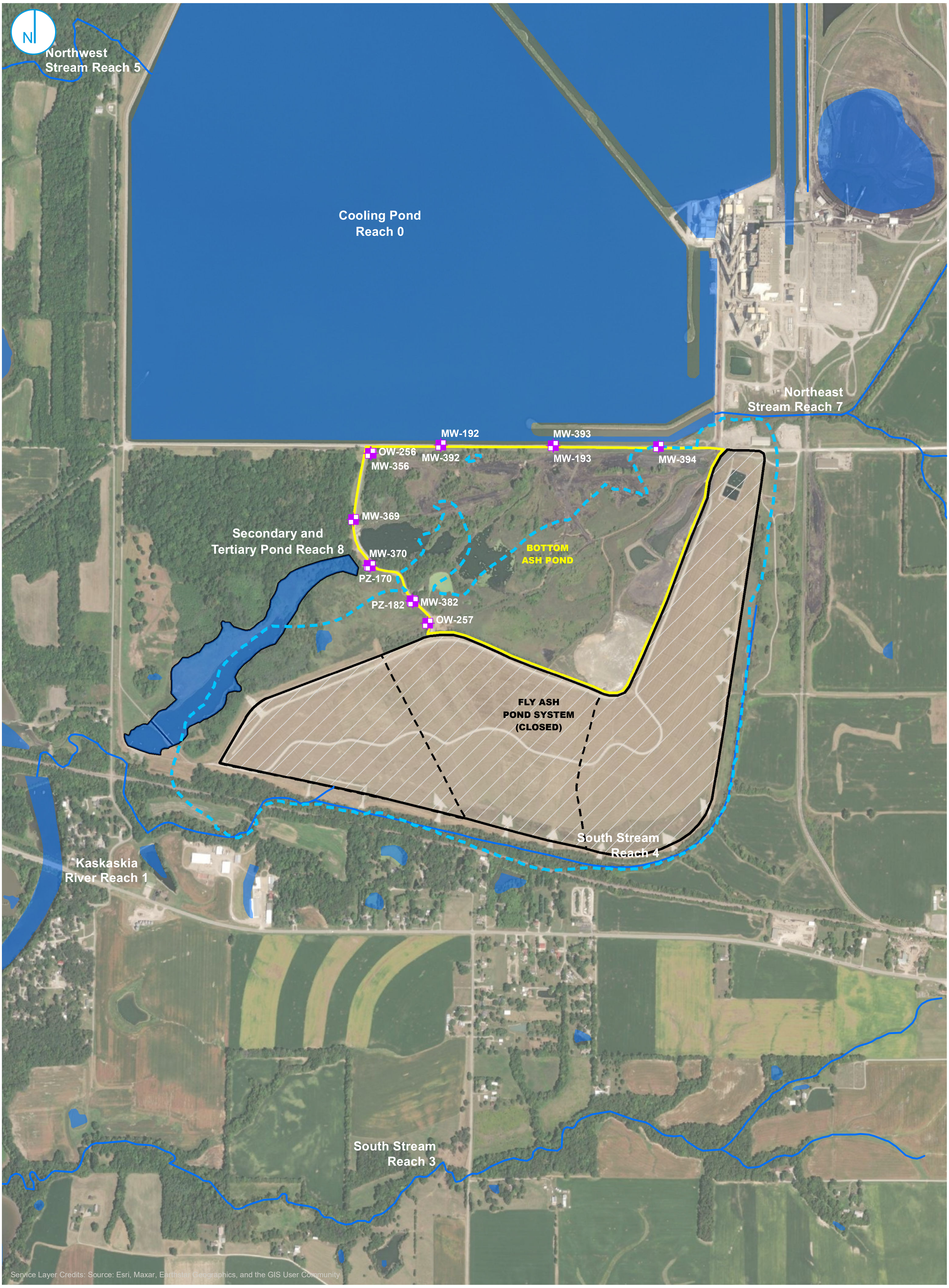
GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 6-4



CIP - MODEL PREDICTED BORON CONCENTRATION

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

- 35 I.A.C. § 845 REGULATED UNIT (SUBJECT UNIT)
- FLY ASH POND SYSTEM
- LIMITS OF FINAL COVER
- SITE FEATURE
- RIVER
- WATERBODY
- MAXIMUM EXTENT OF THE BORON PLUME ABOVE THE STANDARD GWPS FOR BORON (2 mg/L) AT 93 YEARS FOLLOWING IMPLEMENTATION OF THE CIP CLOSURE SCENARIO
- PROPOSED BAP COMPLIANCE WELLS

0 500 1,000 Feet

CIP - MODEL PREDICTED MAXIMUM BORON PLUME IN ALL LAYERS APPROXIMATELY 93 YEARS AFTER IMPLEMENTATION

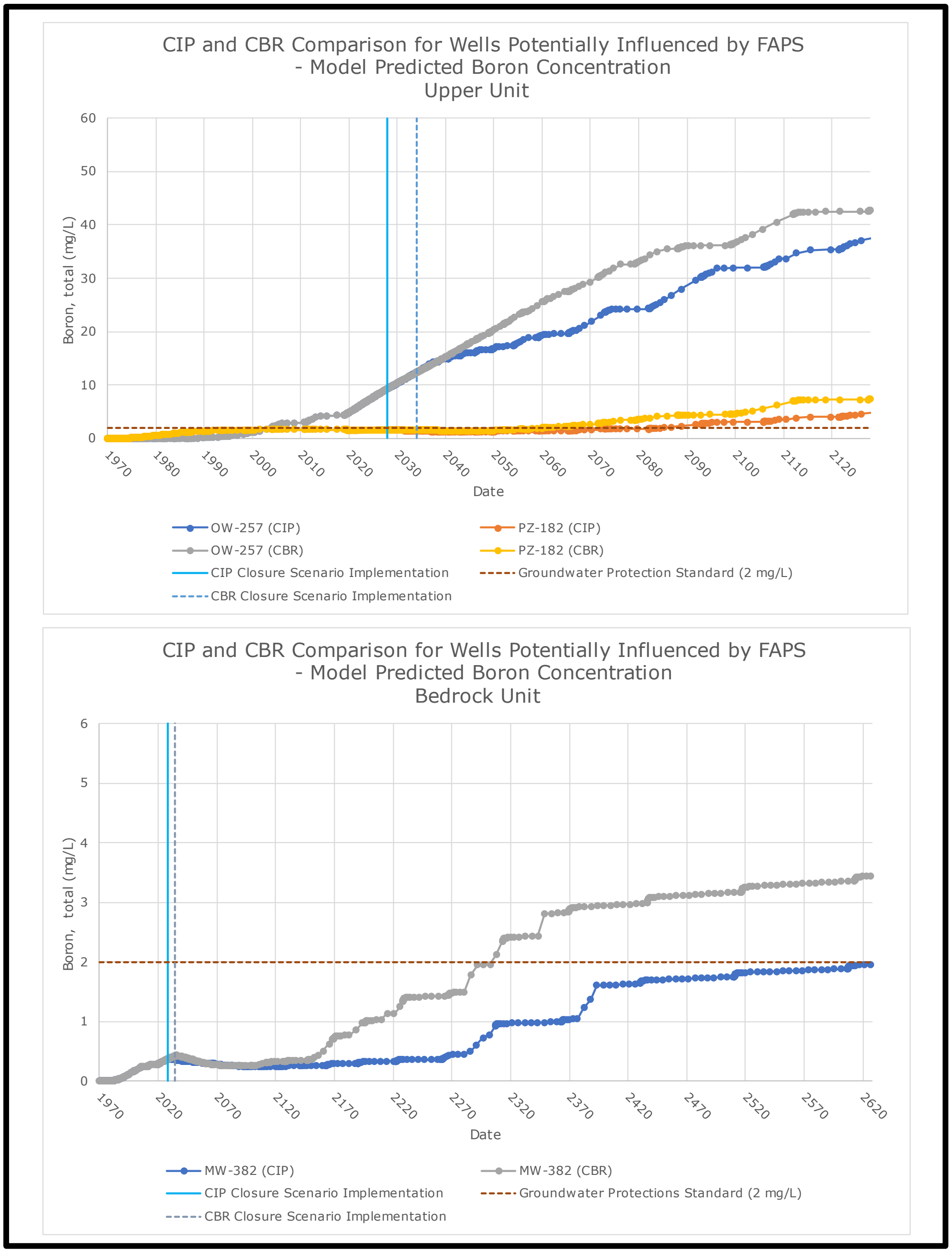
FIGURE 6-5

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

FIGURE 6-6



CIP AND CBR - MODEL PREDICTED BORON CONCENTRATION AT PROPOSED BAP COMPLIANCE MONITORING WELLS PZ-182, OW-257, AND MW-382

GROUNDWATER MODELING REPORT
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

APPENDICES

APPENDIX A

DRAFT DETERMINATION OF POTENTIAL EXCEEDANCES (TABLE 1) AND DRAFT SUMMARY OF POTENTIAL EXCEEDANCES (TABLE 2)

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES

DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-192	UU	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-192	UU	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00106	0.015	0.015	0.01	Background
MW-192	UU	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0758	2.0	0.027	2	Standard
MW-192	UU	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-192	UU	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0270	2.0	2.0	2	Standard
MW-192	UU	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-192	UU	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	25.6	200	161	200	Standard
MW-192	UU	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.10	0.0015	0.1	Standard
MW-192	UU	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.000816	0.006	0.001	0.006	Standard
MW-192	UU	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.399	4.0	2.0	4	Standard
MW-192	UU	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-192	UU	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0101	0.096	0.096	0.04	Background
MW-192	UU	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-192	UU	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00208	0.10	0.092	0.1	Standard
MW-192	UU	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.137	5.0	1.5	5	Standard
MW-192	UU	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-192	UU	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	26.7	400	208	400	Standard
MW-192	UU	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-192	UU	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	429	1420	1420	1200	Background
MW-192	UU	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	6.9/7.0	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-193	UU	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.006	0.001	0.006	Standard
MW-193	UU	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00126	0.015	0.015	0.01	Background
MW-193	UU	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0674	2.0	0.027	2	Standard
MW-193	UU	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-193	UU	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0263	2.0	2.0	2	Standard
MW-193	UU	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-193	UU	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	34.4	200	161	200	Standard
MW-193	UU	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.0015	0.1	Standard
MW-193	UU	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-193	UU	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.250	4.0	2.0	4	Standard
MW-193	UU	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.0075	0.001	0.0075	Standard
MW-193	UU	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00358	0.096	0.096	0.04	Background
MW-193	UU	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-193	UU	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.092	0.1	Standard
MW-193	UU	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.275	5.0	1.5	5	Standard
MW-193	UU	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-193	UU	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	152	400	208	400	Standard
MW-193	UU	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-193	UU	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	513	1420	1420	1200	Background
MW-193	UU	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	6.7/7.3	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-194	UU	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-194	UU	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.000899	0.015	0.015	0.01	Background
MW-194	UU	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0726	2.0	0.027	2	Standard
MW-194	UU	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-194	UU	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.0250	2.0	2.0	2	Standard
MW-194	UU	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-194	UU	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	27.7	200	161	200	Standard
MW-194	UU	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.0015	0.1	Standard
MW-194	UU	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-194	UU	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.270	4.0	2.0	4	Standard
MW-194	UU	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-194	UU	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00478	0.096	0.096	0.04	Background

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-194	UU	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-194	UU	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00146	0.10	0.092	0.1	Standard
MW-194	UU	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.0936	5.0	1.5	5	Standard
MW-194	UU	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-194	UU	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	96.7	400	208	400	Standard
MW-194	UU	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-194	UU	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	428	1420	1420	1200	Background
MW-194	UU	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	6.7/7.0	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-356	UA	257	Antimony, total	mg/L	12/29/2015 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-356	UA	257	Arsenic, total	mg/L	12/29/2015 - 04/03/2023	CI around median	0.00100	0.010	0.0036	0.01	Standard
MW-356	UA	257	Barium, total	mg/L	12/29/2015 - 04/03/2023	CI around median	0.0297	2.0	0.028	2	Standard
MW-356	UA	257	Beryllium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-356	UA	257	Boron, total	mg/L	12/29/2015 - 04/03/2023	CI around median	1.94	2.0	1.8	2	Standard
MW-356	UA	257	Cadmium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-356	UA	257	Chloride, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	28.6	200	153	200	Standard
MW-356	UA	257	Chromium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.002	0.10	0.0015	0.1	Standard
MW-356	UA	257	Cobalt, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.006	0.001	0.006	Standard
MW-356	UA	257	Fluoride, total	mg/L	12/29/2015 - 04/03/2023	CI around mean	1.90	4.0	1.9	4	Standard
MW-356	UA	257	Lead, total	mg/L	12/29/2015 - 04/03/2023	Most recent sample	0.00100	0.0075	0.001	0.0075	Standard
MW-356	UA	257	Lithium, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	0.0554	0.096	0.096	0.04	Background
MW-356	UA	257	Mercury, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-356	UA	257	Molybdenum, total	mg/L	12/29/2015 - 04/03/2023	CI around median	0.00150	0.10	0.030	0.1	Standard
MW-356	UA	257	Radium 226 + Radium 228, total	pCi/L	12/29/2015 - 04/03/2023	CI around median	0.100	5.0	1.6	5	Standard
MW-356	UA	257	Selenium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-356	UA	257	Sulfate, total	mg/L	12/29/2015 - 04/03/2023	CI around mean	44.5	400	208	400	Standard
MW-356	UA	257	Thallium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-356	UA	257	Total Dissolved Solids	mg/L	12/29/2015 - 04/03/2023	CI around mean	662	1420	1420	1200	Background
MW-356	UA	257	pH (field)	SU	12/29/2015 - 04/03/2023	CI around median	7.7/7.8	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-369	UA	257	Antimony, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	-0.00205	0.006	0.001	0.006	Standard
MW-369	UA	257	Arsenic, total	mg/L	12/29/2015 - 03/13/2023	CI around geomean	0.00143	0.010	0.0036	0.01	Standard
MW-369	UA	257	Barium, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	0.0682	2.0	0.028	2	Standard
MW-369	UA	257	Beryllium, total	mg/L	12/29/2015 - 03/13/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-369	UA	257	Boron, total	mg/L	12/29/2015 - 03/13/2023	CB around linear reg	-0.153	2.0	1.8	2	Standard
MW-369	UA	257	Cadmium, total	mg/L	12/29/2015 - 03/13/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-369	UA	257	Chloride, total	mg/L	12/29/2015 - 03/13/2023	CI around geomean	85.7	200	153	200	Standard
MW-369	UA	257	Chromium, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	0.00105	0.10	0.0015	0.1	Standard
MW-369	UA	257	Cobalt, total	mg/L	12/29/2015 - 03/13/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-369	UA	257	Fluoride, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	-1.29	4.0	1.9	4	Standard
MW-369	UA	257	Lead, total	mg/L	12/29/2015 - 03/13/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-369	UA	257	Lithium, total	mg/L	12/29/2015 - 03/13/2023	CI around mean	0.0231	0.096	0.096	0.04	Background
MW-369	UA	257	Mercury, total	mg/L	12/29/2015 - 03/13/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-369	UA	257	Molybdenum, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	-0.0110	0.10	0.030	0.1	Standard
MW-369	UA	257	Radium 226 + Radium 228, total	pCi/L	12/29/2015 - 03/13/2023	CI around mean	0.350	5.0	1.6	5	Standard
MW-369	UA	257	Selenium, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	-0.0252	0.050	0.001	0.05	Standard
MW-369	UA	257	Sulfate, total	mg/L	12/29/2015 - 03/13/2023	CB around T-S line	-97.6	400	208	400	Standard
MW-369	UA	257	Thallium, total	mg/L	12/29/2015 - 03/13/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-369	UA	257	Total Dissolved Solids	mg/L	12/29/2015 - 03/13/2023	CI around median	726	1420	1420	1200	Background
MW-369	UA	257	pH (field)	SU	12/29/2015 - 03/13/2023	CB around linear reg	6.4/8.2	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-370	UA	257	Antimony, total	mg/L	12/29/2015 - 04/03/2023	CB around T-S line	-0.000708	0.006	0.001	0.006	Standard
MW-370	UA	257	Arsenic, total	mg/L	12/29/2015 - 04/03/2023	CB around T-S line	0.0000713	0.010	0.0036	0.01	Standard
MW-370	UA	257	Barium, total	mg/L	12/29/2015 - 04/03/2023	CB around T-S line	0.0237	2.0	0.028	2	Standard
MW-370	UA	257	Beryllium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-370	UA	257	Boron, total	mg/L	12/29/2015 - 04/03/2023	CI around median	1.79	2.0	1.8	2	Standard
MW-370	UA	257	Cadmium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-370	UA	257	Chloride, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	1380	200	153	200	Standard
MW-370	UA	257	Chromium, total	mg/L	12/29/2015 - 04/03/2023	CB around T-S line	0.00141	0.10	0.0015	0.1	Standard
MW-370	UA	257	Cobalt, total	mg/L	12/29/2015 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-370	UA	257	Fluoride, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	2.96	4.0	1.9	4	Standard
MW-370	UA	257	Lead, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.001	0.0075	0.001	0.0075	Standard
MW-370	UA	257	Lithium, total	mg/L	12/29/2015 - 04/03/2023	CI around mean	0.131	0.096	0.096	0.04	Background
MW-370	UA	257	Mercury, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-370	UA	257	Molybdenum, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	0.00721	0.10	0.030	0.1	Standard
MW-370	UA	257	Radium 226 + Radium 228, total	pCi/L	12/29/2015 - 04/03/2023	CI around geomean	0.500	5.0	1.6	5	Standard
MW-370	UA	257	Selenium, total	mg/L	12/29/2015 - 04/03/2023	Most recent sample	0.00100	0.050	0.001	0.05	Standard
MW-370	UA	257	Sulfate, total	mg/L	12/29/2015 - 04/03/2023	CI around mean	248	400	208	400	Standard
MW-370	UA	257	Thallium, total	mg/L	12/29/2015 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-370	UA	257	Total Dissolved Solids	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	2950	1420	1420	1200	Background
MW-370	UA	257	pH (field)	SU	12/29/2015 - 04/03/2023	CB around linear reg	7.3/7.6	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-382	UA	257	Antimony, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.001	0.006	0.001	0.006	Standard
MW-382	UA	257	Arsenic, total	mg/L	12/29/2015 - 03/14/2023	CI around median	0.00110	0.010	0.0036	0.01	Standard
MW-382	UA	257	Barium, total	mg/L	12/29/2015 - 03/14/2023	CI around mean	0.0168	2.0	0.028	2	Standard
MW-382	UA	257	Beryllium, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-382	UA	257	Boron, total	mg/L	12/29/2015 - 03/14/2023	CI around median	1.71	2.0	1.8	2	Standard
MW-382	UA	257	Cadmium, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-382	UA	257	Chloride, total	mg/L	12/29/2015 - 03/14/2023	CI around mean	34.6	200	153	200	Standard
MW-382	UA	257	Chromium, total	mg/L	12/29/2015 - 03/14/2023	CB around linear reg	0.00522	0.10	0.0015	0.1	Standard
MW-382	UA	257	Cobalt, total	mg/L	12/29/2015 - 03/14/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-382	UA	257	Fluoride, total	mg/L	12/29/2015 - 03/14/2023	CI around mean	2.78	4.0	1.9	4	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-382	UA	257	Lead, total	mg/L	12/29/2015 - 03/14/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-382	UA	257	Lithium, total	mg/L	12/29/2015 - 03/14/2023	CI around mean	0.0580	0.096	0.096	0.04	Background
MW-382	UA	257	Mercury, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-382	UA	257	Molybdenum, total	mg/L	12/29/2015 - 03/14/2023	CB around linear reg	0.00185	0.10	0.030	0.1	Standard
MW-382	UA	257	Radium 226 + Radium 228, total	pCi/L	12/29/2015 - 03/14/2023	CI around geomean	0.274	5.0	1.6	5	Standard
MW-382	UA	257	Selenium, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-382	UA	257	Sulfate, total	mg/L	12/29/2015 - 03/14/2023	CB around linear reg	352	400	208	400	Standard
MW-382	UA	257	Thallium, total	mg/L	12/29/2015 - 03/14/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-382	UA	257	Total Dissolved Solids	mg/L	12/29/2015 - 03/14/2023	CB around linear reg	1040	1420	1420	1200	Background
MW-382	UA	257	pH (field)	SU	12/29/2015 - 03/14/2023	CI around mean	7.7/7.9	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-392	UA	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-392	UA	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.000499	0.015	0.015	0.01	Background
MW-392	UA	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0330	2.0	0.027	2	Standard
MW-392	UA	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-392	UA	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	1.50	2.0	2.0	2	Standard
MW-392	UA	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-392	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around median	334	200	161	200	Standard
MW-392	UA	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.0015	0.1	Standard
MW-392	UA	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-392	UA	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	3.33	4.0	2.0	4	Standard
MW-392	UA	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-392	UA	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0458	0.096	0.096	0.04	Background
MW-392	UA	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-392	UA	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.092	0.1	Standard
MW-392	UA	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.130	5.0	1.5	5	Standard
MW-392	UA	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-392	UA	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	31.6	400	208	400	Standard
MW-392	UA	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-392	UA	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	1350	1420	1420	1200	Background
MW-392	UA	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	7.2/8.0	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-393	UA	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-393	UA	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.015	0.015	0.01	Background
MW-393	UA	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0198	2.0	0.027	2	Standard
MW-393	UA	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-393	UA	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	1.41	2.0	2.0	2	Standard
MW-393	UA	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-393	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	439	200	161	200	Standard
MW-393	UA	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00150	0.10	0.0015	0.1	Standard
MW-393	UA	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-393	UA	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	5.61	4.0	2.0	4	Standard
MW-393	UA	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.0075	0.001	0.0075	Standard
MW-393	UA	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0564	0.096	0.096	0.04	Background
MW-393	UA	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-393	UA	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	-0.000724	0.10	0.092	0.1	Standard
MW-393	UA	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.0719	5.0	1.5	5	Standard
MW-393	UA	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.050	0.001	0.05	Standard
MW-393	UA	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	193	400	208	400	Standard
MW-393	UA	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-393	UA	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	1330	1420	1420	1200	Background
MW-393	UA	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	7.6/8.4	6.5/12	7.4/11.5	6.5/9	Standard/Background
MW-394	UA	845	Antimony, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.000829	0.006	0.001	0.006	Standard
MW-394	UA	845	Arsenic, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.000713	0.015	0.015	0.01	Background

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-394	UA	845	Barium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0245	2.0	0.027	2	Standard
MW-394	UA	845	Beryllium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.004	0.001	0.004	Standard
MW-394	UA	845	Boron, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	1.50	2.0	2.0	2	Standard
MW-394	UA	845	Cadmium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.001	0.005	0.001	0.005	Standard
MW-394	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	468	200	161	200	Standard
MW-394	UA	845	Chromium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	-0.000440	0.10	0.0015	0.1	Standard
MW-394	UA	845	Cobalt, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.006	0.001	0.006	Standard
MW-394	UA	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	3.10	4.0	2.0	4	Standard
MW-394	UA	845	Lead, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.0075	0.001	0.0075	Standard
MW-394	UA	845	Lithium, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.0478	0.096	0.096	0.04	Background
MW-394	UA	845	Mercury, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.0002	0.002	0.0002	0.002	Standard
MW-394	UA	845	Molybdenum, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	0.00440	0.10	0.092	0.1	Standard
MW-394	UA	845	Radium 226 + Radium 228, total	pCi/L	10/27/2022 - 04/03/2023	CI around mean	0.302	5.0	1.5	5	Standard
MW-394	UA	845	Selenium, total	mg/L	10/27/2022 - 04/03/2023	CI around median	0.00100	0.050	0.001	0.05	Standard
MW-394	UA	845	Sulfate, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	175	400	208	400	Standard
MW-394	UA	845	Thallium, total	mg/L	10/27/2022 - 04/03/2023	All ND - Last	0.002	0.002	0.002	0.002	Standard
MW-394	UA	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	1730	1420	1420	1200	Background
MW-394	UA	845	pH (field)	SU	10/27/2022 - 04/03/2023	CI around mean	7.5/8.0	6.5/12	7.4/11.5	6.5/9	Standard/Background
OW-256	UU	257	Antimony, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.006	0.001	0.006	Standard
OW-256	UU	257	Arsenic, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00110	0.010	0.0036	0.01	Standard
OW-256	UU	257	Barium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0898	2.0	0.028	2	Standard
OW-256	UU	257	Beryllium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.004	0.001	0.004	Standard
OW-256	UU	257	Boron, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.216	2.0	1.8	2	Standard
OW-256	UU	257	Cadmium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.005	0.001	0.005	Standard
OW-256	UU	257	Chloride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	54.0	200	153	200	Standard
OW-256	UU	257	Chromium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.10	0.0015	0.1	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
OW-256	UU	257	Cobalt, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.006	0.001	0.006	Standard
OW-256	UU	257	Fluoride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.230	4.0	1.9	4	Standard
OW-256	UU	257	Lead, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.0075	0.001	0.0075	Standard
OW-256	UU	257	Lithium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00590	0.096	0.096	0.04	Background
OW-256	UU	257	Mercury, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0002	0.002	0.0002	0.002	Standard
OW-256	UU	257	Molybdenum, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.10	0.030	0.1	Standard
OW-256	UU	257	Radium 226 + Radium 228, total	pCi/L	03/14/2023 - 03/14/2023	Most recent sample	1.26	5.0	1.6	5	Standard
OW-256	UU	257	Selenium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.050	0.001	0.05	Standard
OW-256	UU	257	Sulfate, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	77.0	400	208	400	Standard
OW-256	UU	257	Thallium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.002	0.002	0.002	Standard
OW-256	UU	257	Total Dissolved Solids	mg/L	03/14/2023 - 03/14/2023	Most recent sample	538	1420	1420	1200	Background
OW-256	UU	257	pH (field)	SU	03/14/2023 - 03/14/2023	Most recent sample	6.7/6.7	6.5/12	7.4/11.5	6.5/9	Standard/Background
OW-257	UU	257	Antimony, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00230	0.006	0.001	0.006	Standard
OW-257	UU	257	Arsenic, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00400	0.010	0.0036	0.01	Standard
OW-257	UU	257	Barium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.114	2.0	0.028	2	Standard
OW-257	UU	257	Beryllium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.004	0.001	0.004	Standard
OW-257	UU	257	Boron, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.693	2.0	1.8	2	Standard
OW-257	UU	257	Cadmium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.005	0.001	0.005	Standard
OW-257	UU	257	Chloride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	9.00	200	153	200	Standard
OW-257	UU	257	Chromium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00170	0.10	0.0015	0.1	Standard
OW-257	UU	257	Cobalt, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00260	0.006	0.001	0.006	Standard
OW-257	UU	257	Fluoride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.390	4.0	1.9	4	Standard
OW-257	UU	257	Lead, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00150	0.0075	0.001	0.0075	Standard
OW-257	UU	257	Lithium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0268	0.096	0.096	0.04	Background
OW-257	UU	257	Mercury, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0002	0.002	0.0002	0.002	Standard
OW-257	UU	257	Molybdenum, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00300	0.10	0.030	0.1	Standard

