Form
CCR 1

Illinois Environmental Protection Agency
CCR Residual Surface Impoundment Permit Application
CCR Form 1 – General Provisions

Bureau of Water ID Number:

CCR Permit Number:

Facility Name:

For IEPA Use Only

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 IAC 845.210(b))

Facility, Operator, and Owner Information

1.1 Facility Name

Joliet #9 Generating Station

1.2 Illinois EPA CCR Permit Number (if applicable)

Initial Permit

1.3 Facility Contact Information

Name (first and last)	Title	Phone Number
DeAndre Cooley	Environmental Specialist	779-279-2321

Email address
DeAndre.Cooley@NRG.com

1.4 Facility Mailing Address

Street or P.O. box
1800 Channahon Road

City or town	State	Zip Code
Joliet	Illinois	60436

1.5 Facility Location

Street, route number, or other specific identifier
1601 Patterson Road

County name	County code (if known)	
Will		
City or town	**State**	**Zip Code**
Joliet	Illinois	60436

1.6 Name of Owner/Operator

Midwest Generation, LLC

Facility, Operator, and Owner Info

1.7 **Owner/Operator Contact Information**

Name (first and last): William Naglosky

Title: Plant Manager

Phone Number: 815-207-5412

Email address: william.naglosky@nrg.com

1.8 **Owner/Operator Mailing Address**

Street or P.O. box: 804 Carnegie Center

City or town: Princeton

State: New Jersey

Zip Code: 08540

SECTION 2: LEGAL DESCRIPTION (35 IAC 845.210(c))

Legal Description

2.1 **Legal Description of the facility boundary**

That part of the Southeast Quarter of Section 20, and the Northeast Quarter of Section 29, Lying south of Patterson Road, West of Brandon Road, and lying north of the north line of the South 233' of the North half of the Northeast quarter of Section 29, all in Township 35 North, Range 10 East of the third Principal meridian, in Will County, IL

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 IAC 845.810)

Internet Site

3.1 **Web Address(es) to publicly accessible internet site(s) (CCR website)**

https://midwestgenerationllc.com/illinois-ccr-rule-compliance-data-and-information/

3.2 **Is/are the website(s) titled "Illinois CCR Rule Compliance Data and Information"**

[✓ Yes] No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification

4.1 **List all the Impoundment Identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.**

W1970450046-01	☑	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description
	☐	Attached written description

	☐	Attached written description
	☐	Attached written description
	☐	Attached written description

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

Checklist and Certification Statement

5.1 In Colum 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing.

Column 1		Column 2	
Section 1: Facility, Operator, and Owner Information	☑	w/attachments	☑
Section 2: Legal Description	☑	w/attachments	☐
Section 3: Publicly Accessible Internet Site Requirement	☑	w/attachments	☐
Section 4: Impoundment Identification	☑	w/attachments	☑

5.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name) of Owner/Operator William Naglosky	Official Title Plant Manager
Signature William Naglosky	Date Signed 1/28/22

Form 2CC

Illinois Environmental Protection Agency

CCR Surface Impoundment Permit Application

Form CCR 2CC – Closure Construction

Bureau of Water ID Number:

CCR Permit Number:

Facility Name:

For IEPA Use Only

SECTION 1: DESIGN AND CONSTRUCTION PLANS (35 Ill. Adm. Code 845.220)

Design and Construction Plans (Construction History)

Design and Construction Plans (Construction History)	1.1	CCR surface impoundment name.
		Lincoln Stone Quarry
	1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
		W1970450046-01
	1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).
		That part of the Southeast Quarter of Section 20, and the Northeast Quarter of Section 29, Lying south of Patterson Road, West of Brandon Road, and lying north of the north line of the South 233' of the North half of the Northeast quarter of Section 29, all in Township 35 North, Range 10 East of the third Principal meridian, in Will County, IL
	1.4	State the purpose for which the CCR surface impoundment is being used.
		Used as a disposal facility for bottom ash/boiler slag from Joliet #9 and Joliet #29 generating stations. LSQ is no longer active.
	1.5	How long has the CCR surface impoundment been in operation?
		Exact construction date is unknown. The Lincoln Stone Quarry has been operating as a surface impoundment since 1962
	1.6	List the types of CCR that have been placed in the CCR surface impoundment.
		Bottom ash and boiler slag

Design and Construction Plans (Continued)

1.7 List the name of the watershed within which the CCR surface impoundment is located.

Des Plaines watershed

1.8 What is the size in acres of the watershed within which the CCR surface impoundment is located?

28,808 acres

1.9 Check the corresponding boxes to indicate that you have attached the following:

☑	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.
☑	A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment.
☑	A statement of the method of site preparation and construction of each zone of the CCR surface impoundment.
☑	A statement of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.
☑	Drawings satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(1)(F).
☑	A description of the type, purpose, and location of existing instrumentation.
☑	Area capacity curves for the CCR impoundment.
☑	A description of each spillway and diversion design features and capacities and provide the calculations used in their determination.
☑	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.

1.10.1 Is there any record or knowledge of structural instability of the CCR surface impoundment?

☐ Yes ☑ No

1.10.2 If you answered yes to Item 1.10.1, provide detailed explanation of the structural instability.

SECTION 2: NARRATIVE DESCRIPTION OF THE FACILITY (35 Ill. Adm. Code 845.220)

Narrative Description

2.1 List the types of CCR expected in the CCR surface impoundments.

LSQ is no longer active and will not receive future CCR.

2.2 Have you attached a chemical analysis of each type of expected CCR?

☑ Yes

2.3 Estimate of the maximum capacity of the surface impoundment in gallons or cubic yards.

6,300,000 cubic yards

2.4 The rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.

0	GPD		dTn

2.5 Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.

LSQ is no longer active

2.6 Have you attached an on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment?

☑ Yes

SECTION 3: MAPS (35 Ill. Adm. Code 845.220)

Maps

3.1 Check the corresponding boxes to indicate that you have attached the following maps:

☑ A site location map on the most recent United Sates Geological Survey (USGS) quadrangle of the area from the 7 ½ minute series (topographic) or on another map whose scale clearly shows the information required in 35 Ill. Adm. Code 845.220(a)(3).

☑ Site plans maps satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(4).

SECTION 4: ATTACHMENTS

Attachments

4.1 Check the corresponding boxes to indicate that you have attached the following:

☑ A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.

☑ Plans and specifications fully describing the design, nature, function, and interrelationship of each individual component of the facility.

☑ The signature and seal of a qualified professional engineer.

☑ Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under 35 Ill. Adm. Code 845.240.

Attachments (Continued)		☑	A summary of the issues raised by the public during the public notification and public meetings.
		☑	A summary of any revisions, determinations, or other considerations made in response to those issues raised by the public during the public notification and public meetings.
		☑	A list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in erosion control and environmental remediation.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in the operation of heavy equipment and excavation.

SECTION 5: GROUNDWATER MONITORING PROGRAM

Groundwater Monitoring	5.1	Indicate that you have attached the following components of a new groundwater monitoring program or any modifications to an existing groundwater monitoring program by checking the corresponding boxes:	
		☑	A hydrogeologic site investigation meeting the requirements of 35 Ill. Adm. Code 845.620, if applicable.
		☑	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.
		☑	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 35 Ill. Adm. Code 845.640 and 845.650.

SECTION 6: CLOSURE (35 Ill. Adm. Code 845.220(d))

Closure	6.1	What is the closure prioritization category under 35 Ill. Adm. Code 845.700(g), if applicable?	
		Category 3	
	6.2	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The final closure plan, as specified in 35 Ill. Adm. Code 845.720(b), which includes the closure alternatives analysis required by 35 Ill. Adm. Code 845.710.
		☑	Proposed schedule to complete closure.
		☑	Post-closure care plan as specified in 35 Ill. Adm. Code 845.780(d).

SECTION 7: GROUNDWATER MODELING (35 Ill. Adm. Code 845.220(d)(3))

Groundwater	7.1	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards.
		☑	All modeling inputs and assumptions.
		☑	Description of the fate and transport of contaminants with the selected corrective action over time.

		☐	Capture zone modeling, if applicable.
		☑	Any necessary licenses and software needed to review and access both the model and the data contained within the model.

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

APPLICATION FOR INITIAL CONSTRUCTION PERMIT

JOLIET 9 GENERATING STATION
MIDWEST GENERATION, LLC
JOLIET, ILLINOIS

Illinois EPA Site No. 1970450046

January 28, 2022

Submitted To:

Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62702

Prepared For:

Midwest Generation, LLC
Patterson Rd.
Joliet, IL 60436

Prepared By:

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

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Introduction

Midwest Generation, LLC (Midwest Generation) currently operates the natural gas-fired generating station, referred to as Joliet #9 Station, located in Joliet, Illinois ("Site" or "generating station"). Midwest Generation converted the generating station from coal to natural gas in 2016. As part of the previous coal-fired operations, the station operated Lincoln Stone Quarry (LSQ) to manage/store the coal combustion residuals (CCR) created at the generating station as part of the electricity generating process. LSQ consists of an inactive West Filled Area (WFA), the formerly active Main Quarry, and the North Quarry. Decant water from the Main Quarry is gravity drained to the North Quarry. The North Quarry is not used to manage/store CCR but rather as a settling pond that is used to treat the water discharged from the Main Quarry.

The CCR from the generating station was sluiced into LSQ, where it was temporarily contained, the CCR settled from the sluice water, and the sluice water was ultimately discharged via the North Quarry settling pond to the Des Plaines River through an existing NPDES permit. After the sluice water and wastewater was discharged, the CCR remained within LSQ. LSQ was also used to manage low volume wastewater from the generating station at the same time it was used to manage CCR. LSQ stopped receiving CCR and low volume wastewater in 2019 and neither CCR nor low volume wastewater is currently being sent to LSQ.

The LSQ is operated and permitted as a landfill regulated by Illinois Environmental Protection Agency (EPA) Bureau of Land under 35 Ill. Adm. Code, Subtitle G, Part 811. It has been permitted as a landfill since approximately 1976. The operations are still subject to the conditions and requirements of its landfill Operating Permit No. 1994-241-LFM Modification No. 24. In 2015, the LSQ was also determined to be regulated under the newly passed Federal Register, Environmental Protection Agency, 40 CFR Parts 257.94 and 257.95 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule dated April 17, 2015 (Federal CCR Rule) and subsequent amendments. The LSQ operations also fall under the newly promulgated Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule).

The objective of this submittal is to apply for the initial construction permit for Lincoln Stone Quarry at the Joliet #9 Generating Station to close LSQ in compliance with Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments. The information required for a construction permit application for existing surface impoundments as specified under 35 Ill. Adm. Code 845.220(a) of the State CCR Rule is provided in the following sections.

The Permit is organized with supporting Tables and Figures that are referenced in the discussions being provided at the end of the full Permit text with the table numbers and figures tied to the Section number within which they are referenced with sequential numbering (e.g., Tables referenced in Section 9 are numbered 9-1, 9-2, etc. Figures referenced in Section 9 are numbered Figure 9-1, 9-2, etc.). Specific Attachments referenced within each Section are provided in a similar fashion (e.g., Attachment 1 information is tied to Section 1 of the Permit text, Attachment 2 information is tied to Section 2 of the Permit text, etc.). It should be noted that if Section does not reference an Attachment then that Attachment number is not included as part of the permit application. For example, Section 10 does not reference an Attachment; therefore, there is no Attachment 10 in this permit application.

1.0 History of Construction, 845.220(a)(1)

The history of construction of the CCR surface impoundment as specified in Section 845.220(a)(1) is presented below.

1.1 CCR Surface Impoundment Identifying Information

The identifying information associated with the CCR surface impoundments at the generating station are listed in the table below.

Name	Owner/Operator	Impoundment ID Number
Lincoln Stone Quarry	Midwest Generation 804 Carnegie Center Princeton, NJ 08540	W1970450046-01

1.2 Purpose of CCR Surface Impoundment

The Lincoln Stone Quarry has been used as a disposal facility for bottom ash/boiler slag from Joliet #9 and Joliet #29 Generating Stations. The disposal facility consists of an inactive portion, the West Filled Area (WFA), and the active CCR disposal area referred to as the Main Quarry. The North Quarry contains a settling pond that is used to treat the water discharged from the Main Quarry. LSQ is no longer in service with the last ash being placed in 2019 and will not be used in the future for CCR disposal.

1.3 CCR Surface Impoundment Length of Operation

The exact date of construction for the LSQ in unknown. The LSQ has been operating as a disposal facility since 1962 when the WFA was being used for ash placement. As of 1975, the WFA had been closed and the Main Quarry was used for the disposal of CCR until 2019. The CCR sluicing system was decommissioned in 2016. Based on an operations start date of 1962, the overall quarry operated for CCR disposal for approximately 57 years. The North Quarry was never used to manage or store CCR. A Notice of Intent to Initiate Closure of the LSQ was submitted on March 24, 2021 by Midwest Generation.

1.4 Type of CCR in Surface Impoundment

The types of CCR present in the LSQ are bottom ash and boiler slag. Some fly ash may also have been placed into the WFA during early operations. The chemical constituents that make up the CCR is explained in further detail in Section 2.0.

1.5 Name and Size of the Watershed

LSQ is present within the Des Plaines River watershed, which is approximately 28,808 acres in size.

1.6 Description of CCR Surface Impoundment Foundation

This section focuses on the WFA and the Main Quarry because they were used to manage and store CCR. LSQ is a former dolomite quarry and site observations and topographic documents show LSQ is incised on all sides. The surrounding ground elevation of the WFA and the Main Quarry is at approximately 590-600 ft above mean sea level (ft amsl) with the base of the Main Quarry ranging from 510 ft amsl to a low point of 477 ft amsl, and the base of the WFA at approximately 480 ft amsl. The surrounding walls of LSQ are Silurian Dolomite bedrock, which is topped with overburden soil. The overburden ranges from approximately 5 feet in thickness to 20 feet in thickness as the ground elevations increase to the south, west, and east. The overburden to the north, remains at a relatively constant elevation because Patterson Road is constructed adjacent to LSQ. The Silurian Dolomite extends from below the overburden soil to the base of the LSQ and at least 50 feet below the base of LSQ.

1.6.1 Physical Properties of Foundation Materials

The physical properties of the foundation materials in which LSQ exists is Silurian Dolomite, which is underlain by the Maquoketa group bedrock. The Silurian dolomite is divided into four units; a weathered bedrock rind, Joliet Formation dolomite, Kankakee Formation dolomite and the Elwood/Wilhelmi dolomite. Beneath the Silurian dolomite is the Ordovician age Maquoketa Group consisting of the Brainard Shale, Fort Atkinson dolomite and the Scales Shale. The Scales Shale is a well-documented regional aquitard, which separates shallow groundwater within the Silurian Dolomite from the deeper aquifers.

The dolomite beneath the facility is divided into a “shallow” Silurian zone and a “deep” Ordovician zone. A “lower permeability” zone identified, as the Brainard Shale (approximately 10-feet thick) separates these two more permeable zones. The lower permeability zone is mappable across the site and has been used by the Illinois State Geological Survey (ISGS) as a tracer bed.

The shallow zone dolomite is about 140 to 150 feet thick. This places the bottom of the shallow zone and top of the lower permeability zone (Brainard Shale) at an elevation of approximately 430 to 440 feet msl. The thickness between the top and the bottom of the Brainard Shale is approximately 10 feet, with its base at an elevation between about 420 to 430 feet msl. The deep zone is 30 to 40 feet thick, so the boundary between the deep zone and the underlying Scales Shale member of the Maquoketa group is at an elevation of approximately 380 to 400 feet msl. As previously noted, the deepest portions of the bottom of LSQ lie at an elevation of approximately 477 feet msl, which is within the shallow Silurian dolomite zone and above the Brainard Shale low permeability zone.

1.6.2 Engineering Properties of Foundation Materials

The engineering properties for the foundation materials were obtained from regional and site-specific data (Harza Engineering (1976), MACTEC (2004)) that document fractures in the Silurian dolomite. Site-specific and regional data are consistent in describing a primary joint set that is vertical and oriented about N52ºE and N40ºW. The N40ºW joints are described as “more distinct”. Natural spacing between the joint sets ranges from 3 to more than 10 feet, and joint apertures are described as less than 1/16th -inch. Bedding plane fractures are also described. Descriptions from the quarry walls and from cores obtained during drilling show significant clay infilling of the vertical joints and bedding plane fractures.

Borings completed in 2005/2006 by KPRG and Associates, Inc. (KPRG) for monitoring wells G46S/D, G47S/D and G48S/D were cored using HQ-series core barrels. Estimates of the Rock Quality Designation (RQD) were made for the dolomite based on visual inspection and measurements of the cores. The RQD is a measure that determines the quality of rock and is used as part of the early site evaluation process when determining locations for engineered structures such as power facilities, underground tunnels, and dams. During the early site evaluation process, the RQD is used to determine any potential problems of bearing capacity, settlement, or sliding. The higher the RQD percentage, the more competent the rock and its ability to support structures, resist settlement and prevent sliding. The upper approximate 10 to 15 feet of Silurian dolomite was weathered and highly fractured with RQDs ranging from 16.5% to 34%. Once competent bedrock was reached, the RQDs within the Silurian dolomite ranged from a low of 15.4 % in an isolated, highly fractured zone to 100% with an overall average of 76.6% and median of 84.8%. An RQD greater than 75% is considered good and an RQD greater than 90% is considered excellent.

1.7 Description of the Construction Materials, Methods, and Dates

The descriptions of the construction materials, methods, and dates are based on site investigations, available site drawings, and site observations.

1.7.1 Physical and Engineering Properties of Construction Materials

LSQ is an incised surface impoundment with Silurian dolomite bedrock walls, so the physical and engineering properties of the construction materials for this section are the same as the physical and engineering properties of the foundation materials. As described in Section 1.6.1, the physical properties for the foundation materials were described as Silurian dolomite underlain by the Maquoketa group formation. The engineering properties are the same as those listed in Section 1.6.2. As discussed in Section 1.6.2, the RQD for the Silurian dolomite is identified as good with an overall average of 76.6% and a median of 84.8%.

1.7.2 Construction Methods

LSQ was created by the quarrying and removal of the dolomite from the area used regionally for construction purposes, with the resulting void now filled with CCR. The disposal boundary of the CCR is created by the vertical dolomite walls and the quarry floor that remained after the quarrying operations were completed. A wall of bedrock exists between the North Quarry and the Main Quarry on which Patterson Road is built upon. Approximately 115 feet of the bedrock wall between the Main Quarry and the North Quarry contains a dike constructed of compacted soil. The overall length of the bedrock wall between the North Quarry and the Main Quarry is approximately 1,800 feet long. This dike contains the discharge pipes that allows water to gravity drain from the Main Quarry into the North Quarry settling pond. The Main Quarry discharge pipes are flow controlled using manually activated valves to either increase or decrease the water level in the Main Quarry as needed. The discharged water enters the North Quarry settling pond from where it is pumped to the Des Plaines River through a NPDES regulated discharge.

The CCR was sluiced into the WFA and the Main Quarry through steel pipes that run along the surface. The sluiced CCR was initially sent to the WFA and then into the Main Quarry once the WFA was filled and covered with a clayey soil layer. Three CCR sluice pipes entered the LSQ property at the northwest corner where they separated and the CCR sluice pipe from the Joliet #9 generating station ran east along the ground to the northwest corner of the Main Quarry. The remaining two pipes from the Joliet #29 generating station ran south through the WFA and then turned east towards the southwest corner of the Main Quarry where they most recently discharged.

1.7.3 Construction Dates

The actual dates of the quarrying operation are unknown, but LSQ has been used as a disposal facility for ash from 1962 until 2019. Therefore, the creation of the LSQ surface impoundment through mining is some time prior to 1962.

1.8 Detailed Dimensional Drawings

Detailed dimensional drawings are not available for LSQ. The drawing in Attachment 1 is an aerial survey of LSQ in 1975 that shows the closed WFA, the active sluicing area of the Main Quarry (south portion of Main Quarry), an east-west trending clay berm separating the north and south halves of the Main Quarry to facilitate ongoing mining operations on the north side from the sluicing operations on the south side, and the access through to the North Quarry.

1.9 Instrumentation

Water level monitoring instrumentation was installed in the northeast corner of the Main Quarry to monitor the water level within the Main Quarry. Included in the instrumentation is a pressure transducer, data logger, and radio antenna to transmit data to a website accessible by MWG. This same style of water level monitoring instrumentation was installed in Boyd’s Quarry to monitor the water level differential between the two quarries. Boyd’s Quarry is located immediately east of LSQ.

A groundwater extraction system was installed beginning in 2010 with the construction of four (4) extraction wells and expanded in 2012 with the construction of eight (8) additional extraction wells. The system was constructed along the southern perimeter of LSQ to address an observed reversal in groundwater flow to the southeast instead of towards the north, which is its natural flow direction and that required to be maintained by the landfill operating permit (i.e., inward gradient). As discussed in Section 9 below, the noted change in groundwater flow direction within the dolomite is the result of ongoing, unrelated quarrying operations at the Vulcan Laraway Quarry located approximately 1,000 feet to the southeast of the LSQ. The system was constructed in accordance with IEPA approved Permit Modification No. 12 (dated December 1, 2009), No. 16 (dated August 8, 2011), and No. 17 (dated July 2, 2012).

The objective of the groundwater extraction system is to establish a hydraulic trough between the Main Quarry/WFA and the south property boundary to sufficiently capture water moving from the facility to the south and to re-establish an inward hydraulic gradient from the south property boundary to the north. The groundwater extraction system discharges the groundwater into the Main Quarry where it is discharged through the NPDES regulated outfall.

1.10 Area-Capacity Curve

An area-capacity curve for LSQ is included as Figure 1.

1.11 Spillway and Diversion Capacities and Calculations

CCR is no longer sluiced into the Main Quarry at LSQ. Therefore, the discharge pipes from the Main Quarry to the North Quarry settling pond only have to manage the discharge from stormwater runoff that enters the Main Quarry. Stormwater runoff from the Main Quarry discharges through two (2) 20-inch diameter steel pipes into the North Quarry settling pond. From the settling pond, the water is discharged to the Des Plaines River using up to three discharge pumps capable of pumping at about 4,200 gallons per minute (gpm) each for a total pump rate of 12,600 gpm. The stormwater runoff volume from the 1,000-year, 24-hour flood is approximately 69.1 acre-feet (3,009,800 cubic feet) and a flow rate of about 15,600 gpm over 24 hours. The Main Quarry has a capacity of up to 1,400 acre-feet, indicating the Main Quarry has the capacity to contain the 1,000-year, 24-hour flood without exceeding the capacity of the settling pond and the settling pond pumps.

1.12 Surveillance, Maintenance, and Repair Construction Specifications

Specifications for the surveillance, maintenance, and repair associated with LSQ were not available for this application. Repairs did occur as needed on the sluice pipes, but this consisted of removing the unsatisfactory section of pipe and replacing with the same size pipe. Specifications for this work were not available. The WFA soil cover is routinely inspected for any potential erosion and repairs are completed as necessary. The vegetation on the soil cover is also inspected to remove any deep-rooted growth and mowed as necessary.

1.13 Record of Structural Instability

There is no record or knowledge of structural instability associated with LSQ.

2.0 Narrative Description of the Facility, 845.220(a)(2)

2.1 CCR Chemical Analysis

The bottom ash CCR that was sluiced to the Main Quarry was sampled and analyzed for the parameters listed in Section 845.600(a) except for total dissolved solids. One representative composite sample was collected from ash sluiced from the Joliet #9 generating station and one from the ash sluiced from the Joliet #29 generating station. The results of those analyses are presented in Table 2. The laboratory data packages are included in Attachment 2-1.

A piezometer located within the WFA (P105) was sampled quarterly in 2012 for chemical analysis of landfill permit parameters. This data was used to provide leachate chemistry data for subsequent numerical groundwater modeling in support of the Groundwater Impact Assessment (GIA) and landfill operating permit renewal. The summary table of that quarterly sampling data is included in Attachment 2-2.

2.2 Maximum Capacity

Lincoln Stone Quarry has a maximum capacity of approximately 6,300,000 cubic yards.

2.3 Waste Streams

LSQ is not in service and does not receive CCR or non-CCR waste streams at this time. When LSQ was operating, an average of 34,891 CY of CCR was sluiced into it from both stations. This value is based on the annual ash placement data from 2008 through 2015, except for the year 2013. The stations were converted to natural gas in March 2016.

2.4 On-Site Transportation Plan

The LSQ property is a secure property. The property boundary is fenced with gates that provide access, but the gates are locked unless accessed by a key. The keys that control the gate access are kept secure in the Joliet #9 station guard shack. The key can only be obtained by non-Midwest Generation personnel with permission from Midwest Generation.

Upon approval of this permit, LSQ will be closed and not used as a CCR surface impoundment. During the closure activities, Patterson Road, and two gates located at the northwest corner of the property will be used for access by construction personnel to bring materials and equipment that will be used. The normal day to day operations of LSQ does not require access. Patterson Road is used to access LSQ, as needed, to perform the weekly inspection required by the current landfill permit and the newly promulgated Illinois CCR Rule. Patterson Road is accessed from the north by Brandon Road, via Chicago Street from the east, and via Brandon Road from the south. Patterson Road is not accessible from the west. On a quarterly basis, groundwater sampling will be performed at the monitoring wells that surround LSQ and Brandon Road and Patterson Road will be used to access the wells. Each sampling event requires three weeks to perform. These roads are shown on Figure 2.

Specifically discussing closure, construction equipment would be brought to the site either by Brandon Road from the north or south, and/or Patterson Road from the east. Patterson Road is then used to access LSQ so the equipment can enter the quarry to perform the work. The closure materials, such as the geomembrane, engineered turf, and sand infill, would be brought to LSQ using the same access roads as the construction equipment. As stated above, Patterson Road is accessed via Brandon Road and Chicago Street, and these roads would be used to bring the construction equipment and closure materials to LSQ.

3.0 Site Location Map, 845.220(a)(3)

A site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7 ½ minute topographic series has been included in Attachment 3. This map includes details regarding the facility and adjacent properties boundaries extending 1000 meters, surface waters, the prevailing wind direction, and the limits of all 100-year floodplains. Alongside this, all natural areas designated as a Dedicated Illinois Nature Preserve under the Natural Areas

Preservation Act, all historic and archaeological sites designated by the National Historic Preservation Act and the Illinois Historic Sites Advisory Council Act, and all areas identified as critical habitat under the Endangered Species Protection Act of 1973 and the Illinois Endangered Species Protection Act are also shown on this map.

4.0 Site Plan Map, 845.220(a)(4)

Site plan maps in accordance with 845.220(a)(1)(4) are included in Attachment 4. The information required is depicted on multiple maps. Figure 4-1 shows the entire Lincoln Stone Quarry including the existing groundwater monitoring wells and the main service corridors, transportation routes, and access roads. Cross-sectional maps showing the boundaries above and below ground level of LSQ are included on Figures 4-2 through 4-4.

5.0 Construction Description, 845.220(a)(5)

LSQ is no longer used as a disposal location for CCR and will be closed. LSQ will be closed with the CCR remaining in place and a final cover system compliant with 845.750 will be installed. The installation of the final cover system (FCS) will achieve the following performance standards:

- Control, minimize, or eliminate, to the maximum extent feasible, the post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

- Preclude the probability of future impoundment of water, sediment, or slurry;

- Include measures that provide for major slope stability to prevent the sloughing or movement of the FCS during the closure and post-closure care period;

- Minimize the need for future maintenance of the FCS and LSQ; and

- Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.

The following construction activities will be conducted to execute the closure in place in accordance with 845.750:

- Site Clearing and Decommissioning;
- Dewatering;
- Regrade and Compact CCR;
- Install Underdrain System; and
- Install Final Cover System;

Each of these items are discussed in detail in the following paragraphs.

5.1 Site Clearing and Decommissioning of Sluice Pipelines

Vegetation will be removed from the site to execute the closure. Trees and grass from the east side of the WFA and other areas around LSQ as needed will be removed and disposed of either onsite or offsite. The topsoil and clay on the WFA will be scraped to expose the existing CCR material and stockpiled. This will allow the east portion of the WFA to be regraded to lessen the existing slope and assist in creating the desired elevations needed to install the FCS.

Three sluice pipelines enter LSQ from under Patterson Road along the west side of the WFA. Two sluice pipelines run along the west and south sides of the WFA and then discharge into the southwest corner of the Main Quarry. The third sluice pipeline runs along the north side of the WFA and discharges into the northwest corner of the Main Quarry. Abandoned portions of the former sluice pipelines still exist along the southern perimeter of the Main Quarry.

The FCS will connect to the contours of the existing grade of LSQ and the WFA along the southwest and northwest corners of the Main Quarry. This will require the sluice pipes in these areas to be removed to accommodate the proposed grade of the FCS to be tied into the existing grade. These removed portions of the sluice pipelines will be hauled from the site to a disposal facility or a salvage yard. The remaining portions of the sluice pipelines can be left in place as long as they do not interfere with the closure activities.

5.2 Dewatering

The Main Quarry will be dewatered to an extent to allow the CCR to be regraded and compacted. The Main Quarry discharge pipes will be used to dewater the Main Quarry by gravity to the inlet elevation of the pipes, which is approximately 527.5 feet amsl. At the point where the discharge pipes have dewatered the Main Quarry to the maximum extent possible, the remaining water will be artificially pumped from the Main Quarry through the discharge pipes. The discharge pipes from the Main Quarry drain by gravity into the settling pond located inside the North Quarry, from which the water is then pumped to the Des Plaines River. The discharge to the Des Plaines River is a NPDES regulated outfall. Continuing to pump the water through the discharge pipes will allow this water to be discharged using LSQ’s existing NPDES discharge permit. As much of the water as possible will be pumped from the Main Quarry to expose the CCR. This is necessary to regrade and compact the CCR to minimize settling and allow it to support the FCS.

5.3 Regrade and Compact CCR

The CCR in LSQ will be regraded to a relatively uniform elevation to allow for the placement of the FCS. In general, the majority of the CCR is located in three different places: 1) in the southern portion of the Main Quarry, 2) the WFA and 3) a pile located on the east side of the Main Quarry. The CCR in the southern portion of the Main Quarry will be redistributed over the entire surface area of the Main Quarry to achieve a relatively uniform elevation. The CCR in the WFA has already been covered and will remain covered in place, except for the east slope, which will be regraded to lessen the existing slope and allow for the placement of the FCS. The FCS will then be placed over the CCR in the Main Quarry and the regraded eastern slope of the WFA. CCR from the upper portion of the east pile will be redistributed along with the other CCR in the Main Quarry to form the surface on which the FCS will be placed. This CCR will be distributed over the entire extent of the Main Quarry with the surface sloping towards the existing drainage pipes for the Main Quarry.

The CCR will be compacted to stabilize it prior to placement of the FCS and to reduce the potential for future settling. Due to the sandy composition of the CCR, most settlement will occur during regrading and compaction with time dependent settling of the CCR expected to be insignificant.

5.4 Underdrain

A Groundwater Impact Assessment (GIA) was performed on the groundwater flow system for LSQ in response to the mining operations at Vulcan Quarry. The approved GIA numerical groundwater model was used to evaluate the rebound of the water table once Vulcan Quarry mining to the southeast was ceased along with their ongoing dewatering operations. The model estimated that once Vulcan Quarry ceased mining and the groundwater levels around the Main Quarry returned to passive levels, the water level in the Main Quarry would reach an approximate elevation of 540 ft amsl. In order to address this situation an underdrain system will be installed in the Main Quarry.

The underdrain system will be installed to assist in controlling the flow of groundwater that enters the bottom of the Main Quarry. If the water level within the Main Quarry rises to an approximate 540 ft amsl elevation, this projected water level would be higher than the proposed elevation of the FCS and this would put upward pressure on the FCS. In order to prevent the water level from rising too high and causing upward pressure on the FCS an underdrain system will be installed. The underdrain system will create an outlet for rising groundwater and will prevent any uplifting pressure on the FCS. This portion of the underdrain system will be installed near the existing discharge pipes and consists of five (5) pipes arrayed evenly as a half circle, as shown on Sheet 3. Each pipe is four (4) inches in diameter and three of the pipes are approximately 150 feet long and two of the pipes are approximately 700 feet long. The longer pipes extent toward the south and southwest. The pipes will connect to the existing Main Quarry discharge pipes. The location and configuration would allow the water to be discharged without the need for pumping.

5.5 Installation of the Final Cover System

The closure of the Quarry will consist of installing the FCS over the regraded CCR. The FCS will comply with 35 Ill. Adm. Code 845.750(c). The FCS will be the ClosureTurf cover system created by Watershed Geo, LLC, which uses a geomembrane low permeability layer and synthetic turf with a sand/aggregate infill as the final protective layer. The geomembrane low permeability layer will be installed in accordance with the manufacturer’s recommendations. The final protective layer will be constructed to protect the geomembrane from UV damage, minimize erosion, and control stormwater runoff.

ClosureTurf consists of a structured geomembrane overlain by engineered synthetic turf infilled with sand/aggregate. The proposed structured geomembrane that will be used is MicroDrain, which is a 50-mil high-density polyethylene (HDPE) structured geomembrane that combines a studded drain surface on the top side and spiked friction surface on the bottom side into one geomembrane liner. The geomembrane will be deployed with the spike side down and the stud side up on top of the regraded CCR. The geomembrane will be deployed perpendicular to the slope elevation contours and the deployment method will protect the geomembrane as well as the regraded CCR. Adequate anchoring will be used, such as sand bags, to prevent uplift by wind during the deployment of the geomembrane. The edges of each geomembrane section are overlapped in the downgrade direction a minimum of three inches to form the seam that is then welded together. Welding is performed by either extrusion welding or hot wedge welding depending on manufacturer's recommendations and as construction of the geomembrane dictates.

Since LSQ does not have a bottom/sidewall liner to tie the FCS into, the geomembrane will abut the vertical rock sidewalls. The slope of the geomembrane will follow the slope of the regraded CCR, which is sloped away from the intersection between the vertical rock sidewalls and the geomembrane to minimize the potential for infiltration.

The geomembrane will be covered with engineered synthetic turf. The engineered synthetic turf is green and replaces the need for an erosion layer and vegetation while providing a natural look and feel of grass and protecting the geomembrane from extreme weather. The engineered turf will be installed in accordance with the manufacturer's recommendations and equipment used during the installation will not damage the turf or the underlying geomembrane. The engineered synthetic turf will be rolled out on top of the geomembrane starting from the highest slope to the lowest slope. The engineered turf will be deployed so that the filaments of the engineered turf are pointed upslope and the edges of each section touch each other so the seams can be joined together. The turf will be laid substantially smooth and it will be secured with sandbags at the top of any slope after it is deployed. The engineered synthetic turf will cover all of the geomembrane and will follow the same slope as the geomembrane. The sections of the engineered turf are joined together either by sewing with polyester thread or by fusion seaming with a fusion welder.

A specialized sand infill will be placed between the blades of the engineered synthetic turf after the turf is in place on top of the geomembrane. The sand infill will be spread with a minimum thickness of 0.5 inches and a maximum thickness of 0.75 inches using conveyor systems and/or express blowers. The infill will be driven into the space between the synthetic blades and the sand will meet ASTM C-33-03 for fine aggregates. The infill thickness will be checked at approximately 100-foot grid intervals. The sand infill installation will be done as to not damage or displace previously installed ClosureTurf components and the placement will not occur with snow or ice on the engineered turf.

An anchor trench will be used on the top of the slope of the regraded WFA to anchor the ClosureTurf system. The anchor trench will bury the top slope edge of the geomembrane and engineered turf beneath two feet of soil to ensure it does not slide down the regraded slope. The soil that is placed in the anchor trench will be compacted to prevent the potential pullout of the geomembrane and engineered turf. QA/QC testing will be performed on the ClosureTurf cover system as part of the installation.

The FCS will be installed at and below the perimeter rim elevation of LSQ with the FCS sloping inward. Thus, all the runoff from the FCS will drain inward towards the existing discharge pipes. Runoff from adjacent local drainage areas will be drained into the Main Quarry and directed toward the existing discharge pipes, which will convey the runoff to the North Quarry settling pond. The existing discharge pipes are two 20” diameter metal pipes. The existing discharge pipes from the Main Quarry discharge to the settling pond in the North Quarry, from which the water is pumped to the Des Plaines River. The settling pond, and the North Quarry itself, also are below the surrounding ground surface.

The ClosureTurf final cover system uses a geomembrane liner as the low permeability layer control, minimize, or eliminate, to the maximum extent possible, the post-closure infiltration of liquids in the CCR below. The geomembrane’s hydraulic flux must be equivalent or superior to a 3-foot layer of soil with a hydraulic conductivity of 1x10^{-7} cm/sec. The comparison of the two liners was done based on the liquid flow rate through an area for each layer type. The calculations and their results are shown in Attachment 5-2, which show that the geomembrane with a liquid flow rate of 7.74x10^{-10} cm^3/s/cm^2 provides a greater reduction compared to the earthen material with a liquid flow rate of 1.15x10^{-7} cm^3/s/cm^2.

Drawings for the proposed closure discussed above are located in Attachment 5.

After contractors have been chosen to conduct the closure construction and prior to earth moving activities, the contractor certifications identified on permit form 2CC will be provided to IEPA.

6.0 Facility Component Plans and Specifications, 845.220(a)(6)

LSQ was used as the final disposal location for CCR from Joliet #29 and Joliet #9 generating stations. Plans and specifications for LSQ are not available, except for a drawing from 1975 that shows the contours of LSQ at that time. The drawing shows that what is now the WFA has been completely filled and covered and the CCR is being sluiced into the southern half of the Main Quarry. The north half of the Main Quarry was separated from the south half by a clay wall that ran from Branden Road to the now filled WFA. At that time, the north half of the Main Quarry may have still been mined with access to this area from the North Quarry under Patterson Road.

The CCR was placed in LSQ by sluicing it from each generating station using overland steel pipes. The Joliet #29 CCR was sluiced through aboveground steel pipes over the Des Plaines River, through the Joliet #9 generating station site, along the west side of the North Quarry, and enters LSQ at the northwest corner. From where it enters LSQ, the Joliet #29 sluice pipes run aboveground adjacent to the West Filled Area, and then discharges into the Main Quarry at the southwest corner. There are two pipes that were used to sluice CCR from Joliet #29. The CCR from Joliet #9 was sluiced into LSQ using aboveground steel piping that is the same size as the Joliet #29 sluice piping. The Joliet #9 CCR sluice piping travels from the Joliet #9 station aboveground adjacent to the Joliet #29 sluice piping to the northwest corner of LSQ. From this point, the Joliet #9 sluice pipe travels along the northern slope of the WFA and discharged into the Main Quarry at the northwest corner.

LSQ would contain the sluice water and allow the CCR to settle and remain within the Main Quarry. The water separated from the CCR would discharge to a settling pond in the North Quarry through two 20-inch diameter steel pipes located in the center of the north wall of the Main Quarry.

The water discharged from the Main Quarry is collected in the North Quarry settling pond where it is discharged to the Des Plains River using up to three pumps and aboveground piping from the settling pond pumps to the river.

7.0 Closure Construction, 845.220(d)

7.1 Closure Prioritization Category

In accordance with the requirements of Section 845.700(c), the category designation for LSQ is Category 3. The Category 3 designation for LSQ is based on the following:

- LSQ is an inactive CCR surface impoundment.
- There are no potable water supply wells or setbacks of existing potable water supply wells downgradient of LSQ. As such, Midwest Generation is not aware of any imminent threat to human health or the environment.
- Midwest Generation used the Illinois EPA EJ Start tool found at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c to determine that the Joliet #9 Generating Station (1601 S. Patterson Rd, Joliet 60436) LSQ is within one mile of an area of environmental justice concern.

7.2 Final Closure Plan

The preliminary Closure Plan was submitted as part of the initial operating permit for Joliet #9/Lincoln Stone Quarry and it identified that LSQ was to be closed by leaving the CCR in place and covering with a final cover system in accordance with 845.750. The preliminary Closure Plan has been finalized to comply with Section 845.720(b). The final Closure Plan is included as part of this application in Attachment 7-1.

7.3 Closure Alternatives Analysis

A closure alternatives analysis (CAA) was completed for LSQ. The CAA evaluated closing LSQ by removal in accordance with 845.740 and closure in place in accordance with 845.750. The completed CAA is included in Attachment 7-2.

7.4 Proposed Closure Schedule

The proposed schedule to execute the closure of LSQ is included in the Final Closure Plan in Attachment 7-1. The initial closure activity is applying for and obtaining an IEPA construction permit and the final closure step is submitting a closure report and closure certification with the closure construction activities occurring in between. Once the closure construction is complete, an acceptance report will be submitted to IEPA. The total time to execute the closure activities is estimated to be approximately forty-three (43) months. An estimated schedule of anticipated closure activities is summarized in the table below:

Table – Closure-in-Place Major Milestone Schedule

Closure Activity	Schedule
Complete Closure Construction Documents and Obtain IEPA Closure Construction Permit	15 months
Site Clearing and Decommissioning of Sluice Pipelines	3 Months
Dewatering	5 Months
Regrade and Compact CCR	7 Months
Installation of the Final Cover System	7 Months
Closure Certification and Report	6 Months

7.5 Post-Closure Plan

The preliminary Post-Closure Plan was submitted with the initial operating permit for Joliet #9/Lincoln Stone Quarry. That Plan outlined the maintenance and inspection requirements for the final cover system. The preliminary Post-Closure Plan has been finalized in accordance with 845.780(b). The final Post-Closure Plan is included as part of this application in Attachment 7-3.

8.0 Groundwater Modeling, 845.220(d)(3)

The groundwater modeling of the CCR surface impoundment as specified in Section 845.220(d)(3) is presented below.

8.1 Groundwater Modeling Inputs and Assumptions

The modeling that was conducted for LSQ used the previously existing 2013 model that was updated with more current data for Boyd’s Quarry, the Main Quarry and the extraction system. The modeling conducted was based on a theoretical distribution of dissolved contaminants beneath LSQ, assuming a source, to demonstrate the impact of the analyzed closure alternatives.

To support the modeling of the engineering alternatives, a theoretical unit source with a concentration of “1” was established beneath LSQ and projected forward in time 100 years with advection and dispersion to establish an equilibrated distribution of contaminants in groundwater. The equilibrated distribution (base case) of the mass was then used as the initial concentrations in the groundwater for model runs to simulate the closure alternatives to evaluate corresponding improvement in groundwater quality from the base case scenario. The groundwater modeling inputs and assumptions are discussed in the groundwater modeling report included in Attachment 8.

8.2 Groundwater Modeling Results

Groundwater modeling was performed as part of evaluating the effectiveness of the proposed closure alternatives. From the initial equilibrated model run discussed in Section 8.1, four (4) closure alternatives were modeled and compared. The results of the groundwater modeling are discussed in further detail in the groundwater modeling report in Attachment 8.

The following general conclusions are forwarded for consideration in the overall engineering evaluations of corrective action/closure alternatives:

- Conceptual Closure Alternative 1 more quickly reduces the relative impacts in the shallow dolomite groundwater system and also will negatively affect private well performance including resulting in dewatered residential wells east of LSQ.

- Conceptual Closure Alternatives 2, 3 and 4 do not negative affect private well performance and will not cause dewatering of residential wells.

- Conceptual Alternatives 2, 3 and 4 have similar short-term reduction in constituent concentrations. Alternatives 3 and 4 provide for some additional long-term performance improvement in some constituent concentrations.

- Regardless of the conceptual alternative evaluated, meeting proposed GWPSs for various constituents will take time and therefore institutional controls such as GMZs and property deed restrictions for water use will be required.

8.3 Capture Zone Modeling

Capture zone modeling is not applicable based on the selected method of closure.

8.4 Groundwater Modeling Software

The groundwater modeling was completed using standard publically available platforms, which included MODFLOW-NWT and for contaminant transport MT3D-USGS. The graphical user interface is Groundwater Vistas. Both MODFLOW-NWT and MT3D-USGS are publically available programs that can be downloaded from the USGS website at https://water.usgs.gov/water-resources/software/modflow-nwt/ and https://www.usgs.gov/software/mt3d-usgs-groundwater-solute-transport-simulator-modflow, respectively.

9.0 Groundwater Monitoring Program, 845.220(a)(7)

9.1 Hydrogeologic Site Characterization

The following subsections provide information on the geology and hydrogeology of the site as required under Section 845.620(b). Site geology and hydrogeology are discussed separately below. Referenced Tables and Figures are provided at the end of this report. Other supporting documentation is provided with the referenced Attachment.

