REPORT

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Will County Generating Station
Romeoville, Illinois

Submitted to:

KPRG and Associates, Inc.
14665 W. Lisbon Road, Suite 1A
Brookfield, WI 53005

and:

Midwest Generation, LLC
Will County Generating Station
529 East Romeo Road
Romeoville, IL 60446

Prepared by:

BAS Groundwater Consulting Inc.
3649 Evergreen Parkway Ste 1510
Evergreen, Colorado 80437
+1 720 334-8249

May 8, 2023

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Author:
Betsy Semmens, RG
President/BAS Groundwater Consulting Inc.

Contributor:
Dacey Zelman-Fahm
Senior GIS Analyst/*BAS Groundwater Consulting Inc.*
Rochelle Destrampe, RG
Senior Hydrogeologist/*BAS Groundwater Consulting Inc.*

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Midwest Generation, LLC

KPRG and Associates, Inc.

Illinois Environmental Protection Agency (IEPA)

Executive Summary

This report documents the results of a numerical groundwater modeling analysis of groundwater flow in the vicinity of the four inactive ash ponds at the Midwest Generation, LLC (Midwest Generation) Will County Generating Station (Will Co Station). The purpose of the numerical groundwater modeling was to create a tool capable of evaluating groundwater flow paths in the vicinity of the ash ponds and to provide a platform upon which proposed engineering scenarios for closure can be overlain and evaluated for their short and long-term effectiveness relative to improvements of groundwater quality. The results of the modeling are intended for input into the engineering considerations and evaluations of various closure alternatives being evaluated for Will Co Station. This modeling is a requirement under Illinois Administrative Code Title 35 Part 845.220(d)(3).

The model has a uniform grid spacing of 50 ft and has four layers. The groundwater flow model was run in the software MODFLOW-NWT and the transport model was run with the software MT3D-USGS. The model represents the regional flow direction to the Des Plaines River to the west and the Chicago Sanitary and Ship Canal to the east, with no-flow boundaries on the north and south sides of the model.

The model was calibrated to water levels measured in monitoring wells upgradient and downgradient of the four ash ponds (Ash Ponds 1N, 1S, 2S, and 3S). The model achieved a good calibration, with a scaled root mean squared error of less than 10 percent. The model was the most sensitive to the modeled values of hydraulic conductivity, vertical anisotropy, and the regional recharge rate.

To meet the modeling requirements of Part 845.220(d)(3), a hypothetical initial situation was created in which a constant surrogate mass (relative concentration of “1”) was modeled at the four ash ponds and allowed to discharge freely to groundwater. The resulting hypothetical distribution of concentrations served as the initial concentrations to four predictive scenarios of closure alternatives. In summary, the predictive modeling results indicate that all four evaluated alternatives for closure of the ash ponds resulted in improvement to groundwater quality. For any parameter detections above proposed GWPSs, all four closure alternatives were found to reduce impacts to below the respective proposed GWPS. All alternatives also have a good overall long-term performance.

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Table of Abbreviations

Abbreviation	Definition
ADAMP	Adaptive damping
af/yr	Acre-feet per year
amsl	Above mean sea level
bgs	Below ground surface
CCR	Coal Combustion Residuals
State CCR Rule	Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments, Section 845.220(d)(3)
CSSC	Chicago Sanitary and Ship Canal
cfd	Cubic feet per day
cm/s	Centimeters per second
ft	Feet
ft/ft	Feet per foot
ft/d	Feet per Day
ft^2	Feet squared
ft^2/d	Feet or foot squared per day
GHB	General Head Boundary
GIS	Geographic information systems
gpm	Gallons per minute
GWPS	Groundwater protection standards
HCLOSEXMD	Head change closure criterion
HFB	Horizontal flow barrier
in/yr	Inches per year
ISGS	Illinois State Geological Survey
ILWATER	Illinois Water Well Database
K	Hydraulic conductivity
Kh	Horizontal hydraulic conductivity
Kv	Vertical hydraulic conductivity
LINMETH	Linear solution method

Abbreviation	Definition
MAP	Mean annual precipitation
Midwest Generation	Midwest Generation LLC
mg/l	Milligrams per liter
PCGn	Preconditioned conjugate gradient
phi	Sum of squared residuals
RMS	Root Mean Square
Will Co Station	Will County Generating Station
%	Percent

1.0 INTRODUCTION

This report documents the results of a numerical groundwater modeling analysis of groundwater flow in the vicinity of the on-site Ash Ponds 1 North (1N), 1 South (1S), 2 South (2S) and 3 South (3S) at the Midwest Generation, LLC (Midwest Generation) Will County Generating Station (Will Co Station). The numerical groundwater flow and transport modeling was conducted as required under the Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (State CCR Rule) Section 845.220(d)(3).

2.0 BACKGROUND

Will County Station is an inactive coal power generating station located on the eastern bank of the Des Plaines River in Section 2, Township 36 North, Range 10 East, in the City of Romeoville, Will County, Illinois. As noted above, there are four ash ponds at the site (1N, 1S, 2S and 3S) all of which are inactive at this time. The locations of the facility and ash ponds are shown on Figure 1. Will County Station is bordered by Romeo Road and vacant land to the north, the Des Plaines River to the west, a rock quarry to the south, and the Chicago Sanitary and Ship Canal (CSSC) to the east (Figure 2). There are 15 monitoring wells located on site, The groundwater monitoring program for pond 1N consists of five wells with wells MW-01 and MW-02 being upgradient monitoring points and wells MW-07, MW-14 and MW-15 being downgradient monitoring points. The groundwater monitoring program for pond 1S also consists of five wells with MW-03 and MW-04 being the upgradient monitoring points and wells MW-08, MW-09 and MW-13 being downgradient monitoring points. The monitoring well network for the combined Ponds 2S and 3S consists of six monitoring points with wells MW-05 and MW-06 being upgradient monitoring wells and wells MW-09, MW-10, MW-11 and MW-12 being downgradient monitoring points. It is noted that monitoring well MW-09 is a common downgradient well for the Pond 1S network and the combined ponds 2S and 3S network. The locations of site monitor wells are shown on Figure 2.

The purpose of the numerical groundwater modeling was to create a tool capable of evaluating groundwater flow paths near the ash ponds and to estimate changes to monitored constituent concentrations at the Will County site from pond closure alternatives being evaluated.

3.0 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Section 4.0: Conceptual Model – This section provides information that was used to refine the conceptual model of groundwater flow at Will County Station. The conceptual model formed the basis for construction and calibration of the numerical model.
- Section 5.0: Numerical Groundwater Flow Model – This section provides a description of the numerical model construction, calibration, and sensitivity analysis. The calibrated groundwater flow model was used as the basis to conduct predictive analyses of closure construction activities.

- Section 6.0: Predictive Model Simulations – This section provides results of predictive analyses that were used to evaluate changes to the water table, groundwater flow paths, and contaminant concentrations beneath and adjacent to the ash ponds under multiple closure alternatives.
- Section 7.0: Conclusions – This section provides a summary of the modeling and predictive analysis.
- Section 8.0: References – This section provides a list of references used in the analysis documented in this report.

Figures and tables follow the main text of the report.

4.0 CONCEPTUAL MODEL

Site data were compiled as part of this modeling study and used to update the conceptual model of groundwater flow at Will Co Station. The numerical model was constructed to represent the updated conceptual model.

Components of the conceptual model of groundwater flow include:

- climate
- lithology and geologic framework
- aquifer properties
- nature of groundwater flow
- water budget

Each of these components of the conceptual model is presented below.

4.1 Climate

Will Co Station is located within the humid continental climate zone with warm to hot and humid summers and cold and snowy winters. The Romeoville Forecast Office weather station is located relatively near Will Co Station (see Figure 3) and provides data to evaluate long-term trends in precipitation. Precipitation data from this station was averaged for monthly and annual averages and are provided in Table 1. Long-term average monthly precipitation has ranged from just over 2 inches in January and February to over 4 inches in late Spring and Summer (April through August). The long-term mean annual precipitation (MAP) from these data is 42 inches.

4.2 Geology

The geology at Will Co Station was summarized by KPRG in the Application for Initial Operating Permit for Ponds 2S and 3S (KPRG, 2021) as well as in the Application for initial Operating Permit for Ponds 1N and 1S (KPRG 2022) as approximately 1 to greater than 20 feet (ft) of unconsolidated deposits underlain by Silurian Dolomite to approximately 140 ft below ground surface (bgs). The Silurian dolomite is underlain by the Maquoketa Group which includes the Scales Shale, which is considered to be a regional aquitard separating the shallow groundwater within the unconsolidated deposits and Silurian Dolomite from the deeper, underlying Cambro-Ordovician aquifers. The Applications (KPRG, 2021 and 2022) summarized the general site lithology from site boreholes as:

- Fill (approx. 5 ft to 10 ft thick) – Consisting of a thin layer of sand and gravel roadway followed by brown and black silty clay and silty sand mixed with gravel and crushed dolomite. The fill may include coal, black cinders, and slag.
- Silty Sand, Silt and Clay (approx. 1 ft – 16 ft thick) – Consisting of gravelly tan to brown silty sand fining downward to gray/greenish mottled silty clays and clay.
- Bedrock – Dolomite bedrock. Top of weathered bedrock is generally encountered between 9 ft and greater than 20 ft below ground surface with depth increasing towards the southwest. It is noted that at monitoring well location MW-12, top of bedrock was not encountered at the terminus of the boring at 20 ft below ground surface.

Surficial geology was obtained from the Romeoville Quadrangle Map (Caron, 2017) and is shown on Figure 4. Borehole logs for the site wells were compiled along with logs for nearby wells from the Illinois State Geological Survey's (ISGS) Water and Related Wells Database (ILWATER) and are presented in Table 2 and Figure 5. Lithology in the borehole logs is displayed in three dimensions in Figure 6 and includes the groups:

- Loam
- Overburden
- Topsoil
- Fill
- Clay, and Sandy Clay
- Clay, Sand, and Gravel
- Clay
- Silt and Clay
- Sand
- Sand and Gravel
- Dolomite
- Carbonate and Shale
- Carbonate

- Shale

Near the site the unconsolidated lithology is dominated by silty sand, silt, and clay. The lithologic intervals provided guidance on initial model calibration through the definition of zones of hydraulic conductivity that were later modified as discussed further in Section 5.2.1.

4.3 Aquifer Properties

Aquifer properties of hydraulic conductivity (K) and storage are important controls on groundwater movement and behavior and are necessary parameters to define in a numerical model. Hydraulic conductivity values were initially estimated for monitor wells MW-01, -04, -06, -07, and -09, screened in the carbonate unit, from slug tests (Patrick Engineering 2011). The geometric mean of the test data for these wells was approximately 30 feet per day (ft/d) for each well, as calculated by (Patrick Engineering, 2011). The slug test data were reviewed as part of this current modeling study and the data were reanalyzed using corrected input values for the well casing and borehole dimensions, effective porosity of the sand filter pack material, and minor line fitting refinement. The revised hydraulic conductivity estimated values are summarized in Table 3 for comparison. The revised geometric mean of the test data for these wells decreased to approximately 20 ft/d for each well.

4.4 Nature of Groundwater Flow

Groundwater occurs under unconfined conditions with depth to water ranging from approximately 8 ft at monitor well MW-11 to approximately 13 ft at monitor wells MW-04 and -08 (KPRG, 2022). Saturated conditions are generally encountered near or at the top of weathered carbonate bedrock. Four quarterly groundwater flow maps based on monitoring well water levels were presented in the Applications (Figures 9-7 through 9-10 of KPRG, 2021 and 2022). The maps show groundwater flow direction is generally to the west beneath the ash ponds toward the Des Plaines River which is the main hydrogeologic discharge boundary in the vicinity of the Ponds. Patrick Engineering (2011) discussed that groundwater flow in the greater plant area should be largely controlled by the Des Plaines River to the west of the site and the CSSC to the east of the site with groundwater likely flowing toward both features during most periods of the year. Based on water levels measured in the site monitor wells, the noted groundwater divide that separates flow directions to the west (Des Plaines River) and the east (CSSC) is east of the ash ponds, and therefore groundwater beneath the ash ponds flows to the west towards the Des Plaines River.

Groundwater level measurements from the site wells from June 2011 through September 2022 were used for this modelling effort. A summary of these data is provided in Table 4 including minimum and maximum measured water level elevations and the average water level elevation from the 1st and 3rd quartiles to eliminate statistical outliers. These average water levels, for monitor wells MW-01 through MW-12 were used as the water level calibration targets. It should be noted that site monitor wells MW-13, -14, and -15 were installed in 2021 and therefore only have water level data since second quarter 2021. The average of these more recent water levels was also used as calibration targets for the model calibration. No recent, shallow water levels were found in the

Illinois Domestic Wells Database or the Illinois Water and Related Wells Database (2021) to supplement these site data for the model calibration.

4.5 Impacted Groundwater

As noted above, the CCR groundwater monitoring network for Ash Ponds 2S and 3S has six wells: MW-05, MW-06, and MW-09 through -12. Wells MW-05 and MW-06 are upgradient monitoring wells and wells MW-09 through -12 are downgradient monitoring wells. CCR sampling under the Federal Rule was initiated in 2015 for the identified Appendix III and Appendix IV parameters and assessment monitoring under that program is ongoing for Appendix III and Appendix IV parameters. Also, starting in second quarter 2021, sampling under the new State CCR Rule was initiated quarterly for all Federal CCR Rule Appendix III/IV parameters plus turbidity since the State Rule does not distinguish between detection and assessment monitoring parameter lists. Ash Ponds 1N and 1S were not part of the Federal Rule CCR program, however, they are covered under the State CCR Rule. Therefore, eight rounds of groundwater monitoring were initiated in the second quarter 2021 for all parameters specified in Section 845.600(a)(1) plus turbidity to provide the data needed for establishing the required background concentrations. Subsequent to those eight rounds of sampling, quarterly sampling for all parameters has been ongoing.

As discussed in the Illinois CCR Compliance Ash Ponds 1 North and 1 South Annual Groundwater Monitoring and Corrective Action Report, and in the Illinois CCR Compliance Ash Ponds 2 South and 3 South Annual Groundwater Monitoring and Corrective Action Report, both dated January 30, 2023 the following parameters were detected at concentrations above proposed Groundwater Protection Standards during the 4th quarter 2022 sampling in downgradient monitoring wells:

- Arsenic
- Calcium
- Chloride
- Molybdenum
- Sulfate

These parameters will be the focus of predictive modeling comparisons for the various alternatives discussed in Section 6.0 below. It is noted that boron was also added to the above list of parameters to be evaluated in Section 6.0 since this is a main indicator of potential CCR impacts.

4.6 Water Budget

A conceptual water budget was developed for Will Co Station to provide context of the results of the calibrated model water budget (ASTM D5447-17, 2017). The identified and estimated components of the conceptual water budget included:

- recharge to groundwater
- discharge of groundwater to the CSSC
- discharge of groundwater to the Des Plaines River

The conceptualized estimate for each of these components of the water budget is discussed below. The conceptual water budget was used as an initial definition of the water budget in the numerical model, and components were adjusted during model calibration.

4.6.1 Recharge to Groundwater

Recharge from the infiltration of precipitation to the water table has been estimated in a regional, general context for northeastern Illinois:

- A groundwater/surface water model for the Upper Fox River Basin in Southeastern Wisconsin estimated recharge of approximately 4 to 4.4 inches/year (in/yr) (Feinstein, Fienen, Kennedy, Buchwald, & Greenwood, 2012).
- The Illinois State Water Survey (ISWS) estimated shallow groundwater recharge using a geographic information system (GIS) approach coupled with pattern recognition (Interagency Coordinating Committee on Groundwater, 2010). A generalized map of potential recharge at Illinois power plants shows the Will Co Station on the edge of the border between areas with "moderately low to low" to "very high" recharge potential.

Recharge from precipitation was initially assumed in the groundwater model at 1.3 in/yr, which equates to approximately 3 percent of MAP. This rate over the model domain minus the river (Section 5.1) equates to approximately 18 acre-feet per year (af/yr) (2,200 cubic feet per day (cfd)).

4.6.2 Discharge to Des Plaines River

The boundaries to the groundwater model are discussed below in Section 5.1.3. Groundwater flow west to the Des Plaines River was estimated using Darcy's Law

$$Q = KA\frac{dh}{dl}$$

where Q is the Darcy Flux, K is the hydraulic conductivity (ft/d), A is the cross-sectional area (ft), and dh/dl is the hydraulic gradient (feet per foot (ft/ft)). Using the length of the western model boundary (4,900 ft), an assumed thickness of weathered carbonate bedrock of up to 10 ft, an assumed hydraulic conductivity of 20 ft/d, and a hydraulic gradient of 0.0049 ft/ft estimated from the water level contours shown on the quarterly groundwater flow maps referenced in Section 4.4 above, a rough estimate of groundwater flow from the east in the weathered carbonate bedrock was calculated as 40 af/yr (4,800 cfd). It is reasonably assumed that groundwater flow through the weathered carbonate bedrock is sufficiently greater than flow through the underlying more competent carbonate bedrock. Given the close proximity to the Des Plaines River as the groundwater discharge boundary in the vicinity of the ponds, the conceptual model water budget does not extend or consider flow in the deeper carbonate bedrock.

4.6.3 Discharge to CSSC

Groundwater flow east to the CSSC was likewise estimated with Darcy's law. This feature was included in the conceptual model because it is a discharge location for groundwater beneath the larger plant area further east of the ponds and is included in the numerical modeling area. As previously stated, groundwater beneath the ash ponds flows to the west to the Des Plaines River and is not expected to interact with the CSSC. The same assumptions were made for the value of hydraulic conductivity and hydraulic gradient as the estimate of discharge to the Des Plaines River (Section 4.5.2) and using the length of the canal within the model domain (4,038 ft), the resulting Darcy flux for groundwater discharge to the CSSC, upgradient of the ash ponds, was estimated as 33 af/yr (3,958 cfd).

This discussion of the conceptual water budget is an order-of-magnitude, first approximation to estimate the components of the water budget that will be represented in the numerical model. The conceptual water budget does not completely balance (i.e., there is greater outflow than inflow), however, the conceptual water budget is only used in a general sense to provide initial estimates for defined boundary conditions and to provide an "order-of-magnitude" comparison to the calibrated model water budget.

5.0 NUMERICAL GROUNDWATER FLOW MODEL

A numerical groundwater flow model was constructed for Will Co Station. This section describes the construction and calibration of the numerical model.

5.1 Model Construction

The numerical model was created to cover the area of the ash ponds at Will Co Station and Midwest Generation Will Co Generating Station property (Figure 8). The model domain extends east from Midwest Generation property to the CSSC, north and south from Midwest Generation property approximately 100 ft to East Romeo Road on the north and just south of Material Road on the south, and west to the Des Plaines River. The selection of lateral boundaries to the model is further described below. The overall, active model area is approximately 0.4 square miles.

5.1.1 Software Selection

The groundwater flow system was simulated with MODFLOW-NWT (Niswonger, 2011), an advanced version of the widely used MODFLOW software. Groundwater Vistas (Version 8.0) (Environmental Simulations Inc. (ESI), 2020), a graphical user interface, was used to parameterize the model input, write MODFLOW files, and visualize results. MODFLOW-NWT was considered over MODFLOW-2000, MODFLOW-2005, or MODFLOW-USG because it has enhanced solvers that employ upstream weighting for non-linear problems, it is a relatively recent, widely used, and non-proprietary release of MODFLOW. It was coupled with the widely-used and non-proprietary transport model MT3DMS (Zheng, 2012), which was used for the transport simulations.

5.1.2 Model Grid and Layering

The model has a uniform grid spacing of 50 ft, has 85 rows and 104 columns (see Figure 9) and four layers yielding a total of 15,940 active cells. The MODFLOW-NWT model was constructed with length and time units of feet and days, respectively. The coordinate system State Plane Illinois East, NAD 83, FIPS 1201 was used for all coordinates and for GIS data management. The model grid has an origin at coordinates 1,056,125, 1,807,439, rotated three degrees to the northwest.

Lithology data was compiled from site well logs and ISGS drill logs and organized into geological units as described in Section 4.2. Contacts were used to create surfaces of the top of the carbonate unit and of the top of the Maquoketa Shale using Seequent Leapfrog™ software (Seequent Limited, 2021), as well as to visualize the borehole lithology. Model layers one and two represent the unconsolidated materials, and model layers three and four represent the carbonate unit. The top of model layer 3 was defined from the created carbonate surface and the bottom of the model was defined from the created surface of the Maquoketa Shale.

The top of the model was defined with surface topography from the U.S. Geological Survey (U.S. Geological Survey, 2021). The volume of unconsolidated material above the carbonate unit was divided into two model layers to simulate groundwater flow through the unconsolidated sediments. Near the ash ponds model layers one and two, together, range in thickness from 2 to 20 ft, consistent with site borehole lithology. Model layer 3 represents weathered carbonate bedrock and was defined as 10 ft thick, as deemed appropriate from site well logs. Representative sections through the model domain are provided in Figure 10 to show the layering in an east-west model row (row 50) and a north-south model column (column 22) through the site.

5.1.3 Model Boundaries

The outside edges of the model domain must be defined with model boundaries to describe how groundwater inside the model domain interacts with groundwater outside the model domain. Additionally, boundaries can be defined interior to the model domain to represent sources and sinks of groundwater such as pumping wells or infiltration through a pond. Exterior boundaries of the numerical model are shown on Figure 8 and include:

- River boundary along the western edge of the model domain, aligned with the Des Plaines River.

- No-flow boundaries along the north and south edges of the model.
- General head boundaries (GHB) along the CSSC

The river boundary along the model's western edge is defined with a stage set to 582 ft at the north end to 577 ft at the south end, consistent with surface topography. The river was defined in model layers 1 through 3. The river was assumed to be 10 ft deep consistent with nearby USGS gage data, and the conductance was set from the model cell dimensions and an assumed hydraulic conductivity of 50 ft/d and a thickness of 1 foot, to represent relative ease of exchanging water between the river and groundwater.

GHB were defined along the CSSC. The GHB was defined in model layer 1 at elevations equal to land surface topography in each model cell. Elevations of the GHB range from 576 ft to 591 ft. Conductance was set from the dimensions of the model cells and assumed hydraulic conductivity of 50 ft/d and thickness of 1 foot to represent relative ease of exchanging water between the CSSC and groundwater.

The northern and southern model boundaries were defined with no flow boundaries to represent streamlines (groundwater flow directions) as expected from the conceptualized direction of groundwater flow.

5.1.4 Model Stresses

In addition to the exterior model boundaries described in Section 5.1.3, MODFLOW boundaries and properties were used in the interior of the model domain to simulate stresses (inflows and outflows) on the groundwater system as follows:

- GHBs were defined in model layer 1 in the area of retention ponds south of the Ash Pond 3S and the small pond north of Ash Pond 1S to represent potential recharge to groundwater. The GHB was defined at an elevation of 583 ft for the southern retention ponds and 590 ft for the northern pond, consistent with topographic data, and an assumed conductance of 1.5 square foot per day (ft^2/d), determined during model calibration.
- GHBs were defined in the footprints of Ash Ponds 1N and 1S to represent potential infiltration to groundwater. Ponds 1N and 1S have been regraded to a drainage system that maintains less than one-foot of water within the ponds and include a Poz-o-pac liner with an estimated permeability of $1x10^{-5}$ centimeters per second (cm/s). The GHB for these ponds was set one foot above the pond bottom elevation of 582.5 ft, and an assumed conductance of 10 ft^2/d, found during model calibration.
- Recharge from precipitation was defined throughout the model domain using MODFLOW's recharge package. Recharge was simulated at approximately 1.5 in/yr (3.5E-04 ft/d) or approximately 4 percent MAP. This is slightly higher than the initial recharge rate assumed in the conceptual water budget of 3 percent MAP (Section 4.5.1) and was increased slightly as part of model calibration. No recharge from precipitation was assigned below the CSSC or ponds that are covered by the GHB, and beneath the Des Plaines River that is covered by the river boundaries.

- Ash Ponds 2S and 3S were simulated with recharge as with the rest of the model domain. Ash Ponds 2S and 3S are lined but the relatively low recharge rate (3.5E-04 ft/d) simulated in the base model provides a relatively small amount of seepage through these ponds and allows for comparison with closure alternatives that cap the ponds.

5.1.5 Numerical Parameters

The Preconditioned Conjugate Gradient (PCGn) package was used with MODFLOW-NWT to solve the system of equations within the model domain. The type of solver was tested in early model runs and the PCGn solver provided a stable solution in a fast computational time compared to other solvers available with MODFLOW. The solver was used with adaptive damping (ADAMP) and the XMD linear solution method (LINMETH), again to provide a stable and computationally quick solution.

Optimal settings for the PCGn with XMD were found during model calibration. Key numerical parameters were a head change closure criterion (HCLOSEXMD) of 1E-04 ft for inner iterations and 1E-05 ft for outer iterations, 2,000 maximum outer iterations and 2,000 maximum inner iterations.

5.2 Model Calibration

The following sections describe the approach taken to calibrate the model and the results of the model calibration.

5.2.1 Approach

The groundwater flow model was first calibrated through a trial-and-error approach by adjusting hydraulic conductivity and recharge rates until the model reasonably matched field measurements in site wells. Model calibration then continued with parameter estimation techniques in PEST software (Doherty, 2010), used with pilot points within Groundwater Vistas.

The flow model calibration relied on the measured water level data provided by KPRG for the site wells MW-01 through MW-15. The period of measured water levels from site wells MW-01 through MW-12 since 2011, and MW-13 through MW-15 since 2021 were averaged, having removed outliers determined from the interquartile range, and used as model calibration targets (Table 4). The data from the site wells were considered reliable and were given a target weight of 1.

In addition to calibrating to measured water levels in the wells, qualitative considerations of model calibration included:

- General groundwater flow directions, and patterns in the hydraulic gradient including western flow to the Des Plains River from beneath the ash ponds and eastern flow toward the CSSC east of the ash ponds, a less steep hydraulic gradient across Ash Pond 1S, and south/southwest flow directions across Ash Pond 3S,

- General consistency in the modeled hydraulic conductivity and the field-measured hydraulic conductivity,
- General consistency in the modeled water budget with the conceptual water budget,
- Saturated conditions near the weathered carbonate bedrock surface near the site, and
- Limiting or eliminating flooding above the surface of the model.

The measure of model calibration, other than the qualitative considerations, was to minimize the calibration residual, measured as the difference between measured and modeled groundwater elevations in wells. A negative residual indicates that the modeled groundwater elevation is higher than the measured elevation, and a positive residual indicates that the modeled groundwater elevation is lower. The statistical measures of average residual, sum of squared residuals, and root mean square (RMS) error were used to objectively evaluate the calibration.

The RMS error was calculated as:

$$\mathrm{RMS} = \left[\frac{1}{\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{h_o} - \mathrm{h_s})^2\right]^{0.5}$$

where $h_o - h_s$ is the target residual and n is the number of observed groundwater elevation values. The RMS error is typically scaled against the range in observed groundwater elevations in the model area. A scaled RMS error of less than 10% is the standard calibration criteria that is generally considered acceptable throughout the industry (Anderson, 2015).

Initially, the lithologic intervals in borehole locations were intersected with the model grid and zones of hydraulic conductivity ("K zones") and were drawn around these lithologic groups (i.e., grouped together areas of silty sand, areas of sand and gravel, etc). Hydraulic conductivity was defined for these K zones based on literature values and professional judgement for initial model calibration. After the basic model calibration was completed by varying the values of hydraulic conductivity and recharge, the model calibration was refined using pilot points and PEST software. The manual calibration suggested relatively low values of hydraulic conductivity in the unconsolidated sediments, lower than the data for hydraulic conductivity determined for site wells in the weathered carbonate bedrock (Table 3). Pilot points were defined throughout model layers 2 and 3, the layers that contain the site wells for calibration, to estimate the horizontal and vertical hydraulic conductivity values. The initial value of horizontal hydraulic conductivity in the unconsolidated sediments (layers 1 and 2) was 1 ft/d with a range between 0.1 and 30 ft/d, and in the weathered bedrock (layer 3) was 20 ft/d, consistent with the revised estimates of hydraulic conductivity (Table 3) with a range between 1 and 40 ft/d. This range was deemed reasonable to account for the accuracy of field-measured hydraulic conductivity.

5.2.2 Model Calibration Results

The calibrated distribution of horizontal hydraulic conductivity in the model is shown for each model layer on Figures 11a and 11b. The calibrated model calculated groundwater level contours are shown on Figure 12. The spatial distribution of the calibration residuals is shown on Figure 13 and a scatter plot of the residuals are shown on Figure 14. The calibrated model water budget is provided in Table 5, the model calibration residuals are provided in Table 6, and the calibrated model statistics are provided in Table 7. Recharge from precipitation was simulated at approximately 1.5 in/yr (3.5E-04 ft/d), consistent with the conceptual model and equal to approximately 3.7 percent of MAP (Section 4.5.1)

5.2.2.1 Calibrated Hydraulic Conductivity

The model calibrated distribution of horizontal hydraulic conductivity ranges from approximately 0.1 to 25 ft/d in the unconsolidated sediments (model layers 1 and 2), and from approximately 0.8 to 40 ft/d in the weathered carbonate bedrock (model layer 3). The deeper carbonate bedrock (model layer 4) was assumed equal to 0.15 ft/d. Use of PEST software for the model calibration resulted in a krigged distribution of hydraulic conductivity rather than zones of hydraulic conductivity. A krigged surface is appropriate for heterogeneous unconsolidated sediments and for the heterogeneous weathered carbonates. PEST was used to estimate horizontal and vertical hydraulic conductivity in model layers 2 and 3. The vertical hydraulic conductivity was allowed to be up to 1,000 times lower than the horizontal hydraulic conductivity in the unconsolidated sediments (model layers 1 and 2) and was allowed to be up to 10 times lower than the horizontal hydraulic conductivity in the weathered carbonate bedrock (model layer 3). The deeper carbonate bedrock (model layer 4) was assumed to be vertically isotropic.

The resulting distribution of horizontal hydraulic conductivity in the unconsolidated sediments (model layers 1 and 2) has the highest values (approximately 17 to 25 ft/d) east of the ash ponds near monitor well MW-02, near MW-10, and along the southern part of the model domain. The lowest values (approximately 0.1 to 0.2 ft/d) are found near Pond 2S and Pond 3S, and along the eastern perimeter of the site (Figure 11a). The resulting distribution of horizontal hydraulic conductivity in the weathered carbonate bedrock (model layer 3) has the highest values (approximately 30 to 40 ft/d) beneath Pond 1S, and south and east of the ash ponds, and the lowest values (approximately 1 ft/d) east of the retention pond, northeast of Pond 1N, and along the eastern perimeter of the site (Figure 11b).

The resulting vertical hydraulic conductivity values (Kv) in the unconsolidated sediments (model layers 1 and 2) range from equal to horizontal to three orders of magnitude lower than the horizontal values (Kh), representing a vertical anisotropy ratio that ranges from 1:1 to 1:1000 Kh:Kv, which is appropriate for layered clays, silt, and sand and common in modeling applications (Anderson, 2015). The calibrated vertical anisotropy ratio in the unconsolidated sediments is less than 10 throughout much of the model domain and is highest (lowest Kv values) near Ponds 1N and 1S, and south of Ash Pond 3S beneath the retention ponds (Figure 11a). The calibrated vertical anisotropy ratio in the weathered carbonate bedrock (model layer 3) is less than in the unconsolidated sediments and is generally between 1 and 5 beneath the ash ponds (Figure 11b). The ratio is highest (lowest Kv values) in the southern and eastern portions of the model domain.

The calibrated values of hydraulic conductivity at wells MW-01, -04, -06, -07, and -09 were compared to the field data for these wells (Table 3). The modeled values of hydraulic conductivity for these five wells are generally consistent with the revised estimates of hydraulic conductivity (Table 3), with the greatest difference between the test data and the calibrated model seen at monitor wells MW-06 and MW-09. The differences between the field-measured and modeled values in these wells is about 50%, which is still within an acceptable range when considering that the representativeness of hydraulic conductivity estimates based on field slug-testing at specific points within an aquifer which can easily be an order-of-magnitude off of actual larger scale aquifer hydraulic conductivity. The calibrated model's approximate values of horizontal hydraulic conductivity in the model cells containing and surrounding these monitor wells are:

- MW-01: 19 ft/d,
- MW-04: 27 ft/d,
- MW-06: 10 ft/d,
- MW-07: 8 ft/d, and
- MW-09: 12 ft/d.

These values are, overall, consistent with the estimates of hydraulic conductivity for these wells (Table 3).

5.2.2.2 Calibrated Water Budget

The model calibrated water budget is provided in Table 5. Groundwater recharge equals 20 af/yr (2,366 cfd), which is fairly consistent with the conceptual water budget estimate of 18 af/yr. Additionally, the GHB and recharge zone at the retention ponds and Ash Ponds provided 9 af/yr (1,030 cfd) to the groundwater budget. The total modeled inflow to groundwater is 28 af/yr (3,396 cfd).

Outflows from the groundwater model include discharge to the Des Plaines River and the CSSC. Discharge to the GHB representing the CSSC on the east side of the model equalled 8 af/yr (931 cfd), lower than the conceptual water budget estimate but represents the balanced water budget with spatially varying hydraulic conductivity. As previously discussed, the groundwater divide between westward and eastward flow occurs east of the Ash Ponds, and groundwater beneath the Ash Ponds flows to the west to the Des Plaines River. Outflows to the Des Plaines River equalled 21 af/yr (2,465 cfd), lower than the conceptual water budget estimate, but again, representing the balanced water budget with spatially varying hydraulic conductivity. The total outflows from the groundwater system balance the inflows at 28 af/yr (3,396 cfd) (Table 5).

5.2.2.3 Statistics and Residuals

The calibration residuals and modeled water level for each well is provided in Table 6. Calibration residuals for the site wells range from -0.25 ft in well MW-14 to 0.5 ft in well MW-13. The average residual is 0.06 ft (Table 7). The RMS error is 0.23 ft, or 8.7 percent of the change in hydraulic head across the model domain (Table 7), below the recommended threshold of 10 percent for the scaled RMS error (Anderson, 2015).

The sum of squared residuals (phi) for the calibration targets from the manual calibration was 14.2 square feet (ft^2), representing the starting point for the PEST calibration. The final, calibrated phi was 0.23 ft^2, representing a significant improvement of the calibration by the PEST software.

The modeled water level contours are shown on Figure 12. The modeled water level contours generally match the overall westward groundwater flow direction shown on the groundwater contour maps referenced above in Section 4.4. (i.e., Figures 9-7 through 9-10 of the Applications (KPRG, 2021, 2022)). This includes the expression of a gentler hydraulic gradient beneath the ash ponds, and the steeper hydraulic gradient along the western edge of Pond 2S. The calibration residuals for each calibration target (well) are shown on Figure 13. The overall model calibration to measured groundwater levels in site wells is very close, within one-half foot everywhere.