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
OW-257	UU	257	Radium 226 + Radium 228, total	pCi/L	03/14/2023 - 03/14/2023	Most recent sample	1.72	5.0	1.6	5	Standard
OW-257	UU	257	Selenium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.050	0.001	0.05	Standard
OW-257	UU	257	Sulfate, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	140	400	208	400	Standard
OW-257	UU	257	Thallium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.002	0.002	0.002	Standard
OW-257	UU	257	Total Dissolved Solids	mg/L	03/14/2023 - 03/14/2023	Most recent sample	840	1420	1420	1200	Background
OW-257	UU	257	pH (field)	SU	03/14/2023 - 03/14/2023	Most recent sample	7.2/7.2	6.5/12	7.4/11.5	6.5/9	Standard/Background
PZ-170	UU	257	Antimony, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00230	0.006	0.001	0.006	Standard
PZ-170	UU	257	Arsenic, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.010	0.0036	0.01	Standard
PZ-170	UU	257	Barium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0950	2.0	0.028	2	Standard
PZ-170	UU	257	Beryllium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.004	0.001	0.004	Standard
PZ-170	UU	257	Boron, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.363	2.0	1.8	2	Standard
PZ-170	UU	257	Cadmium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.005	0.001	0.005	Standard
PZ-170	UU	257	Chloride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	86.0	200	153	200	Standard
PZ-170	UU	257	Chromium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00280	0.10	0.0015	0.1	Standard
PZ-170	UU	257	Cobalt, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00850	0.006	0.001	0.006	Standard
PZ-170	UU	257	Fluoride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.190	4.0	1.9	4	Standard
PZ-170	UU	257	Lead, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.0075	0.001	0.0075	Standard
PZ-170	UU	257	Lithium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0294	0.096	0.096	0.04	Background
PZ-170	UU	257	Mercury, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0002	0.002	0.0002	0.002	Standard
PZ-170	UU	257	Molybdenum, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.10	0.030	0.1	Standard
PZ-170	UU	257	Radium 226 + Radium 228, total	pCi/L	03/14/2023 - 03/14/2023	Most recent sample	1.31	5.0	1.6	5	Standard
PZ-170	UU	257	Selenium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.050	0.001	0.05	Standard
PZ-170	UU	257	Sulfate, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	288	400	208	400	Standard
PZ-170	UU	257	Thallium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.002	0.002	0.002	Standard
PZ-170	UU	257	Total Dissolved Solids	mg/L	03/14/2023 - 03/14/2023	Most recent sample	1300	1420	1420	1200	Background
PZ-170	UU	257	pH (field)	SU	03/14/2023 - 03/14/2023	Most recent sample	6.6/6.6	6.5/12	7.4/11.5	6.5/9	Standard/Background

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
PZ-182	UU	257	Antimony, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.006	0.001	0.006	Standard
PZ-182	UU	257	Arsenic, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00100	0.010	0.0036	0.01	Standard
PZ-182	UU	257	Barium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0670	2.0	0.028	2	Standard
PZ-182	UU	257	Beryllium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.004	0.001	0.004	Standard
PZ-182	UU	257	Boron, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.464	2.0	1.8	2	Standard
PZ-182	UU	257	Cadmium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.005	0.001	0.005	Standard
PZ-182	UU	257	Chloride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	35.0	200	153	200	Standard
PZ-182	UU	257	Chromium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.10	0.0015	0.1	Standard
PZ-182	UU	257	Cobalt, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00100	0.006	0.001	0.006	Standard
PZ-182	UU	257	Fluoride, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.160	4.0	1.9	4	Standard
PZ-182	UU	257	Lead, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00360	0.0075	0.001	0.0075	Standard
PZ-182	UU	257	Lithium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0143	0.096	0.096	0.04	Background
PZ-182	UU	257	Mercury, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.0002	0.002	0.0002	0.002	Standard
PZ-182	UU	257	Molybdenum, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.10	0.030	0.1	Standard
PZ-182	UU	257	Radium 226 + Radium 228, total	pCi/L	03/14/2023 - 03/14/2023	Most recent sample	1.39	5.0	1.6	5	Standard
PZ-182	UU	257	Selenium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.001	0.050	0.001	0.05	Standard
PZ-182	UU	257	Sulfate, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	155	400	208	400	Standard
PZ-182	UU	257	Thallium, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.002	0.002	0.002	0.002	Standard
PZ-182	UU	257	Total Dissolved Solids	mg/L	03/14/2023 - 03/14/2023	Most recent sample	746	1420	1420	1200	Background
PZ-182	UU	257	pH (field)	SU	03/14/2023 - 03/14/2023	Most recent sample	6.6/6.6	6.5/12	7.4/11.5	6.5/9	Standard/Background

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Notes:

🟨 Potential exceedance of GWPS

HSU = hydrostratigraphic unit:
  UA = Uppermost Aquifer
  UU = Upper Unit
Program = regulatory program data were collected under:
  257 = 40 C.F.R. Part 257 Subpart D (Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments)
  845 = 35 I.A.C. Part 845 (Sampling events completed to assess well locations for inclusion in the Part 845 monitoring well network)
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
Sample Count = number of samples from Sampled Date Range used to calculate the Statistical Result
Statistical Calculation = method used to calculate the statistical result:
Statistical Result = calculated in accordance with Statistical Analysis Plan using constituent concentrations observed at monitoring well during all sampling events within the specified date range
For pH, the values presented are the lower / upper limits
GWPS = Groundwater Protection Standard
GWPS Source:
  Standard = standard specified in 35 I.A.C. § 845.600(a)(1)
  Background = background concentration (see cover page for additional information)

TABLE 2. SUMMARY OF POTENTIAL EXCEEDANCES
DRAFT REVISION TO THE HISTORY OF POTENTIAL EXCEEDANCES
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Sample Location	HSU	Program	Constituent	Result Unit	Sample Date Range	Statistical Calculation	Statistical Result	GWPS	Background	Part 845 Standard	GWPS Source
MW-370	UA	257	Chloride, total	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	1380	200	153	200	Standard
MW-370	UA	257	Lithium, total	mg/L	12/29/2015 - 04/03/2023	CI around mean	0.131	0.096	0.096	0.04	Background
MW-370	UA	257	Total Dissolved Solids	mg/L	12/29/2015 - 04/03/2023	CB around linear reg	2950	1420	1420	1200	Background
MW-392	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around median	334	200	161	200	Standard
MW-393	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	439	200	161	200	Standard
MW-393	UA	845	Fluoride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	5.61	4.0	2.0	4	Standard
MW-394	UA	845	Chloride, total	mg/L	10/27/2022 - 04/03/2023	CI around mean	468	200	161	200	Standard
MW-394	UA	845	Total Dissolved Solids	mg/L	10/27/2022 - 04/03/2023	CI around mean	1730	1420	1420	1200	Background
PZ-170	UU	257	Cobalt, total	mg/L	03/14/2023 - 03/14/2023	Most recent sample	0.00850	0.006	0.001	0.006	Standard

Notes:
HSU = hydrostratigraphic unit:
  UA = Uppermost Aquifer
  UU = Upper Unit
Program = regulatory program data were collected under:
  257 = 40 C.F.R. Part 257 Subpart D (Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments)
  845 = 35 I.A.C. Part 845 (Sampling events completed to assess well locations for inclusion in the Part 845 monitoring well network)
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
Sample Count = number of samples from Sampled Date Range used to calculate the Statistical Result
Statistical Calculation = method used to calculate the statistical result:
Statistical Result = calculated in accordance with Statistical Analysis Plan using constituent concentrations observed at monitoring well during all sampling events within the specified date range
For pH, the values presented are the lower / upper limits
GWPS = Groundwater Protection Standard
GWPS Source:
  Standard = standard specified in 35 I.A.C. § 845.600(a)(1)
  Background = background concentration (see cover page for additional information)

APPENDIX B
ALTERNATE SOURCE DEMONSTRATION BALDWIN POWER PLANT, BOTTOM ASH POND, CCR UNIT 601 (RAMBOLL, 2023)

Intended for

Dynegy Midwest Generation, LLC

Date

April 30, 2023

Project No.

1940102203-001

40 C.F.R. § 257.95(g)(3)(ii): ALTERNATE SOURCE DEMONSTRATION

BALDWIN POWER PLANT

BOTTOM ASH POND

CCR UNIT 601

RAMBOLL Bright ideas. Sustainable change.

CERTIFICATIONS

I, Brian G. Hennings, a professional geologist in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: April 30, 2023

BRIAN G. HENNINGS
196.001482

I, Anne Frances Ackerman, a qualified professional engineer in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used other than for its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.

Anne Frances Ackerman
Qualified Professional Engineer
062-060586
Illinois
Ramboll Americas Engineering Solutions, Inc.
Date: April 30, 2023

ANNE FRANCES
ACKERMAN
062.060586

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA
T 414-837-3607
F 414-837-3608
https://ramboll.com

CONTENTS

TABLES (IN TEXT)

FIGURES (IN TEXT)

FIGURES (ATTACHED)

APPENDICES

ACRONYMS AND ABBREVIATIONS

40 C.F.R.	Title 40 of the Code of Federal Regulations
35 I.A.C.	Title 35 of the Illinois Administrative Code
A5D	Assessment Monitoring Sampling Event A5D
ASD	Alternate Source Demonstration
BAP	Bottom Ash Pond
bgs	below ground surface
BPP	Baldwin Power Plant
CCR	coal combustion residuals
cm/s	centimeters per second
FAPS	Fly Ash Pond System
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LOE(s)	line(s) of evidence
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NRT	Natural Resource Technology, Inc.
NRT/OBG	Natural Resource Technology, an OBG Company
PMP	potential migration pathways
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SEP	Sequential extraction procedure
SSI	statistically significant increase
SSL	statistically significant level
XRD	X-ray diffraction

1. INTRODUCTION

Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.95(g)(3)(ii) allows the owner or operator of a coal combustion residuals (CCR) unit 90 days from the date of determination of statistically significant levels (SSLs) over groundwater protection standards (GWPS) of groundwater constituents listed in Appendix IV of 40 C.F.R. § 257 to complete a written demonstration that a source other than the CCR unit being monitored caused the SSL(s) (Alternate Source Demonstration [ASD]), or that the SSL(s) resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

This ASD has been prepared on behalf of Dynegy Midwest Generation, LLC, by Ramboll Americas Engineering Solutions, Inc. (Ramboll), to provide pertinent information pursuant to 40 C.F.R. § 257.95(g)(3)(ii) for the Baldwin Power Plant (BPP) Bottom Ash Pond (BAP) located near Baldwin, Illinois.

The most recent Assessment Monitoring sampling event (A5D) was completed on September 30, 2022, and analytical data was received on November 15, 2022. Additional background and compliance monitoring wells were installed around the BAP in September and October of 2022. Following the well installations, eight monthly rounds of groundwater sampling were initiated per 35 I.A.C. § 845. Analytical data from all monitoring events, from December 2015 through A5D, were evaluated in accordance with the Statistical Analysis Plan (Natural Resource Technology, an OBG Company [NRT/OBG], 2017a) to determine any statistically significant increases (SSIs) of Appendix III parameters over background concentrations or SSLs of Appendix IV parameters over GWPSs. That evaluation identified one SSL at a compliance monitoring well as follows:

- Lithium at well MW-370

Pursuant to 40 C.F.R. § 257.95(g)(3)(ii), the lines of evidence (LOEs) presented in **Section 3** demonstrate that sources other than the BAP were the cause of the lithium SSL listed above. This ASD was completed by April 30, 2023, within 90 days of determination of the SSLs (January 30, 2023), as required by 40 C.F.R. § 257.95(g)(3)(ii).

2. BACKGROUND

2.1 Site Location and Description

The BPP is located in southwest Illinois in Randolph and St. Clair Counties. The Randolph County portion of the BPP is located within Sections 2, 3, 4, 9, 10, 11, 14, 15, and 16 of Township 4 South and Range 7 West. The St. Clair County portion of the property is located within Sections 33, 34, and 35 of Township 3 South and Range 7 West. The BAP is approximately one-half mile west-northwest of the Village of Baldwin.

The BPP property is bordered to the west by the Kaskaskia River; to the east by Baldwin Road, farmland, and strip-mining areas; to the southeast by the Village of Baldwin; to the south by the Illinois Central Gulf railroad tracks, scattered residences, and State Route 154; and to the north by farmland. The St. Clair/Randolph County Line crosses east-west at approximately the midpoint of Baldwin Lake (Cooling Pond). **Figure 1** shows the location of the BAP, as well as the Fly Ash Pond System (FAPS), Secondary Pond, Tertiary Pond, and Baldwin Lake (Cooling Pond). The BAP is adjacent to the FAPS, which was approved for closure by Illinois Environmental Protection Agency (IEPA) on August 16, 2016.

2.2 Groundwater Monitoring

The BAP groundwater monitoring system for compliance with 40 C.F.R. § 257 consists of two background monitoring wells (MW-304 and MW-306) and four compliance monitoring wells (MW-356, MW-369, MW-370, and MW-382). A map showing the groundwater monitoring system, including the CCR unit and all background and compliance monitoring wells, is presented in **Figure 1**. **Figure 1** also shows porewater location TPZ-164, as well as the monitoring wells that were installed in 2022. New monitoring well MW-358 was installed in 2022 upgradient of the BAP and compliance monitoring well MW-370 (compliance monitoring well with identified lithium SSL) with a well screen (363.7 to 373.7 feet North American Vertical Datum of 1988 [NAVD88]) that overlaps with MW-370 well screen elevations (355.6 to 365.6 feet NAVD88).

Groundwater samples are collected and analyzed in accordance with the Sampling and Analysis Plan prepared for the BAP (NRT/OBG, 2017b). Statistical evaluation of analytical data is performed in accordance with the Statistical Analysis Plan (NRT/OBG, 2017a).

2.3 Site Hydrogeology and Stratigraphy

Three hydrostratigraphic units are present at the Site, including CCR, an upper unit, and a bedrock unit. These units are described in detail in the Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan (Natural Resources Technology, Inc. [NRT], 2016) and the Hydrogeologic Site Characterization Report (Ramboll, 2021); and are summarized below.

- **CCR:** CCR, consisting primarily of fly ash, bottom ash, and boiler slag. Also includes earthen fill deposits of predominantly clay and silt materials from on-site excavations that were used to construct berms and roads surrounding the various impoundments across the Site. The 2022 Site Investigation observed up to 28.2 feet of bottom ash towards the center of the BAP (XPW05).
- **Upper Unit:** Predominantly clay with some silt and minor sand, silt layers, and occasional sand lenses. Includes the lithologic layers identified as the Cahokia Alluvium, Peoria Loess,

Equality Formation, and Vandalia Till Member. This unit is composed of unlithified natural geologic materials and extends from the water table to the bedrock. Thin sand seams and the interface (contact) between the Upper Unit and bedrock have been identified as potential migration pathways (PMPs). No continuous sand seams were observed in the Upper Unit within or immediately adjacent to the BAP; however, the sand seams may act as a PMP due to relatively higher hydraulic conductivities (on the order of 10^{-4} centimeters per second [cm/s]) than the surrounding clays (on the order of 10^{-5} cm/s).

- **Bedrock Unit:** Shallow bedrock beneath the BAP yields small amounts of water from interconnected pores, cracks, fractures, crevices, joints, and bedding planes and is the only water-bearing unit that is continuous across the Site; this unit is considered the Uppermost Aquifer (UA) and is composed of Pennsylvanian and Mississippian-aged interbedded shale and limestone bedrock having a regional strike that is generally north to northeast with a dip of 2 to 3 degrees to the east into the Illinois Basin (Breeden et. al, 2018; Bristol and Howard, 1971). The surface elevation varies across the site, generally sloping downward from east to west, and the unlithified Upper Unit thins from east to west. The top of bedrock depth ranges between 12.5 feet below ground surface (bgs) near the Kaskaskia River and 70 feet bgs within the East Fly Ash Pond (part of the FAPS). Limestone layers intercepted at the Site are generally light to dark gray, fine-grained, thin bedded, banded, argillaceous, and competent except where weathered. Weathering of the limestone produces a calcareous clay. The limestone layers are interbedded with thin shale layers and are sometimes fossiliferous or sandy. The shale layers are generally weathered, competent, silty, slightly micaceous, fissile, and dark gray. Where highly weathered shale (*i.e.,* decomposed bedrock) was encountered, the shale was non-fissile and resembled an unlithified stiff clay with medium to high plasticity. Bedrock in the vicinity of

Water quality in the Uppermost Aquifer (*i.e.,* Pennsylvanian and Mississippian-aged bedrock) degrades with increasing depth as water becomes increasingly mineralized. Therefore, water quality at monitoring wells with screens placed in deeper bedrock layers (*e.g.,* MW-358 and MW-370) would be expected to demonstrate more influence from the naturally increased mineralization than wells screened shallower in the bedrock. Groundwater flow in bedrock is toward the northwest in the east and central areas of the BAP, and southwest in the east area of the FAPS. The Secondary and Tertiary ponds were created in a former drainage channel and bedrock groundwater flows toward these ponds as illustrated in **Figure 2**. Groundwater elevations vary seasonally, generally less than 7 feet, although flow directions are generally consistent. Groundwater elevations across the Site range between approximately 370 and 450 feet NAVD88.

3. ALTERNATE SOURCE DEMONSTRATION: LINES OF EVIDENCE

This ASD is based on the following LOEs:

1. The lithium concentration in the BAP porewater is lower than the concentrations observed in compliance monitoring well location MW-370.
2. Compliance monitoring well MW-370 has a similar ionic composition to upgradient monitoring well MW-358.
3. An aquifer solids evaluation identified naturally occurring lithium associated with the shale bedrock as a source for lithium in the Uppermost Aquifer.

These LOEs are described and supported in greater detail below. Monitoring wells and the BAP porewater sample locations are shown in **Figure 1**.

3.1 LOE #1: The lithium concentration in the BAP porewater is lower than the concentrations observed in compliance monitoring well location MW-370.

Table A below provides summary statistics for lithium in background wells, MW-370 and BAP porewater collected from TPZ-164, and the five new porewater wells installed in 2022.

Table A. Summary Statistics for Lithium in MW-370 and BAP Porewater (December 2015 to March 2023).

Sample Location	Lithium (milligrams per liter [mg/L])		
	Minimum	Maximum	Median
Background Groundwater[1]	0.010	0.096	0.055
Exceedance Groundwater (MW-370)	0.098	0.22	0.14
BAP Porewater[2]	<0.005	0.035	0.013

Notes:

[1] Background groundwater was collected at monitoring wells MW-304 and MW-306.

[2] BAP porewater was collected at TPZ-164 (September 2018 through November 2022), XPW01, XPW02, XPW04, XPW05, and XPW06 (October 2022 through January 2023).

The following observations can be made from **Table A** above:

- Concentrations of lithium in background wells ranged from 0.010 to 0.096 mg/L, with a median concentration of 0.055 mg/L.
- Concentrations of lithium in downgradient compliance monitoring well MW-370 ranged from 0.098 to 0.22 mg/L, with a median concentration of 0.14 mg/L.
- Concentrations of lithium in BAP porewater ranged from non-detect (<0.005 mg/L) to 0.035 mg/L, with a median concentration of 0.013 mg/L.
- The median lithium concentration observed in porewater is an order of magnitude lower than the median lithium concentrations observed in compliance monitoring well MW-370.
- The highest observed lithium concentration in porewater is approximately six times lower than the maximum concentration observed in compliance monitoring well MW-370.

If the BAP was the source of lithium in downgradient groundwater, BAP porewater concentrations of lithium would be expected to be higher than the groundwater concentrations. The median lithium concentration observed in porewater is below the median lithium concentrations observed in both background and compliance groundwater monitoring wells, indicating that lithium concentrations are not related to the BAP.

3.2 LOE #2: Compliance monitoring well MW-370 has a similar ionic composition to upgradient monitoring well MW-358.

Stiff diagrams graphically represent ionic composition of aqueous solutions. **Figure A** on the following page shows a series of Stiff diagrams that display the ionic compositions of groundwater from background monitoring wells (brown); compliance monitoring wells (blue); and upgradient monitoring well MW-358 (tan). Polygons with similar shapes on Stiff diagrams indicate solutions with similar ionic compositions, whereas polygons with different shapes indicate solutions with dissimilar ionic compositions. The larger the area of the polygon, the greater the concentration of the various ions. A Stiff diagram was included in **Figure A** for one out-of-network, upgradient, monitoring well, MW-358, due to similarities with MW-370 with respect to ionic composition, well screen elevation, and the composition of the bedrock material.

Compliance monitoring well MW-370 has chloride as the dominant anion and a substantially higher proportion of Na+K, similar to upgradient well MW-358. Upgradient monitoring well MW-358 is screened in a similar shaley bedrock material and at a similar elevation to MW-370 (**Figures 3 and 4**). The similarity in ionic composition in compliance well MW-370 and upgradient well MW-358 suggests that groundwater at these locations and depths is from a similar lithologic material that has undergone a similar amount of naturally occurring dissolution, and supports the conclusion that natural variability of groundwater in the Uppermost Aquifer is responsible for the lithium SSL at MW-370.

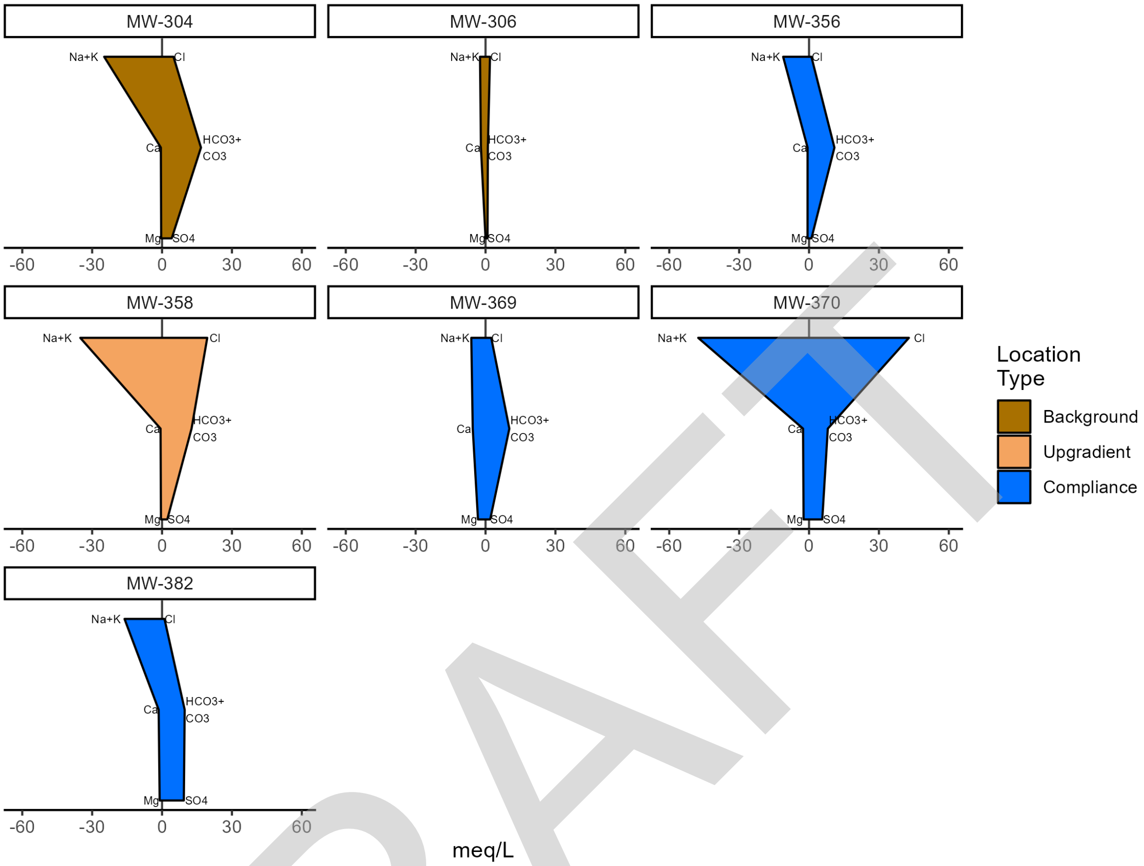


Figure A. Stiff Diagram Showing Ionic Composition of Samples of BAP Background (Brown), Compliance Groundwater (Blue), and Upgradient Groundwater (Tan).