9.1.1 Geology

The physiography of Will County is made up of ground moraines, end moraines, outwash plains, stream terraces, flood plains and bogs. It is in the Till Plaines and Great Lakes Sections of the Central Lowland Province. Near surface soils in the vicinity of the subject impoundment include a variety of silt and silty clay loams. These soils are well to poorly drained. Organic content ranges from 0.02 to 7 percent (generally decreasing with depth) and have a negligible to slight accelerated erosion rate, a generally moderate to high corrosivity rate and a pH range from slightly acidic to slightly basic (4.5 to 8.4). Surface runoff class is low to medium (Soil Survey of Will County Illinois). Based on the Surficial Geology Map of the Chicago Region (ISGS Circular No. 460, 1971) the surficial deposits in the vicinity of the subject surface impoundment are identified as part of the Henry Formation which is generally described as sand and gravel with local beds of silt and/or exposed Silurian dolomite bedrock.

The general stratigraphy in the area consists of unconsolidated glacial deposits, which overlay Silurian dolomite. The Silurian dolomite is underlain by the Maquoketa Group, which includes the Scales Shale, which is considered a regional aquitard separating the overlying Silurian dolomite from the deeper Cambro-Ordovician sandstone and limestone aquifers. Substantial hydrogeologic characterization was completed as part of groundwater quality assessment and landfill operating permit renewal submittals (the LSQ is currently operating as an Illinois EPA licensed landfill Permit No. 1994-241-LFM, Modification No. 24). Boring logs from monitoring wells around the Lincoln Stone Quarry are provided in Attachment 9-1 and a site map showing the locations is provided on Figure 9-1. Based on an evaluation of this data, the following general site-specific stratigraphy is defined and geologic cross-sections are provided as Figures 9-2 through 9-4.

Surface sediments in the area around the LSQ facility are comprised of approximately 20 to 30 feet of unconsolidated glacial overburden (this thickness may vary substantially across the site) that is underlain by Silurian-aged dolomite. The Silurian dolomite is divided into four units; a weathered bedrock rind, Joliet Formation dolomite, Kankakee Formation dolomite and the Elwood/Wilhelmi dolomite. Beneath the Silurian dolomite is the Ordovician age Maquoketa Group consisting of the Brainard Shale, Fort Atkinson dolomite and the Scales Shale. The Scales Shale is a recognized regional aquitard that hydraulically isolates the deeper bedrock aquifers from the shallower units.

Regional and site-specific data (Harza Engineering (1976), MACTEC (2004)) document fractures in the Silurian dolomite. Site-specific and regional data are consistent in describing a primary joint set that is vertical and oriented about N52°E and N40°W. The N40°W joints are described as “more distinct”. Natural spacing between the joint sets ranges from 3 to more than 10 feet, and joint apertures are described as less than 1/16th -inch. Bedding plane fractures are also described. Descriptions from the quarry walls and from cores obtained during drilling show significant clay infilling of the vertical joints and bedding plane fractures. Evidence of water movement through fractures is interpreted from iron staining and mineralization (primarily calcite, with some pyrite and marcasite).

There is additional fracturing at the quarry wall and the fractures/joints tend to be more open at the wall. This is interpreted to be a localized phenomenon that is the result of the blasting and unloading from quarry operations. This effect does not appear to extend greater than about 10 or 15 feet away from the quarry wall.

The dolomite beneath the facility is divided into a “shallow” Silurian dolomite zone and a “deep” Ordovician dolomite zone. A “lower permeability” zone identified, as the Brainard Shale (approximately 10-feet thick) separates these two more permeable zones. The lower permeability zone is mappable across the site and has been used by the Illinois State Geological Survey (ISGS) as a tracer bed.

The shallow zone dolomite is about 140 to 150 feet thick. This places the bottom of the shallow zone and top of the lower permeability zone (Brainard Shale) at an elevation of approximately 430 to 440 feet msl. The thickness between the top and the bottom of the Brainard Shale is approximately 10 feet, with its base at an elevation between about 420 to 430 feet msl. The deep zone is 30 to 40 feet thick, so the boundary between the deep zone and the underlying Scales Shale member of the Maquoketa group is at an elevation of approximately 380 to 400 feet msl. The deepest portions of bottom of the Main Quarry lie at an elevation of approximately 477 feet msl, which is within the shallow Silurian dolomite zone and above the Brainard Shale low permeability zone.

Hydrogeologic evaluations have interpreted a horizon of higher permeability within the shallow Silurian dolomite. The higher permeability zone extends from approximately 500 feet msl down to approximately 430 feet msl, and is partially penetrated by LSQ. This interpretation is based on evidence of increased vuggy horizons logged from core samples, down-hole geophysical data obtained from boreholes on both the north and south sides of LSQ and an integration of all aquifer testing data from various studies which include packer tests and single well slug tests. This increased permeability feature assists in the understanding and interpretation of existing groundwater flow conditions beneath the site.

Silurian dolomite is a calcium-magnesium carbonate rock that includes horizons of cherty (silica) nodules and is documented both regionally and locally to include mineralization along fractures and within vugs. The mineralization includes, but is not limited to calcite (calcium carbonate) and various sulfide minerals such as pyrite, marcasite, etc. As such, the presence of these minerals and associated weathering products can also be expected within the overlying unconsolidated materials.

There are no underground mines beneath the subject CCR surface impoundment.

9.1.2 Hydrogeology

Based on information from the Soil Survey of Will County, the average annual regional precipitation is approximately 37 inches with about 63% of that total falling between April and October of any given year. The average seasonal snowfall is approximately just over 10 inches. More local precipitation data is provided in Table 9-1.

Outside of remnant quarry ponds in the vicinity (e.g., Boyd’s Quarry), the nearest natural surface water body is the Des Plaines River located to the north of the subject CCR unit (see Figure 9-1). This reach of river is further identified as the Lower Des Plaines River which starts upstream of the site at the confluence of the river with the Chicago Ship and Sanitary Canal (CSSC) at the E.J. & E railroad bridge (river mile 290.1). The CSSC is the main tributary to this segment of river contributing approximately 80% of the flow to the river. The segment of river adjacent to the subject site is part of the Dresden Island Pool which starts at the Brandon Road Lock and Dam (river mile 286) which is immediately upstream of the subject CCR surface impoundment. The Dresden Island Pool is 14 miles in length, approximately 800 feet wide with depth varying between 2 to 15 feet (Lower Des Plaines River Use Attainability Analysis Final Report, IEPA, December 2003). There are no drinking water intakes within the Dresden Island Pool and for that matter on any portion of the Des Plaines River downstream of the site (Meet Your Water – An Introduction to Understanding Drinking Water in Northeastern Illinois, Metropolitan Planning Council, 2017).

The water table beneath the site is encountered within the unconsolidated overburden and/or the upper portion of the shallow dolomite. There is sufficient potentiometric and chemical data from clustered piezometers around LSQ to indicate that the “shallow” dolomite zone and “deep” dolomite zone can be viewed as separate water bearing units. The intervening Brainard Shale is of sufficiently lower permeability that it impedes downward migration and mixing of the groundwater. The different groundwater flow patterns within the shallow and deep zones are discussed further below. The Scales Shale member of the Maquoketa Group, which defines the base of the deep zone of Ordovician dolomite, is widely accepted as a regional aquitard that hydraulically separates the groundwater of the overlying dolomite from deeper groundwater in the older Cambro-Ordovician sandstone and carbonate units beneath it.

Monitoring wells surrounding the LSQ include “WT-series” wells (water table), “S-series” wells (shallow dolomite) and “D-series” wells (deep dolomite). Natural groundwater flow in the area is from the south and east to the north and west. This flow pattern largely parallels surface drainage from topographically high areas to the Des Plaines River and likely represents a topographically driven groundwater flow system. However, ongoing dewatering activities at the Laraway Quarry located approximately 1,000 feet to the southeast of the LSQ have resulted in a component of groundwater flow to the southeast within the “shallow” dolomite. Groundwater flow within each zone is discussed below. Water level measurements from monitoring wells which the subsequent flow map discussions are based are provided in Table 9-2.

Water Table (WT-Series Wells)

Water table maps for the 3rd and 4th Quarters 2020 and the 1st and 2nd Quarters 2021 are provided on Figures 9-5 through 9-8. These are based on water levels obtained from groundwater assessment monitoring wells installed as part of landfill permit studies which include screens that straddle the phreatic surface. The maps indicate that groundwater flow within the upper portion of the saturated zone is generally in a northerly and westerly direction. The near surface groundwater from the south and east of the site flows through the Main Quarry and WFA. This is consistent with the natural groundwater flow patterns defined as part of the initial landfill permit application. All four quarters show consistent patterns, which are also consistent with historical water table data.

Shallow Zone (S-Series Wells)

The potentiometric surface maps of the shallow zone dolomite for the 3rd and 4th Quarters 2020 and the 1st and 2nd Quarters 2021 are provided on Figures 9-9 through 9-12. The maps show generally lower heads than were mapped in 1993 when elevation data were first collected in support of landfill permit development. This is in part the natural result of wet conditions that existed during 1993 baseline data collection and in part the result of dewatering associated with the operations of Laraway Quarry, beginning circa 1997. In spite of the general decline in heads, the groundwater flow patterns north and west of the facility remain consistent with the 1993 flow patterns.

The south-southeasterly component of groundwater flow was defined along the south perimeter of the Joliet/Lincoln Stone Quarry facility that was not evident in 1993 data. This component of flow has been determined to be the result of unrelated, off-site dewatering activities associated with surface mining operations at Laraway Quarry, approximately 1,000 feet to the southeast of the Joliet/Lincoln Stone Quarry facility that began circa 1997. This change of natural flow conditions along the south side of the Joliet/Lincoln Stone Quarry facility was not observed in the water table conditions which were described above (i.e., groundwater flow at the water table elevations continued to flow from south to north, into the quarry). The noted change of natural flow within the shallow dolomite unit has been determined by hydrogeologic investigation work to be the result of a higher permeability horizon that exists at, and just beneath, the base of Joliet/Lincoln Stone Quarry (approximate lowest quarry base elevation of 477 feet msl) within the shallow dolomite. This zone is undergoing additional depressurization as a result of dewatering operations at Laraway Quarry located approximately 1,000 feet southeast of the site. This depressurization is allowing for a component of groundwater flow to move from Joliet/Lincoln Stone Quarry to the south-southeast.

To address the south-southeasterly groundwater flow component within the shallow zone, a total of twelve extraction wells (X101 through X112) were installed. The first four extraction wells (X101 through X104) were installed during the February to April 2010 timeframe and this portion of the system was put into full operation on April 30, 2010. The remaining eight extraction wells (X105 through X112) were installed during the October 2011 through January 2012 timeframe and this portion of the system was put into full operation on February 16, 2012.

The hydraulic effects of the pumping system are clearly seen on the shallow zone potentiometric surface maps. A cone of depression has been established between south perimeter wells G48S, G47S, G46S, G38S and G39S and the Main Quarry/WFA. Groundwater from the south perimeter of the site is generally being drawn back to the north to the extraction well system. Water from the Main Quarry/WFA is also being intercepted by the extraction system. The extracted water is being discharged back into the Main Quarry.

In addition, Midwest Generation voluntarily implemented a program to replace any potable water wells to the southeast between the LSQ and Laraway Quarry which were screened within the Silurian dolomite with deeper water wells screened within the Cambro-Ordovician aquifers beneath the Scales Shale. The shallow dolomite wells were subsequently abandoned. This effectively removed any potential groundwater use receptors to the southeast that may have been affected by this artificially modified flow pattern.

Deep Zone (D-Series Wells)

The potentiometric surface maps for the deep zone dolomite for the 3rd and 4th Quarters 2020 and the 1st and 2nd Quarters 2021 are provided on Figures 9-13 through 9-16.

Groundwater flow within this zone is in a westerly direction. The overall flow patterns are generally consistent with historic conditions within the deep zone. Variations from earlier annual submittals during initial landfill permit development appear to be interpretive artifacts that are the result of variations in the number and distribution of control points for the maps, rather than changes in flow direction in the deep zone. For example, in 1993, there were only four monitoring points controlling the interpretation of the deep zone. There are now 13 wells within this zone providing a more detailed assessment.

Based on the above discussed geology/hydrogeology and as discussed further below, the groundwater monitoring network for the purposes of CCR unit monitoring is necessarily focused on the shallow dolomite zone (S-series wells). Table 9-3 provides a summary of the flow direction, gradient and an estimated rate of groundwater flow for each quarterly sampling event from the 3rd quarter 2020 through the 2nd quarter 2021. The flow rate was calculated using the following equation:

$$V_s = \frac{K\,dh}{n_e\,dl}\text{ , where}$$

V_s is seepage velocity (distance/time)
K is hydraulic conductivity (distance/time)
dh/dl is hydraulic gradient (unitless)
n_e is effective porosity (unitless)

The average hydraulic conductivity of 1.38×10^{-5} ft/sec used in Table 9-3 was obtained from the Revised Groundwater Impact Assessment Lincoln Stone Quarry Landfill – Addendum to IEPA Application Logs 2004-052 and 2009-213 dated March 13, 2013. The estimated effective porosity of the aquifer materials (0.05) was also obtained from the above noted document.

At this time, based on the geology discussion in Section 9.1.1 and the site-specific hydrogeology discussions above, the groundwater beneath the CCR surface impoundment is considered as Class I Potable Resource Groundwater in accordance with Section 620.210. It is noted, however, that a Zone of Attenuation (ZOA) was established to the north of the LSQ as part of the initial landfill operating permit and a Groundwater Management Zone (GMZ) has been established to the south-southeast of the LSQ as part of the landfill permit renewal process and associated with the corrective action implemented in response to the component of groundwater flow moving to the southeast due to Laraway Quarry dewatering activities. The extent of the established ZOA and approved GMZ is provided on Figure 9-17.

A survey of all potable water sources within a 2,500 feet radius of the LSQ was completed. The following databases and sources of information were utilized in order to determine community water source and water well locations and construction in the vicinity of the ash pond wastewater treatment systems:

- Illinois State Geological Survey (ISGS) -Water Well Database Query;
- Illinois State Water Survey (ISWS) Private Well Database and water well construction report request; and
- Illinois Division of Public Water Supply web-based Geographic System (GIS) files;
- ILWATER

The survey results are provided on Figure 9-18. There are no wells within the impacted aquifer downgradient of the LSQ. There are two water wells to the west of LSQ on Joliet #9 Generation Station property (owned by Midwest Generation) both of which are screened within the deeper aquifers beneath the Scales Shale and have had a successful compliance record during sampling in accordance with the drinking water regulations. There are 19 water wells located to the east of LSQ and/or Boyd’s Quarry. All of these wells are sidegradient of the LSQ and are screened within the Silurian Dolomite. There are eight existing water wells to the south of LSQ and/or Boyd’s Quarry. All of these wells were voluntarily replaced by Midwest Generation circa 2006 into the deeper Cambro-Ordovician aquifers beneath the Scales Shale due to the noted migration of groundwater to the southeast of LSQ associated with the dewatering activities at the Vulcan Quarry located to the southeast. There were an additional six wells located in that direction which are no longer present due to the expansion of Vulcan Quarry mining (circled in dashed red line). Also circled with a red dashed line and identified as well locations A through F on Figure 9-18 are six wells that are incorrectly located within the ILWATER database or no they longer exist. Field inspections of these locations indicate no water wells present in those areas. Review of available well log information for wells A, B and C indicate actual well addresses outside of the noted search radius (i.e., well A is located at 513 Woodruf Rd. which is approximately 3,900 feet to the east of mapped location; well B is located at 2317 W. Jefferson Street in Joliet which is over 1 mile to the north-northwest; and well C which has an address of 100 Peru Street in Troy Grove, Illinois which is in the LaSalle-Ottawa, Illinois vicinity). Well D is a 1943 vintage well log with LSQ ownership but this well is no longer present. Wells E and F have an owner name but no address and there are no wells present in those areas.

A search of the Illinois Department of Natural Resources dedicated nature preserve database (https://www2.illinois.gov/dnr/INPC/Pages/NaturePreserveDirectory.aspx) was performed to determine whether there may be a nearby dedicated nature preserve. No dedicated nature preserves were identified in the vicinity of the subject CCR surface impoundment.

Based on the geology of the site presented in Section 9.1.1 and the above hydrogeology discussions, the primary contaminant migration pathway for a potential release from the subject CCR surface impoundment would be through the lower portion of the Silurian dolomite (shallow zone) with movement towards the extraction well line along the southern periphery of the site and to the north towards the Des Plaines River. There are no potable water wells downgradient of the subject CCR surface impoundment screened within the aquifer of concern. There are two deep water wells as noted above associated with former operations at the Joliet #9 power plant. Also, as previously discussed, there are no potable surface water intakes on the Des Plaines River either along or downstream of the subject site.

There is extensive quarterly groundwater quality data dating back to 1993 associated with the ongoing groundwater monitoring performed under the existing landfill operating permit for the LSQ. This data through the 4th quarter 2020 is provided in Attachment 9-2 in the form of time versus concentration curves. The (LSQ), however, was also identified as being subject to the new federal requirements under Federal Register, Environmental Protection Agency, 40 CFR Parts 257.94, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule dated April 17, 2015 (Federal CCR Rule). To meet the Federal CCR Rule requirements, a detection monitoring network focused on the "shallow zone" dolomite was developed based on the hydrogeology discussion in Section 9.1.2, and consists of wells R08S, G20S, G30S, R32S, G44S, G45S, G46S, G47S, G48S and T03S). Wells T03S (side-gradient) and G45S are considered background monitoring wells and the remaining wells are considered downgradient wells. The locations of these wells are shown on Figure 9-1.

As required under the Federal CCR Rule, eight rounds of background sampling were completed for the monitoring wells within the monitoring network for the subject CCR surface impoundment. This included the full list of Appendix III (detection monitoring) and IV (assessment monitoring) parameters. All currently available CCR groundwater monitoring data available through 2nd quarter 2021 is provided in Table 9-4. In addition, it is noted that Illinois EPA added turbidity measurements to the list with a required eight rounds of background of that parameter for each well in the monitoring network for the subject CCR surface impoundment. This data is provided in Table 9-5.

9.2 Groundwater Monitoring System Design and Construction Plan

A comprehensive monitoring well network has been established as part of ongoing landfill permit requirements and work completed in support of that landfill operating permit. The well depths were determined based on depth to groundwater and the base elevation of the LSQ being monitored. The well locations and depths were agreed upon by Illinois EPA Bureau of Land (BOL) as part of operating permit review/approval. Based on review of the Federal and State CCR Rule, LSQ is also being regulated as an existing, incised CCR surface impoundment. As discussed above, a separate CCR groundwater monitoring network has been established for this unit. The detection monitoring network focuses on the "shallow zone" dolomite based on the hydrogeology discussion in Section 9.1.2 and consists of wells R08S, G20S, G30S, R32S, G44S, G45S, G46S, G47S, G48S and T03S). Wells T03S (side-gradient) and G45S are considered for background monitoring purposes and the remaining wells are considered downgradient wells. The locations of these wells are shown on Figure 9-1. This proposed monitoring well network will be utilized for determining whether potential leakage from the regulated unit may be causing or contributing to groundwater impacts in the vicinity of the units.

The monitoring wells were installed by either Harza Engineering, Andrews Engineering or KPRG and Associates, Inc. (KPRG) at varying times. The wells were drilled using air drilling techniques (rotary or hammer). Some of the well's borings were cored using either "NX" or "HQ" series core barrels. The wells were completed with standard 2-inch inner-diameter, schedule 80 PVC casing with 10-feet of 0.010 slot PVC screen. Filter sand pack around each screen was extended to approximately 2-feet above the top of the well screen. The remainder of the annulus was backfilled with bentonite grout. Surface completions include stick-up (above grade two to three feet) locking protector casings set in concrete aprons. The wells may be further protected by traffic bollards, as necessary. Boring logs and/or well construction summaries for these wells are provided in Attachment 9-1. Top-of-casing elevations were surveyed by an Illinois licensed surveyor and are included in the previously referenced Table 9-2.

Each of the identified monitoring wells within the sampling network is outfitted with a dedicated sampling system. Specifically, each well has a QED Environmental Systems (QED) Well Wizard Model P1101M dedicated sampling pump with Model No. 37789 intake screens (0.010-inch slot). The screens are set within approximately one foot of the base of the monitoring well.

In accordance with requirements under Section 845.630(g), Attachment 9-3 includes an Illinois licensed Professional Engineer certification of the above defined monitoring system.

9.3 Groundwater Sampling and Analysis Program

9.3.1 Sample Frequency

The LSQ is regulated under the Federal CCR Rule. As such, all of the above defined CCR monitoring wells (upgradient and downgradient) have been sampled on a quarterly basis starting the 4th quarter of 2015 for eight consecutive quarters for both Appendix III and Appendix IV parameters specified in the Federal CCR Rule which is the same parameter listing as provided under the State CCR Rule Section 845.600(a) plus calcium. Additional sampling has also been completed as part of assessment monitoring requirements. This dataset will facilitate the development of proper statistical evaluation procedures for the site and use in development of applicable GWPSs for each constituent pursuant to Section 845.600(b). Illinois EPA added turbidity as an additional parameter that will require development of a statistical background. Since this parameter was not included within the Federal CCR Rule, eight rounds of turbidity measurements were obtained within the 180-day period since the effective date of the State Rule. However, this restricted period of background data collection does not facilitate evaluation of potential seasonal variations during the development of statistical background for this parameter.

Currently, all wells within this CCR monitoring network are being sampled on a quarterly basis for all parameters specified in Section 845.600(a) plus calcium and turbidity. Between quarterly monitoring events, groundwater level measurements from all designated CCR monitoring wells will be also obtained and recorded. Water levels are also obtained concurrently from the Main Quarry through an electronic pressure transducer used to monitor ongoing water levels within that unit.

Quarterly groundwater monitoring will continue during the active life of the impoundment and the post-closure care period or, if closure is by removal, then in accordance with monitoring frequency requirements under Section 845.740(b). It is noted that if after 5 years of quarterly monitoring it can be demonstrated that the facility meets the requirements specified in Section 845.650(b)(4), the owner can petition the Illinois EPA to shift the monitoring frequency to semi-annual.

9.3.2 Sampling Preparation and Calibrations

Prior to any sampling event, the Station's designated Environmental Specialist shall be notified in advance of sampling crew arrival so that any arrangements can be made, including security clearance and training.

Prior to sampling activities, and at intervals recommended by the manufacturer, all non-dedicated equipment shall be cleaned and calibrated. Specifically, the field parameter water quality meter to be used for pH, specific conductance, turbidity and temperature will be calibrated using standard reference solutions. In addition, an operational check of the electronic water level probe will also be performed by placing the probe into a bucket of water and ensuring that the audio signal is triggered when the sensor meets the water interface. The associated tape measure of the probe will also be checked for wear.

The monitoring network consists of all dedicated sampling equipment (QED Well Wizard P1101M). The controller used to operate individual bladder pumps will be checked and maintained prior to arrival at the site based on manufacturer specifications.

All lab ware shall be obtained directly from an Illinois certified laboratory. Upon arrival to the site, the monitoring wells will be assessed for structural integrity. Each well cover (either stick-up or flush mount) will be inspected for proper labels, locks, any damage and be cleared of any flora or fauna that may be on the well or in the vicinity that would affect the sample or the sampling operation. In addition to any other notable observations, all of the above shall be entered on the sampling sheets. Once the well is uncovered and unlocked, and the well casing inspected, the well head shall be inspected for damage and cleanliness. At that point, the well will be considered ready for sampling per procedures described below.

9.3.3 Groundwater Sample Collection

Prior to initiating sampling, a round of groundwater levels will be collected from each monitoring well using an electronic water level probe. The timeframe over which these water levels are collected should be minimized and should not exceed 8 hours. The depth to water will be measured to the nearest one-hundredth of a foot from the top of casing using an electronic water level meter. The water level probe should be properly decontaminated between each reading using procedures specified in Section 9.3.4.

All of the monitoring wells at this Station are equipped with dedicated, down-hole, bladder pumps. At the top of casing for each well is a manifold with air and water quick connects and a port for a water level meter probe to fit so that an undisturbed water level can be obtained. Immediately prior to sampling, the depth to water will be measured again to the nearest one-hundredth of a foot from the top of casing using an electronic water level indicator and recorded onto the sampling sheets. Once recorded, an air compressor and flow controller will be attached to the air side quick connect and disposable tubing attached to the discharge connection. The discharge tubing will be run to a flow-through cell of the water quality meter. A discharge line from the flow-through cell will be placed into a vessel to allow for the measurement of the volume of groundwater removed. The water quality meter will be attached within the flow-through cell that allows for real time readings of pH, specific conductivity and temperature. It is noted that a calibration check of the water quality meter should be performed at the start and end of each day of sampling and recorded in the field notes. If the meter calibration-check shows drift outside of manufacturer specifications, the meter should be recalibrated in the field using standard solutions per manufacturer requirements.

The air controller will be set to the necessary pressure and to the slowest pumping interval, approximately 50 second refill and 10 second pump (flow rates at this setting tend to be less than 100 milliliters/minute), and the compressor will be started. The intent of the low flow pumping will be to minimize drawdown in the well with an ideal goal of keeping the drawdown to 0.30 feet or less. Once the water has filled the flow-through cell, a reading of the parameters will be recorded. Readings will continue to be recorded until such time as all parameters are deemed stable for three consecutive measurements at which point a sample will be collected from the tubing prior to the flow-through cell. An unfiltered groundwater sample shall be collected directly from the water tubing after it is disconnected from the flow-through cell. The laboratory provided bottles shall be properly filled. Once the sample is collected, the bottles shall be properly labeled and placed on ice as necessary.

If the well would pump dry prior to stabilized field parameter readings, the well will be allowed to recover for up to 24-hours at which point water sample collection will be initiated.
In the event that a dedicated bladder pump fails to work, the following procedures should be implemented:

- Pull the dedicated tubing and pump from the well and ensure that the tubing does not come in contact with the ground.

- Visually inspect the intake of the pump for clogging from sedimentation. If clogging is noted, clean the intake with distilled water. If there is no clogging, dismantle the pump casing and inspect the bladder for any holes, cracks or tears.

- If the bladder is determined to be compromised (i.e., wear has resulted in cracking or tearing), remove the bladder and replace it with a new bladder. Properly clean all parts of the pump using procedures described in Section 9.3.4, reassemble the pump and slowly lower it back down hole. Continue sampling as described above.

- If the entire pump is determined to have failed, a new pump will need to be ordered for replacement and a modified sampling procedure will be implemented as described below.

In the case of bladder pump failure, at a specific well during a sampling event, the alternate sampling method will be the use of a portable peristaltic pump (the pump itself does not go down-hole) assuming depth to water is less than 23 feet bgs. Clean disposable polyethylene tubing will be attached to the pump and the tubing will be slowly lowered down hole along with the water level probe. The pump will be operated at the lowest rate possible to achieve the same goals as for sampling described above (generally below 300 milliliters/minute, which is within the range of standard low flow protocols). Water will be collected in a clean glass jar for field parameter readings. Once stable field parameters are recorded, the sample will be collected directly onto laboratory prepared containers for analysis. Upon completion of sample collection, the water level meter and tubing should be removed from the well. The polyethylene tubing should be disconnected from the pump and discarded. The water level meter should be properly decontaminated as specified in Section 9.3.4. If depth to water is such that a peristaltic pump cannot be used, a submersible pump will need to be used. The submersible pump must be properly cleaned as specified in Section 9.3.4 prior to placement down the well. All subsequent procedures will be the same as above. The alternate sampling pump use will be recorded on the field data sheet for that well and noted in any subsequent reporting summary.

9.3.4 Equipment Decontamination

Any equipment that is used down-hole at more than one sampling location must be thoroughly decontaminated between uses. Based on procedures described above, only the water level meter is anticipated to be in this category, however, if a submersible pump needs to be used during a particular sampling event due to dedicated pump failure (see Section 9.3.3), these procedures will also apply. The water level meter probe and any measuring tape, or any other non-dedicated equipment that may need to be placed down the well that extended below the water surface, will need to be cleaned with an Alconox solution, or equivalent, wash followed by a double rinse with distilled water. Any pump tubing that is not dedicated should be discarded and only clean tubing should be used down-hole.

9.3.5 Sample Preservation, Chain-of-Custody and Shipment

Since measurement of total recoverable metals is required by the State CCR Rule, the samples will not be filtered prior to collection. This will facilitate the analysis to capture both the particulate fraction and dissolved fraction of metals in natural groundwater. Groundwater samples will be collected directly into Illinois certified laboratory provided containers. Those containers will be prepared by the laboratory to contain any necessary chemical preservation. The samples shall be stored at temperatures required by the lab following sample collection. Table 9-6 includes a summary of sample bottle requirements, preservatives and holding times

All groundwater samples collected shall be transferred to the laboratory under proper COC procedures. The laboratory provided COC, completed with all pertinent information, shall be maintained from sample collection through receipt by the laboratory. The information shall include, but is not limited to, the following:

- project name and number, state samples collected in, sample name and type, time and date collected, analysis requested, and printed name and signatures of person(s) sampling.

The COC shall be completed and properly relinquished by the field sampler(s) with all samples clearly printed or typed.

All samples will be either delivered directly to the laboratory or be shipped using Federal Express or a similar overnight service. It should be noted that Total Dissolved Solids (TDS) analysis has a 7-day holding time. TDS samples should be shipped to the laboratory within 72 hours after collection. All other holding times for the specified parameters are long enough to facilitate one shipment after the full round of sampling is complete.

9.3.6 Analytical Methods

A list of the analytical methods to be used by the laboratory for each specified parameter is included in the above referenced Table 9-6. Individual detection limits for the parameters may change slightly from sample to sample depending on potential matrix interferences with a sample (e.g., amount of suspended solids/sediment) and/or the concentration of the constituent in the sample. However, the base detection limits will be set at or below the applicable Illinois Class I Drinking Water Standards as defined in Section 845.600(a)(1) for that compound which are also provided in Table 9-6.

9.3.7 Quality Assurance and Quality Control

Laboratory

Only an Illinois certified analytical laboratory will be used for sample analysis. The laboratory will be conducting their work under their specific approved Quality Assurance and Quality Control (QA/QC) program. A copy of their program can be available upon request. A standard Level II data documentation package will be included in all subsequent reporting, however, the lab will be requested to also provide a Level IV data documentation package (i.e., U.S. EPA Contract Laboratory Protocol equivalent) in the event more detailed data validation/evaluation is deemed necessary.

Field

The QA/QC program for field work will include the collection of blind duplicates and the use of a laboratory supplied trip blank. The blind duplicate will be collected from a random well during every sampling event in which more than three (3) samples are collected. The duplicate will be blind in the manner that there will be no way for the laboratory to determine from which well or point the sample was collected.

Upon receipt of the analytical data, a determination will be made if the duplicate is consistent with the sample collected from the well/point. A generally acceptable range for groundwater samples is +/- 30 percent. If outside the acceptable range, a resample may be determined to be necessary and reanalyzed. The trip blank analytical data will be reviewed for any values other than non-detect. If there are any questions regarding the duplicate, trip blank, or other reported analytical QA/QC runs, the laboratory will be contacted to determine the effect on data quality, if any, and usability. If necessary, a specific well may need to be re-sampled.

9.3.8 Statistical Methods

A proposed statistical evaluation plan meeting the requirements specified in Section 845.640(f) is provided in Attachment 9-4 along with a certification of the plan by an Illinois licensed Professional Engineer.

9.4 Groundwater Monitoring Program Section

The groundwater sample and water level collection frequency is discussed in Section 9.3.1 above.

As previously noted, the monitoring well system for the subject unit consists of wells R08S, G20S, G30S, R32S, G44S, G45S, G46S, G47S, G48S and T03S). Wells T03S (side-gradient) and G45S are considered background monitoring wells and the remaining wells are considered downgradient wells.

Eight rounds of background sampling for the purposes of statistical evaluation and background determination is available from the initial groundwater sampling which occurred starting in 2015 in compliance with the Federal CCR Rule requirements. Subsequent groundwater sampling has also occurred on a quarterly basis for the seven detection monitoring parameters listed under Appendix III of the Federal CCR Rule detection monitoring requirements and since this unit is currently within assessment monitoring under the Federal CCR Rule, additional Appendix IV sampling data is also available. All available CCR monitoring data through the end of the second quarter 2021 is summarized in Table 9-4 and the eight rounds of turbidity data collected since the enactment of the State CCR Rule in April 2021 in Table 9-5.

Using the currently available data for the subject CCR surface impoundment, site specific Groundwater Protection Standards (GWPSs) have been established in accordance with Section 845.600(b) and are summarized in Table 9-7. The background concentrations noted in Table 9-7 were calculated using the statistical evaluation approach noted in Section 9.3.8 and provided in Attachment 9-4. A presentation of the statistical evaluations which resulted in the background concentration calculations is provided in Attachment 9-5.

Once the proposed GWPSs presented in this permit application are approved by Illinois EPA, these values will be used for all subsequent groundwater monitoring data comparisons. Monitoring will continue on a quarterly basis for all constituents specified in Section 845.600(a)(1) plus calcium and turbidity. In accordance with Section 845.610(b)(3)(D), a data summary report will be submitted to Illinois EPA within 60-days of receipt of all analytical data which will include a groundwater flow map for the quarterly sampling event, summary of water level elevations collected during the reporting period (monthly measurements), and a data summary including summary data tables with a comparison against the established/approved GWPSs. This report will be placed the facility's operating record.

If during a monitoring event, a constituent(s) is/are detected above an established/approved GWPS, that well will be resampled. If the resample data confirms that the constituent(s) concentration(s) is/are above the GWPS then the following will occur:

- Characterize the nature and extent of the potential release and any relevant site conditions that may affect the remedy evaluation/selection. This characterization must meet the requirements set forth under Section 845.650(d)(1).

- If groundwater impacts extend off-site, provide off-site landowner/resident notifications as specified under Section 845.650(d)(2) and place the notifications into the facility's operating record. This must occur within no more than 30-days of determination that a GWPS has been exceeded.

- An Alternate Source Demonstration (ASD) may be initiated and completed for submittal to Illinois EPA review/approval as allowed under Section 845.650(e). Place the ASD into the facility's operating record.

- Within 90-days of determining that a constituent(s) was detected above an established/approved GWPS at a downgradient waste boundary monitoring point, initiate an assessment of corrective measures meeting the requirements specified under Section 845.660 unless an ASD is submitted in accordance with Section 845.650(d)(2) and subsequently approved by the Illinois EPA.

By no later January 31st of each year, an Annual Groundwater Monitoring and Corrective Action Report will be prepared for inclusion as part of an Annual Consolidated Report for the facility. The Annual Groundwater Monitoring and Corrective Action Report will meet the requirements set forth under Section 845.610(e)(1 through 4). The Annual Consolidated Report will be placed into the facility's operating record.

10.0 Professional Engineer Certification, 845.220(a)(8)

This construction permit application has been prepared to meet the requirements of 35 Ill. Adm. Code 845.220(a) and 845.220(d).

1/28/22
Joshua D. Davenport, P.E.
Illinois Professional Engineer

JOSHUA D. DAVENPORT
062-061945

11.0 Owner Certification, 845.220(a)(9)

A certification stating that the owner or operator of the CCR surface impoundment has completed the public notification and public meetings that are required under the Ill. Adm. Code Title 35, Part 845 Section 240 is included in Attachment 11. Also included is a summary of the issues raised by the public and a summary of any revisions, determinations, or other considerations made in response to those issues. A list of interested persons in attendance who would like to be added to the Agent's list for the facility is also attached.

OPERATING PERMIT TABLES

Table 2. Lincoln Stone Quarry/Joliet 9 Generating Station
Lincoln Stone Quarry CCR Chemical Constituents Analytical Results

Parameter Name	Slag Sample 8/31/2021	Bottom Ash Sample 8/31/2021
Antimony	<1.8	<1.8 F1
Arsenic	<0.88	1.5 F1
Barium	4,400	3,000
Beryllium	3.3	1.5 F1
Boron	110	130 F1 V
Cadmium	<0.18	<0.18
Calcium	110,000	100,000
Chloride	<20	<20
Chromium	37	12 F1
Cobalt	20	15
Fluoride	<1.0	<1.0
Lead	0.67	5.6
Lithium	32	20 V
Mercury	<0.015	<0.016
Molybdenum	<0.88	1.1 F1
Selenium	<0.88	<0.89 F1
Sulfate	<2.0	560
Thallium	3.6	2.9
Radium 226	2.41	1.54
Radium 228	1.97	1.63
Radium 226 & 228	4.38	3.17

Notes:

All results are in milligrams per kilogram (mg/kg), except for radium, which is pCi/L

F1 - MS and/or MSD recovery exceeds control limits

V - Serial Dilution exceeds the control limits

Table 9-1. Summary of Local Precipitation Data - Midwest Generation, LLC, Joliet #9 Lincoln Stone Quarry

Joliet #9 Lincoln Stone Quarry	
Month	**Average Monthly Precipitation* (inches)**
January	1.09
February	1.27
March	2.01
April	3.66
May	3.9
June	4.65
July	4.41
August	4.08
September	3.02
October	3.09
November	2.4
December	1.81

Notes:

* - Historical precipitation data was obtained from the National Oceanic and Atmospheric Administration. Precipitation data was averaged from four stations located within Joliet and Elgin, Illinois. Dates of precipitation data range from 1894-2020.

Table 9-2. Groundwater Elevations, Midwest Generation, LLC, Joliet Station #9.

Well ID	Date[1]	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
R08S	Nov-2015	578.65	66.74	511.91
	May-2016	578.65	67.02	511.63
	Jun-2016	578.65	67.50	511.15
	Aug-2016	578.65	67.47	511.18
	Nov-2016	578.65	67.84	510.81
	Feb-2017	578.65	69.28	509.37
	May-2017	578.65	67.56	511.09
	Jul-2017	578.65	67.54	511.11
	Sep-2017	578.65	65.72	512.93
	Nov-2017	578.65	64.83	513.82
	Mar-2018	578.65	65.12	513.53
	May-2018	578.65	65.31	513.34
	Oct-2018	578.62	65.48	513.14
	May-2019	578.62	67.24	511.38
	Nov-2019	578.62	66.78	511.84
	Apr-2020	578.62	65.63	512.99
	Oct-2020	578.62	68.14	510.48
	Apr-2021	578.62	69.20	509.42
G20S	Nov-2015	580.33	55.33	525.00
	May-2016	580.33	51.32	529.01
	Jun-2016	580.33	53.14	527.19
	Aug-2016	580.33	61.32	519.01
	Nov-2016	580.33	54.69	525.64
	Feb-2017	580.33	52.41	527.92
	May-2017	580.33	46.06	534.27
	Jul-2017	580.33	47.85	532.48
	Sep-2017	580.33	49.02	531.31
	Nov-2017	580.33	52.57	527.76
	Mar-2018	580.33	46.65	533.68
	May-2018	580.33	48.83	531.50
	Oct-2018	580.91	49.46	531.45
	May-2019	580.91	39.03	541.88
	Nov-2019	580.91	41.82	539.09
	Apr-2020	580.91	41.69	539.22
	Oct-2020	580.91	46.74	534.17
	Apr-2021	580.91	45.69	535.22
G30S	Nov-2015	524.40	2.74	521.66
	May-2016	524.40	2.53	521.87
	Jun-2016	524.40	3.54	520.86
	Aug-2016	524.40	2.45	521.95
	Nov-2016	524.40	2.57	521.83
	Feb-2017	524.40	2.13	522.27
	May-2017	524.40	1.69	522.71
	Jul-2017	524.40	1.96	522.44
	Sep-2017	524.40	1.84	522.56
	Nov-2017	524.40	1.48	522.92
	Mar-2018	524.40	1.48	522.92
	May-2018	524.40	1.62	522.78
	Oct-2018	524.70	2.51	522.19
	May-2019	524.70	1.57	523.13
	Nov-2019	524.70	1.53	523.17
	Apr-2020	524.70	1.03	523.67
	Oct-2020	524.70	2.19	522.51
	Apr-2021	524.70	2.55	522.15
R32S	Nov-2015	536.81	19.99	516.82
	May-2016	536.81	19.72	517.09
	Jun-2016	536.81	20.51	516.30
	Aug-2016	536.81	20.51	516.30
	Nov-2016	536.81	20.24	516.57
	Feb-2017	536.81	21.12	515.69
	May-2017	536.81	19.33	517.48
	Jul-2017	536.81	19.38	517.43
	Sep-2017	536.81	17.91	518.90
	Nov-2017	536.81	16.32	520.49
	Mar-2018	536.81	16.98	519.83
	May-2018	536.81	20.26	516.55
	Oct-2018	536.99	18.32	518.67
	May-2019	536.99	19.28	517.71
	Nov-2019	536.99	19.09	517.90
	Apr-2020	536.99	17.74	519.25
	Oct-2020	536.99	20.76	516.23
	Apr-2021	536.99	22.06	514.93

MSL - Mean Sea Level
TOC - Top of Casing
[1] - Date of water levels collected at beginning of quarter, actual sample date may vary.

Table 9-2. Groundwater Elevations, Midwest Generation, LLC, Joliet Station #9.

Well ID	Date[1]	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
G44S	Nov-2015	586.69	80.54	506.15
	May-2016	586.69	80.42	506.27
	Jun-2016	586.69	80.68	506.01
	Aug-2016	586.69	80.65	506.04
	Nov-2016	586.69	80.69	506.00
	Feb-2017	586.69	84.34	502.35
	May-2017	586.69	82.14	504.55
	Jul-2017	586.69	81.13	505.56
	Sep-2017	586.69	80.15	506.54
	Nov-2017	586.69	77.10	509.59
	Mar-2018	586.69	78.74	507.95
	May-2018	586.69	80.17	506.52
	Oct-2018	586.53	78.21	508.32
	May-2019	586.53	80.05	506.48
	Nov-2019	586.53	79.96	506.57
	Apr-2020	586.53	79.25	507.28
	Oct-2020	586.53	81.51	505.02
	Apr-2021	586.53	82.51	504.02
G45S	Nov-2015	603.31	68.90	534.41
	May-2016	603.31	67.28	536.03
	Jun-2016	603.31	68.88	534.43
	Aug-2016	603.31	68.39	534.92
	Nov-2016	603.31	66.69	536.62
	Feb-2017	603.31	65.34	537.97
	May-2017	603.31	63.07	540.24
	Jul-2017	603.31	63.44	539.87
	Sep-2017	603.31	63.10	540.21
	Nov-2017	603.31	62.28	541.03
	Mar-2018	603.31	61.82	541.49
	May-2018	603.31	68.50	534.81
	Oct-2018	603.90	66.74	537.16
	May-2019	603.90	62.72	541.18
	Nov-2019	603.90	62.38	541.52
	Apr-2020	603.90	60.10	543.80
	Oct-2020	603.90	65.51	538.39
	Apr-2021	603.90	67.71	536.19
G46S	Nov-2015	601.32	95.78	505.54
	May-2016	601.32	96.74	504.58
	Jun-2016	601.32	97.31	504.01
	Aug-2016	601.32	97.32	504.00
	Nov-2016	601.32	97.50	503.82
	Feb-2017	601.32	98.14	503.18
	May-2017	601.32	98.43	502.89
	Jul-2017	601.32	98.96	502.36
	Sep-2017	601.32	96.61	504.71
	Nov-2017	601.32	95.65	505.67
	Mar-2018	601.32	96.80	504.52
	May-2018	601.32	95.59	505.73
	Oct-2018	601.43	91.34	510.09
	May-2019	601.43	101.40	500.03
	Nov-2019	601.43	100.01	503.83
	Apr-2020	601.43	100.19	501.24
	Oct-2020	601.43	101.44	499.99
	Apr-2021	601.43	103.09	498.34
G47S	Nov-2015	612.32	99.44	512.88
	May-2016	612.32	95.48	516.84
	Jun-2016	612.32	96.58	515.74
	Aug-2016	612.32	96.79	515.53
	Nov-2016	612.32	88.96	523.36
	Feb-2017	612.32	96.41	515.91
	May-2017	612.32	92.61	519.71
	Jul-2017	612.32	93.53	518.79
	Sep-2017	612.32	93.50	518.82
	Nov-2017	612.32	92.57	519.75
	Mar-2018	612.32	93.63	518.69
	May-2018	612.32	93.51	518.81
	Oct-2018	612.10	96.29	515.81
	May-2019	612.10	91.78	520.32
	Nov-2019	612.10	91.98	520.12
	Apr-2020	612.10	89.34	522.76
	Oct-2020	612.10	86.78	525.32
	Apr-2021	612.10	96.78	515.32

MSL - Mean Sea Level

TOC - Top of Casing

[1] - Date of water levels collected at beginning of quarter, actual sample date may vary.