A scatter plot of the calibration residuals is provided for both all wells and site wells in Figure 14. In a perfect model calibration, each point would fall on a 1:1 line. Ideally deviations from the line should be balanced between high and low representing a lack of bias in the model calibration toward over- or under-prediction of the groundwater system. The calibration residuals for all wells are generally close to the 1:1 line, with the points falling both above and below the line, representing a relatively balanced, on whole, calibration to the site wells.

These results demonstrate that the model reasonably matches the overall groundwater elevations across the model domain, and the water balance reasonably represents the conceptual model of groundwater flow. The calibrated model is appropriate to use for basic predictive simulations.

5.3 Model Sensitivity

A sensitivity analysis was conducted as part of the model calibration. Calibrating the numerical model was an effort of refining the heterogeneity and distribution of the horizontal and vertical hydraulic conductivity values and the recharge to match measured water levels in the wells. During the PEST and manual trial-and-error calibration model runs, the model was the most sensitive to the values of hydraulic conductivity. The model calibration was particularly sensitive to the areas of higher hydraulic conductivity south and east of the ash ponds, which improved the model calibration to the site wells. The modeled values of hydraulic conductivity were determined during the PEST calibration and attempts to adjust the values consistently worsened the overall model calibration.

The model calibration is sensitive to the recharge rate, but to a lesser extent than it is to hydraulic conductivity. A sensitivity model run was conducted with recharge increased to 1.68 inches per year (in/yr) (3.84E-04 ft/d), or 4 percent of MAP. Water levels were raised in all monitoring well locations, and the scaled RMS error increased from 8.7 percent to 9.1 percent.

Sensitivity model runs were conducted to test the value of hydraulic conductivity of the more competent carbonate (model layer 4). Lowering the hydraulic conductivity to 0.07 ft/d from 0.15 ft/d had a large impact on the model calibration, particularly in raising the water levels in the unconsolidated sediments and increasing the scaled RMS error from 8.7 to 11.1 percent. Raising the hydraulic conductivity of the more competent carbonate (model layer 4) from 0.15 to 0.3 resulted in generally lower water levels in the model and worsened the scaled RMS error from 8.7 to 14.1 percent.

A sensitivity model run was conducted in which the horizontal hydraulic conductivity of the weathered carbonate unit (model layer 3) was uniformly set to 20 ft/d, the geometric mean of the field tests of permeability, and the vertical hydraulic conductivity was set to 2 ft/d. This test was designed to test the sensitivity of the model calibration to heterogeneity of the hydraulic conductivity within the weathered carbonate unit. With the uniform value of hydraulic conductivity for the weathered carbonate in model layer 3, water levels in the weathered carbonates were significantly lowered, and calibration worsened, with the scaled RMS error increasing to 45.5 percent.

A sensitivity model run was conducted in which the vertical hydraulic conductivity was set equal to the horizontal hydraulic conductivity. The calibrated values of vertical hydraulic conductivity are lower than the horizontal values, particularly in the unconsolidated sediments where the ratio is as high as 1:1,000 horizontal to vertical. With the vertical hydraulic conductivity set equal to the horizontal, the model calibration was only slightly affected. Water levels were lowered, particularly in the unconsolidated sediments, and the scaled RMS error increased to 8.9 percent from 8.7 percent.

From this sensitivity analysis it is determined that the calibrated set of modeled parameters are the most appropriate to represent site groundwater conditions and for use in predictive model simulations.

6.0 PREDICTIVE MODEL SIMULATIONS

Four predictive, contaminant transport model runs were conducted to demonstrate the impact to potential impacted groundwater from ash pond closure alternatives. The closure alternatives tested with the predictive model included combinations of removing all CCR materials and/or capping the ponds or encapsulating the ash in place. Closure management of all four ash ponds (Ponds 1N, 1S, 2S, and 3S) were tested concurrently with the predictive models. Transport modeling was performed using the software MT3D-USGS, a widely used and accepted version of the MT3D software designed to be compatible with MODFLOW-NWT.

The calibrated, steady state groundwater flow model was used as the basis for a hypothetical 100-year transport simulation of a surrogate constituent from each of the four ash ponds (Ponds 1N, 1S, 2S, and 3S). A uniform porosity of 35 percent was assumed for model layers 1 through 3, and a uniform value of 6 percent was assumed for the competent bedrock in model layer 4. To provide a platform upon which to evaluate potential closure alternatives, a hypothetical release from the four ash ponds was established. The hypothetical (artificial) release assumes that the ash ponds are full of ash and water with no liners present. The surrogate constituent was simulated by hypothetically introducing a concentration in groundwater of "1" beneath each of the four ash ponds, as shown on Figure 15. The hypothetical mass was defined in groundwater beneath the ash ponds using a constant source boundary condition with value of "1" and forward tracked for 100 years. Mass was moved through the groundwater system with advection and dispersion, and dispersion was simulated with a uniform value of 1 foot in the longitudinal direction, 0.1 ft in the transverse direction, and 0.01 ft in the vertical direction. The resulting hypothetical plume within the unconsolidated sediments and weathered bedrock is shown on Figure 16 and shows mass extending from the ash ponds to the Des Plaines River. The mass in groundwater at the ash ponds is continuous in these runs, therefore the mass is shown at the relative concentration of "1" beneath the ash ponds in all figures. This plume was the starting condition for the predictive scenarios of the conceptual closure alternatives for the ash ponds. The results of the predictive modeling for the four closure alternatives are provided on Figures 17 through 24.

6.1 Closure Alternative 1

Closure Alternative 1 simulates the removal of CCR materials from the ash ponds. In this scenario, the mass boundary condition was removed from the water table and the 100-year distribution of dissolved surrogate mass (Figure 16) was used as the initial concentrations. With this closure alternative, the distribution of dissolved contaminants that resulted from the hypothetical (artificial), continuous release of mass from the ash ponds was reduced over time within the unconsolidated sediments and weathered carbonates after the removal of the source mass at the ash ponds. These plumes are shown on Figure 17 at 5 and 25 years, and on Figure 18 at 50 and 100 years. As the figures show, the dissolved mass is reduced beneath each ash pond with the removal of the CCR materials. Relative concentrations downgradient of the ash ponds are reduced to less than approximately 0.7 within 5 years. Within 25 years the dissolved mass beneath and downgradient from Ash Ponds 1N and 1S is reduced to a relative concentration of less than 0.2 (Figure 17). Figure 18 shows relative concentrations at 50 years and shows further reduction in the area of shallow groundwater impacted with relative concentrations less than 0.2. By 100 years, the dissolved mass is effectively removed from shallow groundwater (Figure 18).

6.2 Closure Alternative 2

Closure Alternative 2 simulated the closure-in-place of the ash ponds. In this scenario, the hypothetical mass boundary condition remained at the water table, and recharge was simulated within the footprint of the ash ponds at a reduced rate of 1E-15 m/s (2.83E-10 ft/d), representing an impermeable designed and placed cap/cover system. The 100-year distribution of dissolved surrogate mass (Figure 16) was used as the initial concentrations.

The modeled results of Closure Alternative 2 on dissolved mass in the unconsolidated sediments and weathered bedrock are shown at 5 and 25 years on Figure 19, and at 50 and 100 years on Figure 20. Within 5 years relative concentrations in shallow groundwater are reduced to less than 0.7 downgradient of Ash Pond 1N and less than 0.9 downgradient of Ash Pond 1S (Figure 19). Relative concentrations have decreased by a change of about 10 percent to relative concentrations less than 0.4 downgradient of Ash Ponds 2S and 3S. Within 25 years relative concentrations have reduced below 0.3 downgradient of Ash Ponds 1N, 2S, and 3S, and below relative concentrations of approximately 0.8 downgradient of Ash Pond 1S (Figure 19). Relative concentrations are mostly stable after 25 years with little change at years 50 and 100 (Figure 20).

6.3 Closure Alternative 3

Closure Alternative 3 simulated the isolation/stabilization of the ash materials and closure-in-place at the ash ponds. In this scenario, as in Closure Alternative 2, the mass boundary condition remained at the water table, recharge through the ash ponds was simulated at a reduced rate to represent a placed cap/cover, and the 100-year distribution of dissolved surrogate mass (Figure 16) was used as the initial concentrations. Additionally, the four ash ponds were hydraulically isolated by defining a barrier wall with MODFLOW's Horizontal Flow Barrier (HFB) package (Figure 21). The HFBs were defined with a hydraulic conductivity of 2.83E-04 ft/d and a thickness of 1 foot. The HFBs were extended through the base of the model layer 1. No-flow cells were defined beneath the ash ponds in model layer 2 to represent the vertical isolation of the ash material within the pond footprints.

The modeled results of Closure Alternative 3 are shown for unconsolidated sediments and weathered bedrock on Figure 22 at 5 and 25 years, and on Figure 23 at 50 and 100 years. By 5 years, relative concentrations have decreased downgradient of the Ash Ponds 1N and 1S to less than approximately 0.6, and to less than approximately 0.8 downgradient of Ash Pond 2S (Figure 22). By 25 years, the dissolved mass is mostly confined to the pond footprints, where the source mass is encapsulated by the HFBs and underlying no-flow boundaries. Relative concentrations less than approximately 0.1 to 0.2 remain downgradient of Ash Ponds 1N and 3S (Figure 22). There is little change to the downgradient dissolved mass by 50 years, and by 100 years, the dissolved mass is effectively removed from the shallow groundwater downgradient of the Ash Ponds (Figure 23).

6.4 Closure Alternative 4

Closure Alternative 4 simulated the removal of ash materials from Ash Ponds 2S and 3S which would be placed into Ponds 1 N and 1S followed by closure-in-place of the ash materials in ash ponds 1N and 1S. In this scenario, the mass boundary condition was removed from the water table beneath ash ponds 2S and 3S and remained beneath ash ponds 1N and 1S. Recharge was simulated within the footprint of ash ponds 1N and 1S at a reduced rate of 1E-15 m/s (2.83E-10 ft/d), representing an impermeable designed and placed cap/cover system. The 100-

year distribution of dissolved surrogate mass (Figure 16) was used as the initial concentrations. This model scenario is functionally the same as model scenario 1 for ash ponds 2S and 3S and the same as model scenario 2 for ash ponds 1N and 1S.

By 5 years, relative concentrations have decreased in groundwater in the unconsolidated sediments and weathered bedrock downgradient of Ash Ponds 2S and 3S (Figure 24). Maximum relative concentrations in shallow groundwater downgradient of these ash ponds are approximately 0.8 on the northern end of Ash Pond 2S (Figure 24). Relative concentrations have decreased by approximately 0.1 to 0.2 (relative change) downgradient of Ash Pond 1N (Figure 24). By 25 years, relative concentrations in shallow groundwater are below 0.1 beneath and downgradient of Ash Ponds 2S and 3S (Figure 24). Relative concentrations are below 0.3 in shallow groundwater downgradient of Ash Ponds 1N and 1S (Figure 24).

By 50 years the dissolved mass is effectively removed from shallow groundwater downgradient of Ash Ponds 2S and 3S (Figure 25). Relative concentrations in shallow groundwater downgradient of Ash Ponds 1N and 1S have mostly stabilized by 50 years to less than 0.3 and have not reduced further within 100 years (Figure 25).

6.5 Relation to Constituent Concentrations

The trends of predicted reduction in the surrogate mass concentrations discussed in Sections 6.1 through 6.4 for the four closure alternatives were related to the concentrations of several CCR constituents being monitored in groundwater that were detected at concentrations above their proposed Groundwater Protection Standards (GWPSs) during the 4th quarter 2022 groundwater monitoring event. Specifically, these were arsenic, boron, calcium, chloride, molybdenum, and sulfate. The concentrations of these constituents from the 4th quarter 2022 monitoring in downgradient monitoring wells were used as the starting concentrations for this evaluation. The percent decrease in the surrogate concentrations from the starting concentrations was calculated through the 100-year simulation for each closure alternative, at nine, downgradient CCR monitoring well locations MW-07 through MW-15 (Figure 26):

- MW-07, -14, and -15 downgradient of Ash Pond 1N,
- MW-08, -09 and -13 downgradient of Ash Pond 1S,
- MW-09, -10, -11 and -12 downgradient of Ash Ponds 2S and 3S

The relative reduction of the surrogate concentration over time can be related to the dissolved mass of any constituent by applying the percent decrease of the surrogate concentration to an initial concentration of a specific constituent of concern. As noted above, an initial concentration was assigned at each of these nine monitoring well locations for specific constituents of concern based on the 4th quarter 2022 sampling event as provided in Table 8. The *proposed* Section 845.600(a) GWPSs for each constituent for Ponds 1N, 1S, and 2S/3S are provided in Table 9 and are shown on the graphs in Figures 27 through 44.

The calculated percent decrease in the surrogate concentration over the 100-year model simulations was applied to the assigned initial concentration in each monitoring well. For example, the initial concentration (4th quarter 2022 sampling data) for arsenic in monitoring well MW-07 is 0.0032 milligrams per liter (mg/l) (Table 8). The initial, relative surrogate concentration in monitoring well MW-07 is 0.75 (relative to the source concentration of "1") (Figure 16). The decrease in the surrogate concentration throughout the 100-year closure scenario was calculated as a percentage of the initial, relative concentration in this monitoring well, and the percentage decrease was applied to the initial concentration of 0.0032 mg/l to yield a curve of decreasing arsenic concentrations for the model scenario. The resulting concentrations for each constituent of concern in each monitoring well was compared to the proposed Section 845.600(a) GWPSs for each constituent. The GWPSs are presented as dashed lines on each monitoring well's decay curve graph for each model scenario.

The decay curves for arsenic concentrations are shown on Figures 27, 28, and 29 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of arsenic are below the proposed GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells except MW-10 and MW-11. Therefore, all of the arsenic decay curves start below the dashed line representing the arsenic proposed GWPSs on Figures 27 through 29, except in monitoring wells MW-10 and MW-11. Arsenic concentrations decrease over time in all four model scenarios, including in monitoring wells MW-10 and MW-11 (Figure 29). Arsenic concentrations decrease below the proposed GWPS in monitoring wells MW-10 and MW-11 in all closure alternatives within approximately 4 to 15 years.

The decay curves for boron concentrations are shown on Figures 30, 31, and 32 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of boron are below the proposed GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells therefore, all of the boron decay curves start below the dashed line representing the boron GWPSs on Figures 30 through 32. Boron concentrations decrease over time in all four model scenarios.

The decay curves for calcium concentrations are shown on Figures 33, 34, and 35 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of calcium are below the GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells except MW-15, therefore, all of the calcium decay curves start below the dashed line representing the calcium GWPSs on Figures 33 through 35 except for monitoring well MW-15. Calcium concentrations decrease over time in all four model scenarios at all well locations. At well MW-15, the calcium concentration is reduced to below the proposed GWPS of 109.5 mg/l in all four scenarios within approximately 2 to 5 years (Figure 33).

The decay curves for chloride concentrations are shown on Figures 36, 37, and 38 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of chloride are below the proposed GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells except MW-09 in which the chloride concentration is equal to the proposed GWPS of 200 mg/l.

Therefore, all of the chloride decay curves start below the dashed line representing the chloride GWPSs on Figures 36 through 38 except for monitoring well MW-09. Chloride concentrations decrease over time in all four model scenarios. Chloride concentrations decrease below the proposed GWPS of 200 mg/l in monitoring well MW-09 in all closure alternatives within approximately 1 to 1.5 years (Figure 37).

The decay curves for molybdenum concentrations are shown on Figures 39, 40, and 41 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of molybdenum are below the proposed GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells except MW-08 in which the molybdenum concentration is slightly higher (0.11 mg/l) than the proposed GWPS of 0.1 mg/l. Therefore, all of the molybdenum decay curves start below the dashed line representing the molybdenum GWPSs on Figures 39 through 41 except for monitoring well MW-08. Molybdenum concentrations decrease over time in all four model scenarios. Molybdenum concentrations decrease below the proposed GWPS of 0.1 mg/l in monitoring well MW-08 in all closure alternatives within approximately 2 to 5 years (Figure 40).

The decay curves for sulfate concentrations are shown on Figures 42, 43, and 44 for monitoring wells downgradient of Ash Ponds 1N, 1S, and 2S/3S, respectively for Closure Alternatives 1 through 4. The current concentrations of sulfate are below the GWPSs for Ash Ponds 1N, 1S, and 2S/3S in all downgradient monitoring wells except MW-14 in which the sulfate concentration is higher (570 mg/l) than the proposed GWPS of 547.6 mg/l. Therefore, all of the sulfate decay curves start below the dashed line representing the sulfate GWPSs on Figures 42 through 44 except for monitoring well MW-14. Sulfate concentrations decrease over time in all four model scenarios. Sulfate concentrations decrease below the proposed GWPS of 547.6 mg/l in monitoring well MW-14 similarly in all closure alternatives within approximately 1.5 years (Figure 42).

7.0 SUMMARY

A numerical groundwater flow model was created for the vicinity of the four ash ponds at the Will County Generating Station. The model was calibrated to water levels in site wells to reasonably replicate the groundwater flow patterns beneath the site. Groundwater flow paths from the site and the ash ponds are predicted generally to the west toward the Des Plaines River. The model was used predictively to simulate a hypothetical release scenario to the underlying water table based upon which the effectiveness of engineering closure options can be evaluated. A hypothetical surrogate constituent was simulated beneath the four ash ponds in the groundwater. The hypothetical surrogate mass travelled with the groundwater flow paths toward the Des Plaines River. This hypothetical distribution of mass served as the initial concentrations to four predictive scenarios of mass removal or various closure in-place alternatives at the ash ponds. The hypothetical scenarios assume that the ash ponds are full of ash and water with no liner allowing for impacts to discharge constituents to the water table. The predictive scenarios of mass removal or various in-place closure scenarios then illustrate the relative reduction in the concentrations in groundwater as a result. In summary, the modeling results indicate that all four evaluated alternatives for closure of the ash ponds resulted in improvement to groundwater quality. For any parameter detections above proposed GWPSs, all four closure alternatives were found to reduce impacts to below the respective proposed GWPS. All alternatives also have a good overall long-term performance.

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BAS Groundwater Consulting Inc.

Betsy Semmens

Betsy Semmens, RG
President/BAS Groundwater Consulting

TABLES

Table 1: Precipitation Data near Will County Station

Month	Average Monthly Precipitation (inches)[1,2]
January	2.18
February	2.02
March	2.80
April	4.30
May	5.01
June	4.86
July	4.22
August	4.53
September	3.27
October	3.71
November	2.39
December	2.27
Average Annual Precipitation[1]	42.0

Notes:

[1]Data were averaged for the periods of complete records available for the Romeoville Forecast Office station

[2]Periods of complete records were determined as months with 5 or less missing days and years without months with more than 5 missing days

Table 2: Compiled Borehole Lithology

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft, bgs	ft, bgs		
121974178000	0	18	fill, clay	FILL
121974178000	18	120	limestone	Carbonates
121974178000	120	200	soft green shale	shale
121974281000	0	62	limestone	Carbonates
121974281000	62	71	limestone w/shale layers	Carbonates and Shale
121974281000	71	77	limestone	Carbonates
121974281000	77	79	limestone - shale mix	Carbonates and Shale
121974281000	79	128	limestone	Carbonates
121974281000	128	216	shale	shale
121973091600	0	3	sand & gravel	sand and gravel
121973091600	3	140	rock	Carbonates
121973091600	140	160	shale	shale
121973467500	0	15	clay & gravel	clay, sand, gravel
121973467500	15	145	rock	Carbonates
121973467500	145	180	shale	shale
121972436300	0	1	drift	sand
121972436300	1	145	lime	Carbonates
121972436300	145	239	shale & lime - Maquoketa	shale
121972438900	0	88	drift	sand
121972438900	88	153	lime	Carbonates
121972438900	153	218	sandy lime	Carbonates
121972438900	218	611	lime & shale	shale
121970352400	0	15	sandy clay	clay, sand
121970352400	15	39	gravel	sand and gravel
121970352400	39	42	broken limestone	Carbonates
121970352400	42	115	limestone	Carbonates
121970127500	135	315	Maquoketa	shale
121970025300	0	156	limestone	Carbonates
121970025300	156	317	Maquoketa	shale
121970184300	0	42	overburden	topsoil
121970184300	42	160	rock formation	Carbonates
121972479600	0	5	clay	clay
121972479600	5	145	limestone	Carbonates
121972583600	0	50	till	overburden
121972583600	50	60	limestone	Carbonates
121970127600	124	310	Maquoketa	shale
121974644100	0	3	Topsoil	topsoil
121974644100	3	20	clay-shale	clay
121974644100	20	49	dolomite	carbonates
121974634900	0	1	Sugar Run-Romeo Trans	carbonates
121974634900	1	21.6	Romeo Dolomite	carbonates
121974634900	21.6	23.1	Romeo-Markgraf Trans	carbonates
121974634900	23.1	43.7	Markgraf Trans	carbonates
121974634900	43.7	44.9	Markgraf-Brandon Bridge Trans	carbonates
121974634900	44.9	53	Brandon Bridge Dolomite	carbonates
121974482200	0	0.42	Asphalt 5"	
121974482200	0.42	1.25	Brown sand & gravel, damp (base) 10"	sand and gravel
121974482200	1.25	4	Fill	fill
121974482200	4	5	Brown limestone weathered	Carbonates
121974482200	5	15	Brown limestone	Carbonates
121974655800	0	0.5	black loam	loam
121974655800	0.5	1.42	yellow clayey silt & broken rock	silt and clay
121974655800	1.42	11.42	white limestone	Carbonates
121974655900	0	0.5	black loam	loam
121974655900	0.5	1	yellow clayey silt & broken rock	silt and clay
121974655900	1	11.25	white limestone	Carbonates
121974653200	0	1	soft black clayey loam with some pieces of rock	loam
121974653200	1	3.5	large pieces of rock with some clay	clay, sand, gravel
121974653200	3.5	8	silty hard gray clay with some rock fragments and gravel	clay, sand, gravel
121974653200	8	18.83	silty hard gray clay with some small to very large rock fragments	clay, sand, gravel
121974653200	18.83	19.17	white limestone	Carbonates
121974653200	19.17	24.5	silty hard gray clay with some small to very large rock fragments	clay, sand, gravel
121974653200	35	36	greenish white limestone with some seams of clay	Carbonates

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft, bgs	ft, bgs		
121974655100	0	0.5	black loam	loam
121974655100	0.5	4.83	yellow clayey silt & broken rock	silt and clay
121974655100	4.83	15	white limestone	Carbonates
121974654900	0	0.67	soft black clay loam with some pieces of rock	loam
121974654900	0.67	5.42	very large pieces of yellow limestone	Carbonates
121974654900	5.42	49.25	white limestone	Carbonates
121974654900	49.25	54.25	very hard white-green & pink limestone	Carbonates
121974652500	0	0.5	black loam	loam
121974652500	0.5	1	yellow clayey silt and broken rock	silt and clay
121974652500	1	5.67	white limestone	Carbonates
121974652500	5.67	6	gray sandy silt	sand
121974652500	6	11	white limestone	Carbonates
121974650200	0	12	Silty clay sinkhole filling	fill
121974650200	12	24.2	dolomite	carbonates
121974648700	0	2.5	Weathered brown dolomite and clay	carbonates
121974648700	2.5	5.5	dolomite	carbonates
121974648700	8.6	31.3	dolomite	carbonates
121974622200	0	1.6	Sugar Run-Romeo Trans	carbonates
121974622200	1.6	23.6	Romeo Dolomite	carbonates
121974622200	23.6	25	Romeo-Markgraf Trans	carbonates
121974622200	25	46.6	Markgraf Dolomite	carbonates
121974622200	46.6	47.9	Markgraf-Brandon Bridge Trans	carbonates
121974622200	47.9	57.4	Brandon Bridge Dolomite	carbonates
121974281100	0	57	limestone	carbonates
121974281100	57	76	limestone with shale layers	Carbonates and Shale
121974281100	76	127	limestone	Carbonates
121974281100	127	130	shale	shale
121972552500	0	60	overburden	overburden
121972552500	60	120	rock formation	Carbonates
121973976800	0	12	gravel	sand and gravel
121973976800	12	110	limestone	Carbonates
121973976800	110	120	limestone & shale	Carbonates and Shale
121974053100	0	8	soil rock & clay	topsoil
121974053100	8	141	limestone, flowing well	Carbonates
121973630100	0	3	soil/clay/fill	fill
121973630100	3	15	dolomite	dolomite
121973629800	0	1	crushed limestone roadbase	fill
121973629800	1	8	clay	clay
121973629800	8	25	dolomite	carbonates
121974691400	0	18	clay	clay
121974691400	18	51	clay with fine gravel layers	clay, sand, gravel
121974691400	51	54	coarse caving gravel	sand and gravel
121974691400	54	92	clay with sand layers	clay, sand
121974691400	92	98	clay	clay
121974691400	98	111	limestone with fractures	Carbonates
121974691400	111	131	shale	shale
121974121000	0	4	clay	clay
121974121000	4	18	coarse gravel	sand and gravel
121974121000	18	50	fine gravel	sand and gravel
121974121000	50	147	limestone	Carbonates
121974121000	147	155	limestone & shale mix (hard)	Carbonates and Shale
121974121000	155	220	limestone	Carbonates
121973735700	0	25	clay & boulders	clay
121973735700	25	74	sand & fine gravel	sand and gravel
121973735700	74	125	white limestone	Carbonates
121973735700	125	150	hard gray shale	shale
MW-01	0	5	Fill: Black coal cinders, fine gravel, cobbles, crushed rock	Fill
MW-01	5	9	Gravel, weathered, limestone, silt	sand and gravel
MW-01	9	19	Weathered limestone bedrock	Carbonates
MW-02	0	7	Fill: Black coal ash, brown gravely clay, sand, gray silty clay	Fill
MW-02	7	8.5	Fill: Rubble	Fill
MW-02	8.5	12	Black coal cinders, coal dust, clay fill	Fill
MW-02	12	22	Weathered limestone bedrock	Carbonates
MW-03	0	7.5	FILL: Black coal ash, gravel, coarse sand, crushed rock, limestone, rubble	Fill
MW-03	7.5	10	GC: Gray gravel, silt	sand and gravel
MW-03	10	19.5	Weathered limestone bedrock	Carbonates

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft, bgs	ft, bgs		
MW-04	0	6	FILL: Brown fine sand, black ash, crushed rock, fine to coarse gravel	Fill
MW-04	6	9	Gray silt, weathered limestone, moist to dry	Carbonates
MW-04	9	20	Limestone bedrock, weathered	Carbonates
MW-05	0	8	FILL: Brown silty clay, fine gravel, coarse gravel, crushed limestone	Fill
MW-05	8	9	GC: Brown gravel, clay, silty, wet	clay, sand, gravel
MW-05	9	20	Weathered limestone bedrock	Carbonates
MW-06	0	8	FILL: Crushed stone, brown medium sand, black coal cinders, dry	Fill
MW-06	8	10.5	CL: Gray silty clay, coarse to fine gravel, trace coarse	clay, sand, gravel
MW-06	10.5	18	Weathered limestone bedrock	Carbonates
MW-07	0	3.5	FILL: Crushed stone, gravel, silt, sand	Fill
MW-07	3.5	7	FILL: Rock rubble, dry	Fill
MW-07	7	8.5	GC: Brown gravel, silt, coarse sand, saturated	sand and gravel
MW-07	8.5	18	Weathered limestone bedrock	Carbonates
MW-08	0	0.5	CL: Dark brown clayey silt, dry	Silt and Clay
MW-08	0.5	5.5	FILL: Coarse gravel, crushed rock, dry	Fill
MW-08	5.5	7	FILL: Crushed rock, silty gravel	Fill
MW-08	7	19	Weathered limestone bedrock	Carbonates
MW-09	0	5	FILL: Crushed rock, coarse sand, some silt	Fill
MW-09	5	6	FILL: Some brown silty clay	Fill
MW-09	6	10.5	GC: Gray silty clay, fine and coarse gravel, some coarse sand	clay, sand, gravel
MW-09	10.5	11.5	GC: Clayey gravel	clay, sand, gravel
MW-09	11.5	19	Weathered limestone bedrock	Carbonates
MW-10	0	10	FILL: Crushed Limestone, silt, gravel	Fill
MW-10	10	12	GC: Weathered limestone, clay, sand, gravel	clay, sand, gravel
MW-10	12	20	Weathered limestone bedrock	Carbonates
MW-11	0	1	Roadway of sand and gravel	sand and gravel
MW-11	1	2	Sand and Gravel, Dark brown, fine to medium, silty, dry	sand and gravel
MW-11	2	3	Clay, brown, with sand and gravel, slightly moist	clay, sand, gravel
MW-11	3	7.5	Gravel, limestone/dolomite, dry to slightly moist	sand and gravel
MW-11	7.5	13	Clay, dark brown and black, silty, some sand and gravel, moist	clay, sand, gravel
MW-11	13	22	Weathered Bedrock, dolomite	Carbonates
MW-12	0	1	Roadway of sand and gravel	Fill
MW-12	1	2	Sand, Black, Brown, fine to medium, silty, dry	sand
MW-12	2	4	Clay with Gravel, slightly moist	clay, sand, gravel
MW-12	4	4	Gravel layer	sand and gravel
MW-12	4	7	Clay with Gravel, slightly moist	clay, sand, gravel
MW-12	7	11.5	Silty Sand, fine to medium, black, moist	sand
MW-12	11.5	12	Silty sand, tan to white, fine to medium, wet	sand
MW-12	12	13.5	Silty Sand, brown, medium to coarse, wet	sand
MW-12	13.5	15.5	Silt and clay, dark gray, trace sand and gravel, very soft wet	silt and clay
MW-12	15.5	20	Clay, white, light greenish gray, orange mottled, moist	clay
MW-13	0	1	Brown/Tan Silty Sand	sand
MW-13	1	2	Gray/Brown Silty Sand and Gravel, trace clay, slightly moist	sand
MW-13	2	10	Tan fine sand and gravel, slightly moist	sand and gravel
MW-13	10	16	White Dolomite bedrock, fractured	Carbonates
MW-14	0	1	Brown cobbles, black silty sand, slightly moist	Fill
MW-14	1	5	Black silty sand, travel road gravel, trace clay, slightly moist	sand
MW-14	5	7.5	Increase Gravel	sand and gravel
MW-14	7.5	12	Increase sand	sand and gravel
MW-14	12	16	White Dolomite bedrock	Carbonates
MW-15	0	4	Black and dark brown silty sand, some cobbles, slightly moist	sand
MW-15	4	6	White and tan gravel	sand and gravel
MW-15	6	9	Black silty sand with red brick pieces, moist. Wet at 8 feet	sand
MW-15	9	12	Weathered bedrock and gray silty clay	Carbonates
MW-15	12	16	Tan Dolomite, cherty	Carbonates

Notes:
[1]Depth intervals in feet below ground surface

Table 3: Hydraulic Conductivity Data for Site Wells

Well Name	Screened Depth	Screened Geology	Test Name	2011 Hydraulic Conductivity Estimate		2021 Hydraulic Conductivity Estimate		
	ft bgs			ft/s	ft/d	ft/s	ft/d	geometric mean (ft/d)
MW-01	9 -19	Limestone	U1	8.31E-04	70	3.57E-04	30	24.5
			D1	2.25E-04	20	2.60E-04	20	
MW-04	9.5 - 19.5	Limestone	U2	4.80E-04	40	3.36E-04	30	24.5
			D1	4.53E-04	40	2.06E-04	20	
MW-06	8 - 18	Limestone	U2	3.98E-04	30	1.64E-04	10	20
			D1	3.84E-04	30	4.35E-04	40	
MW-07	7.5 - 17.5	Limestone	U2	2.07E-04	20	2.11E-04	20	14.1
			D2	6.38E-05	10	6.07E-05	10	
MW-09	9 - 19	Limestone	U1	1.22E-03	110	5.42E-04	50	22.4
			D1	6.12E-05	10	9.80E-05	10	

Notes:
ft bgs = feet below ground surface
ft/d = feet per day
ft/s = feet per second

Table 4: Groundwater Elevation Data

	MW-01	MW-02	MW-03	MW-04	MW-05	MW-06	MW-07	MW-08	MW-09	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15
Groundwater Elevation:															
Minimum (ft)	581.84	581.75	581.36	581.45	581.70	580.61	580.92	579.95	580.56	579.13	579.48	579.66	581.50	581.35	581.87
Maximum (ft)	584.01	584.11	584.51	584.25	584.14	583.01	583.33	582.97	583.52	582.07	582.60	581.64	582.95	582.47	584.17
1st Quartile (ft)	582.53	582.42	582.60	582.15	582.45	581.33	581.48	581.05	581.11	579.93	580.05	580.18	581.78	581.61	582.27
3rd Quartile (ft)	583.31	583.30	583.32	582.94	583.14	582.04	582.38	581.83	582.41	580.63	580.83	580.65	581.95	582.06	582.84
IQR (ft)	0.78	0.89	0.72	0.79	0.69	0.71	0.90	0.78	1.30	0.70	0.78	0.46	0.17	0.45	0.57
Lower Bound (ft)	581.35	581.08	581.52	580.95	581.41	580.27	580.12	579.87	579.15	578.88	578.88	579.49	581.52	580.94	581.40
Upper Bound (ft)	584.49	584.63	584.41	584.13	584.18	583.10	583.74	583.01	584.37	581.68	582.00	581.34	582.21	582.74	583.70
Average (ft)[1]	582.95	582.89	582.89	582.59	582.82	581.74	581.98	581.47	581.74	580.27	580.37	580.40	581.86	581.82	582.50

Notes:

ft = feet

IQR = Interquartile range

[1]The calculated average water level was used as the calibration head target in the numerical groundwater flow model

Table 5: Calibrated Water Budget

Component	Conceptual Flux	Modeled Flux	
	af/yr	af/yr	cfd
INFLOWS			
Recharge	18	20	2,366
Infiltration through retention and ash ponds		9	1,030
Total Inflows		28	3,396
OUTFLOWS			
Discharge to Des Plaines River	40	21	2,465
Discharge to CSSC	33	8	931
Total outflows		28	3,396

Notes:

af/yr = acre-feet per year

cfd = cubic feet per day

CSSC = Chicago Sanitary and Ship Canal

Table 6: Calibration Residuals

Well	Easting	Northing	Target Value[1]	Modeled Water Level	Residual
	NAD83, State Plane, IL East, ft		ft	ft	ft
MW-01	1057345.6	1809996.0	582.95	582.94	0.01
MW-02	1057227.4	1809764.1	582.89	582.86	0.03
MW-03	1057288.7	1809532.1	582.89	582.89	0.00
MW-04	1057266.8	1809357.1	582.59	582.59	0.00
MW-05	1057262.4	1809173.3	582.82	582.50	0.32
MW-06	1057253.7	1808915.1	581.74	581.85	-0.11
MW-07	1057013.0	1809947.9	581.98	582.05	-0.07
MW-08	1056894.8	1809466.5	581.47	581.54	-0.07
MW-09	1056851.2	1809244.1	581.74	581.34	0.40
MW-10	1056798.0	1808931.7	580.27	580.32	-0.05
MW-11	1056809.2	1809070.5	580.37	580.53	-0.16
MW-12	1056797.4	1808740.8	580.40	580.47	-0.07
MW-13[2]	1056860.1	1809334.5	581.86	581.36	0.50
MW-14[2]	1056945.2	1809726.9	581.82	582.07	-0.25
MW-15[2]	1057062.7	1810105.3	582.50	582.08	0.42