3.3 LOE #3: An aquifer solids evaluation identified naturally occurring lithium associated with the shale bedrock as a source of lithium in the Uppermost Aquifer

Solid phase analyses were completed on samples collected from the Site to support the conclusion that lithium concentrations in groundwater at MW-370 are associated with naturally occurring lithium in the Uppermost Aquifer materials (limestone and shale bedrock formation). A review of the geochemical and site conditions was completed by Geosyntec Consultants, Inc. and is included as **Appendix A**. The following conclusions were made based on the results of the aquifer solids evaluation:

- Lithium host-minerals occur in the UA throughout the Site and constitute natural sources of lithium in BAP soils.
- Lithium is present in both upgradient and downgradient shale samples at the Site, with the largest concentrations observed in upgradient solids samples.
- Natural lithium occurrence in aquifer material from the Site is associated with multiple phases and therefore interacts with groundwater through different mechanisms at different locations and depths.

- Naturally occurring lithium associated with the shale bedrock comprising the UA at the Site was identified as a source of lithium in Site groundwater.

4. CONCLUSIONS

Based on the following three LOEs, it has been demonstrated that the lithium SSL at MW-370 is not due to the BAP:

1. The lithium concentration in the BAP porewater is lower than the concentrations observed in compliance monitoring well location MW-370.
2. Compliance monitoring well MW-370 has a similar ionic composition to upgradient monitoring well MW-358.
3. An aquifer solids evaluation identified naturally occurring lithium associated with the shale bedrock as a source for lithium in the Uppermost Aquifer.

This information serves as the written ASD prepared in accordance with 40 C.F.R. § 257.95(g)(3)(ii) that the SSL observed during the A5D sampling event was not due to the BAP. Therefore, a corrective measures assessment is not required, and the BAP will remain in assessment monitoring. Additional data is being collected to identify the source of the SSLs.

5. REFERENCES

Breeden, J.R., J.A. Devera, W.J. Nelson, and F.B. Denny, 2018. Bedrock Geology of Baldwin Quadrangle, Randolph and St. Clair Counties, Illinois: Illinois State Geological Survey, USGS-STATEMAP contract report, 2 sheets, 1:24,000.

Bristol, H.M., and Howard, R.H., 1971. Paleogeologic map of the Sub- Pennsylvanian Chesterian (Upper Mississippian) surface in the Illinois Basin: Illinois State Geological Survey, Circular 458, plate 1.

Geosyntec Consultants, Inc., 2023. Technical Memorandum – Evaluation of Lithium Sources within Aquifer Solids, Baldwin Power Station – Bottom Ash Pond, April 24, 2023.

Natural Resource Technology, Inc. (NRT), 2016. *Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan. Baldwin Fly Ash Pond System. Baldwin Energy Complex, Baldwin, IL*.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017a. *Statistical Analysis Plan, Baldwin Energy Complex, Havana Power Station, Hennepin Power Station, Wood River Power Station, Dynegy Midwest Generation, LLC*. October 17, 2017.

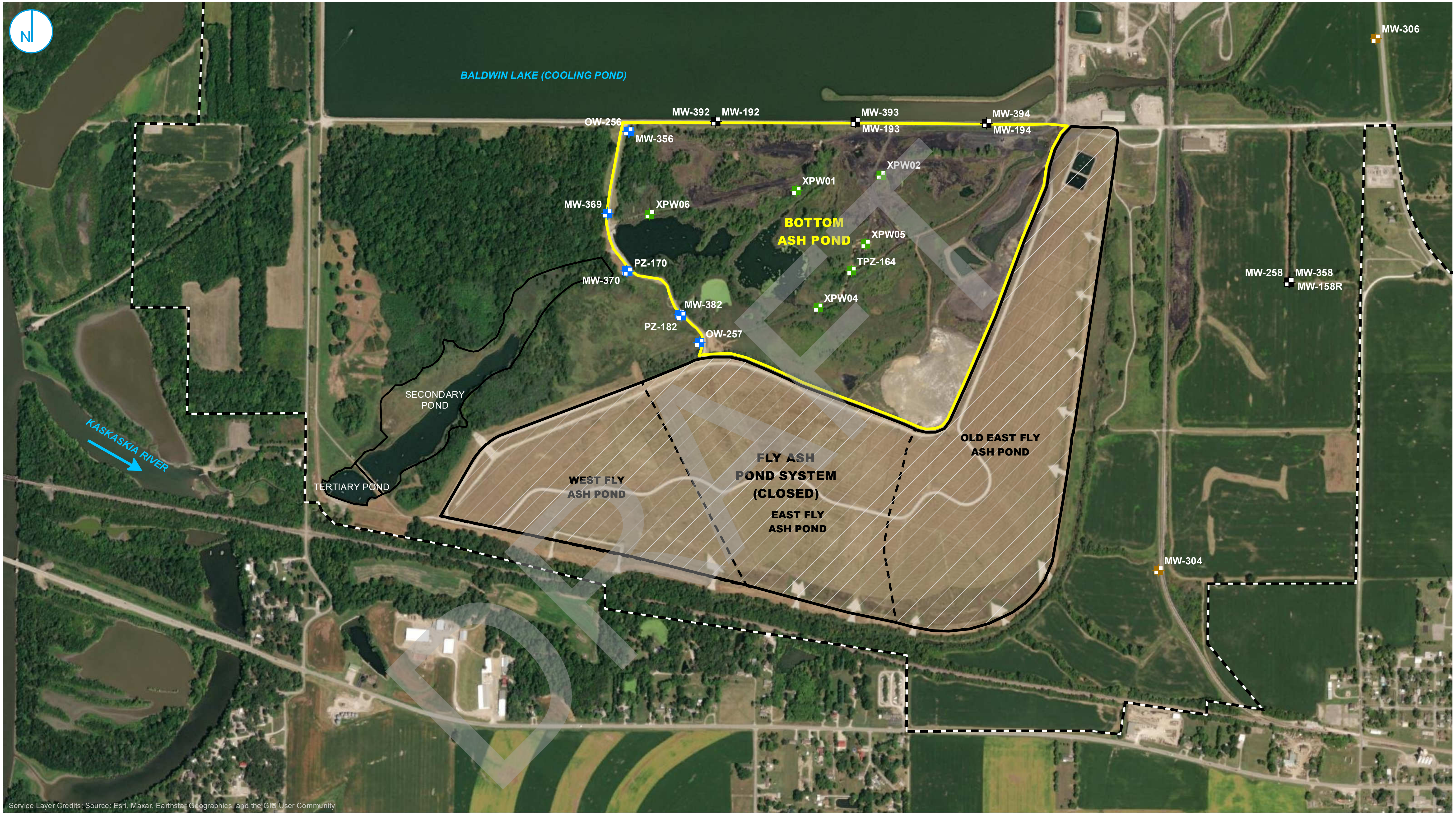
Natural Resource Technology, an OBG Company (NRT/OBG), 2017b. *Sampling and Analysis Plan, Final, Baldwin Bottom Ash Pond, Baldwin Energy Complex, Baldwin, Illinois, Project No. 2285*. October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report. Baldwin Bottom Ash Pond. Baldwin Power Plant. Baldwin, Illinois*.

FIGURES

Y:\Mapping\Projects\22\2285\MXD\Alt_Source_Dem\Baldwin_AP\2023\Figure 1_Sampling Location Map.mxd

PROJECT: 169000XXXX | DATED: 4/25/2023 | DESIGNER: GALARNMC



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

- BACKGROUND WELL
- COMPLIANCE WELL
- MONITORING WELL
- PORE WATER WELL
- REGULATED UNIT (SUBJECT UNIT)
- FLY ASH POND SYSTEM (CLOSED)
- SITE FEATURE
- CAPPED AREA
- PROPERTY BOUNDARY

0 400 800 Feet

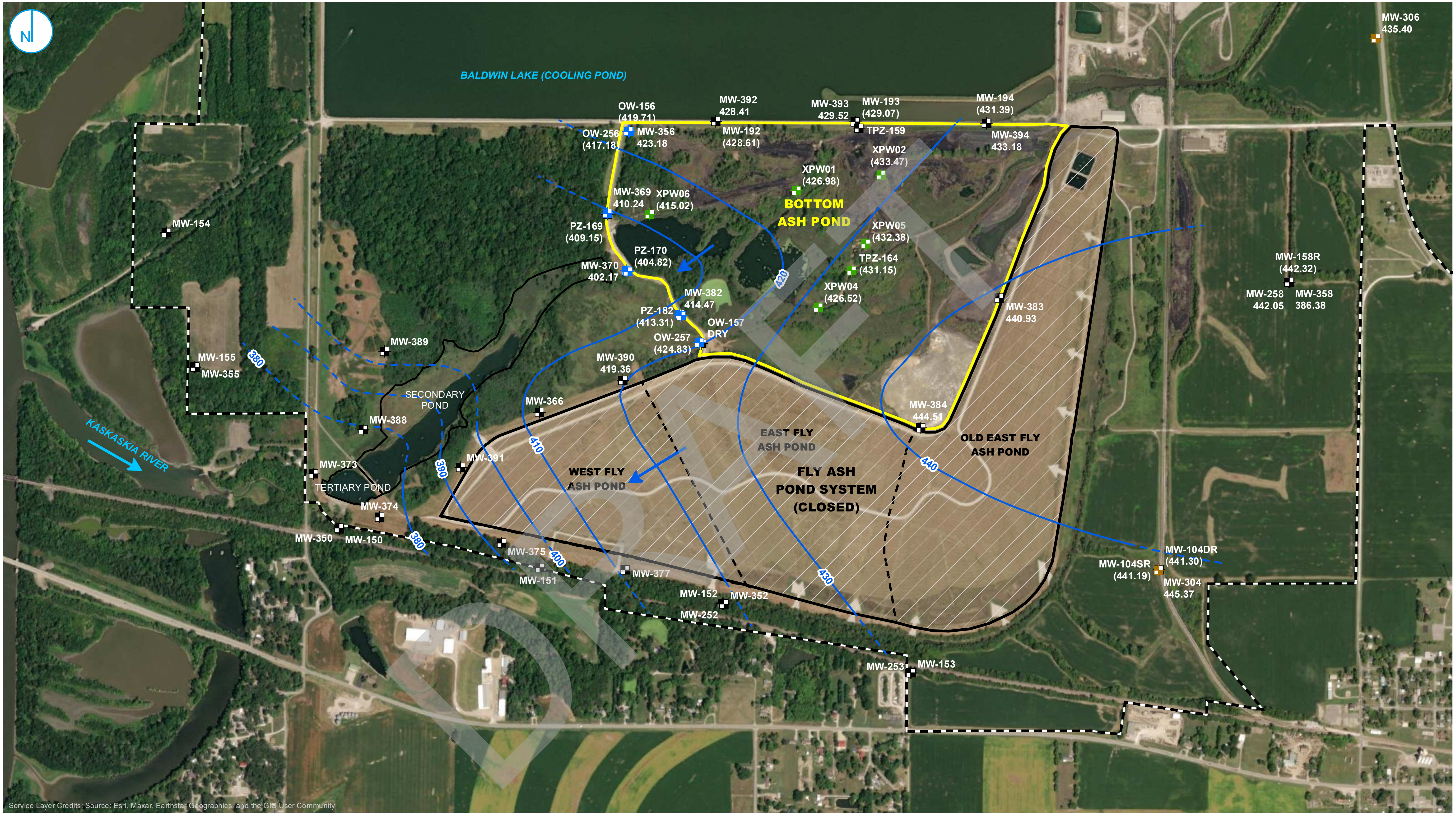
SAMPLING LOCATION MAP

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



🟦 COMPLIANCE WELL

🟧 BACKGROUND WELL

🟩 PORE WATER WELL

⬛ MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (10-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

PART 845 REGULATED UNIT (SUBJECT UNIT)

FLY ASH POND SYSTEM (CLOSED)

SITE FEATURE

CAPPED AREA

PROPERTY BOUNDARY

0 400 800 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

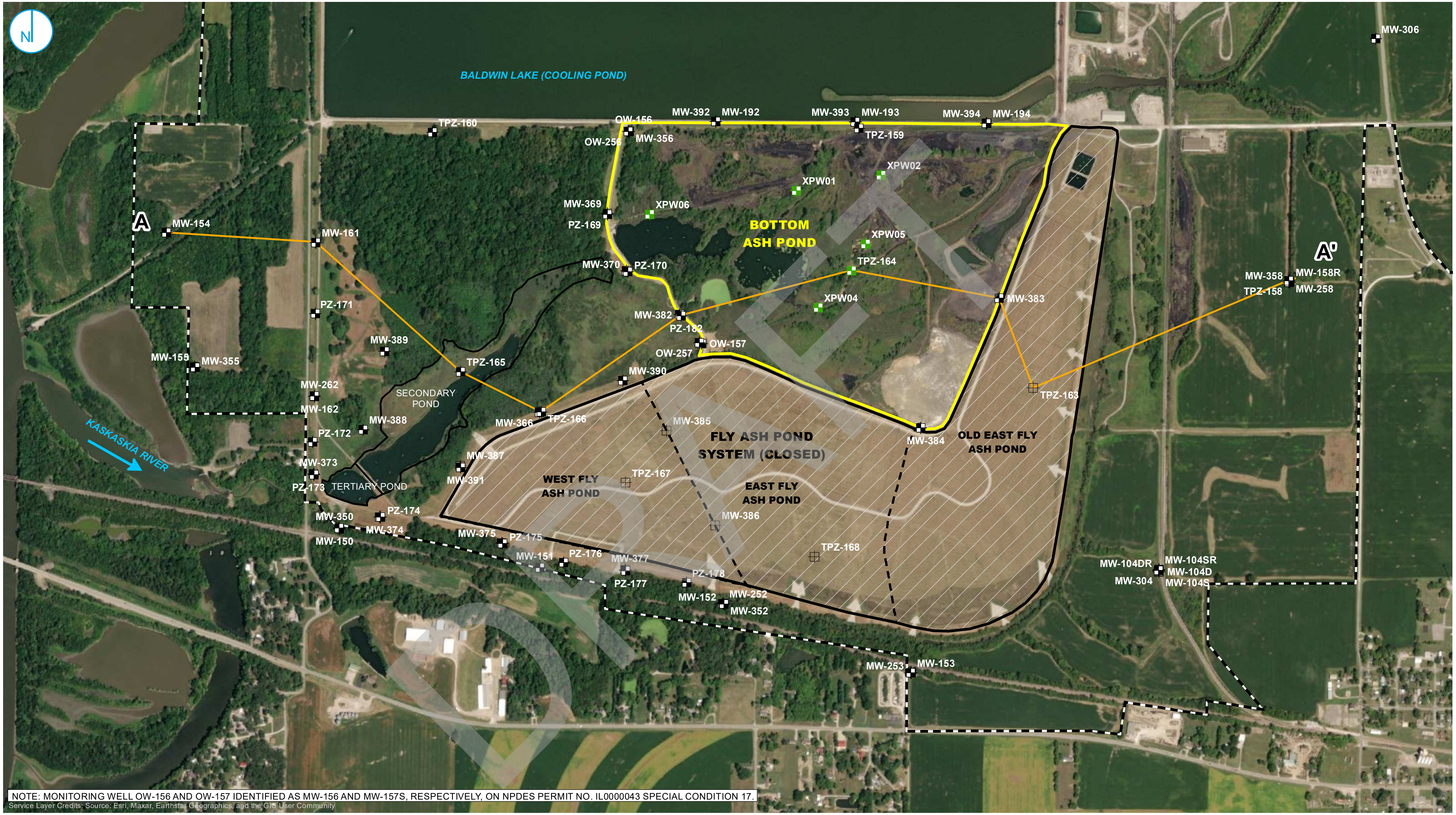
UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP DECEMBER 12, 2022

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



NOTE: MONITORING WELL OW-156 AND OW-157 IDENTIFIED AS MW-156 AND MW-157S, RESPECTIVELY, ON NPDES PERMIT NO. IL0000043 SPECIAL CONDITION 17.

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

⊠ MONITORING WELL AND PIEZOMETER LOCATION

🟩 PORE WATER WELL

⊞ CLOSED MONITORING WELL

● CCR SOURCEWATER SAMPLE

CROSS SECTION TRANSECT

— A to A'

0 400 800 Feet

🟨 REGULATED UNIT (SUBJECT UNIT) FLY ASH

☐ POND SYSTEM (CLOSED)

☐ SITE FEATURE

▨ LIMITS OF FINAL COVER

⬚ PROPERTY BOUNDARY

CROSS SECTION LOCATION MAP

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 3

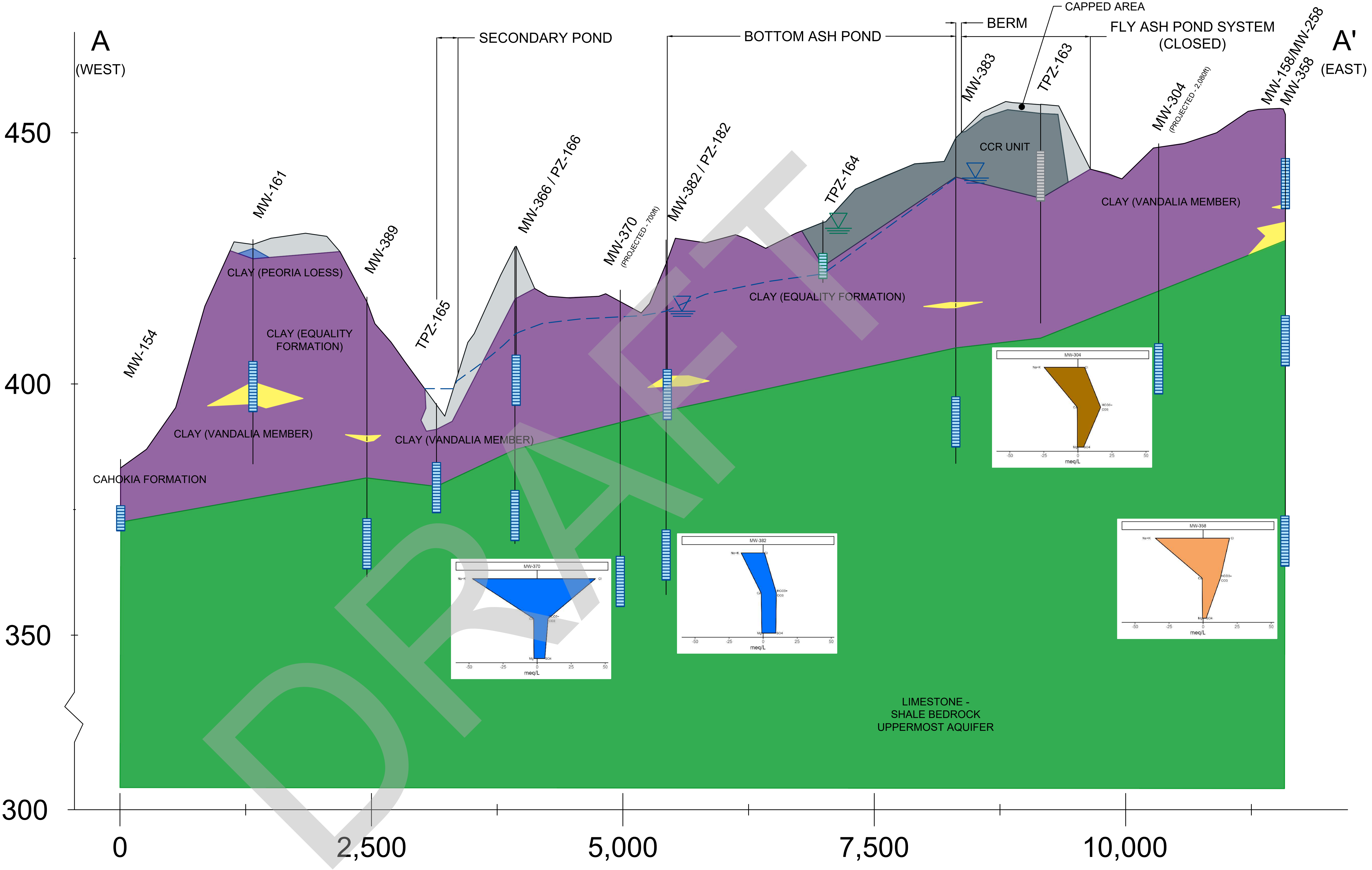
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

C:\Users\EngelhsaOneDrive - Ramboll\Projects\Vistra\EVS\Baldwin\Working Files\CAD\Baldwin Cross Sections.dwg

PROJECT: 1940100806 DATED: 4/24/2023 2:04 PM DESIGNER: ENGELHSA

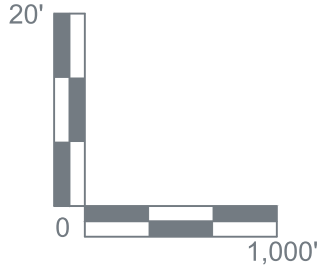
NOTES
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 50X.
4. Groundwater elevations measured on December 12, 2022.



STIFF DIAGRAM LOCATION TYPE:
🟫 BACKGROUND
🟧 UPGRADIENT
🟦 COMPLIANCE

LEGEND
⬛ COAL COMBUSTION RESIDUALS (CCR)
⬜ FILL
🟪 CLAY (CL/CH)
🟦 SILT (ML)
🟨 SAND (SP/SM/SW)
🟩 BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)

▤ WELL SCREEN INTERVAL
-·- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
▽ UPPERMOST AQUIFER GROUNDWATER ELEVATION
▽ POREWATER ELEVATION
▼ OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)



CROSS SECTION A-A'

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILINOIS

FIGURE 4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDICES

APPENDIX A

TECHNICAL MEMORANDUM - EVALUATION OF LITHIUM SOURCES WITHIN AQUIFER SOLIDS, BALDWIN POWER STATION - BOTTOM ASH POND (GEOSYNTEC CONSULTANTS, INC., 2023)

Geosyntec
consultants

500 W. Wilson Bridge Road, Suite 250
Worthington, Ohio 43085
PH 614.468.0421
FAX 614.468.0416
www.geosyntec.com

DRAFT – SUBJECT TO CHANGE. PRIVILEGED & CONFIDENTIAL

TECHNICAL MEMORANDUM

Date: April 24, 2023

To: Brian Voelker - Vistra

Copies to: Stu Cravens and Phil Morris - Vistra

From: Allison Kreinberg and Ryan Fimmen, Ph.D. - Geosyntec Consultants

Subject: Evaluation of Lithium Sources within Aquifer Solids
Baldwin Power Station – Bottom Ash Pond

Geosyntec Consultants, Inc. (Geosyntec) has completed a review of geochemical and site conditions at the Baldwin Power Plant Bottom Ash Pond (BAP; the Site) to evaluate the influence of the bedrock lithology on groundwater composition at downgradient monitoring well MW-370.

Alternate source demonstrations (ASDs) prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll) concluded that sources other than the BAP were the cause of statistically significant levels (SSL) of lithium at MW-370. This technical review has identified naturally occurring lithium associated with the shale bedrock as a source of elevated lithium in Site groundwater.

SITE CONDITIONS

The groundwater monitoring network for the BAP consists of four downgradient compliance wells (MW-356, MW-369, MW-370, and MW-382) and two upgradient background wells (MW-304 and MW-306). These monitoring locations are shown in the map provided as **Attachment 1**. Site geology consists of glacial drift deposits comprised of clastic material overlying Pennsylvanian and Mississippian-age bedrock (Ramboll, 2021). The geologic units comprising subsurface lithologies at the Site are listed in descending order:

- Equality Formation: predominantly clay and sandy clay, with intermittent sand lenses and some secondary carbonate concretions
- Pearl Formation: predominantly fine-medium grained sand with intermittent gravel
- Vandalia Till: clay and sandy clay diamicton with intermittent silt, sand, and gravel lenses
- Bedrock: Mississippian-age limestone and shale which underlies unconsolidated material beneath the western portion of the Site, and Pennsylvanian-age limestone and shale which

> underlies unconsolidated material beneath the eastern portion of the Site. The gradual change from Mississippian bedrock to Pennsylvanian bedrock is believed to occur approximately beneath the central portion of the Site (Willman et al., 1967).

Limestone bedrock at the Site is generally thinly bedded, argillaceous, and competent, with localized areas of increased weathering (Ramboll, 2021). The result of this limestone weathering is a calcareous clay lithology. Layers of limestone bedrock are interbedded with thin shale layers which are sometimes calcareous and sometimes siliciclastic. The shale layers are generally more weathered than the limestone bedrock but are generally still competent. Locations of highly weathered, non-fissile, clay-like shale with medium to high plasticity have been observed.

The Uppermost Aquifer (UA) in the vicinity of the BAP is the shallow limestone/shale bedrock. Although sand lenses are present within the unconsolidated material overlying bedrock, these lenses have not been found to be laterally continuous. Groundwater in the vicinity of the BAP flows through bedrock from east to west primarily through secondary porosity features, predominantly joints and fractures, which are present at variable frequencies within the UA.