Table 9-2. Groundwater Elevations, Midwest Generation, LLC, Joliet Station #9.

Well ID	Date[1]	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
G48S	Nov-2015	620.77	106.83	513.94
	May-2016	620.77	105.20	515.57
	Jun-2016	620.77	104.95	515.82
	Aug-2016	620.77	104.77	516.00
	Nov-2016	620.77	102.41	518.36
	Feb-2017	620.77	103.05	517.72
	May-2017	620.77	100.06	520.71
	Jul-2017	620.77	102.31	518.46
	Sep-2017	620.77	102.88	517.89
	Nov-2017	620.77	100.83	519.94
	Mar-2018	620.77	99.77	521.00
	May-2018	620.77	100.74	520.03
	Oct-2018	620.78	105.79	514.99
	May-2019	620.78	98.18	522.60
	Nov-2019	620.78	98.30	522.48
	Apr-2020	620.78	95.54	525.24
	Oct-2020	620.78	100.63	520.15
	Apr-2021	620.78	104.98	515.80
T03S	Nov-2015	629.65	136.30	493.35
	May-2016	629.65	135.24	494.41
	Jun-2016	629.65	134.26	495.39
	Aug-2016	629.65	134.13	495.52
	Nov-2016	629.65	135.03	494.62
	Feb-2017	629.65	134.92	494.73
	May-2017	629.65	131.87	497.78
	Jul-2017	629.65	135.99	493.66
	Sep-2017	629.65	136.40	493.25
	Nov-2017	629.65	133.61	496.04
	Mar-2018	629.65	131.05	498.60
	May-2018	629.65	134.42	495.23
	Oct-2018	629.89	140.03	489.86
	May-2019	629.89	125.79	504.10
	Oct-2019	629.89	132.92	496.97
	Apr-2020	629.89	133.84	496.05
	Oct-2020	629.89	135.88	494.01
	Apr-2021	629.89	138.78	491.11
G31S	Dec-2018	535.78	25.70	510.08
	Jun-2019	535.78	23.46	512.32
	Oct-2019	535.78	26.89	508.89
	Apr-2020	535.78	25.75	510.03
	Oct-2020	535.78	28.09	507.69
	Apr-2021	535.78	28.65	507.13
G33S	Dec-2018	535.66	27.06	508.60
	Jun-2019	535.66	23.41	512.25
	Oct-2019	535.66	25.64	510.02
	Apr-2020	535.66	27.00	508.66
	Oct-2020	535.66	32.27	503.39
	Apr-2021	535.66	33.03	502.63
T01S	Dec-2018	621.78	115.39	506.39
	Jun-2019	621.78	112.91	508.87
	Oct-2019	621.78	113.37	508.41
	Apr-2020	621.78	111.50	510.28
	Oct-2020	621.78	118.64	503.14
	Apr-2021	621.78	122.36	499.42
T02S	Dec-2018	626.16	133.88	492.28
	Jun-2019	626.16	128.33	497.83
	Oct-2019	626.16	129.36	496.80
	Apr-2020	626.16	128.41	497.75
	Oct-2020	626.16	131.54	494.62
	Apr-2021	626.16	131.50	494.66
T04S	Dec-2018	631.35	158.00	473.35
	Jun-2019	631.35	152.54	478.81
	Oct-2019	631.35	152.07	479.28
	Apr-2020	631.35	152.24	479.11
	Oct-2020	ABD	ABD	ABD
	Apr-2021	ABD	ABD	ABD
T05S	Dec-2018	623.45	123.78	499.67
	Jun-2019	623.45	116.70	506.75
	Oct-2019	623.45	117.14	506.31
	Apr-2020	623.45	115.73	507.72
	Oct-2020	623.45	120.68	502.77
	Apr-2021	623.45	123.71	499.74
T06S	Dec-2018	621.02	112.72	508.30
	Jun-2019	621.02	111.86	509.16
	Oct-2019	621.02	112.43	508.59
	Apr-2020	621.02	109.45	511.57
	Oct-2020	621.02	112.20	508.82
	Apr-2021	621.02	117.22	503.80

MSL - Mean Sea Level
TOC - Top of Casing
1 - Date of water levels collected at beginning of quarter, actual sample date may vary.
ABD - Abandoned. Vulcan property well removed by Vulcan as part of mine expansion.

Table 9-2. Groundwater Elevations, Midwest Generation, LLC, Joliet Station #9.

Well ID	Date[1]	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
T08S	Dec-2018	627.39	128.97	498.42
	Jun-2019	627.39	124.37	503.02
	Oct-2019	627.39	125.15	502.24
	Apr-2020	627.39	123.91	503.48
	Oct-2020	627.39	126.50	500.89
	Apr-2021	627.39	130.24	497.15
T09S	Dec-2018	603.74	94.75	508.99
	Jun-2019	603.74	102.30	501.44
	Oct-2019	603.74	101.91	501.83
	Apr-2020	603.74	100.63	503.11
	Oct-2020	603.74	103.07	500.67
	Apr-2021	603.74	104.28	499.46

MSL - Mean Sea Level
TOC - Top of Casing
[1] - Date of water levels collected at beginning of quarter, actual sample date may vary.

Table 9-3. Hydraulic Gradient, Direction and Seepage Velocity. Midwest Generation, LLC, Joliet #9 Generation Station.

DATE	Natural Groundwater Flow Direction	K_{avg} (ft/sec)*	Average Hydraulic Gradient (ft/ft)	Porosity (unitless)**	Estimated Seepage Velocity (ft/day)
11/2015	Northerly and Westerly	1.38E-05	0.0293	0.05	0.70
5/2016	Northerly and Westerly	1.38E-05	0.0289	0.05	0.69
6/2016	Northerly and Westerly	1.38E-05	0.0287	0.05	0.68
8/2016	Northerly and Westerly	1.38E-05	0.0293	0.05	0.70
11/2016	Northerly and Westerly	1.38E-05	0.0301	0.05	0.72
2/2017	Northerly and Westerly	1.38E-05	0.0431	0.05	1.03
5/2017	Northerly and Westerly	1.38E-05	0.0364	0.05	0.87
7/2017	Northerly and Westerly	1.38E-05	0.0378	0.05	0.90
8/2017	Northerly and Westerly	1.38E-05	0.0364	0.05	0.87
11/2017	Northerly and Westerly	1.38E-05	0.0319	0.05	0.76
3/2018	Northerly and Westerly	1.38E-05	0.0384	0.05	0.92
5/2018	Northerly and Westerly	1.38E-05	0.0222	0.05	0.53
12/2018	Northerly and Westerly	1.38E-05	0.0321	0.05	0.77
6/2019	Northerly and Westerly	1.38E-05	0.0282	0.05	0.67
11/2019	Northerly and Westerly	1.38E-05	0.0269	0.05	0.64
5/2020	Northerly and Westerly	1.38E-05	0.0376	0.05	0.90
10/2020	Northerly and Westerly	1.38E-05	0.0311	0.05	0.74
4/2021	Northerly and Westerly	1.38E-05	0.0221	0.05	0.53

* K_{avg} - Average hydraulic conductivity (feet/second) from Revised Groundwater Impacts assessment Lincoln Stone Quarry, 3/13/2013.

** - Porosity estimate from Revised Groundwater Impacts assessment Lincoln Stone Quarry, 3/13/2013.

Table 9-4. Groundwater Analytical Results - Midwest Generation, LLC, Joliet #9 Generating Station, Joliet, IL.

Well	Date	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Radium 226 + 228 Combined	Selenium	Thallium
G45S up-gradient	11/20/2015	0.81	120	180	0.35	7.20	360	810	< 0.003	0.0081	0.044	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.35	< 0.0005	0.036	< 0.0002	0.0120	1.76	< 0.0025	< 0.002
	5/12/2016	0.68	110	140	0.34	7.37	230	860	< 0.003	0.0076	0.041	< 0.001	< 0.0005	< 0.005	< 0.001	0.34	< 0.0005	0.036	< 0.0002	0.0100	3.01	< 0.0025	< 0.002
	6/30/2016	0.48	87	110	0.34	7.50	170	670	< 0.003	0.0075	0.031	< 0.001	< 0.0005	< 0.005	< 0.001	0.34	< 0.0005	0.034	< 0.0002	0.008	2.05	< 0.0025	< 0.002
	8/25/2016	0.47	94	100	0.35	7.28	170	790	< 0.003	0.0076	0.036	< 0.001	< 0.0005	< 0.005	< 0.001	0.35	< 0.0005	0.031	< 0.0002	0.0086	1.91	< 0.0025	< 0.002
	11/16/2016	0.41	91	90	0.33	7.34	170	620	< 0.003	0.0079	0.033	< 0.001	< 0.0005	< 0.005	< 0.001	0.33	< 0.0005	0.028	< 0.0002	0.0094	2.04	< 0.0025	< 0.002
	2/14/2017	0.43	97	97	0.32	7.36	160	620	< 0.003	0.0093	0.037	< 0.001	< 0.0005	< 0.005	< 0.001	0.32	< 0.0005	0.029	< 0.0002	0.0083	1.85	< 0.0025	< 0.002
	5/23/2017	0.36	85	110	0.35	7.30	150	660	< 0.003	0.0082	0.033	< 0.001	< 0.0005	< 0.005	< 0.001	0.35	< 0.0005	0.027	< 0.0002	0.0093	1.40	< 0.0025	< 0.002
	7/7/2017	0.42	94	120	< 0.1	7.21	150	600	< 0.003	0.0086	0.035	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.1	< 0.0005	0.030	< 0.0002	0.007	1.88	< 0.0025	< 0.002
	9/26/2017	0.43	110	130	0.3	7.21	160	790	< 0.003	0.0096	0.04	< 0.001	< 0.0005	< 0.005	< 0.001	0.3	< 0.0005	0.029	< 0.0002	0.0079	2.14	< 0.0025	< 0.002
	11/21/2017	0.34	96	130	0.33	7.29	180	700	< 0.003	0.0094	0.038	< 0.001	< 0.0005	< 0.005	< 0.001	0.33	< 0.0005	0.028	< 0.0002	0.0072	8.45	< 0.0025	< 0.002
	3/9/2018	0.38	97	110	0.32	7.18	180	710	< 0.003	0.0093	0.036	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.32	< 0.0005	0.028	^ < 0.0002	0.008	1.89	< 0.0025	< 0.002
	5/21/2018	0.76	110	150	0.33	7.00	230	970	NA	0.0072	0.047	NA	NA	NA	< 0.001	0.33	< 0.0005	0.033	NA	0.013	2.37	< 0.0025	NA
	12/7/2018	0.46	91	120	0.33	7.02	100	740	NA	0.0090	0.034	NA	NA	NA	< 0.001	0.330	< 0.0005	0.031	NA	0.0100	1.910	< 0.0025	NA
	6/28/2019	0.39	96	130	0.33	7.51	120	720	NA	0.0100	0.039	NA	NA	NA	< 0.001	0.33	< 0.0005	0.032	NA	0.0087	1.99	< 0.0025	NA
	11/14/2019	0.48	110	170	0.33	7.33	170	830	NA	< 0.0100	0.042	NA	NA	NA	< 0.001	0.33	< 0.0005	0.034	NA	0.0100	2.89	< 0.010	NA
	6/26/2020	0.62	130	220	0.33	7.21	240	970	NA	0.011	0.049	NA	NA	NA	< 0.001	0.33	< 0.0005	0.039	NA	0.0088	3.1	< 0.0025	NA
	12/11/2020	0.70	120	180	0.38	7.16	220	760	NA	0.011	0.042	NA	NA	NA	< 0.001	0.38	^+< 0.0005	0.038	NA	0.012	1.88	< 0.0025	NA
	6/28/2021	0.44	91	110	0.35	7.20	150	680	< 3	0.01	0.034	< 1.00	< 0.50	< 5.00	< 0.001	0.35	< 0.0005	0.031	< 0.00020	0.0083	DNYA	< 0.0025	< 2.00
T03S up-gradient	11/19/2015	0.5	110	75	0.22	7.07	250	710	< 0.003	0.0019	0.063	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.22	< 0.0005	0.019	< 0.0002	0.0260	1.101	< 0.0025	< 0.002
	5/5/2016	0.84	100	100	0.21	7.16	190	820	< 0.003	0.0013	0.081	< 0.001	< 0.0005	< 0.005	< 0.001	0.21	< 0.0005	0.018	< 0.0002	0.03	1.43	< 0.0025	< 0.002
	6/28/2016	0.98	100	94	0.19	7.30	180	910	< 0.003	0.0011	0.086	< 0.001	< 0.0005	< 0.005	0.0011	0.19	< 0.0005	0.017	< 0.0002	0.037	1.18	< 0.0025	< 0.002
	8/25/2016	1.1	110	99	0.20	7.32	180	880	< 0.003	< 0.001	0.086	< 0.001	< 0.0005	< 0.005	< 0.001	0.2	< 0.0005	0.016	< 0.0002	0.043	1.54	< 0.0025	< 0.002
	11/17/2016	1.3	120	100	0.19	7.14	150	860	< 0.003	0.0012	0.096	< 0.001	< 0.0005	< 0.005	0.0012	0.19	< 0.0005	0.022	< 0.0002	0.14	1.61	< 0.0025	< 0.002
	2/15/2017	1.0	98	110	0.19	7.36	230	810	< 0.003	0.0011	0.086	< 0.001	< 0.0005	< 0.005	0.0013	0.19	< 0.0005	< 0.05	< 0.0002	0.12	0.938	< 0.0025	< 0.002
	5/22/2017	1.4	110	78	0.23	7.25	160	740	< 0.003	0.0017	B 0.088	^ < 0.001	< 0.0005	< 0.005	0.0015	0.23	0.0023	0.019	< 0.0002	0.13	1.21	< 0.0025	< 0.002
	7/7/2017	1.1	100	F1 71	< 0.1	7.32	180	710	< 0.003	< 0.001	0.078	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.1	< 0.0005	0.019	< 0.0002	0.099	1.11	< 0.0025	< 0.002
	9/26/2017	1.3	110	80	0.21	7.19	240	790	< 0.003	0.0011	0.086	< 0.001	< 0.0005	< 0.005	0.0013	0.21	< 0.0005	0.018	< 0.0002	0.14	1.33	< 0.0025	< 0.002
	11/20/2017	1.7	98	90	0.24	7.13	230	770	< 0.003	0.0014	0.087	< 0.001	< 0.0005	< 0.005	< 0.001	0.24	< 0.0005	0.02	< 0.0002	0.2	1.59	< 0.0025	< 0.002
	3/7/2018	1.5	110	110	0.23	7.34	250	900	< 0.003	0.0023	0.093	< 0.001	< 0.0005	< 0.005	0.0013	0.23	< 0.0005	0.022	< 0.0002	0.26	1.30	< 0.0025	< 0.002
	5/17/2018	1.8	100	82	0.24	7.07	210	890	NA	0.001	0.087	NA	NA	NA	0.0013	0.24	< 0.0005	0.021	NA	0.240	1.25	< 0.0025	NA
	12/11/2018	1.8	100	140	0.23	6.96	160	890	NA	0.0014	0.095	NA	NA	NA	0.0012	0.230	< 0.0005	0.021	NA	0.270	1.31	< 0.0025	NA
	6/24/2019	2.7	100	89	0.27	7.17	260	830	NA	0.0020	0.090	NA	NA	NA	0.0010	0.270	< 0.0005	0.027	NA	0.370	1.33	< 0.0025	NA
	10/28/2019	1.5	100	73	0.25	7.19	< 500	780	NA	< 0.0100	0.088	NA	NA	NA	0.0011	0.25	< 0.0050	0.026	NA	0.210	1.38	< 0.0100	NA
	6/23/2020	2.3	97	74	0.33	7.29	240	770	NA	0.0024	0.093	NA	NA	NA	< 0.001	0.33	< 0.0005	0.025	NA	0.23	1.65	< 0.0025	NA
	12/15/2020	1.4	140	F1 170	0.27	7.01	280	960	NA	0.0013	0.11	NA	NA	NA	0.0015	0.27	< 0.0005	0.031	NA	0.14	1.74	< 0.0025	NA
	6/22/2021	0.92	120	130	0.23	6.94	220	980	< 0.0030	0.0016	0.085	< 0.001	< 0.0005	< 0.005	< 0.001	0.23	< 0.0005	0.029	H< 0.00020	0.071	DNYA	< 0.0025	< 0.0020
R08S down-gradient	11/23/2015	6.9	130	77	0.19	7.80	520	740	< 0.003	0.0019	0.052	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.14	< 0.0002	0.410	1.608	0.0061	< 0.002
	5/6/2016	6.1	120	80	0.19	7.70	380	820	< 0.003	0.0013	0.052	< 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.14	< 0.0002	0.390	1.08	0.0079	< 0.002
	6/28/2016	6.8	130	89	0.18	7.49	320	960	< 0.003	0.0019	0.056	< 0.001	< 0.0005	< 0.005	< 0.001	0.18	< 0.0005	0.14	< 0.0002	0.37	1.87	F1 0.0074	< 0.002
	8/25/2016	6.3	120	84	0.19	7.54	350	890	< 0.003	0.0015	0.053	< 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.13	< 0.0002	0.33	1.50	0.0032	< 0.002
	11/21/2016	6.4	120	86	0.17	7.53	280	790	< 0.003	0.0016	0.052	< 0.001	< 0.0005	< 0.005	< 0.001	0.17	< 0.0005	0.140	< 0.0002	0.36	2.13	0.0037	< 0.002
	2/14/2017	5.4	150	220	0.17	7.60	280	1,000	< 0.003	0.002	0.081	< 0.001	< 0.0005	< 0.005	< 0.001	0.17	< 0.0005	0.120	< 0.0002	0.3	2.71	0.0029	< 0.002
	5/25/2017	12	250	90	0.17	7.56	340	830	< 0.006	0.0028	0.092	^ < 0.002	< 0.001	< 0.01	< 0.002	0.17	< 0.001	0.250	< 0.0002	0.64	0.821	0.021	< 0.004
	7/6/2017	6.3	140	87	0.17	7.62	350	830	< 0.003	0.002	0.052	< 0.001	< 0.0005	< 0.005	< 0.001	0.17	^ < 0.0005	0.140	< 0.0002	0.35	1.15	0.0054	^ < 0.002
	9/25/2017	7.3	140	81	0.15	7.57	390	840	< 0.003	0.002	0.048	< 0.001	< 0.0005	< 0.005	< 0.001	0.15	0.00067	0.130	< 0.0002	0.38	1.27	0.0079	< 0.002
	11/21/2017	7.3	130	89	0.15	8.05	380	800	< 0.003	0.0017	0.046	< 0.001	< 0.0005	< 0.005	< 0.001	0.15	< 0.0005	0.140	< 0.0002	0.34	1.09	0.015	< 0.002
	3/8/2018	7.4	150	83	0.14	8.62	420	850	< 0.003	0.0016	0.05	< 0.001	< 0.0005	< 0.005	< 0.001	0.14	< 0.0005	0.150	< 0.0002	0.37	1.55	0.012	< 0.002
	5/18/2018	7.7	140	82	0.14	8.25	320	920	NA	0.0013	0.046	NA	NA	NA	< 0.001	0.14	< 0.0005	0.150	NA	0.35	1.22	0.017	NA
	12/13/2018	7.7	140	79	0.15	8.11	240	800	NA	0.0012	0.046	NA	NA	NA	< 0.001	0.150	< 0.0005	0.150	NA	0.370	1.450	0.0170	NA
	6/19/2019	8.5	140	83	0.14	8.10	360	820	NA	0.0013	0.044	NA	NA	NA	< 0.001	0.140	< 0.0005	0.160	NA	0.370	1.5	0.0150	NA
	11/11/2019	6.4	140	84	0.15	7.91	360	730	NA	< 0.010	0.044	NA	NA	NA	< 0.001	0.150	< 0.0005	0.15	NA	0.340	1.31	0.0130	NA
	6/26/2020	7.9	140	83	0.15	8.32	370	750	NA	0.0011	0.043	NA	NA	NA	< 0.001	0.15	< 0.0005	0.14	NA	0.36	1.68	0.017	NA
	12/14/2020	8.0	130	88	0.18	8.15	400	700	NA	0.0015	0.04	NA	NA	NA	< 0.001	0.18	< 0.0005	0.14	NA	0.38	1.53	0.0081	NA
	6/23/2021	7.6	140	79	0.16	8.07	430	810	< 0.003	0.0011	0.042	< 0.001	< 0.0005	< 0.005	< 0.001	0.16	< 0.0005	0.15	H< 0.00020	0.37	DNYA	0.011	< 0.002
G20S down-gradient	11/19/2015	1.2	59	12	0.82	7.73	110	410	< 0.003	< 0.001	0.049	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.82	< 0.0005	0.036	< 0.0002	0.0068	2.078	< 0.0025	< 0.002
	5/11/2016	1.2	53	12	0.81	7.52	77	410	< 0.003	< 0.001	0.049	< 0.001	< 0.0005	< 0.005	< 0.001	0.81	< 0.0005	0.037	0.00027	0.011	2.52	< 0.0025	< 0.002
	6/29/2016	1.2	`	12	0.82	7.38	69	460	< 0.003	< 0.001	0.051	< 0.001	< 0.0005	< 0.005	0.0011	0.82	< 0.0005	0.04	< 0.0002	0.014	2.79	< 0.0025	< 0.002
	8/23/2016	1.3	56	13	0.81	7.41	67	420	< 0.003	< 0.001	0.047	< 0.001	< 0.0005	< 0.005	< 0.001	0.81	< 0.0005	0.039	< 0.0002	0.017	3.67	< 0.0025	< 0.002
	11/17/2016	1.3	59	11	0.74	7.44	55	420	< 0.003	< 0.001	0.056	< 0.001	< 0.0005	< 0.005	0.0018	0.74	< 0.0005	0.042	< 0.0002	0.019	1.98	< 0.0025	< 0.002
	2/13/2017	1.2	54	13	0.69	7.30	93	400	< 0.003	< 0.001	0.046	< 0.001	< 0.0005	< 0.005	< 0.0010	0.69	< 0.0005	0.04	< 0.0002	0.018	2.44	< 0.0025	< 0.002
	5/24/2017	1.3	55	12	0.81	7.45	66	430	< 0.003	< 0.001	0.046	^ < 0.001	< 0.0005	< 0.005	< 0.0010	0.81	< 0.0005	0.038	< 0.0002	0.017	2.15	< 0.0025	< 0.002
	7/5/2017	1.3	61	12	0.76	7.37	70	400	< 0.003	< 0.001	0.054	< 0.001	< 0.0005	< 0.005	0.0021	0.76	^ < 0.0005	0.04	< 0.0002	0.019	1.83	< 0.0025	^ < 0.002
	9/25/2017	1.3	60	12	0.78	7.30	76	440	< 0.003	< 0.001	0.051	< 0.001	< 0.0005	< 0.005	0.0015	0.78	< 0.0005	0.036	< 0.0002	0.022	2.19	< 0.0025	< 0.002
	11/20/2017	1.3	59	13	0.78	7.06	85	390	< 0.003	< 0.001	0.051	< 0.001	< 0.0005	< 0.005	0.0022	0.78	< 0.0005	0.041	< 0.0002	0.021	2.50	< 0.0025	< 0.002
	3/6/2018	1.4	63	12	0.76	7.32	88	460	< 0.003	< 0.001	0.049	^ < 0.001	< 0.0005	< 0.005	< 0.0010	0.76	< 0.0005	0.042	< 0.0002	0.021	2.83	< 0.0025	< 0.002
	5/16/2018	1.2	61	12	0.75	7.06	87	410	NA	< 0.001	0.049	NA	NA	NA	0.0024	0.75	^ < 0.0005	0.04	NA	0.019	2.12	< 0.0025	NA
	12/07/18	1.2	58	12	0.76	7.41	65	480	NA	< 0.001	0.048	NA	NA	NA	0.0010	0.760	0.0048	0.042	NA	0.0230	2.26	< 0.0025	NA
	6/18/2019	1.3	62	13	0.75	7.18	65	440	NA	< 0.001	0.051	NA	NA	NA	0.0018	0.750	< 0.0005	0.041	NA	0.017	2.11	< 0.0025	NA
	11/5/2019	1.2	58	13	0.74	7.88	71	410	NA	< 0.010	0.050	NA	NA	NA	0.0023	0.740	< 0.0005	0.044	NA	0.021	1.74	< 0.0100	NA
	6/24/2020	1.3	58	13	0.79	7.81	63	360	NA	< 0.010	0.045	NA	NA	NA	< 0.001	0.79	< 0.0005	0.038	NA	0.019	2.07	< 0.0025	NA
	12/11/2020	1.4	61	14	0.89	7.41	69	390	NA	< 0.001	0.043	NA	NA	NA	< 0.001	0.89	^+< 0.0005	0.042	NA	0.022	2.160	< 0.0025	NA
	6/23/2021	1.3	60	14	0.77	7.46	70	390	< 0.003	< 0.001	0.047	< 0.001	< 0.0005	< 0.005	< 0.001	0.77	< 0.0005	0.047	H< 0.00020	0.022	DNYA	< 0.0025	< 0.002
G30S down-gradient	11/20/2015	5.80	63	190	1.3	7.46	580	1,000	< 0.003	0.014	0.041	^ < 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.022	< 0.0002	0.33	1.484	< 0.0025	< 0.002
	5/10/2016	5.4	53	190	1.30	7.68	390	1,100	< 0.003	0.017	0.039	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.021	< 0.0002	0.3	1.41	< 0.0025	< 0.002
	6/30/2016	5.2	60	F1 180	1.30	7.73	410	990	< 0.003	0.013	0.04	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.023	< 0.0002	0.3	1.17	< 0.0025	< 0.002
	8/25/2016	5.7	59	F1 180	1.30	7.70	390	1,100	< 0.003	0.015	0.039	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.02	< 0.0002	0.31	1.87	< 0.0025	< 0.002
	11/18/2016	6.4	57	170	1.2	8.04	320	1,100	< 0.003	0.016	0.043	< 0.001	< 0.0005	< 0.005	< 0.001	1.2	< 0.0005	0.023	< 0.0002	0.33	2.36	< 0.0025	< 0.002
	2/14/2017	5.4	62	190	1.2	7.70	450	1,000	< 0.003	0.011	0.042	< 0.001	< 0.0005	< 0.005	< 0.001	1.2	< 0.0005	0.021	< 0.0002	0.24	1.84	< 0.0025	< 0.002
	5/25/2017	11	110	180	1.4	7.67	430	1,100	< 0.006	0.019	0.078	^ < 0.002	< 0.001	< 0.01	< 0.002	1.4	< 0.001	0.04	< 0.0002	0.45	1.76	< 0.005	< 0.004
	7/7/2017	6.6	54	190	1.3	7.48	410	1,100	< 0.003	0.011	0.039	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.021	< 0.0002	0.26	1.59	< 0.0025	< 0.002
	9/26/2017	6.7	62	190	1.3	8.07	460	1,100	< 0.003	0.011	0.041	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.021	< 0.0002	0.2	1.41	< 0.0025	< 0.002
	11/20/2017	6.1	52	210	1.3	7.77	440	1,100	< 0.003	0.01	0.04	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.019	< 0.0002	0.19	1.73	< 0.0025	< 0.002
	3/7/2018	5.1	56	200	1.3	7.97	470	1,100	< 0.003	0.011	0.043	< 0.001	< 0.0005	< 0.005	< 0.001	1.3	< 0.0005	0.019	< 0.0002	0.14	1.94	< 0.0025	< 0.002
	5/17/2018	5.7	55	210	1.2	7.77	540	1,100	NA	0.011	0.043	NA	NA	NA	< 0.001	1.2	< 0.0005	0.021	NA	0.13	1.57	F1 < 0.0025	NA
	12/15/2018	5.8	57	200	1.2	7.99	200	1,100	NA	0.0069	0.041	NA	NA	NA	< 0.001	1.2	< 0.0005	0.022	NA	0.065	2.04	< 0.0025	NA
	6/26/2019	5.4	57	220	1.1	7.98	350	1,100	NA	0.0074	0.041	NA	NA	NA	< 0.001	1.1	< 0.0005	0.018	NA	0.065	1.18	F1 < 0.0025	NA
	11/6/2019	4.5	58	210	1.1	7.99	350	1,100	NA	0.01	0.041	NA	NA	NA	< 0.001	1.1	< 0.0005	0.019	NA	0.013	1.620	0.01	NA
	6/25/2020	4.9	57	220	1.1	8.33	410	1,100	NA	0.0053	0.042	NA	NA	NA	< 0.001	1.1	< 0.0005	0.019	NA	0.02	2.19	< 0.0025	NA
	12/7/2020	5.3	57	220	1.2	7.83	450	1,100	NA	0.0044	0.043	NA	NA	NA	< 0.001	1.2	< 0.0005	0.024	NA	0.018	2.16	< 0.0025	NA
	6/30/2021	5.9 B	61	200	1.1	7.88	470	1,100	3	< 0.017	0.048	U ^1+ 1	< 0.5	< 5	< 0.001	1.1	< 0.0005	0.024	< 0.00020	0.017	DNYA	< 0.0025	< 2

Notes: All units are in mg/l except pH is in standard units and radium is in pCi/L.

F1 - MS and/or MSD Recovery outside of limits.

B - Compound was found in the blank and sample.

Table 1. Groundwater Analytical Results - Midwest Generation, LLC, Joliet #9 Generating Station, Joliet, IL.

Well	Date	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Radium 226 + 228 Combined	Selenium	Thallium
R32S down-gradient	11/19/2015	1.3	99	88	0.28	7.32	210	640	< 0.003	0.0018	0.033	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.28	< 0.0005	0.04	< 0.0002	0.16	1.928	< 0.0025	< 0.002
	5/5/2016	1.9	100	140	0.32	7.38	210	810	< 0.003	0.0034	0.039	< 0.001	< 0.0005	< 0.005	< 0.001	0.32	0.0005	0.069	< 0.0002	0.29	2.26	< 0.0025	< 0.002
	6/29/2016	2.5	110	110	0.35	7.53	280	860	< 0.003	0.0021	0.042	< 0.001	< 0.0005	< 0.005	< 0.001	0.35	< 0.0005	0.065	< 0.0002	0.43	2.12	< 0.0025	< 0.002
	8/26/2016	3.0	120	100	0.4	7.30	330	850	< 0.003	0.0014	0.043	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.4	< 0.0005	0.056	< 0.0002	0.48	2.39	< 0.0025	< 0.002
	11/18/2016	3.3	120	99	0.34	7.38	270	830	< 0.003	0.0016	0.042	< 0.001	< 0.0005	< 0.005	< 0.001	0.34	< 0.0005	0.063	< 0.0002	0.55	3.17	< 0.0025	< 0.002
	2/16/2017	F1 4.0	120	99	0.34	7.39	340	830	< 0.003	0.002	0.039	< 0.001	< 0.0005	< 0.005	< 0.001	0.34	< 0.0005	0.064	< 0.0002	0.57	1.76	F1 < 0.0025	< 0.002
	5/25/2017	8.3	240	88	0.42	7.54	320	850	< 0.006	0.0042	0.075	^ < 0.002	< 0.001	< 0.01	< 0.002	0.42	< 0.001	0.14	< 0.0002	1.4	1.82	< 0.005	< 0.004
	7/7/2017	6.2	120	96	0.42	7.61	360	830	< 0.003	0.0043	0.04	< 0.001	< 0.0005	< 0.005	< 0.001	0.42	< 0.0005	0.1	< 0.0002	0.87	2.08	< 0.0025	< 0.002
	9/28/2017	4.8	140	78	0.36	7.29	290	870	< 0.003	0.003	0.044	< 0.001	< 0.0005	< 0.005	< 0.001	0.36	< 0.0005	0.086	< 0.0002	0.57	1.79	< 0.0025	< 0.002
	11/21/2017	5.7	120	97	0.38	7.50	390	900	< 0.003	0.0037	0.041	< 0.001	< 0.0005	< 0.005	< 0.001	0.38	< 0.0005	0.11	< 0.0002	0.74	1.82	< 0.0025	< 0.002
	3/7/2018	5.8	130	86	0.32	7.57	350	880	< 0.003	0.0029	0.042	< 0.001	< 0.0005	< 0.005	< 0.001	0.32	< 0.0005	0.11	< 0.0002	0.67	2.56	< 0.0025	< 0.002
	5/21/2018	4.4	120	77	0.29	7.13	310	1,000	NA	0.0024	0.04	NA	NA	NA	< 0.001	0.29	< 0.0005	0.1	NA	0.64	2.22	< 0.0025	NA
	12/13/2018	3.5	120	F1 72	0.26	7.43	280	880	NA	0.0019	0.043	NA	NA	NA	< 0.001	0.260	0.0017	0.080	NA	0.560	2.23	< 0.0025	NA
	6/27/2019	6.3	140	74	0.27	7.33	380	880	NA	0.0027	0.041	NA	NA	NA	< 0.001	0.270	< 0.0005	0.090	NA	0.810	2.67	< 0.0025	NA
	11/6/2019	4.8	150	69	0.27	7.45	360	820	NA	< 0.01	0.039	NA	NA	NA	< 0.001	0.270	< 0.0005	0.13	NA	0.580	2.370	< 0.0100	NA
	6/29/2020	6.0	130	71	0.28	7.47	400	790	NA	0.0021	0.038	NA	NA	NA	< 0.001	0.28	< 0.0005	0.11	NA	0.64	3.92	< 0.0025	NA
	12/16/2020	6.1	150	F1 66	0.34	7.43	430	840	NA	0.0025	0.038	NA	NA	NA	< 0.001	0.34	^+< 0.0005	0.11	NA	0.75	3.22	F1 < 0.0025	NA
	6/28/2021	4.0 B	130	56	0.3	7.16	430	790	< 3	< 0.001	0.036	< 1	< 0.5	< 5	< 0.001	0.3	< 0.0005	0.071	< 0.00020	0.53	DNYA	< 0.0025	< 2
G44S down-gradient	11/20/2015	1.0	120	43	0.21	7.11	220	640	< 0.003	0.0012	0.053	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.21	< 0.0005	0.017	< 0.0002	0.1000	1.161	< 0.0025	< 0.002
	5/9/2016	0.91	110	37	0.18	7.39	120	690	< 0.003	< 0.001	0.049	< 0.001	< 0.0005	< 0.005	< 0.001	0.18	< 0.0005	0.015	< 0.0002	0.046	< 0.415	< 0.0025	< 0.002
	6/30/2016	0.69	100	32	0.18	7.59	99	620	< 0.003	< 0.001	0.044	< 0.001	< 0.0005	< 0.005	< 0.001	0.18	< 0.0005	0.014	< 0.0002	0.025	0.879	< 0.0025	< 0.002
	8/26/2016	0.9	120	36	0.19	7.12	110	710	< 0.003	< 0.001	0.053	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.014	< 0.0002	0.047	0.816	< 0.0025	< 0.002
	11/16/2016	0.82	120	26	0.17	7.15	88	530	< 0.003	< 0.001	0.048	< 0.001	< 0.0005	< 0.005	< 0.001	0.17	< 0.0005	0.011	< 0.0002	0.041	0.475	< 0.0025	< 0.002
	2/16/2017	0.86	120	30	0.15	7.38	120	620	< 0.003	< 0.001	0.051	< 0.001	< 0.0005	< 0.005	< 0.001	0.15	< 0.0005	0.014	< 0.0002	0.044	0.729	< 0.0025	< 0.002
	5/24/2017	0.83	120	31	0.19	7.08	95	600	< 0.003	< 0.001	0.048	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.011	< 0.0002	0.031	1.02	< 0.0025	< 0.002
	7/10/2017	0.83	110	30	< 0.1	7.00	110	700	< 0.003	< 0.001	0.049	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.1	< 0.0005	0.012	< 0.0002	0.061	0.667	< 0.0025	< 0.002
	9/28/2017	0.99	130	30	0.19	7.13	100	730	< 0.003	< 0.001	0.048	< 0.001	< 0.0005	< 0.005	< 0.001	0.19	< 0.0005	0.014	< 0.0002	0.081	0.614	< 0.0025	< 0.002
	11/21/2017	0.79	110	35	0.18	7.06	120	640	< 0.003	< 0.001	0.051	< 0.001	< 0.0005	< 0.005	< 0.001	0.18	< 0.0005	0.016	< 0.0002	0.055	0.913	< 0.0025	< 0.002
	3/7/2018	0.91	120	36	0.18	7.19	110	670	< 0.003	0.0014	0.053	< 0.001	< 0.0005	< 0.005	< 0.001	0.18	< 0.0005	0.017	< 0.0002	0.049	1.31	< 0.0025	< 0.002
	5/17/2018	0.98	120	35	0.18	7.02	96	780	NA	< 0.001	0.054	NA	NA	NA	< 0.001	0.18	< 0.0005	0.016	NA	0.071	0.714	< 0.0025	NA
	12/10/2018	1.1	120	43	0.19	7.41	78	630	NA	< 0.001	0.057	NA	NA	NA	< 0.001	0.19	< 0.0005	0.019	NA	0.14	0.454	< 0.0025	NA
	6/19/2019	1.3	130	59	0.19	7.02	140	720	NA	< 0.001	0.062	NA	NA	NA	< 0.001	0.19	< 0.0005	0.023	NA	0.13	0.841	< 0.0025	NA
	11/12/2019	1.3	140	53	0.21	7.22	160	670	NA	< 0.01	0.065	NA	NA	NA	< 0.001	0.21	< 0.0005	0.026	NA	0.20	1.01	< 0.01	NA
	6/29/2020	1.4	130	52	0.21	7.30	160	670	NA	< 0.001	0.06	NA	NA	NA	< 0.001	0.21	< 0.0005	0.024	NA	0.15	1.860	< 0.0025	NA
	12/15/2020	1.7	140	52	0.25	7.17	180	650	NA	< 0.001	0.062	NA	NA	NA	< 0.001	0.25	< 0.0005	0.03	NA	0.28	1.18	< 0.0025	NA
	6/302021	1.9 B	120	65	0.21	7	170	730	< 3	< 0.001	0.058	U ^1+ 1	< 0.5	< 5	< 0.001	0.21	< 0.0005	0.026	< 0.00020	0.22	DNYA	< 0.0025	< 2.0
G46S down-gradient	11/23/2015	6.0	110	80	0.27	7.32	430	780	< 0.003	0.0033	0.064	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.27	< 0.0005	0.073	< 0.0002	0.5	1.468	< 0.0025	< 0.002
	5/9/2016	7.7	100	100	0.28	7.77	360	940	< 0.003	0.0018	0.099	< 0.001	< 0.0005	< 0.005	< 0.001	0.28	0.0005	0.11	< 0.0002	0.7	1.85	< 0.0025	< 0.002
	6/30/2016	7.9	100	99	0.29	8.26	290	880	< 0.003	0.0014	0.098	< 0.001	< 0.0005	< 0.005	< 0.001	0.29	< 0.0005	0.13	< 0.0002	0.71	1.94	< 0.0025	< 0.002
	8/26/2016	7.2	100	120	0.35	7.48	350	1,000	< 0.003	0.0027	0.054	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.35	< 0.0005	0.12	< 0.0002	1.2	1.17	< 0.0025	< 0.002
	11/18/2016	6.5	110	120	0.39	7.56	330	1,000	< 0.003	0.0025	0.051	< 0.001	< 0.0005	< 0.005	< 0.0010	0.39	< 0.0005	0.13	< 0.0002	1.8	< 0.601	< 0.0025	< 0.002
	2/16/2017	6.1	100	150	0.41	7.94	410	1,000	< 0.003	0.0024	0.053	< 0.001	< 0.0005	< 0.005	< 0.0010	0.41	< 0.0005	0.091	< 0.0002	1.4	1.07	< 0.0025	< 0.002
	5/22/2017	6.8	100	130	0.44	7.37	350	970	< 0.003	0.0033	B 0.046	^ < 0.001	< 0.0005	< 0.005	< 0.0010	0.44	< 0.0005	0.11	< 0.0002	1.4	0.683	< 0.0025	< 0.002
	7/6/2017	4.9	100	150	0.41	7.33	290	880	< 0.003	0.0034	0.044	< 0.001	< 0.0005	< 0.005	0.0010	0.41	^ < 0.0005	0.076	< 0.0002	0.92	0.709	< 0.0025	^ < 0.002
	9/27/2017	4.9	88	160	0.4	7.28	270	890	< 0.003	0.0043	0.031	< 0.001	< 0.0005	< 0.005	< 0.0010	0.4	< 0.0005	0.091	< 0.0002	0.63	0.754	< 0.0025	< 0.002
	11/21/2017	5.3	78	170	0.43	7.73	270	800	< 0.003	0.0055	0.032	< 0.001	< 0.0005	< 0.005	< 0.0010	0.43	< 0.0005	0.11	< 0.0002	0.68	0.776	< 0.0025	< 0.002
	3/8/2018	5.9	110	140	0.41	7.75	350	940	< 0.003	0.0039	0.049	< 0.001	< 0.0005	< 0.005	< 0.0010	0.41	0.00053	0.093	< 0.0002	0.82	1.29	< 0.0025	< 0.002
	5/18/2018	5.9	110	120	0.4	7.66	260	1,100	NA	0.0028	0.048	NA	NA	NA	< 0.0010	0.4	< 0.0005	0.073	NA	0.84	1.07	< 0.0025	NA
	12/11/2018	7.60	120	110	0.38	7.66	270	1,100	NA	0.0023	0.055	NA	NA	NA	< 0.001	0.380	< 0.0005	0.096	NA	1.20	1.22	< 0.0025	NA
	6/19/2019	13	89	69	0.33	7.64	440	1,000	NA	0.014	0.040	NA	NA	NA	< 0.001	0.330	< 0.0005	0.22	NA	1.80	1.37	< 0.0025	NA
	11/13/2019	10	120	68	0.37	7.68	470	1,000	NA	< 0.050	0.041	NA	NA	NA	< 0.001	0.310	< 0.0050	0.11	NA	1.60	1.3	< 0.0100	NA
	6/29/2020	13	96	74	0.34	8.06	510	980	NA	0.075	0.05	NA	NA	NA	< 0.001	0.34	< 0.0050	0.23	NA	1.7	2.780	< 0.0025	NA
	12/15/2020	10	120	73	0.35	7.74	540	1,000	NA	0.27	0.075	NA	NA	NA	< 0.001	0.35	< 0.00085	0.21	NA	1.5	2.16	< 0.0025	NA
	6/30/2021	15 B	120	67	0.3	7.4	590	1,000	< 3	0.044	0.05	U ^1+ 1	< 0.5	< 5	< 0.001	0.3	< 0.0005	0.21	< 0.00020	1.6	DNYA	< 0.0025	< 2
G47S down-gradient	11/23/2015	4.6	11	160	0.45	9.22	480	700	< 0.003	0.018	0.018	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.45	< 0.0005	0.036	< 0.0002	0.32	0.898	0.003	< 0.002
	5/6/2016	5.0	7.8	140	0.72	9.86	410	910	< 0.003	0.034	0.017	< 0.001	< 0.0005	< 0.005	< 0.001	0.72	< 0.0005	0.033	< 0.0002	0.41	0.736	0.0033	< 0.002
	7/1/2016	6.4	8.4	150	0.68	9.32	340	860	< 0.003	0.022	0.019	< 0.001	^ < 0.0005	< 0.005	< 0.001	0.68	< 0.0005	0.038	< 0.0002	0.53	1.01	< 0.0025	< 0.002
	8/24/2016	9.3	9.2	140	0.67	9.19	300	830	< 0.003	0.017	0.023	< 0.001	< 0.0005	< 0.005	< 0.001	0.67	< 0.0005	0.028	< 0.0002	0.41	1.06	< 0.0025	< 0.002
	11/16/2016	15	1.3	F1 150	1.8	10.08	620	1,700	< 0.003	0.14	0.0091	< 0.001	< 0.0005	< 0.005	< 0.001	1.8	< 0.0005	0.015	< 0.0002	1.4	< 1.38	0.0038	< 0.002
	2/15/2017	7.6	4.4	160	1.1	9.26	540	1,200	< 0.003	0.059	0.016	< 0.001	< 0.0005	< 0.005	< 0.001	1.1	< 0.0005	< 0.05	< 0.0002	0.57	0.716	0.0035	< 0.002
	5/23/2017	18	0.93	160	2.2	10.03	720	1,800	< 0.003	0.18	0.0081	^ < 0.001	< 0.0005	< 0.005	< 0.001	2.2	< 0.0005	0.013	< 0.0002	1.3	< 0.361	0.0025	< 0.002
	7/10/2017	18	1.2	150	2.1	10.06	780	1,800	< 0.003	0.17	0.0085	< 0.001	< 0.0005	< 0.005	< 0.001	2.1	< 0.0005	0.013	< 0.0002	1.2	0.733	< 0.0025	< 0.002
	9/27/2017	18	1.1	150	2.0	10.15	750	1,900	< 0.003	0.21	0.0085	< 0.001	< 0.0005	< 0.005	< 0.001	2	< 0.0005	0.014	< 0.0002	1.3	0.836	0.0027	< 0.002
	11/22/2017	21	1.1	150	2.1	10.56	710	1,800	< 0.003	0.23	0.009	< 0.001	< 0.0005	< 0.005	< 0.001	2.1	< 0.0005	0.012	< 0.0002	1.5	0.692	0.0044	< 0.002
	3/8/2018	18	1.1	170	2.1	10.67	780	1,900	< 0.003	0.25	0.009	< 0.001	< 0.0005	< 0.005	< 0.001	2.1	< 0.0005	0.014	< 0.0002	1.4	0.790	0.0042	< 0.002
	5/18/2018	3.7	1.1	160	1.7	7.79	570	1,800	NA	0.23	0.0087	NA	NA	NA	< 0.001	1.7	< 0.0005	0.015	NA	1.5	1.01	0.0039	NA
	12/11/2018	13	2.8	140	1.1	10.14	440	1,300	NA	0.140	0.0110	NA	NA	NA	< 0.001	1.10	< 0.0005	0.023	NA	1.10	0.597	0.0031	NA
	6/28/2019	13	2.9	130	1.3	9.95	450	1,400	NA	0.13	0.0120	NA	NA	NA	< 0.001	1.30	< 0.0005	0.028	NA	1.00	0.566	< 0.0025	NA
	11/7/2019	4.3	15	140	0.55	8.39	410	1,100	NA	0.029	0.0170	NA	NA	NA	< 0.001	0.55	< 0.0050	0.053	NA	0.38	1.02	< 0.0100	NA
	6/30/2020	5.2	16	120	0.59	9.04	F1 440	1,000	NA	0.037	0.015	NA	NA	NA	< 0.001	0.59	< 0.0050	0.052	NA	0.46	1.240	0.004	NA
	12/7/2020	7.6	11	120	1.1	9.13	500	1,100	NA	0.066	0.012	NA	NA	NA	< 0.001	1.1	< 0.0005	0.047	NA	0.62	< 0.466	< 0.003	NA
	6/24/2021	6.1 B	12	110	0.66	8.68	470	1,000	< 0.003	0.04	0.013	< 0.001	< 0.0005	< 0.005	< 0.001	0.66	< 0.0005	0.05	U H 0.00020	0.48	DNYA	0.0027	< 0.002
G48S down-gradient	11/20/2015	11.00	6.9	120	1.5	9.08	760	1,100	< 0.003	0.03	0.015	^ < 0.001	< 0.0005	< 0.005	< 0.001	1.5	< 0.0005	0.015	< 0.0002	1.4	0.8512	< 0.0025	< 0.002
	5/5/2016	9.30	5.9	120	1.5	9.53	560	1,200	< 0.003	0.046	0.014	< 0.001	< 0.0005	< 0.005	< 0.001	1.5	< 0.0005	0.016	< 0.0002	1.2	0.800	< 0.0025	< 0.002
	7/1/2016	9.50	4.2	120	1.4	9.60	480	1,100	< 0.003	0.038	0.011	< 0.001	^ < 0.0005	< 0.005	< 0.001	1.4	< 0.0005	0.013	< 0.0002	1.2	1.01	< 0.0025	< 0.002
	8/24/2016	10.00	5.5	120	1.4	9.31	420	1,100	< 0.003	0.032	0.014	< 0.001	< 0.0005	< 0.005	< 0.001	1.4	< 0.0005	0.012	< 0.0002	1.1	1.16	< 0.0025	< 0.002
	11/16/2016	9.80	10	110	1.4	9.61	340	1,100	< 0.003	0.03	0.018	< 0.001	< 0.0005	< 0.005	< 0.001	1.4	< 0.0005	0.016	< 0.0002	1.1	1.65	< 0.0025	< 0.002
	9/27/2017	7.60	18	100	1.1	8.94	480	1,100	< 0.003	0.024	0.019	< 0.001	< 0.0005	< 0.005	< 0.001	1.1	< 0.0005	0.019	< 0.0002	0.72	1.32	< 0.0025	< 0.002
	11/22/2017	8.60	12	120	1.2	9.42	450	1,000	< 0.003	0.027	0.015	< 0.001	< 0.0005	< 0.005	< 0.001	1.2	< 0.0005	0.016	< 0.0002	0.77	1.27	< 0.0025	< 0.002
	3/8/2018	5.30	62	100	0.85	8.13	450	1,000	< 0.003	0.017	0.031	< 0.001	< 0.0005	< 0.005	< 0.001	0.85	< 0.0005	0.023	< 0.0002	0.51	2.30	< 0.0025	< 0.002
	5/18/2018	5.90	53	100	0.92	7.79	370	1,100	NA	0.022	0.023	NA	NA	NA	< 0.001	0.92	< 0.0005	0.023	NA	0.49	0.962	< 0.0025	NA
	12/11/2018	7.30	23	110	1.1	8.42	310	1,000	NA	0.023	0.016	NA	NA	NA	< 0.001	1.1	0.0049	0.019	NA	0.79	0.921	< 0.0025	NA
	6/25/2019	7.10	28	110	1.0	8.07	390	1,000	NA	0.022	0.018	NA	NA	NA	< 0.001	0.95	< 0.0005	0.022	NA	0.73	1.33	< 0.0025	NA
	11/7/2019	5.80	18	100	0.89	7.83	380	1,000	NA	0.012	0.027	NA	NA	NA	< 0.001	0.89	< 0.005	0.019	NA	0.59	1.24	< 0.01	NA
	6/26/2020	7.10	16	110	1.0	9.20	400	940	NA	0.022	0.017	NA	NA	NA	< 0.001	1.0	< 0.005	0.021	NA	0.54	0.971	< 0.0025	NA
	12/7/2020	6.00	29	110	1.1	8.4	410	890	NA	0.016	0.02	NA	NA	NA	< 0.001	1.1	< 0.0005	0.026	NA	0.41	2.00	< 0.0025	NA
	6/24/2021	4.3 B	96	96	0.71	7.27	480	1,100	< 0.003	0.0026	0.035	< 0.001	< 0.0005	< 0.005	< 0.001	0.71	< 0.0005	0.032	U H 0.00020	0.26	DNYA	< 0.0025	< 0.002

Notes: All units are in mg/l except pH is in standard units and radium is in pCi/L.
F1 - MS and/or MSD Recovery outside of limits.
B - Compound was found in the blank and sample.