Notes:

ft = feet

[1]The target value for site-specific wells is the long-term average of measured water levels

Table 7: Calibration Statistics

Parameter	
Average Residual (ft)	0.06
Minimum Residual (ft)	-0.25
Maximum Residual (ft)	0.50
Sum of Squared Residuals (ft^2)	0.81
RMS Error (ft)	0.23
%RMS[1]	8.7%

Notes:
ft = feet
ft^2 = feet squared
RMS = root mean squared

[1]Calculated by dividing the RMS error by the range in measurec

Table 8: Fourth Quarter Sampling Results for Constituents of Concern in Downgradient CCR Monitoring Wells

Monitoring Well	Arsenic	Boron	Calcium	Chloride	Molybdenum	Sulfate	Pond
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
MW-07	0.0032	3	59	140	0.087	440	1N
MW-08	0.014	3.5	110	120	0.11	500	1S
MW-09	0.0093	2.4	37	200	0.068	180	1S
MW-10	0.015	4.4	130	160	0.097	220	2S/3S
MW-11	0.013	3.8	120	130	0.052	66	2S/3S
MW-12	0.0017	2.3	160	180	0.029	180	2S/3S
MW-13	0.0015	1.6	140	160	0.017	400	1S
MW-14	0.0024	3.1	83	120	0.073	570	1N
MW-15	0.0038	4.1	170	120	0.03	480	1N

Notes:
CCR = Coal Combustion Residuals
mg/l = miligrams per liter

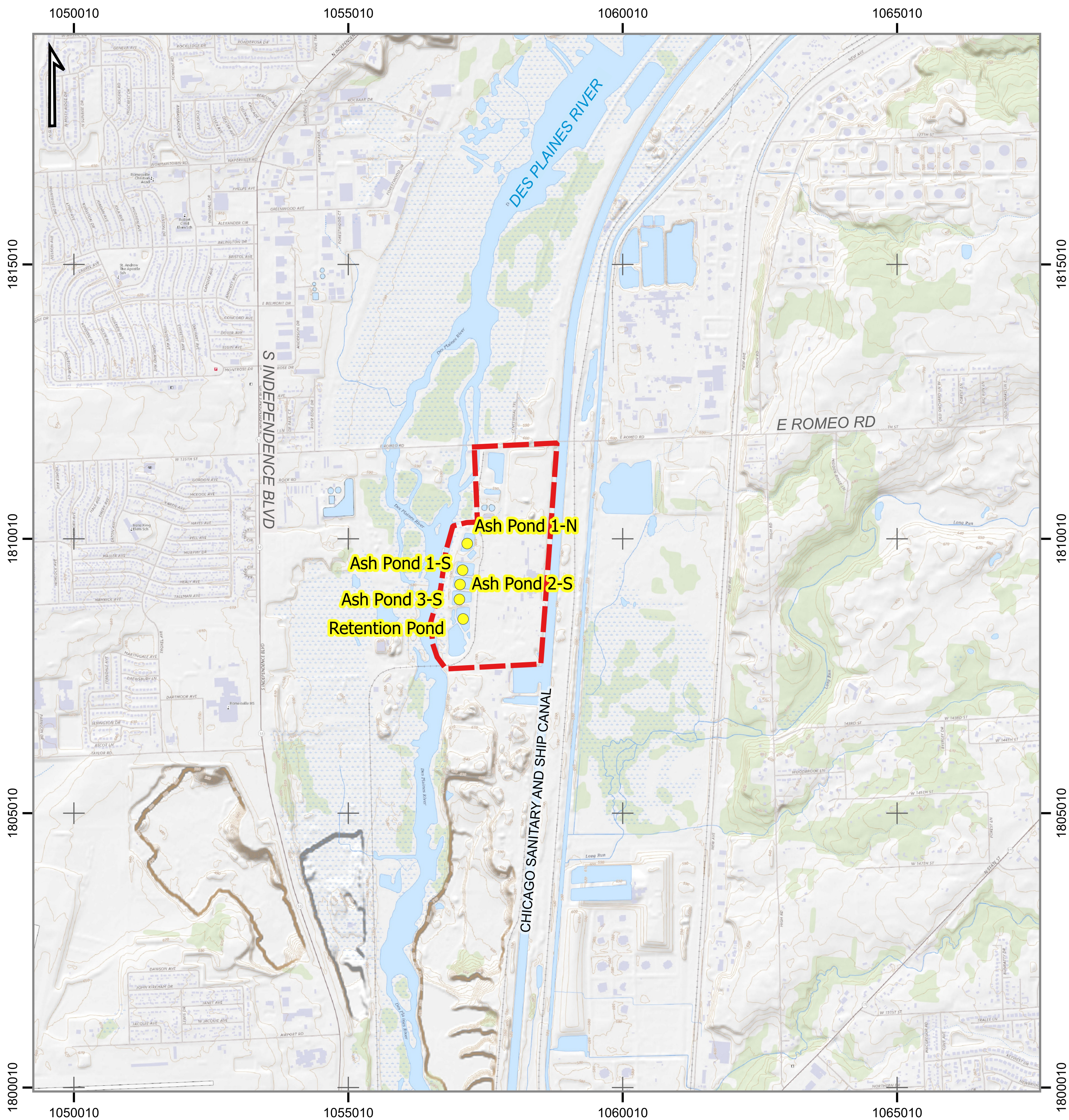
Table 9: Proposed Groundwater Protection Standards

Ash Pond	Arsenic	Boron	Calcium	Chloride	Molybdenum	Sulfate
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1N	0.01	6.5	109.5	200	0.1	547.6
1S	0.017	6.97	362	200	0.1	1217
2S/3S	0.01	4.739	313.4	200	0.172	1053

Notes:

mg/l = miligrams per liter

FIGURES



LEGEND

APPROXIMATE SITE BOUNDARY

0 0.5 mi

FEET

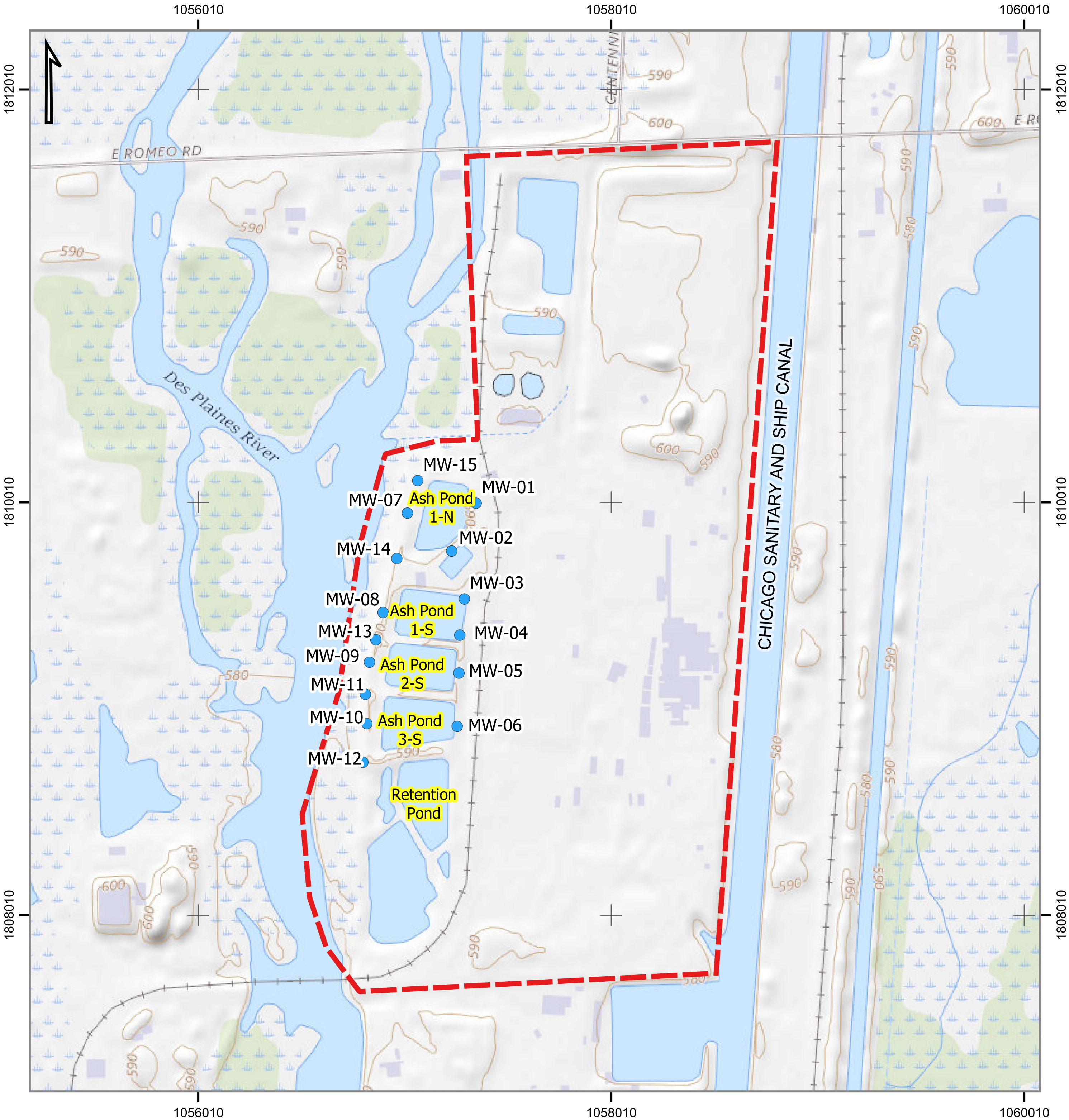
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure1_LocationMap.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**LOCATION MAP**

SCALE AT ANSI A			
1:30,000	DRAWN	DZF	03/29/2023
	CHECKED	BAS	03/29/2023
BAS PROJECT No. 21141501		FIGURE: 1	



LEGEND

- SITE MONITORING WELL
- APPROXIMATE SITE BOUNDARY

0 400 800 ft

FEET

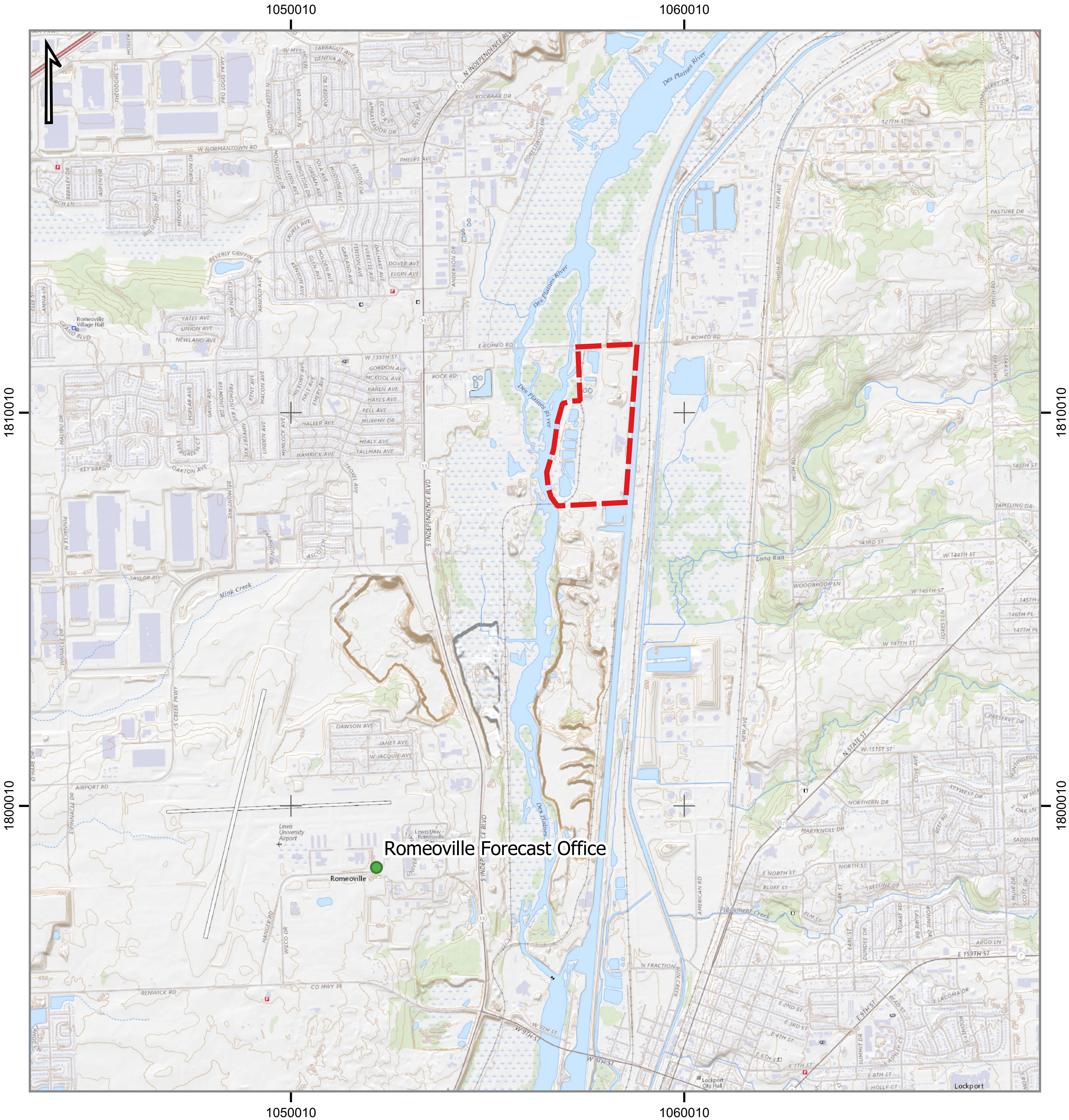
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure2_SiteWells.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**WILL COUNTY STATION SITE MONITORING WELLS**

SCALE AT ANSI A	DRAWN	DZF	05/09/2023
1:8,000	CHECKED	BAS	05/09/2023
BAS PROJECT No. 21141501		FIGURE: **2**	



LEGEND

- CLIMATE STATION
- APPROXIMATE SITE BOUNDARY

0 2,000 4,000 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure3_ClimateStations.qgz

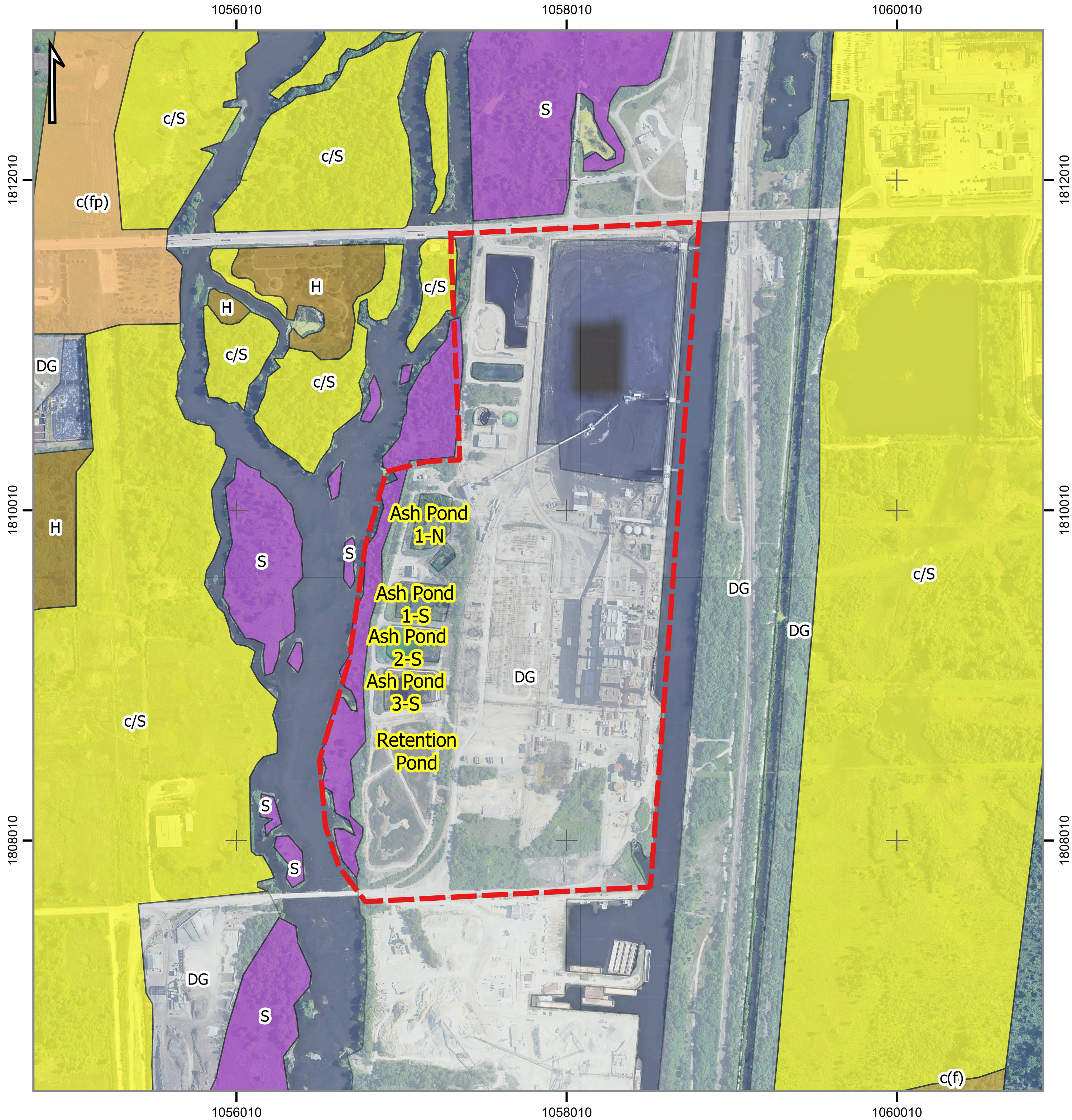
BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CLIMATE STATIONS NEAR WILL COUNTY STATION**

SCALE AT ANSI A	DRAWN	DZF	01/11/2023
1:42,000	CHECKED	BAS	01/11/2023

BAS PROJECT No.	FIGURE:
21141501	**3**



LEGEND

APPROXIMATE SITE BOUNDARY

SURFACE GEOLOGY

- DISTURBED GROUND (DG)
- SILURIAN BEDROCK (S) (DOLOMITE)
- CAHOKIA FORMATION (c/S)
- CAHOKIA FORMATION, FAN (c(f))
- HENRY FORMATION (H)
- CAHOKIA FORMATION, FLOODPLAIN (c(fp))

0 500 1,000 ft

FEET

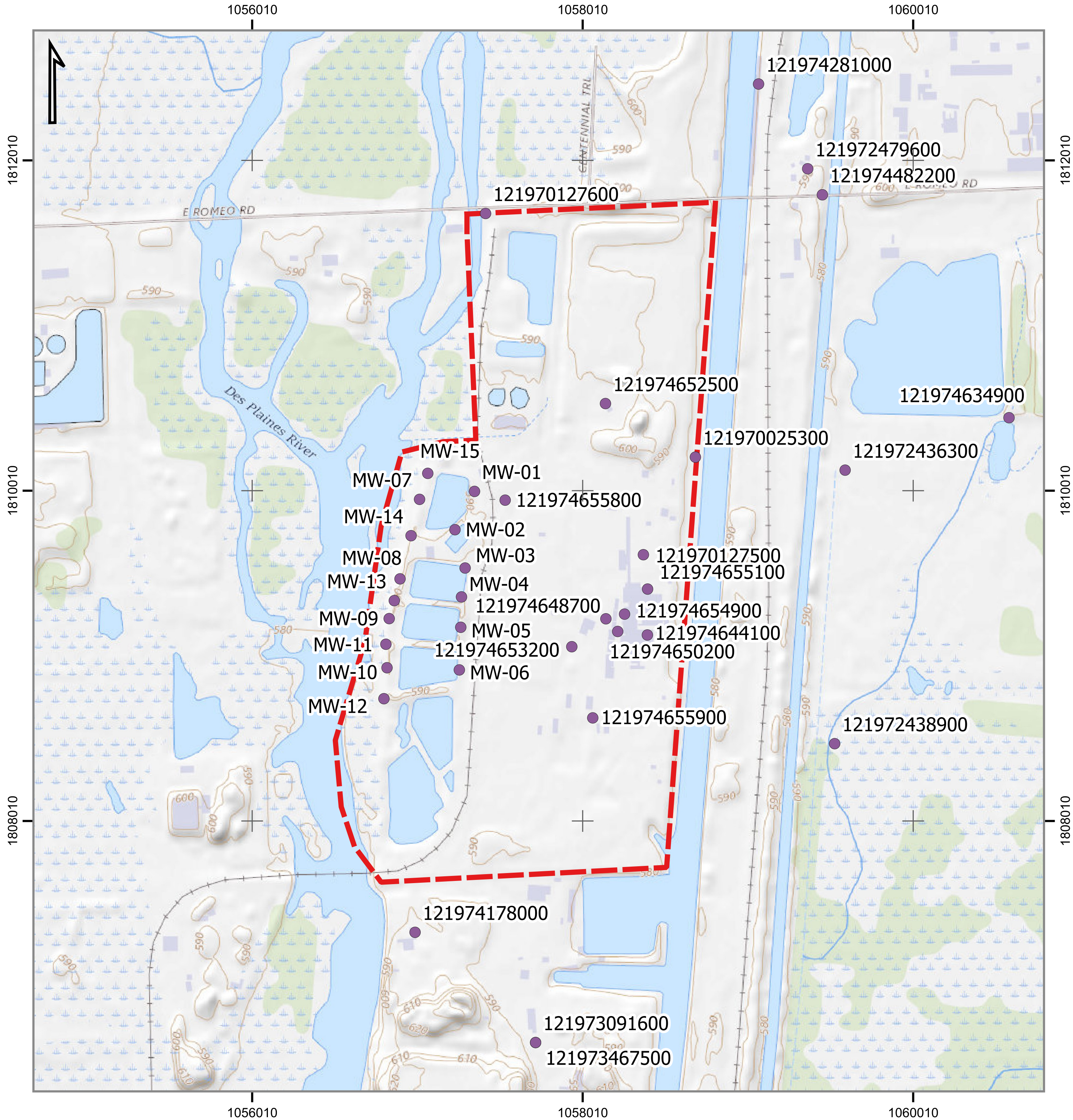
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure4_Geology.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**SURFACE GEOLOGY**

SCALE AT ANSI A	DRAWN	DZF	03/29/2023
1:10,000	CHECKED	BAS	03/29/2023
BAS PROJECT No. 21141501		FIGURE: 4	



LEGEND

APPROXIMATE SITE BOUNDARY

WELLS WITH BOREHOLE LITHOLOGY DATA

0 500 1,000 ft

FEET

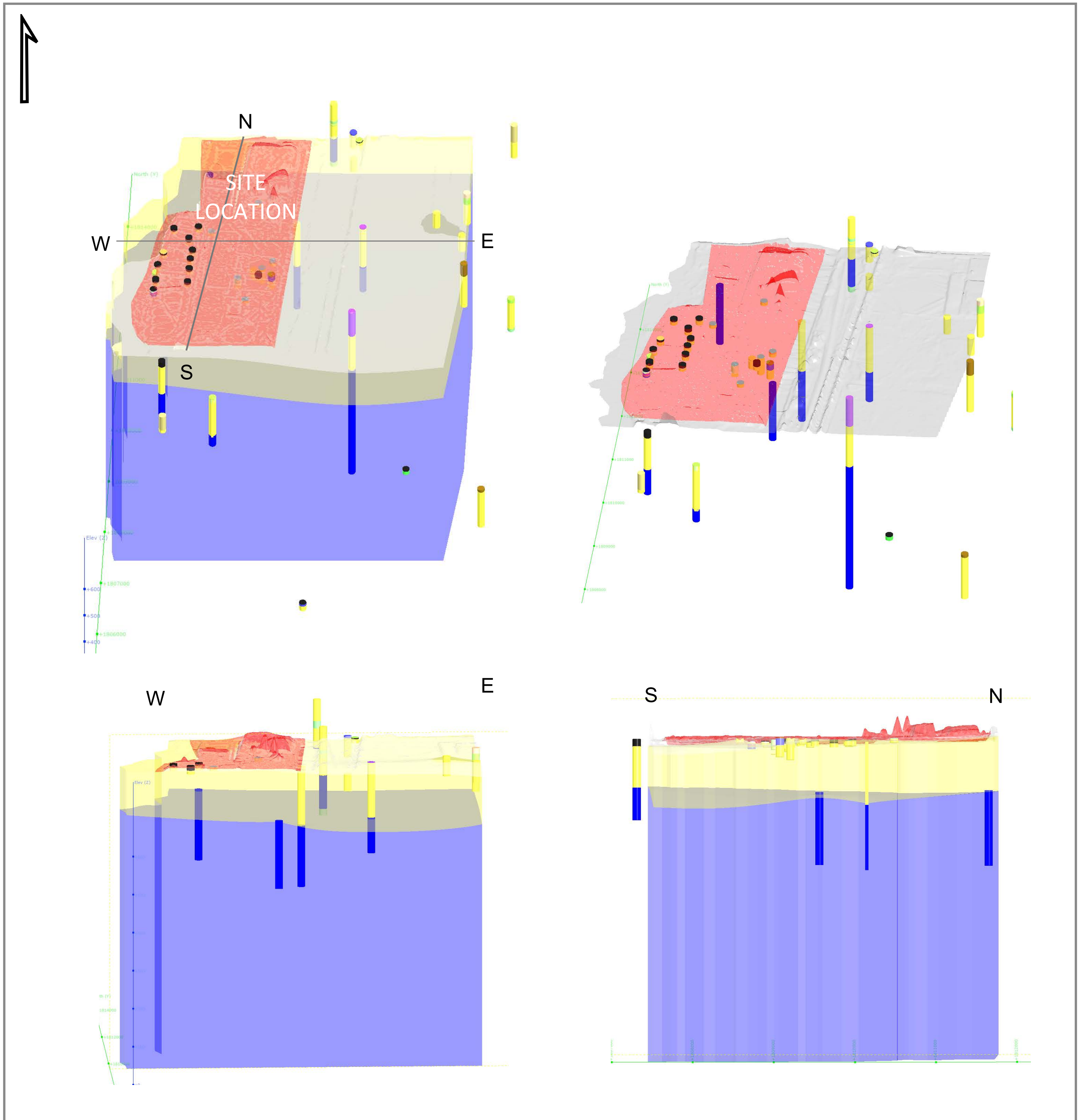
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure5_WellsWBoreholes.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**WELLS WITH BOREHOLE LITHOLOGY DATA**

SCALE AT ANSI A 1:10,000	DRAWN	DZF	01/11/2023
	CHECKED	BAS	01/11/2023
BAS PROJECT No. 21141501	FIGURE: 5		



LEGEND

Leapfrog_Geology

- Fill
- overburden
- topsoil
- loam
- clay, sand
- silt and clay
- clay
- clay, sand, gravel
- sand
- sand and gravel
- dolomite
- carbonates
- carbonates and shale
- shale

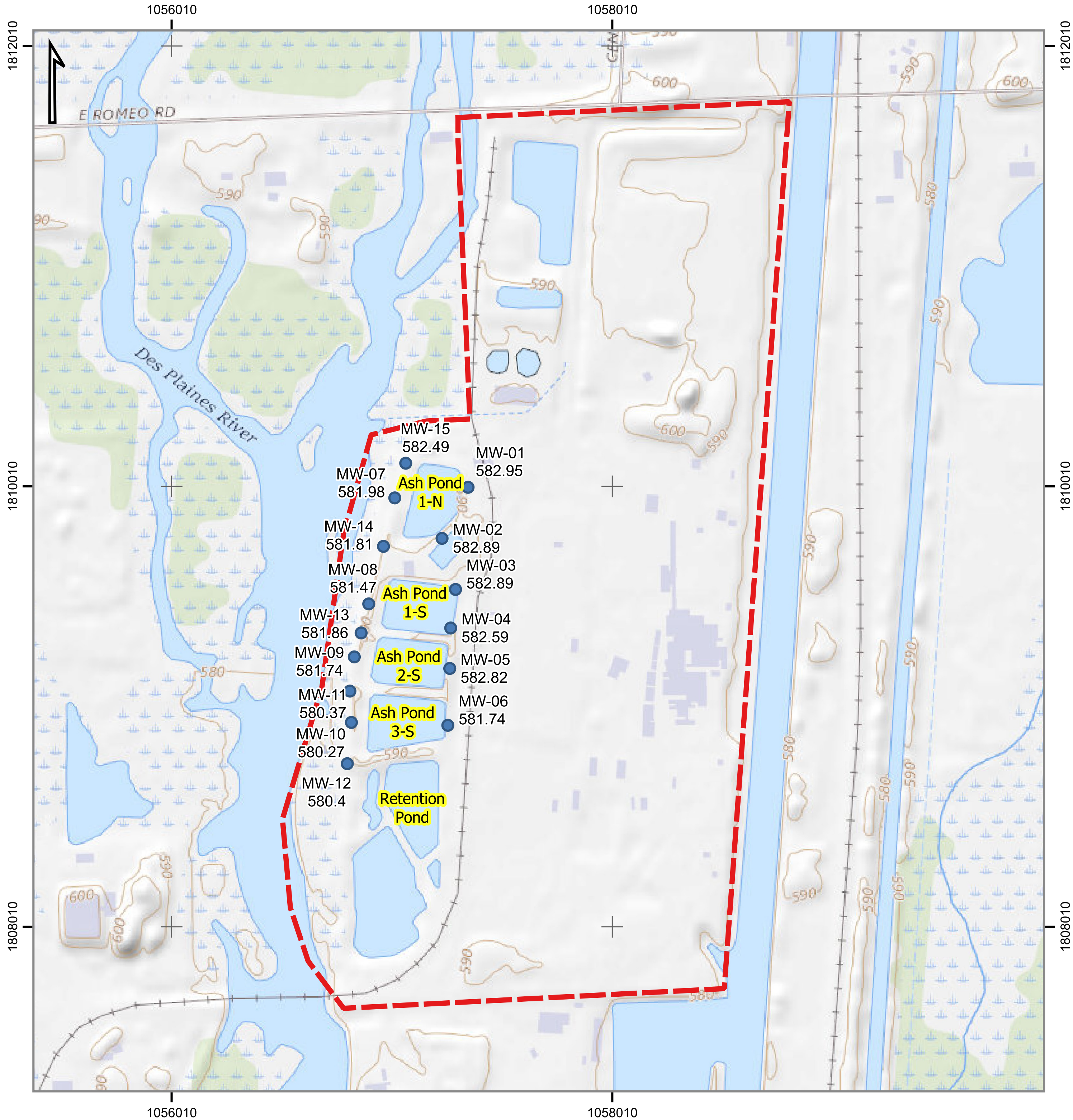
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure6_LeapfrogGeology.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**BOREHOLE LITHOLOGY DATA**

SCALE AT ANSI A	DRAWN	DZF	01/11/2023
	CHECKED	BAS	01/11/2023
BAS PROJECT No. 21141501		FIGURE: **6**	



LEGEND

AVERAGE WATER LEVEL ELEVATION (FT, AMSL)

APPROXIMATE SITE BOUNDARY

0 400 800 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure7_WellsWWaterLevelData.qgz

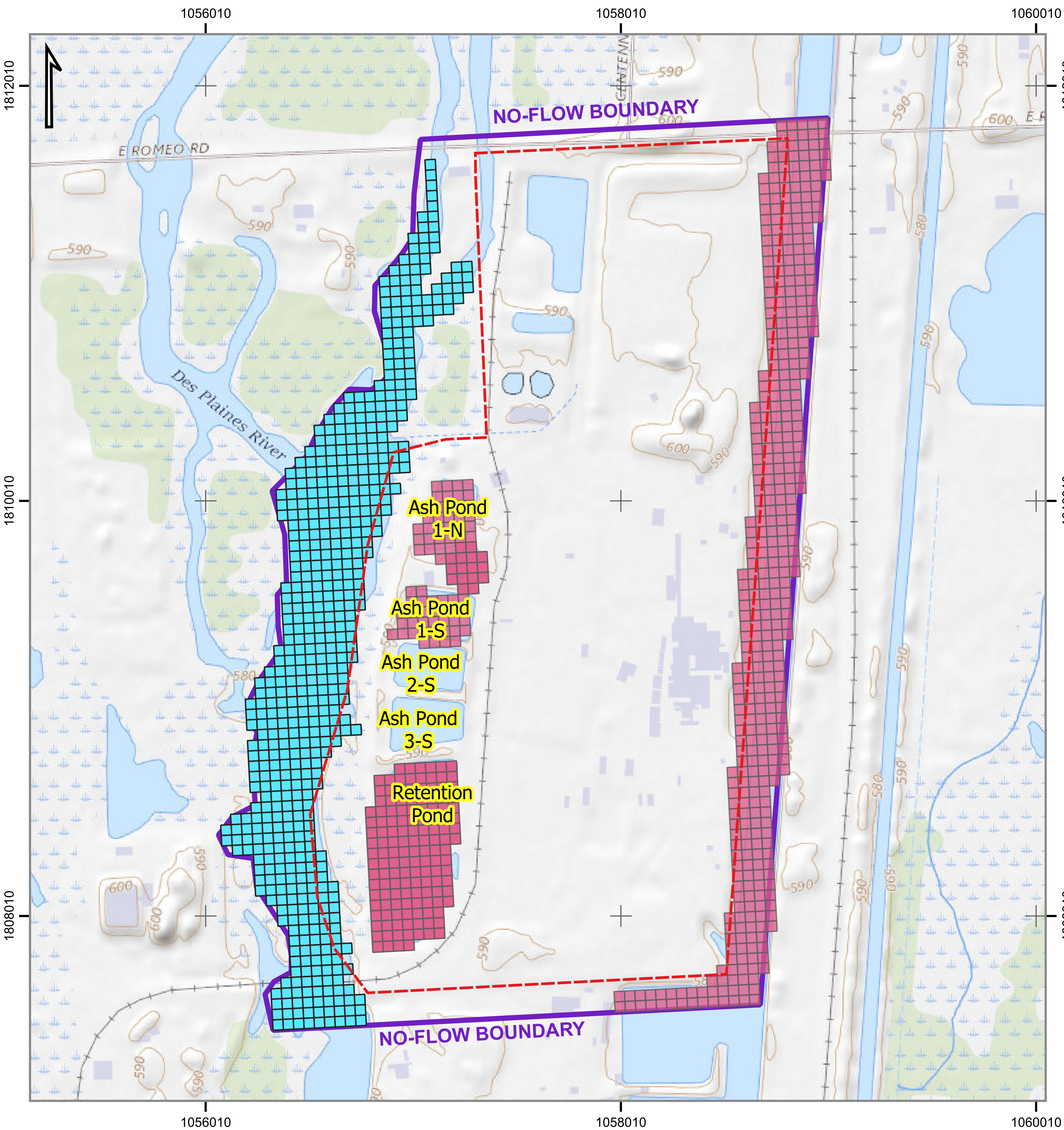
BAS GROUNDWATER CONSULTING

K P R G

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**WELLS WITH WATER LEVEL DATA**