Geologic cross-sections of the lithology underlying the BAP are provided as **Attachment 2**. The fracture network within the deeper portions of the UA bedrock is overlain by unconsolidated, predominantly low permeability clay with some silt, resulting in confined to semi-confined groundwater conditions with mostly upward vertical gradients and or flowing artesian conditions observed in the unconsolidated and UA bedrock units across the Site. The observed upward vertical gradients (upwelling) result in deeper groundwater characteristic of older lithologies mixing with shallow formation water in the UA. The flat horizontal groundwater gradient beneath the Site and the mostly upward vertical gradients also suggests the BAP is not an area of significantly increased recharge or infiltration to the UA. Groundwater quality in the UA has observed to decrease with increasing depths as confined formation water is increasingly mineralized (Ramboll, 2021).

GROUNDWATER CONDITIONS

The observed lithium SSL was identified by comparing the reported groundwater concentrations at downgradient monitoring well MW-370 to the site-specific groundwater protection standard (GWPS). The site-specific GWPS for lithium was established at 0.0958 mg/L, as the Site background concentrations were greater than the health-based level of 0.040 mg/L established in 40 CFR § 257.95(h)(2). Groundwater samples collected from recently installed upgradient monitoring well MW-358, which is screened in the Mississippian-age limestone and shale bedrock strata, contained lithium concentrations ranging from 0.0592 to 0.0957 mg/L. These upgradient concentrations, as well as previously observed results from background well MW-304, are elevated with respect to the health-based GWPS. This observation indicates that lithium is present at concentrations across the Site which suggest that a naturally occurring geogenic source of lithium to groundwater is present in these strata.

AQUIFER SOLIDS EVALUATION

Geosyntec reviewed the results of analyses completed on solid phase samples collected from the Site to support the conclusion that the lithium concentrations in groundwater at MW-370 in excess of the site-specific GWPS are associated with the limestone and shale bedrock formation.

Samples were collected from soil borings advanced in September and October 2022 at one location upgradient of the BAP (MW-358) and three locations downgradient of the BAP (MW-392, MW-393, and MW-394). These boring logs, plus the boring log for monitoring well MW-370, are provided as **Attachment 3**. Additional information regarding monitoring well construction and lithology depths of these locations and MW-370 is provided in **Table 1**. Three samples each were collected from various depth intervals/lithologies at MW-358 and MW-392, and one sample each was collected from the unconsolidated overburden at MW-393 and MW-394[1]. The samples were submitted for analysis of mineralogy via X-ray diffraction (XRD), total lithium, and lithium distribution within the aquifer solids using sequential extraction procedure (SEP). SEP uses progressively stronger reagents to solubilize metals from increasingly recalcitrant phases. Although these procedures do not identify the specific metal phases in a soil/aquifer matrix, they do provide a means to evaluate association of constituents with different classes of solids (Tessier et al, 1979).

Results for total and SEP analyses of lithium in these samples are presented in **Table 2** and the analytical laboratory reports are provided as **Attachment 4**. As a first step to evaluate data quality in an SEP analysis, the sum of individual extraction steps from the SEP was compared to the total lithium concentration. The sum of the SEP procedure is not expected to be exactly equal to the total metals analysis but should generally be consistent with the total metals analysis. As can be seen in **Table 2**, the total lithium concentrations ranged from 6.0 micrograms per gram of material (µg/g) to 20 µg/g in the shale samples. The summed concentrations of lithium from the SEP analyses ranged from 7 to 73 µg/g. The results were generally consistent between the total metals analyses and the summed SEP steps, indicating good metals recovery and data quality. One notable exception is the sample collected from 86-88 feet (ft.) below ground surface (bgs) at upgradient location MW-358, which had a total lithium concentration of 20.0 µg/g and a summed SEP total of 73 µg/g. While a difference was observed, both results indicate lithium is present within shale materials upgradient of the Site.

---

[1] Select samples, including those collected from MW-393 and MW-394, are excluded from subsequent results tables and discussion to emphasize findings associated with the bedrock lithologies.

These results indicate that lithium is present in both upgradient and downgradient shale samples at the Site, with the largest concentrations observed in upgradient samples. Most lithium in these samples was found to be associated with the residual metals fraction, which is typically considered to be immobile and not readily soluble. The abundance of lithium within the residual fraction indicates association with inseparable primary mineral phases such as clay minerals (Tessier et al., 1979). Lithium was also found to be associated with iron/manganese oxides in multiple samples (maximum of 25% associated with iron/manganese oxides in the sample collected from the 47-49 ft. bgs samples from MW-358), and a small component of lithium was found to be associated with organic material in the 86-88 ft. bgs sample collected from MW-358. These results indicate that natural lithium occurrence in aquifer material from the Site is associated with multiple phases and therefore interacts with groundwater through different mechanisms at different locations and depths.

Clay minerals are known to be common geosorbents for naturally occurring lithium (Starkey, 1982). Lithium is known to leach from lithium-hosting igneous rocks and micas through weathering processes. Mineral alteration reactions occurring in micas may result in lithium-rich micas transforming directly to illitic clays, and then to mixed-layer and smectite clays. The lithium within these primary minerals either becomes incorporated directly into the crystal structures of these clay minerals or is transported in solution and later concentrated in brines through evaporation (Ronov et al., 1970). Lithium-enriched brines constitute a common source of lithium in clay minerals, as eroded fine-grained materials deposited in these brines are capable of housing aqueous lithium within vacant sites in octahedral layers comprising their crystal structures (Schultz, 1969). SEP results from **Table 2** support the conclusion that naturally occurring lithium is observed in soils around the BAP, and that the majority of this lithium is associated with the residual solids fraction which consists of primary minerals. Field lithologic descriptions of samples indicate that nearly all of the samples collected and analyzed consist of clay or shale, both of which are comprised primarily of mica and clay minerals which are known to be hosts of natural lithium. Based on SEP results and lithologic observations, the data suggests that lithium in BAP soils is naturally occurring and primarily associated with micas and clays, with a smaller component associated with leachable oxides and organic material.

Mineralogical analyses were completed using X-ray diffraction (XRD) to evaluate whole rock mineralogy and evaluate the abundance of clays and micas within the aquifer solids. Whole rock mineralogy results are provided in **Table 3**. Sample mineralogy consists predominantly of quartz, mica (muscovite), feldspars (albite and microcline), and clay minerals (chlorite, kaolinite) (**Table 3**). Of these minerals, muscovite and clays are known hosts of natural lithium within their crystal structures (Zawidzki, 1976; Starkey, 1982). The combined abundances of muscovite or clay minerals account for between 30 to 49% of samples within the bedrock shale samples, with an average value of 43%. As indicated on **Table 3**, these minerals are present at sizeable abundances both upgradient and downgradient of the BAP, indicating that these lithium-host minerals occur in the UA throughout the Site and constitute natural sources of lithium.

MW-370 is screened from 53-63 ft. bgs within an interval of shaley limestone, with additional shale and clay directly overlying this material, as indicated by the boring log included in **Attachment 3**. It is likely that lithium-hosting micas and clay minerals are present within the screened interval of this monitoring well, the leachable component of which may act as a geogenic source of lithium in groundwater. Additionally, groundwater downgradient of the BAP may be mixing with deeper groundwater in contact with lithium-bearing micas and clay minerals within the deep shale lithologies observed upgradient of the Site due to the observed upward vertical gradient within the bedrock unit.

CONCLUSION

Naturally occurring lithium associated with the shale bedrock comprising the UA at the Site was identified as a source for lithium in Site groundwater. Solid phase samples collected from upgradient and downgradient locations around the BAP contained variable lithium, with the highest total lithium concentration observed in the upgradient deep shale sample. SEP analyses of the solid phase samples determined that the majority of lithium in the solid phase is associated with the residual metals fraction. The residual metals fraction corresponds to primary minerals such as micas and clay minerals, which are known to host natural lithium in their crystal structures, either as a result of mineral formation (micas) or depositional/alteration processes (clays). XRD confirmed the presence of micas and clay minerals in the aquifer solids at an average of 43% of the bedrock total mineralogy, suggesting an abundance of common lithium-hosting minerals which may release lithium to groundwater. This solid phase assessment supports the determination that MW-370 groundwater geochemistry appears to be related to shaley aquifer solid material.

REFERENCES

Ramboll. 2019. Alternative Source Demonstration. Baldwin Bottom Ash Pond. April.

Ramboll. 2022. Annual Groundwater Monitoring and Corrective Action Report. Baldwin Bottom Ash Pond. January

Ramboll. 2021. Hydrogeologic Site Characterization Report. Baldwin Bottom Ash Pond. October.

Ronov, A.B., Migdisov, A.A., Voskresenskaya, N.T., and Korzine, G.A. 1970. Geochemistry of lithium in the sedimentary cycle. Geochemistry International. v. 7, p. 75-102.

Schultz, L.G. 1969. Lithium and potassium absorption, dehydroxylation temperature, and structural water content of aluminous smectites. Clays and Clay Minerals. v. 17, no. 3, p. 115-150.

Starkey, H.C. 1982. The role of clays in fixing lithium. United States Geological Survey. Bulletin 1278-F.

Tessier, A., Campbell, P.G.C., and Bisson, M. 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical Chemistry. v. 5, no.7, p. 844-851.

Willman, H.B., and others. 1967. Geologic Map of Illinois. Illinois State Geologic Survey. Champaign, Illinois.

Zawidzki, Pawel. 1976. Lithium distribution in micas and its bearing on the lithium geochemistry of granitoids. Polska Akademia Nauk, Archiwum Mineralogiczne. v. 32, p. 95-152.

TABLES

Table 1 - Relevant Monitoring Well Information
Baldwin Power Plant

Monitoring Well	Well Classification	Screened Interval	Depth of Well	Geologic Material Within Screened Interval	Interval of Observed Alluvial Clay	Interval of Observed Bedrock
MW-370	Downgradient	53-63	66	Shaley limestone, Limestone	0-28.5	28.5-66
MW-358	Upgradient	80-90	90	Limestone, Shale	4-21	21-90
MW-392	Downgradient	74-84	84	Shale, Limestone	1-33	52-84
MW-393	Downgradient	75-85	85	Shale	1-27, 31-40	57-85
MW-394	Downgradient	73-83	85	Shale, Limestone	3-20, 22-37	37-85

Notes:
Depths provided in units of feet below ground surface
Observed clay and bedrock intervals are based on the boring logs provided in Attachment 3.

Table 2 - Lithium SEP Results Summary
Baldwin Power Plant

Well ID	**MW-358**		**MW-358**		**MW-392**		**MW-392**	
Depth (ft)	**(47-49)**		**(86-88)**		**(66-68)**		**(80-82)**	
Location	**Upgradient**		**Upgradient**		**Downgradient**		**Downgradient**	
Boring Log Description	**Shallow Shale**		**Deeper Shale Body**		**Shale**		**Shale transitioning to limestone**	
Total Lithium	6.0		20.0		15.0		8.0	
SEP Results								
	Concentration	% of Total	Concentration	% of Total	Concentration	% of Total	Concentration	% of Total
Water Soluble Fraction	<2	--	<2	--	<2	--	<2	--
Exchangeable Metals Fraction	<2	--	<2	--	<2	--	<2	--
Metals Bound to Carbonates Fraction	<2	--	<2	--	<2	--	<2	--
Metals Bound to Fe/Mn Oxides Fraction	3.0	25%	5.0	7%	2.0	10%	<2	--
Bound to Organic Material Fraction	<2	--	3.0	4%	<2	--	<2	--
Residual Metals Fraction	9.0	75%	65.0	89%	19.0	90%	7.0	100%
SEP Total	12.0	100%	73.0	100%	21.0	100%	7.0	100%

Notes:
SEP - sequential extraction procedure
All results shown in microgram of lithium per gram of soil (µg/g).
Total lithium was analyzed using aqua regia digest, ICP-MS
Non-detect values are shown as less than the detection limit.
The lithium fraction associated with each SEP phase is shown.
% of total lithium is calculated from the sum of the SEP fractions.

Table 3 - Summary of Rietveld Quantitative Analysis
X-Ray Diffraction Results
Baldwin Power Plant

Well ID			**MW-358**	**MW-358**	**MW-392**	**MW-392**
Depth (ft bgs)			**(47-49)**	**(86-88)**	**(66-68)**	**(80-82)**
Location			**Upgradient**	**Upgradient**	**Downgradient**	**Downgradient**
Boring Log Description			**Shallow Shale**	**Deeper Shale Body**	**Shale**	**Shale transitioning to limestone**
Mineral/Compound	**Formula**	**Mineral Type**	(wt %)	(wt %)	(wt %)	(wt %)
Quartz	SiO_2	Silicate	33.0	34.9	27.2	29.1
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Mica	37.6	30.5	29.7	14.5
Albite	$NaAlSi_3O_8$	Feldspar	8.2	3.4	4.5	1.0
Microcline	$KAlSi_3O_8$	Feldspar	9.4	8.1	6.9	2.9
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	Clay	-	-	16.3	6.8
Diaspore	aAlO.OH	Oxyhydroxide	-	-	-	-
Pyrite	FeS_2	Sulfide	1.0	0.8	-	1.2
Kaolinite	$Al_2Si_2O_5(OH)_4$	Clay	9.0	18.4	-	8.2
Calcite	$CaCO_3$	Carbonate	1.8	1.7	14.8	31.5
Anatase	TiO_2	Oxide	-	2.1	0.7	0.4
Leucite	$KAlSi_2O_6$	Zeolite	-	-	-	2.4
Siderite	$FeCO_3$	Carbonate	-	-	-	1.9
Dolomite	$CaMg(CO_3)_2$	Carbonate	-	-	-	-
Gypsum	$CaSO_4 \cdot 2H_2O$	Sulfate	-	-	-	-
Diopside	$CaMgSi_2O_6$	Pyroxene	-	-	-	-
Clay Minerals Total			9	18	16	15
Clays + Muscovite Total			47	49	46	30

Notes

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

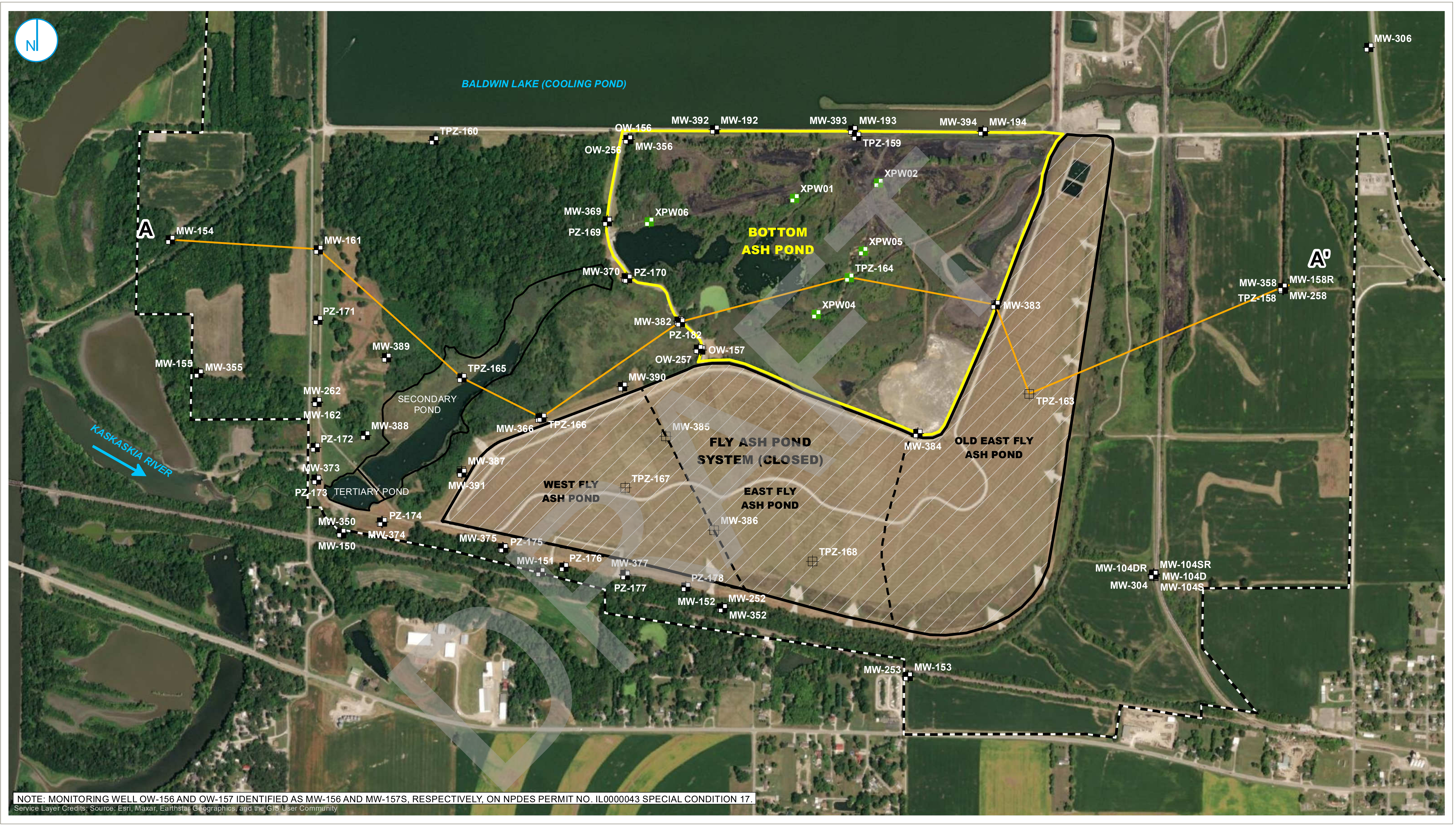
Sample depths are shown in feet below ground surface (ft bgs).

ATTACHMENT 1

Cross Section Location Map

Y:\Mapping\Projects\22\2285\MXD\Alt_Source_Demo\Baldwin_AP\2023\Figure 3_Cross Section Locations.mxd

PROJECT: 169000XXXX | DATED: 4/24/2023 | DESIGNER: GALARNMC



NOTE: MONITORING WELL OW-156 AND OW-157 IDENTIFIED AS MW-156 AND MW-157S, RESPECTIVELY, ON NPDES PERMIT NO. IL0000043 SPECIAL CONDITION 17.

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

⊞ MONITORING WELL AND PIEZOMETER LOCATION

🟩 PORE WATER WELL

⊞ CLOSED MONITORING WELL

● CCR SOURCEWATER SAMPLE

CROSS SECTION TRANSECT

— A to A'

▭ REGULATED UNIT (SUBJECT UNIT) FLY ASH

▭ POND SYSTEM (CLOSED)

▭ SITE FEATURE

▨ LIMITS OF FINAL COVER

▭ PROPERTY BOUNDARY

0 400 800 Feet

CROSS SECTION LOCATION MAP

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILLINOIS

FIGURE 3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

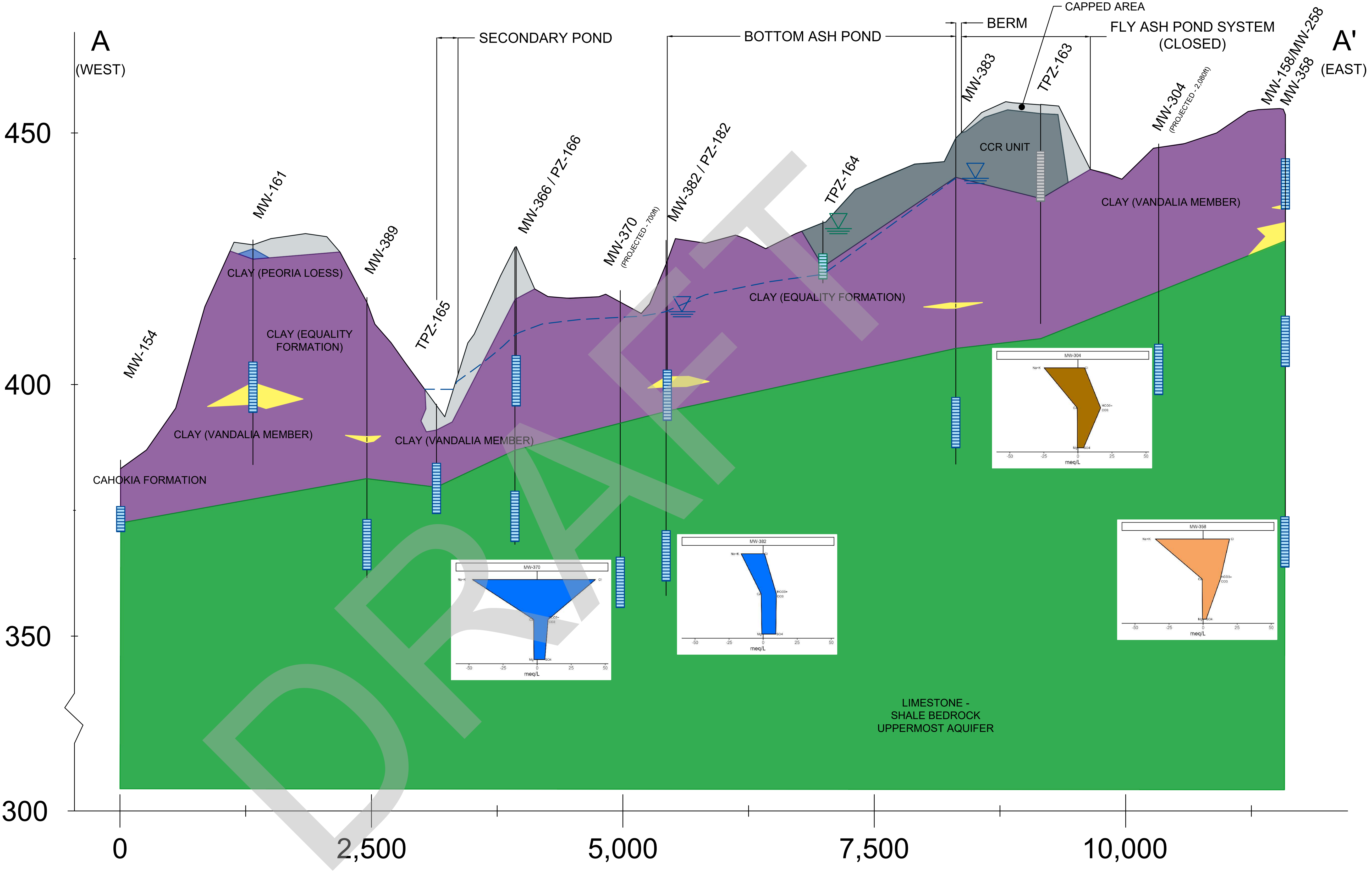
RAMBOLL

ATTACHMENT 2

Cross Section A-A'

NOTES

1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 50X.
4. Groundwater elevations measured on December 12, 2022.