Table 9-5. Groundwater Turbidity - Midwest Generation, LLC, Joliet #9 Generating Station

Well ID	Date	Turbidity (NTU)
G45S	3/12/2021	0.87
	4/5/2021	0.33
	4/23/2021	0.54
	5/18/2021	0.36
	6/8/2021	0.64
	7/2/2021	1.4
	8/12/2021	0.36
	9/2/2021	0.46
T03S	3/15/2021	2.42
	4/1/2021	0.44
	4/22/2021	94
	5/17/2021	0.47
	6/7/2021	0.47
	7/1/2021	0.3
	8/12/2021	0.34
	9/1/2021	0.67
R08S	3/12/2021	0.19
	4/1/2021	0.46
	4/23/2021	0.34
	5/18/2021	0.24
	6/8/2021	0.2
	7/1/2021	0.17
	8/12/2021	0.58
	9/2/2021	0.42
G20S	3/12/2021	0.32
	4/1/2021	0.29
	4/22/2021	0.14
	5/18/2021	0.63
	6/8/2021	0.2
	7/1/2021	0.29
	8/12/2021	0.32
	9/2/2021	0.48
G30S	3/12/2021	0.05
	4/2/2021	0.14
	4/23/2021	0.25
	5/18/2021	0.43
	6/8/2021	0.61
	7/2/2021	0.48
	8/13/2021	0.31
	9/2/2021	0.48
R32S	3/12/2021	0.42
	4/5/2021	0.81
	4/23/2021	1.23
	5/18/2021	1.78
	6/8/2021	1.14
	7/2/2021	0.42
	8/13/2021	0.57
	9/30/2021	0.39
G44S	3/15/2021	3.66
	4/5/2021	3.89
	4/23/2021	3.31
	5/18/2021	1.41
	6/8/2021	1.42
	7/2/2021	1.37
	8/12/2021	1.56
	9/2/2021	1.38
G46S	3/15/2021	18.4
	4/5/2021	106.5
	4/23/2021	59.2
	5/18/2021	181
	6/8/2021	3140
	7/1/2021	11.6
	8/12/2021	112
	9/2/2021	43.3
G47S	3/15/2021	0.12
	4/5/2021	0.1
	4/22/2021	0.16
	5/18/2021	0.14
	6/8/2021	0.53
	8/13/2021	0.18
	9/2/2021	0.68
G48S	3/15/2021	0.47
	4/5/2021	0.14
	4/22/2021	0.22
	5/18/2021	0.44
	6/8/2021	0.24
	7/1/2021	0.91
	8/13/2021	0.23
	9/2/2021	0.63

Table 9-6. Summary of Sample Bottles, Preservation Holding Time, and Analytical Methods. Midwest Generation, LLC, Joliet #9 Generating Station, Joliet, IL.

PARAMETER	ANALYTICAL METHOD	CONTAINER	PRESERVATION	HOLD TIME	METHOD DETECTION LIMIT (MG/L)	Section 845.600(a) Standards
Boron	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.0245	2
Calcium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.106	NS
Chloride	SM4500 Cl-E	1 L plastic	None, < 6 °C	28 days	1.22	200
Fluoride	SM4500 F-C	1 L plastic	None, < 6 °C	28 days	0.019	4
pH	SM4500 H^+ -B	1 L plastic	None, < 6 °C	immediate *	Field Parameter	6.5 - 9.0 (secondary standard)
Sulfate	SM4500 SO_4 -E	1 L plastic	None, < 6 °C	28 days	2	400
Total Dissolved Solids	SM2400 C	1 L plastic	None, < 6 °C	7 days	6.1	1200
Antimony	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00101	0.006
Arsenic	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000439	0.01
Barium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000841	2
Beryllium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000237	0.004
Cadmium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00019	0.005
Chromium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000608	0.1
Cobalt	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000189	0.006
Lead	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000141	0.0075
Lithium	6010 C	250 mL plastic	HNO_3, < 6 °C	6 months	0.00215	0.04
Mercury	7470 A	250 mL plastic	HNO_3, < 6 °C	28 days	0.0000611	0.002
Molybdenum	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00162	0.1
Selenium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000834	0.05
Thallium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000591	0.002
Radium 226	903.0	1 L plastic	HNO_3	180 days	1 pCi/L	5 pCi/L **
Radium 228	904.0	2 L plastic	HNO_3	180 days	1 pCi/L	5 pCi/L **

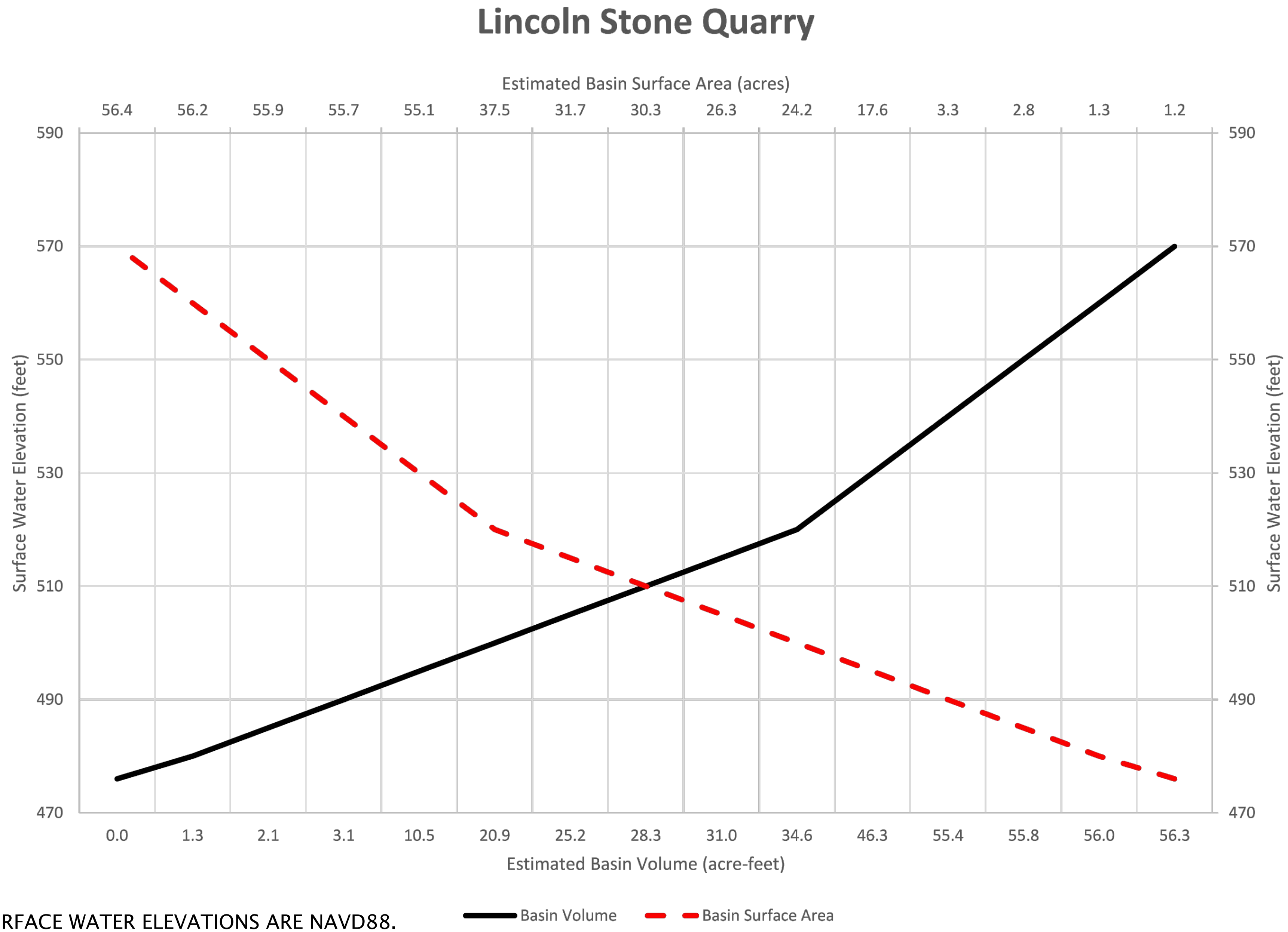
Notes: It is noted that some parameters may be combined with others within the same container.
* - The result for pH is obtained in the field and is not submitted to the laboratory.
** - Combined Radium 226/228
mL - milliliters
L - liters
°C - degrees Celsius
HNO_3 - Nitric Acid
NS- No Standard

Table 9-7. Proposed Site-Specific Groundwater Protection Standards - Joliet #9 Lincoln Stone Quarry

Upgradient Well(s)	Parameter	Section 845.600 Standards	Interwell Background Prediction Limit	**Proposed GWPS**
G45S and T03S Pooled	Antimony	0.006	0.003	**0.006**
T03S	Arsenic	0.01	0.003	**0.01**
G45S	Barium	2	0.05	**2**
G45S and T03S Pooled	Beryllium	0.004	0.001	**0.004**
G45S	Boron	2.0	1.039	**2**
G45S and T03S Pooled	Cadmium	0.005	0.001	**0.005**
G45S	Chloride	200	232.4	**232.4**
G45S and T03S Pooled	Chromium	0.1	0.005	**0.1**
G45S	Cobalt	0.006	0.001	**0.006**
T03S	Combined Radium 226 + 228 (pCi/L)	5.0	1.922	**5.0**
G45S	Fluoride	4.0	0.389	**4.0**
G45S and T03S Pooled	Lead	0.0075	0.0023	**0.0075**
G45S	Lithium	0.04	0.042	**0.042**
G45S and T03S Pooled	Mercury	0.002	0.0002	**0.002**
G45S	Molybdenum	0.10	0.014	**0.10**
G45S and T03S Pooled	pH (standard units)	6.5-9.0	6.85-7.62	**6.5-9.0**
G45S and T03S Pooled	Selenium	0.05	0.003	**0.05**
G45S	Sulfate	400	369.6	**400**
G45S and T03S Pooled	Thallium	0.002	0.002	**0.002**
G45S	Total Dissolved Solids	1200	1053	**1200**
G45S	Calcium	NE	138.4	**138.4**
G45S and T03S Pooled	Turbidity	NE	94	**94**

All values are in mg/L (ppm) unless otherwise noted.
NE - Not Established
Bold - Site-specific Groundwater Protection Standard based on Section 845.600(a)(2)

OPERATING PERMIT FIGURES



NOTES:

1. SURFACE WATER ELEVATIONS ARE NAVD88.
2. BASIN VOLUMES ARE ESTIMATED BASED ON AS-BUILT INFORMATION AND 2008 SITE TOPOGRAPHY.
3. AREA-CAPACITY CURVE CREATED BY KPRG AND ASSOCIATES, INC. AS PART OF COMPLETING THE OPERATING PERMIT N ACCORDANCE WITH TITLE 35 PART 845.

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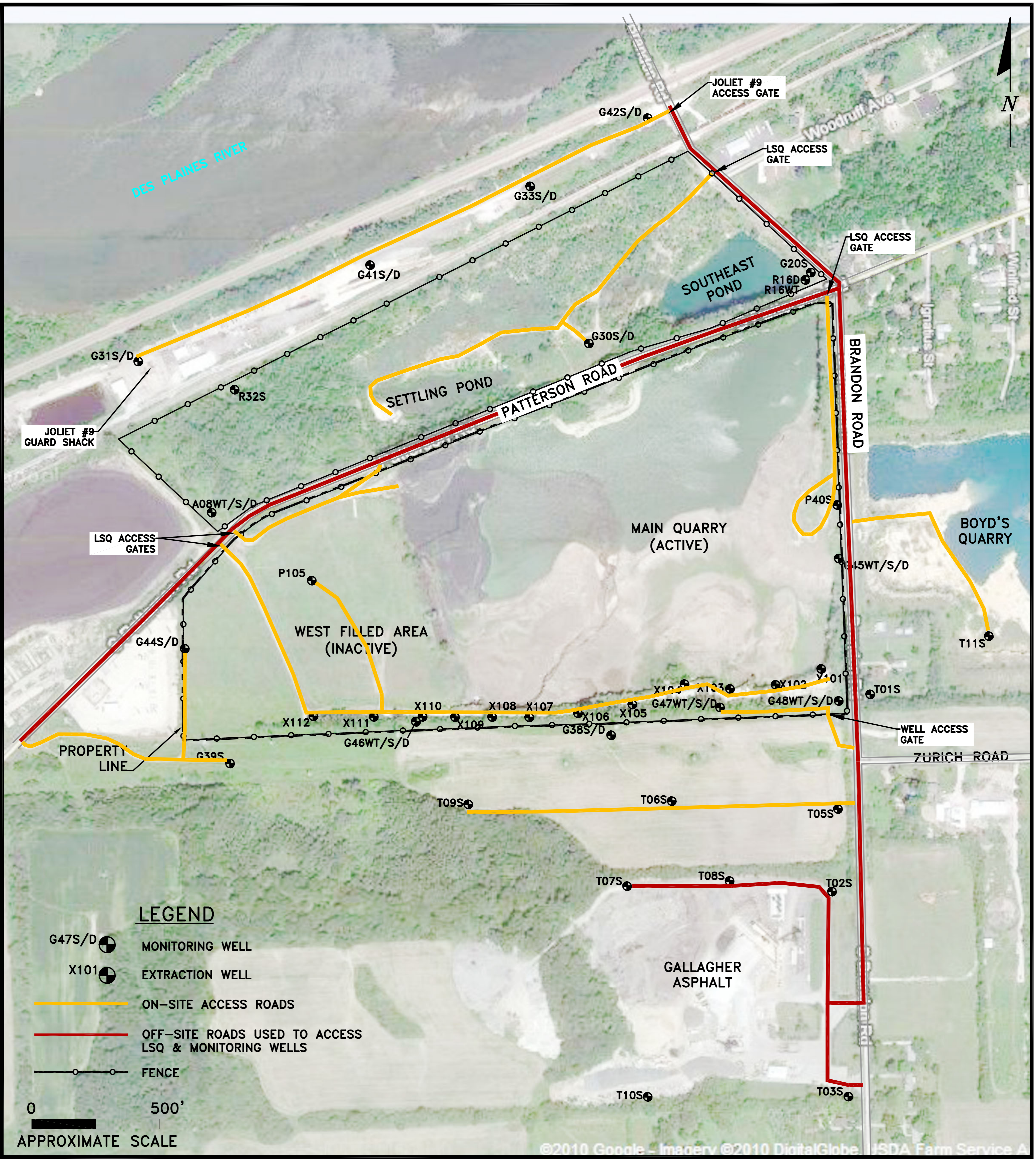
414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

LINCOLN STONE QUARRY
AREA-CAPACITY CURVE

JOLIET 9 STATION
JOLIET, ILLINOIS

Scale: NTS
Date: October 15, 2021
KPRG Project No. 19520.3
FIGURE 1

W:\projects\midwest generation\operating-constructing permits\joliet 9\area-capacity curve.dwg



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LSQ TRANSPORTATION MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

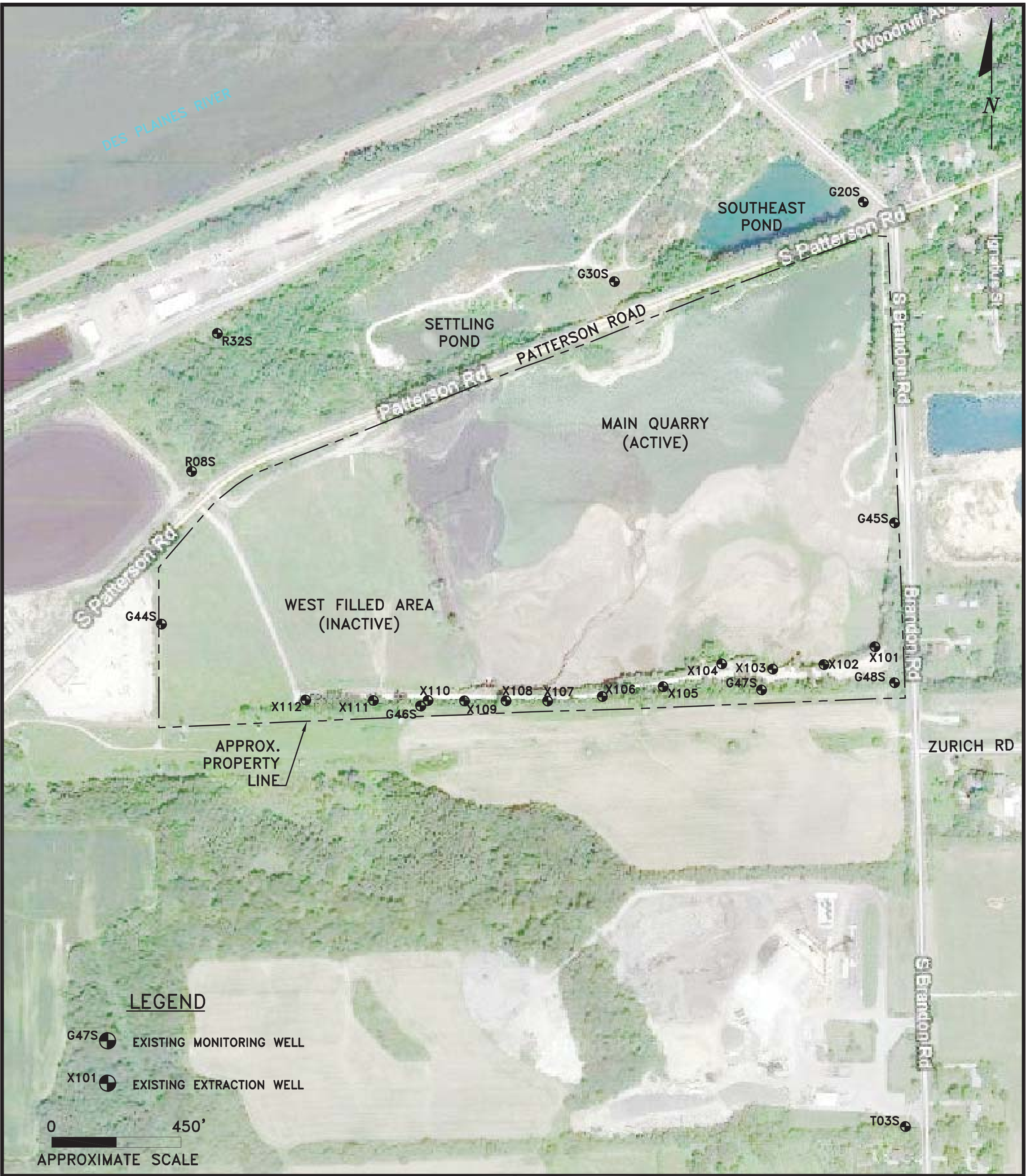
Scale: 1" = 500'

Date: January 19, 2022

KPRG Project No. 19620.4

FIGURE 2

W:\projects\midwest generation\lincoln quarry gw monitoring\permit well map 4-4-14.dwg



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CCR MONITORING WELL SITE MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

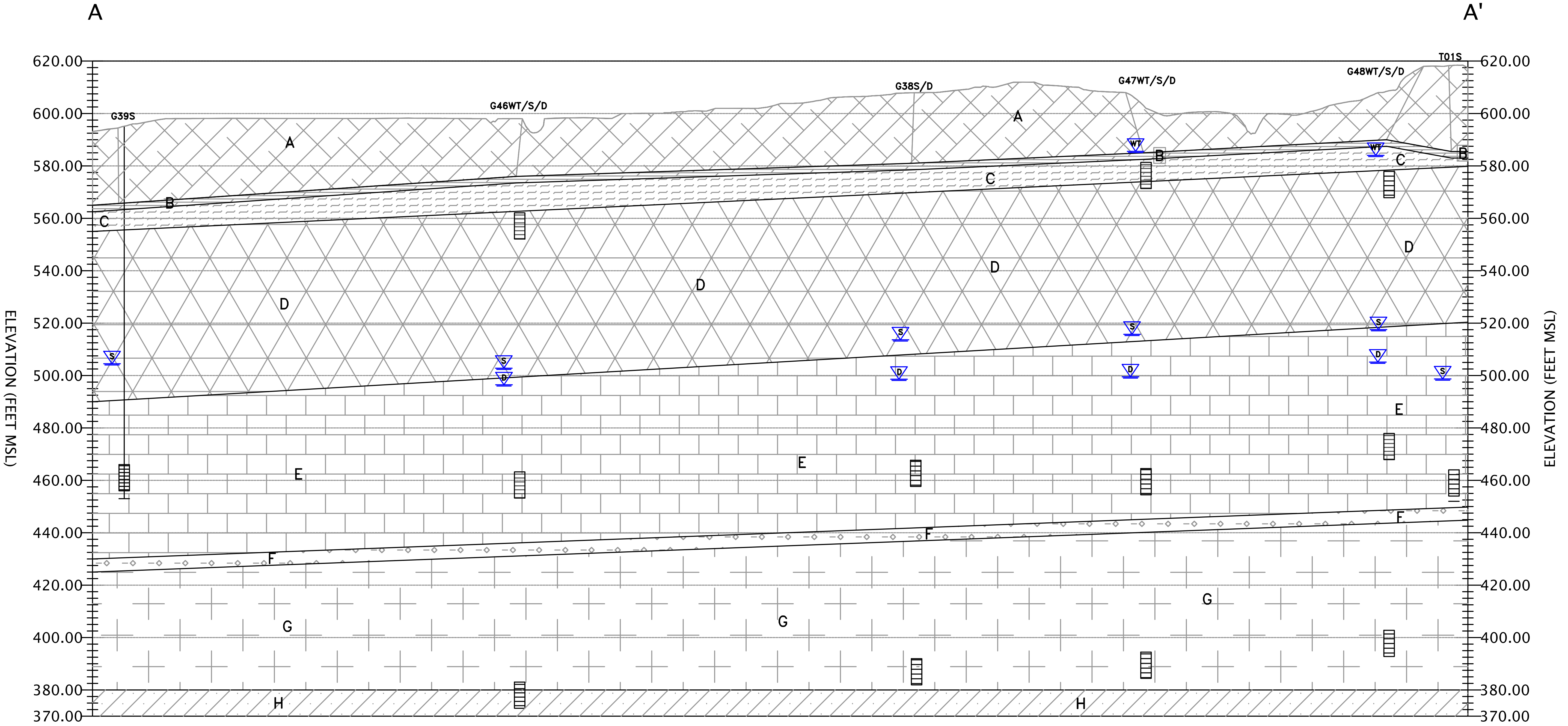
Scale: 1" = 450'

Date: January 2, 2018

KPRG Project No. 21406.12

FIGURE 9-1

W:\c\projects\midwest generation\lincoln quarry gw monitoring\permit well map 4-4-14.dwg



LEGEND

A	UNCONSOLIDATED OVERBURDEN
B	WEATHERED DOLOMITE
C	JOLIET FORMATION DOLOMITE
D	KANKAKEE FORMATION DOLOMITE
E	ELWOOD/WILHELMI DOLOMITE
F	BRAINARD SHALE
G	FORT ATKINSON DOLOMITE
H	SCALES SHALE
WT	WT-WELLS WATER LEVEL (5/21)
D	D-WELLS WATER LEVEL (5/21)
S	S-WELLS WATER LEVEL (5/21)
— — —	PROJECTED POND OUTLINE

40'
0
200'
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

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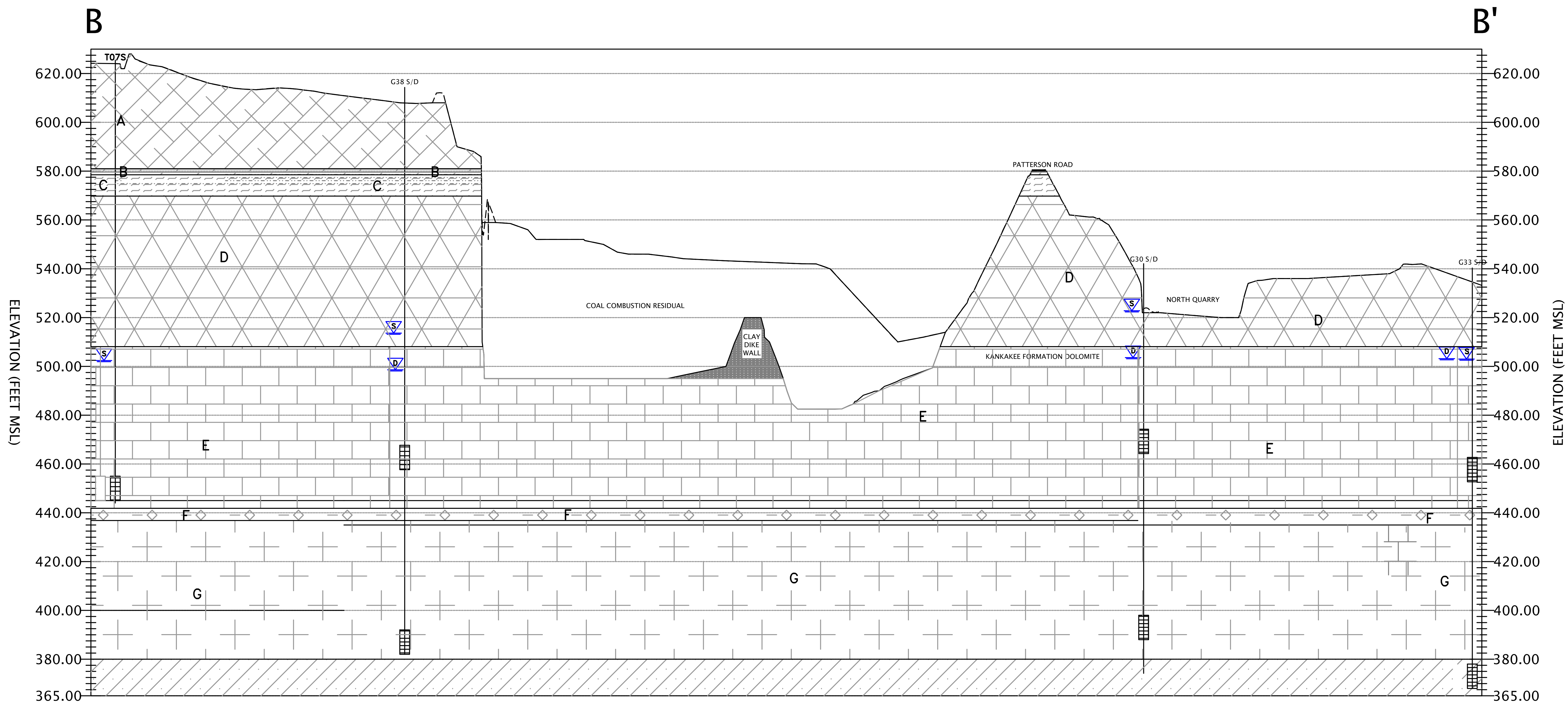
CROSS SECTION A–A'

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE
Date: October 14, 2021
KPRG Project No. 19520.4
FIGURE 9–2



LEGEND

A UNCONSOLIDATED OVERBURDEN

B WEATHERED DOLOMITE

C JOLIET FORMATION DOLOMITE

D KANKAKEE FORMATION DOLOMITE

E ELWOOD/WILHELMI DOLOMITE

F BRAINARD SHALE

G FORT ATKINSON DOLOMITE

H SCALES SHALE

WT WT–WELLS WATER LEVEL (5/21)

D D–WELLS WATER LEVEL (5/21)

S S–WELLS WATER LEVEL (5/21)

40'

200'

0

APPROXIMATE SCALE

E N V I R O N M E N T A L C O N S U L T A T I O N & R E M E D I A T I O N

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CROSS SECTION B–B'

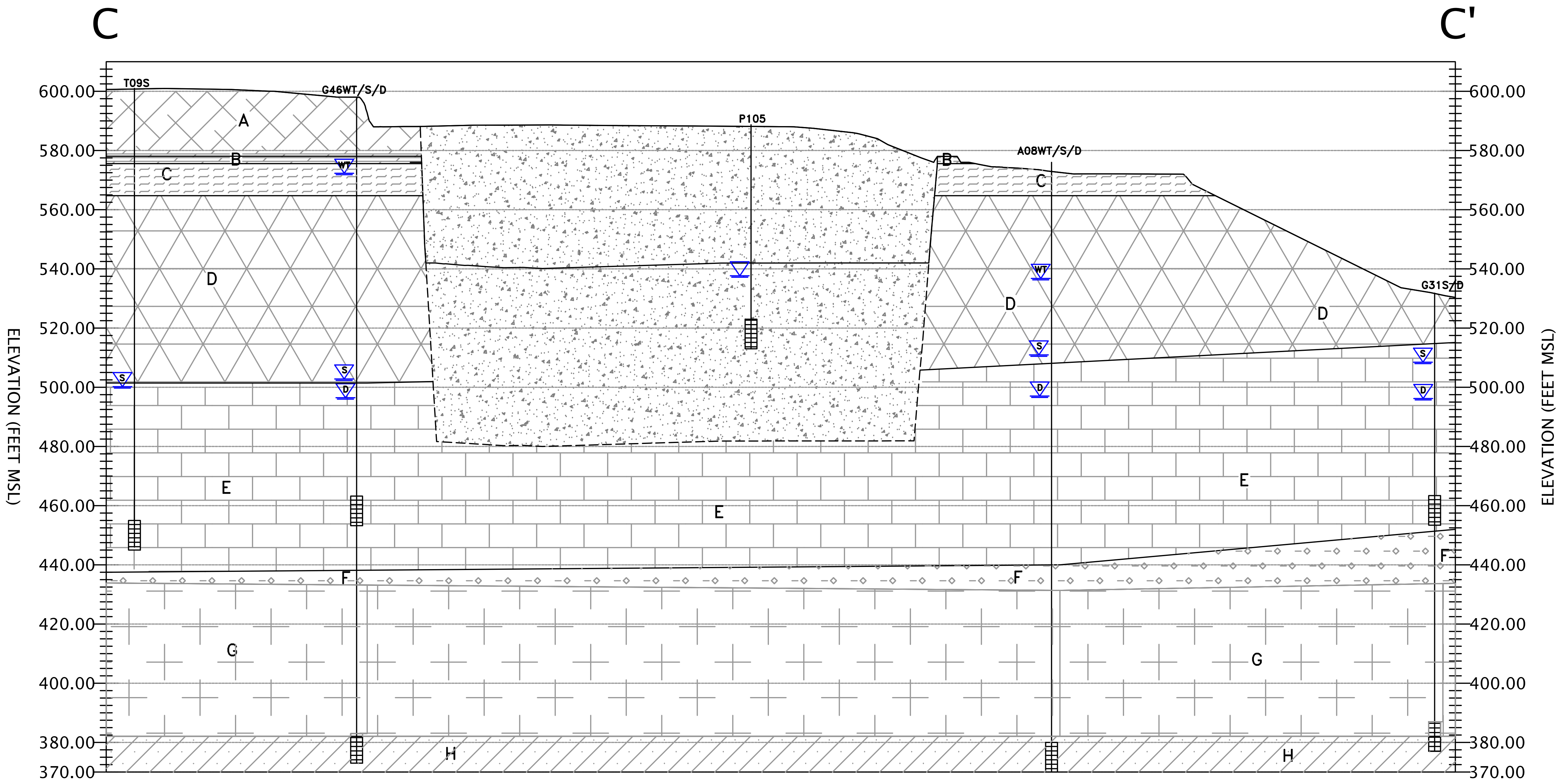
LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE

Date: October 14, 2021

KPRG Project No. 19520.4

FIGURE 9–3



LEGEND

A	UNCONSOLIDATED OVERBURDEN
B	WEATHERED DOLOMITE
C	JOLIET FORMATION DOLOMITE
D	KANKAKEE FORMATION DOLOMITE
E	ELWOOD/WILHELMI DOLOMITE
F	BRAINARD SHALE
G	FORT ATKINSON DOLOMITE
H	SCALES SHALE
WT	WT–WELLS WATER LEVEL (5/21)
D	D–WELLS WATER LEVEL (5/21)
S	S–WELLS WATER LEVEL (5/21)
- - - - - - - - - -	PROJECTED POND OUTLINE

40'
200'
0
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

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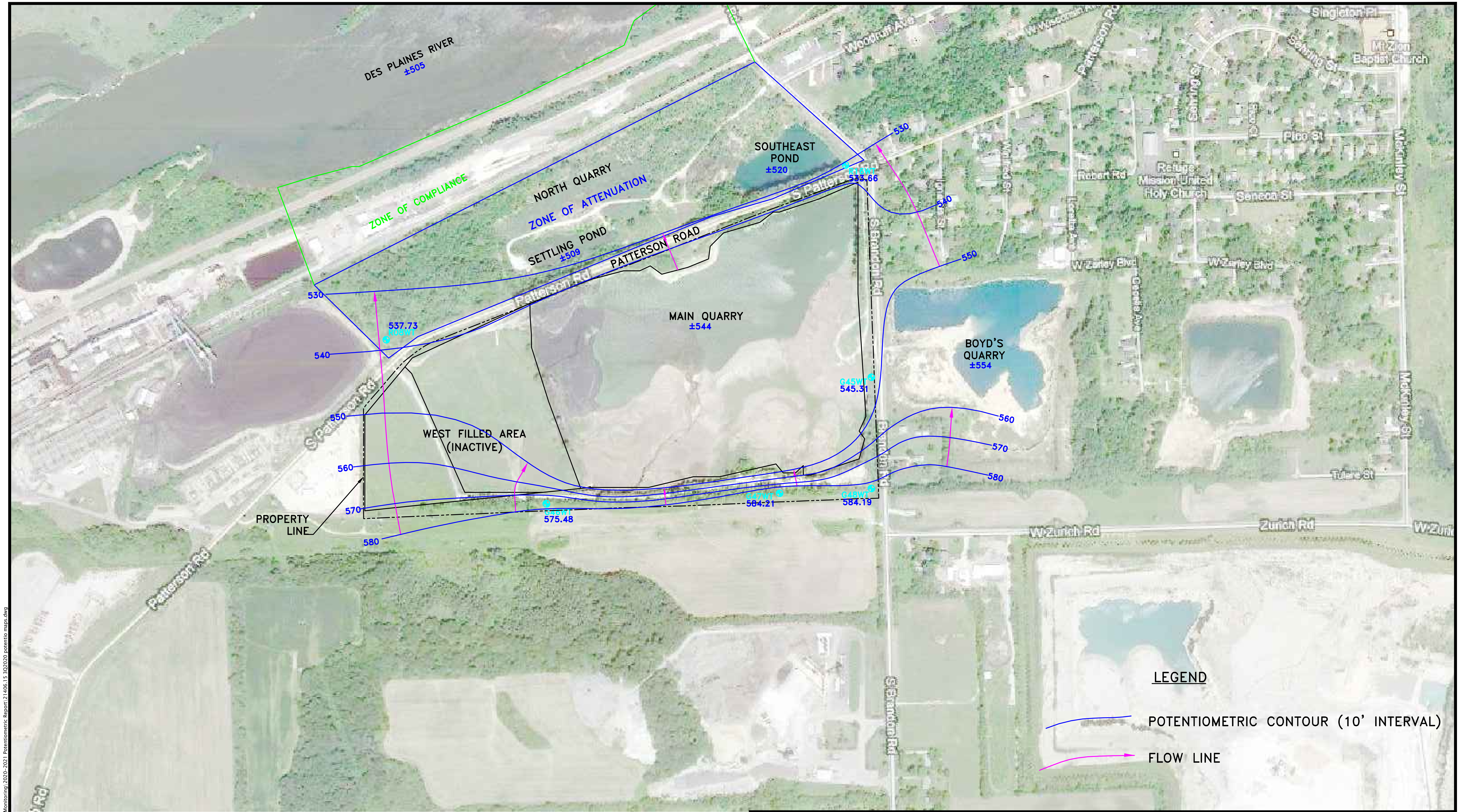
CROSS SECTION C–C'

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE
Date: October 14, 2021
KPRG Project No. 19520.4
FIGURE 9–4



Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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WATER TABLE POTENTIOMETRIC SURFACE MAP JULY/AUGUST 2020

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'

Date: June 16, 2021

KPRG Project No. 21406.15

FIGURE 9-5

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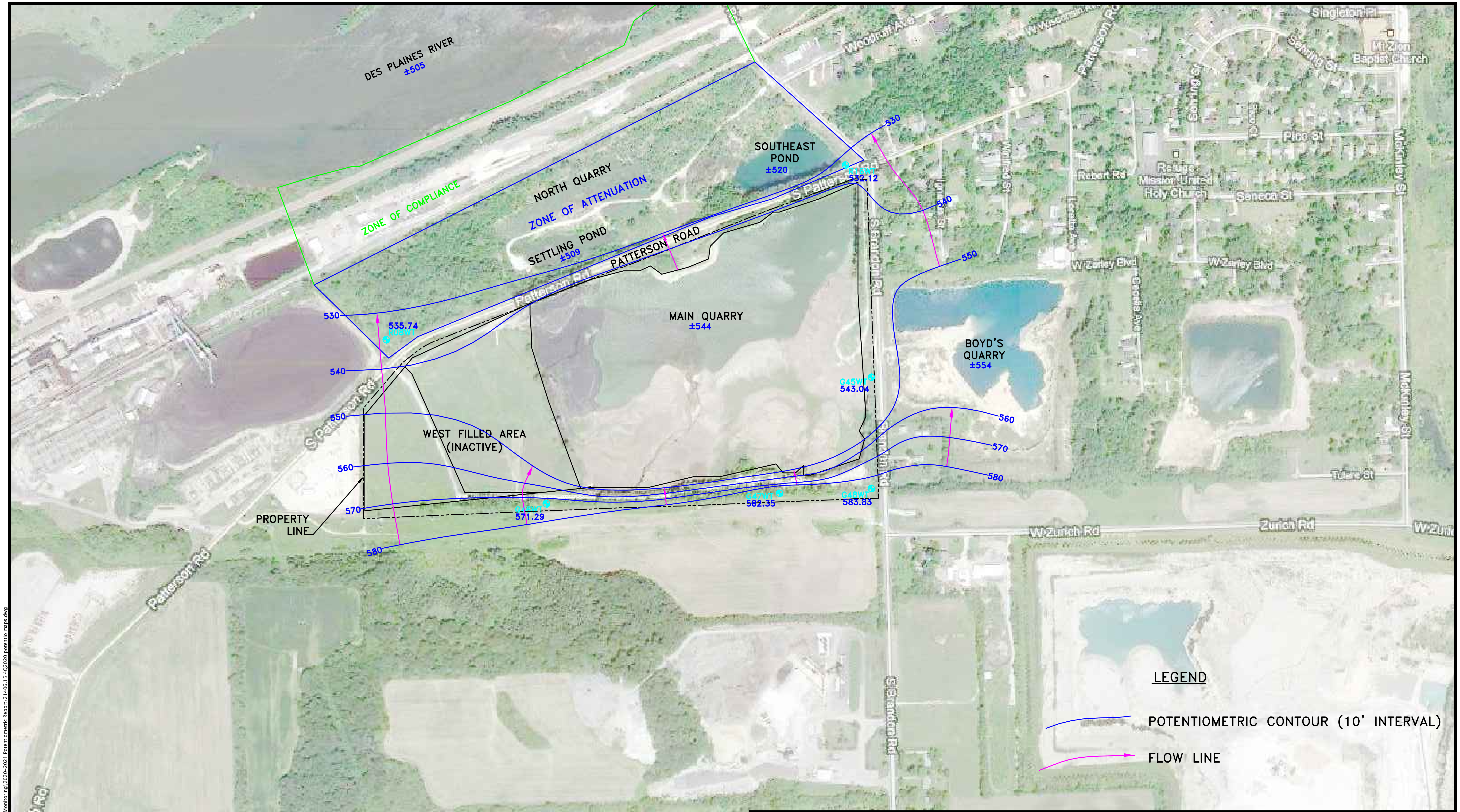
w:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 4Q2020 potentio maps.dwg



Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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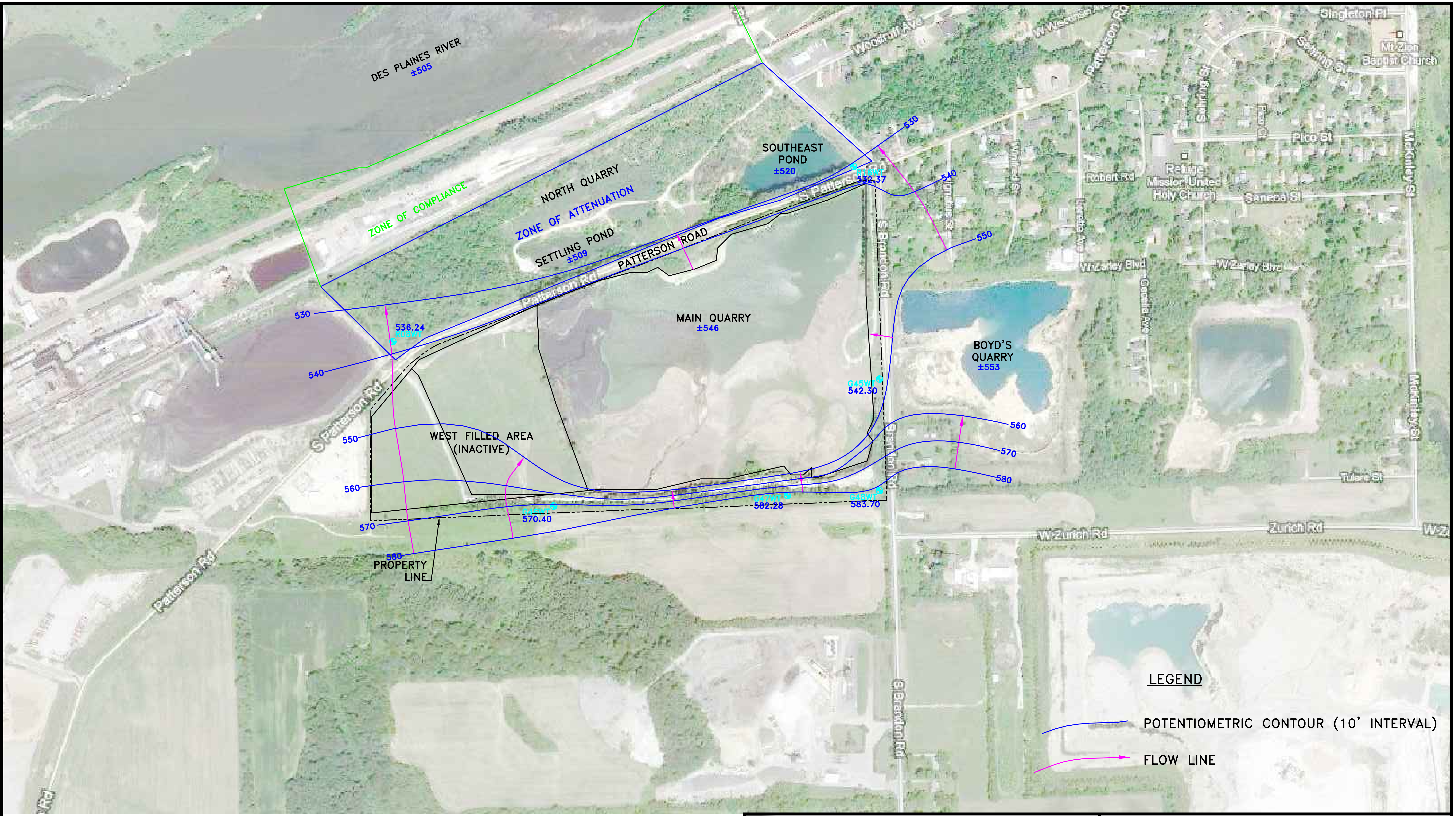
WATER TABLE POTENTIOMETRIC SURFACE MAP OCTOBER/NOVEMBER 2020

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 17, 2021

KPRG Project No. 21406.15
FIGURE 9-6



Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

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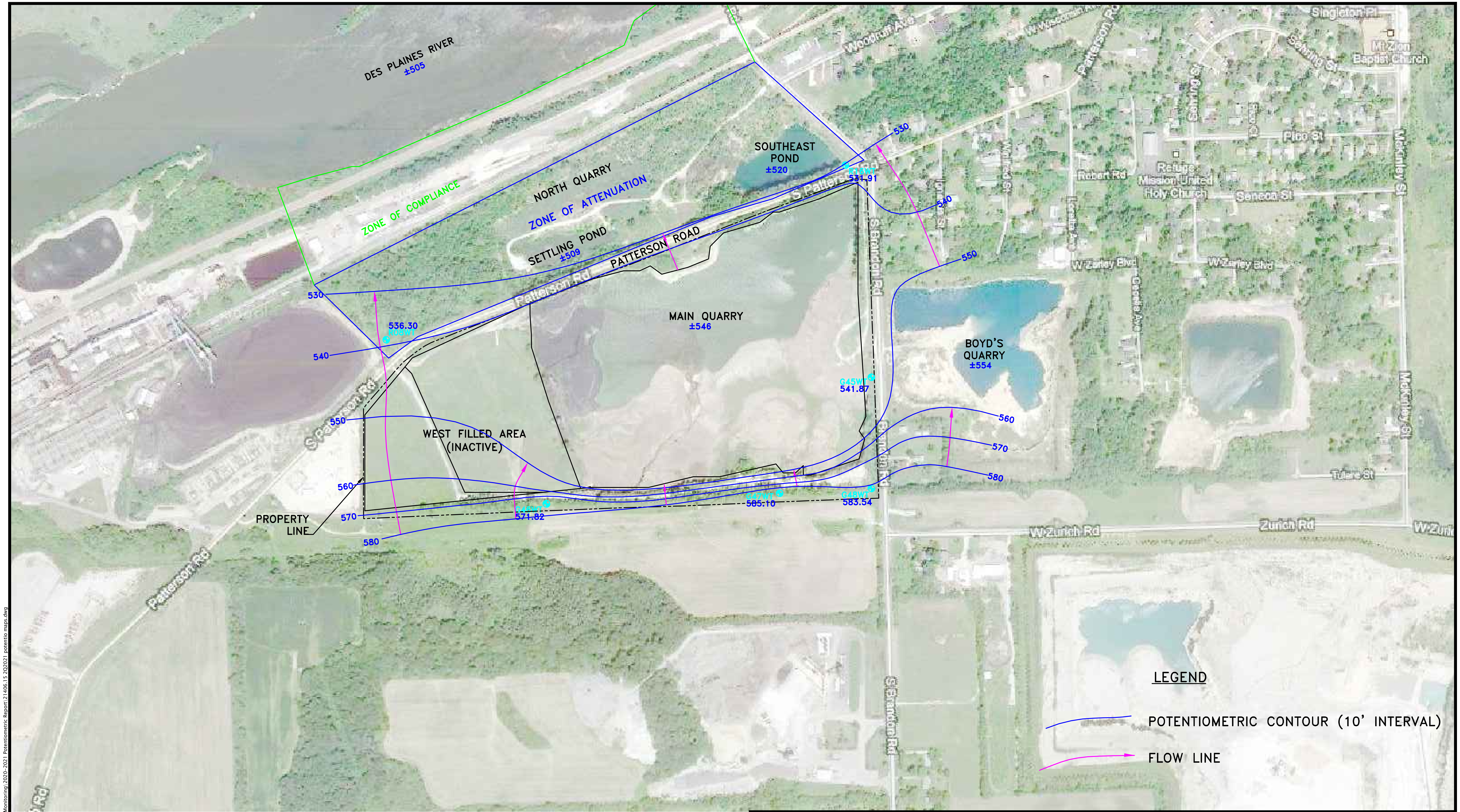
WATER TABLE POTENTIOMETRIC SURFACE MAP
JANUARY/FEBRUARY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 17, 2021
KPRG Project No. 21406.15
FIGURE 9-7

W:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 1Q2021 potentio maps.dwg



Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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WATER TABLE POTENTIOMETRIC SURFACE MAP
APRIL/MAY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 17, 2021

KPRG Project No. 21406.14
FIGURE 9-8

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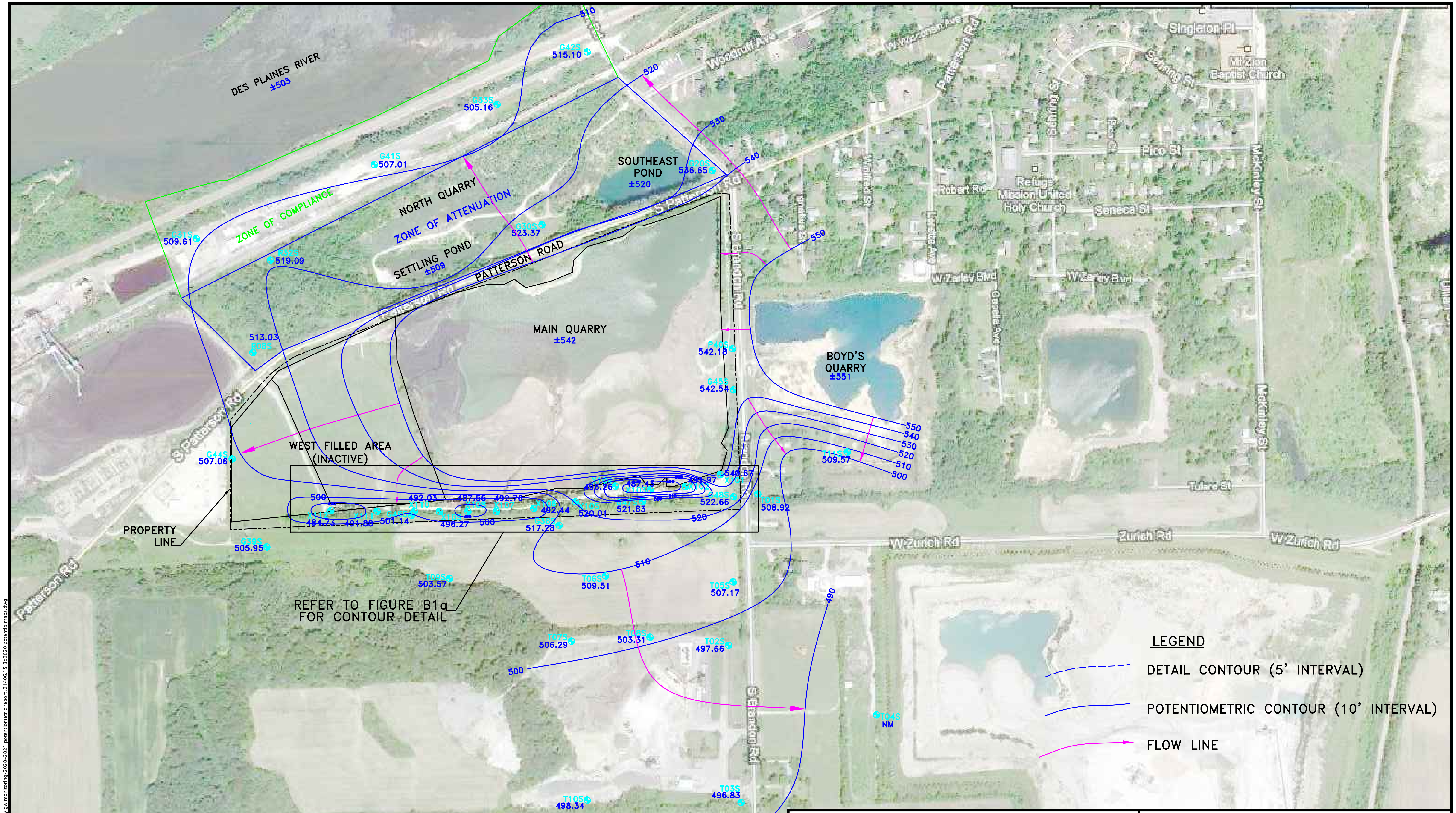

0 450'
APPROXIMATE SCALE

N

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

W:\projects\midwest generation\lincoln quarry gw monitoring\2020-2021 potentiometric report\21406.15 3q2020 potentio maps.dwg

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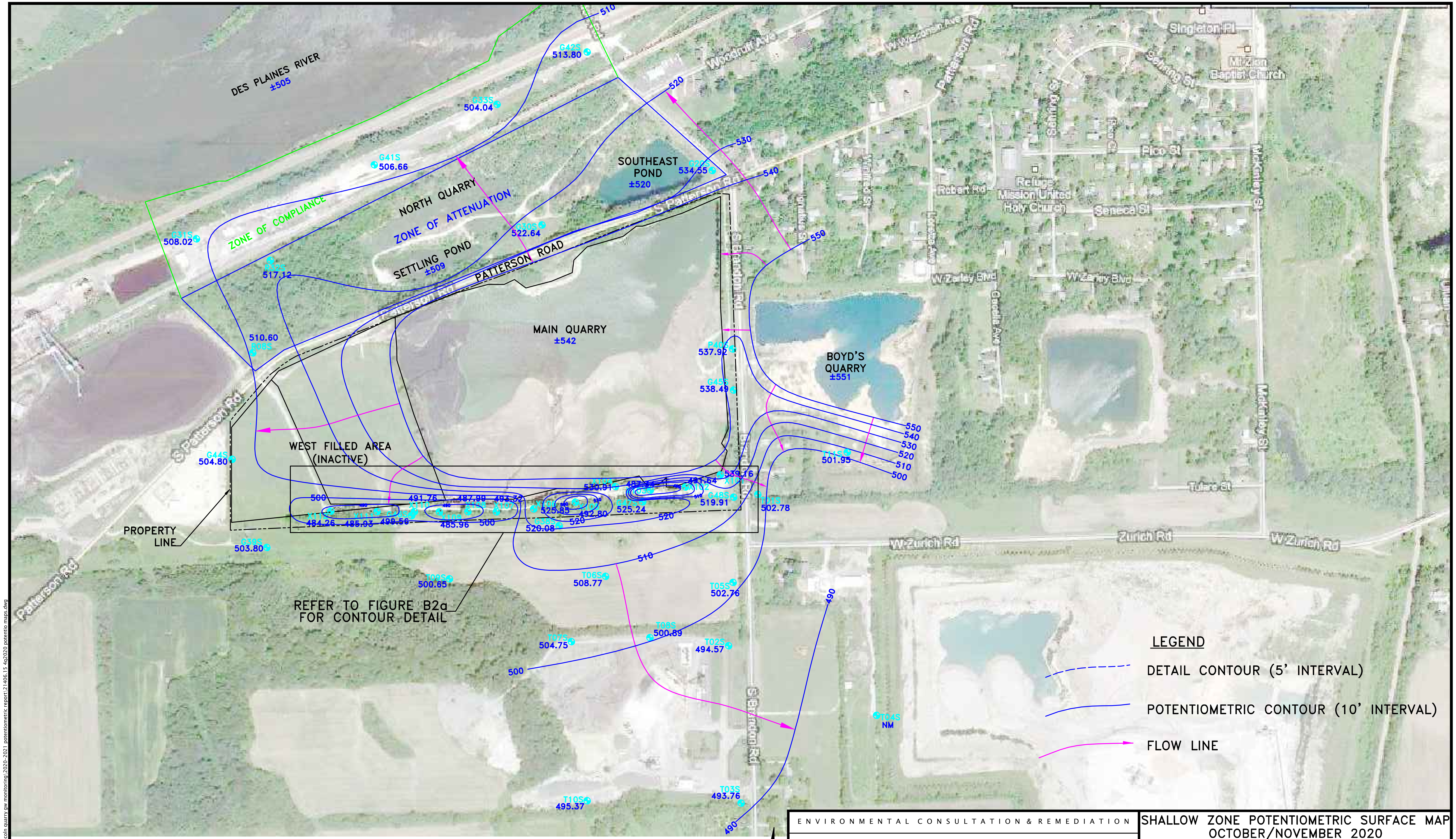
SHALLOW ZONE POTENTIOMETRIC SURFACE MAP
JULY/AUGUST 2020

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'	Date: June 23, 2021
KPRG Project No. 21406.15	FIGURE 9-9



LEGEND

DETAIL CONTOUR (5' INTERVAL)

POTENTIOMETRIC CONTOUR (10' INTERVAL)

FLOW LINE

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

W:\projects\midwest generation\lincoln quarry gw monitoring\2020-2021 potentiometric report\21406.15 4q2020 potentio maps.dwg

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SHALLOW ZONE POTENTIOMETRIC SURFACE MAP
OCTOBER/NOVEMBER 2020

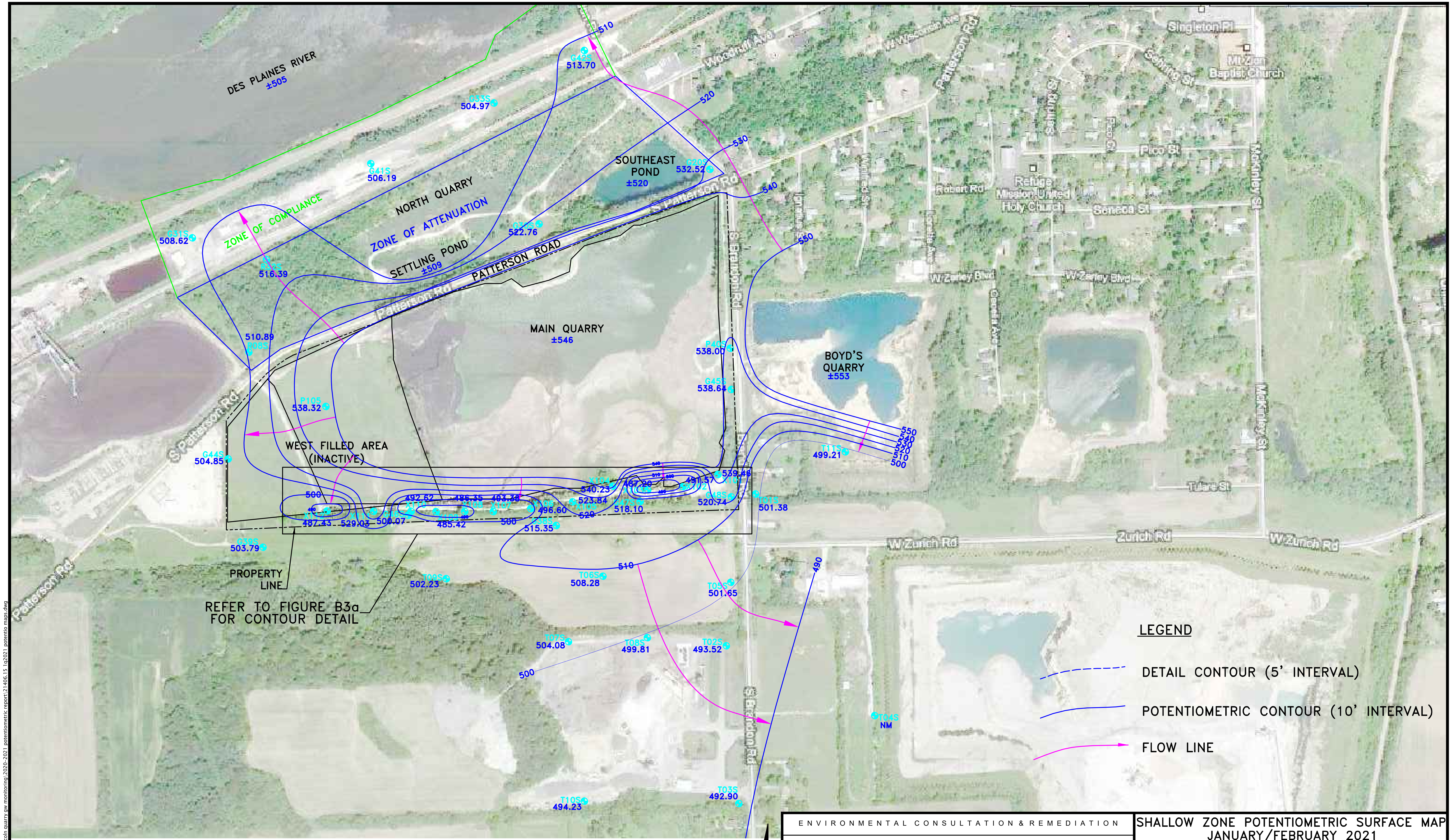
LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'

Date: June 23, 2021

KPRG Project No. 21406.15

FIGURE 9-10



0 450'

APPROXIMATE SCALE

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

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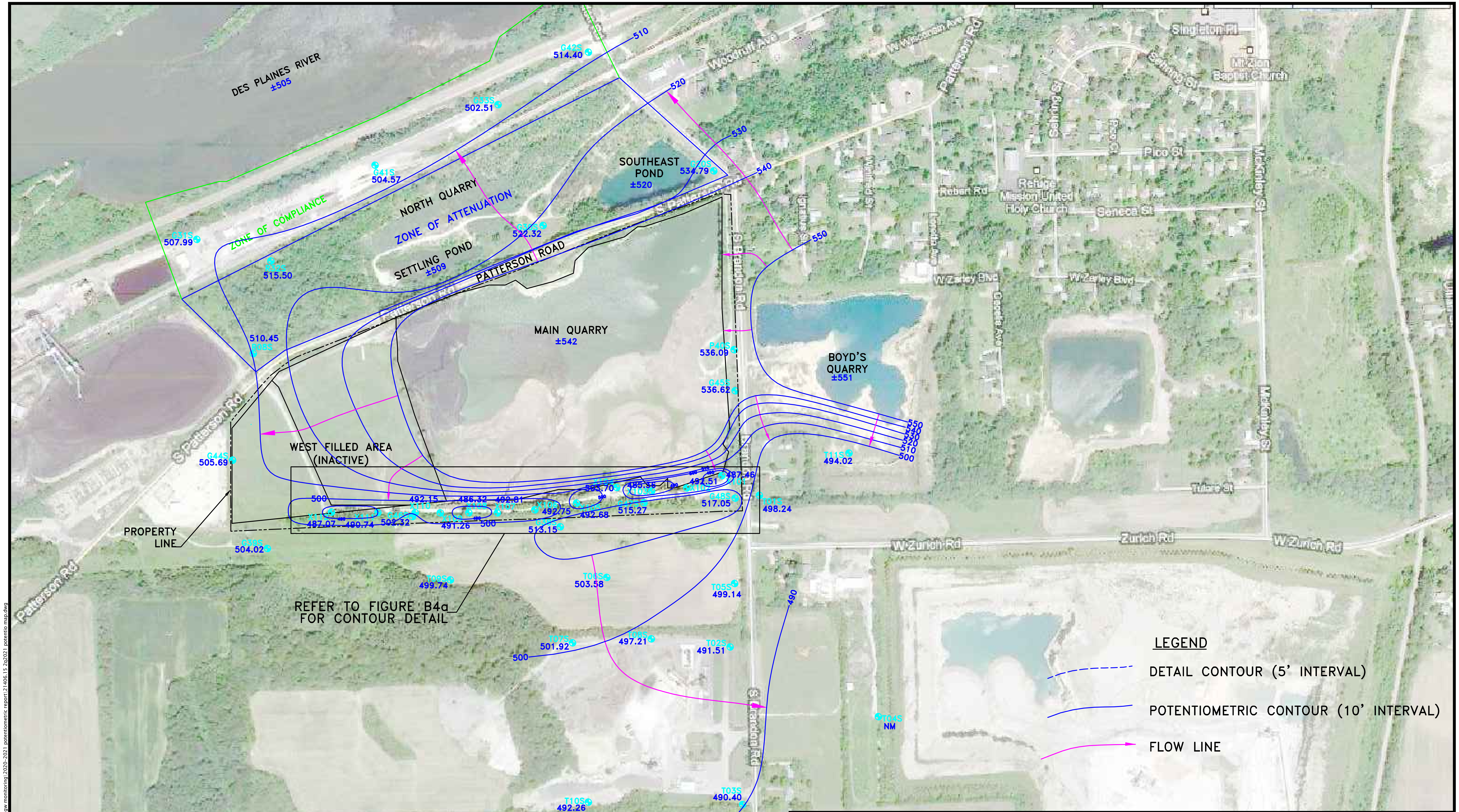
SHALLOW ZONE POTENTIOMETRIC SURFACE MAP
JANUARY/FEBRUARY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'	Date: June 23, 2021
KPRG Project No. 21406.15	FIGURE 9-11

W:\projects\midwest generation\lincoln quarry gw monitoring\2020-2021 potentiometric report\21406.15 1q2021 potentio maps.dwg



0 450'
APPROXIMATE SCALE

N

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

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SHALLOW ZONE POTENTIOMETRIC SURFACE MAP
APRIL/MAY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 22, 2021

KPRG Project No. 21406.15
FIGURE 9-12

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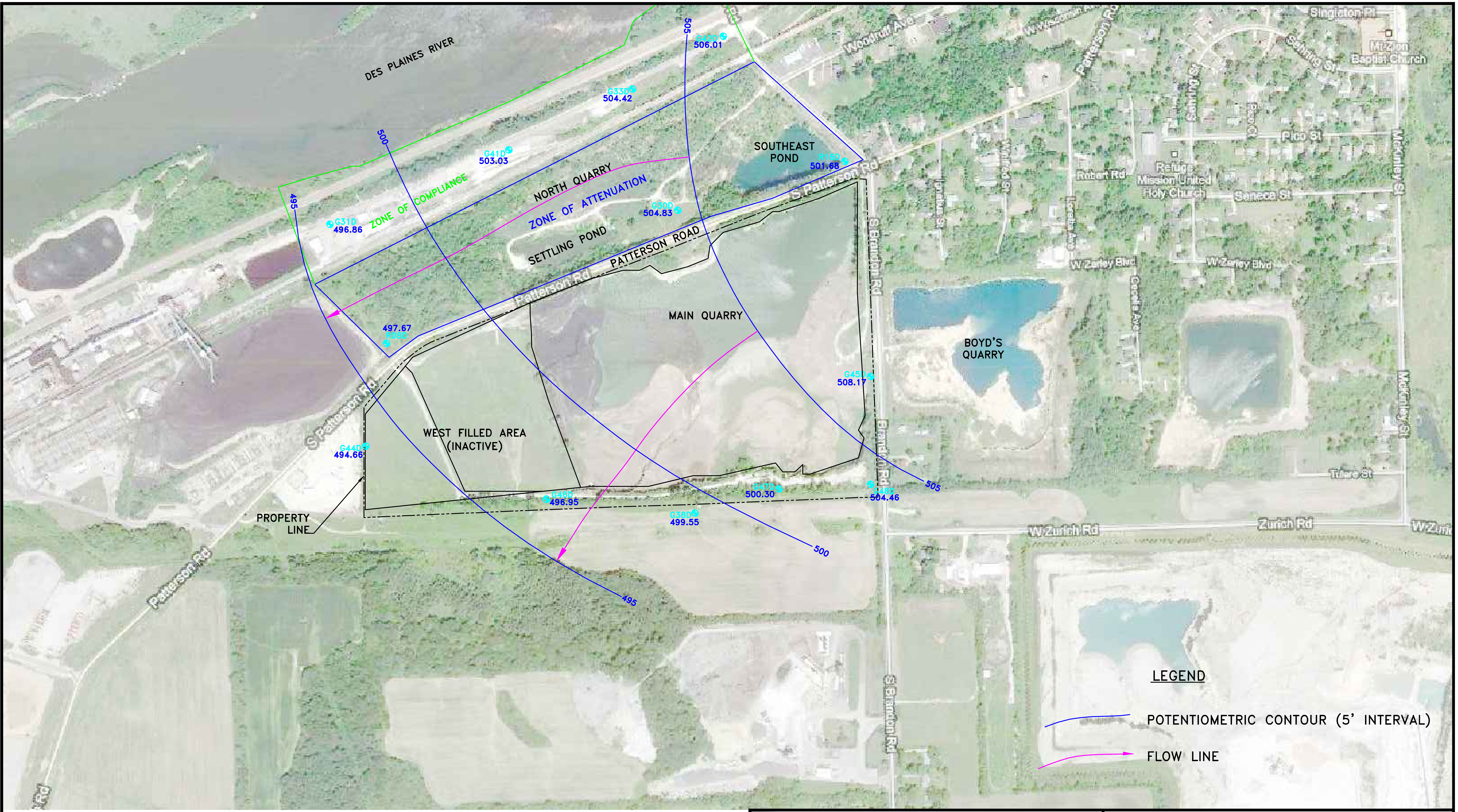

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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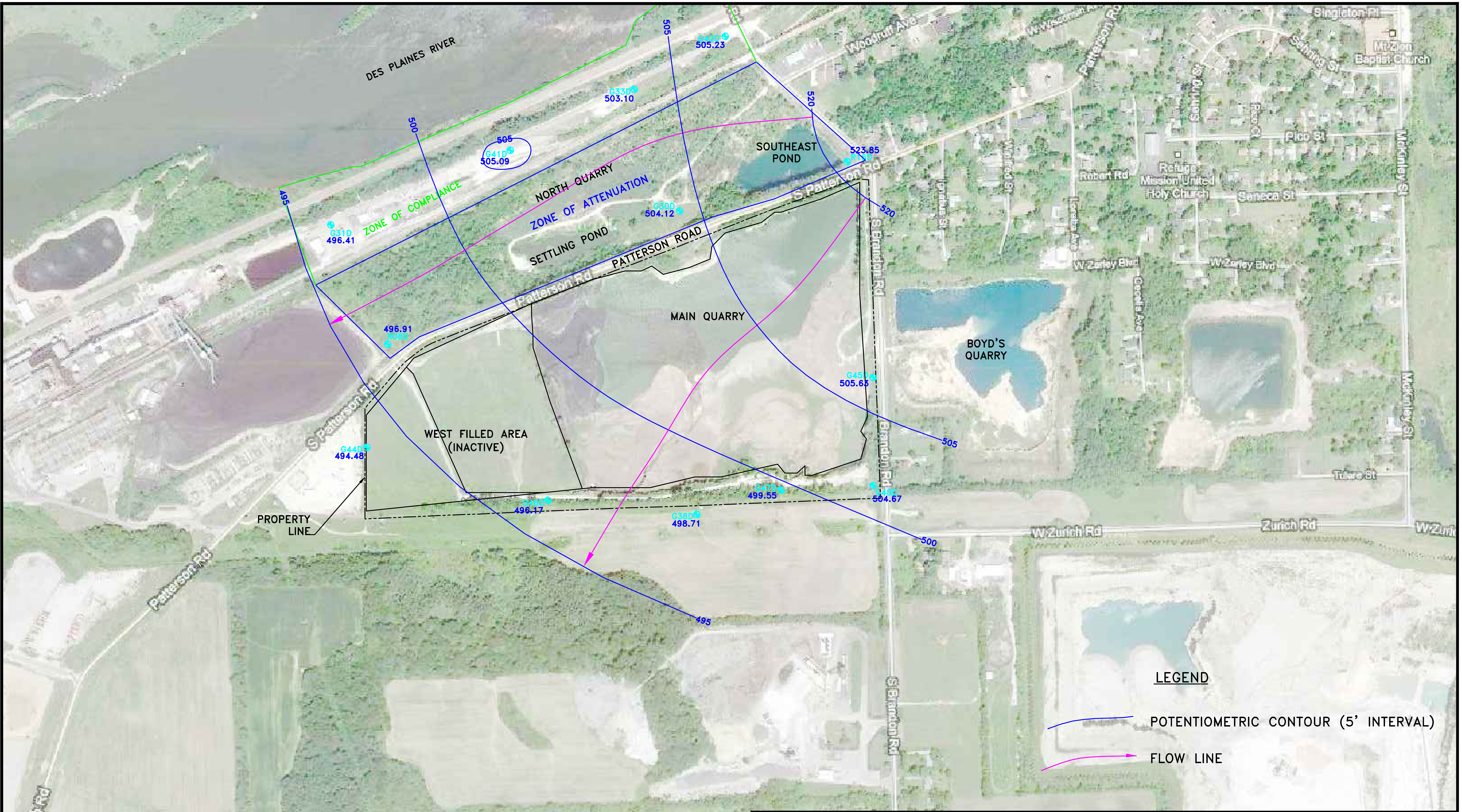
DEEP ZONE POTENTIOMETRIC SURFACE MAP
JULY/AUGUST 2020

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 16, 2021

KPRG Project No. 21406.15
FIGURE 9-13

W:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 3Q2020 Potentiometric maps.dwg



Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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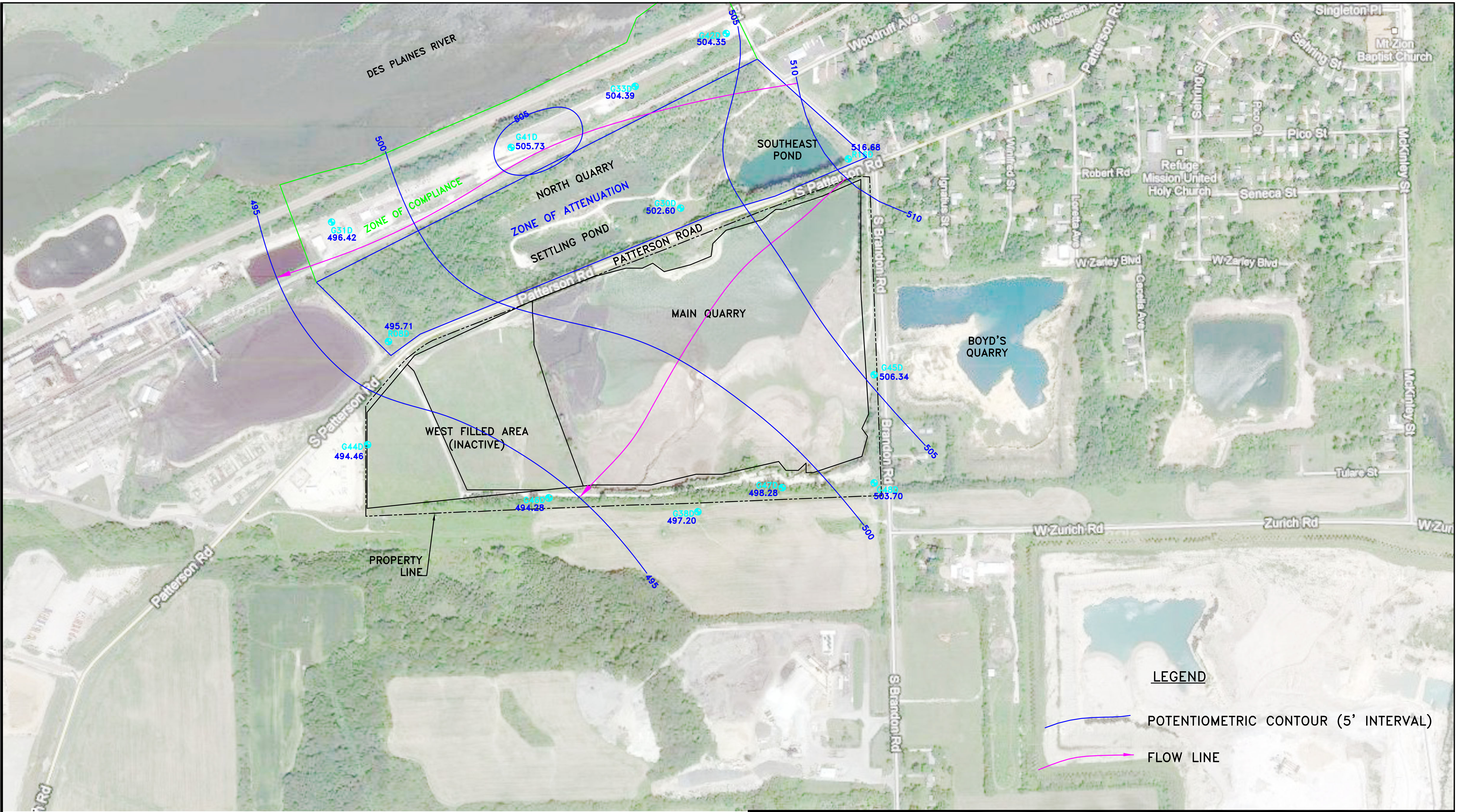
DEEP ZONE POTENTIOMETRIC SURFACE MAP
OCTOBER/NOVEMBER 2020

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: June 23, 2021
KPRG Project No. 21406.15
FIGURE 9-14

W:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 4Q2020 Potentiometric maps.dwg



LEGEND

POTENTIOMETRIC CONTOUR (5' INTERVAL)

FLOW LINE

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

ENVIRONMENTAL CONSULTATION & REMEDIATION

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DEEP ZONE POTENTIOMETRIC SURFACE MAP
JANUARY/FEBRUARY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

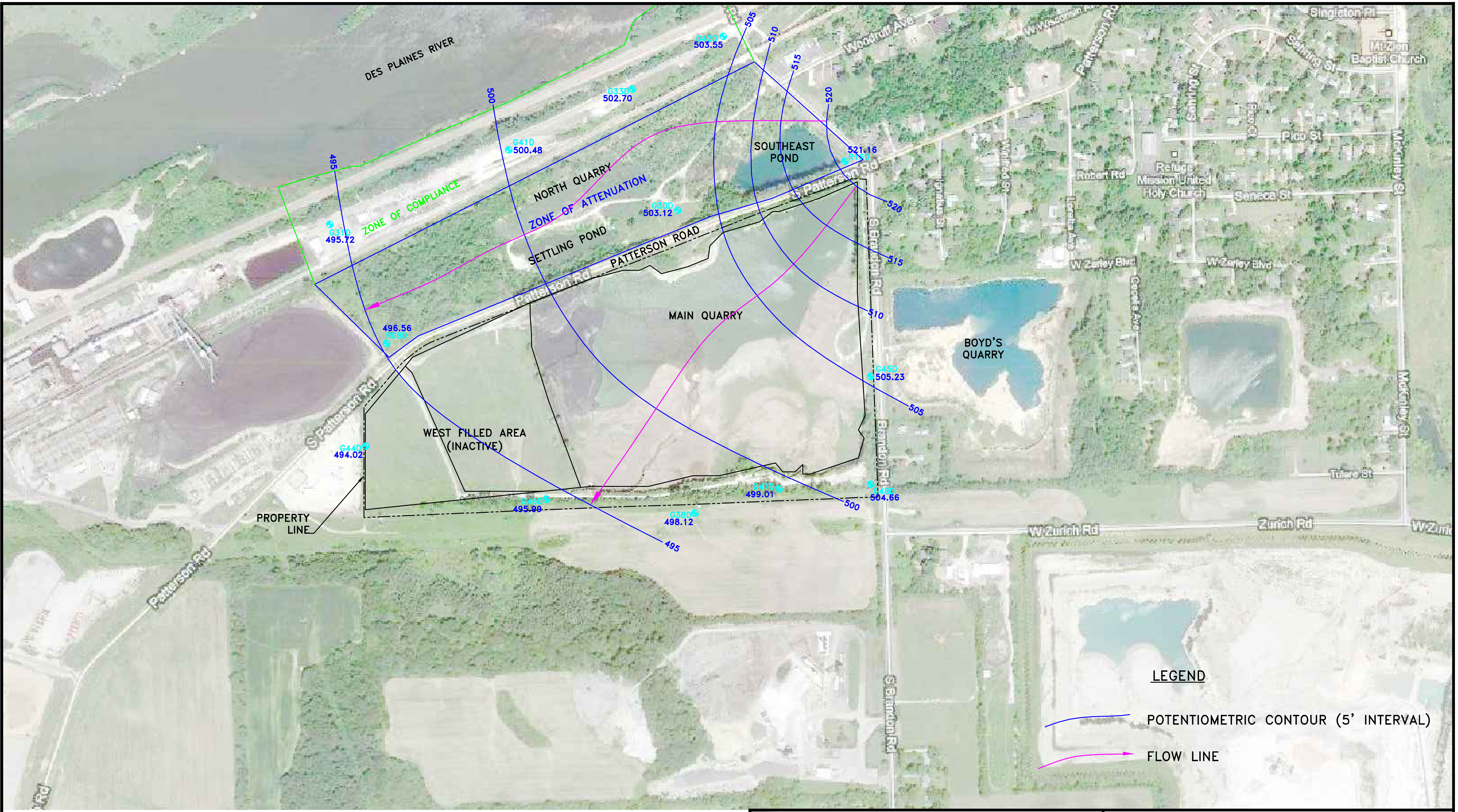
Scale: 1" = 450'

Date: June 23, 2021

KPRG Project No. 21406.15

FIGURE 9-15

W:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 1Q2021 potentio maps.dwg



LEGEND

POTENTIOMETRIC CONTOUR (5' INTERVAL)

FLOW LINE

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

ENVIRONMENTAL CONSULTATION & REMEDIATION

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DEEP ZONE POTENTIOMETRIC SURFACE MAP
APRIL/MAY 2021

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

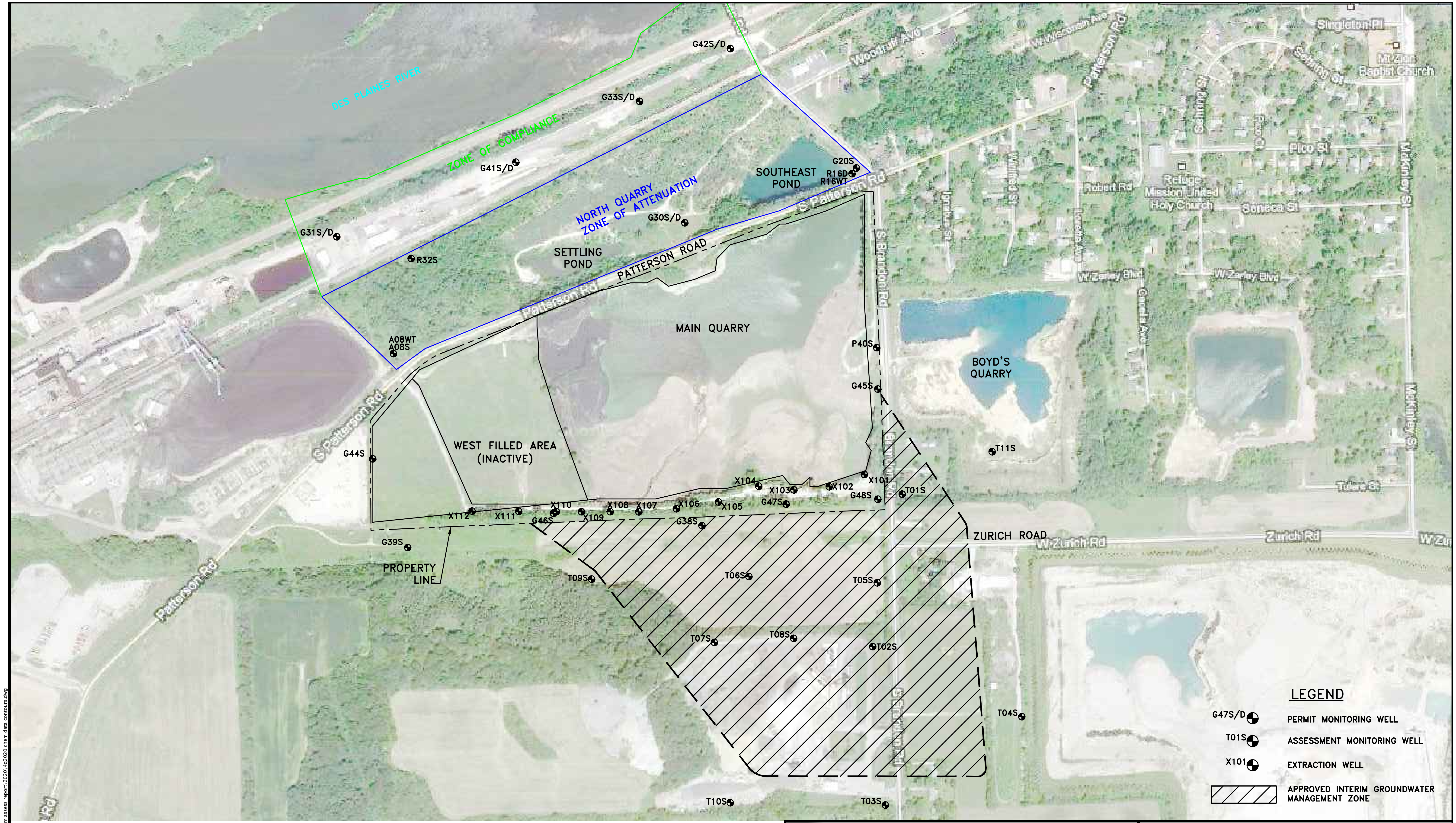
Scale: 1" = 450'

Date: June 17, 2021

KPRG Project No. 21406.15

FIGURE 9-16

W\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 2Q2021 potentio maps.dwg



W:\projects\midwest generation\extract system assess report\2020\4q2020 chem data contours.dwg

Note: WT – Water Table Well; S – Shallow Zone Well; D – Deep Zone Well

0 450'
APPROXIMATE SCALE

N

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GROUNDWATER
MANAGEMENT ZONE

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: February 22, 2021

KPRG Project No. 21406.14

FIGURE 9-17

Note: * – NO TOTAL DEPTH GIVEN

LEGEND

●	WATER WELL
42053	SHORT API WELL ID
900	TOTAL DEPTH
(A)	WELL EITHER MISLOCATED OR NO LONGER EXISTS (SEE TEXT DISCUSSION)

0 600'
APPROXIMATE SCALE

N

ENVIRONMENTAL CONSULTATION & REMEDIATION

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2500' RADIUS POTABLE WELL MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 600'
Date: September 13, 2021

KPRG Project No. 19520.4
FIGURE 9-18

w:\Projects\Midwest Generation\Lincoln Quarry GW Monitoring\2020-2021 Potentiometric Report\21406.15 4Q2020 potentio maps.dwg

OPERATING PERMIT ATTACHMENTS

ATTACHMENT 1
HISTORY OF CONSTRUCTION

GENERAL NOTES

THE SITE BENCHMARK IS LOCATED AT NORTHING 1758972.424 AND EASTING 1048071.277 WITH ELEVATION 584.19.