SCALE AT ANSI A	DRAWN	DZF	01/11/2023
1:7,500	CHECKED	BAS	01/11/2023

BAS PROJECT No.	FIGURE:
21141501	7



LEGEND

- MODEL BOUNDARY
- GENERAL HEAD BOUNDARY
- RIVER BOUNDARY
- APPROXIMATE SITE BOUNDARY

0 400 800 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure8_ModelBoundary.qgz

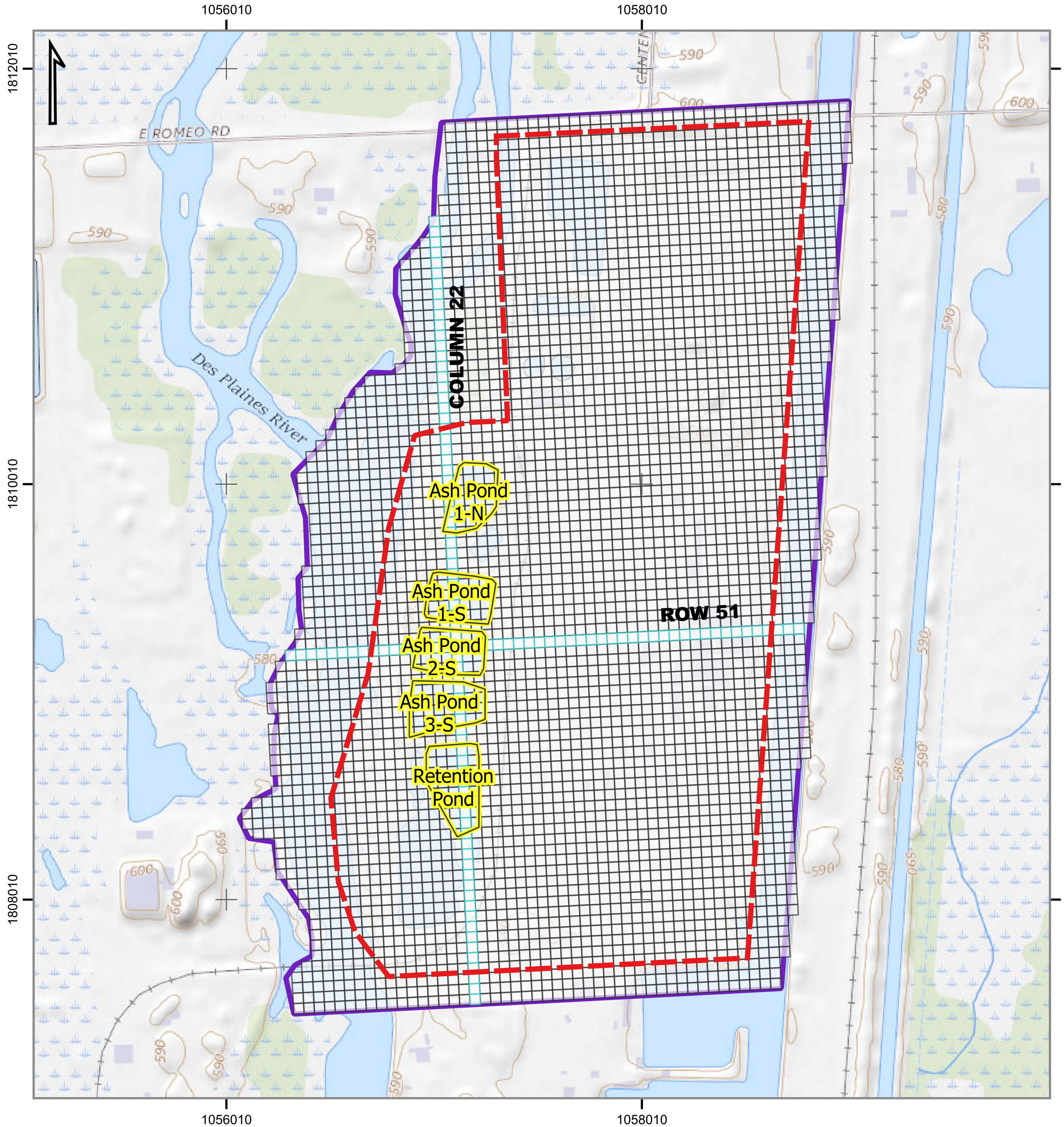
BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**MODEL BOUNDARY CONDITIONS**

SCALE AT ANSI A	DRAWN	DZF	03/20/2023
1:8,000	CHECKED	BAS	03/20/2023

BAS PROJECT No.	FIGURE:
21141501	8



LEGEND

- MODEL BOUNDARY
- MODEL GRID
- APPROXIMATE SITE BOUNDARY

HIGHLIGHTED SECTIONS SHOWN ON FIGURE 10

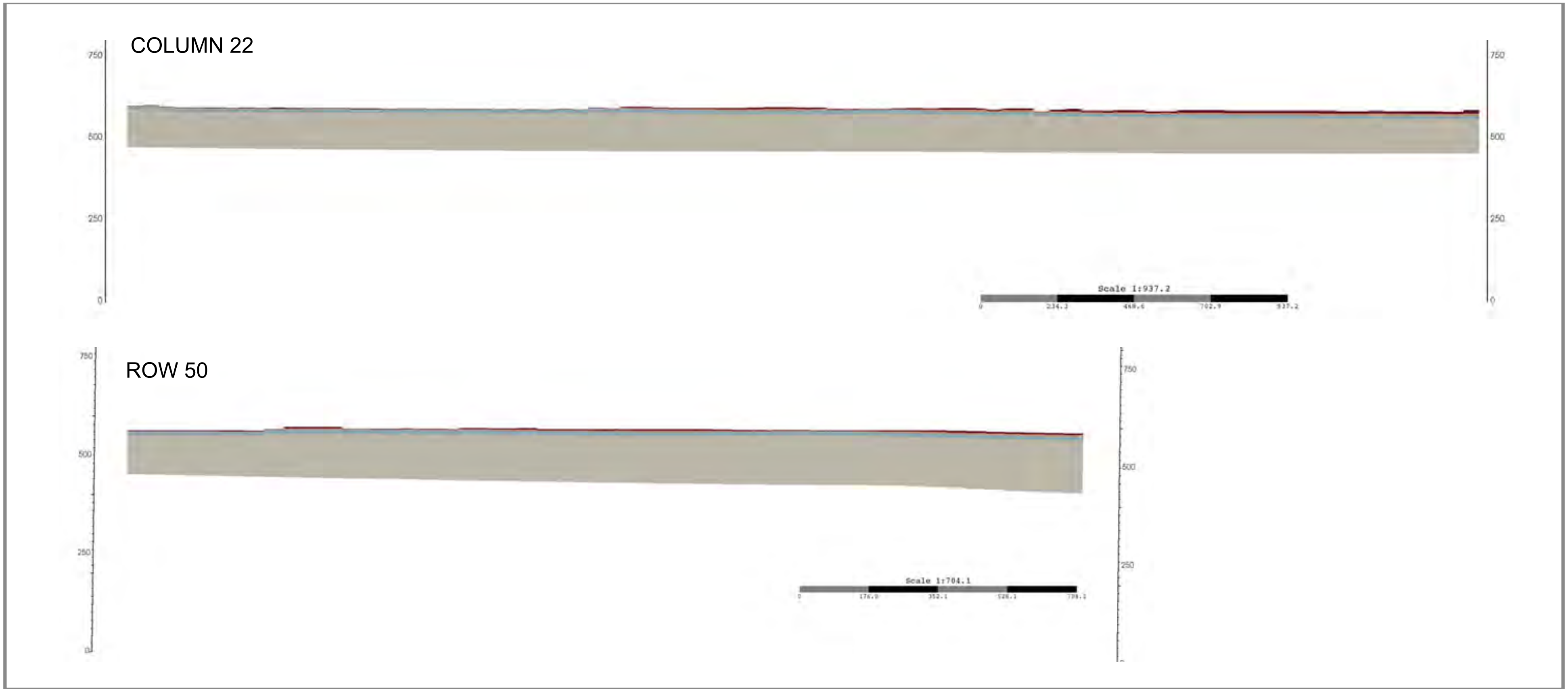
0 400 800 ft
FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure9_ModelGrid.qgz

BAS GROUNDWATER CONSULTING
KPRG

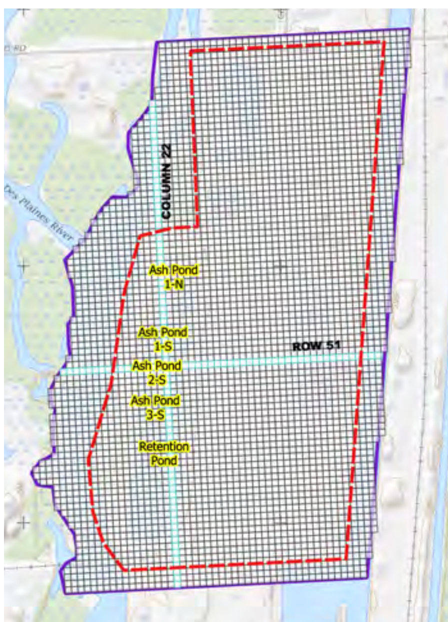
CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**MODEL GRID**

SCALE AT ANSI A	DRAWN	DZF	03/29/2023
1:8,000	CHECKED	BAS	03/29/2023
BAS PROJECT No. 21141501	FIGURE: 9		



LEGEND

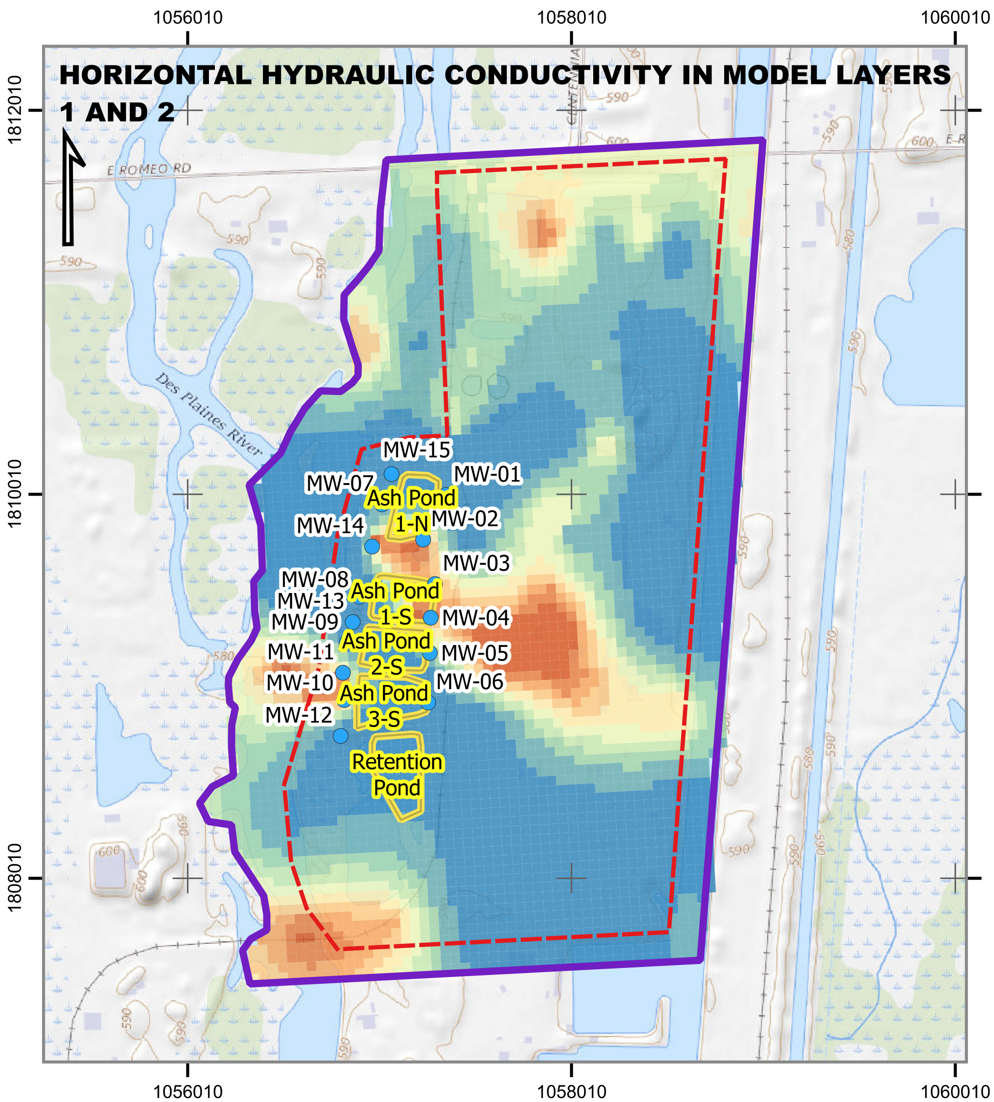
- LAYER 1
- LAYER 2
- LAYER 3
- LAYER 4

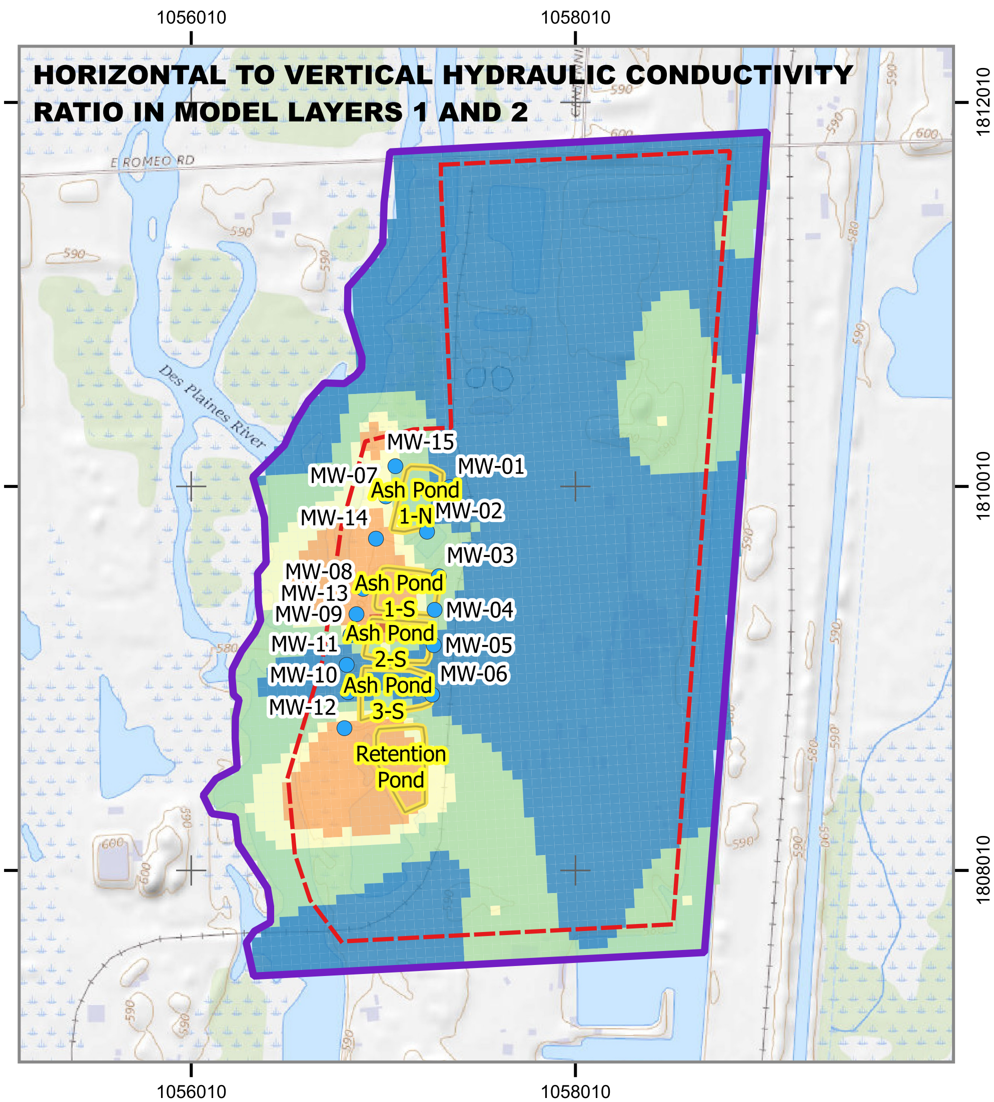


Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure10_ModelLayering.qgz

BAS GROUNDWATER CONSULTING
KPRG

CLIENT	MIDWEST GENERATION		
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL		
TITLE	**MODEL LAYERING**		
SCALE AT ANSI A	DRAWN	DZF	01/11/2023
	CHECKED	BAS	01/11/2023
BAS PROJECT No. 21141501		FIGURE: **10**	





LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

SITE MONITORING WELL

CALIBRATED HORIZONTAL HYDRAULIC CONDUCTIVITY VALUES, FT/D

0.08 - 0.74	6.76 - 9.78
0.74 - 1.75	9.78 - 13.27
1.75 - 3.04	13.27 - 16.91
3.04 - 4.58	16.91 - 21.85
4.58 - 6.76	21.85 - 25

HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY RATIO

- 1 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 - 1000

BAS GROUNDWATER CONSULTING

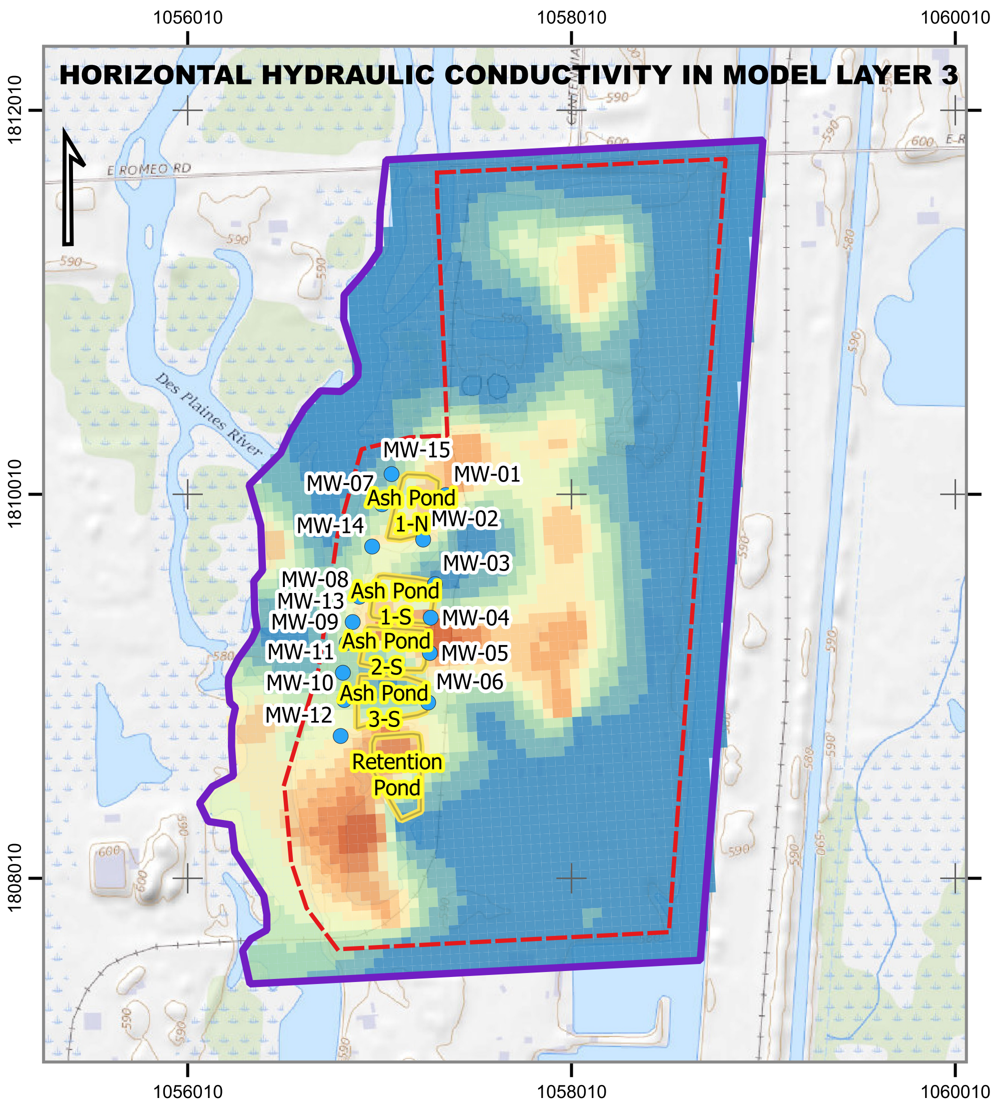
KPRG

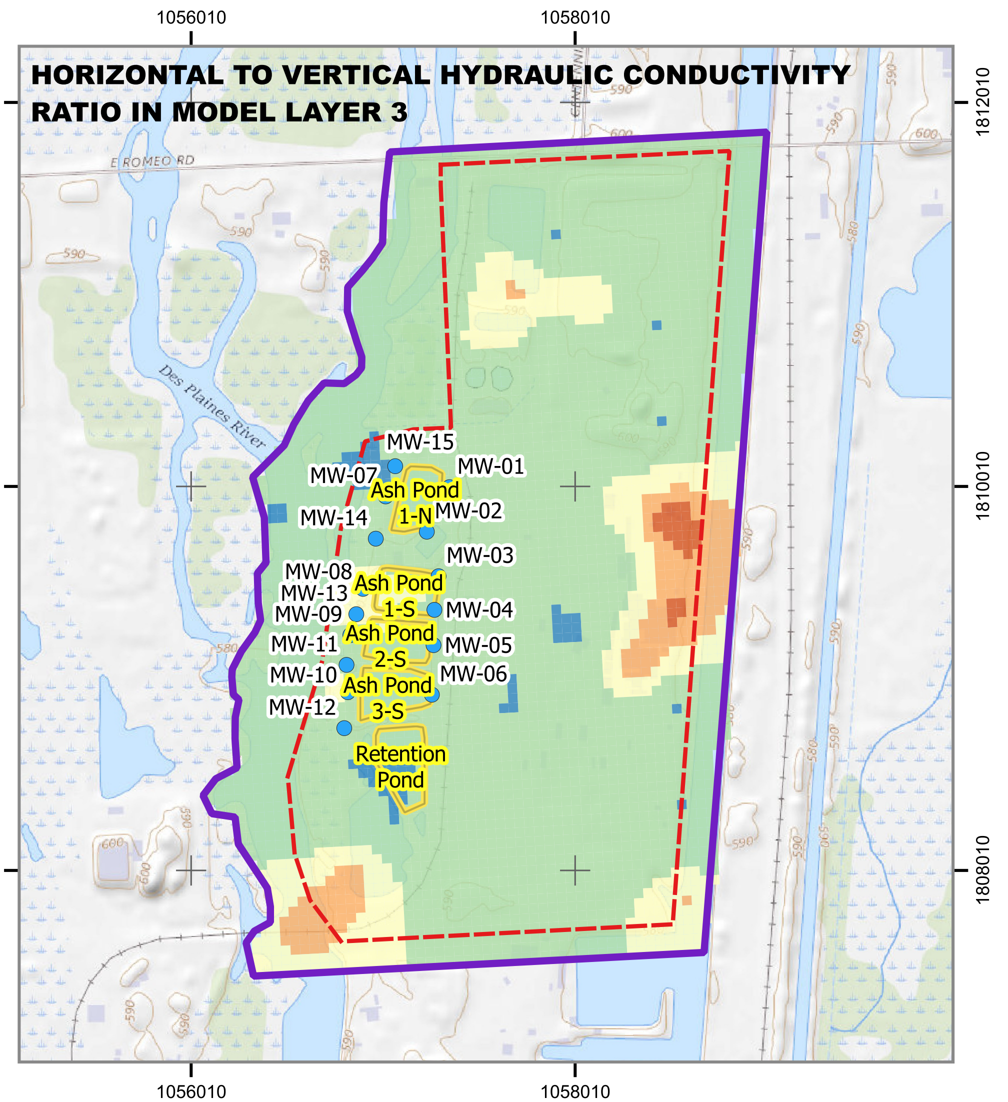
0 600 1,200 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11a_CalibratedKsLayers1_2.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CALIBRATED HYDRAULIC CONDUCTIVITY DISTRIBUTION IN MODEL LAYERS 1 & 2**
SCALE AT ANSI A	1:12,000
DRAWN	DZF 03/29/2023
CHECKED	BAS 03/29/2023
BAS PROJECT No.	21141501
FIGURE:	**11a**





LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

SITE MONITORING WELL

CALIBRATED HORIZONTAL HYDRAULIC CONDUCTIVITY VALUES, FT/D

0.8 - 2.4	16.2 - 21.5
2.4 - 5.1	21.5 - 26.8
5.1 - 8.3	26.8 - 31.1
8.3 - 12	31.1 - 36.6
12 - 16.2	36.6 - 40

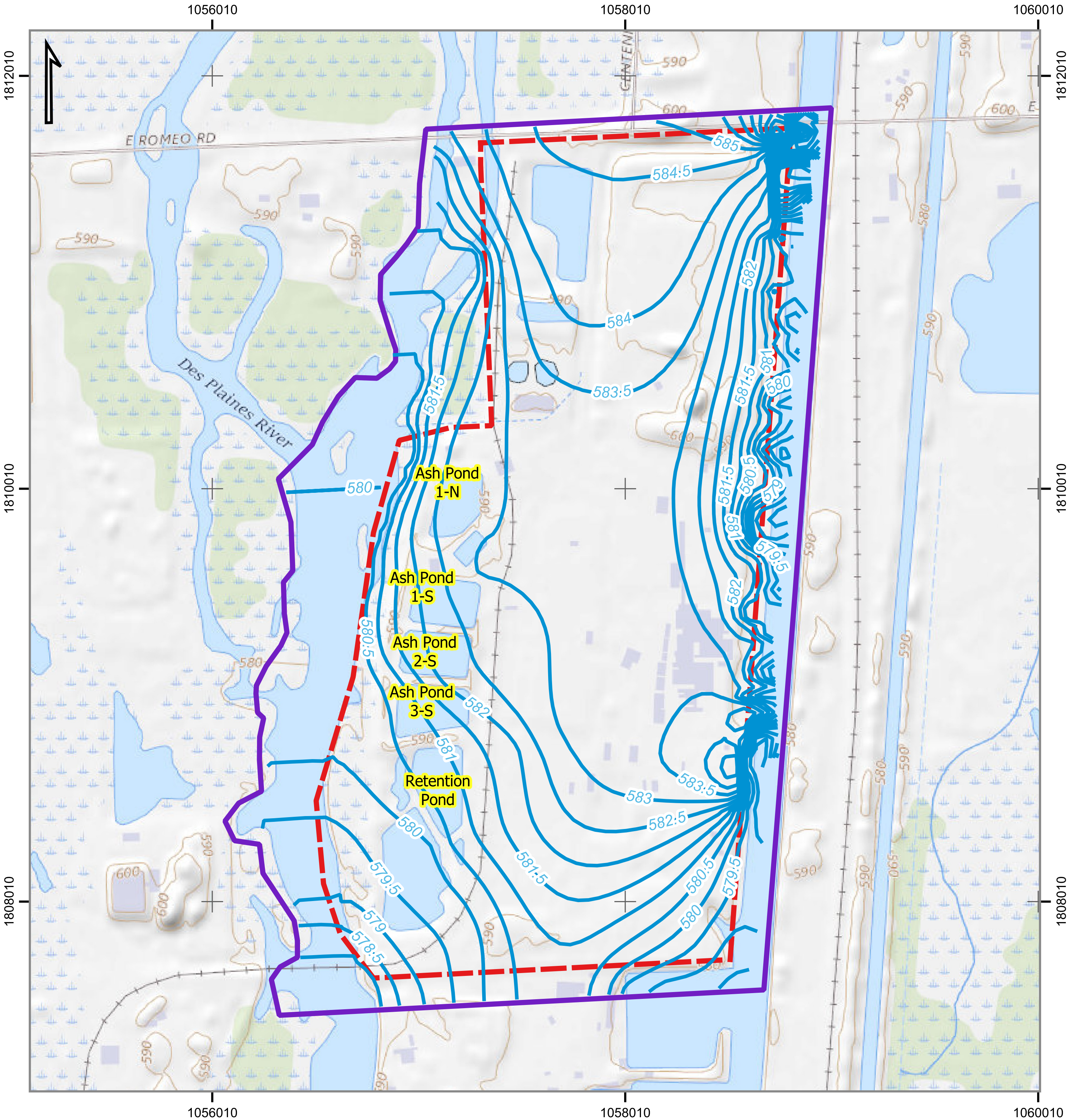
HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY RATIO

- 0.1 - 1.0
- 1.0 - 3.0
- 3.0 - 5.0
- 5.0 - 7.0
- 7.0 - 10.0

0 600 1,200 ft
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11b_CalibratedKsLayers3_4.qgz

CLIENT	MIDWEST GENERATION		
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL		
TITLE	CALIBRATED HYDRAULIC CONDUCTIVITY DISTRIBUTION IN MODEL LAYERS 3 & 4		
SCALE AT ANSI A 1:12,000	DRAWN	DZF	03/29/2023
	CHECKED	BAS	03/29/2023
BAS PROJECT No. 21141501	FIGURE: 11b		



LEGEND

- MODELED WATER LEVEL ELEVATION CONTOUR (FT, AMSL)
- APPROXIMATE SITE BOUNDARY

0 400 800 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure12_CalibratedWLs.qgz

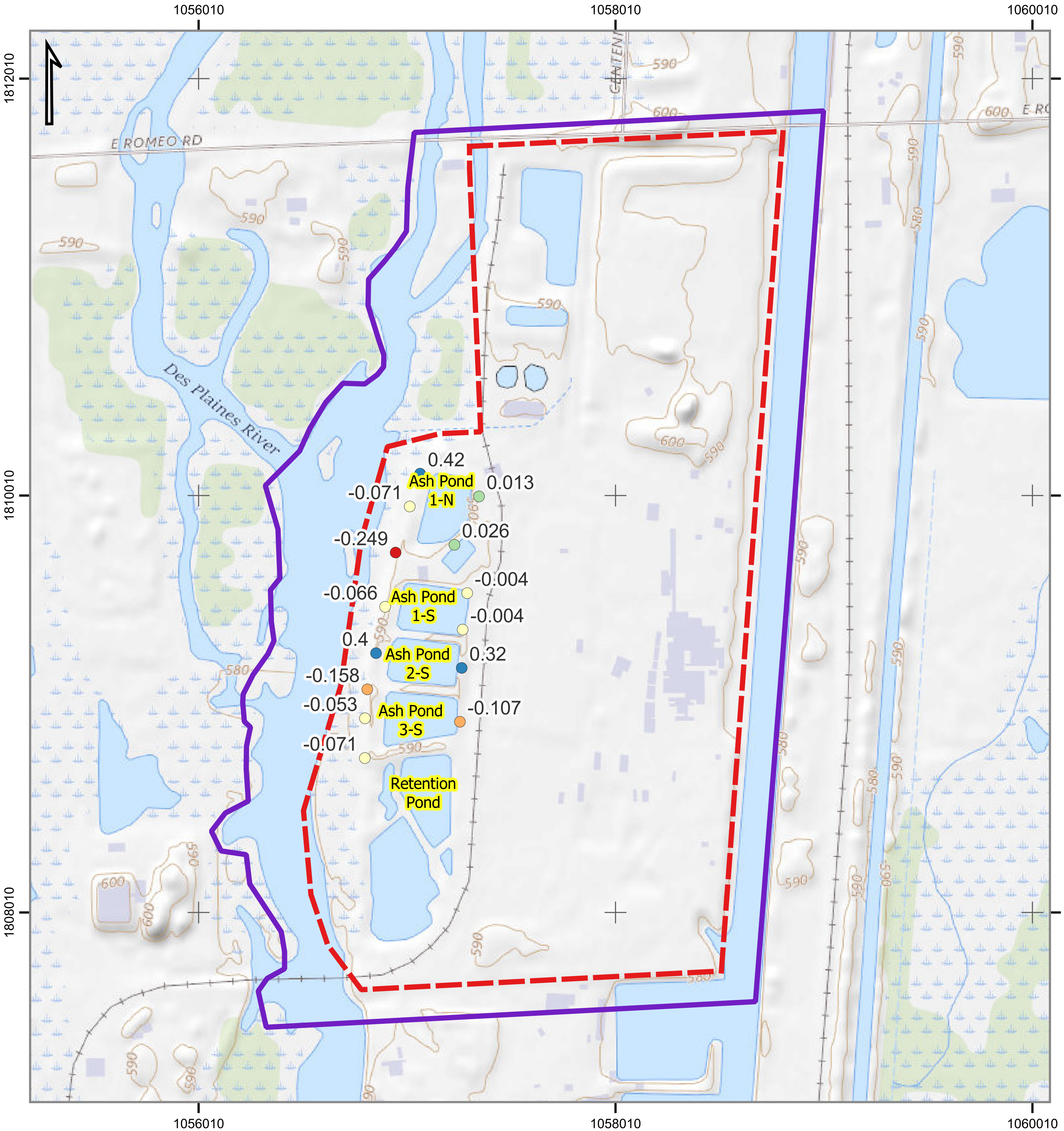
BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CALIBRATED WATER LEVEL ELEVATIONS IN CARBONATES**

SCALE AT ANSI A	DRAWN	DZF	04/05/2023
1:8,000	CHECKED	BAS	04/05/2023

BAS PROJECT No.	FIGURE:
21141501	**12**



LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

RESIDUALS (FT.)

- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - 0
- 0 - 0.1
- 0.1 - 0.5

0 400 800 ft

FEET

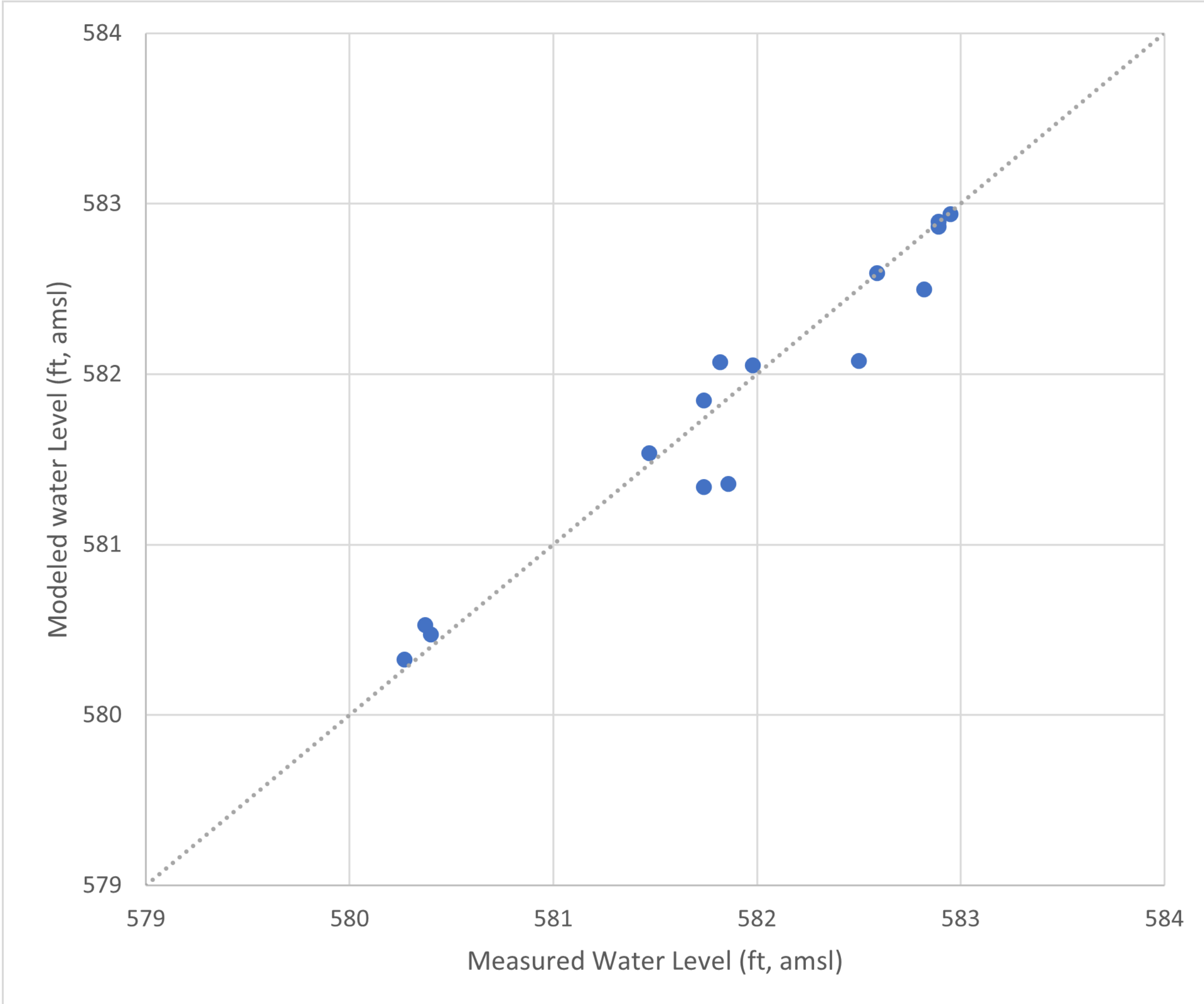
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure13_CalibratedResiduals.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CALIBRATED WATER LEVEL RESIDUALS**

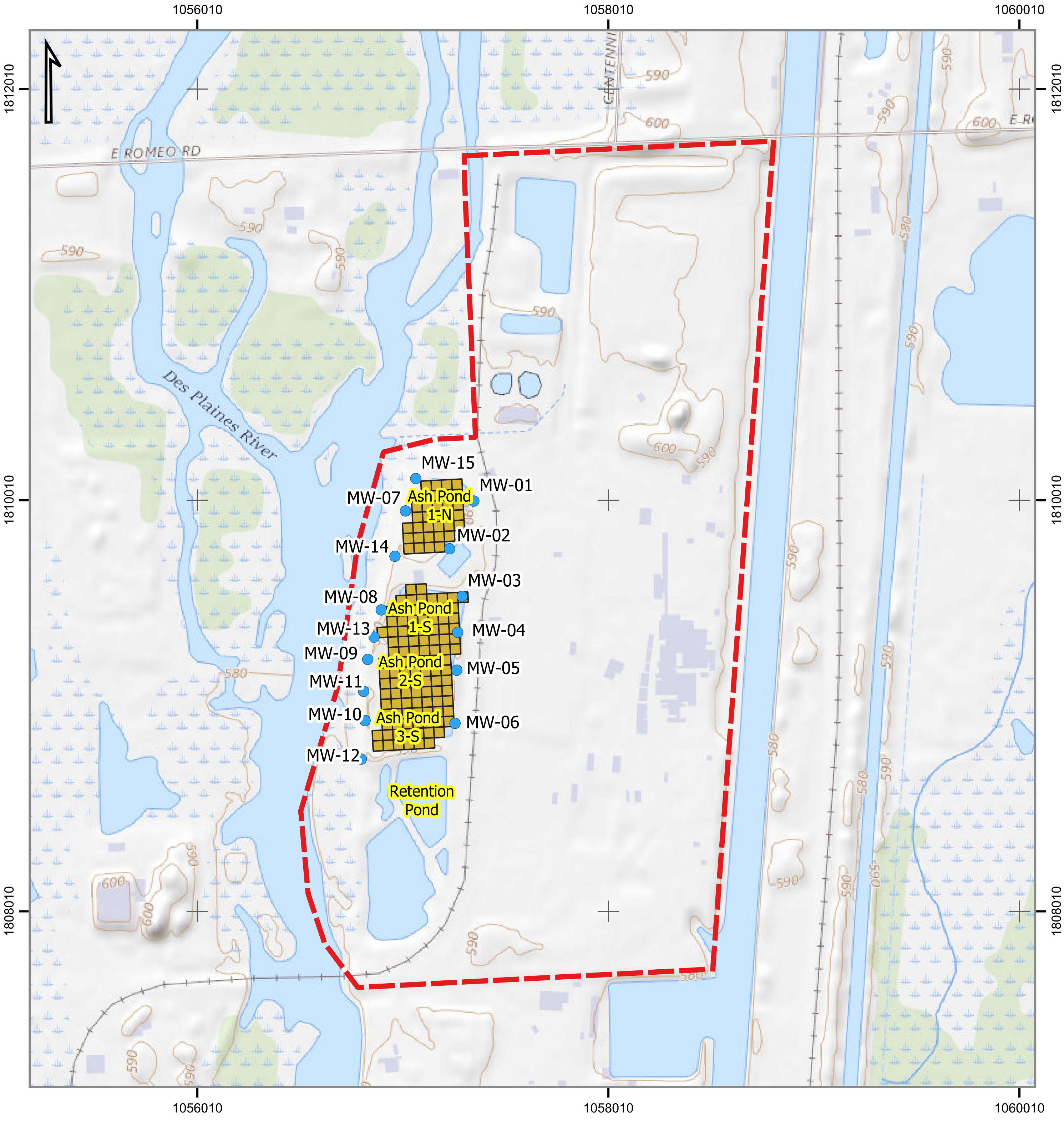
SCALE AT ANSI A	DRAWN	DZF	05/09/2023
1:8,000	CHECKED	BAS	05/09/2023
BAS PROJECT No. 21141501		FIGURE: **13**	



SCALE AT ANSI A	DRAWN	DZF	04/05/2023
	CHECKED	BAS	04/05/2023
BAS PROJECT No. 21141501		FIGURE: 14	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CALIBRATION SCATTER PLOT**

Project File: Figure14_CalibrationScatterPlot.qgz



LEGEND

- SITE MONITORING WELL
- APPROXIMATE SITE BOUNDARY
- SOURCE AREAS FOR INITIAL SURROGATE SIMULATION

0 400 800 ft

FEET

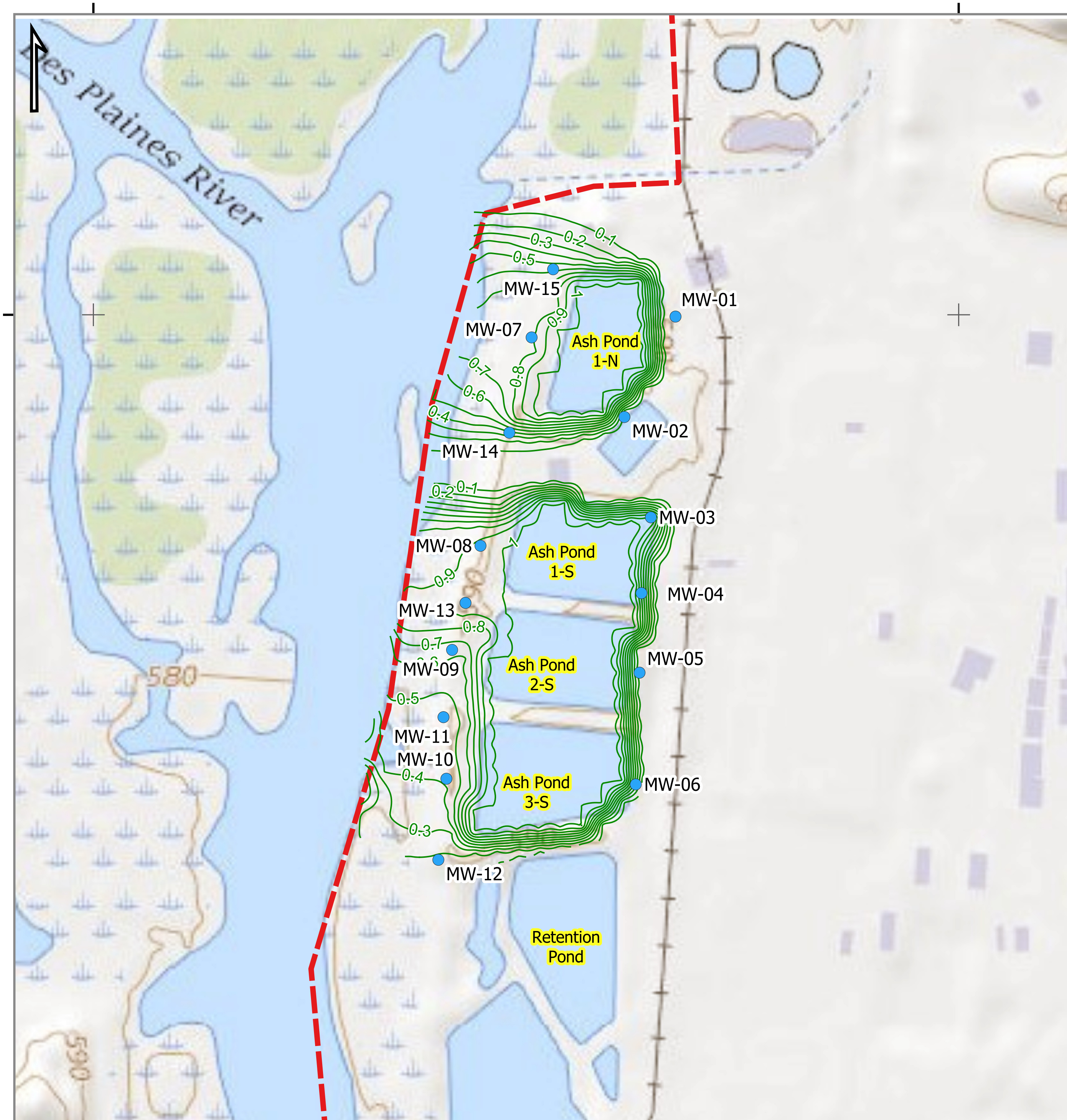
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure15_SourceAreas_SurrogateSimulations.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**SOURCE AREAS FOR INITIAL SURROGATE SIMULATION**

SCALE AT ANSI A	DRAWN	DZF	04/05/2023
1:8,000	CHECKED	BAS	04/05/2023
BAS PROJECT No. 21141501	FIGURE: **15**		



LEGEND

SITE MONITORING WELL

APPROXIMATE SITE BOUNDARY

100-YEAR RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

0 200 400 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure16_SurrogateSimulations.qgz

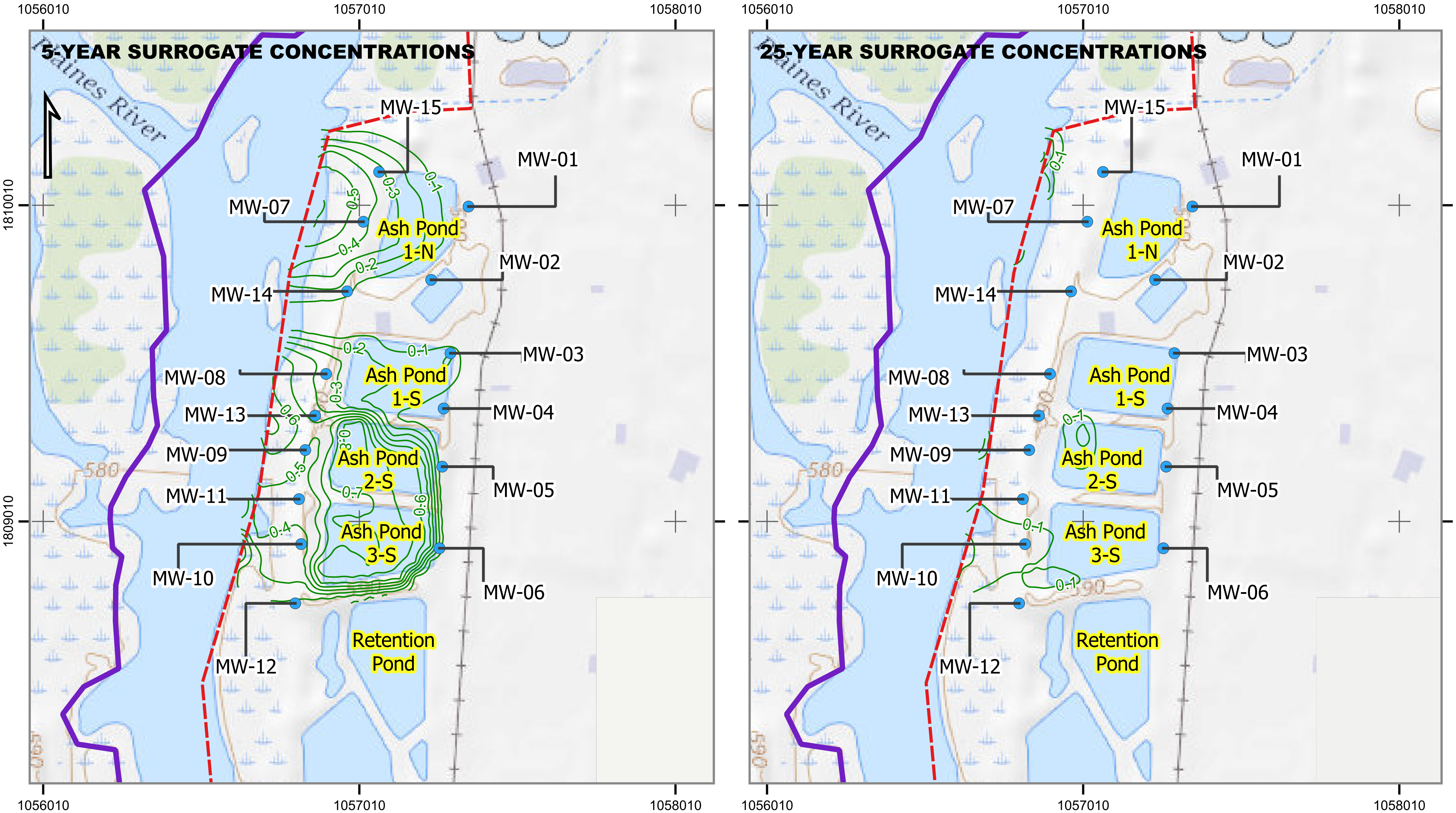
BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**100-YEAR RELATIVE SURROGATE CONCENTRATIONS**

SCALE AT ANSI A	DRAWN	DZF	04/21/2023
1:4,000	CHECKED	BAS	04/21/2023

BAS PROJECT No.	FIGURE:
21141501	**16**



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

KPRG

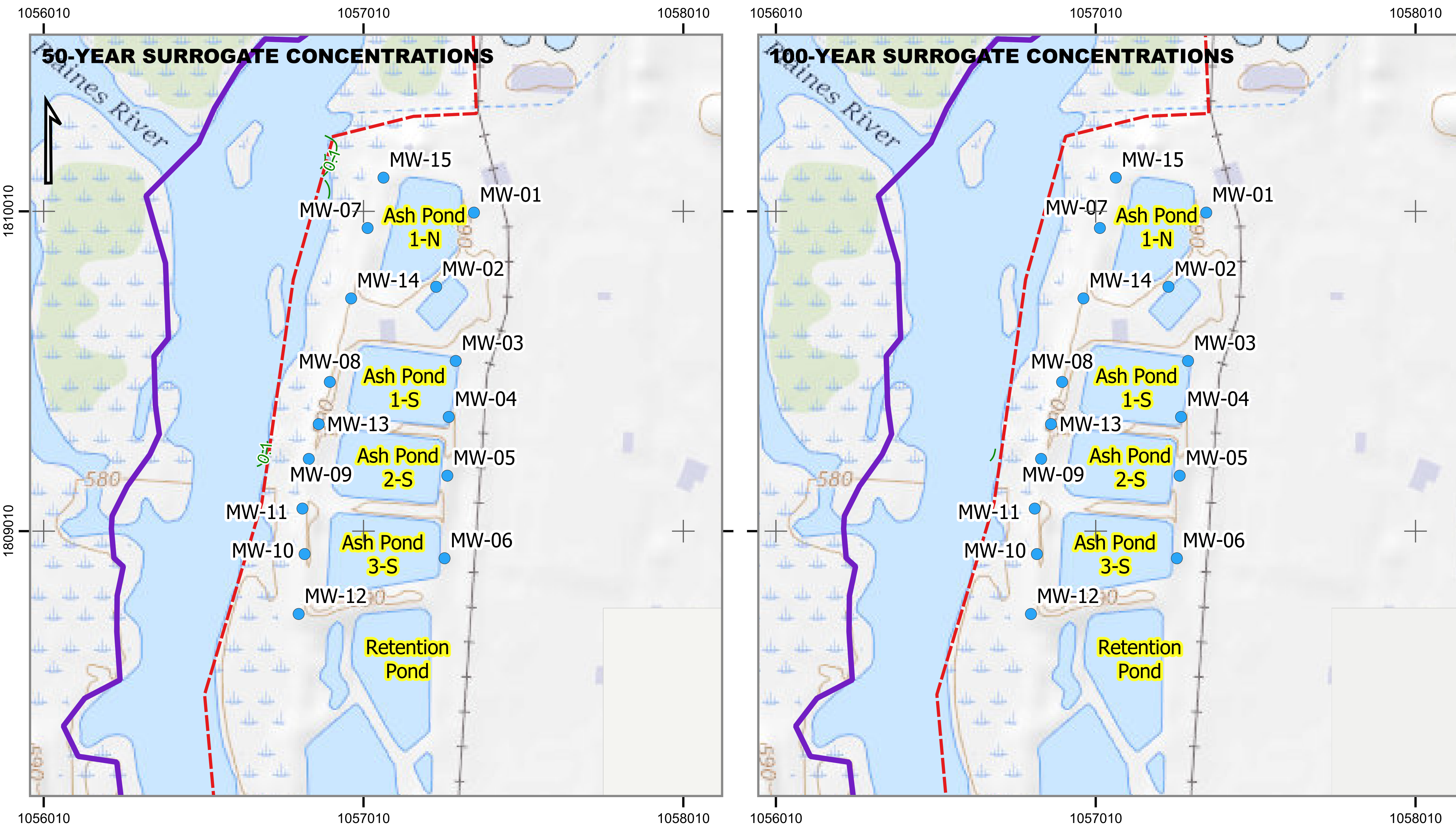
0 200 400 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure17_RelativeSurrogateConcentrations_5_25_Years_Scenario1.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 5 AND 25 YEARS, SCENARIO 1**

SCALE AT ANSI A	DRAWN	DZF	04/21/2023
1:5,400	CHECKED	BAS	04/21/2023
BAS PROJECT No. 21141501		FIGURE: 17	



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

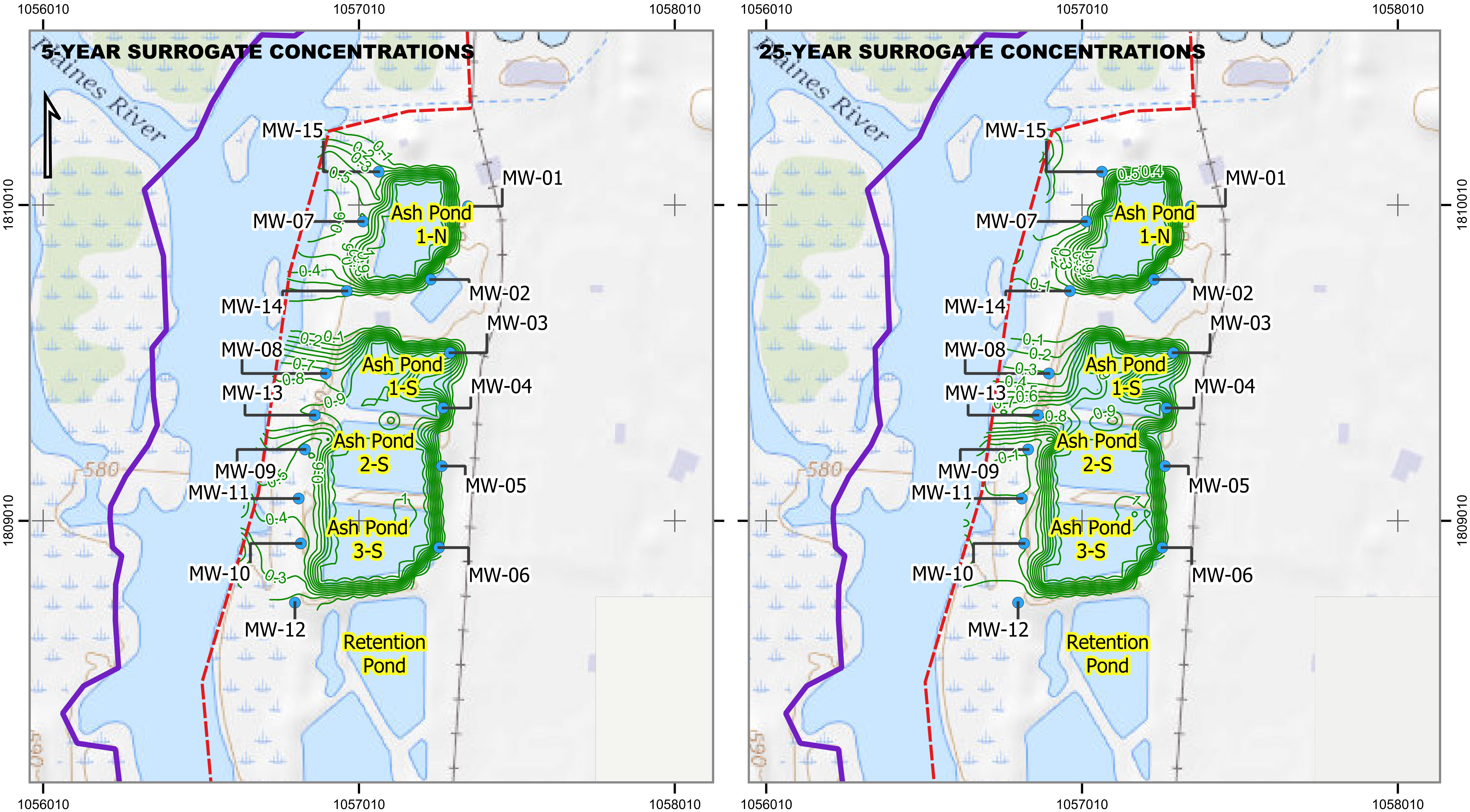
BAS GROUNDWATER CONSULTING KPRG

0 200 400 ft
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure18_RelativeSurrogateConcentrations_50_100_Years_Scenario1.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 50 AND 100 YEARS, SCENARIO 1**

SCALE AT ANSI A		
1:5,400	DRAWN DZF	04/21/2023
	CHECKED BAS	04/21/2023
BAS PROJECT No. 21141501	FIGURE: **18**	



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

K P R G

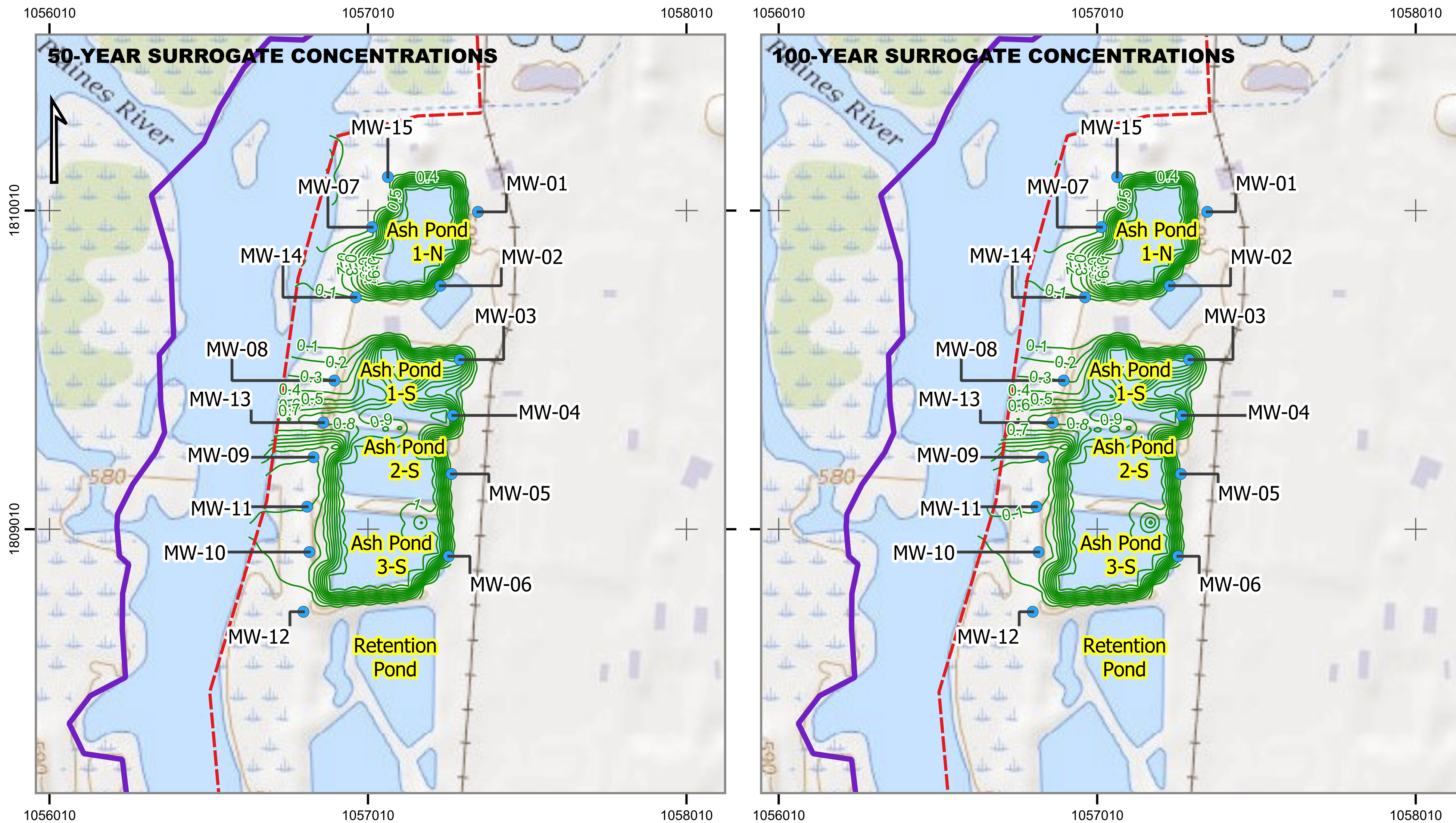
0 200 400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure19_RelativeSurrogateConcentrations_5_25_Years_Scenario2.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 5 AND 25 YEARS, SCENARIO 2**

SCALE AT ANSI A	DRAWN	DZF	04/21/2023
1:5,400	CHECKED	BAS	04/21/2023
BAS PROJECT No. 21141501	FIGURE: 19		



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

KPRG

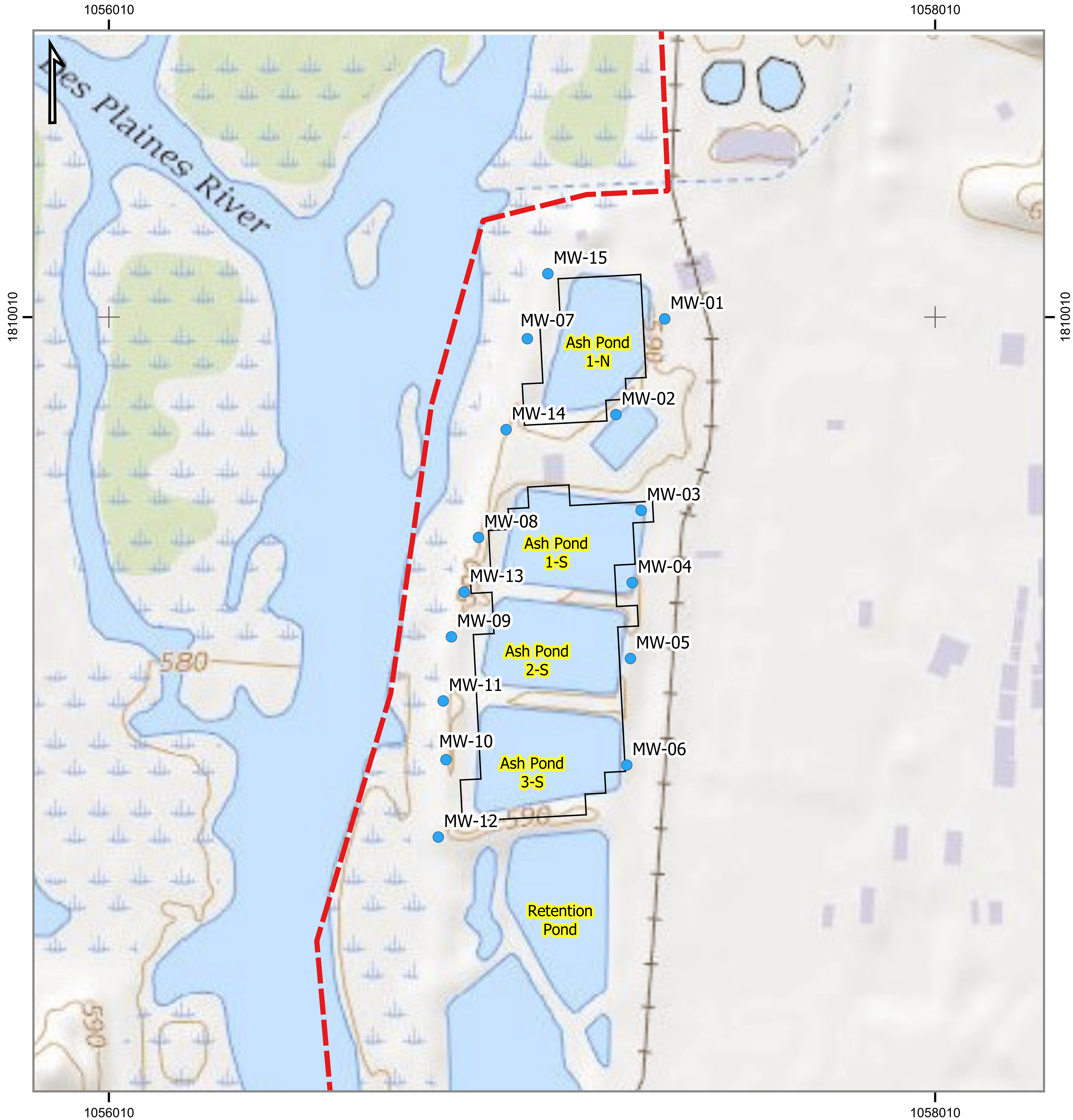
0 200 400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure20_RelativeSurrogateConcentrations_50_100_Years_Scenario2.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 50 AND 100 YEARS, SCENARIO 2**

SCALE AT ANSI A	*DRAWN*	*DZF*	04/21/2023
1:5,400	*CHECKED*	*BAS*	04/21/2023
BAS PROJECT No. 21141501		*FIGURE:* **20**	



LEGEND

- SITE MONITORING WELL
- APPROXIMATE SITE BOUNDARY
- AREA OF BARRIER WALL

0 200 400 ft

FEET

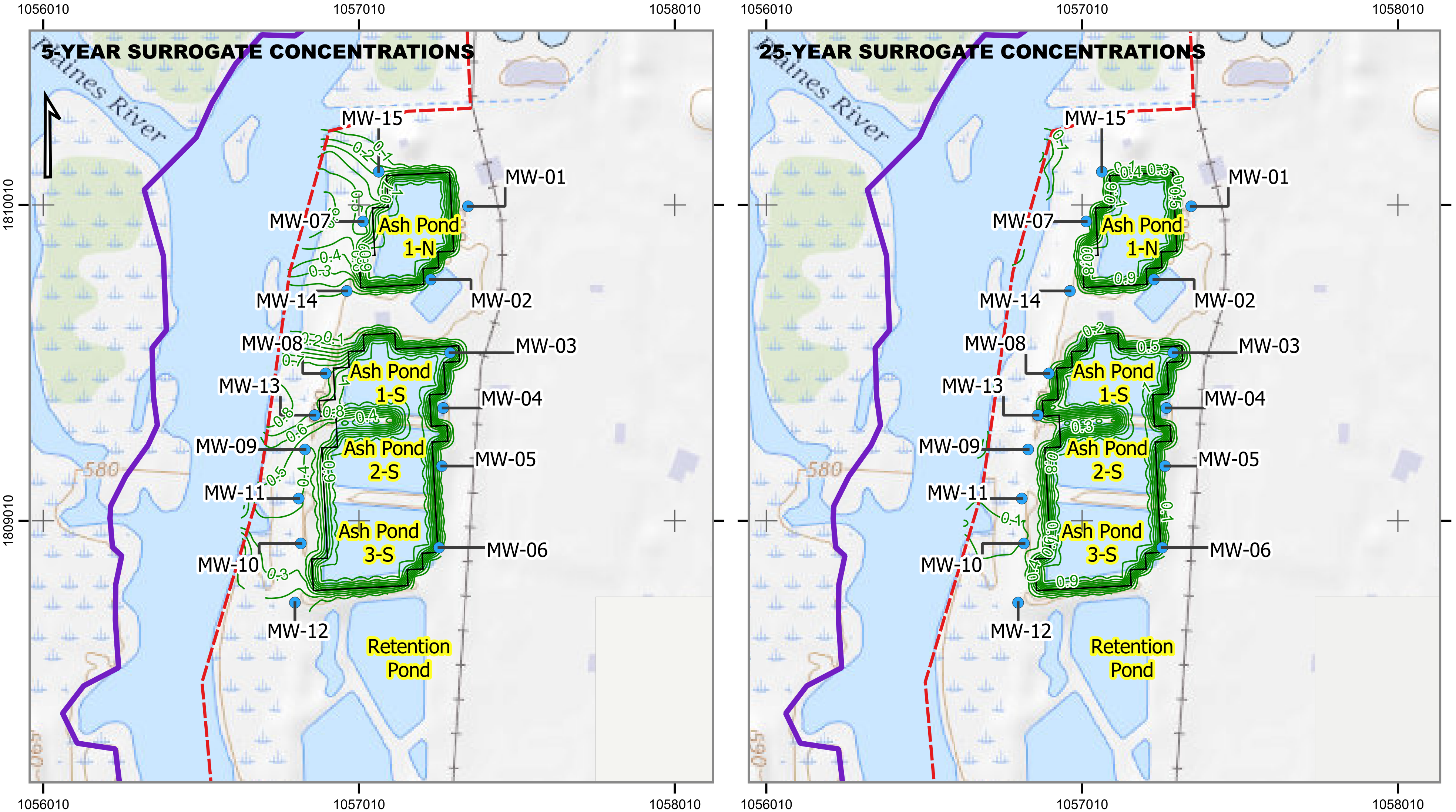
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure21_AreaOfBarrierWallForClosureAlt3.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**AREA OF BARRIER WALL FOR CLOSURE ALTERNATIVE 3**