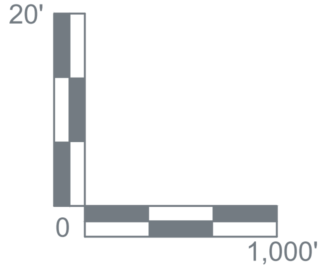
STIFF DIAGRAM LOCATION TYPE:

🟫	BACKGROUND
🟧	UPGRADIENT
🟦	COMPLIANCE

LEGEND

▩	COAL COMBUSTION RESIDUALS (CCR)
▢	FILL
🟪	CLAY (CL/CH)
🟦	SILT (ML)
🟨	SAND (SP/SM/SW)
🟩	BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)

▤	WELL SCREEN INTERVAL
- -	UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
▽	UPPERMOST AQUIFER GROUNDWATER ELEVATION
▽	POREWATER ELEVATION
▼	OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)



CROSS SECTION
A-A'

ALTERNATE SOURCE DEMONSTRATION
BOTTOM ASH POND
BALDWIN POWER PLANT
BALDWIN, ILINOIS

FIGURE 4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

ATTACHMENT 3

Boring Logs

NATURAL
RESOURCE
TECHNOLOGY

SOIL BORING LOG INFORMATION

Facility/Project Name: Baldwin Energy Complex

License/Permit/Monitoring Number:

Boring Number: MW-370

Boring Drilled By: Name of crew chief (first, last) and Firm: Mark Baetje
Bulldog Drilling

Date Drilling Started: 11/20/2015

Date Drilling Completed: 11/24/2015

Drilling Method: 4 1/4 HSA and rotary

Common Well Name: MW-370

Final Static Water Level: Feet (NAVD88)

Surface Elevation: 418.67 Feet (NAVD88)

Borehole Diameter: 8.3 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 556,826.50 N, 2,381,936.14 E E / [✓ W]

1/4 of 1/4 of Section , T N, R

Lat 38° 11' 44.1702"

Long -89° 52' 10.8084"

Local Grid Location

Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID:

County: Randolph

State: Illinois

Civil Town/City/ or Village: Baldwin

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	0 - 2' **SILTY CLAY** CL/ML.	CL/ML									0-28' Blind Drilled. See log PZ-170 for soil description.
			2 3	2 - 4' Shelby Tube Sample.										
			4 5 6 7	4 - 8' **SILTY CLAY** CL/ML.	CL/ML									
			8 9	8 - 10' **SILTY CLAY** to **LEAN CLAY:** CL/ML.	CL/ML									
			10 11 12	10 - 12' **LEAN CLAY:** CL.	CL									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Natural Resource Technology
234 W. Florida St., Fifth Floor, Milwaukee, WI 53204

Tel: (414) 837-3607
Fax: (414) 837-3608

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
				12 - 14' Shelby Tube Sample.										
			13											
			14	14 - 24' **SILTY CLAY** CL/ML.										
			15											
			16											
			17											
			18											
			19		CL/ML									
			20											
			21											
			22											
			23											
			24	24 - 26' Shelby Tube Sample.										
			25											
			26	26 - 28' **SILTY CLAY** CL/ML.										
			27		CL/ML									
1 SS	10 10	23 50/4"	28	28 - 28.4' **LEAN CLAY:** CL, yellowish brown (10YR 5/4), trace angular limestone gravel, soft, medium plasticity, moist.	CL									
1 CORE	60 18.5		29	28.4 - 28.9' **SHALE:** BDX (SH), gray, highly decomposed, very weak.	BDX (SH)									Core 1, RQD=51%
			30	28.9 - 38.1' **SHALEY LIMESTONE:** BDX (LS/SH), light gray to gray, intensely fractured (extremely narrow to moderately narrow apertures), medium to thickly bedded, microcrystalline, moderately decomposed, very strong.	BDX (LS/SH)									
			31											
			32											

SOIL BORING LOG INFORMATION SUPPLEMENT

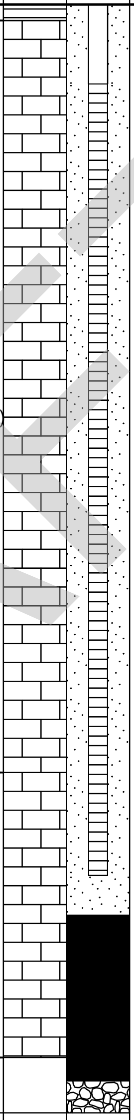
Boring Number MW-370

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well	Diagram	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			33	28.9 - 38.1' **SHALEY LIMESTONE:** BDX (LS/SH), light gray to gray, intensely fractured (extremely narrow to moderately narrow apertures), medium to thickly bedded, microcrystalline, moderately decomposed, very strong. *(continued)*										
2 CORE	51.5 12		34	33.9' - 38.1' gray, greenish gray in fractures, trace fossils, moderately to highly decomposed, slightly to moderately disintegrated, clay in shoe with a hard, reddish brown inclusion.										Core 2, RQD=0%
			35		BDX (LS/SH)									
			36	36' - 37.9' vertical fracture.										
			37											
			38											
3 CORE	24 25			38.1 - 44' **SHALE:** BDX (SH), bluish gray, intensely fractured (extremely narrow to narrow apertures), highly decomposed, weak.										Core 3, RQD=40%
			39											
4 CORE	24 11		40											Core 4, RQD=0%
			41	40.6' - 40.8 shaley limestone layer, light gray to gray, microcrystalline, moderately decomposed, very strong.	BDX (SH)									
5 CORE	36 32			41.1' - 43.2 gray, moderately to highly decomposed.										Core 5, RQD=78%
			42											
			43											
6 CORE	12 28		44	44 - 45.7' **SHALEY LIMESTONE:** BDX (LS/SH), light gray to gray, intensely fractured (extremely narrow to narrow apertures), thin to medium bedded, microcrystalline, slightly decomposed, clay cement in apertures, very strong.										Core 6, RQD=29%
			45		BDX (LS/SH)									
7 CORE	45 27			45' shale layer, bluish gray, moderately fractured (extremely narrow to narrow apertures), highly decomposed, weak.										Core 7, RQD=65%
			46	45.7 - 52.2' **SHALE:** BDX (SH), bluish gray, moderately fractured (tight to narrow), highly decomposed, weak.										
			47											
			48											
			49		BDX (SH)									
8 CORE	24 30													Core 8, RQD=78%
			50											
			51											
9 CORE	24 24		52											Core 9, RQD=0%

SOIL BORING LOG INFORMATION SUPPLEMENT

NATURAL RESOURCE TECHNOLOGY

Boring Number MW-370



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram		Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
10 CORE	24 36		53 54 55	52' clay cement. 52.2 - 61.7' **SHALEY LIMESTONE:** BDX (LS/SH), light gray to gray, intensely fractured (very narrow to narrow), thin to medium bedded, microcrystalline, slightly decomposed, cemented clay in apertures, very strong. 52.7' - 53' clayey sand in aperture. 53' - 53.1 shale bed, bluish gray, fossiliferous, moderately fractured (very narrow to narrow), highly decomposed, weak. 53.1' white to bluish gray, gray in the fractures (extremely narrow to moderately narrow apertures), thinly to medium bedded, slightly to moderately disintegrated.										Core 10, RQD=0%
11 CORE	24 30		56 57	55.7' moderately disintegrated.	BDX (LS/SH)									Core 11, RQD=18%
12 CORE	30 27		58 59 60	58.1' highly decomposed.										Core 12, RQD=39%
13 CORE	36 53		61											Core 13, RQD=89%
			62 63 64 65	61.7 - 65.3' **LIMESTONE:** BDX (LS).	BDX (LS)									
			66	65.3 - 66' Overdrilled for Well Installation.										
				66' End of Boring.										Bedrock corehole reamed 6" in diameter to 66' for well installation.

SOIL BORING LOG INFORMATION

Facility/Project Name Baldwin Power Plant	License/Permit/Monitoring Number	Boring Number MW358

Boring Drilled By: Name of crew chief (first, last) and Firm Blake Weller Cascade Drilling	Date Drilling Started 10/5/2022	Date Drilling Completed 10/8/2022	Drilling Method Sonic

Common Well Name MW358	Final Static Water Level Feet (NAVD88)	Surface Elevation 453.59 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 556,726.26 N, 2,387,756.63 E E / [✓ W]

1/4 of 1/4 of Section , T N, R

Lat 38° 11' 42.9882"

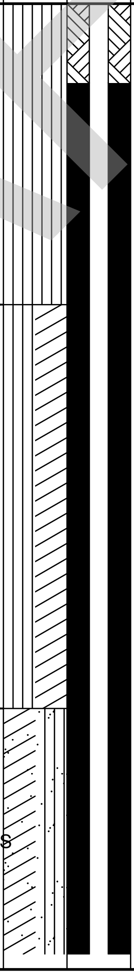
Long -89° 50' 57.9018"

Local Grid Location

Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County Randolph	State IL	Civil Town/City/ or Village Baldwin

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	180 97		1 2 3	0 - 3.8' **SILT:** ML, very dark grayish brown (10YR 3/2), organic material (0-10%), moist to wet. 2.1' dry.	ML									CS= Core Sample Measured Rock Quality Designation (RQD) was modified due to drilling methods, modified RQD equals the sum of recovered core sections greater than 4 inches in length divided by total core recovery.
			4 5 6 7 8	3.8 - 8.9' **CLAYEY SILT:** ML/CL, light gray (10YR 7/2), very dark grayish brown (10YR 3/2) and yellowish brown (10YR 5/8) mottling (20-30%), dry.	ML/CL									
			9 10 11 12	8.9 - 13' **SILTY CLAY WITH SAND:** (CL/ML)S, grayish brown (10YR 5/2), strong brown (7.5YR 5/6) and very dark brown (10YR 2/2) mottling (20-30%), organic material (0-10%), low toughness, low to medium plasticity, stiff.	(CL/ML)S									



I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

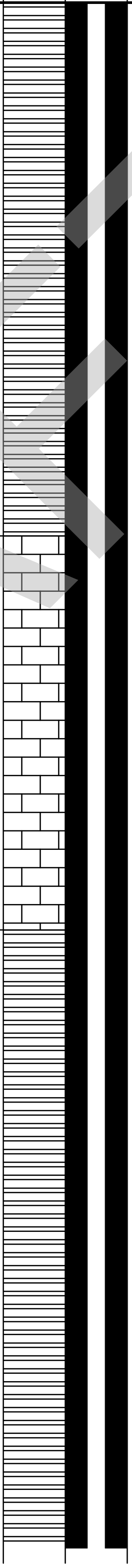
Firm Ramboll
234 W Florida Street, 5th Floor, Milwaukee, WI 53204
Tel: (414)837-3607
Fax: (414)837-3608

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
					(CL/ML)S									
2 CS	60 60		13 14 15 16 17	13 - 17.8' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2), strong brown (7.5YR 5/6) and very dark brown (10YR 2/2) mottling (20-30%), low toughness, medium to high plasticity, stiff to very stiff. 16.1' mottling discontinues.	CL/ML									
3 CS	48 36		18 19 20	17.8 - 21' **SILTY CLAY WITH SAND:** (CL/ML)S, brown (10YR 5/3), strong brown (7.5YR 5/6) and gray (10YR 6/1) mottling (20-30%), gravel (5-15%), no dilatancy, high toughness, low to medium plasticity, hard, moist.	(CL/ML)S									
4 CORE	36 32		21 22 23 24 25 26	21 - 26.5' **SHALE:** BDX (SH), dark gray (GLEY 1 4/N), weathered, thin bedding, moderately fractured. 24' -25.2' wet.	BDX (SH)									RUN #4: Modified RQD = (21/32) = 66%
5 CORE	36 29		27	26.5 - 27.5' **LIMESTONE:** BDX (LS), dark gray (5Y 4/1), shaley, fossiliferous, very strong.	BDX (LS)									RUN #5: Modified RQD = (0/29) = 0%
6 CORE	72 60		28 29 30 31	27.5 - 31.3' **SHALE:** BDX (SH), grayish black (N2), weathered, highly decomposed to residual soil, wet to moist. 29.3' thinly bedded, moderately decomposed. 30' slightly decomposed to competent, moderately fractured.	BDX (SH)									RUN #6: Modified RQD = (45/60) = 75%
			32	31.3 - 32' **COAL:** COAL, black (N1).	COAL									

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW358

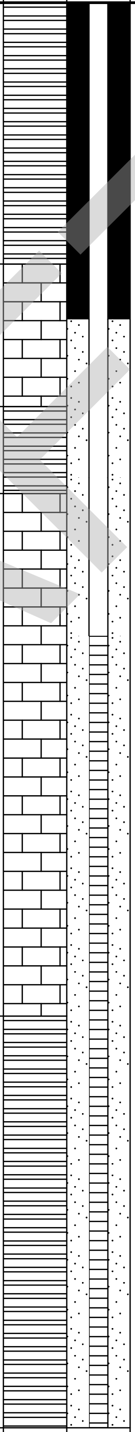
Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			33	32 - 33' **SHALE:** BDX (SH), grayish black (N2), slightly decomposed to competent, moderately fractured, wet to moist.	BDX (SH)									
			34 35	33 - 36' **SHALEY LIMESTONE:** BDX (LS/SH), medium gray (N5), weathered, shaley, higly decomposed, slightly fractured.	BDX (LS/SH)									
7 CORE	72 71		36 37 38 39 40	36 - 40.8' **SHALEY LIMESTONE:** to **SHALE:** BDX (LS/SH), interbedded shale.	BDX (LS/SH)									RUN #7: Modified RQD = (67/71) = 94%
			41	40.8 - 42' **LIMESTONE:** BDX (LS), medium light gray (N6), strong to moderately fractured, slightly decomposed, narrow apertures.	BDX (LS)									
8 CORE	96 85		42 43 44 45 46 47	42 - 58.9' **SHALE:** BDX (SH), medium gray (N5) to medium dark gray (N4), weathered, weak, thinly bedded, moderately to highly fractured.	BDX (SH)									RUN #8: Modified RQD = (81/85) = 94%
			48 49	47.5' dark grayish brown (10YR 4/2), pale olive (5Y 6/4) discoloration, more competent.										
9 CORE	60 60		50	50.2' weak to moderate.										RUN #9: Modified RQD = (52/60) = 87%
			51 52	50.8' olive gray (5Y 5/2).										



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			53	42 - 58.9' **SHALE:** BDX (SH), medium gray (N5) to medium dark gray (N4), weathered, weak, thinly bedded, moderately to highly fractured. *(continued)* 52.2' dark grayish green (5GY 4/2).										
			54	54.1' medium dark gray (N4) to medium gray (N5), weak, highly decomposed, no visible bedding, dry.										
10 CORE	60 58		55		BDX (SH)									RUN #10: Modified RQD = (42/58) = 72%
			56	55.7' dark grayish green (5GY 4/2).										
			57	57.2' light brownish gray (10YR 6/2), thinly bedded, laminated.										
			58	58.2' medium dark gray (N4), strong, intensely fractured, thinly bedded.										
			59	58.9 - 64' **LIMESTONE:** BDX (LS), medium gray (N5), very strong, moderately fractured, visible laminations.										
11 CORE	36 31		60 61 62		BDX (LS)									RUN #11: Modified RQD = (8/31) = 26%
12 CORE	36 36		63											RUN #12: Modified RQD = (31/36) = 86%
			64 65	64 - 75.3' **SHALE:** BDX (SH), medium dark gray (N4) to medium gray (N5), strong, thinly bedded to laminated, moderately fractured. 64.3' grayish green (5GY 5/2), weathered, weak, decomposed.										
13 CORE	48 48		66 67											RUN #13: Modified RQD = (43/48) = 90%
			68		BDX (SH)									
			69	69.3' medium dark gray (N4), weathered, moderate strength.										
14 CORE	60 58		70 71 72											RUN# 14: Modified RQD = (57/58) = 99%

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW358



Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			73 74 75	64 - 75.3' **SHALE:** BDX (SH), medium dark gray (N4) to medium gray (N5), strong, thinly bedded to laminated, moderately fractured. *(continued)*	BDX (SH)									
15 CORE	60 56		76	75.3 - 77.1' **LIMESTONE:** BDX (LS), gray (5Y 6/1), fossiliferous, very strong.	BDX (LS)									RUN #15: Modified RQD = Not Recorded
			77 78	77.1 - 78.2' **SHALE:** BDX (SH), medium dark gray (N4), weathered, weak to moderate strength, moderately decomposed.	BDX (SH)									
16 CORE	60 51		79 80 81 82 83 84	78.2 - 84.8' **LIMESTONE:** BDX (LS), medium dark gray (N4) to medium gray (N5), shaley, fossiliferous, very strong, moderately fractured, laminations (0-5%).	BDX (LS)									RUN #16: Modified RQD = (23/51) = 45%
17 CORE	60 60		85 86 87 88 89 90	84.8 - 90' **SHALE:** BDX (SH), dark gray (N3), weathered, weak to moderate strength, moderately decomposed, moderately fractured, thin bedding.	BDX (SH)									RUN #17: Modified RQD = (28/60) = 47%
				90' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name Baldwin Power Plant	License/Permit/Monitoring Number	Boring Number MW392

Boring Drilled By: Name of crew chief (first, last) and Firm Blake Weller Cascade Drilling	Date Drilling Started 9/9/2022	Date Drilling Completed 9/26/2022	Drilling Method Sonic
Common Well Name MW392	Final Static Water Level Feet (NAVD88)	Surface Elevation 434.07 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 558,140.20 N, 2,382,717.92 E E/[✓ W]

1/4 of 1/4 of Section , T N, R

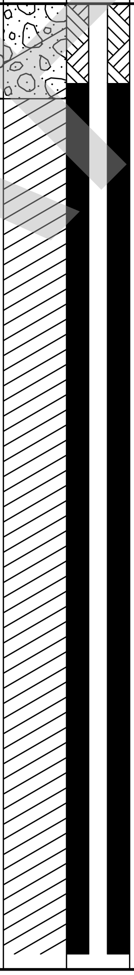
Lat 38° 11' 57.132"

Long -89° 52' 0.9632"

Local Grid Location

Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County Randolph	State IL	Civil Town/City/ or Village Baldwin



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 46		0	0 - 1.2' **FILL, WELL-GRADED GRAVEL WITH CLAY:** GW-GC, pinkish gray (7.5YR 6/2), angular, moist.	(FILL) GW-GC									CS= Core Sample
			1 2 3 4 5 6 7 8 9	1.2 - 16' **FILL, LEAN CLAY:** CL, light brown (7.5YR 6/4), sand (0-5%), no dilatancy, low to medium plasticity, moist.	(FILL) CL									Measured Rock Quality Designation (RQD) was modified due to drilling methods, modified RQD equals the sum of recovered core sections greater than 4 inches in length divided by total core recovery.
2 CS	120 62		10 11 12											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Ramboll
234 W Florida Street, 5th Floor, Milwaukee, WI 53204
Tel: (414)837-3607
Fax: (414)837-3608

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW392

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				1.2 - 16' **FILL, LEAN CLAY:** CL, light brown (7.5YR 6/4), sand (0-5%), no dilatancy, low to medium plasticity, moist. *(continued)*										
			13											
			14		(FILL) CL									
			15											
			16	16 - 20' **LEAN CLAY:** CL, light brown (7.5YR 6/4), sand (0-5%), no dilatancy, low to medium plasticity, moist.										
			17											
			18		CL									
			19											
3 CS	120 33		20	20 - 33' **LEAN CLAY:** CL, pinkish gray (7.5YR 6/2), sand (0-5%), medium to high plasticity, stiff, moist.										
			21											
			22											
			23											
			24											
			25											
			26		CL									
			27											
			28											
			29											
4 CS	120 104		30	30' increasing sand and gravel content.										
			31											
			32											

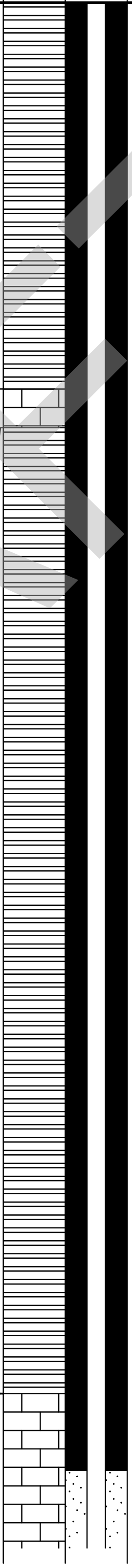
SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW392

Page 3 of 5

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				20 - 33' **LEAN CLAY:** CL, pinkish gray (7.5YR 6/2), sand (0-5%), medium to high plasticity, stiff, moist. *(continued)*	CL									
			33 34	33 - 35' **WELL-GRADED SAND WITH SILT AND GRAVEL:** (SW-SM)g, fine to medium sand, dry.	(SW-SM)g									
			35 36	35 - 36.5' **SANDY SILT WITH GRAVEL:** s(ML)g, light yellowish brown (10YR 6/4), dry.	s(ML)g									
			37 38	36.5 - 39' **CLAYEY SILT:** ML/CL, gray (7.5YR 5/1), sand (5-10%), coal (0-5%), gravel (0-5%), dry.	ML/CL									
			39	39 - 40' **SILTY CLAY:** CL/ML, sand (0-5%), low to medium plasticity, stiff.	CL/ML									
5 CS	120 108		40 41 42 43 44 45 46 47	40 - 48' **SILT WITH SAND:** (ML)s, light brownish gray (10YR 6/2), dry. 44' increasing clay content. 45' (2.5Y 6/2).	(ML)s									
6 CS	84 81		48 49 50 51 52	48 - 52' **SILT:** ML, gray (2.5Y 5/1), sand (0-5%), dry.	ML									

Boring Number MW392



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				52 - 57' **SHALE:** BDX (SH), dark gray (5Y 4/1), highly weathered, hard, dry.										
			53	53' very dark gray (7.5YR 3/1).										
			54											
			55		BDX (SH)									
			56											
7 CORE	60 4		57	57 - 57.5' **LIMESTONE:** BDX (LS), gray (5Y 6/1), slightly fractured.	BDX (LS)									RUN #7: Modified RQD = 0% (No Solid Recovery > 4")
			58	57.5 - 70' **SHALE:** BDX (SH), dark gray (5Y 4/1), weathered, soft, moderately fractured to highly fractured limestone beds (0-5%).										
			59											
			60											
			61											
8 CORE	96 78		62											RUN #8: Modified RQD = (28/78) = 36%
			63											
			64		BDX (SH)									
			65											
			66	66.3' - 67.2' highly fractured, very soft, wet.										
			67											
			68											
			69											
9 CORE	120 62		70	70 - 74.4' **LIMESTONE:** BDX (LS), gray (5Y 6/1), moderately to intensely fractured, moderately wide apertures.										RUN #9: Modified RQD = (28/78) = 36%
			71		BDX (LS)									
			72											

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW392

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			73 74	70 - 74.4' **LIMESTONE:** BDX (LS), gray (5Y 6/1), moderately to intensely fractured, moderately wide apertures. *(continued)*	BDX (LS)									
10 CORE	48 48		75 76 77 78 79 80 81	74.4 - 81.8' **SHALE:** BDX (SH), medium dark gray (N4) to dark gray (N3), slightly weathered, moderately fractured, thinly bedded.	BDX (SH)									RUN #10: Modified RQD = (28/48) = 58%
			82 83	81.8 - 84' **LIMESTONE:** BDX (LS), medium light gray (N6), shaley, fossiliferous, moderately fractured, thinly bedded. 83.2' medium gray (N5).	BDX (LS)									
			84	84' End of Boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Page 1 of 5

Facility/Project Name Baldwin Power Plant	License/Permit/Monitoring Number	Boring Number MW393

Boring Drilled By: Name of crew chief (first, last) and Firm Blake Weller Cascade Drilling	Date Drilling Started 9/9/2022	Date Drilling Completed 10/4/2022	Drilling Method Sonic
Common Well Name MW393	Final Static Water Level Feet (NAVD88)	Surface Elevation 434.59 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 558,133.57 N, 2,383,944.49 E E/[✓ W]

1/4 of 1/4 of Section , T N, R

Lat 38° 11' 57.027"

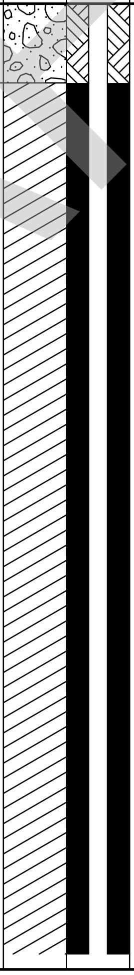
Long -89° 51' 45.5976"

Local Grid Location

Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County Randolph	State IL	Civil Town/City/ or Village Baldwin

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties: Compressive Strength (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
1 CS	120 86			0 - 1' **FILL, WELL-GRADED GRAVEL:** GW, pinkish gray (7.5YR 6/2), angular, moist.	(FILL) GW									CS= Core Sample
			1 2 3 4 5 6 7 8 9	1 - 20' **FILL, LEAN CLAY:** CL, brown (7.5YR 6/4), sand (0-5%), no dilatancy, low to medium plasticity, moist.	(FILL) CL									Measured Rock Quality Designation (RQD) was modified due to drilling methods, modified RQD equals the sum of recovered core sections greater than 4 inches in length divided by total core recovery.
2 CS	120 120		10 11 12	10' sand (0-5%), iron concretions (0-5%).										