THE TOPOGRAPHIC MAP WAS GENERATED USING AERIAL PHOTOGRAPHY BY THE SIDWELL COMPANY IN MAY 2014.

ATTORNEY-CLIENT PRIVILEGE

EXISTING CONDITIONS LEGEND

540	EXISTING CCR CONTOURS
540	EXISTING TOPOGRAPHIC CONTOURS
	EXISTING FENCE
	EXTENT OF SURFACE WATER
○	EXISTING TREE
	EXISTING CLUSTER OF TREES/VEGETATION
	EXISTING SLUICE PIPES

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

KPRG

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

14665 West Lisbon Road, Suite 2B
Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY
CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

KPRG PROJECT NO.
19115

SHEET TITLE
1975 BOTTOM
SITE CONDITIONS

DRAWING DATE
10/29/21

DRAWING SCALE
1" = 200'

SHEET NO.
1

ATTACHMENT 2
NARRATIVE DESCRIPTION OF FACILITY

Attachment 2-1 – Joliet #9 & Joliet #29 CCR Laboratory Data Package

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-204544-1
Client Project/Site: Joliet #29 Ash

For:
KPRG and Associates, Inc.
14665 West Lisbon Road,
Suite 1A
Brookfield, Wisconsin 53005

Attn: Richard Gnat

Diana Mockler

Authorized for release by:
9/15/2021 5:41:59 PM

Diana Mockler, Project Manager I
(219)252-7570
Diana.Mockler@Eurofinset.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Job ID: 500-204544-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-204544-1

Comments

No additional comments.

Receipt

The sample was received on 8/31/2021 1:00 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 22.4º C.

Metals

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Method Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CHI
7471A	Mercury (CVAA)	SW846	TAL CHI
9056A	Anions, Ion Chromatography	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
SM 4500 Cl- E	Chloride, Total	SM	TAL CHI
SM 4500 F C	Fluoride	SM	TAL CHI
300_Prep	Anions, Ion Chromatography, 10% Wt/Vol	MCAWW	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
7471A	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
500-204544-1	Jolet #29 Ash	Solid	08/31/21 10:00	08/31/21 13:00

Client Sample Results

Client Sample ID: Jolet #29 Ash

Lab Sample ID: 500-204544-1

Date Collected: 08/31/21 10:00

Matrix: Solid

Date Received: 08/31/21 13:00

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<1.8	F1	1.8		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Arsenic	**1.5**	**F1**	0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Barium	**3000**		4.4		mg/Kg		09/10/21 08:41	09/13/21 21:10	5
Beryllium	**1.5**	**F1**	0.35		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Boron	**130**	**F1 V**	4.4		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Cadmium	<0.18		0.18		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Calcium	**100000**		89		mg/Kg		09/10/21 08:41	09/13/21 21:10	5
Chromium	**12**	**F1**	0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Cobalt	**15**		11		mg/Kg		09/10/21 08:41	09/14/21 10:57	25
Lead	**5.6**		0.44		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Lithium	**20**	**V**	0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Molybdenum	**1.1**	**F1**	0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Selenium	<0.89	F1	0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1
Thallium	**2.9**		0.89		mg/Kg		09/10/21 08:41	09/12/21 15:18	1

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.016		0.016		mg/Kg		09/09/21 13:15	09/10/21 09:11	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	**560**		19		mg/Kg		09/14/21 11:45	09/14/21 17:58	10
Chloride	<20		20		mg/Kg		09/15/21 09:49	09/15/21 15:04	1
Fluoride	<1.0		1.0		mg/Kg		09/15/21 09:49	09/15/21 12:47	1

Definitions/Glossary

Qualifiers

Metals

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
F1	MS and/or MSD recovery exceeds control limits.
F3	Duplicate RPD exceeds the control limit
F5	Duplicate RPD exceeds limit, and one or both sample results are less than 5 times RL, and the absolute difference between results is < the upper reporting limits for both.
V	Serial Dilution exceeds the control limits

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

QC Association Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Metals

Prep Batch: 617888

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	7471A	
MB 500-617888/12-A	Method Blank	Total/NA	Solid	7471A	
LCS 500-617888/13-A	Lab Control Sample	Total/NA	Solid	7471A	

Prep Batch: 618052

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	3050B	
MB 500-618052/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-618052/2-A	Lab Control Sample	Total/NA	Solid	3050B	
500-204544-1 MS	Jolet #29 Ash	Total/NA	Solid	3050B	
500-204544-1 MSD	Jolet #29 Ash	Total/NA	Solid	3050B	
500-204544-1 DU	Jolet #29 Ash	Total/NA	Solid	3050B	

Analysis Batch: 618070

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	7471A	617888
MB 500-617888/12-A	Method Blank	Total/NA	Solid	7471A	617888
LCS 500-617888/13-A	Lab Control Sample	Total/NA	Solid	7471A	617888

Analysis Batch: 618247

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	6010B	618052
MB 500-618052/1-A	Method Blank	Total/NA	Solid	6010B	618052
LCS 500-618052/2-A	Lab Control Sample	Total/NA	Solid	6010B	618052
500-204544-1 MS	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 MSD	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 DU	Jolet #29 Ash	Total/NA	Solid	6010B	618052

Analysis Batch: 618479

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 MS	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 MSD	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 DU	Jolet #29 Ash	Total/NA	Solid	6010B	618052

Analysis Batch: 618576

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 MS	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 MSD	Jolet #29 Ash	Total/NA	Solid	6010B	618052
500-204544-1 DU	Jolet #29 Ash	Total/NA	Solid	6010B	618052

General Chemistry

Analysis Batch: 617356

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	Moisture	

Prep Batch: 618524

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	300_Prep	

General Chemistry (Continued)

Prep Batch: 618524 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-618524/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-618524/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	

Analysis Batch: 618534

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	9056A	618524
MB 500-618524/1-A	Method Blank	Total/NA	Solid	9056A	618524
LCS 500-618524/2-A	Lab Control Sample	Total/NA	Solid	9056A	618524

Prep Batch: 618692

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	300_Prep	
MB 500-618692/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	

Analysis Batch: 618739

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	SM 4500 F C	618692
MB 500-618692/1-A	Method Blank	Total/NA	Solid	SM 4500 F C	618692
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	SM 4500 F C	618692

Analysis Batch: 618775

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	SM 4500 Cl- E	618692
MB 500-618692/1-A	Method Blank	Total/NA	Solid	SM 4500 Cl- E	618692
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	SM 4500 Cl- E	618692

QC Sample Results

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 500-618052/1-A
Matrix: Solid
Analysis Batch: 618247

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618052

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<2.0		2.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Arsenic	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Barium	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Beryllium	<0.40		0.40		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Boron	<5.0		5.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Cadmium	<0.20		0.20		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Calcium	<20		20		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Chromium	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Cobalt	<0.50		0.50		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Lead	<0.50		0.50		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Lithium	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Molybdenum	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Selenium	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1
Thallium	<1.0		1.0		mg/Kg		09/10/21 08:41	09/12/21 15:12	1

Lab Sample ID: LCS 500-618052/2-A
Matrix: Solid
Analysis Batch: 618247

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	50.0	49.5		mg/Kg		99	80 - 120
Arsenic	10.0	9.09		mg/Kg		91	80 - 120
Barium	200	196		mg/Kg		98	80 - 120
Beryllium	5.00	4.54		mg/Kg		91	80 - 120
Boron	100	83.6		mg/Kg		84	80 - 120
Cadmium	5.00	4.69		mg/Kg		94	80 - 120
Calcium	1000	912		mg/Kg		91	80 - 120
Chromium	20.0	18.3		mg/Kg		91	80 - 120
Cobalt	50.0	46.6		mg/Kg		93	80 - 120
Lead	10.0	9.03		mg/Kg		90	80 - 120
Lithium	50.0	53.2		mg/Kg		106	80 - 120
Molybdenum	100	99.6		mg/Kg		100	80 - 120
Selenium	10.0	8.61		mg/Kg		86	80 - 120
Thallium	10.0	8.77		mg/Kg		88	80 - 120

Lab Sample ID: 500-204544-1 MS
Matrix: Solid
Analysis Batch: 618247

Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	<1.8	F1	49.6	6.04	F1	mg/Kg		12	75 - 125
Arsenic	1.5	F1	9.92	9.59		mg/Kg		81	75 - 125
Beryllium	1.5	F1	4.96	5.09	F1	mg/Kg		72	75 - 125
Boron	130	F1 V	99.2	178	F1	mg/Kg		50	75 - 125
Cadmium	<0.18		4.96	3.82		mg/Kg		75	75 - 125
Chromium	12	F1	19.8	24.8	F1	mg/Kg		67	75 - 125
Lead	5.6		9.92	16.2		mg/Kg		107	75 - 125
Lithium	20	V	49.6	62.1		mg/Kg		85	75 - 125
Molybdenum	1.1	F1	99.2	68.4	F1	mg/Kg		68	75 - 125

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: 500-204544-1 MS
Matrix: Solid
Analysis Batch: 618247
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Selenium	<0.89	F1	9.92	6.39	F1	mg/Kg		64	75 - 125
Thallium	2.9		9.92	10.9		mg/Kg		80	75 - 125

Lab Sample ID: 500-204544-1 MS
Matrix: Solid
Analysis Batch: 618479
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Barium	3000		198	2980	4	mg/Kg		11	75 - 125
Calcium	100000		992	97600	4	mg/Kg		-533	75 - 125

Lab Sample ID: 500-204544-1 MS
Matrix: Solid
Analysis Batch: 618576
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Cobalt	15		49.6	67.5		mg/Kg		105	75 - 125

Lab Sample ID: 500-204544-1 MSD
Matrix: Solid
Analysis Batch: 618247
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Antimony	<1.8	F1	45.0	4.97	F1	mg/Kg		11	75 - 125	19	20
Arsenic	1.5	F1	9.01	8.21	F1	mg/Kg		74	75 - 125	16	20
Beryllium	1.5	F1	4.50	4.74	F1	mg/Kg		72	75 - 125	7	20
Boron	130	F1 V	90.1	183	F1	mg/Kg		61	75 - 125	3	20
Cadmium	<0.18		4.50	3.56		mg/Kg		77	75 - 125	7	20
Chromium	12	F1	18.0	23.7	F1	mg/Kg		67	75 - 125	4	20
Lead	5.6		9.01	14.4		mg/Kg		98	75 - 125	12	20
Lithium	20	V	45.0	57.0		mg/Kg		82	75 - 125	9	20
Molybdenum	1.1	F1	90.1	59.6	F1	mg/Kg		65	75 - 125	14	20
Selenium	<0.89	F1	9.01	5.78	F1	mg/Kg		64	75 - 125	10	20
Thallium	2.9		9.01	10.6		mg/Kg		85	75 - 125	3	20

Lab Sample ID: 500-204544-1 MSD
Matrix: Solid
Analysis Batch: 618479
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Barium	3000		180	3090	4	mg/Kg		74	75 - 125	4	20
Calcium	100000		901	104000	4	mg/Kg		99	75 - 125	6	20

Lab Sample ID: 500-204544-1 MSD
Matrix: Solid
Analysis Batch: 618576
Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Cobalt	15		45.0	58.0		mg/Kg		95	75 - 125	15	20

QC Sample Results

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: 500-204544-1 DU
Matrix: Solid
Analysis Batch: 618247

Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Antimony	<1.8	F1	<1.8		mg/Kg		NC	20
Arsenic	1.5	F1	2.20	F5	mg/Kg		36	20
Beryllium	1.5	F1	1.48		mg/Kg		2	20
Boron	130	F1 V	118		mg/Kg		9	20
Cadmium	<0.18		0.195		mg/Kg		NC	20
Chromium	12	F1	11.3		mg/Kg		2	20
Lead	5.6		5.71		mg/Kg		2	20
Lithium	20	V	19.9		mg/Kg		0	20
Molybdenum	1.1	F1	1.20		mg/Kg		8	20
Selenium	<0.89	F1	<0.90		mg/Kg		NC	20
Thallium	2.9		1.94	F3	mg/Kg		41	20

Lab Sample ID: 500-204544-1 DU
Matrix: Solid
Analysis Batch: 618479

Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Barium	3000		2840		mg/Kg		4	20
Calcium	100000		104000		mg/Kg		1	20

Lab Sample ID: 500-204544-1 DU
Matrix: Solid
Analysis Batch: 618576

Client Sample ID: Jolet #29 Ash
Prep Type: Total/NA
Prep Batch: 618052

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Cobalt	15		13.9		mg/Kg		10	20

Method: 7471A - Mercury (CVAA)

Lab Sample ID: MB 500-617888/12-A
Matrix: Solid
Analysis Batch: 618070

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 617888

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.017		0.017		mg/Kg		09/09/21 13:15	09/10/21 08:27	1

Lab Sample ID: LCS 500-617888/13-A
Matrix: Solid
Analysis Batch: 618070

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 617888

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.179		mg/Kg		107	80 - 120

QC Sample Results

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Method: 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 500-618524/1-A
Matrix: Solid
Analysis Batch: 618534

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618524

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	<2.0		2.0		mg/Kg		09/14/21 11:45	09/14/21 12:53	1

Lab Sample ID: LCS 500-618524/2-A
Matrix: Solid
Analysis Batch: 618534

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618524

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfate	50.0	53.9		mg/Kg		108	80 - 120

Method: SM 4500 Cl- E - Chloride, Total

Lab Sample ID: MB 500-618692/1-A
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618692

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<20		20		mg/Kg		09/15/21 09:49	09/15/21 15:03	1

Lab Sample ID: LCS 500-618692/2-A
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	200	202		mg/Kg		101	85 - 115

Method: SM 4500 F C - Fluoride

Lab Sample ID: MB 500-618692/1-A
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618692

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	<1.0		1.0		mg/Kg		09/15/21 09:49	09/15/21 12:27	1

Lab Sample ID: LCS 500-618692/2-A
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	100	103		mg/Kg		103	80 - 120

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park IL 60484
Phone 708 534-5200 Fax 708 534-5211

Chain of Custody Record

eurofins

244-ATLANTA

Client Information	Sampler Michael Ress	Lab PM Mockler Diana J	Carrier Tracking No(s)	COC No 500-94568-41920 1
Client Contact Richard Gnat	Phone 630-203-7240	E-Mail Diana Mockler@Eurofinset com	State of Origin	Page Page 1 of 1
Company KPRG and Associates Inc	PWSID	**Analysis Requested**		Job # 500-204544
Address 14665 West Lisbon Road Suite 1A	**Due Date Requested**			
City Brookfield	**TAT Requested (days)**			
State Zip WI 53005	**Compliance Project** Δ Yes Δ No			
Phone	PO # 4502042860			
Email richardg@kprginc com	WO #			
Project Name Joliet #9 Ash	Project # 50011504			
Site Illinois	SSOW#			

500-204544 COC

Preservation Codes

A HCL	M Hexane
B NaOH	N None
C Zn Acetate	O AsNaO2
D Nitric Acid	P Na2O4S
E NaHSO4	Q Na2SO3
F MeOH	R Na2S2O3
G Amchlor	S H2SO4
H Ascorbic Acid	T TSP Dodecahydrate
I Ice	U Acetone
J DI Water	V MCAA
K EDTA	W pH 4-5
L EDA	Z other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0 904.0	Ra226Ra228_GFPC Combined Rad 226/228	4500_F_C 6010B, 7471A 9056A SM4500_Cl_E	Total Number of containers	Special Instructions/Note
			Preservation Code		X	X	N	N	N	X	
Joliet #9 Ash	8/31	9:30	C	Solid			X	X	X		
Joliet #29 Ash	8/31	10:00	C	Solid			X	X	X		
				Solid							

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Deliverable Requested I II III IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date	Time	Method of Shipment

Relinquished by Michael Ress	Date/Time 8/31 13:00	Company KPRG	Received by Stephanie Hernandez	Date/Time 8/31/21 1300	Company ETA-CHI
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact Δ Yes Δ No	Custody Seal No	Cooler Temperature(s) °C and Other Remarks 22 4

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204544-1

Login Number: 204544
List Number: 1
Creator: Hernandez, Stephanie

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	22.4
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Accreditation/Certification Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-1

Laboratory: Eurofins TestAmerica, Chicago

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Illinois	NELAP	IL00035	04-29-22

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
7471A	7471A	Solid	Mercury
Moisture		Solid	Percent Moisture
Moisture		Solid	Percent Solids

1
2
3
4
5
6
7
8
9
10
11
12

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ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-204543-1
Client Project/Site: Joliet #9 Ash

For:
KPRG and Associates, Inc.
14665 West Lisbon Road,
Suite 1A
Brookfield, Wisconsin 53005

Attn: Richard Gnat

Diana Mockler

Authorized for release by:
9/21/2021 10:47:01 AM

Diana Mockler, Project Manager I
(219)252-7570
Diana.Mockler@Eurofinset.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Job ID: 500-204543-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-204543-1

Comments

No additional comments.

Receipt

The sample was received on 8/31/2021 1:00 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 22.4º C.

Metals

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Method Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CHI
7471A	Mercury (CVAA)	SW846	TAL CHI
9056A	Anions, Ion Chromatography	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
SM 4500 Cl- E	Chloride, Total	SM	TAL CHI
SM 4500 F C	Fluoride	SM	TAL CHI
300_Prep	Anions, Ion Chromatography, 10% Wt/Vol	MCAWW	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
7471A	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM = "Standard Methods For The Examination Of Water And Wastewater"
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
500-204543-1	Joliet #9 Ash	Solid	08/31/21 09:30	08/31/21 13:00

Client Sample Results

Client Sample ID: Joliet #9 Ash

Date Collected: 08/31/21 09:30
Date Received: 08/31/21 13:00

Lab Sample ID: 500-204543-1
Matrix: Solid

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<1.8		1.8		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Arsenic	<0.88		0.88		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Barium	**4400**		22		mg/Kg		09/15/21 15:57	09/20/21 14:39	25
Beryllium	**3.3**		0.35		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Boron	**110**		4.4		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Cadmium	<0.18		0.18		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Calcium	**110000**		88		mg/Kg		09/15/21 15:57	09/20/21 12:37	5
Chromium	**37**		0.88		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Cobalt	**20**		11		mg/Kg		09/15/21 15:57	09/20/21 14:39	25
Lead	**0.67**		0.44		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Lithium	**32**		0.88		mg/Kg		09/15/21 15:57	09/20/21 12:33	1
Molybdenum	<0.88		0.88		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Selenium	<0.88		0.88		mg/Kg		09/15/21 15:57	09/17/21 20:42	1
Thallium	**3.6**		0.88		mg/Kg		09/15/21 15:57	09/17/21 20:42	1

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.015		0.015		mg/Kg		09/09/21 13:15	09/10/21 08:30	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	<2.0		2.0		mg/Kg		09/14/21 11:45	09/14/21 13:19	1
Chloride	<20		20		mg/Kg		09/15/21 09:49	09/15/21 15:04	1
Fluoride	<1.0		1.0		mg/Kg		09/15/21 09:49	09/15/21 12:35	1

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Metals

Prep Batch: 617888

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	7471A	
MB 500-617888/12-A	Method Blank	Total/NA	Solid	7471A	
LCS 500-617888/13-A	Lab Control Sample	Total/NA	Solid	7471A	

Analysis Batch: 618070

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	7471A	617888
MB 500-617888/12-A	Method Blank	Total/NA	Solid	7471A	617888
LCS 500-617888/13-A	Lab Control Sample	Total/NA	Solid	7471A	617888

Prep Batch: 618772

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	3050B	
MB 500-618772/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-618772/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Analysis Batch: 619274

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	6010B	618772
MB 500-618772/1-A	Method Blank	Total/NA	Solid	6010B	618772
LCS 500-618772/2-A	Lab Control Sample	Total/NA	Solid	6010B	618772

Analysis Batch: 619359

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	6010B	618772
500-204543-1	Joliet #9 Ash	Total/NA	Solid	6010B	618772
MB 500-618772/1-A	Method Blank	Total/NA	Solid	6010B	618772
LCS 500-618772/2-A	Lab Control Sample	Total/NA	Solid	6010B	618772

Analysis Batch: 619496

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	6010B	618772

General Chemistry

Analysis Batch: 617356

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	Moisture	

Prep Batch: 618524

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	300_Prep	
MB 500-618524/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-618524/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	

Analysis Batch: 618534

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	9056A	618524
MB 500-618524/1-A	Method Blank	Total/NA	Solid	9056A	618524
LCS 500-618524/2-A	Lab Control Sample	Total/NA	Solid	9056A	618524

General Chemistry

Prep Batch: 618692

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	300_Prep	
MB 500-618692/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	
500-204543-1 MS	Joliet #9 Ash	Total/NA	Solid	300_Prep	
500-204543-1 MSD	Joliet #9 Ash	Total/NA	Solid	300_Prep	

Analysis Batch: 618739

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	SM 4500 F C	618692
MB 500-618692/1-A	Method Blank	Total/NA	Solid	SM 4500 F C	618692
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	SM 4500 F C	618692
500-204543-1 MS	Joliet #9 Ash	Total/NA	Solid	SM 4500 F C	618692
500-204543-1 MSD	Joliet #9 Ash	Total/NA	Solid	SM 4500 F C	618692

Analysis Batch: 618775

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	SM 4500 Cl- E	618692
MB 500-618692/1-A	Method Blank	Total/NA	Solid	SM 4500 Cl- E	618692
LCS 500-618692/2-A	Lab Control Sample	Total/NA	Solid	SM 4500 Cl- E	618692
500-204543-1 MS	Joliet #9 Ash	Total/NA	Solid	SM 4500 Cl- E	618692
500-204543-1 MSD	Joliet #9 Ash	Total/NA	Solid	SM 4500 Cl- E	618692

1 2 3 4 5 6 7 8 9 10 11 12

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 500-618772/1-A
Matrix: Solid
Analysis Batch: 619274

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618772

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<2.0		2.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Arsenic	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Barium	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Beryllium	<0.40		0.40		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Boron	<5.0		5.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Cadmium	<0.20		0.20		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Calcium	<20		20		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Chromium	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Cobalt	<0.50		0.50		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Lead	<0.50		0.50		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Molybdenum	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Selenium	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1
Thallium	<1.0		1.0		mg/Kg		09/15/21 15:57	09/17/21 19:34	1

Lab Sample ID: MB 500-618772/1-A
Matrix: Solid
Analysis Batch: 619359

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618772

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	<1.0		1.0		mg/Kg		09/15/21 15:57	09/20/21 12:27	1

Lab Sample ID: LCS 500-618772/2-A
Matrix: Solid
Analysis Batch: 619274

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618772

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	50.0	46.8		mg/Kg		94	80 - 120
Arsenic	10.0	9.29		mg/Kg		93	80 - 120
Barium	200	197		mg/Kg		98	80 - 120
Beryllium	5.00	4.68		mg/Kg		94	80 - 120
Boron	100	83.5		mg/Kg		83	80 - 120
Cadmium	5.00	4.54		mg/Kg		91	80 - 120
Calcium	1000	936		mg/Kg		94	80 - 120
Chromium	20.0	18.4		mg/Kg		92	80 - 120
Cobalt	50.0	46.1		mg/Kg		92	80 - 120
Lead	10.0	8.86		mg/Kg		89	80 - 120
Molybdenum	100	98.7		mg/Kg		99	80 - 120
Selenium	10.0	8.49		mg/Kg		85	80 - 120
Thallium	10.0	8.45		mg/Kg		85	80 - 120

Lab Sample ID: LCS 500-618772/2-A
Matrix: Solid
Analysis Batch: 619359

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618772

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Lithium	50.0	47.9		mg/Kg		96	80 - 120

QC Sample Results

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-1

1 2 3 4 5 6 7 8 9 10 11 12

Method: 7471A - Mercury (CVAA)

Lab Sample ID: MB 500-617888/12-A
Matrix: Solid
Analysis Batch: 618070

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 617888

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.017		0.017		mg/Kg		09/09/21 13:15	09/10/21 08:27	1

Lab Sample ID: LCS 500-617888/13-A
Matrix: Solid
Analysis Batch: 618070

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 617888

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Mercury			0.167	0.179		mg/Kg		107	80 - 120		

Method: 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 500-618524/1-A
Matrix: Solid
Analysis Batch: 618534

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618524

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	<2.0		2.0		mg/Kg		09/14/21 11:45	09/14/21 12:53	1

Lab Sample ID: LCS 500-618524/2-A
Matrix: Solid
Analysis Batch: 618534

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618524

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Sulfate			50.0	53.9		mg/Kg		108	80 - 120		

Method: SM 4500 Cl- E - Chloride, Total

Lab Sample ID: MB 500-618692/1-A
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618692

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<20		20		mg/Kg		09/15/21 09:49	09/15/21 15:03	1

Lab Sample ID: LCS 500-618692/2-A
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618692

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Chloride			200	202		mg/Kg		101	85 - 115		

Lab Sample ID: 500-204543-1 MS
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Joliet #9 Ash
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Chloride	<20		197	189		mg/Kg		96	75 - 125		

Method: SM 4500 Cl- E - Chloride, Total (Continued)

Lab Sample ID: 500-204543-1 MSD
Matrix: Solid
Analysis Batch: 618775

Client Sample ID: Joliet #9 Ash
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloride	<20		197	189		mg/Kg		96	75 - 125	0	20

Method: SM 4500 F C - Fluoride

Lab Sample ID: MB 500-618692/1-A
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 618692

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	<1.0		1.0		mg/Kg		09/15/21 09:49	09/15/21 12:27	1

Lab Sample ID: LCS 500-618692/2-A
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	100	103		mg/Kg		103	80 - 120

Lab Sample ID: 500-204543-1 MS
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Joliet #9 Ash
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	<1.0		49.2	50.1		mg/Kg		102	75 - 125

Lab Sample ID: 500-204543-1 MSD
Matrix: Solid
Analysis Batch: 618739

Client Sample ID: Joliet #9 Ash
Prep Type: Total/NA
Prep Batch: 618692

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoride	<1.0		49.2	50.1		mg/Kg		102	75 - 125	0	20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park IL 60484
Phone 708-534 5200 Fax 708 534-5211

Chain of Custody Record

Client Information	Sampler: Michael Ress	Lab PM: Mockler Diana J	Carrier Tracking No(s):	COC No: 500-94568-41920 1
Client Contact: Richard Gnat	Phone: 630-203-7240	E-Mail: Diana Mockler@Eurofinset com	State of Origin:	Page: Page 1 of 1
Company: KPRG and Associates Inc	PWSID:	**Analysis Requested**		Job #: 500-204543

Address: 14665 West Lisbon Road Suite 1A	**Due Date Requested:**
City: Brookfield	**TAT Requested (days):**
State Zip: WI 53005	**Compliance Project:** ∆ Yes ∆ No
Phone:	PO #: 4502042860
Email: richardg@kprginc com	WO #:
Project Name: Joliet #9 Ash	Project #: 50011504
Site: Illinois	SSOW#:

500-204543 COC

Preservation Codes:

A	HCL	M	Hexane
B	NaOH	N	None
C	Zn Acetate	O	AsNaO2
D	Nitric Acid	P	Na2O4S
E	NaHSO4	Q	Na2SO3
F	MeOH	R	Na2S2O3
G	Amchlor	S	H2SO4
H	Ascorbic Acid	T	TSP Dodecahydrate
I	Ice	U	Acetone
J	DI Water	V	MCAA
K	EDTA	W	pH 4-5
L	EDA	Z	other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0, 904.0	Ra226Ra228_GFPC Combined Rad 226/228	4500_F_C, 6010B, 7471A, 9056A, SM4500_Cl_E	Total Number of containers	Special Instructions/Note
				Preservation Code:			N	N	N		
1 Joliet #9 Ash	8/31	9:30	C	Solid			X	X	X		
Joliet #29 Ash	8/31	10:00	C	Solid			X	X	X		
				Solid							

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ____________ *Months*

Deliverable Requested I II III IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date	Time	Method of Shipment:

Relinquished by: Michael Ress	Date/Time: 8/31 13:00	Company: KPRG	Received by: Stephanie Hernandez	Date/Time: 8/31/21 1300	Company: ETA-CH
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: ∆ Yes ∆ No	Custody Seal No:	Cooler Temperature(s) °C and Other Remarks: 22 4

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204543-1

Login Number: 204543

List Source: Eurofins TestAmerica, Chicago

List Number: 1

Creator: Hernandez, Stephanie

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	22.4
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Lab Chronicle

Client Sample ID: Joliet #9 Ash

Lab Sample ID: 500-204543-1

Date Collected: 08/31/21 09:30

Matrix: Solid

Date Received: 08/31/21 13:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			618772	09/15/21 15:57	LK	TAL CHI
Total/NA	Analysis	6010B		1	619274	09/17/21 20:42	JJB	TAL CHI
Total/NA	Prep	3050B			618772	09/15/21 15:57	LK	TAL CHI
Total/NA	Analysis	6010B		1	619359	09/20/21 12:33	JJB	TAL CHI
Total/NA	Prep	3050B			618772	09/15/21 15:57	LK	TAL CHI
Total/NA	Analysis	6010B		5	619359	09/20/21 12:37	JJB	TAL CHI
Total/NA	Prep	3050B			618772	09/15/21 15:57	LK	TAL CHI
Total/NA	Analysis	6010B		25	619496	09/20/21 14:39	JJB	TAL CHI
Total/NA	Prep	7471A			617888	09/09/21 13:15	MJG	TAL CHI
Total/NA	Analysis	7471A		1	618070	09/10/21 08:30	MJG	TAL CHI
Total/NA	Prep	300_Prep			618524	09/14/21 11:45	EAT	TAL CHI
Total/NA	Analysis	9056A		1	618534	09/14/21 13:19	PSP	TAL CHI
Total/NA	Analysis	Moisture		1	617356	09/04/21 11:46	PFK	TAL CHI
Total/NA	Prep	300_Prep			618692	09/15/21 09:49	MS	TAL CHI
Total/NA	Analysis	SM 4500 Cl- E		1	618775	09/15/21 15:04	MS	TAL CHI
Total/NA	Prep	300_Prep			618692	09/15/21 09:49	MS	TAL CHI
Total/NA	Analysis	SM 4500 F C		1	618739	09/15/21 12:35	MS	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-204543-2
Client Project/Site: Joliet #9 Ash

For:
KPRG and Associates, Inc.
14665 West Lisbon Road,
Suite 1A
Brookfield, Wisconsin 53005

Attn: Richard Gnat

Diana Mockler

Authorized for release by:
10/26/2021 8:26:21 AM

Diana Mockler, Project Manager I
(219)252-7570
Diana.Mockler@Eurofinset.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-2

Job ID: 500-204543-2

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-204543-2

Comments
No additional comments.

Receipt
The sample was received on 8/31/2021 1:00 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 22.4º C.

RAD
Methods 903.0, 9315: Radium 226 prep batch 160-527617
Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date.

Joliet #9 Ash (500-204543-1), (LCS 160-527617/2-A), (MB 160-527617/1-A), (500-204327-A-20-D) and (500-204327-A-20-E DU)

Method 904.0: Radium-228 prep batch 160-528400:

Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date. Joliet #9 Ash (500-204543-1), (LCS 160-528400/2-A), (MB 160-528400/1-A) and (500-204543-A-1-D DU)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
Methods 6010B, NONE: The following sample was diluted to bring the concentration of target analytes within the calibration range: Joliet #9 Ash (500-204543-1). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Method Summary

Method	Method Description	Protocol	Laboratory
903.0	Radium-226 (GFPC)	EPA	TAL SL
904.0	Radium-228 (GFPC)	EPA	TAL SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	TAL SL
DPS-0	Preparation, Digestion/ Precipitate	None	TAL SL
DPS-21	Preparation, Digestion/Precipitate Separation (21-Day In-Growth)	None	TAL SL

Protocol References:

EPA = US Environmental Protection Agency
None = None
TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

TAL SL = Eurofins TestAmerica, St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Sample Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
500-204543-1	Joliet #9 Ash	Solid	08/31/21 09:30	08/31/21 13:00

Client Sample Results

Client Sample ID: Joliet #9 Ash

Lab Sample ID: 500-204543-1

Date Collected: 08/31/21 09:30
Matrix: Solid
Date Received: 08/31/21 13:00

Method: 903.0 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**2.41**		0.352	0.414	1.00	0.180	pCi/g	09/19/21 19:06	10/15/21 17:10	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*100*		*40 - 110*	*09/19/21 19:06*	*10/15/21 17:10*	*1*

Method: 904.0 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**1.97**		0.409	0.448	1.00	0.482	pCi/g	09/22/21 16:04	10/06/21 12:35	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*95.3*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*
Y Carrier	*78.9*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*

Method: Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**4.38**		0.540	0.610	5.00	0.482	pCi/g		10/25/21 17:38	1

Definitions/Glossary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-2

Qualifiers

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Rad

Prep Batch: 527617

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	DPS-21	
MB 160-527617/1-A	Method Blank	Total/NA	Solid	DPS-21	
LCS 160-527617/2-A	Lab Control Sample	Total/NA	Solid	DPS-21	

Prep Batch: 528400

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204543-1	Joliet #9 Ash	Total/NA	Solid	DPS-0	
MB 160-528400/1-A	Method Blank	Total/NA	Solid	DPS-0	
LCS 160-528400/2-A	Lab Control Sample	Total/NA	Solid	DPS-0	
500-204543-1 DU	Joliet #9 Ash	Total/NA	Solid	DPS-0	

QC Sample Results

Method: 903.0 - Radium-226 (GFPC)

Lab Sample ID: MB 160-527617/1-A
Matrix: Solid
Analysis Batch: 531966

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 527617

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.1252	U	0.144	0.144	1.00	0.234	pCi/g	09/19/21 19:06	10/15/21 17:14	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*80.9*		*40 - 110*	*09/19/21 19:06*	*10/15/21 17:14*	*1*

Lab Sample ID: LCS 160-527617/2-A
Matrix: Solid
Analysis Batch: 531966

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 527617

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Radium-226			11.3	12.04		1.37	1.00	0.272	pCi/g	106	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*82.8*		*40 - 110*

Method: 904.0 - Radium-228 (GFPC)

Lab Sample ID: MB 160-528400/1-A
Matrix: Solid
Analysis Batch: 530453

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 528400

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.1697	U	0.277	0.278	1.00	0.467	pCi/g	09/22/21 16:04	10/06/21 12:35	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.5*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*
Y Carrier	*80.0*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*

Lab Sample ID: LCS 160-528400/2-A
Matrix: Solid
Analysis Batch: 530453

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 528400

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Radium-228			9.27	10.17		1.24	1.00	0.492	pCi/g	110	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*40 - 110*
Y Carrier	*77.4*		*40 - 110*

Method: 904.0 - Radium-228 (GFPC) (Continued)

Lab Sample ID: 500-204543-1 DU
Matrix: Solid
Analysis Batch: 530453

Client Sample ID: Joliet #9 Ash
Prep Type: Total/NA
Prep Batch: 528400

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Radium-228	1.97			2.501		0.485	1.00	0.427	pCi/g			0.57	1

Carrier	*DU %Yield*	*DU Qualifier*	*Limits*
Ba Carrier	*88.7*		*40 - 110*
Y Carrier	*79.6*		*40 - 110*

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park IL 60484
Phone 708-534 5200 Fax 708 534-5211

Chain of Custody Record

eurofins

244-ATLANTA

Client Information	Sampler Michael Ross	Lab PM Mockler Diana J	Carrier Tracking No(s)	COC No 500-94568-41920 1
Client Contact Richard Gnat	Phone 630-203-7240	E-Mail Diana Mockler@Eurofinset com	State of Origin	Page Page 1 of 1
Company KPRG and Associates Inc	PWSID	**Analysis Requested**		Job # 500-204543

Address
14665 West Lisbon Road Suite 1A

City
Brookfield

State Zip
WI 53005

Phone

Email
richardg@kprginc com

Project Name
Joliet #9 Ash

Site
Illinois

Due Date Requested

TAT Requested (days)

Compliance Project ∆ Yes ∆ No

PO #
4502042860

WO #

Project #
50011504

SSOW#

500-204543 COC

Preservation Codes

A	HCL	M	Hexane
B	NaOH	N	None
C	Zn Acetate	O	AsNaO2
D	Nitric Acid	P	Na2O4S
E	NaHSO4	Q	Na2SO3
F	MeOH	R	Na2S2O3
G	Amchlor	S	H2SO4
H	Ascorbic Acid	T	TSP Dodecahydrate
I	Ice	U	Acetone
J	DI Water	V	MCAA
K	EDTA	W	pH 4-5
L	EDA	Z	other (specify)

Other:

	Sample Identification	**Sample Date**	**Sample Time**	**Sample Type (C=comp, G=grab)**	**Matrix** (W=water S=solid, O=waste/oil, BT=Tissue, A=Air)	**Field Filtered Sample (Yes or No)**	**Perform MS/MSD (Yes or No)**	**903.0, 904.0**	**Ra226Ra228_GFPC Combined Rad 226/228**	**4500_F_C, 6010B, 7471A, 9056A, SM4500_Cl_E**	**Total Number of containers**	**Special Instructions/Note**
					Preservation Code:	☒	☒	N	N	N	☒	
1	Joliet #9 Ash	8/31	9:30	C	Solid			X	X	X		
	Joliet #29 Ash	8/31	10:00	C	Solid			X	X	X		
					Solid							

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ________ Months

Deliverable Requested I II III IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date	Time	Method of Shipment:

Relinquished by Michael Ross	Date/Time 8/31 13:00	Company KPRG	Received by Stephanie Hernandez	Date/Time 8/31/21 1300	Company ETA-CH
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: ∆ Yes ∆ No

Custody Seal No

Cooler Temperature(s) °C and Other Remarks 22 4

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Mockler, Diana J	Carrier Tracking No(s):	COC No: 500-152055.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Diana.Mockler@Eurofinset.com	State of Origin: Illinois	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Illinois		Job #: 500-204543-2
Address: 13715 Rider Trail North, ,	Due Date Requested: 10/3/2021			
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: Joliet #9 Ash	Project #: 50011504			
Site: NRG Midwest Generation LSQ Joliet #9 CCR	SSOW#:			

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0/DPS_21 Radium 226	904.0/DPS_0 Radium 228	Ra226Ra228_GFPC/ Combined Rad 226/228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
Joliet #9 Ash (500-204543-1)	8/31/21	09:30 Central		Solid			X	X	X	2	

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification
Unconfirmed

Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:		Time:		Method of Shipment:	
Relinquished by: Sheri Scott	Date/Time: 8/31/21 1445	Company ETA-CHI	Received by:	Date/Time: 9/1/21 08:37	Company ETA STL	
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company	
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company	
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:			

Ver: 06/08/2021

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204543-2

Login Number: 204543

List Number: 1

Creator: Hernandez, Stephanie

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	22.4
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204543-2

Login Number: 204543
List Number: 2
Creator: Korrinhizer, Micha L

List Source: Eurofins TestAmerica, St. Louis
List Creation: 09/01/21 05:40 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Lab Chronicle

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-2

Client Sample ID: Joliet #9 Ash

Lab Sample ID: 500-204543-1

Date Collected: 08/31/21 09:30

Matrix: Solid

Date Received: 08/31/21 13:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	DPS-21			527617	09/19/21 19:06	HA	TAL SL
Total/NA	Analysis	903.0		1	531971	10/15/21 17:10	ANW	TAL SL
Total/NA	Prep	DPS-0			528400	09/22/21 16:04	ASG	TAL SL
Total/NA	Analysis	904.0		1	530453	10/06/21 12:35	EMH	TAL SL
Total/NA	Analysis	Ra226_Ra228		1	533568	10/25/21 17:38	CAH	TAL SL

Laboratory References:

TAL SL = Eurofins TestAmerica, St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Tracer/Carrier Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #9 Ash

Job ID: 500-204543-2

Method: 903.0 - Radium-226 (GFPC)

Matrix: Solid

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)
Lab Sample ID	**Client Sample ID**	**Ba (40-110)**
500-204543-1	Joliet #9 Ash	100
LCS 160-527617/2-A	Lab Control Sample	82.8
MB 160-527617/1-A	Method Blank	80.9

Tracer/Carrier Legend

Ba = Ba Carrier

Method: 904.0 - Radium-228 (GFPC)

Matrix: Solid

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	**Client Sample ID**	**Ba (40-110)**	**Y (40-110)**
500-204543-1	Joliet #9 Ash	95.3	78.9
500-204543-1 DU	Joliet #9 Ash	88.7	79.6
LCS 160-528400/2-A	Lab Control Sample	78.9	77.4
MB 160-528400/1-A	Method Blank	87.5	80.0

Tracer/Carrier Legend

Ba = Ba Carrier
Y = Y Carrier

1
2
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13

ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-204544-2
Client Project/Site: Joliet #29 Ash

For:
KPRG and Associates, Inc.
14665 West Lisbon Road,
Suite 1A
Brookfield, Wisconsin 53005

Attn: Richard Gnat

Diana Mockler

Authorized for release by:
10/26/2021 8:28:20 AM

Diana Mockler, Project Manager I
(219)252-7570
Diana.Mockler@Eurofinset.com

Table of Contents

Case Narrative

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Job ID: 500-204544-2

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-204544-2

Comments

No additional comments.

Receipt

The sample was received on 8/31/2021 1:00 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 22.4º C.

RAD

Methods 903.0, 9315: Radium 226 prep batch 160-527617
Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date.