SCALE AT ANSI A			
1:4,000	DRAWN	DZF	04/05/2023
	CHECKED	BAS	04/05/2023
BAS PROJECT No. 21141501		FIGURE: 21	



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- AREA OF BARRIER WALL
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

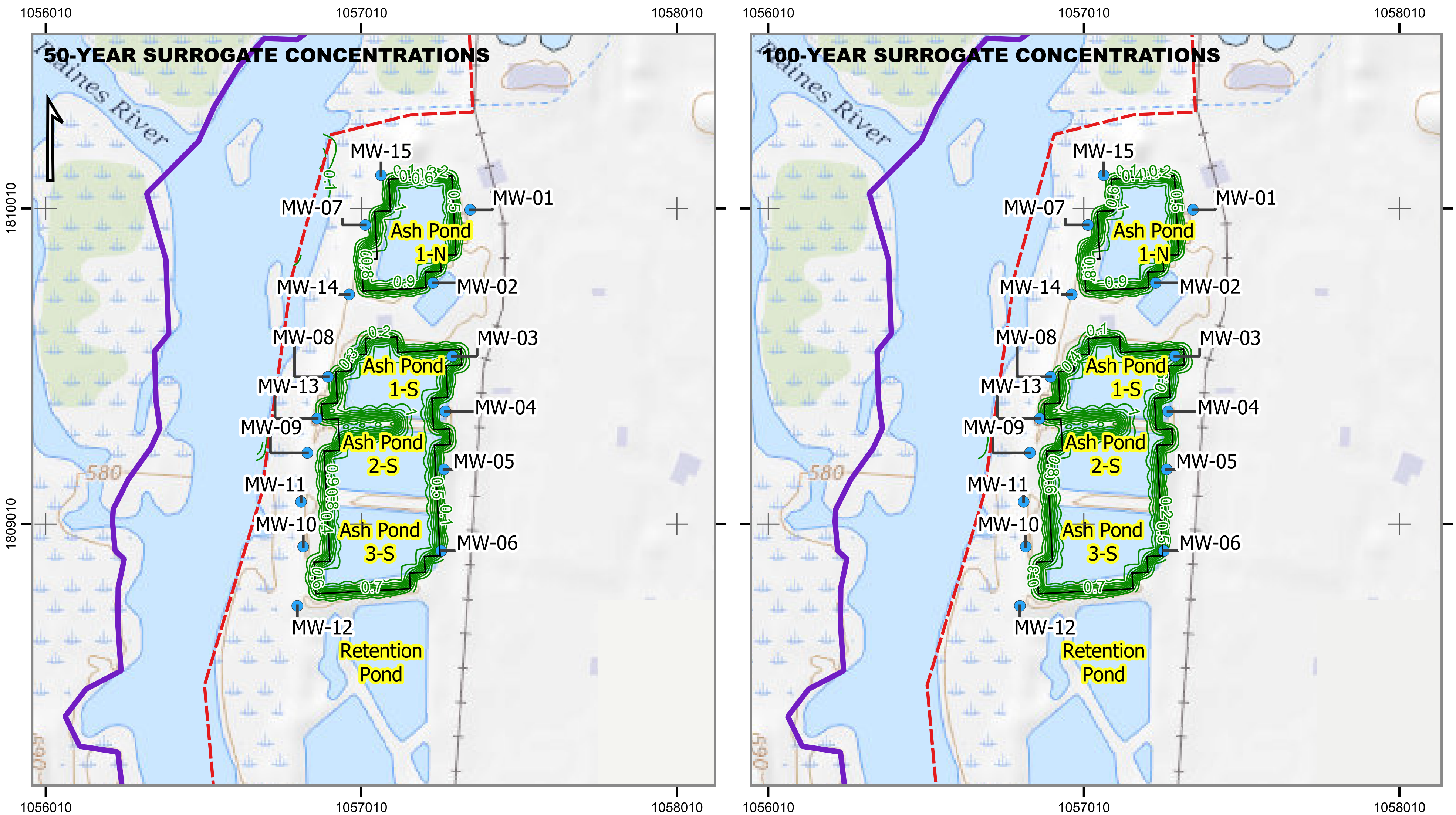
K P R G

0 200 400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure22_RelativeSurrogateConcentrations_5_25_Years_Scenario3.qgz

CLIENT	MIDWEST GENERATION	
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL	
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 5 AND 25 YEARS, SCENARIO 3**	
SCALE AT ANSI A 1:5,400	DRAWN DZF 04/21/2023 CHECKED BAS 04/21/2023	
BAS PROJECT No. 21141501		FIGURE: **22**



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- AREA OF BARRIER WALL
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

K P R G

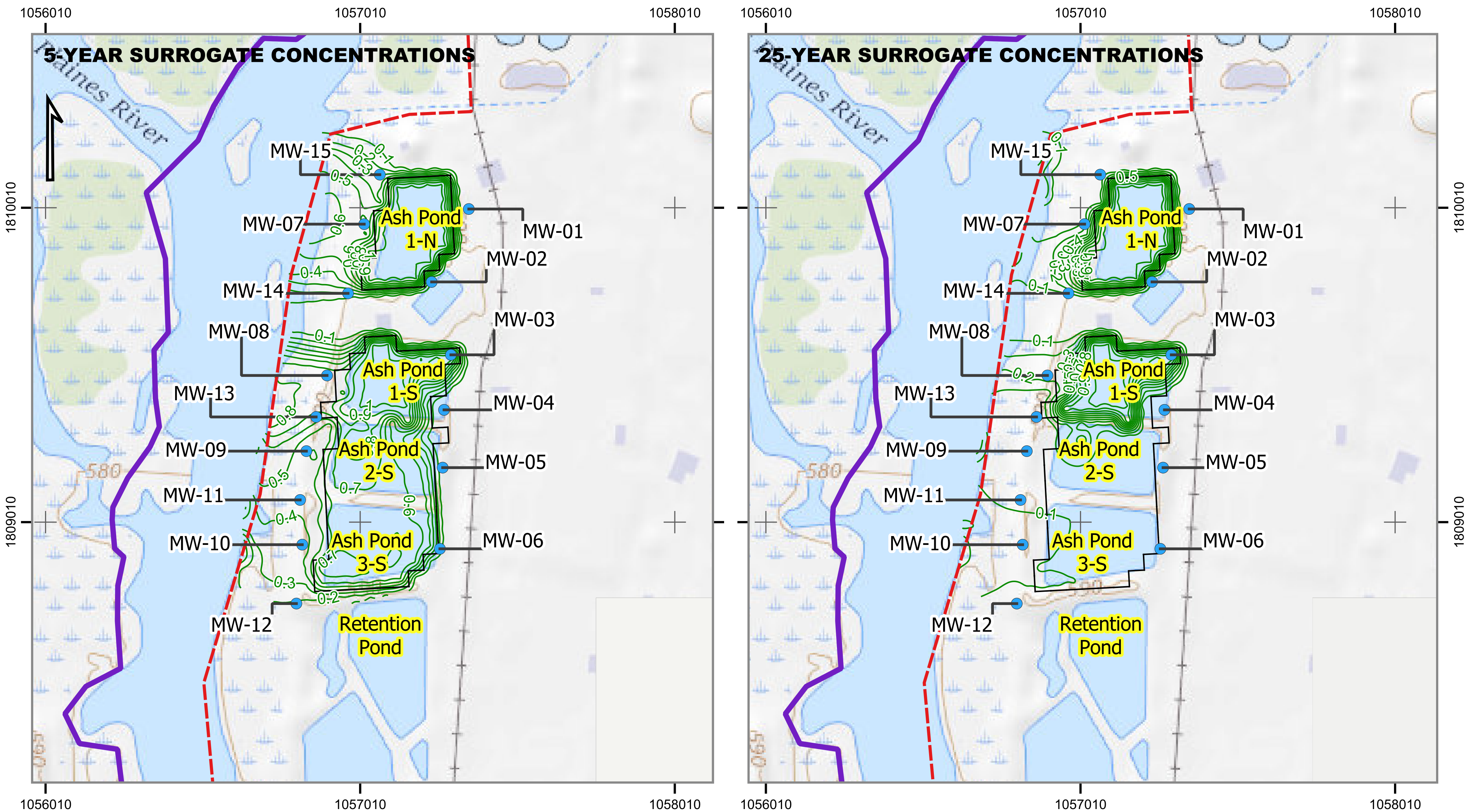
0 200 400 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure23_RelativeSurrogateConcentrations_50_100_Years_Scenario3.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 50 AND 100 YEARS, SCENARIO 3**

SCALE AT ANSI A	DRAWN	DZF	04/21/2023
1:5,400	CHECKED	BAS	04/21/2023
BAS PROJECT No. 21141501	FIGURE: 23		



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- AREA OF BARRIER WALL
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

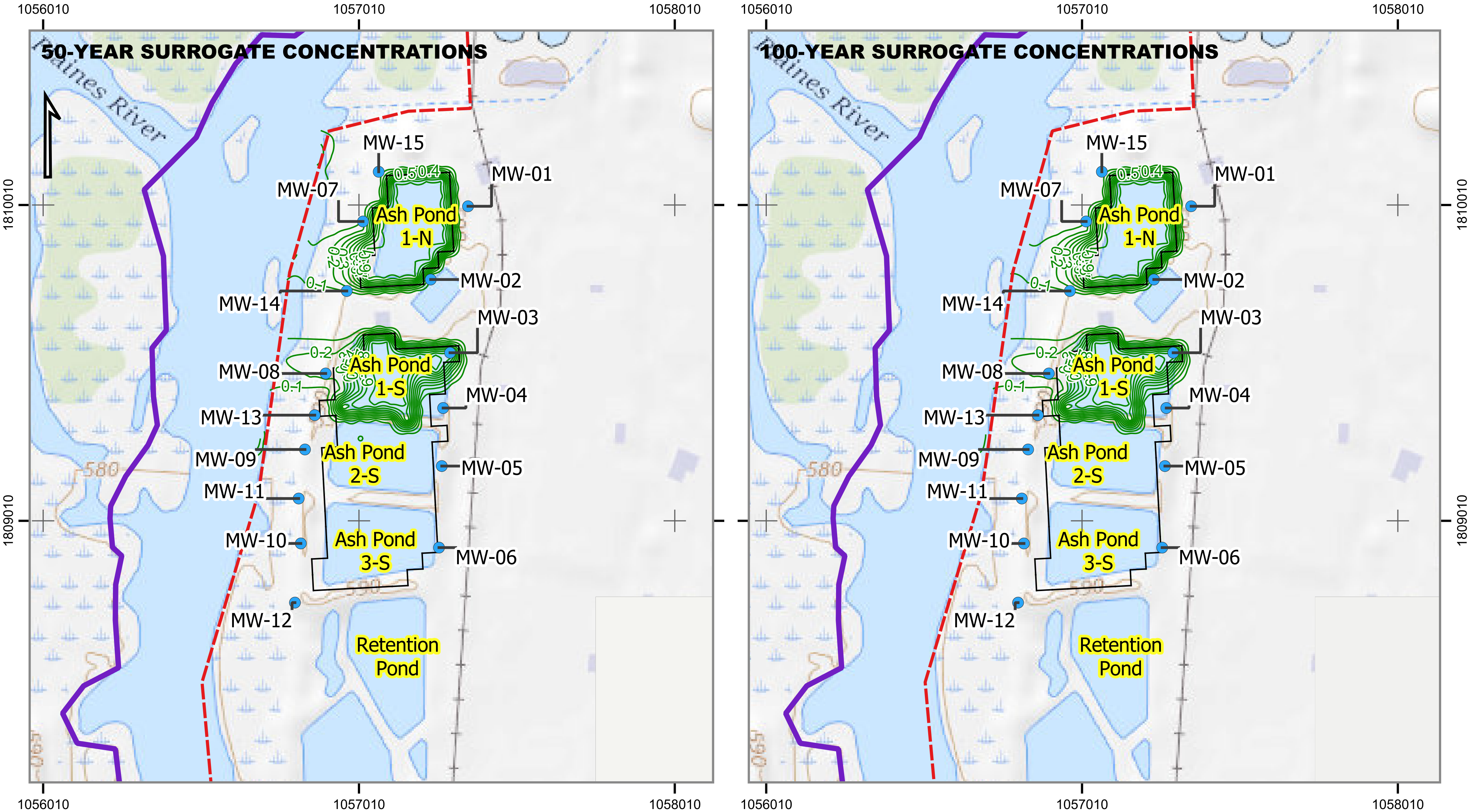
BAS GROUNDWATER CONSULTING

K P R G

0 200 400 ft
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure24_RelativeSurrogateConcentrations_5_25_Years_Scenario4.qgz

CLIENT	MIDWEST GENERATION		
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL		
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 5 AND 25 YEARS, SCENARIO 4**		
SCALE AT ANSI A 1:5,400	DRAWN	DZF	05/09/2023
	CHECKED	BAS	05/09/2023
BAS PROJECT No. 21141501		FIGURE: **24**	



LEGEND

- SITE MONITORING WELL
- MODEL BOUNDARY
- APPROXIMATE SITE BOUNDARY
- AREA OF BARRIER WALL
- RELATIVE SURROGATE CONCENTRATIONS

Maximum relative concentrations above competent bedrock

BAS GROUNDWATER CONSULTING

K P R G

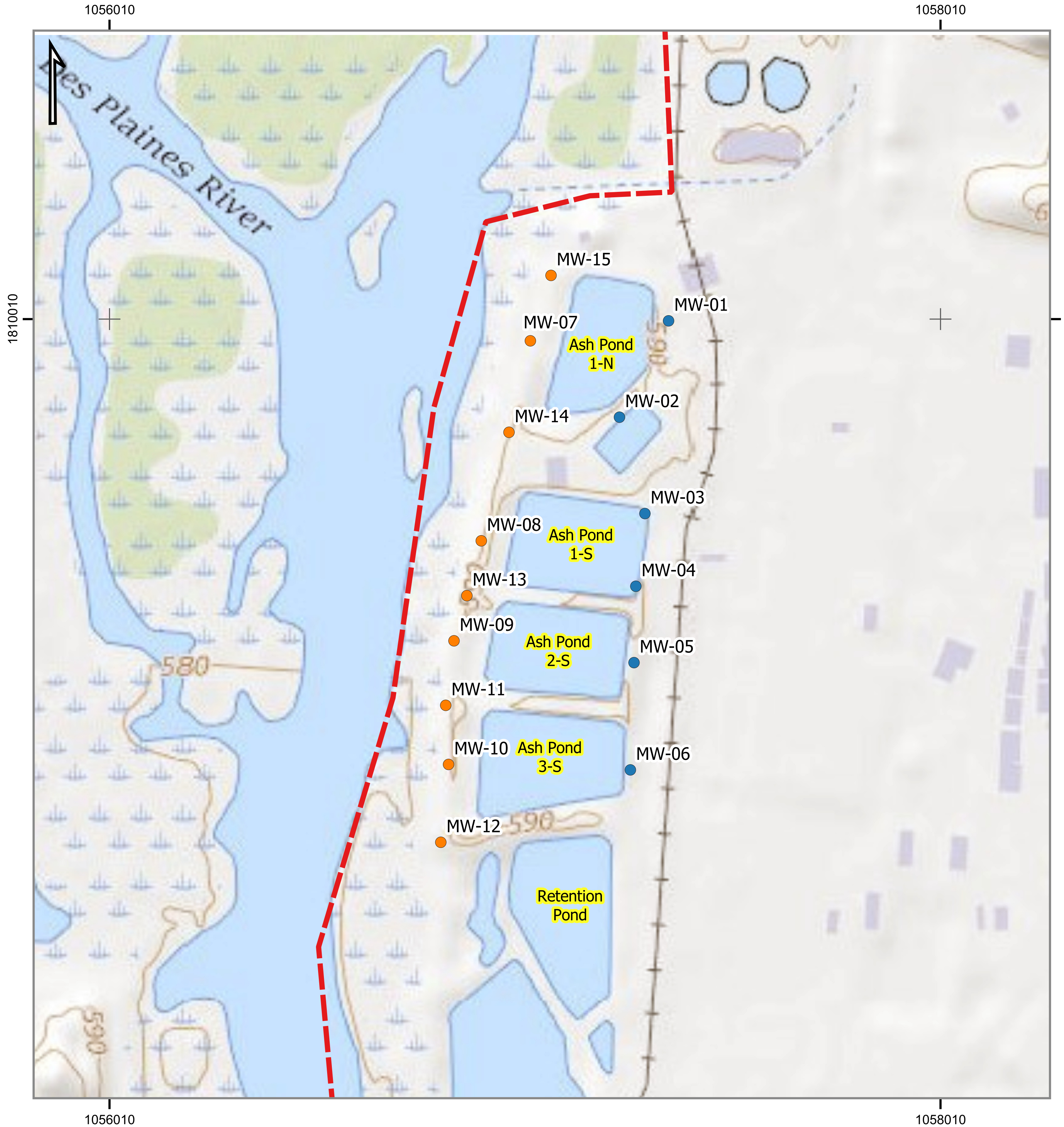
0 200 400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure25_RelativeSurrogateConcentrations_50_100_Years_Scenario4.qgz

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**RELATIVE SURROGATE CONCENTRATIONS AT 50 AND 100 YEARS, SCENARIO 4**

SCALE AT ANSI A	DRAWN	DZF	04/21/2023
1:5,400	CHECKED	BAS	04/21/2023
BAS PROJECT No. 21141501	FIGURE: 25		



LEGEND

SELECTED SITE MONITORING WELL TO EVALUATE DECAY

SITE MONITORING WELL

APPROXIMATE SITE BOUNDARY

0 200 400 ft

FEET

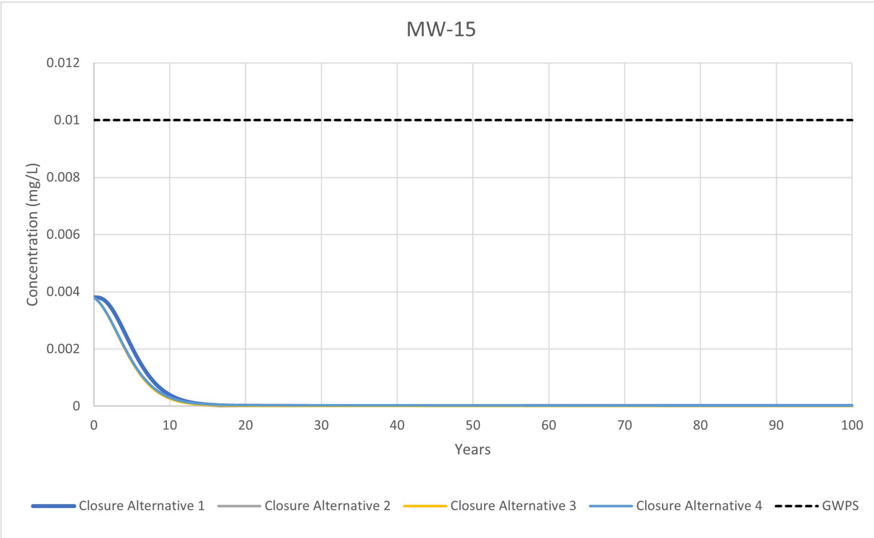
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure26_SelectedMonitoringLocationsToEvaluateDecay.qgz

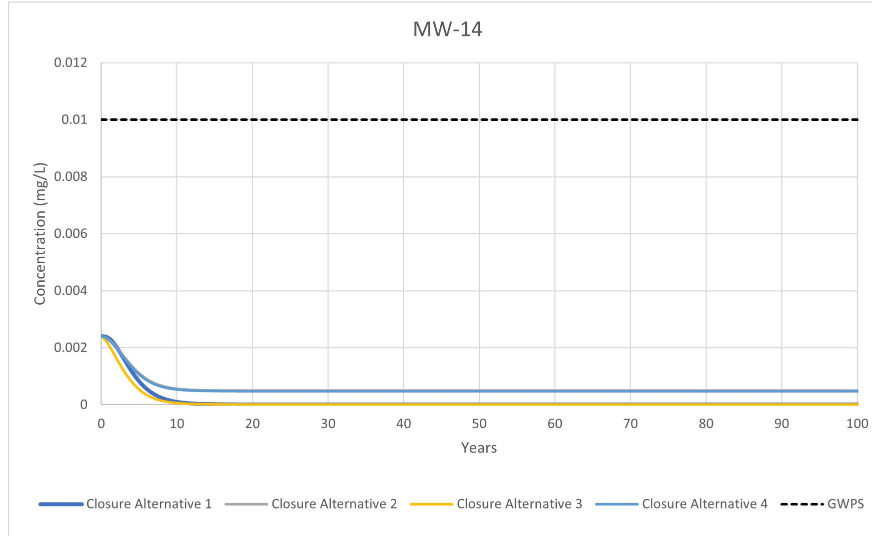
BAS GROUNDWATER CONSULTING

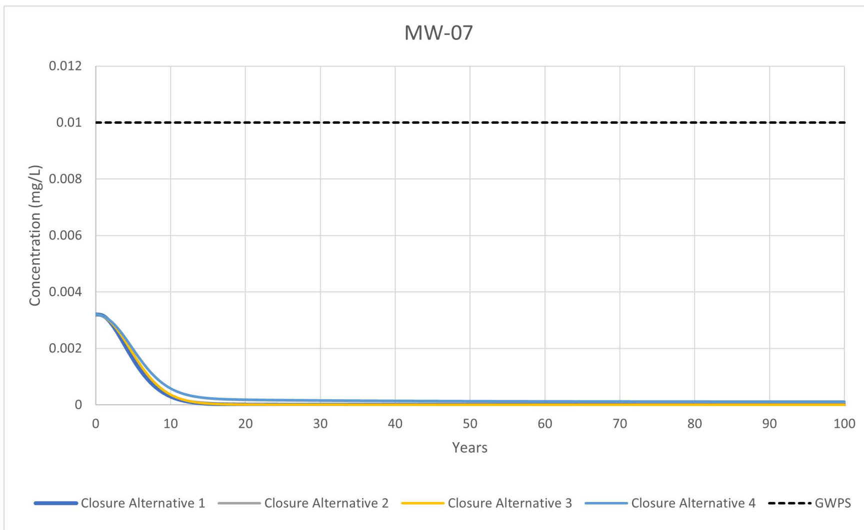
KPRG

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**SELECTED MONITORING LOCATIONS TO EVALUATE DECAY**

SCALE AT ANSI A 1:4,000	DRAWN	DZF	04/05/2023
	CHECKED	BAS	04/05/2023
BAS PROJECT No. 21141501	FIGURE: 26		







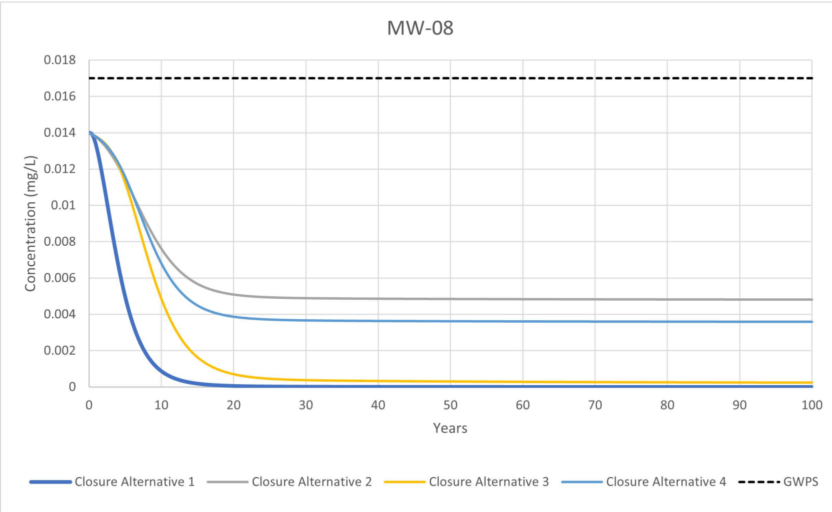
BAS GROUNDWATER CONSULTING

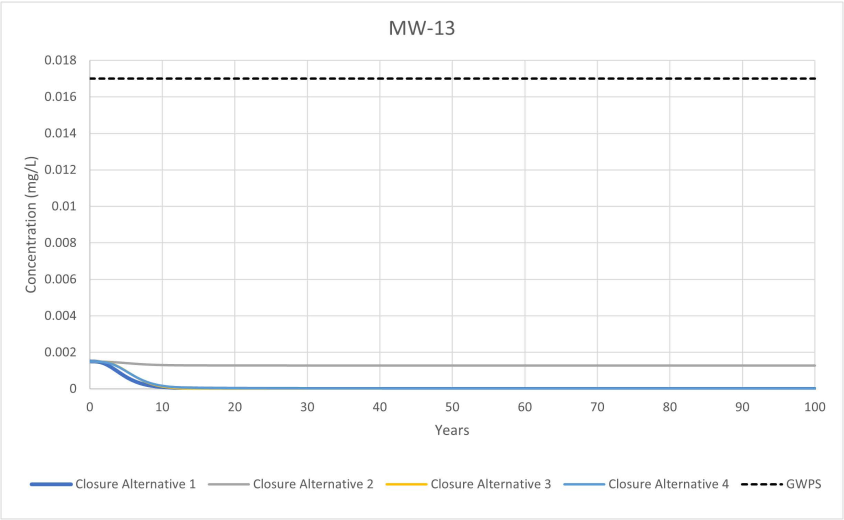
KPRG

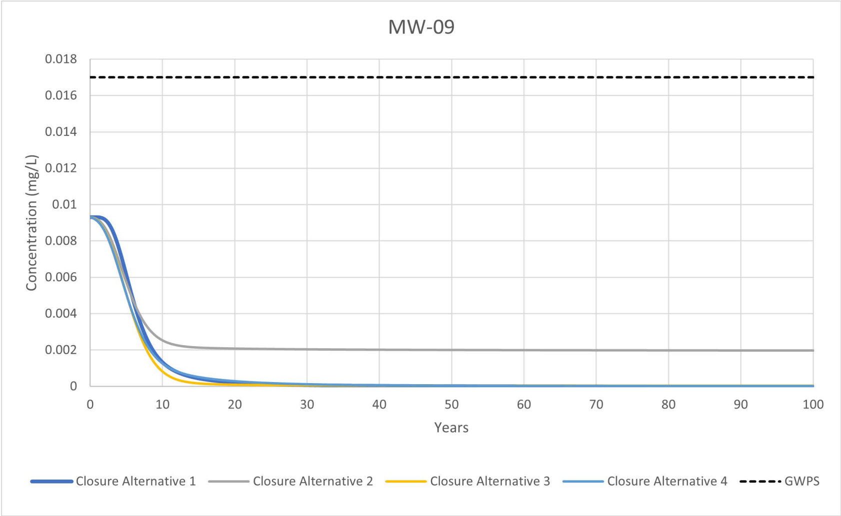
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 27	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**ARSENIC CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS**

Project File: Figure27_ArsenicConcentrations.qgz







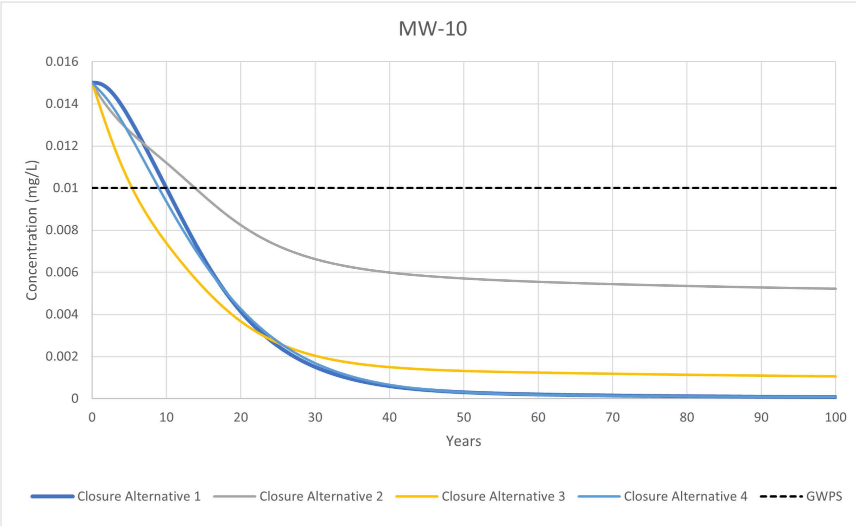
BAS GROUNDWATER CONSULTING

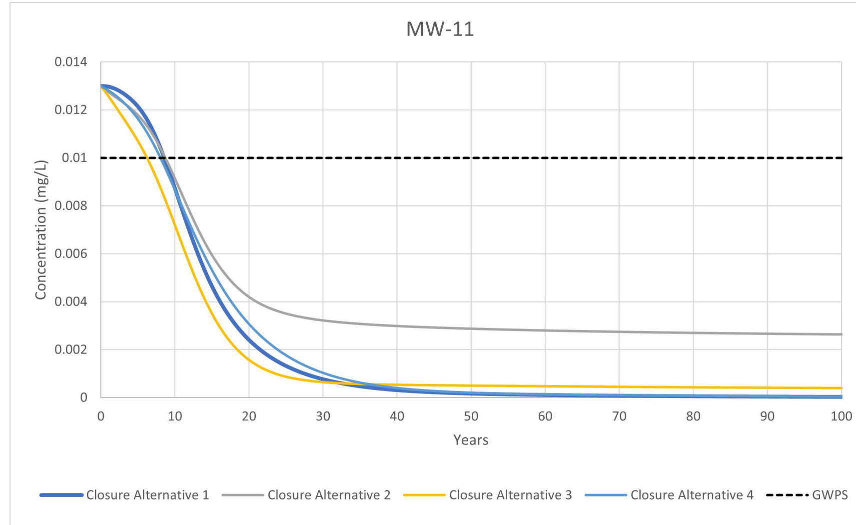
KPRG

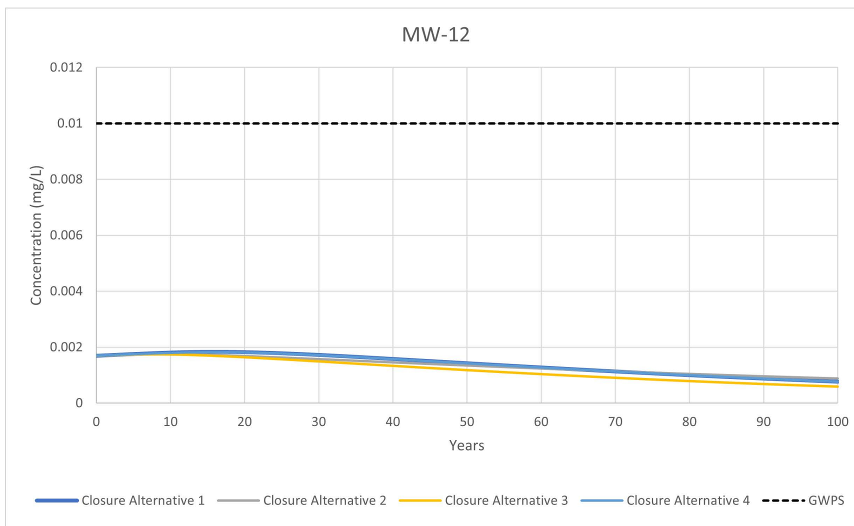
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 28	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**ARSENIC CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS**

Project File: Figure28_ArsenicConcentrations1S.qgz







BAS GROUNDWATER CONSULTING

KPRG

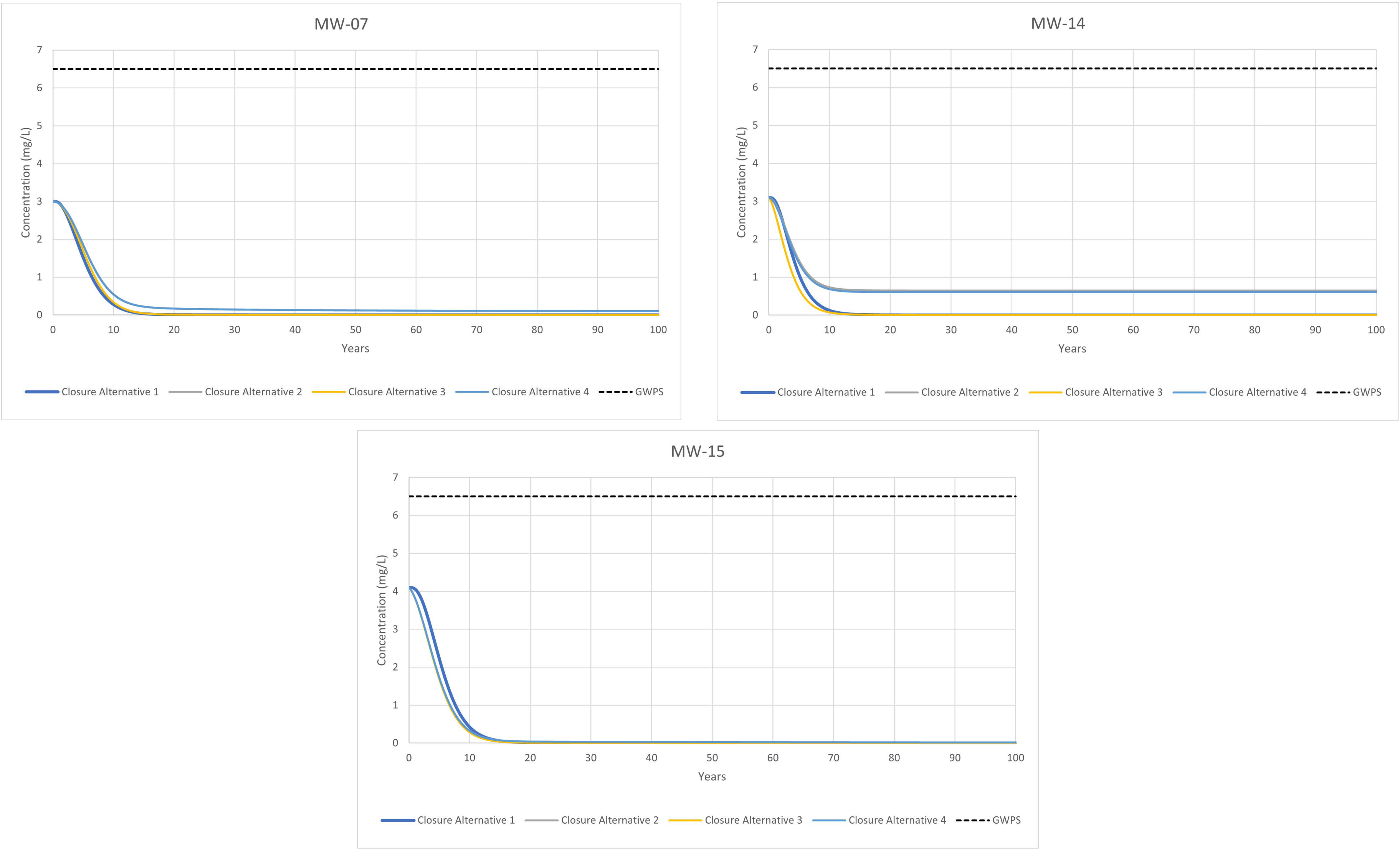
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501	FIGURE: 29		