I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Ramboll
234 W Florida Street, 5th Floor, Milwaukee, WI 53204
Tel: (414)837-3607
Fax: (414)837-3608

Boring Number MW393

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			13 14 15 16 17	1 - 20' **FILL, LEAN CLAY:** CL, brown (7.5YR 6/4), sand (0-5%), no dilatancy, low to medium plasticity, moist. *(continued)*	(FILL) CL									
			18 19	18' medium to high plasticity.										
3 CS	120 120		20 21 22 23	20 - 24' **LEAN CLAY:** CL, light brown (7.5YR 6/4), mottling, sand (0-5%), medium to high plasticity, cohesive, moist.	CL									
			24 25 26	24 - 27' **CLAYEY SAND:** SC, gray (10YR 6/1), fine to medium sand, wet.	SC									
			27 28 29	27 - 31' **SILT WITH SAND:** (ML)s, dark gray (7.5YR 4/1), sand (0-5%), moist.	(ML)s									
4 CS	120 105		30	30' coal fragments (0-5%).										
			31 32	31 - 40' **SILTY CLAY:** CL/ML, dark gray (7.5Y 4/1), organic material (0-5%), gravel (0-5%), stiff to very stiff, moist.	CL/ML									

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW393

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			33 34 35 36 37 38 39	31 - 40' **SILTY CLAY:** CL/ML, dark gray (7.5Y 4/1), organic material (0-5%), gravel (0-5%), stiff to very stiff, moist. *(continued)*	CL/ML									
5 CS	120 120		40 41 42 43 44 45 46 47 48 49	40 - 50' **SILT:** ML, grayish brown (2.5Y 5/2), very stiff to hard, platy, dry.	ML									
6 CS	120 92		50 51 52	50 - 55' **SILT:** ML, dark gray (7.5YR 4/1), sand (0-5%), very stiff to hard, dry.	ML									

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW393

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			53 54	50 - 55' **SILT:** ML, dark gray (7.5YR 4/1), sand (0-5%), very stiff to hard, dry. *(continued)*	ML									
			55 56	55 - 57' **CLAYEY SILT:** ML/CL, gray (10YR 6/1), sand (0-5%), gravel (0-5%), medium plasticity, moist.	ML/CL									
			57 58 59	57 - 60' **LIMESTONE:** BDX (LS), gray (10YR 6/1), rock flour and angular chips (<2").	BDX (LS)									
7 CORE	120 60		60 61 62 63 64 65 66 67 68 69	60 - 70' **SHALE:** BDX (SH), medium gray (N5), weathered, very weak, residual soil, soft, slightly fractured.	BDX (SH)									RUN #7: Modified RQD = (31/60) = 52%
8 CORE	42 40		70 71 72	70 - 73.5' **LIMESTONE:** BDX (LS), medium dark gray (N4), weathered, shaley, thinly bedded, moderately fractured.	BDX (LS)									RUN #8: Modified RQD = (32/40) = 80%

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW393

Page 5 of 5

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			73	70 - 73.5' **LIMESTONE:** BDX (LS), medium dark gray (N4), weathered, shaley, thinly bedded, moderately fractured. *(continued)* 72' medium gray (N5).	BDX (LS)									
9 CORE	78 40		74	73.5 - 85' **SHALE:** BDX (SH), medium gray (N5), weathered, moderately to slightly fractured, thinly laminated.										RUN #9: Modified RQD = (30/40) = 75%
			75											
			76											
			77											
			78											
			79		BDX (SH)									
10 CORE	60 45		80											RUN #10: Modified RQD = (34/45) = 76%
			81											
			82											
			83											
			84	83.5' more competent.										
			85	85' End of Boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Page 1 of 5

Facility/Project Name Baldwin Power Plant	License/Permit/Monitoring Number	Boring Number MW394

Boring Drilled By: Name of crew chief (first, last) and Firm Blake Weller Cascade Drilling	Date Drilling Started 9/25/2022	Date Drilling Completed 10/5/2022	Drilling Method Sonic
Common Well Name MW394	Final Static Water Level Feet (NAVD88)	Surface Elevation 435.51 Feet (NAVD88)	Borehole Diameter 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒

State Plane 558,123.63 N, 2,385,095.76 E E /[✓ W]

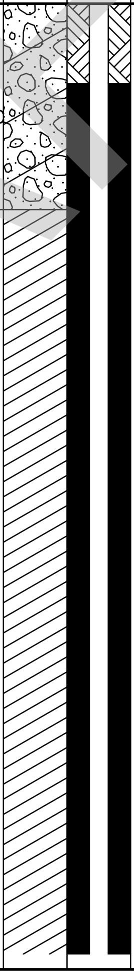
1/4 of 1/4 of Section , T N, R

Lat 38° 11' 56.8911"

Long -89° 51' 31.1756"

Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County Randolph	State IL	Civil Town/City/ or Village Baldwin



Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	72 67			0 - 2.6' **FILL, WELL-GRADED GRAVEL WITH CLAY:** GW-GC, brown (10YR 4/3), angular, moist.										CS= Core Sample
			1		(FILL) GW-GC									Measured Rock Quality Designation (RQD) was modified due to drilling methods, modified RQD equals the sum of recovered core sections greater than 4 inches in length divided by total core recovery.
			2											
			3	2.6 - 20' **LEAN CLAY:** CL, brown (10YR 5/3), reddish brown bottling (20%), sand (0-5%), low to medium plasticity, very stiff to hard, moist.					4					
			4											
			5						4					
2 CS	120 120		6						2.5					
			7		CL				3.5					
			8						2					
			9	9.2' brown (7.5YR 5/3), medium to high plasticity.					2					
			10						3					
			11						2.25					
			12											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Ramboll
234 W Florida Street, 5th Floor, Milwaukee, WI 53204
Tel: (414)837-3607
Fax: (414)837-3608

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number MW394

Page 2 of 5

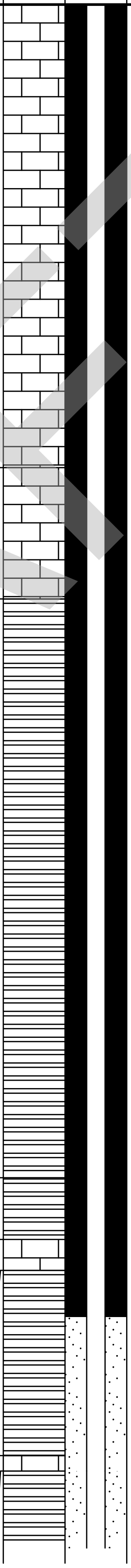
Sample										Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well	Diagram	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				2.6 - 20' **LEAN CLAY:** CL, brown (10YR 5/3), reddish brown bottling (20%), sand (0-5%), low to medium plasticity, very stiff to hard, moist. *(continued)*						2.25					
			13												
			14	14' low to medium plasticity.											
			15							2.5					
3 CS	120 120		16		CL										
			17	16.5' increasing sand and gravel content, gray (GLEY 1 5/1) iron concretions (50%).											
			18												
			19												
			20	20 - 22.1' **SILTY SAND:** SM, yellowish brown (10YR 5/6), fine sand, clay (0-5%), moist.											
			21		SM										
			22	22.1 - 36.8' **LEAN CLAY:** CL, dark yellowish brown (10YR 4/4), greenish gray (GLEY 1 5/10Y) and yellowish brown (10YR 5/6) mottling, sand (0-5%), medium to high plasticity, hard, moist.											
			23							4.5					
			24							4.5					
			25							4.5					
4 CS	120 112		26							4.5					
			27		CL					4.5					
			28							4.5					
			29							4.5					
			30							4.5					
			31							4.5					
			32							4.5					

Boring Number MW394

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
				22.1 - 36.8' **LEAN CLAY:** CL, dark yellowish brown (10YR 4/4), greenish gray (GLEY 1 5/10Y) and yellowish brown (10YR 5/6) mottling, sand (0-5%), medium to high plasticity, hard, moist. *(continued)*					3.75					
			33						4.25					
			34	34.4' olive yellow (5Y 6/6), low to medium plasticity.	CL									
			35						4.5					
5 CS	120 113		36											
			37	36.8 - 48' **Weathered SHALE Bedrock:** BDX (SH), pale olive (5Y 6/3), weathered, argillaceous, fissile, moist.										
			38											
			39											
			40	40' olive gray (5Y 5/2).										
			41											
			42		BDX (SH)									
			43											
			44											
			45											
6 CS	96 96		46											
			47											
			48	48 - 58' **LIMESTONE:** to **SHALE:** BDX (LS), olive gray (5Y 4/2), interbedded limestone and shale, fissile.										
			49											
			50	50' - 50.2' limestone, very strong.	BDX (LS)									
			51											
			52											

SOIL BORING LOG INFORMATION SUPPLEMENT

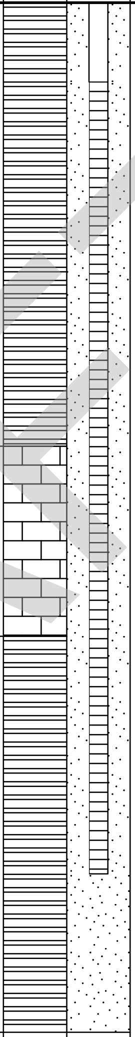
Boring Number MW394



Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
7 CS	48 48		53 54 55 56 57	48 - 58' **LIMESTONE:** to **SHALE:** BDX (LS), olive gray (5Y 4/2), interbedded limestone and shale, fissile. *(continued)* 53.7' - 53.9' limestone, very strong. 54' - 55.6' dark gray (10YR 4/1) to gray (10YR 5/1), more competent. 55.6' gray (10YR 6/1) to dark gray (10YR 4/1), more competent.	BDX (LS)									
8 CORE	18 14		58 59	58 - 59.7' **LIMESTONE:** BDX (LS), medium gray (N5), shaley, laminated, moderately fractured.	BDX (LS)									RUN #8: Modified RQD = (4/14) = 29%
9 CORE	60 60		60 61 62 63 64	59.7 - 68' **SHALE:** BDX (SH), medium dark gray (N4), weathered, very weak to weak, thinly bedded, moderately fractured.	BDX (SH)									RUN #9: Modified RQD = (48/60) = 80%
10 CORE	57 56		65 66 67	64.5 - 67.2' highly decomposed, weathered, wet.										RUN #10: Modified RQD = Not Recorded
			68	68 - 68.4' **LIMESTONE:** BDX (LS), light olive gray (5Y 6/2) to olive gray (5/2).	BDX (LS)									
			69	68.4 - 70.8' **SHALE:** BDX (SH), medium dark gray (N4), weathered, very weak to weak, thinly bedded, moderately fractured.	BDX (SH)									
11 CORE	68 68		70											RUN #11: Modified RQD = (42/68) = 62%
			71	70.8 - 71' **LIMESTONE:** BDX (LS), dark gray (N3), shaley.	BDX (LS)									
			72	71 - 77.6' **SHALE:** BDX (SH), dark gray (N3),										

Boring Number MW394

Sample		Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID 10.6 eV Lamp	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	
12 CORE	60 59		73 74 75 76 77	strong, thinly bedded, moderately fractured. 71 - 77.6' **SHALE:** BDX (SH), dark gray (N3), strong, thinly bedded, moderately fractured. *(continued)*	BDX (SH)									RUN #12: Modified RQD = (44/59) = 75%
			78 79	77.6 - 80' **LIMESTONE:** BDX (LS), medium gray (N5), shaley, weak, moderately fractured.	BDX (LS)									
13 CORE	60 48		80 81 82 83 84	80 - 85' **SHALE:** BDX (SH), medium dark gray (N4), weathered, weak, thinly bedded, moderately fractured, moist to wet.	BDX (SH)									RUN #13: Modified RQD = (40/48) = 83%
			85	85' End of Boring.										



ATTACHMENT 4

Analytical Laboratory Reports

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19218-NOV22**
Reference: Baldwin Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: MW-358 (13-15)	6: MW-358 (47-49)	7: MW-358 (86-88)	8: MW-392 (80-82)
Sample Date & Time					05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00
Ag [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	30	540	380	18
As [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	0.4	11	4.2	< 0.1
Be [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.02	0.06	0.05	< 0.02
B [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 1	8	10	3
Bi [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	21	300	140	75
Cd [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.01	0.04	0.86	0.02
Cr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.1	< 0.1	0.1	< 0.1
Fe [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	17	240	190	< 1
K [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	7	250	190	41
Li [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 2	< 2	< 2	< 2
Mg [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	9	210	150	19
Mn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	0.6	0.9	< 0.5
Mo [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.1	< 0.1	< 0.1	< 0.1
Na [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	65	1800	1600	850
Ni [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	1.2	< 0.5
P [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 3	6	< 3	< 3
Pb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.1	< 0.1	0.2	< 0.1
Si [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	100	950	750	59
Sb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.7	< 0.7	< 0.7	< 0.7
Sr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	0.1	13	5.9	1.4
Sn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	< 0.5	< 0.5
Ti [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	1.1	0.6	0.5	0.6
Tl [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.002	0.006	0.029	< 0.002
V [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 3	< 3	< 3	< 3
Zn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.7	< 0.7	< 0.7	< 0.7

Tessier Leach Fraction 1 - Water Soluble

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA19218-NOV22

Analysis	**9:** **MW-392 (32-33.5)**	**10:** **MW-393 (24-25.5)**	**11:** **MW-394 (20.5-22)**	**12:** **MW-392 (66-68)**
Sample Date & Time	27-Sep-22 09:00	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	33	26	24	59
As [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	0.5	0.3	0.3	0.3
Be [µg/g]	< 0.02	< 0.02	< 0.02	< 0.02
B [µg/g]	< 1	< 1	< 1	5
Bi [µg/g]	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	130	28	25	89
Cd [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	0.02	< 0.01	0.01	0.02
Cr [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Fe [µg/g]	27	14	20	28
K [µg/g]	16	9	12	92
Li [µg/g]	< 2	< 2	< 2	< 2
Mg [µg/g]	40	12	12	44
Mn [µg/g]	1.4	0.7	0.6	< 0.5
Mo [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Na [µg/g]	44	49	43	720
Ni [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
P [µg/g]	< 3	< 3	< 3	< 3
Pb [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Si [µg/g]	100	80	91	140
Sb [µg/g]	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7
Sr [µg/g]	0.3	< 0.1	< 0.1	1.8
Sn [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Ti [µg/g]	0.6	0.6	0.9	0.5
Tl [µg/g]	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	< 0.002	< 0.002	< 0.002	< 0.002
V [µg/g]	< 3	< 3	< 3	< 3
Zn [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7

`Water Soluble Fraction`

Catharine Arnold

CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

Tessier Leach Fraction 2 - Exchangeable Metals

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19219-NOV22**
Reference: Baldwin Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: MW-358 (13-15)	6: MW-358 (47-49)	7: MW-358 (86-88)	8: MW-392 (80-82)
Sample Date & Time					05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00
Ag [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	9	17	8	9
As [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	48	55	15	3.0
Be [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.02	< 0.02	< 0.02	< 0.02
B [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 1	< 1	1	< 1
Bi [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	2000	2500	1300	3500
Cd [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.01	< 0.01	0.58	0.24
Cr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 0.1	< 0.1	< 0.1	< 0.1
Fe [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	2	21	< 1	12
K [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	37	430	300	160
Li [µg/g]	19-Jan-23	23:42	31-Jan-23	09:43	< 2	< 2	< 2	< 2
Mn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	6.5	0.7	1.8	3.6
Mo [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.1	< 0.1	< 0.1	< 0.1
Na [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	45	3200	2600	420
Ni [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.5	< 0.5	< 0.5	0.7
Pb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.1	< 0.1	< 0.1	< 0.1
P [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 3	4	< 3	43
Sb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.7	< 0.7	< 0.7	< 0.7
Sn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	11	100	52	76
Ti [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	0.9	0.3	0.2	0.1
Tl [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.002	0.009	0.006	0.043
V [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 3	< 3	< 3	< 3
Zn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:44	< 0.7	< 0.7	< 0.7	< 0.7

Analysis	**9: MW-392 (32-33.5)**	**10: MW-393 (24-25.5)**	**11: MW-394 (20.5-22)**	**12: MW-392 (66-68)**
Sample Date & Time	27-Sep-22 09:00	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	10	12	12	10
As [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	16	16	10	4.3
Be [µg/g]	< 0.02	< 0.02	< 0.02	< 0.02
B [µg/g]	< 1	< 1	< 1	2
Bi [µg/g]	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	2500	1400	2100	3700
Cd [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	0.02	< 0.01	< 0.01	0.02
Cr [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Fe [µg/g]	8	9	8	10
K [µg/g]	44	35	60	360
Li [µg/g]	< 2	< 2	< 2	< 2
Mn [µg/g]	3.5	1.7	3.2	2.5
Mo [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Na [µg/g]	17	22	30	480
Ni [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Pb [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
P [µg/g]	< 3	< 3	4	< 3
Sb [µg/g]	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7
Sn [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	6.5	4.3	7.4	75
Ti [µg/g]	0.1	0.6	0.3	< 0.1
Tl [µg/g]	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	< 0.002	< 0.002	< 0.002	0.004
V [µg/g]	< 3	< 3	< 3	< 3
Zn [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7

`Fraction 2 Exchangeable Metals`

Catharine Arnold

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

Tessier Leach Fraction 3 - Metals Bound to Carbonates

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19220-NOV22**
Reference: Ramboll Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: MW-358 (13-15)	6: MW-358 (47-49)	7: MW-358 (86-88)	8: MW-392 (80-82)
Sample Date & Time					05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00
Ag [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	30	55	56	25
As [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	25	23	6.9	2.8
Be [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	0.09	0.10	0.07	0.03
B [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 1	2	3	4
Bi [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	110	1300	770	52000
Cd [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	0.04	0.02	2.3	1.0
Cr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	0.6	0.2	0.6	0.2
Fe [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	40	45	42	25
K [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	15	180	120	90
Li [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 2	< 2	< 2	< 2
Mn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	13	7.0	4.3	77
Mo [µg/g]	19-Jan-23	23:42	31-Jan-23	09:45	< 0.1	< 0.1	< 0.1	< 0.1
Ni [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.5	< 0.5	1.9	2.7
Pb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	0.2	0.1	0.9	1.9
P [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 3	13	< 3	100
Sb [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	96	160	150	33
Sn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	0.5	10	7.3	99
Ti [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	0.8	0.6	0.5	1.0
Tl [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	0.19	0.094	0.13	0.31
V [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 3	< 3	< 3	< 3
Zn [µg/g]	19-Jan-23	23:42	31-Jan-23	09:46	< 0.7	< 0.7	< 0.7	3.7

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Tessier Leach Fraction 3 - Metals Bound to Carbonates

LR Report : **CA19220-NOV22**

Analysis	**9: MW-392 (32-33.5)**	**10: MW-393 (24-25.5)**	**11: MW-394 (20.5-22)**	**12: MW-392 (66-68)**
Sample Date & Time	27-Sep-22 09:00	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Al [µg/g]	30	28	23	28
As [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	19	15	12	5.0
Be [µg/g]	0.06	0.04	0.04	0.07
B [µg/g]	< 1	< 1	< 1	3
Bi [µg/g]	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	1500	56	140	35000
Cd [µg/g]	< 0.05	< 0.05	< 0.05	< 0.05
Co [µg/g]	0.05	0.02	0.03	0.27
Cr [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Cu [µg/g]	0.8	0.2	0.2	0.6
Fe [µg/g]	9	14	10	300
K [µg/g]	16	10	15	130
Li [µg/g]	< 2	< 2	< 2	< 2
Mn [µg/g]	20	4.4	7.0	144
Mo [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1
Ni [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Pb [µg/g]	0.2	0.1	0.1	0.4
P [µg/g]	< 3	< 3	4	< 3
Sb [µg/g]	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	130	90	99	96
Sn [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	1.5	0.3	0.8	59
Ti [µg/g]	0.1	1.9	0.6	< 0.1
Tl [µg/g]	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	0.12	0.14	0.17	0.100
V [µg/g]	< 3	< 3	< 3	< 3
Zn [µg/g]	< 0.7	< 0.7	< 0.7	1.0

`Fraction 3 Metals Bound to Carbonates`

Catharine Arnold

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CATHARINE ARNOLD

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Tessier Leach Fraction 4 - Metals Bound to Fe and Mn Oxides

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19221-NOV22**
Reference: Baldwin Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Completed Date**	**4: Analysis Completed Time**	**5: MW-358 (13-15)**	**6: MW-358 (47-49)**	**7: MW-358 (86-88)**	**8: MW-392 (80-82)**	**9: MW-392 (32-33.5)**
Sample Date & Time			05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00	27-Sep-22 09:00
Ag [µg/g]	31-Jan-23	09:47	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Al [µg/g]	31-Jan-23	09:47	290	310	340	220	220
As [µg/g]	31-Jan-23	09:47	< 0.5	< 0.5	< 0.5	1.3	< 0.5
Ba [µg/g]	31-Jan-23	09:47	16	6.4	1.6	4.1	56
Be [µg/g]	31-Jan-23	09:47	0.26	0.16	0.15	0.15	0.21
B [µg/g]	31-Jan-23	09:47	< 1	5	6	6	< 1
Bi [µg/g]	31-Jan-23	09:47	< 0.09	< 0.09	< 0.09	0.14	< 0.09
Ca [µg/g]	31-Jan-23	09:47	71	320	250	130000	2300
Cd [µg/g]	31-Jan-23	09:47	< 0.05	< 0.05	< 0.05	0.13	0.18
Co [µg/g]	31-Jan-23	09:47	3.8	0.33	3.0	2.3	5.1
Cr [µg/g]	31-Jan-23	09:47	2.3	1.2	1.3	1.0	0.9
Cu [µg/g]	31-Jan-23	09:47	1.6	0.4	0.7	0.1	2.9
Fe [µg/g]	31-Jan-23	09:47	1600	1600	1200	1800	1100
K [µg/g]	31-Jan-23	09:47	16	140	110	43	19
Li [µg/g]	31-Jan-23	09:47	< 2	3	5	< 2	< 2
Mn [µg/g]	31-Jan-23	09:47	240	3.1	2.9	190	500
Mo [µg/g]	31-Jan-23	09:47	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Ni [µg/g]	31-Jan-23	09:47	3.1	2.7	4.5	6.5	3.1
Pb [µg/g]	31-Jan-23	09:47	3.3	0.2	1.2	8.4	3.7
P [µg/g]	31-Jan-23	09:47	19	110	77	400	31
Sb [µg/g]	31-Jan-23	09:47	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	31-Jan-23	09:47	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	31-Jan-23	09:47	920	910	710	270	600
Sn [µg/g]	31-Jan-23	09:47	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	31-Jan-23	09:47	0.4	3.1	2.8	237	1.7
Ti [µg/g]	31-Jan-23	09:47	0.4	0.1	0.3	< 0.1	< 0.1
Tl [µg/g]	31-Jan-23	09:47	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
U [µg/g]	31-Jan-23	09:47	0.26	0.068	0.17	0.62	0.15
V [µg/g]	31-Jan-23	09:47	5	< 3	< 3	< 3	3
Zn [µg/g]	31-Jan-23	09:47	2.9	1.9	1.9	13	3.8

Tessier Leach Fraction 4 - Metals Bound to Fe and Mn Oxides

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA19221-NOV22**

Analysis	**10: MW-393 (24-25.5)**	**11: MW-394 (20.5-22)**	**12: MW-392 (66-68)**
Sample Date & Time	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.01	0.02	< 0.01
Al [µg/g]	290	270	490
As [µg/g]	< 0.5	< 0.5	< 0.5
Ba [µg/g]	45	35	1.5
Be [µg/g]	0.16	0.18	0.18
B [µg/g]	< 1	< 1	4
Bi [µg/g]	< 0.09	< 0.09	0.14
Ca [µg/g]	100	350	7600
Cd [µg/g]	0.06	0.14	< 0.05
Co [µg/g]	4.3	3.5	0.62
Cr [µg/g]	1.2	1.2	2.0
Cu [µg/g]	1.5	2.0	0.9
Fe [µg/g]	1500	1200	2700
K [µg/g]	15	22	120
Li [µg/g]	< 2	< 2	2
Mn [µg/g]	380	260	63
Mo [µg/g]	< 0.1	< 0.1	< 0.1
Ni [µg/g]	3.2	3.7	2.5
Pb [µg/g]	3.5	2.1	0.9
P [µg/g]	17	91	110
Sb [µg/g]	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7
Si [µg/g]	660	850	650
Sn [µg/g]	< 0.5	< 0.5	< 0.5
Sr [µg/g]	0.5	1.3	26
Ti [µg/g]	0.3	0.2	0.2
Tl [µg/g]	< 0.02	< 0.02	< 0.02
U [µg/g]	0.12	0.18	0.082
V [µg/g]	< 3	5	< 3
Zn [µg/g]	4.3	7.8	2.8

`Fraction 4 Metals Bound to Fe and Mn Oxides`

Catharine Arnold

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Tessier Leach Fraction 5 - Bound to Organic Material

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19222-NOV22**
Reference: Baldwin Power plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Completed Date	4: Analysis Completed Time	5: MW-358 (13-15)	6: MW-358 (47-49)	7: MW-358 (86-88)	8: MW-392 (80-82)	9: MW-392 (32-33.5)
Sample Date & Time			05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00	27-Sep-22 09:00
Ag [µg/g]	31-Jan-23	09:48	0.14	0.15	0.08	0.07	0.06
Al [µg/g]	31-Jan-23	09:48	980	1300	1100	130	610
As [µg/g]	31-Jan-23	09:48	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Ba [µg/g]	31-Jan-23	09:48	15	11	1.8	3.6	36
Be [µg/g]	31-Jan-23	09:48	0.13	0.32	0.16	0.07	0.12
B [µg/g]	31-Jan-23	09:48	< 1	2	2	2	< 1
Bi [µg/g]	31-Jan-23	09:48	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09
Ca [µg/g]	31-Jan-23	09:48	160	490	220	8600	840
Cd [µg/g]	31-Jan-23	09:48	< 0.05	< 0.05	< 0.05	0.20	< 0.05
Co [µg/g]	31-Jan-23	09:48	1.4	0.45	9.7	3.3	1.3
Cr [µg/g]	31-Jan-23	09:48	2.1	1.0	1.2	< 0.5	1.6
Cu [µg/g]	31-Jan-23	09:48	0.5	1.0	1.8	1.9	0.4
Fe [µg/g]	31-Jan-23	09:48	150	610	1800	220	83
K [µg/g]	31-Jan-23	09:48	15	104	79	25	15
Li [µg/g]	31-Jan-23	09:48	< 2	< 2	3	< 2	< 2
Mg [µg/g]	31-Jan-23	09:48	170	1100	870	200	500
Mn [µg/g]	31-Jan-23	09:48	85	3.6	15	16	92
Mo [µg/g]	31-Jan-23	09:48	< 0.1	< 0.1	< 0.1	0.2	0.4
Na [µg/g]	31-Jan-23	09:48	110	180	150	90	75
Ni [µg/g]	31-Jan-23	09:48	1.9	4.3	13	15	2.1
Pb [µg/g]	31-Jan-23	09:48	1.6	0.1	1.6	3.8	1.3
P [µg/g]	31-Jan-23	09:48	< 3	< 3	< 3	290	5
Sb [µg/g]	31-Jan-23	09:48	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	31-Jan-23	09:48	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	31-Jan-23	09:48	590	480	420	130	530
Sn [µg/g]	31-Jan-23	09:48	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Sr [µg/g]	31-Jan-23	09:48	0.5	5.1	2.8	48	0.9
Ti [µg/g]	31-Jan-23	09:48	0.7	< 0.1	< 0.1	< 0.1	2.9
Tl [µg/g]	31-Jan-23	09:48	< 0.02	< 0.02	0.02	0.05	< 0.02
U [µg/g]	31-Jan-23	09:48	0.17	0.13	0.19	0.25	0.060
V [µg/g]	31-Jan-23	09:48	< 3	< 3	< 3	< 3	3
Zn [µg/g]	31-Jan-23	09:48	1.4	< 0.7	1.8	41	1.7

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Tessier Leach Fraction 5 - Bound to Organic Material

LR Report : **CA19222-NOV22**

Analysis	**10:** MW-393 (24-25.5)	**11:** MW-394 (20.5-22)	**12:** MW-392 (66-68)
Sample Date & Time	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.05	< 0.05	< 0.05
Al [µg/g]	660	870	820
As [µg/g]	< 0.5	< 0.5	< 0.5
Ba [µg/g]	33	45	1.5
Be [µg/g]	0.08	0.15	0.18
B [µg/g]	< 1	< 1	2
Bi [µg/g]	< 0.09	< 0.09	< 0.09
Ca [µg/g]	88	300	2400
Cd [µg/g]	< 0.05	< 0.05	< 0.05
Co [µg/g]	1.2	2.3	0.68
Cr [µg/g]	1.2	1.5	1.1
Cu [µg/g]	0.3	0.8	1.4
Fe [µg/g]	93	120	680
K [µg/g]	14	21	70
Li [µg/g]	< 2	< 2	< 2
Mg [µg/g]	150	280	730
Mn [µg/g]	100	164	15
Mo [µg/g]	0.1	0.3	< 0.1
Na [µg/g]	48	170	95
Ni [µg/g]	1.6	3.5	2.9
Pb [µg/g]	1.7	1.3	0.9
P [µg/g]	4	8	< 3
Sb [µg/g]	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7
Si [µg/g]	470	650	470
Sn [µg/g]	< 0.5	< 0.5	< 0.5
Sr [µg/g]	0.3	1.2	9.8
Ti [µg/g]	2.1	2.5	< 0.1
Tl [µg/g]	< 0.02	< 0.02	< 0.02
U [µg/g]	0.065	0.16	0.080
V [µg/g]	< 3	4	< 3
Zn [µg/g]	1.6	4.0	0.9