Jolet #29 Ash (500-204544-1), (LCS 160-527617/2-A), (MB 160-527617/1-A), (500-204327-A-20-D) and (500-204327-A-20-E DU)

Method 904.0: Radium-228 prep batch 160-528400:

Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date. Jolet #29 Ash (500-204544-1), (LCS 160-528400/2-A), (MB 160-528400/1-A), (500-204543-A-1-C) and (500-204543-A-1-D DU)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals

Methods 6010B, NONE: The following sample was diluted to bring the concentration of target analytes within the calibration range: Jolet #29 Ash (500-204544-1). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Method Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Method	Method Description	Protocol	Laboratory
903.0	Radium-226 (GFPC)	EPA	TAL SL
904.0	Radium-228 (GFPC)	EPA	TAL SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	TAL SL
DPS-0	Preparation, Digestion/ Precipitate	None	TAL SL
DPS-21	Preparation, Digestion/Precipitate Separation (21-Day In-Growth)	None	TAL SL

Protocol References:

EPA = US Environmental Protection Agency
None = None
TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

TAL SL = Eurofins TestAmerica, St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Sample Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
500-204544-1	Jolet #29 Ash	Solid	08/31/21 10:00	08/31/21 13:00

Client Sample Results

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Client Sample ID: Jolet #29 Ash

Lab Sample ID: 500-204544-1

Date Collected: 08/31/21 10:00
Date Received: 08/31/21 13:00

Matrix: Solid

Method: 903.0 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**1.54**		0.311	0.341	1.00	0.252	pCi/g	09/19/21 19:06	10/15/21 17:11	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*104*		*40 - 110*	*09/19/21 19:06*	*10/15/21 17:11*	*1*

Method: 904.0 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**1.63**		0.377	0.406	1.00	0.443	pCi/g	09/22/21 16:04	10/06/21 12:36	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*91.3*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:36*	*1*
Y Carrier	*78.1*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:36*	*1*

Method: Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**3.17**		0.489	0.530	5.00	0.443	pCi/g		10/25/21 17:38	1

Definitions/Glossary

Qualifiers

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

QC Association Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Rad

Prep Batch: 527617

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	DPS-21	
MB 160-527617/1-A	Method Blank	Total/NA	Solid	DPS-21	
LCS 160-527617/2-A	Lab Control Sample	Total/NA	Solid	DPS-21	

Prep Batch: 528400

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-204544-1	Jolet #29 Ash	Total/NA	Solid	DPS-0	
MB 160-528400/1-A	Method Blank	Total/NA	Solid	DPS-0	
LCS 160-528400/2-A	Lab Control Sample	Total/NA	Solid	DPS-0	

QC Sample Results

Client: KPRG and Associates, Inc. Job ID: 500-204544-2
Project/Site: Joliet #29 Ash

Method: 903.0 - Radium-226 (GFPC)

Lab Sample ID: MB 160-527617/1-A
Matrix: Solid
Analysis Batch: 531966

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 527617

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.1252	U	0.144	0.144	1.00	0.234	pCi/g	09/19/21 19:06	10/15/21 17:14	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*80.9*		*40 - 110*	*09/19/21 19:06*	*10/15/21 17:14*	*1*

Lab Sample ID: LCS 160-527617/2-A
Matrix: Solid
Analysis Batch: 531966

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 527617

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Radium-226			11.3	12.04		1.37	1.00	0.272	pCi/g	106	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*82.8*		*40 - 110*

Method: 904.0 - Radium-228 (GFPC)

Lab Sample ID: MB 160-528400/1-A
Matrix: Solid
Analysis Batch: 530453

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 528400

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.1697	U	0.277	0.278	1.00	0.467	pCi/g	09/22/21 16:04	10/06/21 12:35	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*87.5*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*
Y Carrier	*80.0*		*40 - 110*	*09/22/21 16:04*	*10/06/21 12:35*	*1*

Lab Sample ID: LCS 160-528400/2-A
Matrix: Solid
Analysis Batch: 530453

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 528400

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Radium-228			9.27	10.17		1.24	1.00	0.492	pCi/g	110	75 - 125		

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*78.9*		*40 - 110*
Y Carrier	*77.4*		*40 - 110*

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park IL 60484
Phone 708 534-5200 Fax 708 534-5211

Chain of Custody Record

eurofins 244-ATLANTA

Client Information	Sampler Michael Ross	Lab PM Mockler Diana J	Carrier Tracking No(s)	COC No 500-94568-41920 1
Client Contact Richard Gnat	Phone 630-203-7240	E-Mail Diana Mockler@Eurofinset com	State of Origin	Page Page 1 of 1
Company KPRG and Associates Inc	PWSID	**Analysis Requested**		Job # 500-204544
Address 14665 West Lisbon Road Suite 1A	**Due Date Requested**			
City Brookfield	**TAT Requested (days)**			
State Zip WI 53005	**Compliance Project** ∆ Yes ∆ No			
Phone	PO # 4502042860			
Email richardg@kprginc com	WO #			
Project Name Joliet #9 Ash	Project # 50011504			
Site Illinois	SSOW#			

500-204544 COC

Preservation Codes

A HCL	M Hexane
B NaOH	N None
C Zn Acetate	O AsNaO2
D Nitric Acid	P Na2O4S
E NaHSO4	Q Na2SO3
F MeOH	R Na2S2O3
G Amchlor	S H2SO4
H Ascorbic Acid	T TSP Dodecahydrate
I Ice	U Acetone
J DI Water	V MCAA
K EDTA	W pH 4-5
L EDA	Z other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0 904.0	Ra226Ra228_GFPC Combined Rad 226/228	4500_F_C 6010B, 7471A 9056A SM4500_Cl_E	Total Number of containers	Special Instructions/Note
				Preservation Code	X	X	N	N	N	X	
Joliet #9 Ash	8/31	9:30	C	Solid			X	X	X		
Joliet #29 Ash	8/31	10:00	C	Solid			X	X	X		
				Solid							

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Deliverable Requested I II III IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date	Time	Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Michael Ross	8/31 13:00	KPRG	Stephanie Hernandez	8/31/21 1300	ETA-CHI

Custody Seals Intact ∆ Yes ∆ No	Custody Seal No	Cooler Temperature(s) °C and Other Remarks 22 4

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone: 708-534-5200 Fax: 708-534-5211

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Mockler, Diana J	Carrier Tracking No(s):	COC No: 500-152056.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Diana.Mockler@Eurofinset.com	State of Origin: Illinois	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Illinois		Job #: 500-204544-2
Address: 13715 Rider Trail North,	**Due Date Requested:** 10/3/2021			
City: Earth City	**TAT Requested (days):**			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: Joliet #29 Ash	Project #: 50005078			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0/DPS_21 Radium 226	904.0/DPS_0 Radium 228	Ra226Ra228_GFPC/ Combined Rad 226/228	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
Jolet #29 Ash (500-204544-1)	8/31/21	10:00 Central		Solid			X	X	X	2	

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification

Unconfirmed

Deliverable Requested: I, II, III, IV, Other (specify)

Primary Deliverable Rank: 2

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by:

Date:

Time:

Method of Shipment:

Relinquished by:	Date/Time: 8/31/21 1445	Company ETA CHI	Received by:	Date/Time: 9/1/21 08:37	Company ETA STL
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact:
∆ Yes ∆ No

Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204544-2

Login Number: 204544
List Number: 1
Creator: Hernandez, Stephanie

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	22.4
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: KPRG and Associates, Inc.

Job Number: 500-204544-2

Login Number: 204544
List Number: 2
Creator: Korrinhizer, Micha L

List Source: Eurofins TestAmerica, St. Louis
List Creation: 09/01/21 05:40 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Accreditation/Certification Summary

Client: KPRG and Associates, Inc.
Project/Site: Joliet #29 Ash

Job ID: 500-204544-2

Laboratory: Eurofins TestAmerica, St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-22
ANAB	Dept. of Defense ELAP	L2305	04-06-22
ANAB	Dept. of Energy	L2305.01	04-06-22
ANAB	ISO/IEC 17025	L2305	04-06-22
Arizona	State	AZ0813	12-08-21
California	Los Angeles County Sanitation Districts	10259	06-30-22
California	State	2886	06-30-21 *
Connecticut	State	PH-0241	03-31-23
Florida	NELAP	E87689	06-30-22
HI - RadChem Recognition	State	n/a	06-30-22
Illinois	NELAP	004553	11-30-21
Iowa	State	373	12-01-22
Kansas	NELAP	E-10236	10-31-21
Kentucky (DW)	State	KY90125	01-01-22
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-21
Louisiana	NELAP	04080	06-30-22
Louisiana (DW)	State	LA011	12-31-21
Maryland	State	310	09-30-22
MI - RadChem Recognition	State	9005	06-30-22
Missouri	State	780	06-30-22
Nevada	State	MO000542020-1	07-31-22
New Jersey	NELAP	MO002	06-30-22
New York	NELAP	11616	04-01-22
North Dakota	State	R-207	06-30-22
NRC	NRC	24-24817-01	12-31-22
Oklahoma	State	9997	08-31-22
Oregon	NELAP	4157	09-01-22
Pennsylvania	NELAP	68-00540	03-01-22
South Carolina	State	85002001	06-30-22
Texas	NELAP	T104704193	07-31-22
US Fish & Wildlife	US Federal Programs	058448	07-31-22
USDA	US Federal Programs	P330-17-00028	03-11-23
Utah	NELAP	MO000542021-14	08-01-22
Virginia	NELAP	10310	06-14-22
Washington	State	C592	08-30-22
West Virginia DEP	State	381	10-31-22

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Tracer/Carrier Summary

Method: 903.0 - Radium-226 (GFPC)

Matrix: Solid **Prep Type: Total/NA**

Percent Yield (Acceptance Limits)

Lab Sample ID	Client Sample ID	Ba (40-110)
500-204544-1	Jolet #29 Ash	104
LCS 160-527617/2-A	Lab Control Sample	82.8
MB 160-527617/1-A	Method Blank	80.9

Tracer/Carrier Legend

Ba = Ba Carrier

Method: 904.0 - Radium-228 (GFPC)

Matrix: Solid **Prep Type: Total/NA**

Percent Yield (Acceptance Limits)

Lab Sample ID	Client Sample ID	Ba (40-110)	Y (40-110)
500-204544-1	Jolet #29 Ash	91.3	78.1
LCS 160-528400/2-A	Lab Control Sample	78.9	77.4
MB 160-528400/1-A	Method Blank	87.5	80.0

Tracer/Carrier Legend

Ba = Ba Carrier

Y = Y Carrier

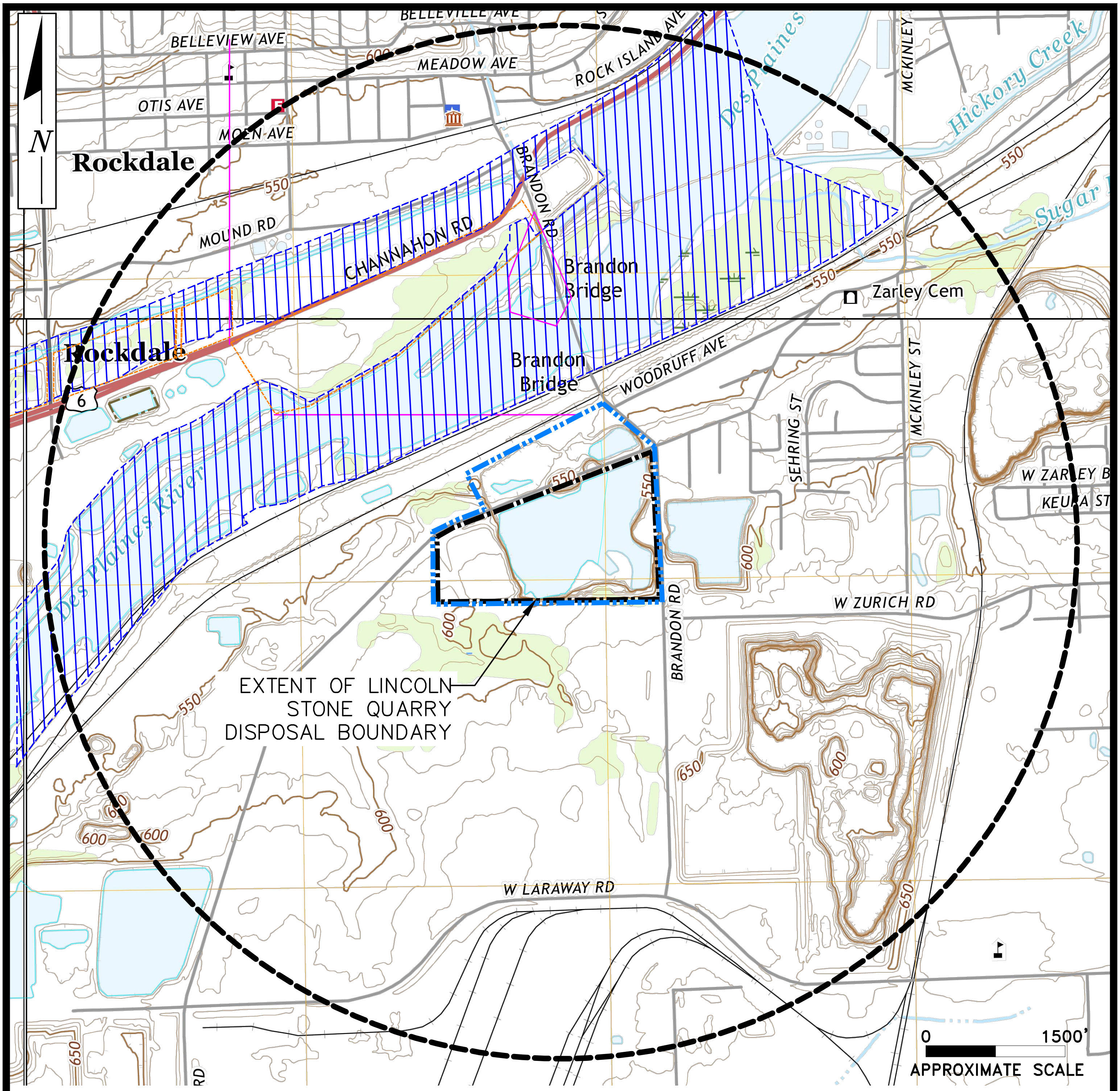
Attachment 2-2 – P105 Leachate Assessment Data

Midwest Generation, LLC - Joliet/Lincoln Stone Quarry--1978090001 - 2012 Assessment Well P105 Data

	Well	P105			
Parameter	Units	1stQtr12	2ndQtr12	3rdQtr12	4thQtr12
Ammonia, Dissolved	mg/L	8.3	8.7	8.8	8.3
Arsenic, Dissolved	ug/L	20	11	13	<10
Barium	ug/L	240	70	53	29
Barium, Dissolved	ug/L	31	27	30	26
Boron, Dissolved	ug/L	10000	11000	12000	10000
Cadmium, Dissolved	ug/L	<2.0	<2.0	<2.0	<2.0
Chloride, Dissolved	mg/L	170	200	190	190
Copper	ug/L	26	<10	11	<10
Depth to Water (ft from MP)	ft	49.75	50.49	50.50	53.35
Depth to Water (ft bls)	ft	47.00	47.74	47.75	50.60
Elevation of GW Surface	ft	541.72	540.98	540.97	538.12
Elevation of Well (MP)	ft	591.47	591.47	591.47	591.47
Elevation Well Bottom	ft	513.71	513.71	513.71	513.71
Field pH	SU	7.38	11.56	7.85	10.55
Field Temperature	Degrees F	35.8	46.0	67.5	60.8
Fluoride, Dissolved	mg/L	0.15	0.15	<0.10	0.16
Iron	ug/L	NA	2000	NA	NA
Lead	ug/L	NA	<5.0	NA	NA
Manganese, Dissolved	ug/L	<10	<10	<10	<10
Mercury	ug/L	NA	<0.20	NA	NA
Molybdenum, Dissolved	ug/L	13000	12000	14000	12000^
Nitrogen, Nitrate	mg/L	<0.10	<0.10	<0.10	<0.10
Nitrogen, Nitrate, Dissolved	mg/L	<0.10	<0.10	<0.10	<0.10
Potassium, Dissolved	mg/L	83	79	81	77
Selenium, Dissolved	ug/L	13	<10	<10	<10
Sodium, Dissolved	mg/L	220	220	220	210
Specific Conductance	umhos/cm	1153	1530	1396	1403
Sulfate, Dissolved	mg/L	410	360	460	460
Total Dissolved Solids	mg/L	1100	1100	1100	1000
Total Organic Carbon	mg/L	5.2	4.7	6.7	7.0
Zinc, Dissolved	ug/L	<20	<20	<20	<20

Notes:
1. A '<' sign means that the analyte was not detected at or above the reporting limit
2. A 'B' sign indicates that the result is less than the reporting limit, but greater than or equal to the method detection limit
3. A '^' sign indicates that an instrument related QC exceeds the control limits
4. NA = Not Analyzed

ATTACHMENT 3
SITE PLAN MAP



LEGEND

- FACILITY BOUNDARY
- SURFACE WATERS
- ▥ LIMITS OF ALL 100-YEAR FLOODPLAINS
- HISTORIC PLACES
- ADJACENT PROPERTY BOUNDARY
- ○ RADIUS DEPICTING 3,280 FEET (1000 METERS) FROM FACILITY BOUNDARY

NOTES:

1. THE USGS BACKGROUND WAS OBTAINED FROM THE U.S.G.S ONLINE TOPOGRAPHY MAP RESOURCE
2. THERE ARE NO KNOWN HISTORIC, ARCHITECTURAL OR ARCHAEOLOGICAL SITES WITHIN THE EXTENT OF LINCOLN STONE QUARRY.
3. THERE ARE NO NATURE PRESERVES IN THE VICINITY OF LINCOLN STONE QUARRY.
4. THERE ARE NO KNOWN CRITICAL HABITATS AND ENDANGERED OR THREATENED SPECIES WITHIN THE EXTENT OF LINCOLN STONE QUARRY.

S
PREVAILING WIND DIRECTION

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

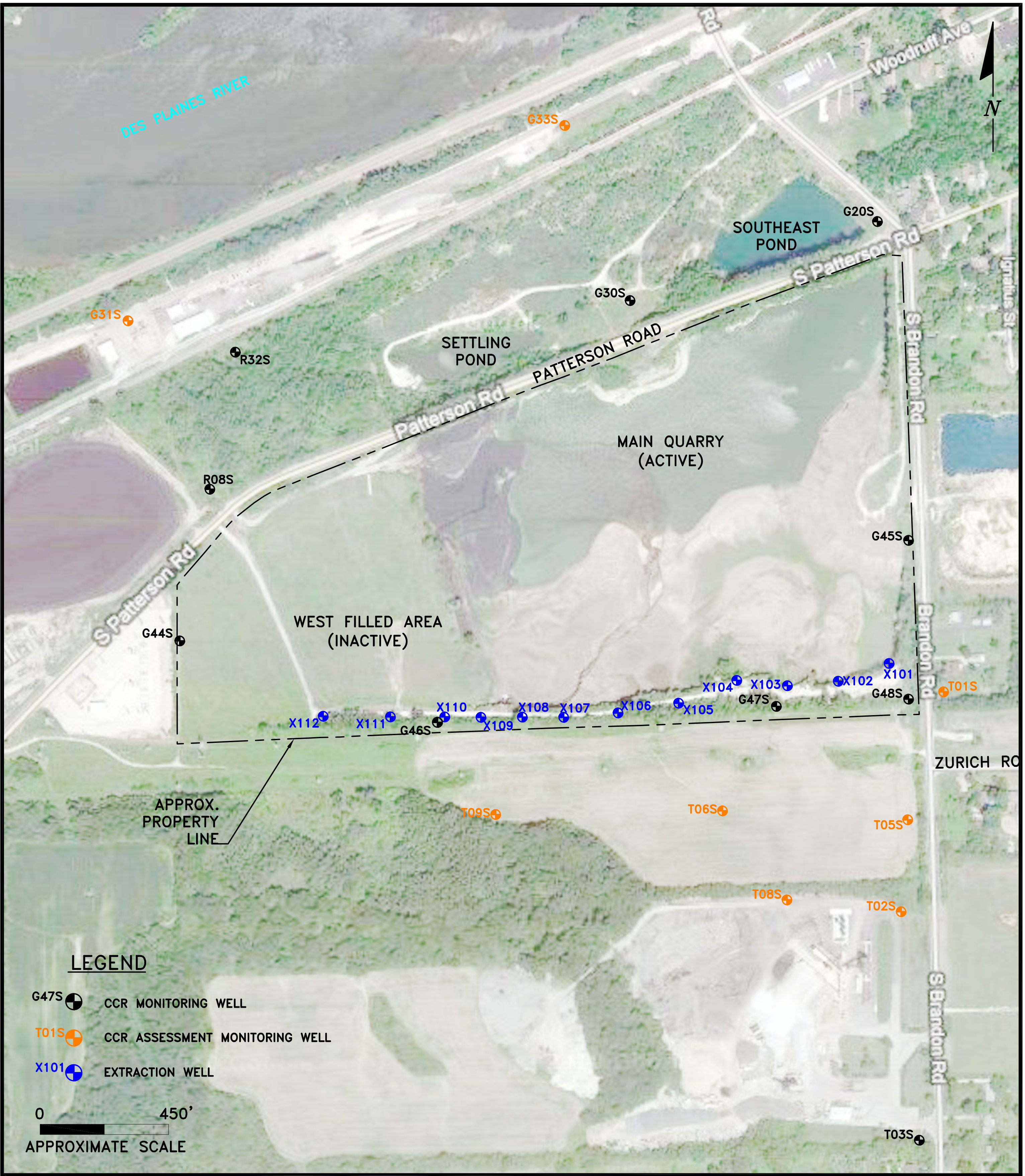
SITE LOCATION MAP

JOLIET #9 GENERATING STATION/LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 1500'
Date: January 24, 2022
KPRG Project No. 19620
FIGURE 3

W:\projects\midwest generation\operate & construct permits\joliet site location maps.dwg

ATTACHMENT 4
SITE PLAN MAPS



ENVIRONMENTAL CONSULTATION & REMEDIATION

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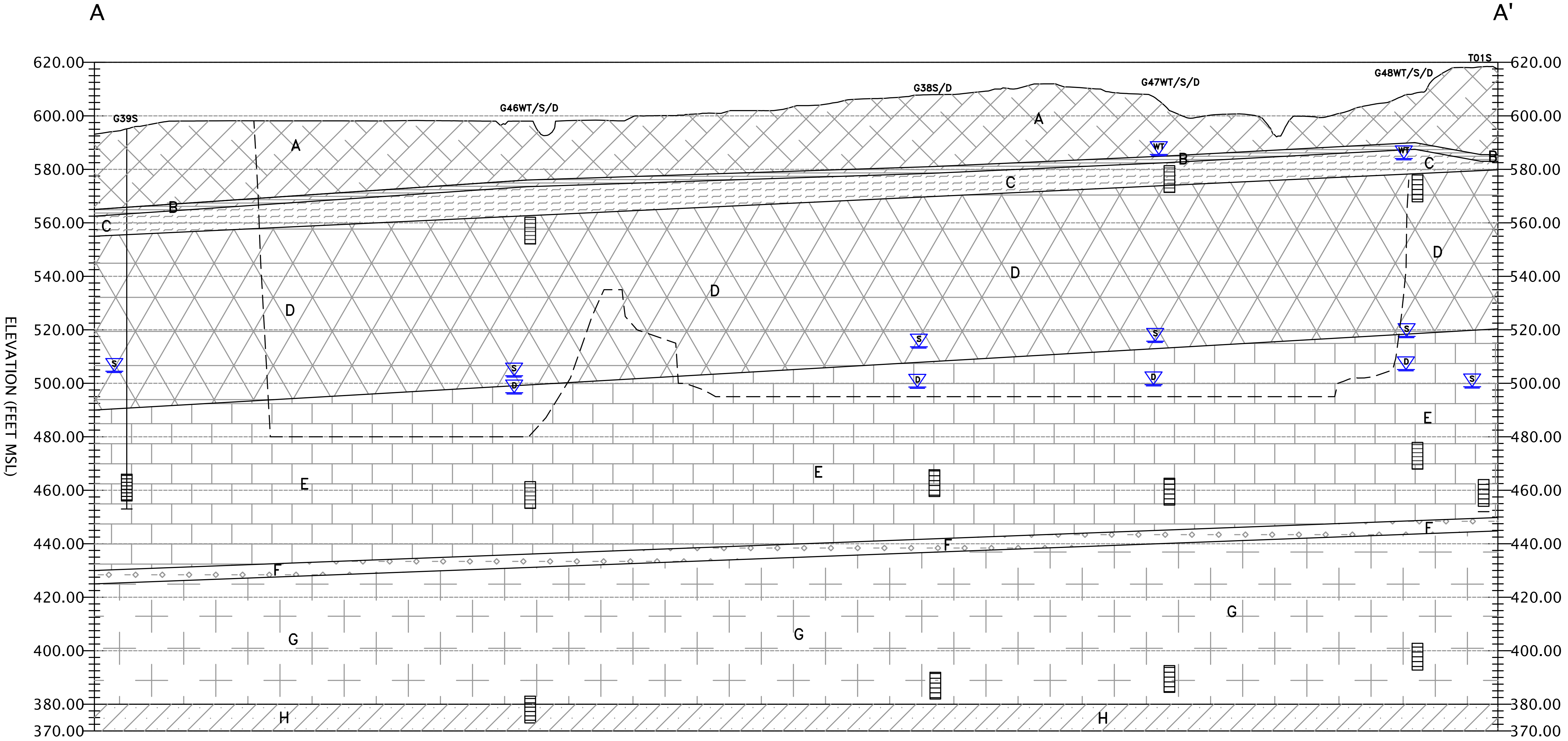
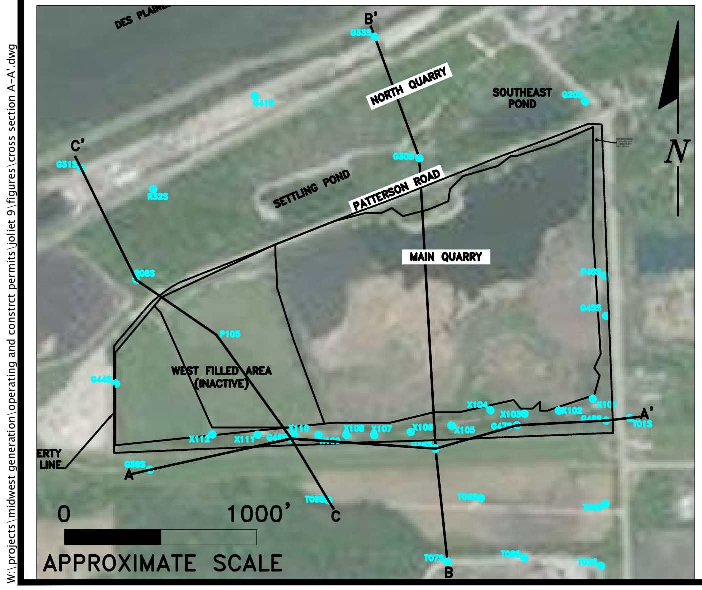
CCR MONITORING WELL SITE MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'
Date: January 13, 2022
KPRG Project No. 19620.4
FIGURE 4-1

W:\projects\midwest generation\lincoln quarry gw monitoring\permit well map 4-4-14.dwg





LEGEND

A	UNCONSOLIDATED OVERBURDEN	F	BRAINARD SHALE
B	WEATHERED DOLOMITE	G	FORT ATKINSON DOLOMITE
C	JOLIET FORMATION DOLOMITE	H	SCALES SHALE
D	KANKAKEE FORMATION DOLOMITE		
E	ELWOOD/WILHELMI DOLOMITE		

WT	WT–WELLS WATER LEVEL (5/21)
D	D–WELLS WATER LEVEL (5/21)
S	S–WELLS WATER LEVEL (5/21)
— — —	PROJECTED POND OUTLINE

40'
200'
0
APPROXIMATE SCALE

E N V I R O N M E N T A L C O N S U L T A T I O N & R E M E D I A T I O N

KPRG

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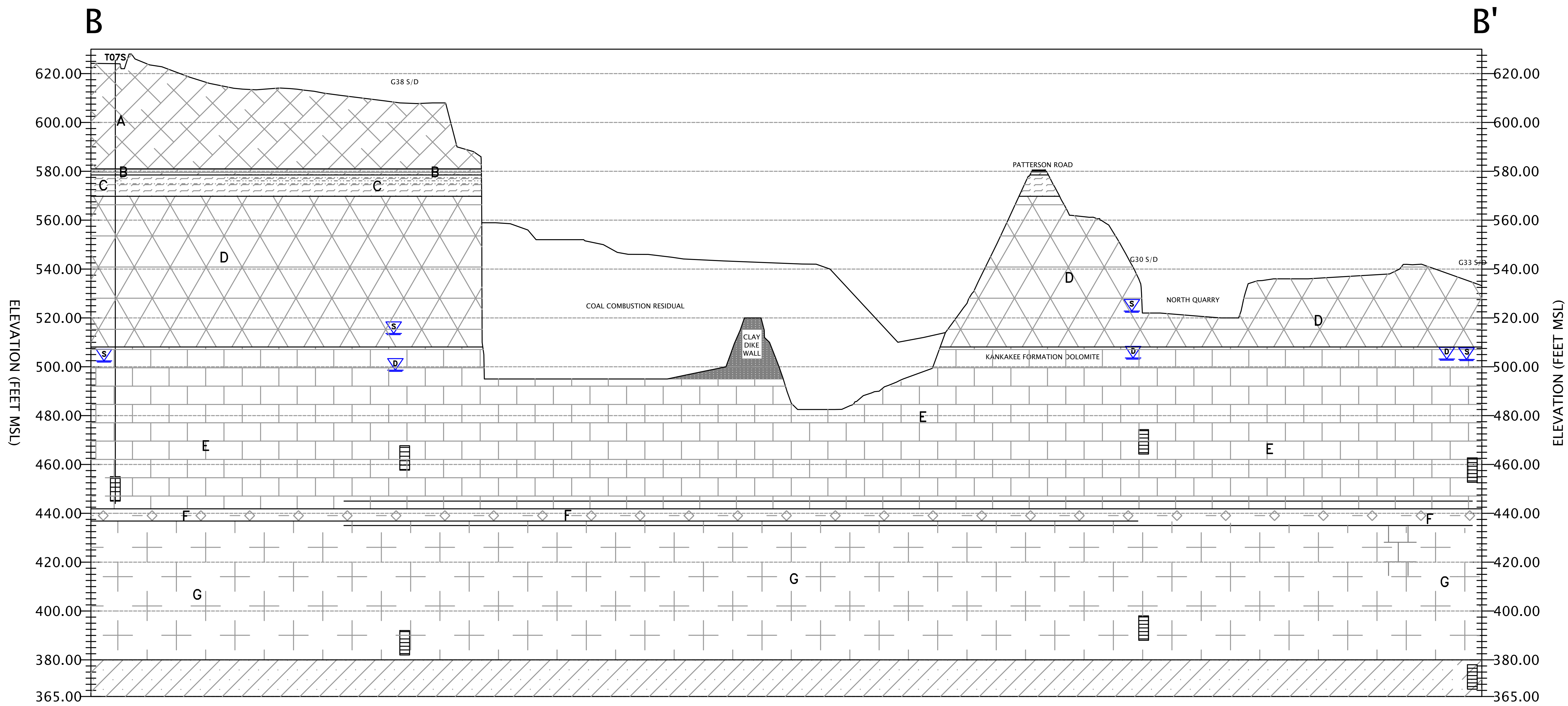
CROSS SECTION A–A'

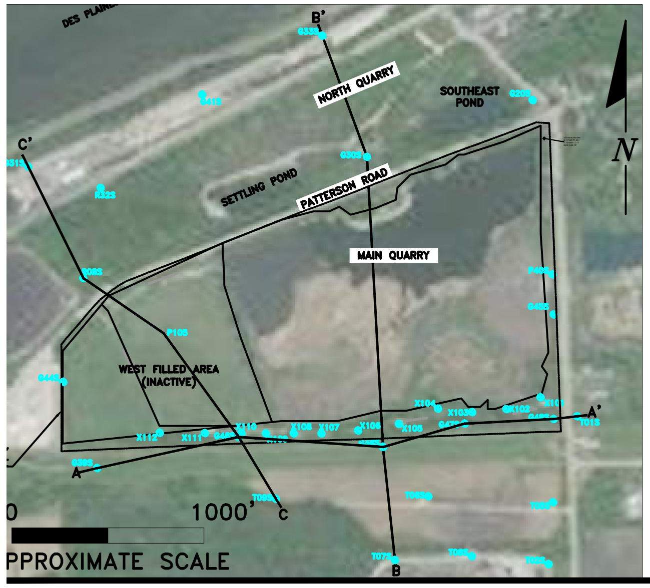
LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE
Date: October 14, 2021

KPRG Project No. 19520.4
FIGURE 4–2

W:\projects\midwest generation\operating and constrct permits\joliet 9\figures\cross section A–A'.dwg





LEGEND

A	UNCONSOLIDATED OVERBURDEN	F	BRAINARD SHALE
B	WEATHERED DOLOMITE	G	FORT ATKINSON DOLOMITE
C	JOLIET FORMATION DOLOMITE	H	SCALES SHALE
D	KANKAKEE FORMATION DOLOMITE		
E	ELWOOD/WILHELMI DOLOMITE		

WT	WT–WELLS WATER LEVEL (5/21)
D	D–WELLS WATER LEVEL (5/21)
S	S–WELLS WATER LEVEL (5/21)

40'
0
200'
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

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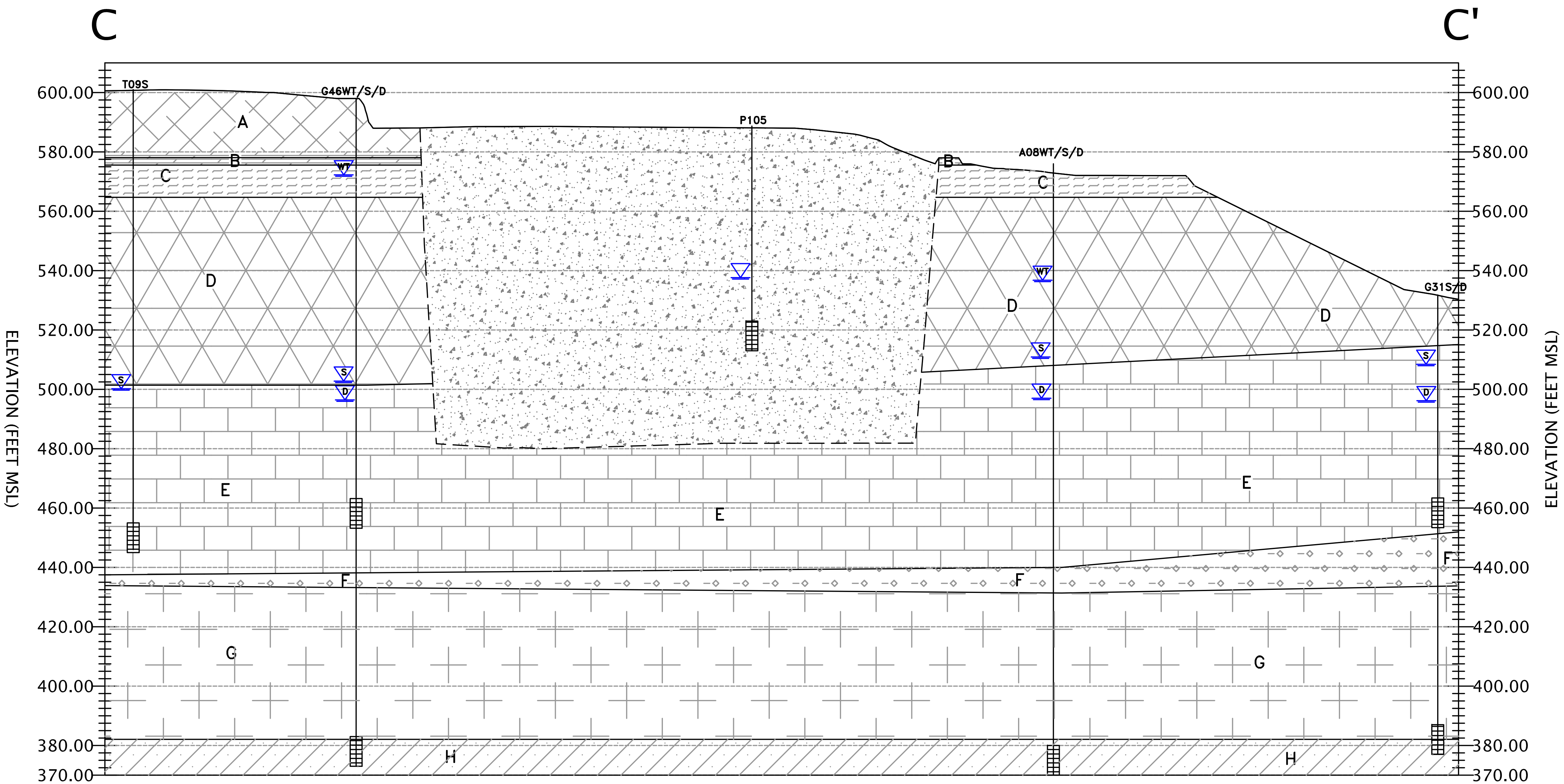
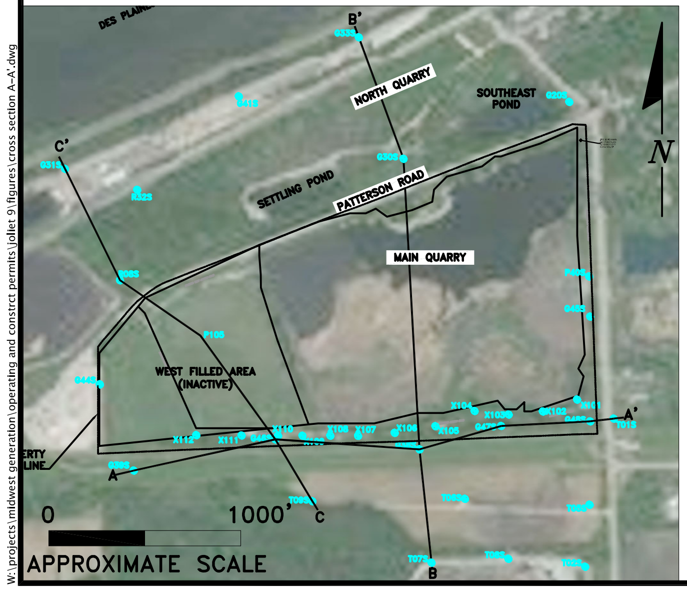
414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630–325–1300 Facsimile 630–325–1593

CROSS SECTION B–B'

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE
Date: October 14, 2021
KPRG Project No. 19520.4
FIGURE 4–3





LEGEND

A	UNCONSOLIDATED OVERBURDEN
B	WEATHERED DOLOMITE
C	JOLIET FORMATION DOLOMITE
D	KANKAKEE FORMATION DOLOMITE
E	ELWOOD/WILHELMI DOLOMITE
F	BRAINARD SHALE
G	FORT ATKINSON DOLOMITE
H	SCALES SHALE
WT	WT-WELLS WATER LEVEL (5/21)
D	D-WELLS WATER LEVEL (5/21)
S	S-WELLS WATER LEVEL (5/21)
— — — — —	PROJECTED POND OUTLINE

40'
200'
0
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

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CROSS SECTION C–C'

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

SEE SCALE
Date: October 14, 2021
KPRG Project No. 19520.4
FIGURE 4–4

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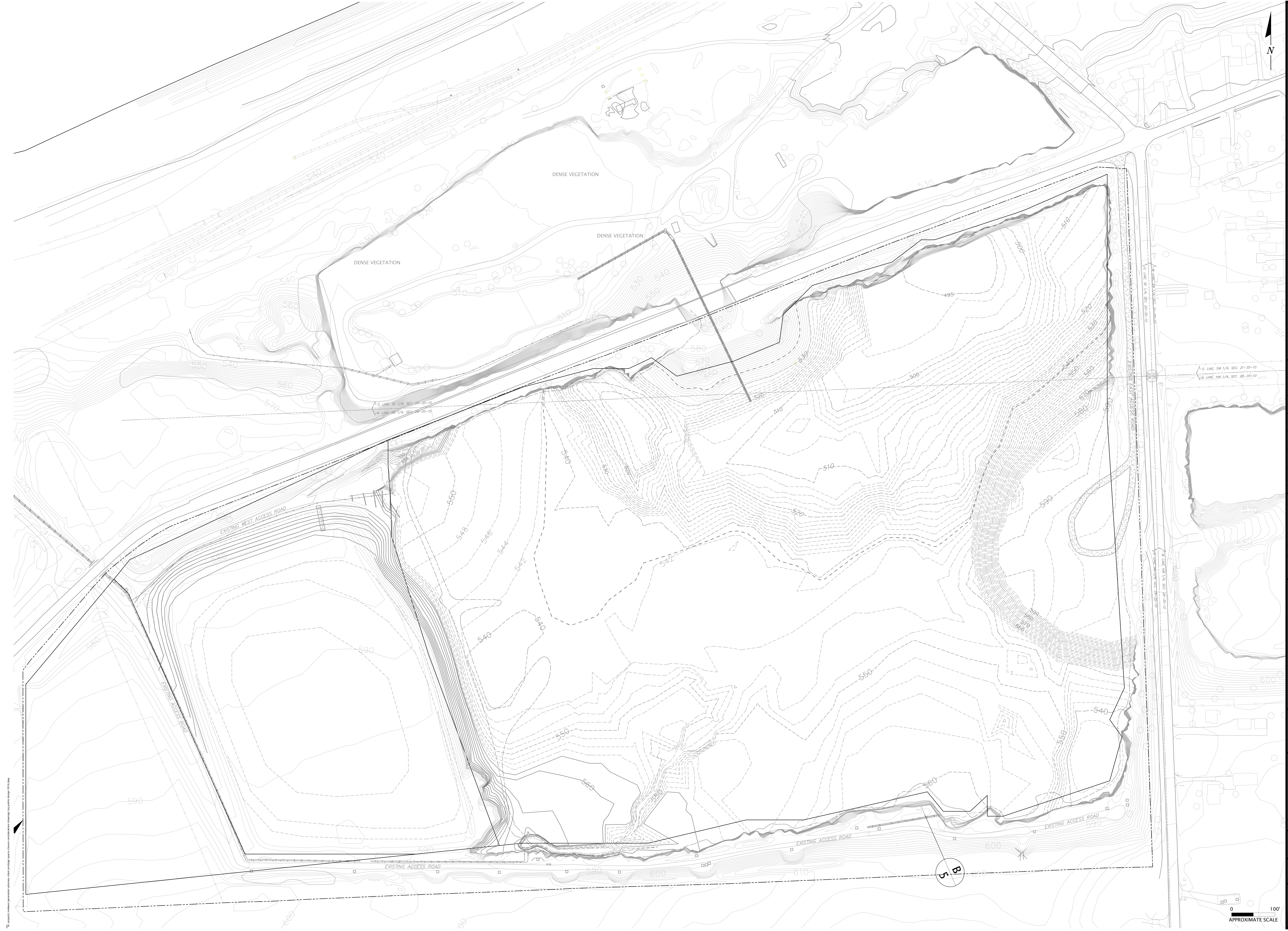
ATTACHMENT 5
CONSTRUCTION DESCRIPTION



GENERAL NOTES

THE SITE BENCHMARK IS LOCATED AT NORTHING 1758972.424 AND EASTING 1048071.277 WITH ELEVATION 584.19.

THE TOPOGRAPHIC MAP WAS GENERATED USING AERIAL PHOTOGRAPHY BY THE SIDWELL COMPANY IN MAY 2014.

540	EXISTING CCR CONTOURS
540	EXISTING TOPOGRAPHIC CONTOURS
	EXISTING FENCE
	EXTENT OF SURFACE WATER
	EXISTING TREE
	EXISTING CLUSTER OF TREES/VEGETATION
	EXISTING SLUICE PIPES

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

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Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY
CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

KPRG PROJECT NO.
19620.4

SHEET TITLE
EXISTING SITE
CONDITIONS

DRAWING DATE
01/19/22

DRAWING SCALE
1" = 100'

SHEET NO.
1

CONSTRUCTION NOTES:

① REMOVE ALL TREES, GRASS AND BRUSH. GRASS/BRUSH MAY BE STOCKPILED ONSITE FOR DISPOSAL. TREES MUST BE REMOVED OFFSITE FOR DISPOSAL.