CLIENT: MIDWEST GENERATION

SITE: WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE: **ARSENIC CONCENTRATIONS OVER TIME, PONDS 2S/3S DOWNGRADIENT WELLS**

Project File: Figure29_ArsenicConcentrations2S3S.qgz



BAS GROUNDWATER CONSULTING

KPRG

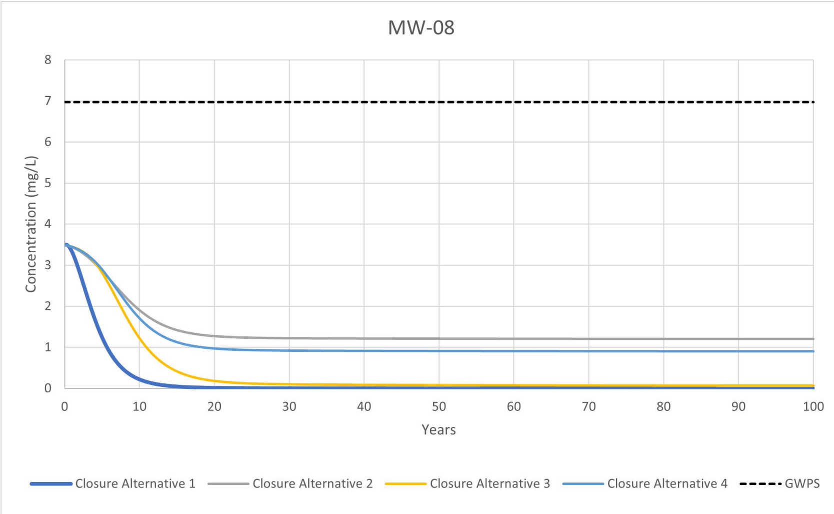
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: **30**	

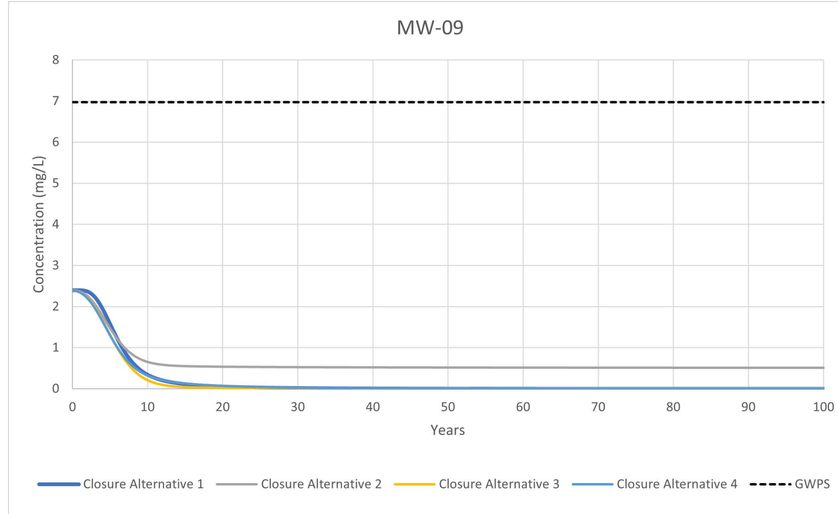
CLIENT
MIDWEST GENERATION

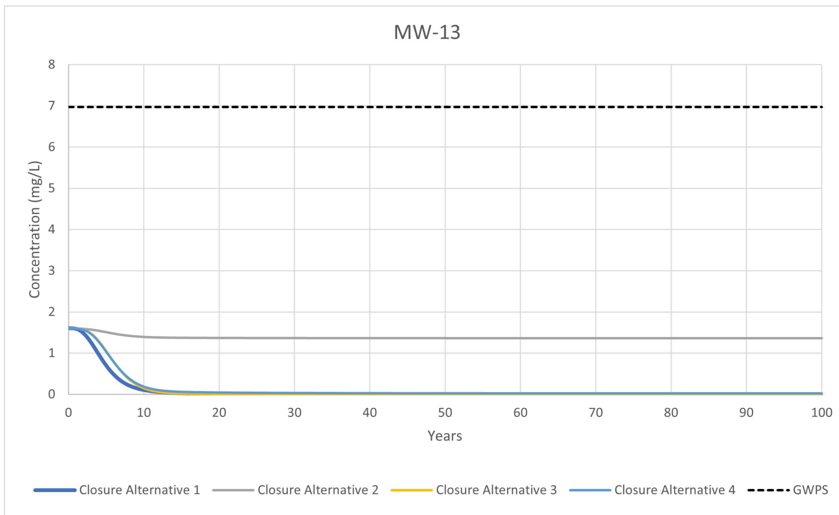
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
BORON CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS

Project File: Figure30_BoronConcentrations1N.qgz







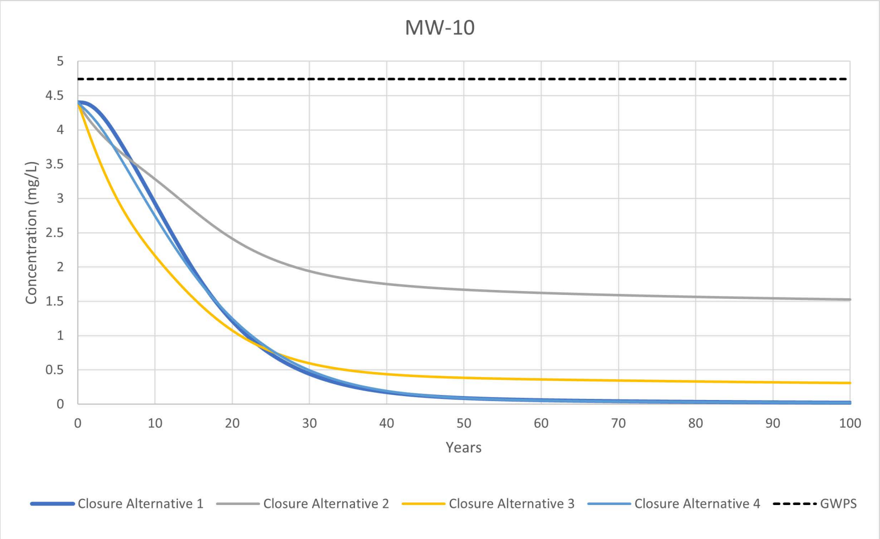
BAS GROUNDWATER CONSULTING

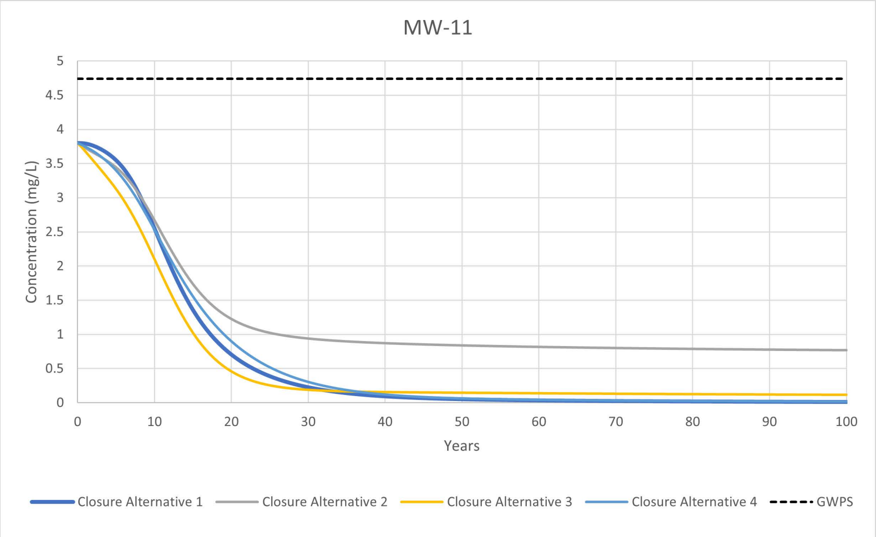
KPRG

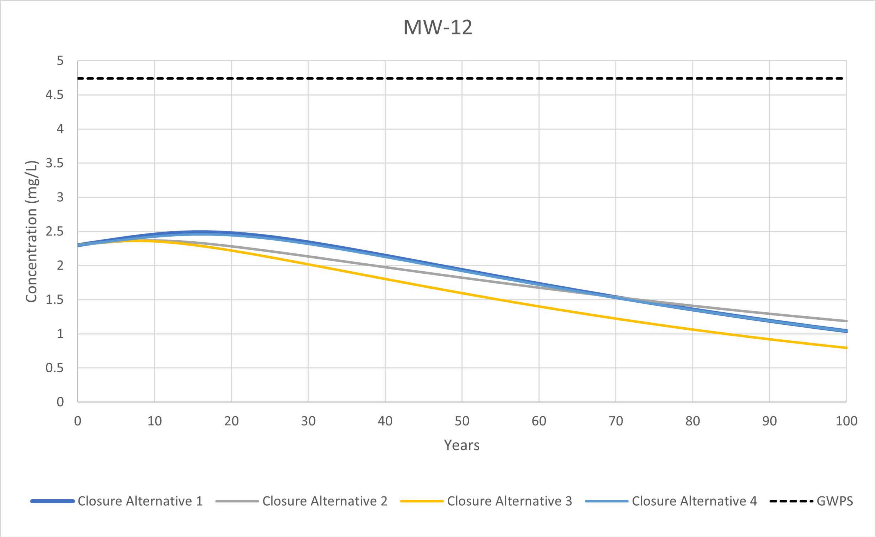
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501	FIGURE: 31		

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**BORON CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS**

Project File: Figure31_BoronConcentrations1S.qgz







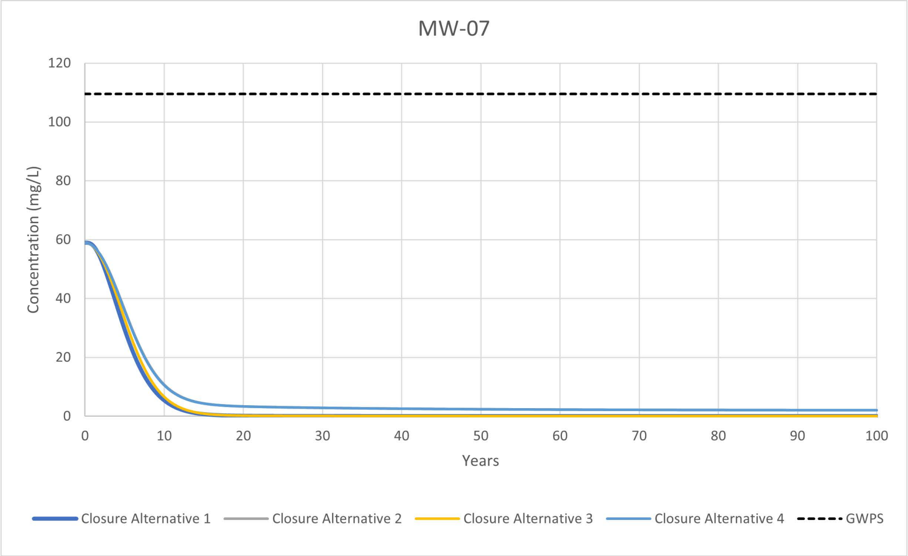
BAS GROUNDWATER CONSULTING

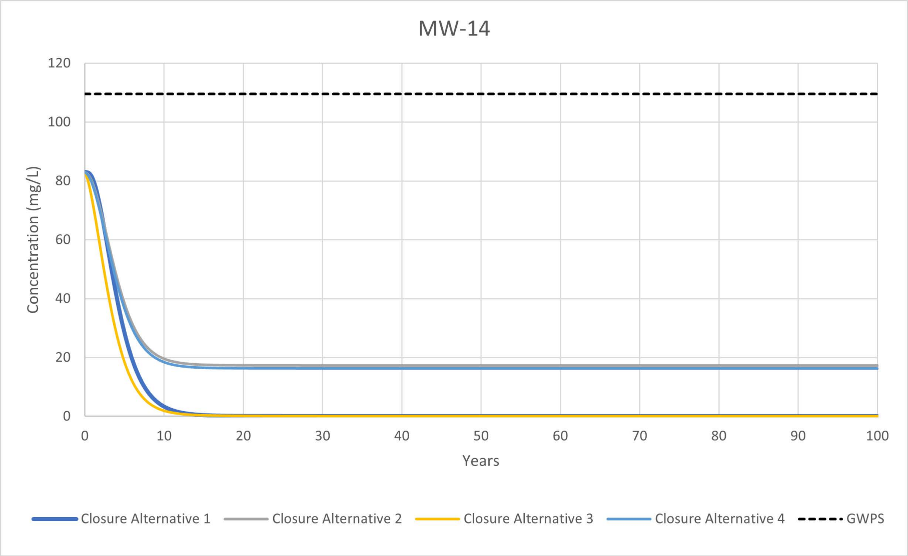
K P R G

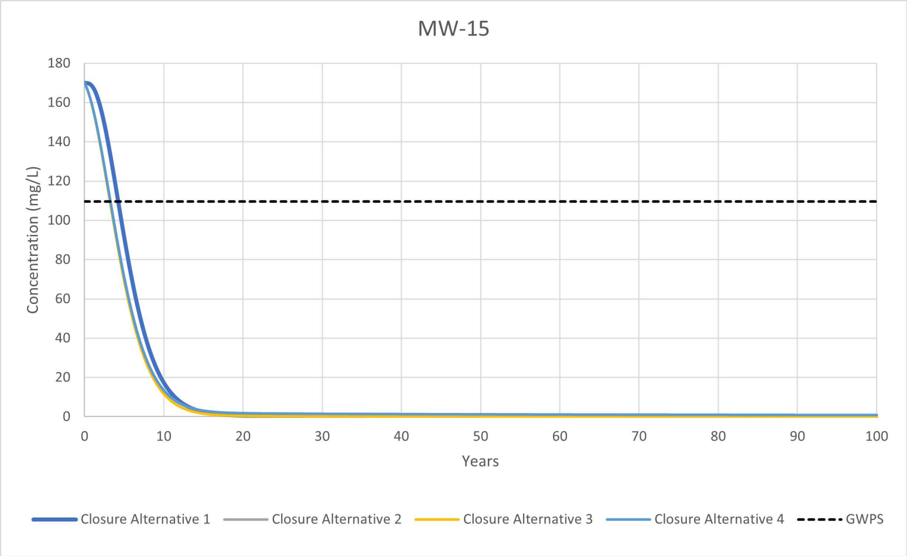
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 32	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**BORON CONCENTRATIONS OVER TIME, POND 2S/3S DOWNGRADIENT WELLS**

Project File: Figure32_BoronConcentrations2S3S.qgz







BAS GROUNDWATER CONSULTING

KPRG

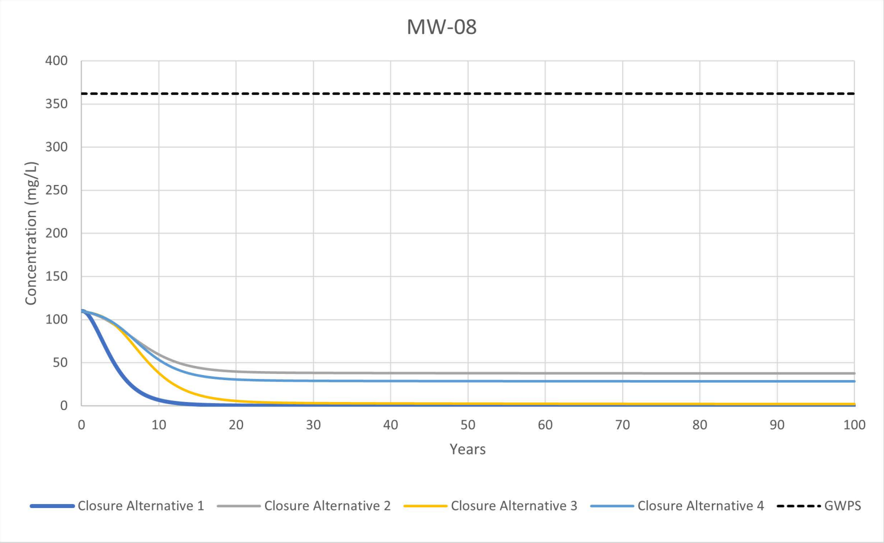
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501	FIGURE: 33		

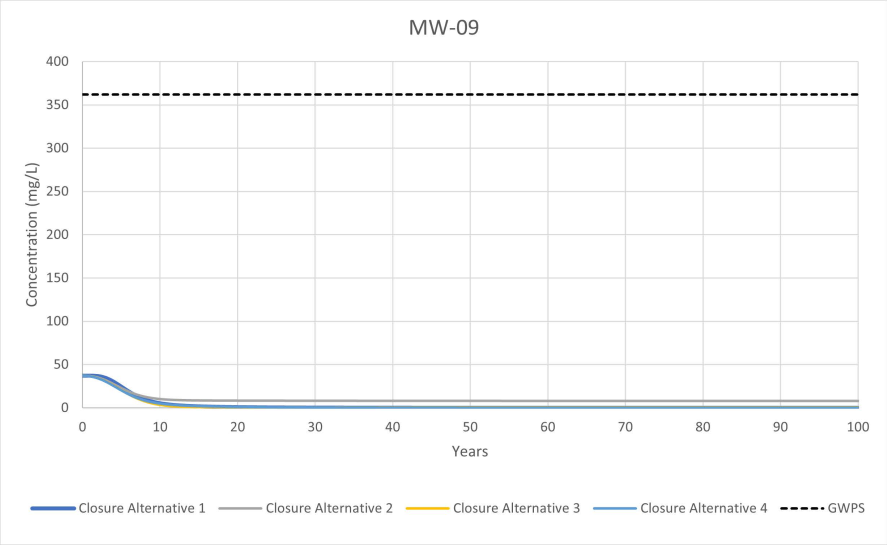
CLIENT
MIDWEST GENERATION

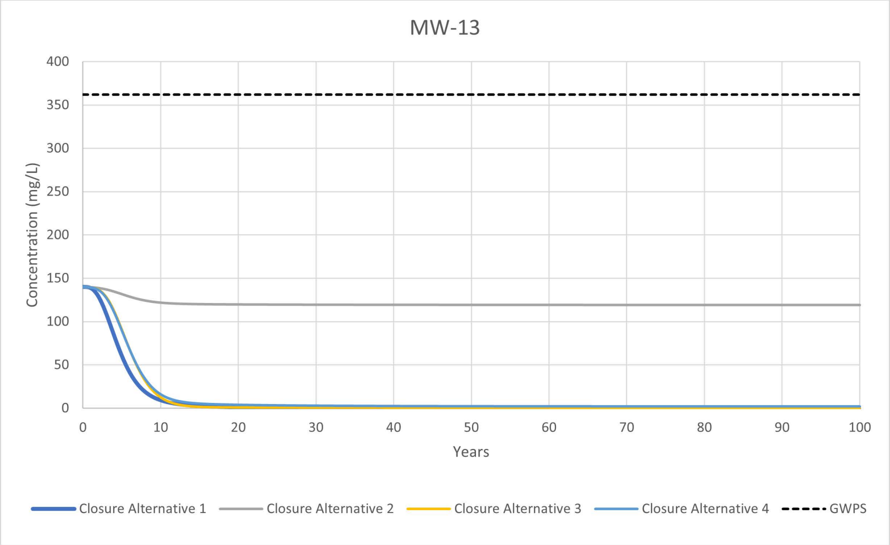
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
CALCIUM CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS

Project File: Figure33_CalciumConcentrations1N.qgz







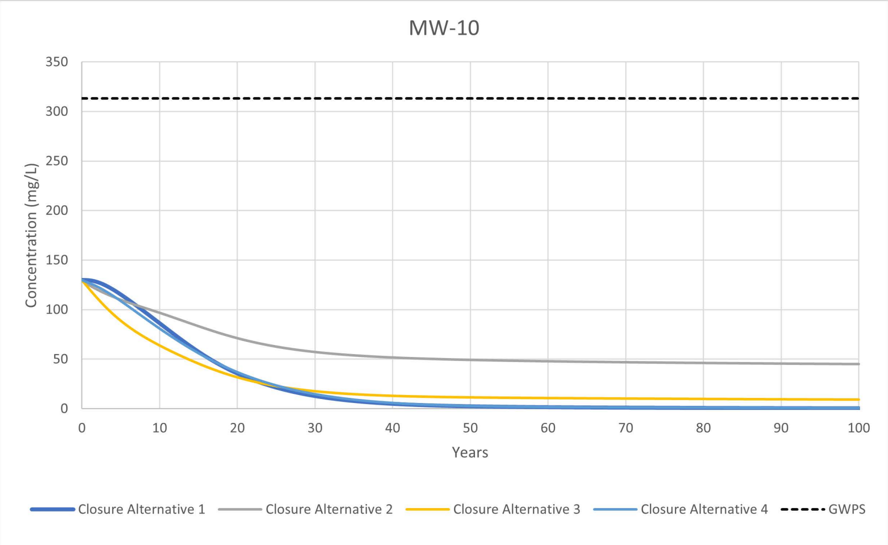
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 34	

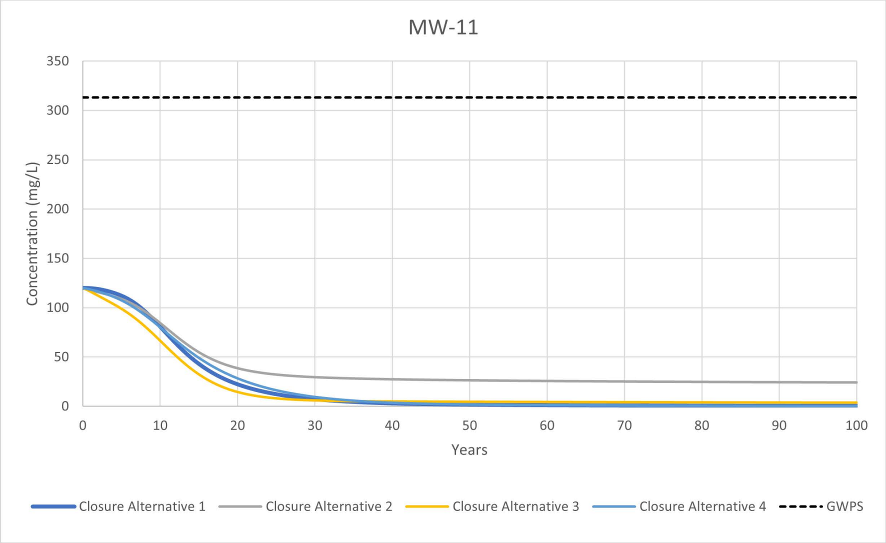
CLIENT
MIDWEST GENERATION

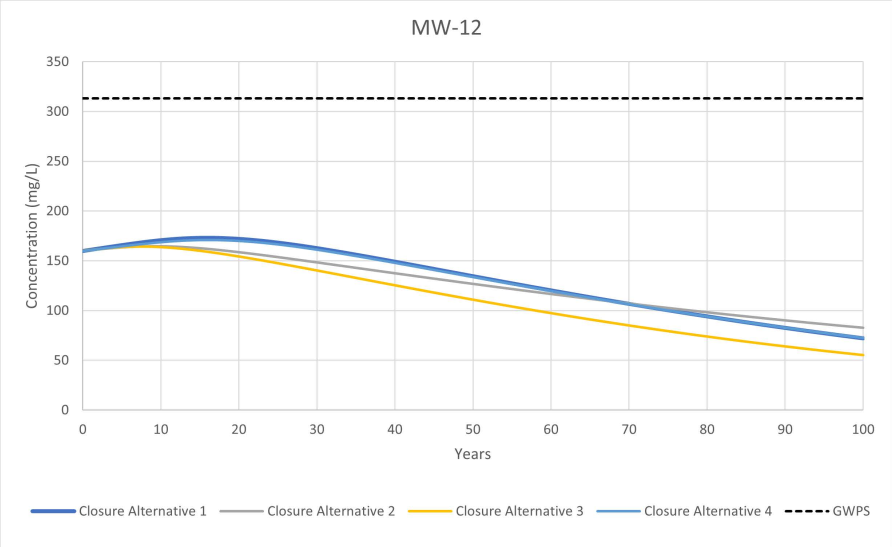
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
CALCIUM CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS

Project File: Figure34_CalciumConcentrations1S.qgz







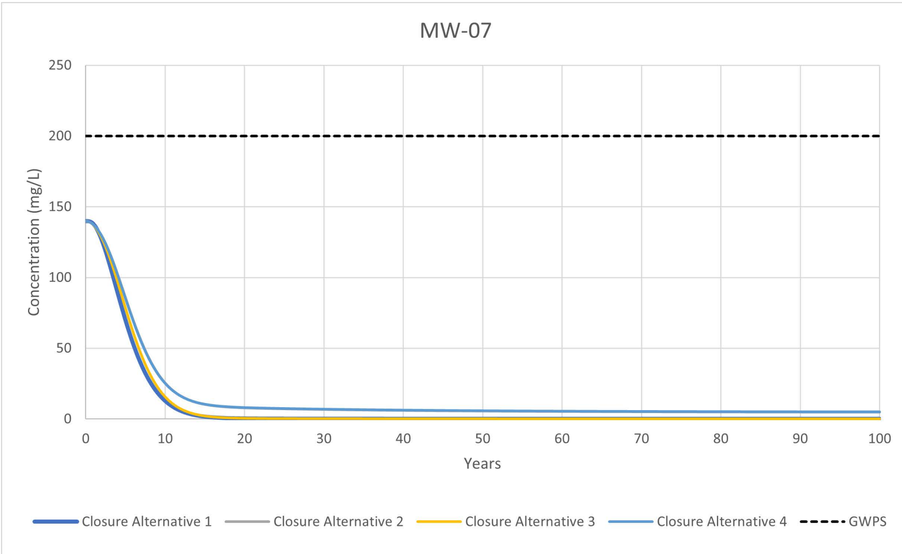
BAS GROUNDWATER CONSULTING

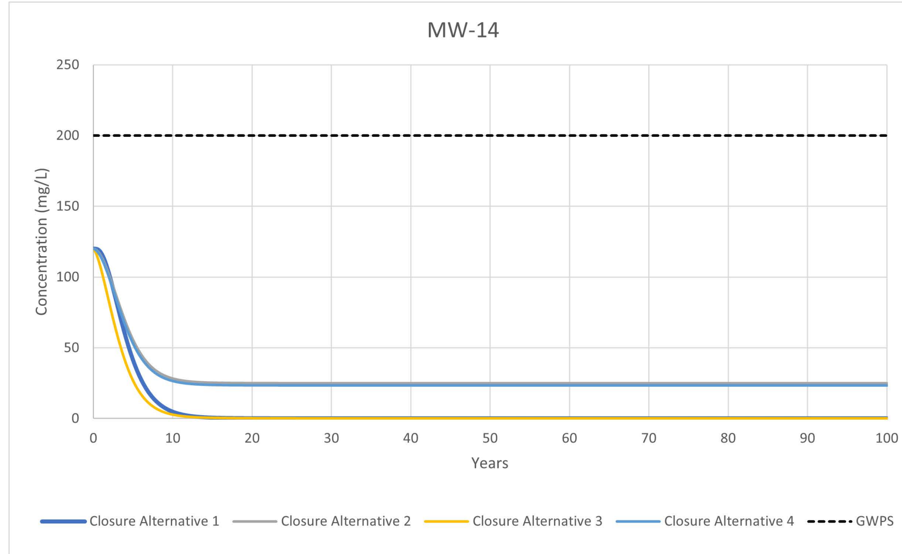
KPRG

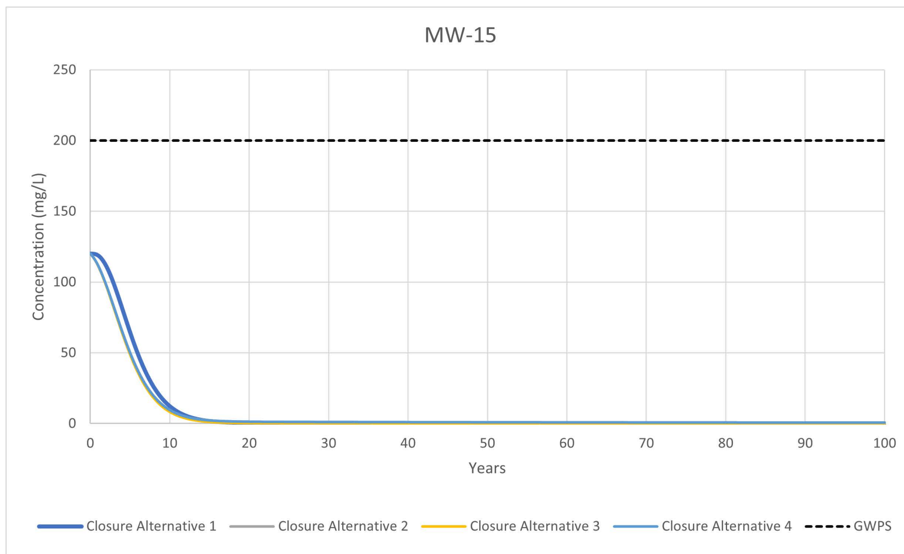
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 35	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CALCIUM CONCENTRATIONS OVER TIME, PONDS 2S/3S DOWNGRADIENT WELLS**

Project File: Figure35_CalciumConcentrations2S3S.qgz







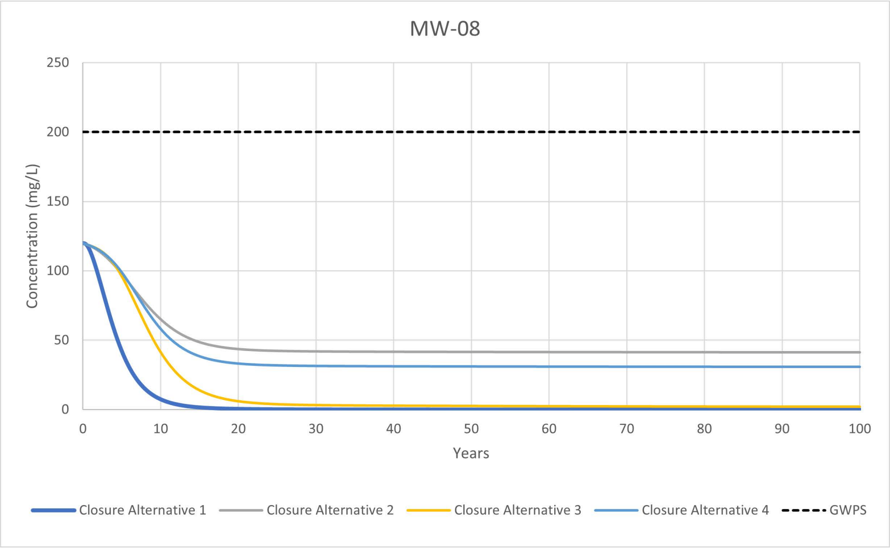
BAS GROUNDWATER CONSULTING

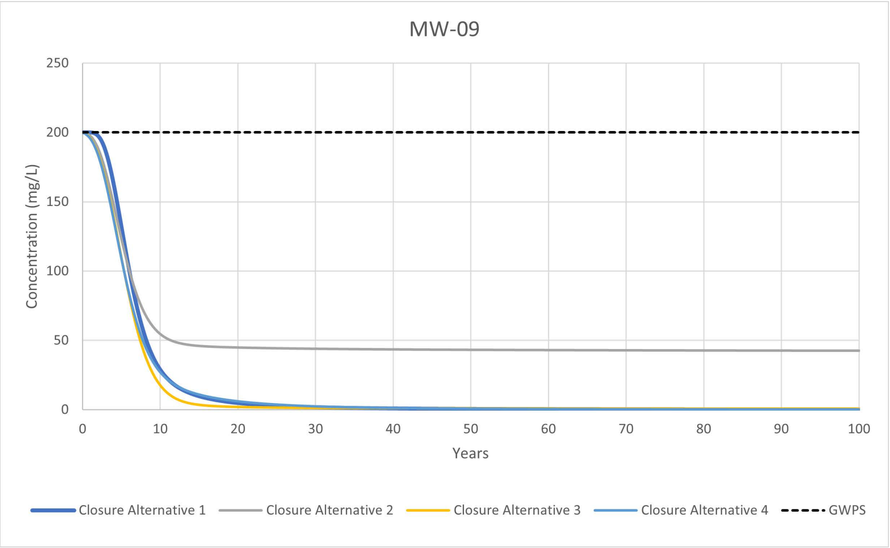
K P R G

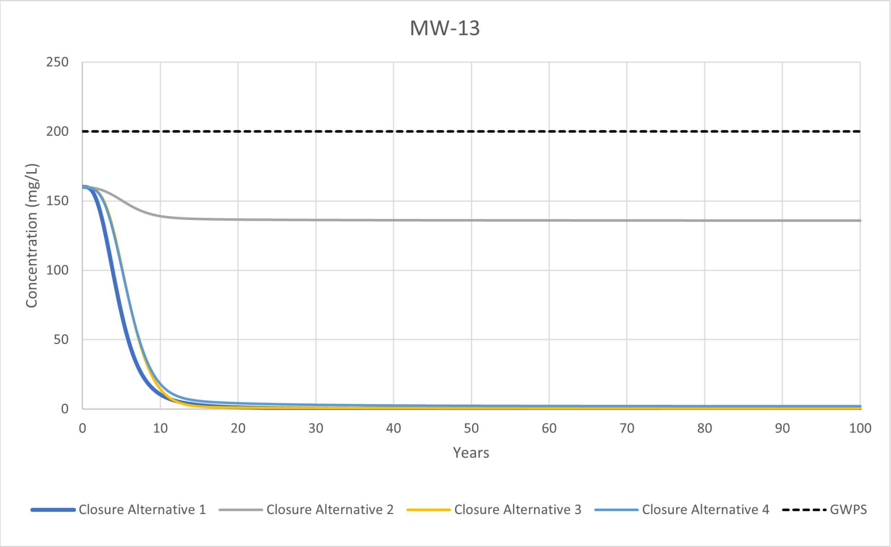
SCALE AT ANSI A	*DRAWN*	*DZF*	03/20/2023
	CHECKED	*BAS*	03/20/2023
BAS PROJECT No. 21141501	*FIGURE:* **36**		