`Fraction 5 Bound to Organic Material`

Catharine Arnold

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0003245986

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19223-NOV22**
Reference: Baldwin Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Completed Date**	**4: Analysis Completed Time**	**5: MW-358 (13-15)**	**6: MW-358 (47-49)**	**7: MW-358 (86-88)**	**8: MW-392 (80-82)**	**9: MW-392 (32-33.5)**
Sample Date & Time			05-Oct-22 14:05	06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00	27-Sep-22 09:00
Ag [µg/g]	31-Jan-23	09:48	0.09	< 0.05	< 0.05	< 0.05	0.07
Al [µg/g]	31-Jan-23	09:48	44000	63000	71000	27000	45000
As [µg/g]	31-Jan-23	09:48	5.8	2.3	9.8	10	8.6
Ba [µg/g]	31-Jan-23	09:48	390	150	140	56	320
Be [µg/g]	31-Jan-23	09:48	0.65	1.4	1.5	0.68	0.87
B [µg/g]	31-Jan-23	09:48	13	60	62	26	21
Bi [µg/g]	31-Jan-23	09:48	0.25	0.26	0.18	0.14	0.25
Ca [µg/g]	31-Jan-23	09:48	2500	150	120	20000	1400
Cd [µg/g]	31-Jan-23	09:48	0.06	< 0.05	< 0.05	0.11	0.08
Co [µg/g]	31-Jan-23	09:48	3.3	7.2	6.4	2.0	6.4
Cr [µg/g]	31-Jan-23	09:48	34	69	75	37	40
Cu [µg/g]	31-Jan-23	09:48	10	9.9	5.7	7.2	15
Fe [µg/g]	31-Jan-23	09:48	22000	42000	22000	14000	28000
K [µg/g]	31-Jan-23	09:48	11000	18000	16000	5100	13000
Li [µg/g]	31-Jan-23	09:48	18	9	65	7	20
Mg [µg/g]	31-Jan-23	09:48	2700	7800	7600	4100	3300
Mn [µg/g]	31-Jan-23	09:48	110	70	51	50	130
Mo [µg/g]	31-Jan-23	09:48	0.9	0.3	0.1	0.1	0.9
Na [µg/g]	31-Jan-23	09:48	6700	560	830	550	5200
Ni [µg/g]	31-Jan-23	09:48	14	32	29	13	21
Pb [µg/g]	31-Jan-23	09:48	10	8.0	7.0	17	12
P [µg/g]	31-Jan-23	09:48	260	240	160	7200	300
Sb [µg/g]	31-Jan-23	09:48	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	31-Jan-23	09:48	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Si [µg/g]	31-Jan-23	09:48	160000	66000	51000	73000	65000
Sn [µg/g]	31-Jan-23	09:48	5.4	5.8	5.8	4.9	5.2
Sr [µg/g]	31-Jan-23	09:48	89	30	25	130	79
Ti [µg/g]	31-Jan-23	09:48	2400	670	570	520	980
Tl [µg/g]	31-Jan-23	09:48	0.47	0.42	0.42	0.17	0.51
U [µg/g]	31-Jan-23	09:48	1.3	0.30	0.99	2.7	1.1
V [µg/g]	31-Jan-23	09:48	54	73	86	95	57
Zn [µg/g]	31-Jan-23	09:48	37	47	32	43	53

Analysis	**10: MW-393 (24-25.5)**	**11: MW-394 (20.5-22)**	**12: MW-392 (66-68)**
Sample Date & Time	04-Oct-22 16:00	25-Sep-22 16:00	26-Sep-22 12:00
Ag [µg/g]	< 0.05	< 0.05	< 0.05
Al [µg/g]	33000	45000	59000
As [µg/g]	10	9.8	0.9
Ba [µg/g]	300	410	93
Be [µg/g]	0.56	0.83	1.2
B [µg/g]	15	16	53
Bi [µg/g]	0.18	0.27	0.20
Ca [µg/g]	1700	3000	170
Cd [µg/g]	< 0.05	0.11	< 0.05
Co [µg/g]	3.2	5.0	6.4
Cr [µg/g]	24	35	71
Cu [µg/g]	9.9	13	12
Fe [µg/g]	19000	27000	43000
K [µg/g]	12000	14000	17000
Li [µg/g]	13	16	19
Mg [µg/g]	2200	3400	9500
Mn [µg/g]	80	140	47
Mo [µg/g]	0.7	2.7	0.2
Na [µg/g]	5100	7700	490
Ni [µg/g]	13	18	31
Pb [µg/g]	9.1	13	4.1
P [µg/g]	230	460	170
Sb [µg/g]	< 0.8	< 0.8	< 0.8
Se [µg/g]	< 0.7	< 0.7	< 0.7
Si [µg/g]	61000	43000	62000
Sn [µg/g]	4.6	5.2	5.6
Sr [µg/g]	70	110	22
Ti [µg/g]	780	1100	560
Tl [µg/g]	0.35	0.50	0.36
U [µg/g]	0.61	1.1	0.097
V [µg/g]	35	57	70
Zn [µg/g]	37	54	48

`Fraction 6 Residual metals`

Catharine Arnold

CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Trace Metals - Aqua Regia Digest, ICP-MS

28-February-2023

Ramboll Americas Engineering Solutions, Inc.
Attn : Evvan Plank

P.O# Box 4873
Syrascuse, New York
13221-7873, USA

Phone: 315-463-7554
Fax:

Date Rec. : 24 November 2022
LR Report: **CA19224-NOV22**
Reference: Baldwon Power Plant Drilling

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Completed Date**	**4: Analysis Completed Time**	**6: MW-358 (47-49)**	**7: MW-358 (86-88)**	**8: MW-392 (80-82)**	**12: MW-392 (66-68)**
Sample Date & Time					06-Oct-22 15:00	08-Oct-22 18:00	26-Sep-22 16:00	26-Sep-22 12:00
Hg MS [ug/g]	09-Dec-22	16:29	12-Dec-22	15:05	< 0.05	< 0.05	< 0.05	< 0.05
As [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	2.1	11	17	1.0
B [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	11	16	16	13
Ba [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	140	45	40	21
Be [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	0.85	0.67	0.85	0.70
Cd [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	< 0.02	< 0.02	0.36	0.09
Co [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	4.4	23	12	6.2
Cr [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	9.5	12	17	16
Li [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	6	20	8	15
Mo [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	0.3	0.3	0.3	0.3
Pb [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	5.7	9.6	17	4.9
Se [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	< 0.7	< 0.7	1.4	< 0.7
Tl [µg/g]	09-Dec-22	16:29	12-Dec-22	15:05	0.05	0.06	0.04	0.03

Catharine Arnold

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Environmental Services*
Project Number/ LIMS No.	*Custom XRD/MI4508-DEC22*
Sample Receipt:	*December 7, 2022*
Sample Analysis:	*December 15, 2022*
Reporting Date:	*December 21, 2022*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 35 kV, 40 mA; Detector: LYNXEYE Regular Scanning: Step: 0.02°, Step time: 0.75s, 2θ range: 6-80°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

ACCREDITATION: SGS Natural Resources Lakefield is accredited to the requirements of ISO/IEC 17025 for specific tests as listed on our scope of accreditation, including geochemical, mineralogical and trade mineral tests. To view a list of the accredited methods, please visit the following website and search SGS Canada Inc. - Minerals: https://www.scc.ca/en/search/palcan.

Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Natural Resources is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	MW-358 (13-15) DEC4508-01 (wt %)	MW-358 (47-49) DEC4508-02 (wt %)	MW-358 (86-88) DEC4508-03 (wt %)	MW-392 (80-82) DEC4508-04 (wt %)
Quartz	58.9	33.0	34.9	29.1
Muscovite	11.2	37.6	30.5	14.5
Albite	13.3	8.2	3.4	1.0
Microcline	5.3	9.4	8.1	2.9
Chlorite	10.8	-	-	6.8
Diaspore	0.5	-	-	-
Pyrite	-	1.0	0.8	1.2
Kaolinite	-	9.0	18.4	8.2
Calcite	-	1.8	1.7	31.5
Anatase	-	-	2.1	0.4
Leucite	-	-	-	2.4
Siderite	-	-	-	1.9
Dolomite	-	-	-	-
Gypsum	-	-	-	-
Diopside	-	-	-	-
TOTAL	100	100	100	100

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

Mineral/Compound	Formula
Quartz	SiO_2
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Albite	$NaAlSi_3O_8$
Microcline	$KAlSi_3O_8$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Diaspore	aAlO.OH
Pyrite	FeS_2
Kaolinite	$Al_2Si_2O_5(OH)_4$
Calcite	$CaCO_3$
Anatase	TiO_2
Leucite	$KAlSi_2O_6$
Siderite	$FeCO_3$
Dolomite	$CaMg(CO_3)_2$
Gypsum	$CaSO_4 \cdot 2H_2O$
Diopside	$CaMgSi_2O_6$

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	MW-392 (32-33.5) DEC4508-05 (wt %)	MW-393 (24-25.5) DEC4508-06 (wt %)	MW-394 (20.5-22) DEC4508-07 (wt %)	MW-392 (66-68) DEC4508-08 (wt %)
Quartz	53.5	68.2	54.9	27.2
Muscovite	13.1	13.0	11.7	29.7
Albite	8.5	7.4	13.1	4.5
Microcline	6.8	9.5	6.7	6.9
Chlorite	7.0	-	7.0	16.3
Diaspore	-	-	-	-
Pyrite	-	0.3	0.3	-
Kaolinite	7.5	-	5.0	-
Calcite	-	-	-	14.8
Anatase	-	-	-	0.7
Leucite	-	-	-	-
Siderite	-	-	-	-
Dolomite	1.2	-	-	-
Gypsum	0.4	-	-	-
Diopside	1.7	1.6	1.4	-
TOTAL	100	100	100	100

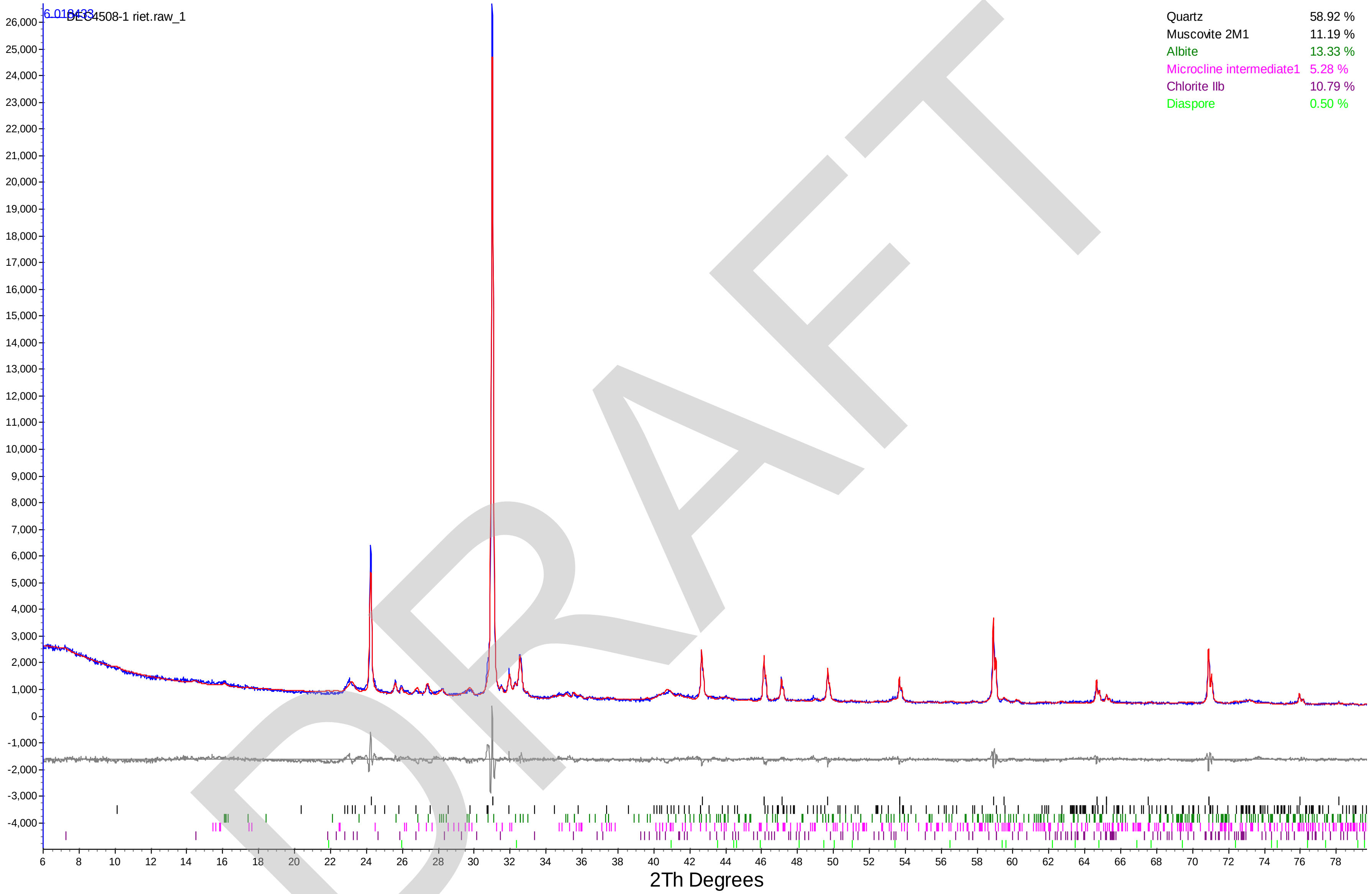
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

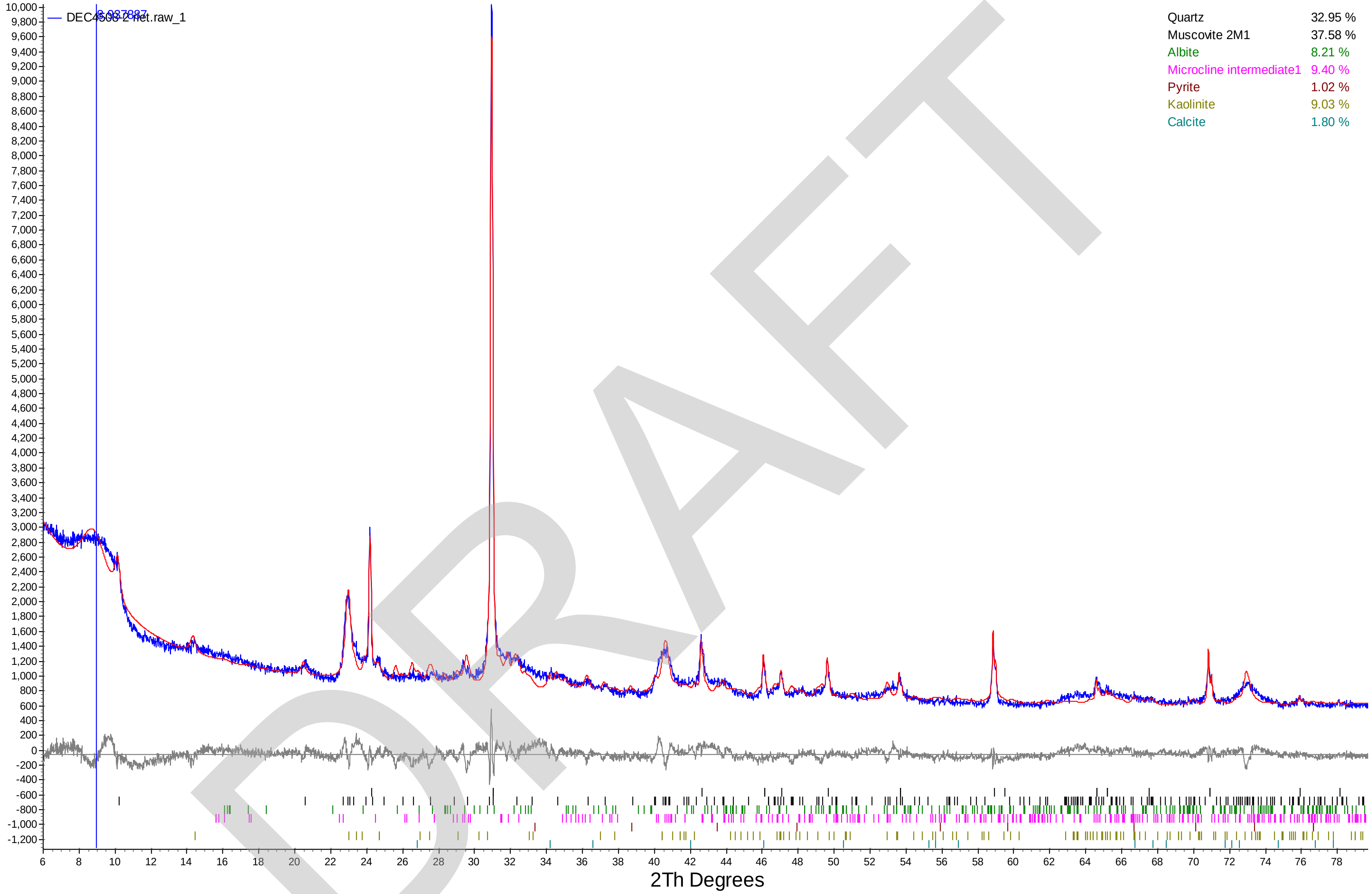
The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

Mineral/Compound	Formula
Quartz	SiO_2
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Albite	$NaAlSi_3O_8$
Microcline	$KAlSi_3O_8$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Diaspore	aAlO.OH
Pyrite	FeS_2
Kaolinite	$Al_2Si_2O_5(OH)_4$
Calcite	$CaCO_3$
Anatase	TiO_2
Leucite	$KAlSi_2O_6$
Siderite	$FeCO_3$
Dolomite	$CaMg(CO_3)_2$
Gypsum	$CaSO_4 \cdot 2H_2O$
Diopside	$CaMgSi_2O_6$

MW-358 (13-15)

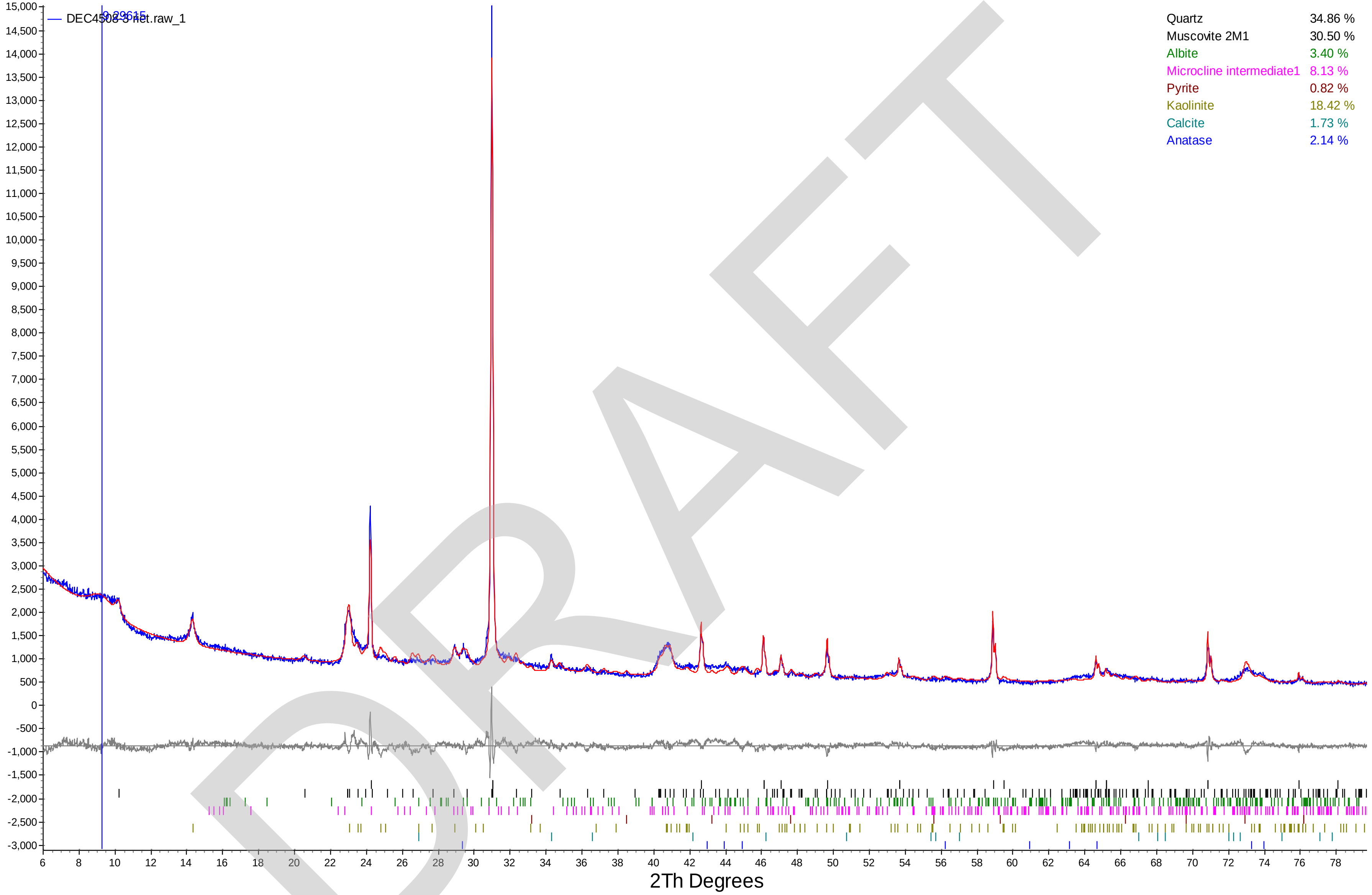

6.018433
DEC4508-1 riet.raw_1
Quartz 58.92 %
Muscovite 2M1 11.19 %
Albite 13.33 %
Microcline intermediate1 5.28 %
Chlorite IIb 10.79 %
Diaspore 0.50 %
26,000
25,000
24,000
23,000
22,000
21,000
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
76
78
2Th Degrees

MW-358 (47-49)



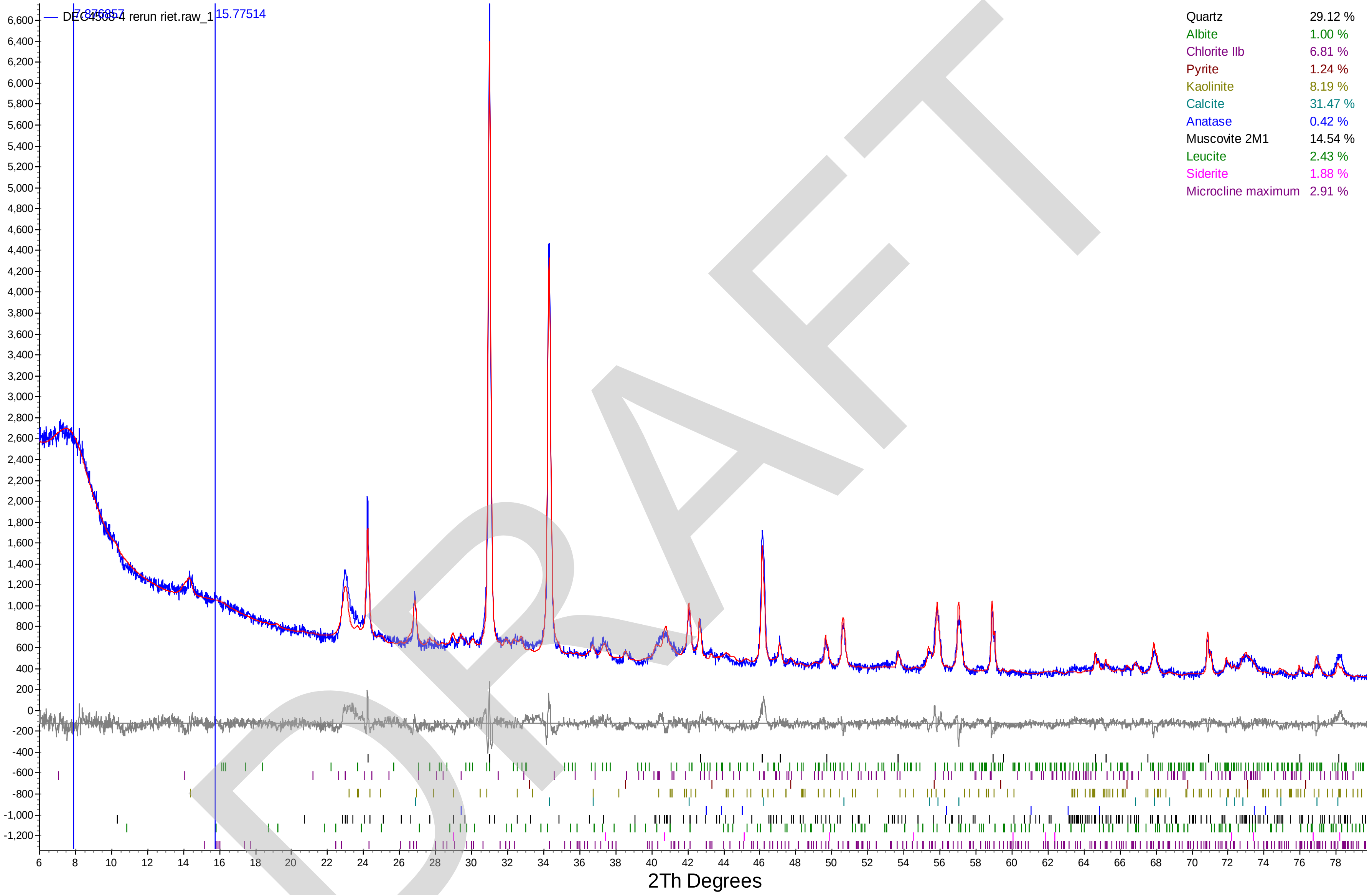
Quartz	32.95 %
Muscovite 2M1	37.58 %
Albite	8.21 %
Microcline intermediate1	9.40 %
Pyrite	1.02 %
Kaolinite	9.03 %
Calcite	1.80 %

MW-358 (86-88)



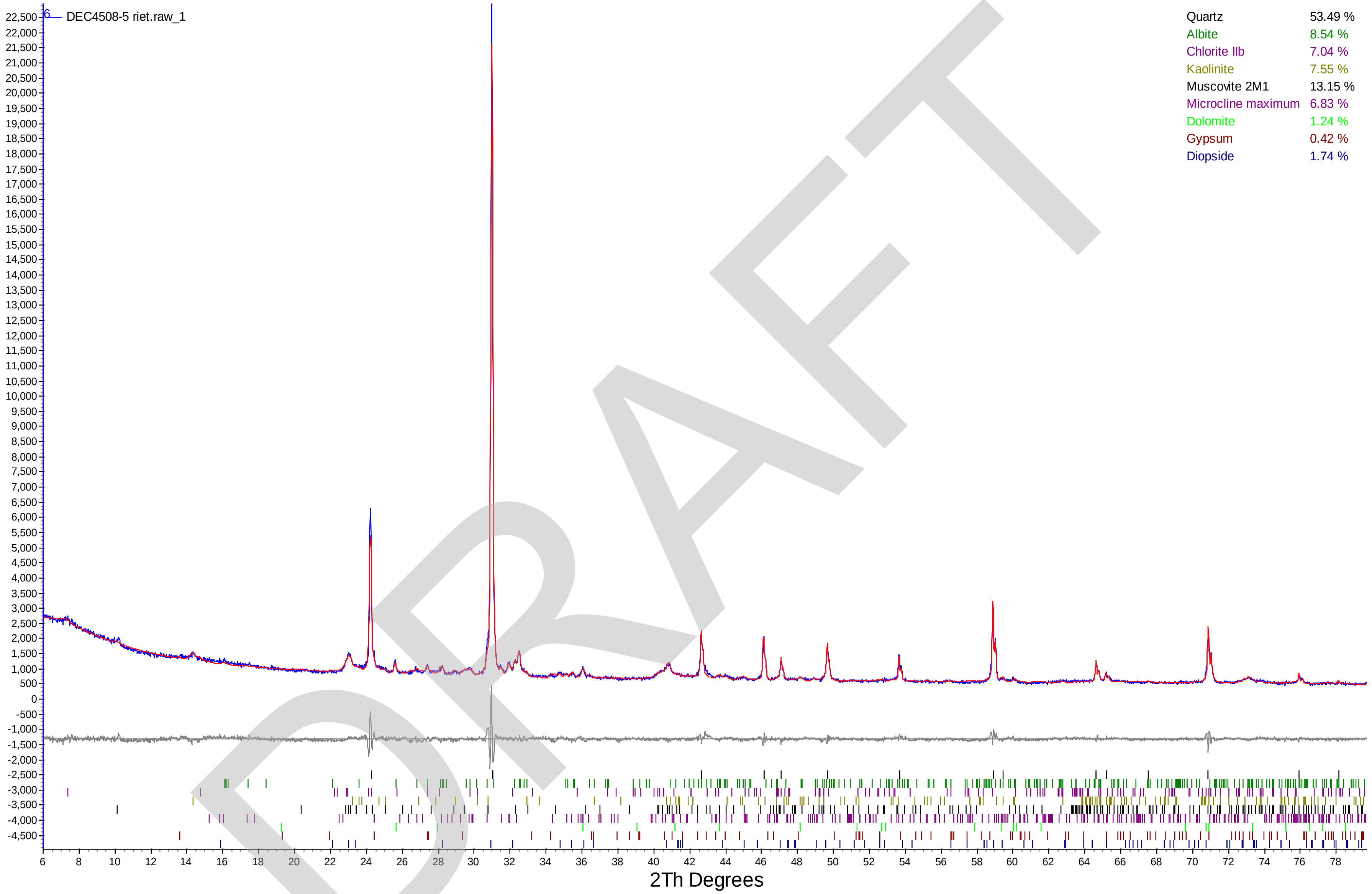
Quartz	34.86 %
Muscovite 2M1	30.50 %
Albite	3.40 %
Microcline intermediate1	8.13 %
Pyrite	0.82 %
Kaolinite	18.42 %
Calcite	1.73 %
Anatase	2.14 %

MW-392 (80-82)



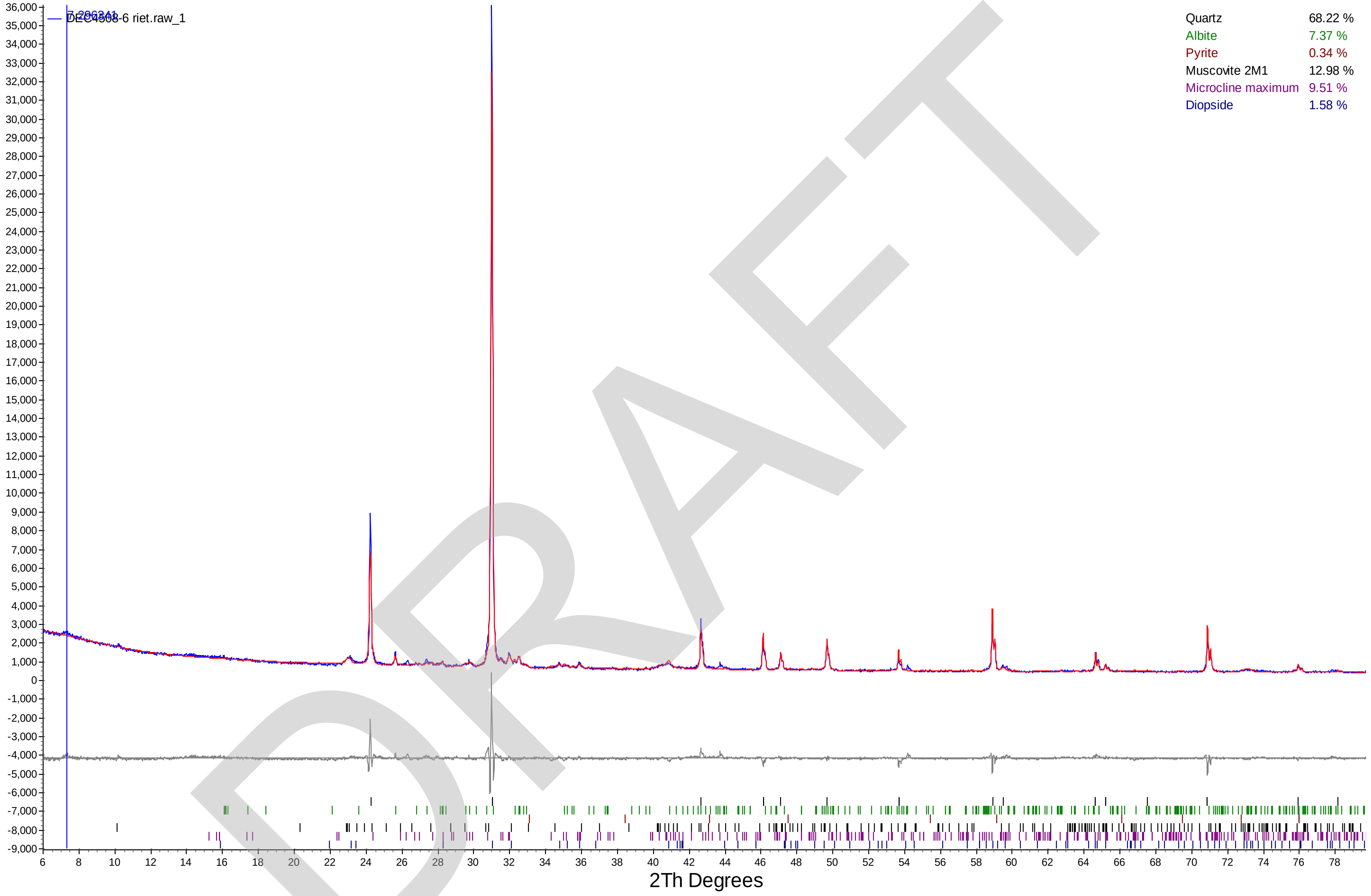
Quartz	29.12 %
Albite	1.00 %
Chlorite IIb	6.81 %
Pyrite	1.24 %
Kaolinite	8.19 %
Calcite	31.47 %
Anatase	0.42 %
Muscovite 2M1	14.54 %
Leucite	2.43 %
Siderite	1.88 %
Microcline maximum	2.91 %

MW-392 (32-33.5)

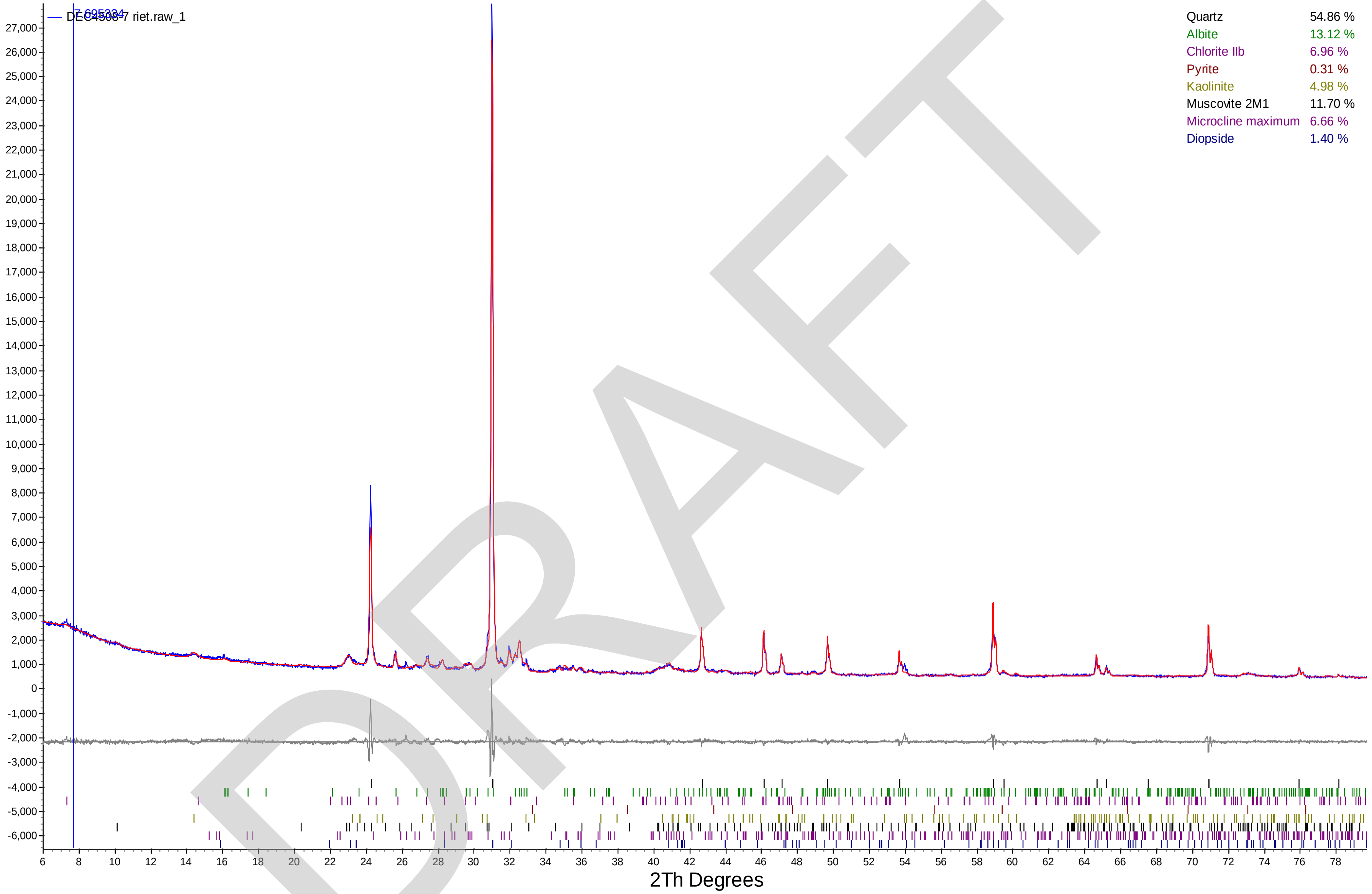

DEC4508-5 riet.raw_1
Quartz 53.49 %
Albite 8.54 %
Chlorite IIb 7.04 %
Kaolinite 7.55 %
Muscovite 2M1 13.15 %
Microcline maximum 6.83 %
Dolomite 1.24 %
Gypsum 0.42 %
Diopside 1.74 %
22,500
22,000
21,500
21,000
20,500
20,000
19,500
19,000
18,500
18,000
17,500
17,000
16,500
16,000
15,500
15,000
14,500
14,000
13,500
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
-2,500
-3,000
-3,500
-4,000
-4,500
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
76
78
2Th Degrees

Environmental Services
Custom XRD/MI4508-DEC22
21-Dec-22

MW-393 (24-25.5)

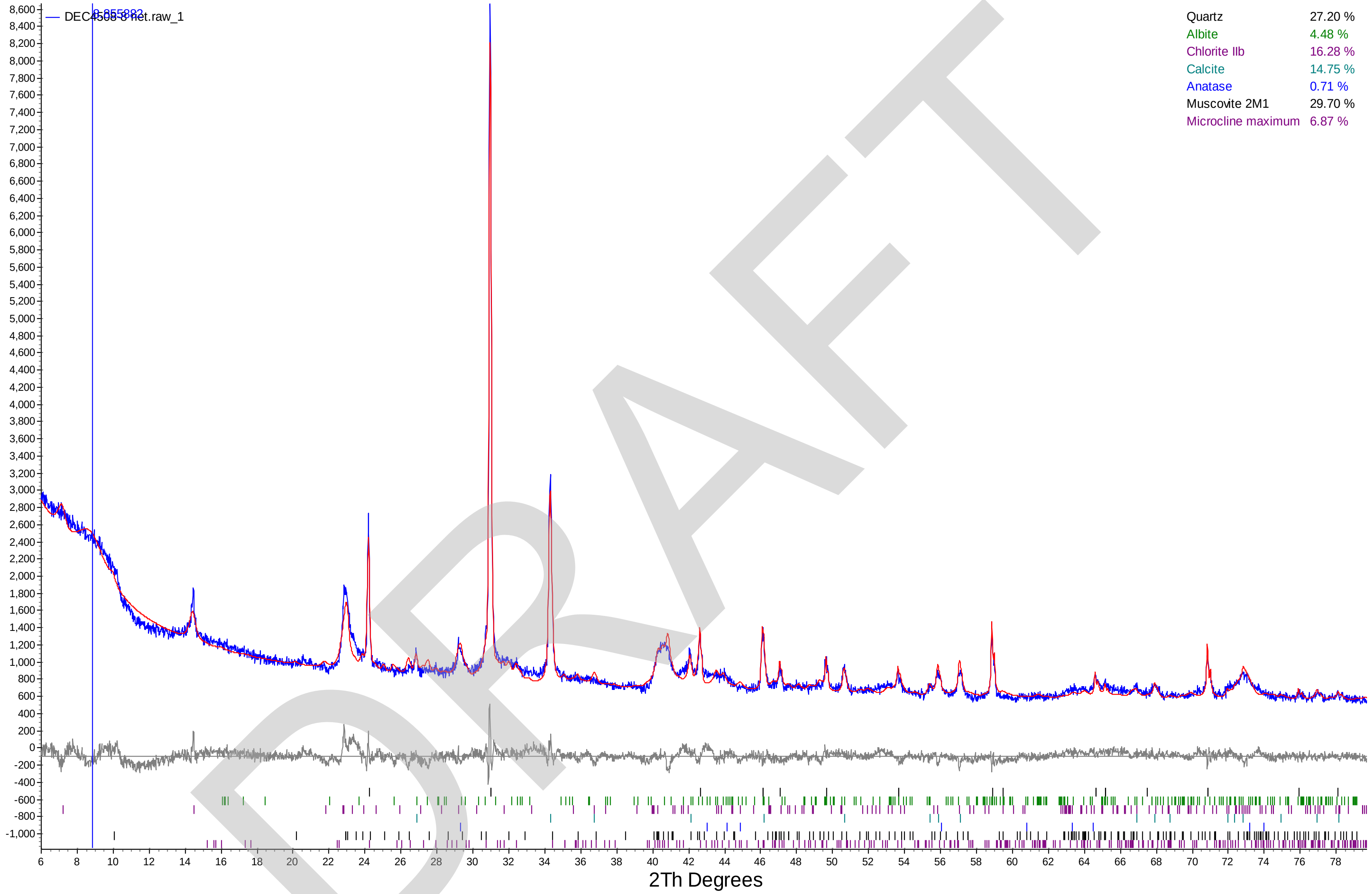


MW-394 (20.5-22)



Quartz	54.86 %
Albite	13.12 %
Chlorite IIb	6.96 %
Pyrite	0.31 %
Kaolinite	4.98 %
Muscovite 2M1	11.70 %
Microcline maximum	6.66 %
Diopside	1.40 %

MW-392 (66-68)



Quartz	27.20 %
Albite	4.48 %
Chlorite IIb	16.28 %
Calcite	14.75 %
Anatase	0.71 %
Muscovite 2M1	29.70 %
Microcline maximum	6.87 %

APPENDIX C
MODFLOW, HELP MODEL, AND FLUX EVALUATION DATA EXPORT FILES (ELECTRONIC ONLY)

APPENDIX D
HELP MODEL OUTPUT FILES

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Slopes **Simulated On:** 1/6/2023 7:23

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness = 6 inches
Porosity = 0.445 vol/vol
Field Capacity = 0.393 vol/vol
Wilting Point = 0.277 vol/vol
Initial Soil Water Content = 0.3673 vol/vol
Effective Sat. Hyd. Conductivity = 1.90E-06 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness = 18 inches
Porosity = 0.452 vol/vol
Field Capacity = 0.411 vol/vol
Wilting Point = 0.311 vol/vol
Initial Soil Water Content = 0.3948 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-06 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness = 0.2 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.01 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E+01 cm/sec
Slope = 25 %
Drainage Length = 150 ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness = 231.72 inches
Porosity = 0.578 vol/vol
Field Capacity = 0.076 vol/vol
Wilting Point = 0.025 vol/vol
Initial Soil Water Content = 0.076 vol/vol
Effective Sat. Hyd. Conductivity = 5.29E-04 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 91.1
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 21.39 acres
Evaporative Zone Depth = 18 inches
Initial Water in Evaporative Zone = 6.845 inches
Upper Limit of Evaporative Storage = 8.094 inches
Lower Limit of Evaporative Storage = 5.394 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 26.923 inches
Total Initial Water = 26.923 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 38.18 Degrees
Maximum Leaf Area Index = 4.5
Start of Growing Season (Julian Date) = 104 days

End of Growing Season (Julian Date) = 285 days
Average Wind Speed = 8 mph
Average 1st Quarter Relative Humidity = 72 %
Average 2nd Quarter Relative Humidity = 64 %
Average 3rd Quarter Relative Humidity = 71 %
Average 4th Quarter Relative Humidity = 72 %

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Slopes
Simulated on: 1/6/2023 7:24

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	3,234,836.6	100.00
Runoff	16.562	[3.613]	1,285,952.1	39.75
Evapotranspiration	24.541	[2.705]	1,905,475.7	58.90
Subprofile1				
Lateral drainage collected from Layer 3	0.5339	[0.485]	41,451.4	1.28
Percolation/leakage through Layer 4	0.000007	[0.000006]	0.5720	0.00
Average Head on Top of Layer 4	0.0002	[0.0002]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000007	[0.000007]	0.5716	0.00
Water storage				
Change in water storage	0.0252	[0.7492]	1,956.9	0.06

* Note: Average inches are converted to volume based on the user-specified area.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Top

Simulated On: 1/6/2023 7:18

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness = 6 inches
Porosity = 0.445 vol/vol
Field Capacity = 0.393 vol/vol
Wilting Point = 0.277 vol/vol
Initial Soil Water Content = 0.3673 vol/vol
Effective Sat. Hyd. Conductivity = 1.90E-06 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness = 18 inches
Porosity = 0.452 vol/vol
Field Capacity = 0.411 vol/vol
Wilting Point = 0.311 vol/vol
Initial Soil Water Content = 0.3951 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-06 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
16 oz Nonwoven Geotextile
Material Texture Number 43

Thickness = 0.11 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.01 vol/vol
Effective Sat. Hyd. Conductivity = 3.00E-01 cm/sec
Slope = 2 %
Drainage Length = 600 ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness = 545.28 inches
Porosity = 0.578 vol/vol
Field Capacity = 0.076 vol/vol
Wilting Point = 0.025 vol/vol
Initial Soil Water Content = 0.076 vol/vol
Effective Sat. Hyd. Conductivity = 5.29E-04 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 89.8
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 53.73 acres
Evaporative Zone Depth = 18 inches
Initial Water in Evaporative Zone = 6.849 inches
Upper Limit of Evaporative Storage = 8.094 inches
Lower Limit of Evaporative Storage = 5.394 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 50.759 inches
Total Initial Water = 50.759 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 38.18 Degrees
Maximum Leaf Area Index = 4.5
Start of Growing Season (Julian Date) = 104 days

End of Growing Season (Julian Date) = 285 days
Average Wind Speed = 8 mph
Average 1st Quarter Relative Humidity = 72 %
Average 2nd Quarter Relative Humidity = 64 %
Average 3rd Quarter Relative Humidity = 71 %
Average 4th Quarter Relative Humidity = 72 %

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Top
Simulated on: 1/6/2023 7:19

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	8,125,655.5	100.00
Runoff	16.544	[3.658]	3,226,692.1	39.71
Evapotranspiration	24.605	[2.679]	4,798,963.4	59.06
Subprofile1				
Lateral drainage collected from Layer 3	0.4260	[0.3581]	83,079.3	1.02
Percolation/leakage through Layer 4	0.061216	[0.074113]	11,939.6	0.15
Average Head on Top of Layer 4	0.7474	[0.9614]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000239	[0.000259]	46.6	0.00
Water storage				
Change in water storage	0.0865	[0.7368]	16,874.2	0.21

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX E
FLUX EVALUATION DATA

APPENDIX E. FLUX EVALUATION DATA
GROUNDWATER MODELING REPORT
BALDWIN POWER PLANT
BOTTOM ASH POND
BALDWIN, ILLINOIS

Calibration Model

Model	**Years (Model Period)**	**HSU**	**Total Flux In[1] (ft^3/d)**	**Total Flux In (gpm)**	
Calibration Model	53	CCR	2098.27	10.90	
Model	**Years (Model Period)**	**HSU**	**Total Flux Out[1] (ft^3/d)**	**Total Flux Out (gpm)**	
Calibration Model	53	CCR	-652.13	-3.39	
Model	**Model Period**	**Boundary Condition**	**Total Flux Out[1] (ft^3/d)**	**Total Flux Out (gpm)**	
Calibration Model	53	Constant Head (Stormwater Management within Active BAP)	-1420.44	-7.38	

Scenario: CIP (CCR removal from the western areas of the BAP, consolidation to the southeast, and eventually northeastern portions of the BAP, and construction of a cover system over the remaining CCR)

Prediction Model	**Years (Post-Construction Period)**	**HSU**	**Total Flux In[1] (ft^3/d)**	**Total Flux In (gpm)**	**Reduction in Flux In Post Closure[2] (Percentage, %)**
CIP	93	CCR	108.27	0.56	95%
Prediction Model	**Years (Post-Construction Period)**	**HSU**	**Total Flux Out[1] (ft^3/d)**	**Total Flux Out (gpm)**	**Reduction in Flux Out Post Closure[2] (Percentage, %)**
CIP	93	CCR	-135.25	-0.70	93%

[O: JJW 1/5/23; C: EGP 1/6/23; C: BGH 1/19/23; U: JJW 5/17/23 C: EGP 5/23/23]

Notes:

1. Reduction in flux as compared to flux at the end of calibration model (model period of 53 years) including flux through constant head boundary conditions in the calibration model when applicable (flux out).
2. Total flux in and out source data provided in flux calculation data files included in Appendix C.

BAP = Bottom Ash Pond
CCR = coal combustion residuals
CIP = closure in place
HSU = Hydrostratigraphic Unit
% = percentage
ft^3/d = cubic feet per day
gpm = gallons per minute