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**CHLORIDE CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS**

Project File: Figure36_ChlorideConcentrations1N.qgz







BAS GROUNDWATER CONSULTING

KPRG

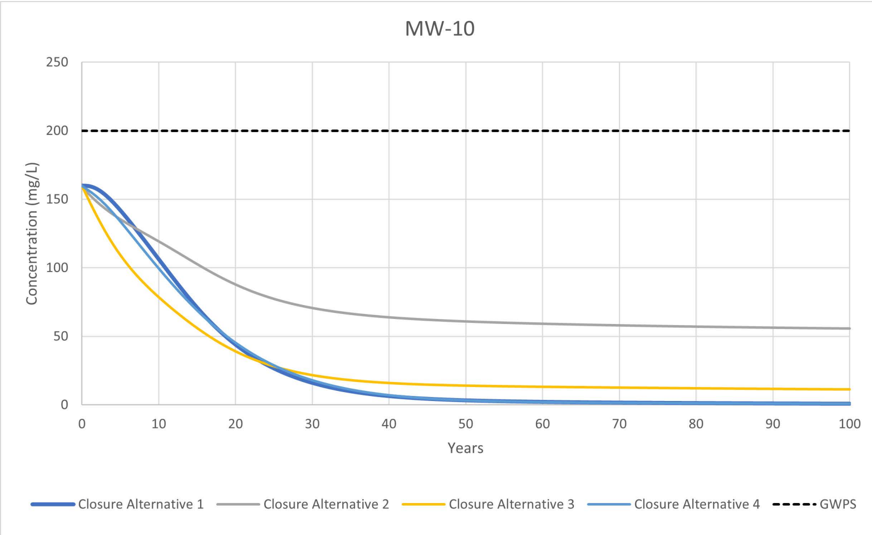
SCALE AT ANSI A	DRAWN DZF 03/20/2023
	CHECKED BAS 03/20/2023
BAS PROJECT No. 21141501	FIGURE: 37

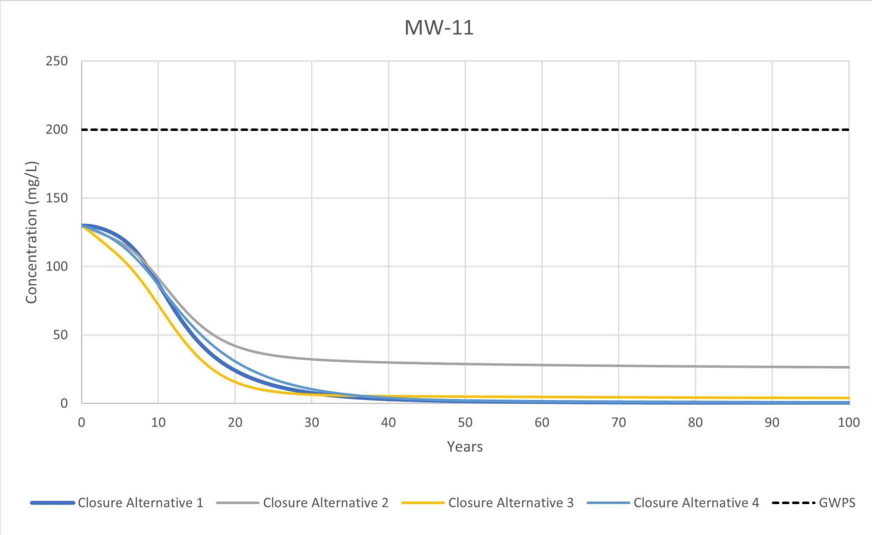
CLIENT
MIDWEST GENERATION

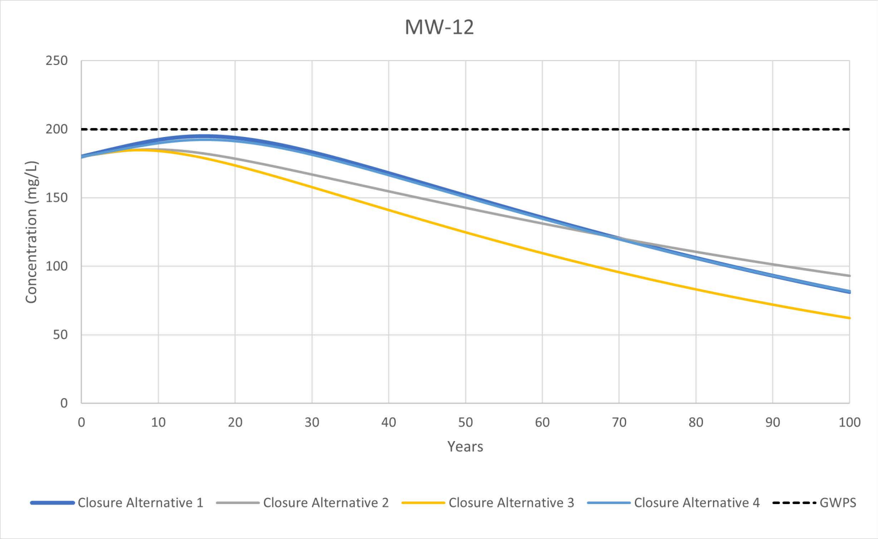
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
CHLORIDE CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS

Project File: Figure37_ChlorideConcentrations1S.qgz







BAS GROUNDWATER CONSULTING

KPRG

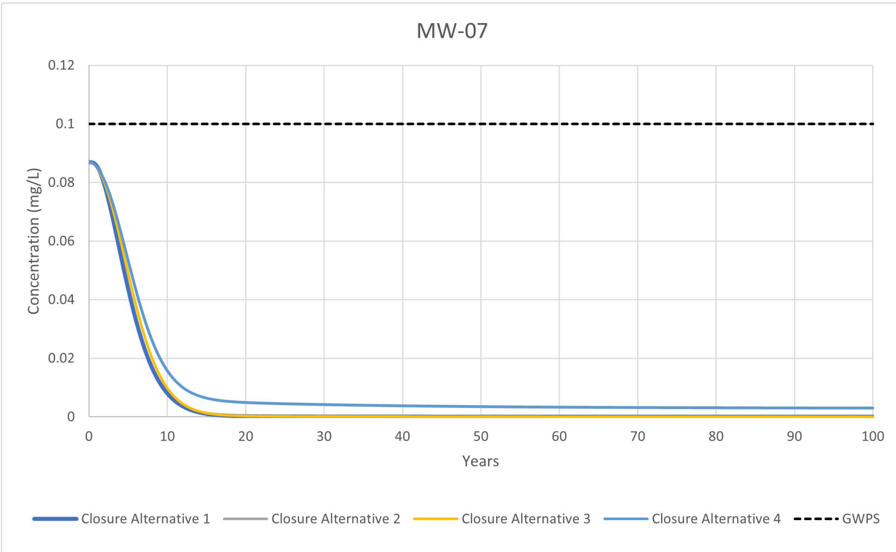
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 38	

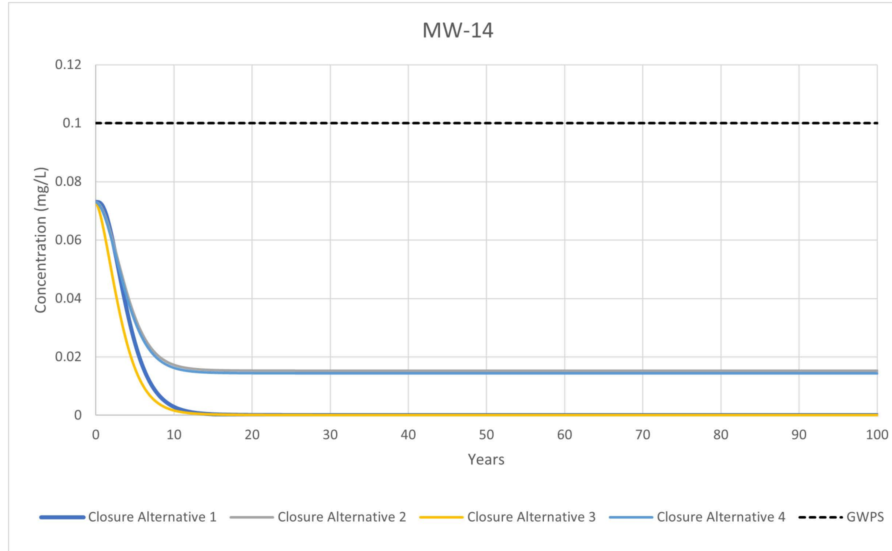
CLIENT
MIDWEST GENERATION

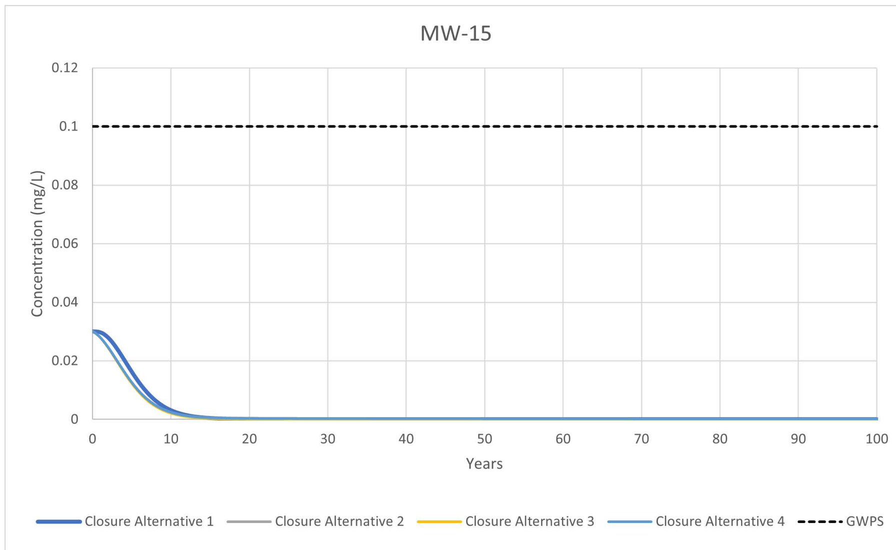
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
CHLORIDE CONCENTRATIONS OVER TIME, PONDS 2S/3S DOWNGRADIENT WELLS

Project File: Figure38_ChlorideConcentrations2S3S.qgz







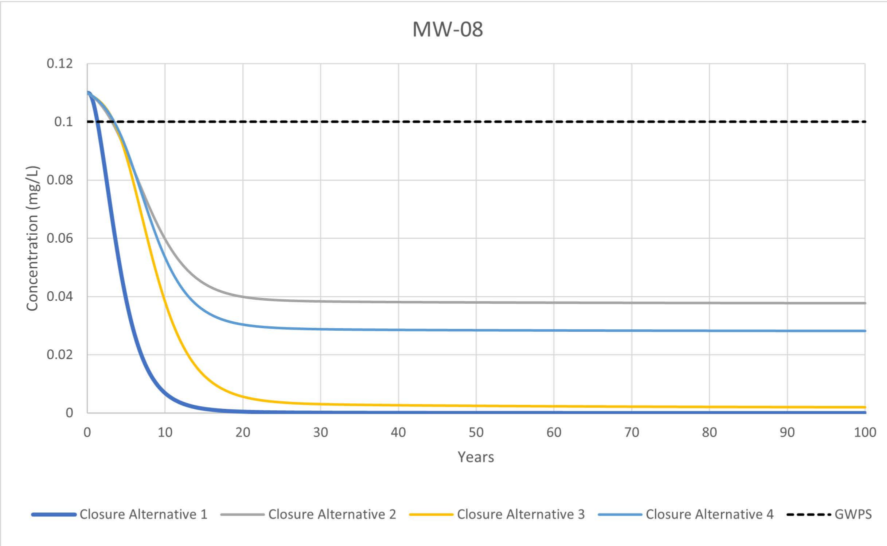
BAS GROUNDWATER CONSULTING

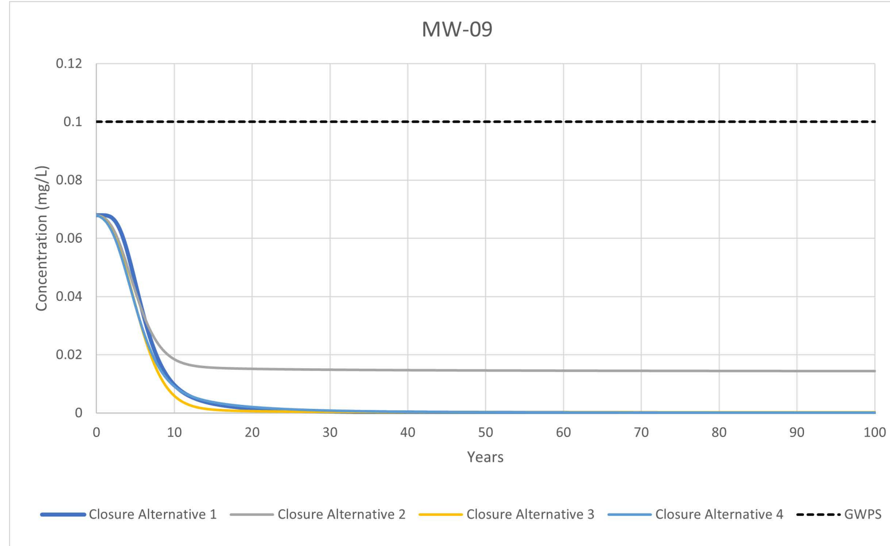
K P R G

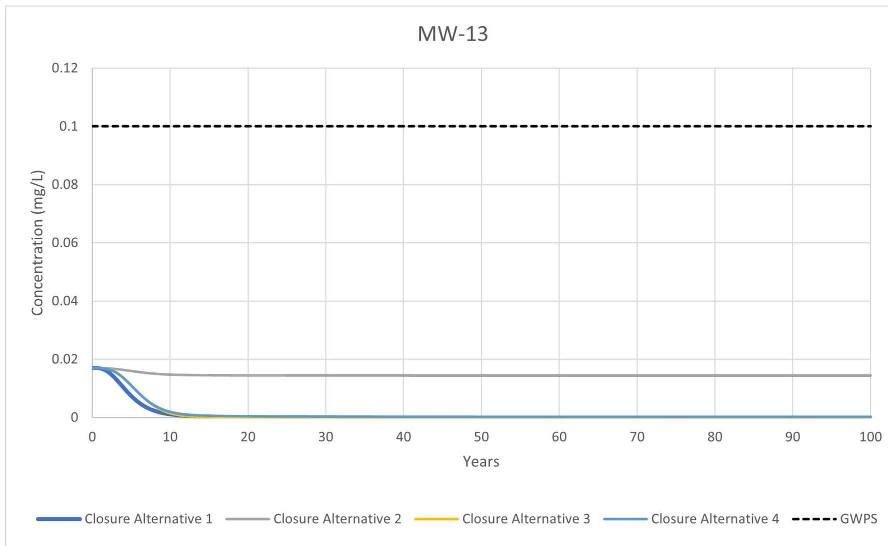
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 39	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**MOLYBDENUM CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS**

Project File: Figure39_MolybdenumConcentrations1N.qgz







BAS GROUNDWATER CONSULTING

KPRG

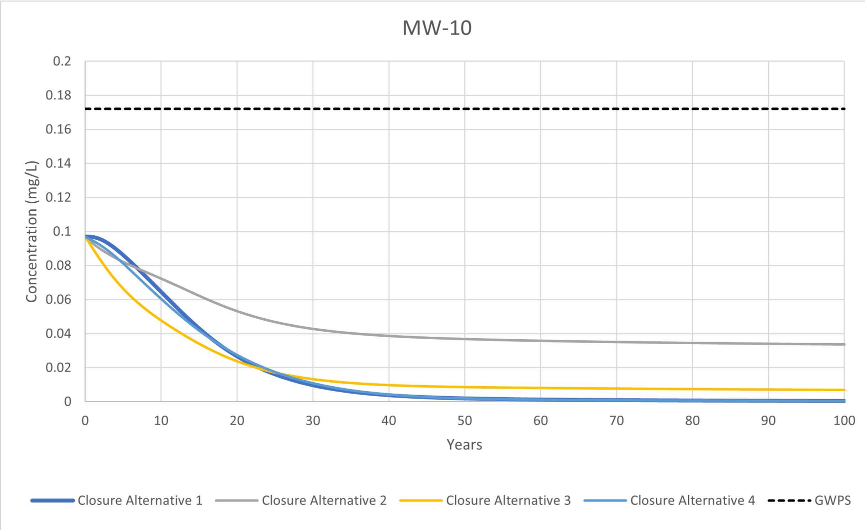
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 40	

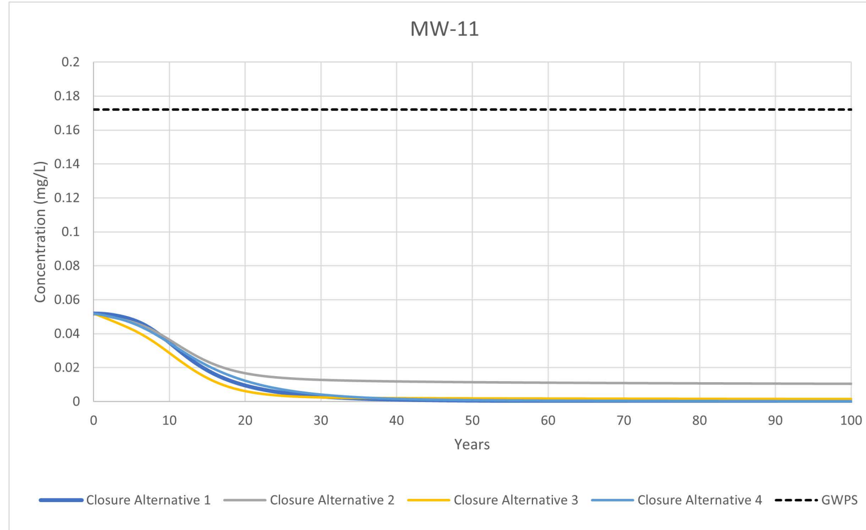
CLIENT
MIDWEST GENERATION

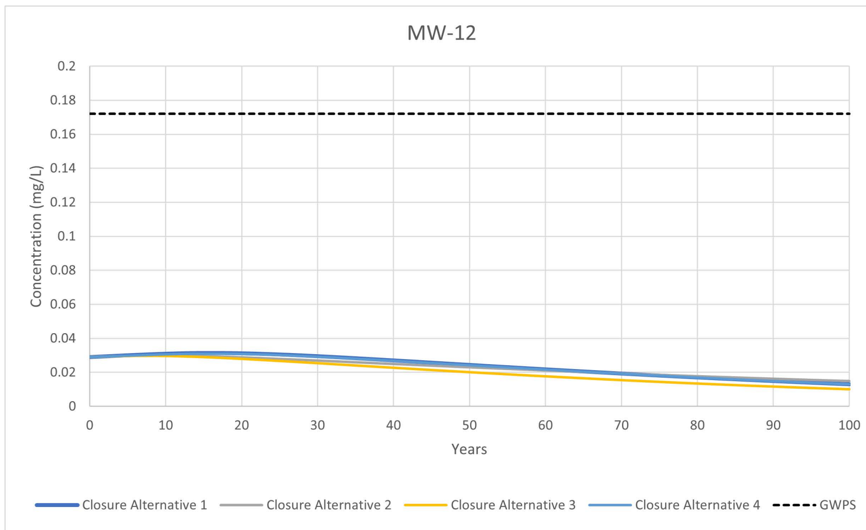
SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
MOLYBDENUM CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS

Project File: Figure40_MolybdenumConcentrations1S.qgz







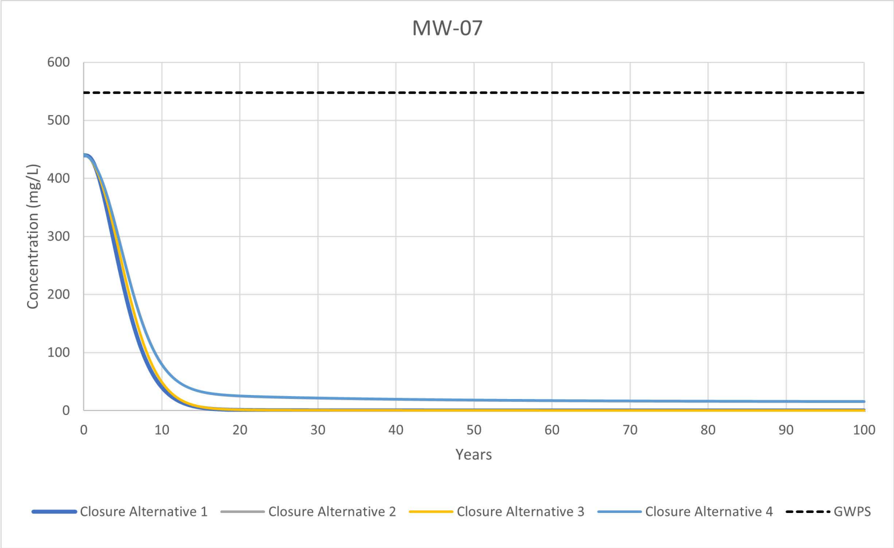
BAS GROUNDWATER CONSULTING

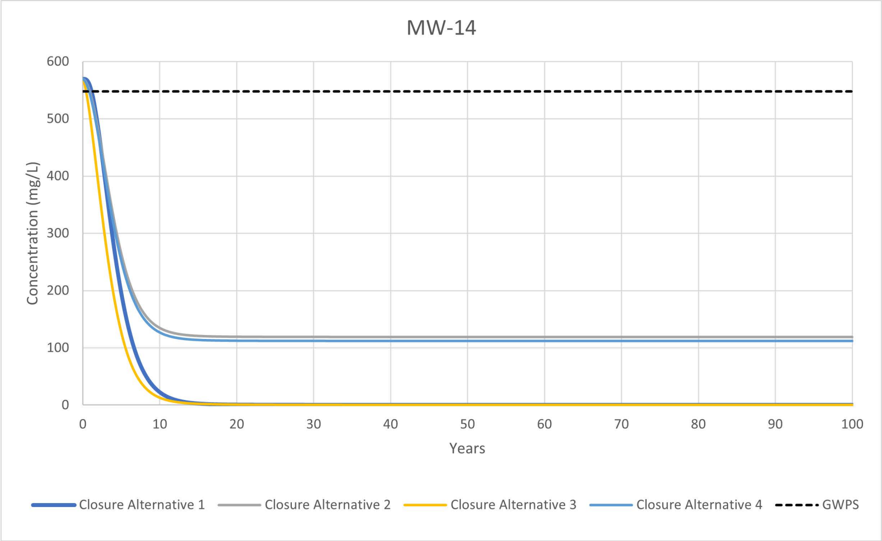
KPRG

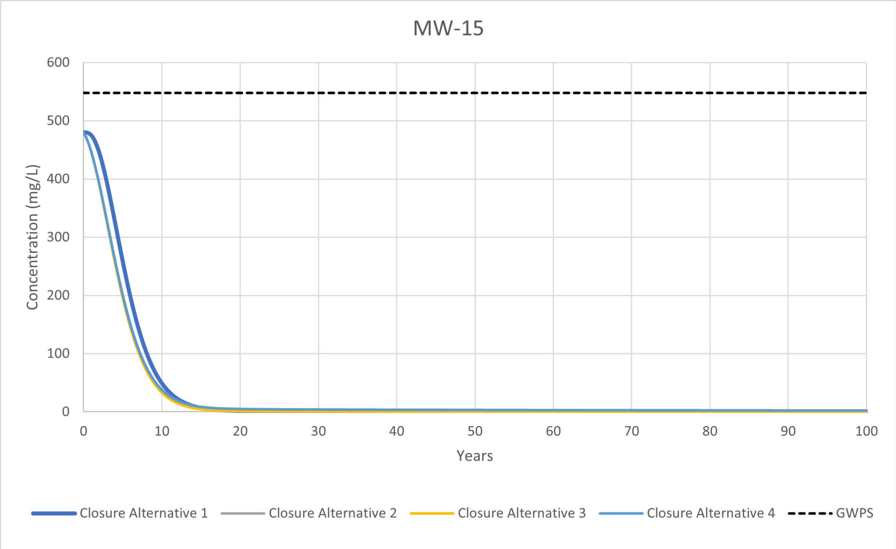
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: **41**	

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**MOLYBDENUM CONCENTRATIONS OVER TIME, PONDS 2S/3S DOWNGRADIENT WELLS**

Project File: Figure41_MolybdenumConcentrations2S3S.qgz







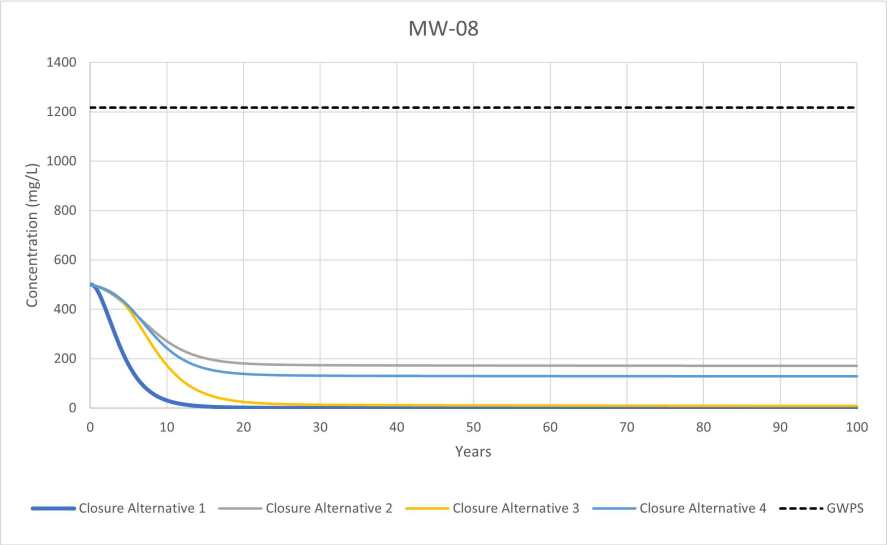
BAS GROUNDWATER CONSULTING

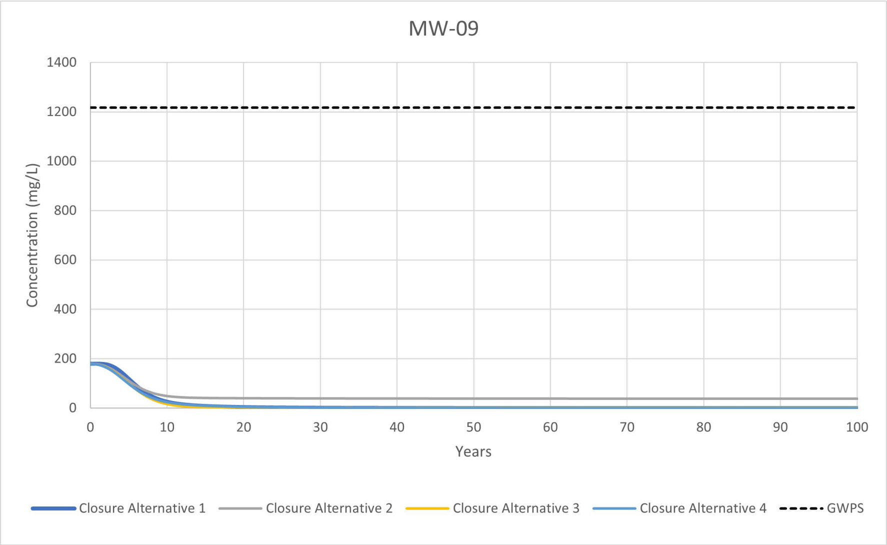
K P R G

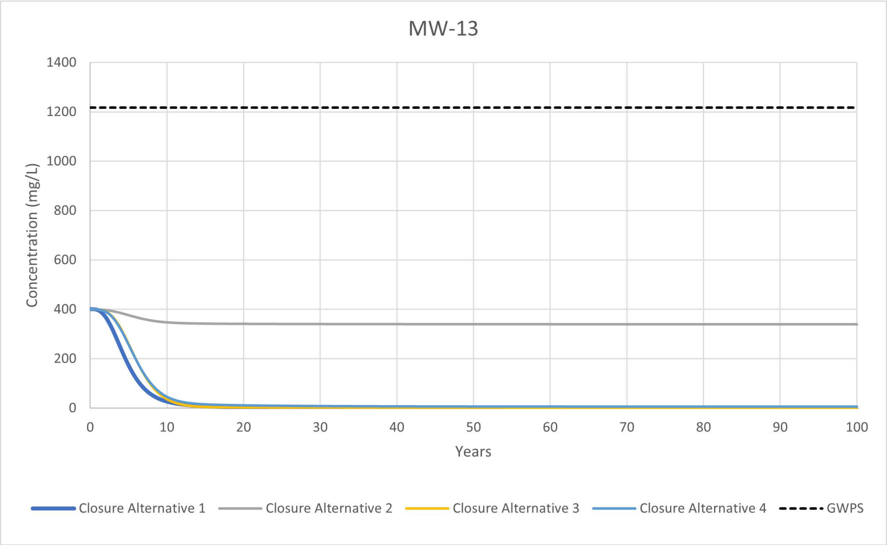
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 42	

CLIENT MIDWEST GENERATION
SITE WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE **SULFATE CONCENTRATIONS OVER TIME, POND 1N DOWNGRADIENT WELLS**

Project File: Figure42_SulfateConcentrations1N.qgz







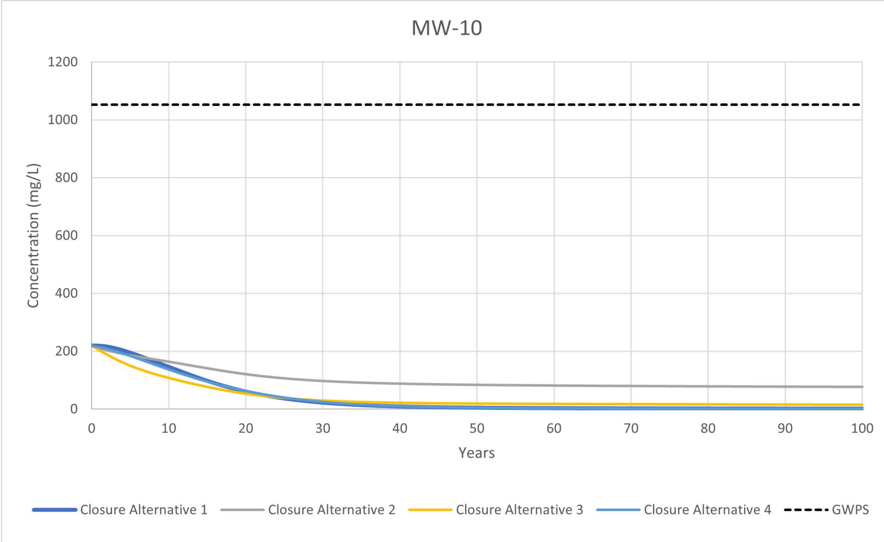
BAS GROUNDWATER CONSULTING

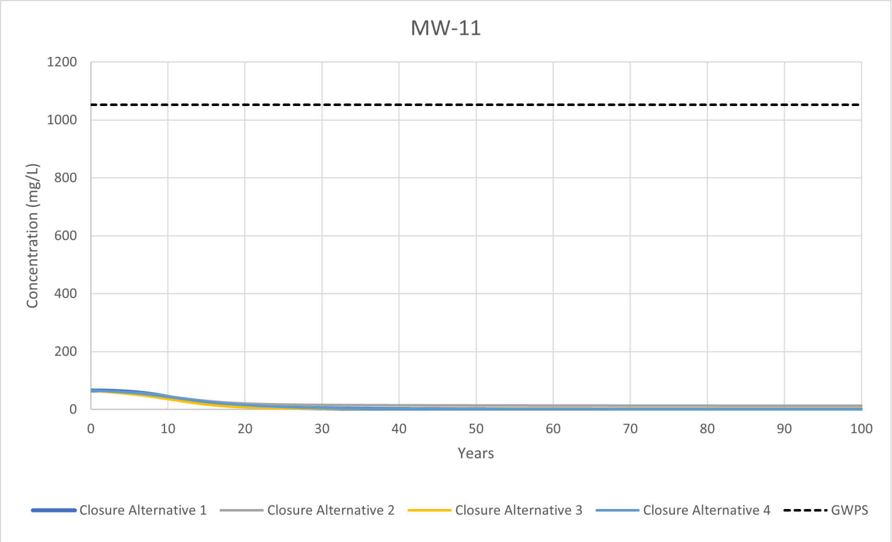
K P R G

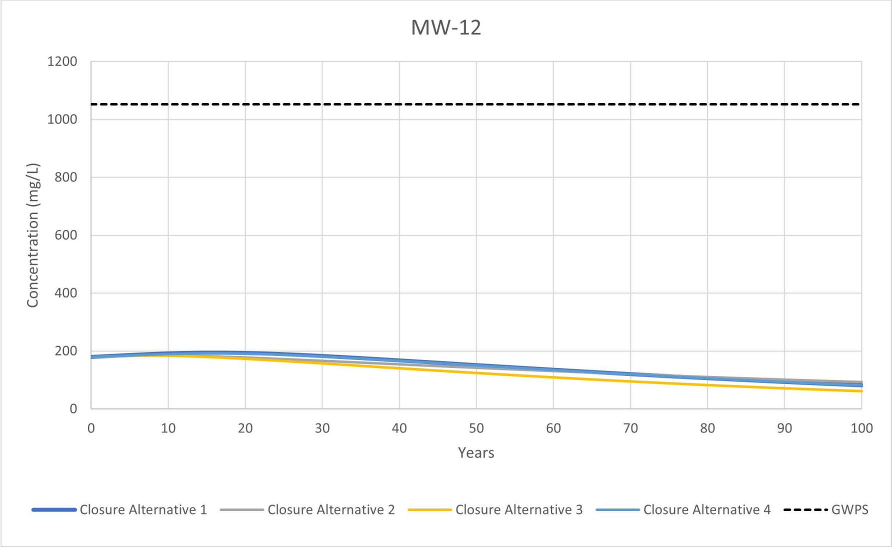
SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501	FIGURE: 43		

CLIENT	MIDWEST GENERATION
SITE	WILL COUNTY 529 OLD ROMEO RD, ROMEOVILLE, IL
TITLE	**SULFATE CONCENTRATIONS OVER TIME, POND 1S DOWNGRADIENT WELLS**

Project File: Figure43_SulfateConcentrations1S.qgz







BAS GROUNDWATER CONSULTING

K P R G

SCALE AT ANSI A	DRAWN	DZF	03/20/2023
	CHECKED	BAS	03/20/2023
BAS PROJECT No. 21141501		FIGURE: 44	

CLIENT
MIDWEST GENERATION

SITE
WILL COUNTY
529 OLD ROMEO RD, ROMEOVILLE, IL

TITLE
SULFATE CONCENTRATIONS OVER TIME, PONDS 2S/3S DOWNGRADIENT WELLS

Project File: Figure44_SulfateConcentrations2S3S.qgz