② DEMOLISH EXISTING SLUICE PIPE SUPPORT STRUCTURE. REMOVE SLUICE PIPES AT LOCATION INDICATED AND CONTINUE REMOVING PIPES GOING EAST. IF NECESSARY, CONSTRUCT A TEMPORARY ROAD TO DEMOLISH EXISTING PIPE SUPPORT STRUCTURE. DISPOSE OF THE PIPE PROPERLY OFFSITE.

③ REMOVE AND STOCKPILE EXISTING RIPRAP FOR LATER REUSE. RIPRAP MAY BE STOCKPILED ONSITE IN AN AREA THAT WILL NOT INTERFERE WITH DEMOLITION/SITE CLEARING ACTIVITIES.

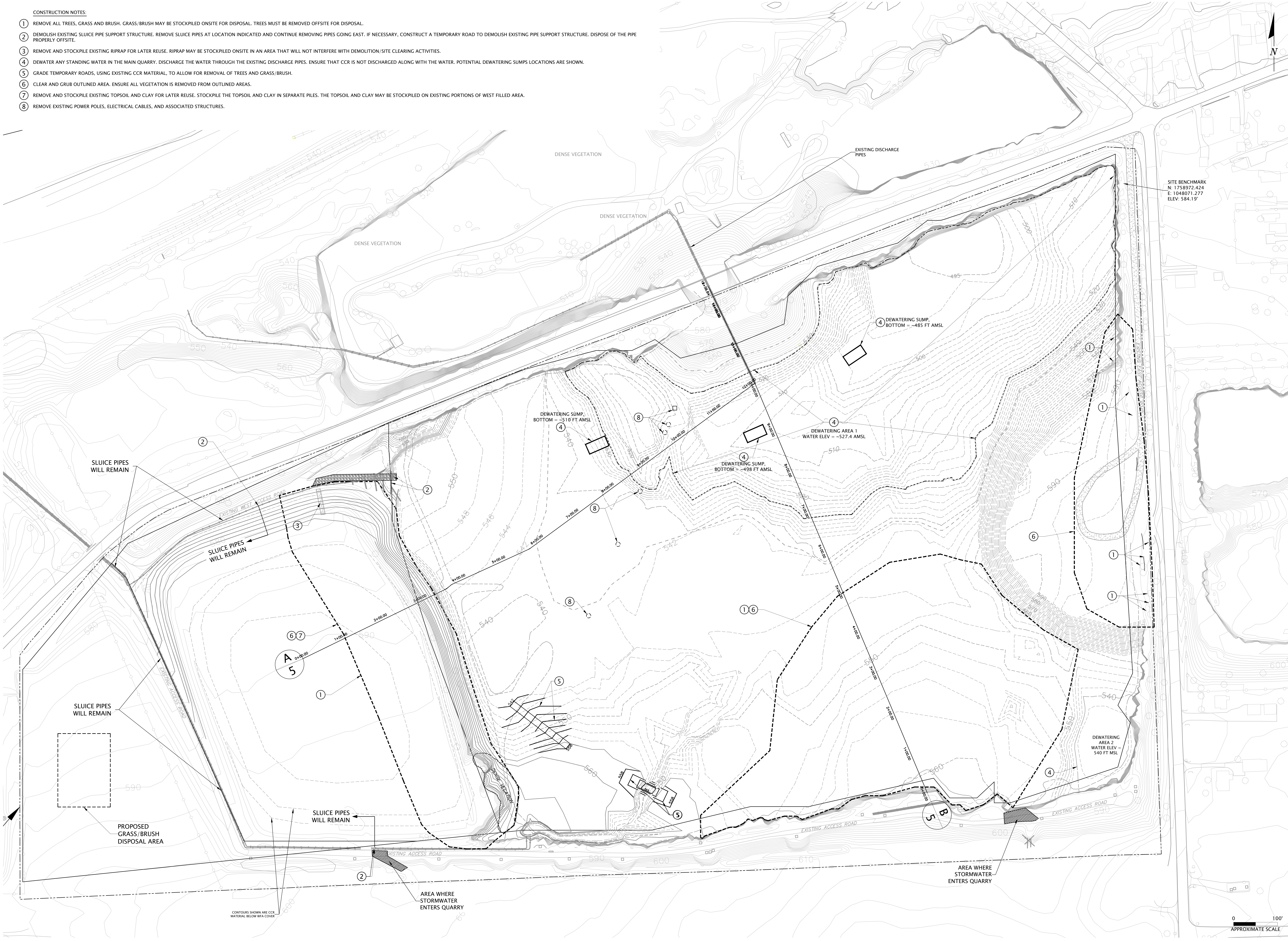
④ DEWATER ANY STANDING WATER IN THE MAIN QUARRY. DISCHARGE THE WATER THROUGH THE EXISTING DISCHARGE PIPES. ENSURE THAT CCR IS NOT DISCHARGED ALONG WITH THE WATER. POTENTIAL DEWATERING SUMPS LOCATIONS ARE SHOWN.

⑤ GRADE TEMPORARY ROADS, USING EXISTING CCR MATERIAL, TO ALLOW FOR REMOVAL OF TREES AND GRASS/BRUSH.

⑥ CLEAR AND GRUB OUTLINED AREA. ENSURE ALL VEGETATION IS REMOVED FROM OUTLINED AREAS.

⑦ REMOVE AND STOCKPILE EXISTING TOPSOIL AND CLAY FOR LATER REUSE. STOCKPILE THE TOPSOIL AND CLAY IN SEPARATE PILES. THE TOPSOIL AND CLAY MAY BE STOCKPILED ON EXISTING PORTIONS OF WEST FILLED AREA.

⑧ REMOVE EXISTING POWER POLES, ELECTRICAL CABLES, AND ASSOCIATED STRUCTURES.



GENERAL NOTES

ATTORNEY-CLIENT PRIVILEGE WORK PRODUCT.

MAP GENERATED BY SIDWELL FROM AERIAL PHOTO TAKEN 2014.

ALL CONTOURS ARE SHOWN IN 2 FEET INTERVALS, UNLESS OTHERWISE STATED.

540 ───	EXISTING CCR CONTOURS
540 ───	EXISTING TOPOGRAPHIC CONTOURS
───	EXISTING FENCE
───	EXTENT OF SURFACE WATER
✿	EXISTING TREE
	EXISTING CLUSTER OF TREES/VEGETATION
───	EXISTING SLUICE PIPES

NO.	REVISION	DATE
1	Add erosion protection	3/23/20

PROJECT FIRM AND ADDRESS

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

14665 West Lisbon Road, Suite 2B
Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

KPRG PROJECT NO.
19620.4

SHEET TITLE
SITE CLEARING AND DEMOLITION

DRAWING DATE
01/19/22

DRAWING SCALE
1" = 100'

SHEET NO.
2

CONSTRUCTION NOTES:

① REGRADE THE EXISTING CCR ACCORDING TO THE CONTOURS SHOWN.

② CONSTRUCT A NEW ACCESS ROAD IN THE LOCATION SHOWN.

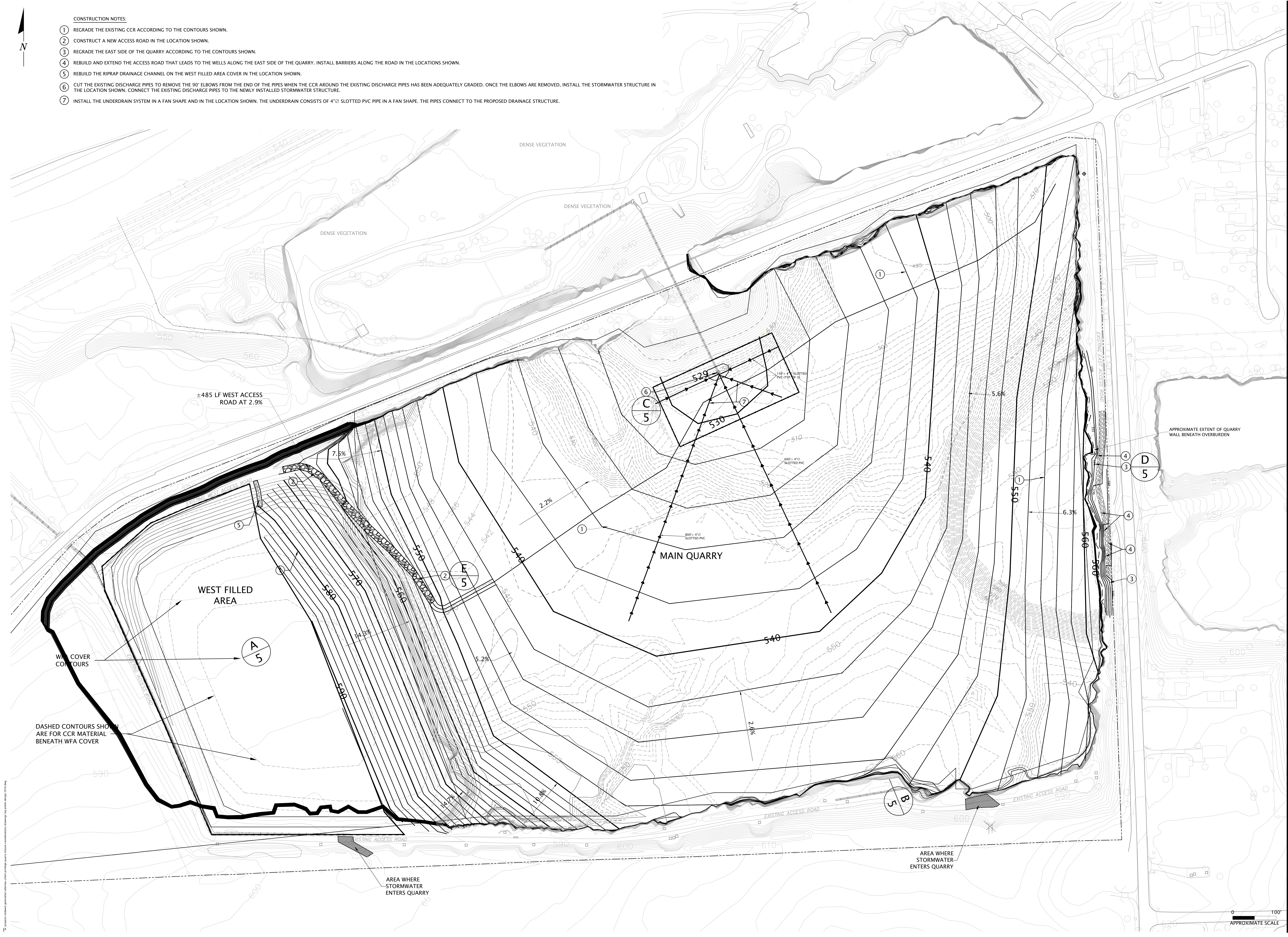
③ REGRADE THE EAST SIDE OF THE QUARRY ACCORDING TO THE CONTOURS SHOWN.

④ REBUILD AND EXTEND THE ACCESS ROAD THAT LEADS TO THE WELLS ALONG THE EAST SIDE OF THE QUARRY. INSTALL BARRIERS ALONG THE ROAD IN THE LOCATIONS SHOWN.

⑤ REBUILD THE RIPRAP DRAINAGE CHANNEL ON THE WEST FILLED AREA COVER IN THE LOCATION SHOWN.

⑥ CUT THE EXISTING DISCHARGE PIPES TO REMOVE THE 90° ELBOWS FROM THE END OF THE PIPES WHEN THE CCR AROUND THE EXISTING DISCHARGE PIPES HAS BEEN ADEQUATELY GRADED. ONCE THE ELBOWS ARE REMOVED, INSTALL THE STORMWATER STRUCTURE IN THE LOCATION SHOWN. CONNECT THE EXISTING DISCHARGE PIPES TO THE NEWLY INSTALLED STORMWATER STRUCTURE.

⑦ INSTALL THE UNDERDRAIN SYSTEM IN A FAN SHAPE AND IN THE LOCATION SHOWN. THE UNDERDRAIN CONSISTS OF 4"∅ SLOTTED PVC PIPE IN A FAN SHAPE. THE PIPES CONNECT TO THE PROPOSED DRAINAGE STRUCTURE.



GENERAL NOTES

ATTORNEY-CLIENT PRIVILEGE WORK PRODUCT

MAP GENERATED BY SIDWELL COMPANY FROM AN AERIAL PHOTO DATED MAY 2014.

540 ——— EXISTING CCR CONTOURS
540 ——— EXISTING TOPOGRAPHIC CONTOURS
——— EXISTING FENCE
——— EXTENT OF SURFACE WATER
EXISTING TREE
EXISTING CLUSTER OF TREES/VEGETATION
——— EXISTING SLUICE PIPES

540 ——— PROPOSED CCR MAJOR CONTOURS
538 ——— PROPOSED CCR MINOR CONTOURS
▨ PROPOSED GRAVEL ROADS

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

14665 West Lisbon Road, Suite 2B
Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY
CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

KPRG PROJECT NO.
19620.4

SHEET TITLE
PROPOSED
GRADING PLAN

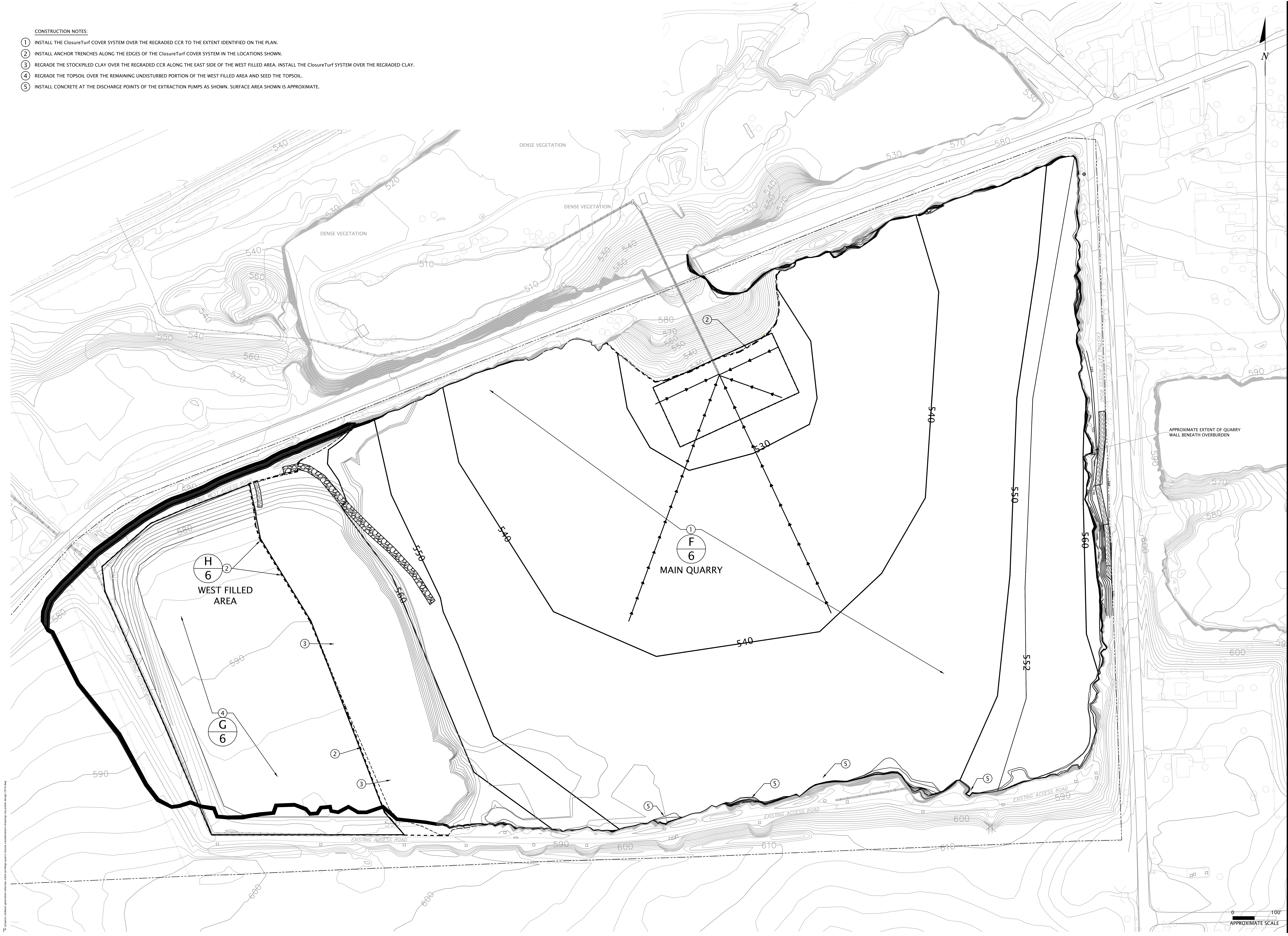
DRAWING DATE
01/19/22

DRAWING SCALE
1" = 100'

SHEET NO.
3

CONSTRUCTION NOTES:

① INSTALL THE ClosureTurf COVER SYSTEM OVER THE REGRADED CCR TO THE EXTENT IDENTIFIED ON THE PLAN.
② INSTALL ANCHOR TRENCHES ALONG THE EDGES OF THE ClosureTurf COVER SYSTEM IN THE LOCATIONS SHOWN.
③ REGRADE THE STOCKPILED CLAY OVER THE REGRADED CCR ALONG THE EAST SIDE OF THE WEST FILLED AREA. INSTALL THE ClosureTurf SYSTEM OVER THE REGRADED CLAY.
④ REGRADE THE TOPSOIL OVER THE REMAINING UNDISTURBED PORTION OF THE WEST FILLED AREA AND SEED THE TOPSOIL.
⑤ INSTALL CONCRETE AT THE DISCHARGE POINTS OF THE EXTRACTION PUMPS AS SHOWN. SURFACE AREA SHOWN IS APPROXIMATE.



GENERAL NOTES

ATTORNEY-CLIENT PRIVILEGE WORK PRODUCT

MAP GENERATED BY SIDWELL COMPANY FROM AN AERIAL PHOTO DATED MAY 2014.

540 EXISTING CCR CONTOURS
540 EXISTING TOPOGRAPHIC CONTOURS
EXISTING FENCE
EXTENT OF SURFACE WATER
EXISTING TREE
EXISTING CLUSTER OF TREES/VEGETATION
EXISTING SLUICE PIPES

540 PROPOSED CCR MAJOR CONTOURS
538 PROPOSED CCR MINOR CONTOURS
PROPOSED GRAVEL ROADS
PROPOSED AREAS OF ArmorFill
PROPOSED ANCHOR TRENCH

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

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Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

KPRG PROJECT NO.
19620.4

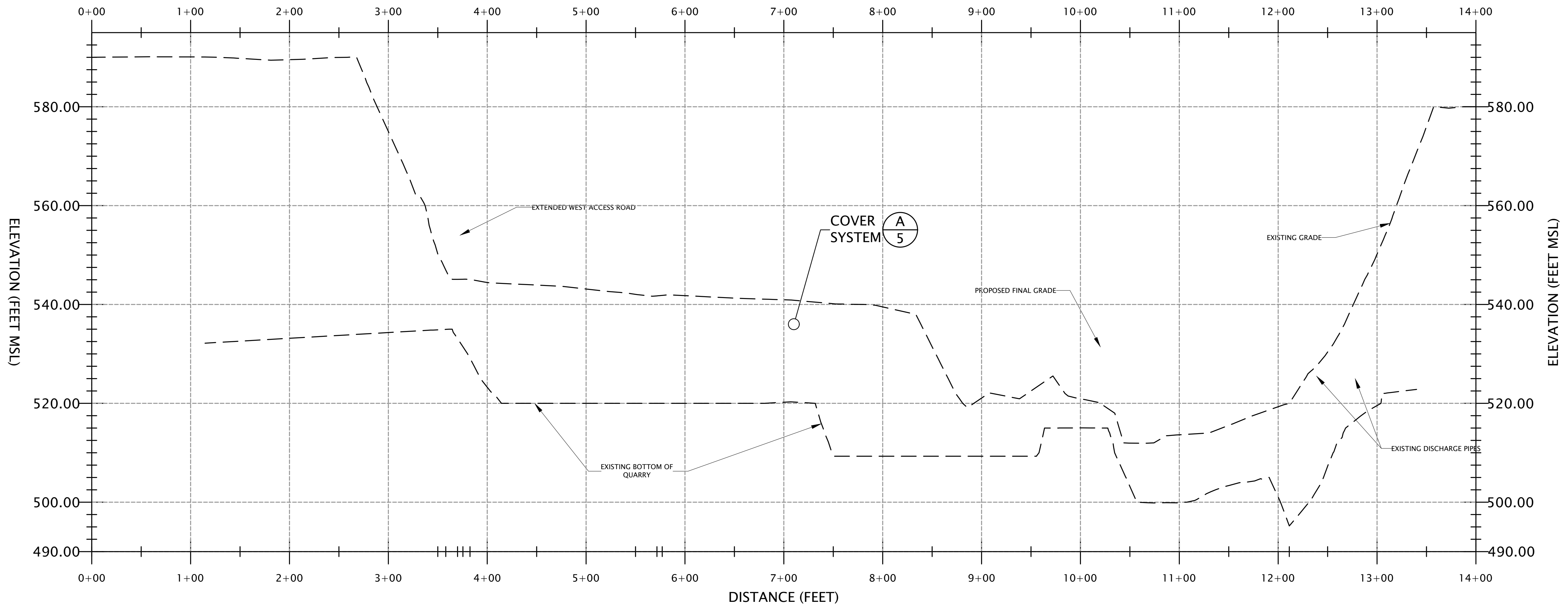
SHEET TITLE

ClosureTurf INSTALLATION PLAN

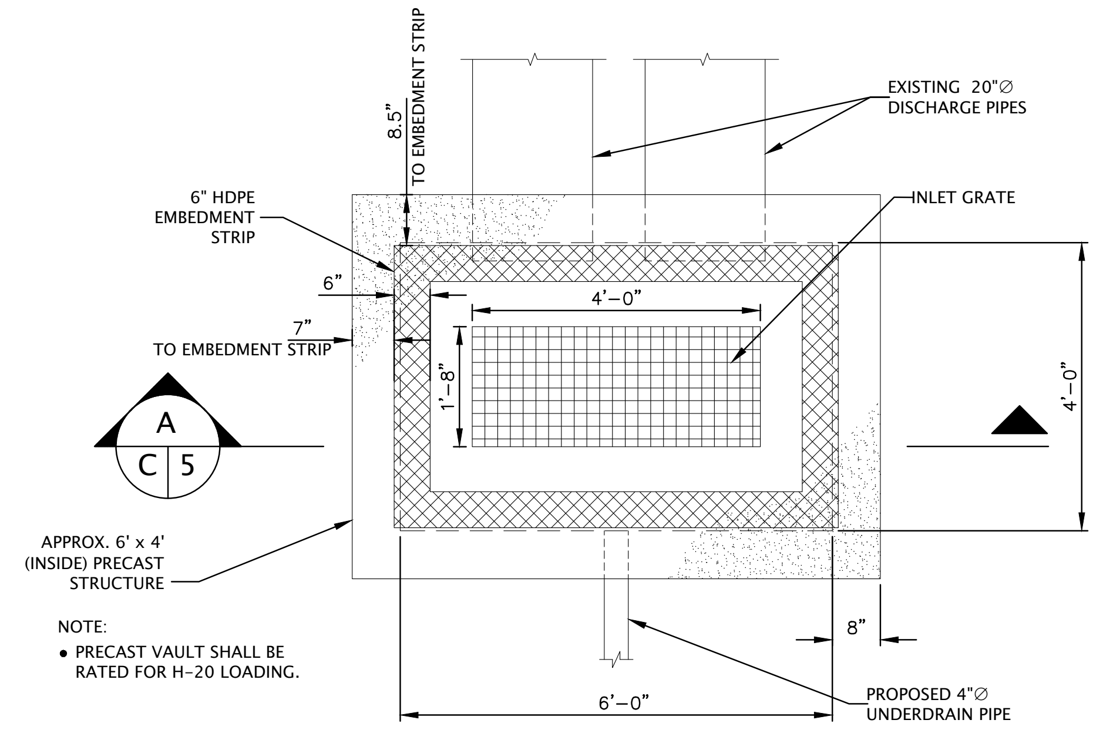
DRAWING DATE
01/19/22

DRAWING SCALE
1" = 100'

SHEET NO.
4



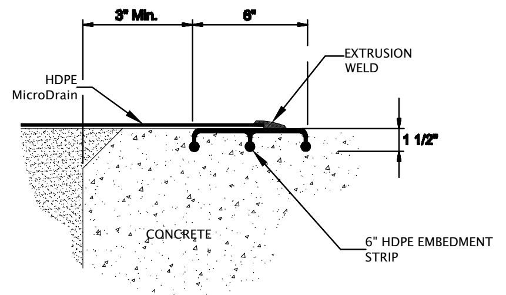
A 5 WFA TO DISCHARGE PIPES PROFILE 1" = 100'



NOTE:

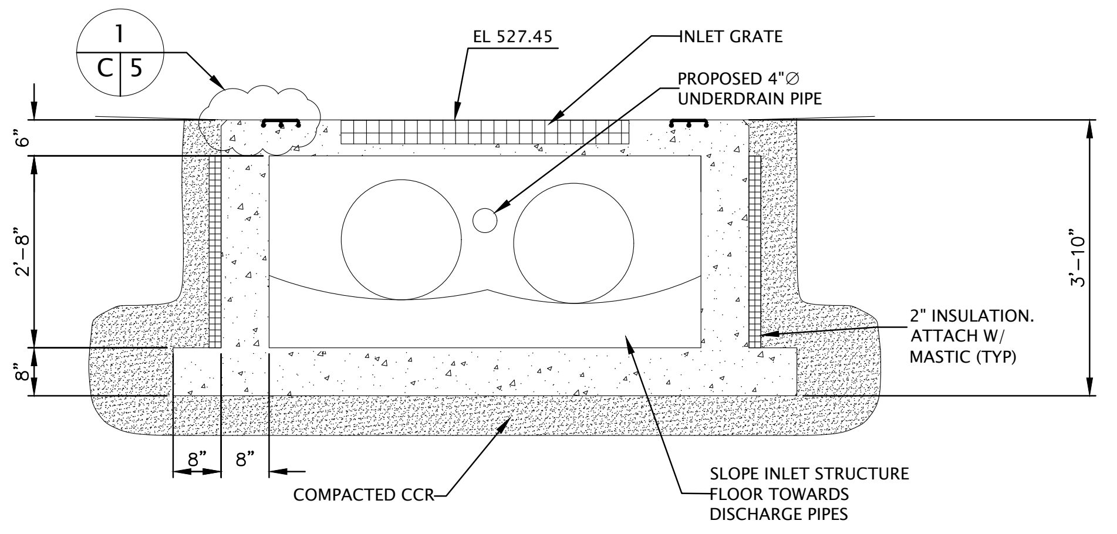
- PRECAST VAULT SHALL BE RATED FOR H-20 LOADING.

INLET STRUCTURE PLAN



NOTE:
THE CCR ADJACENT TO THE INLET STRUCTURE IS TO BE WELL COMPACTED TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT. ALL CONCRETE CORNERS IN CONTACT WITH LINER SHALL BE CHAMFERED A MINIMUM OF 1".

DETAIL 1 C 5



SECTION A C 5

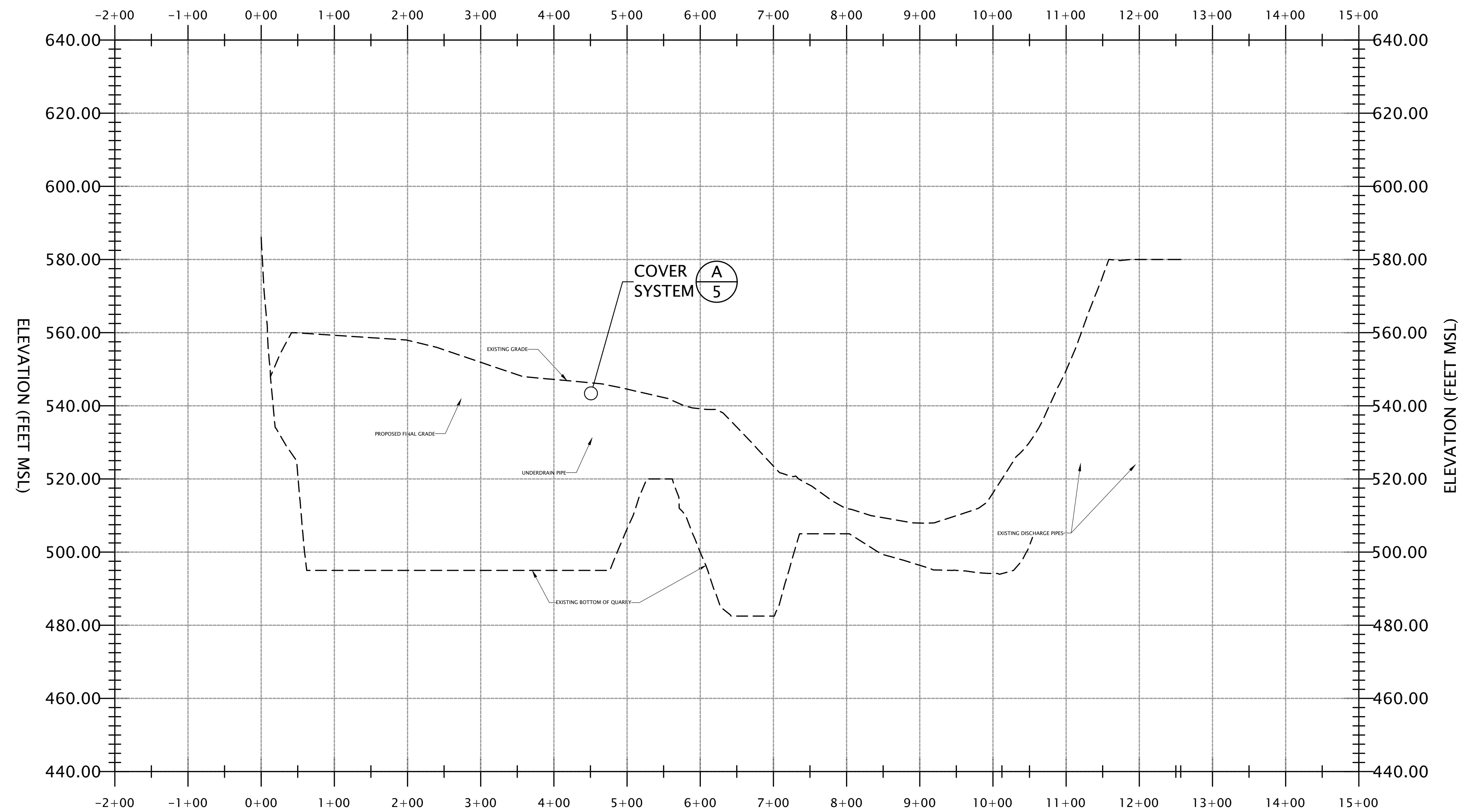
DESIGN NOTES:

1) CONCRETE SHALL BE 4000 psi AT 28 DAYS
2) DESIGN FOR H-20 WHEEL LOADING
3) THE STRUCTURE SHALL CONFORM TO ASTM C913.
4) REINFORCE to 0.12 in.sq./L.F. MINIMUM
5) SEAL SHIPLAP JOINTS WITH BUTYL RUBBER
6) SEAL AROUND PIPE PENETRATIONS WITH WATERSTOP RUBBER JOINTS & GROUT

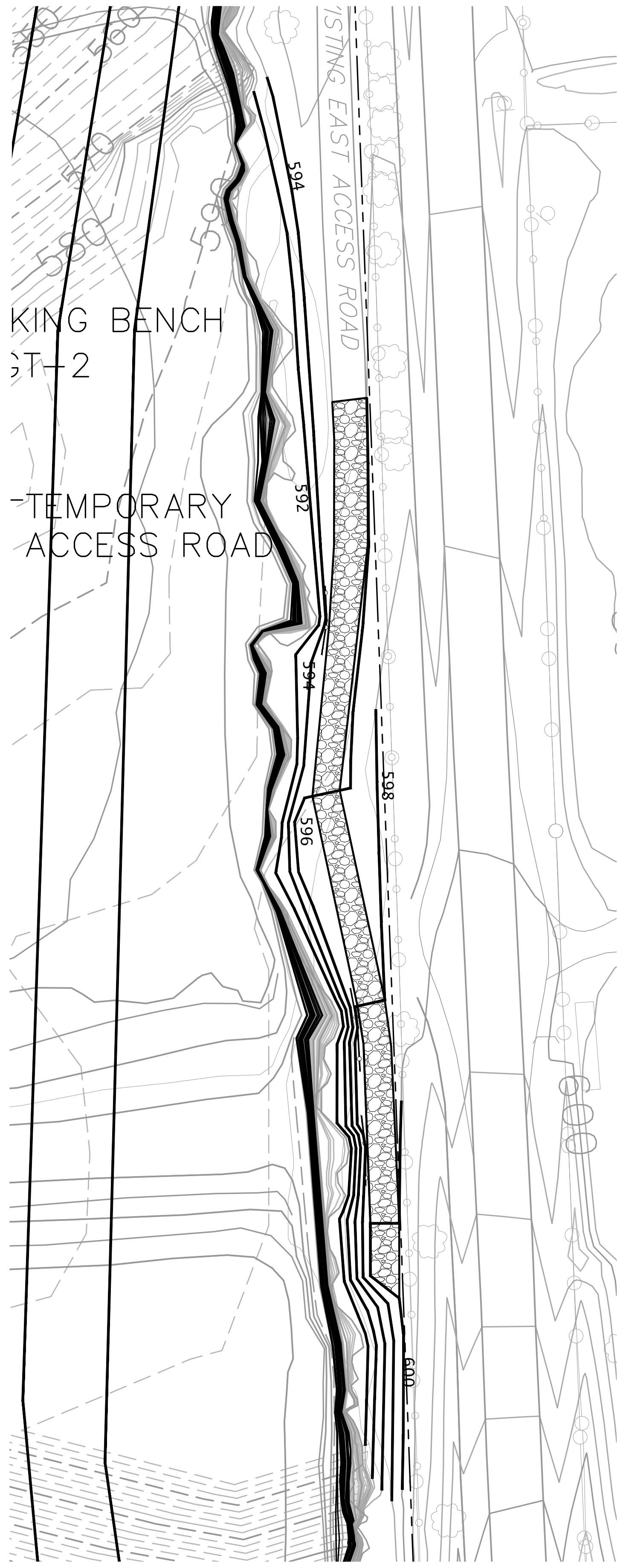
NOTE:

- SLOPED FLOOR MAY BE INSTALLED DURING INLET STRUCTURE INSTALLATION.

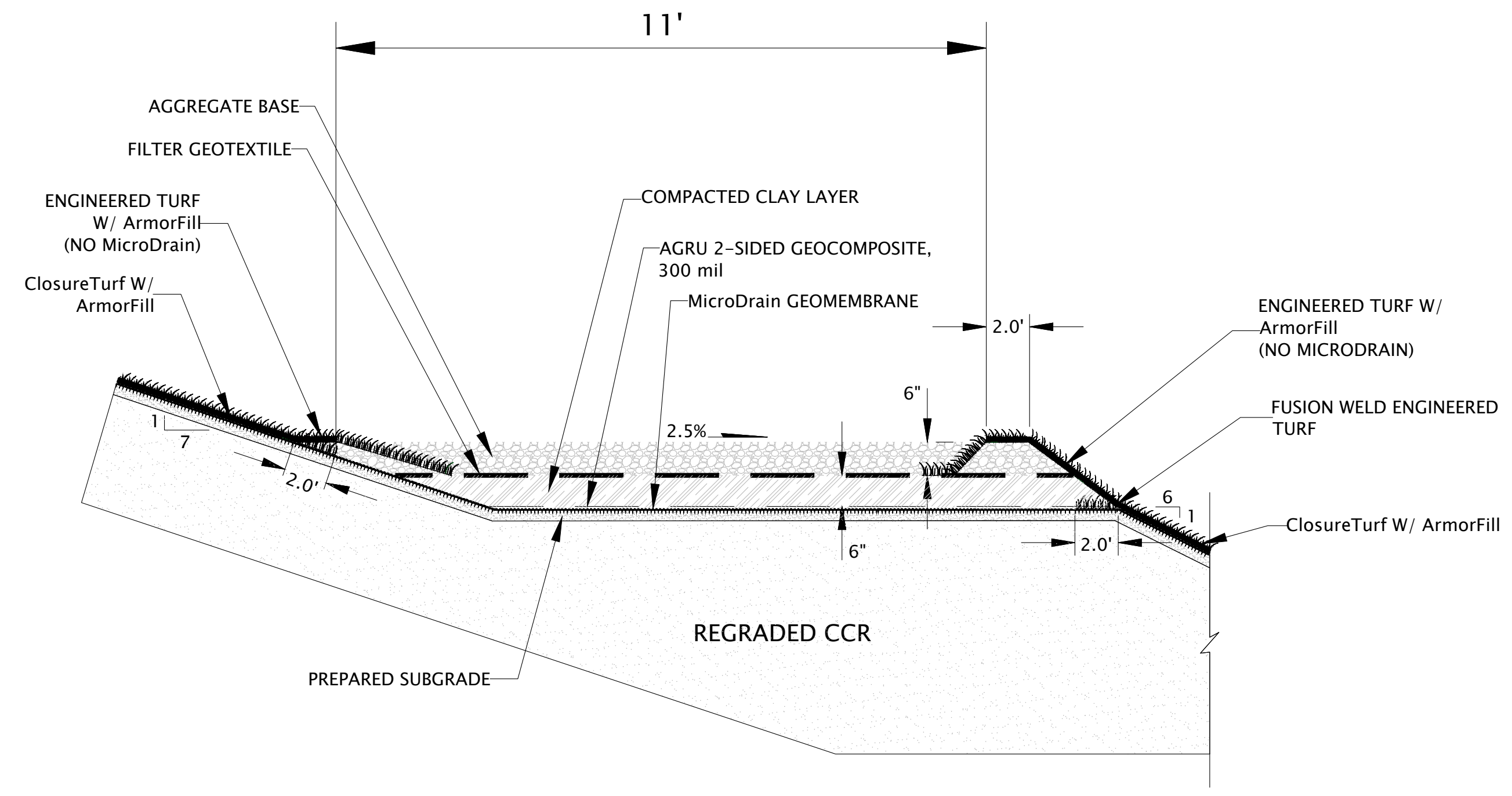
C 5 INLET DRAINAGE STRUCTURE DETAIL N.T.S.



B 5 QUARRY FROM SOUTH TO NORTH PROFILE 1" = 100'



D 5 EAST SLOPE CONTOURS DETAIL PROFILE 1" = 60'



E 5 ACCESS ROAD DETAIL N.T.S.

0 100'
APPROXIMATE SCALE

GENERAL NOTES

ATTORNEY-CLIENT PRIVILEGE WORK PRODUCT

MAP GENERATED BY SIDWELL COMPANY FROM AN AERIAL PHOTO DATED MAY 2014.

540 ───	EXISTING CCR CONTOURS
540 ───	EXISTING TOPOGRAPHIC CONTOURS
───	EXISTING FENCE
───	EXTENT OF SURFACE WATER
○	EXISTING TREE
	EXISTING CLUSTER OF TREES/VEGETATION
───	EXISTING SLUICE PIPES
540 ━━━	PROPOSED CCR MAJOR CONTOURS
538 ───	PROPOSED CCR MINOR CONTOURS
▨	PROPOSED GRAVEL ROADS

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

14665 West Lisbon Road, Suite 2B
Brookfield, Wisconsin 53005
Telephone 262-781-0475
www.KPRGinc.com

PROJECT NAME AND ADDRESS

LINCOLN QUARRY
CLOSURE

1601 S. PATTERSON ROAD
JOLIET, IL 60436

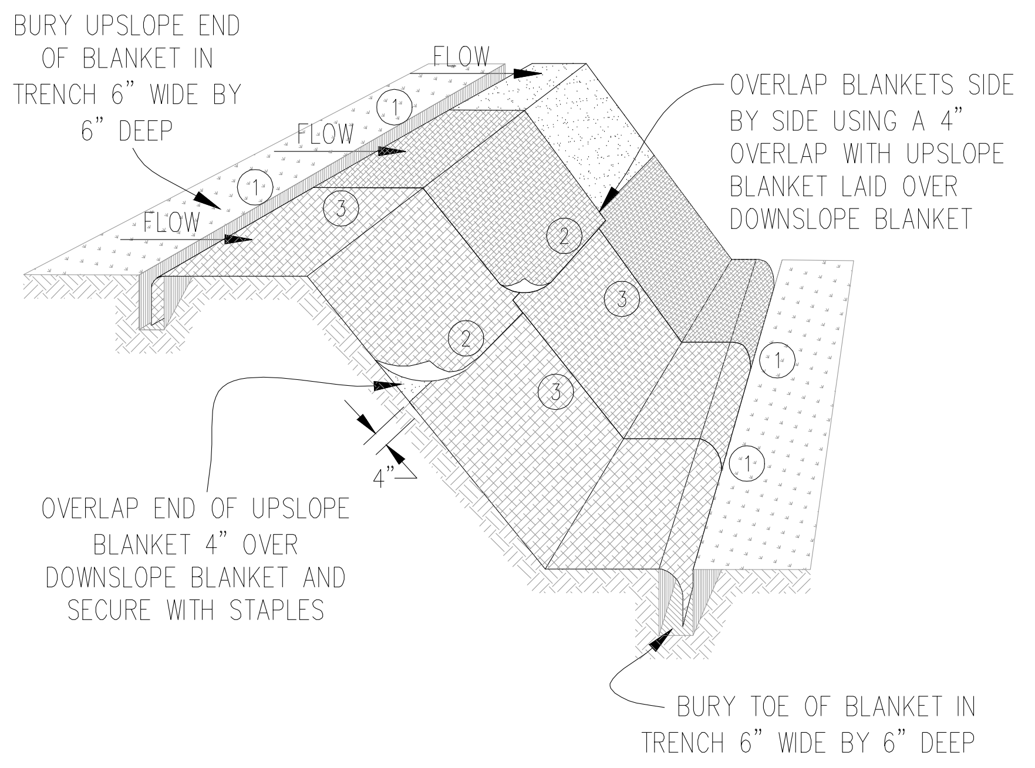
KPRG PROJECT NO.
19620.4

SHEET TITLE
PROFILES AND DETAILS

DRAWING DATE
01/19/22

DRAWING SCALE
1" = 100'

SHEET NO.
5



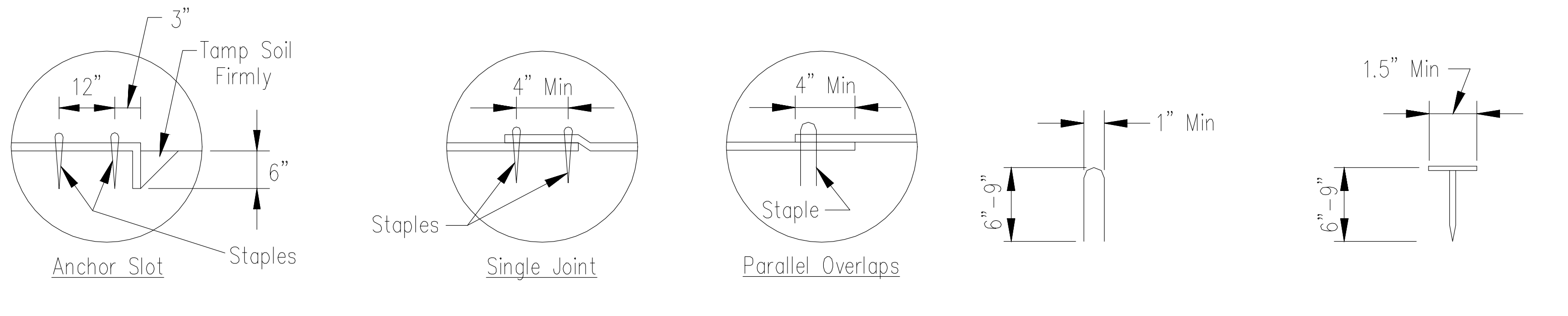
NOTES:

STAPLES SHALL BE PLACED IN A DIAMOND PATTERN AT 2 PER S.Y. FOR STITCHED BLANKETS. NON-STITCHED SHALL USE 4 STAPLES PER S.Y. OF MATERIAL. THIS EQUIATES TO 200 STAPLES WITH STITCHED BLANEKT AND 400 STAPLES WITH NON-STITCHED BLANKET PER 100 S.Y. OF MATERIAL.

STAPLE OR PUSH PIN LENGTHS SHALL BE SELECTED BASED ON SOIL TYPE AND CONDITIONS (MINIMUM STAPLE LENGTH IS 6").

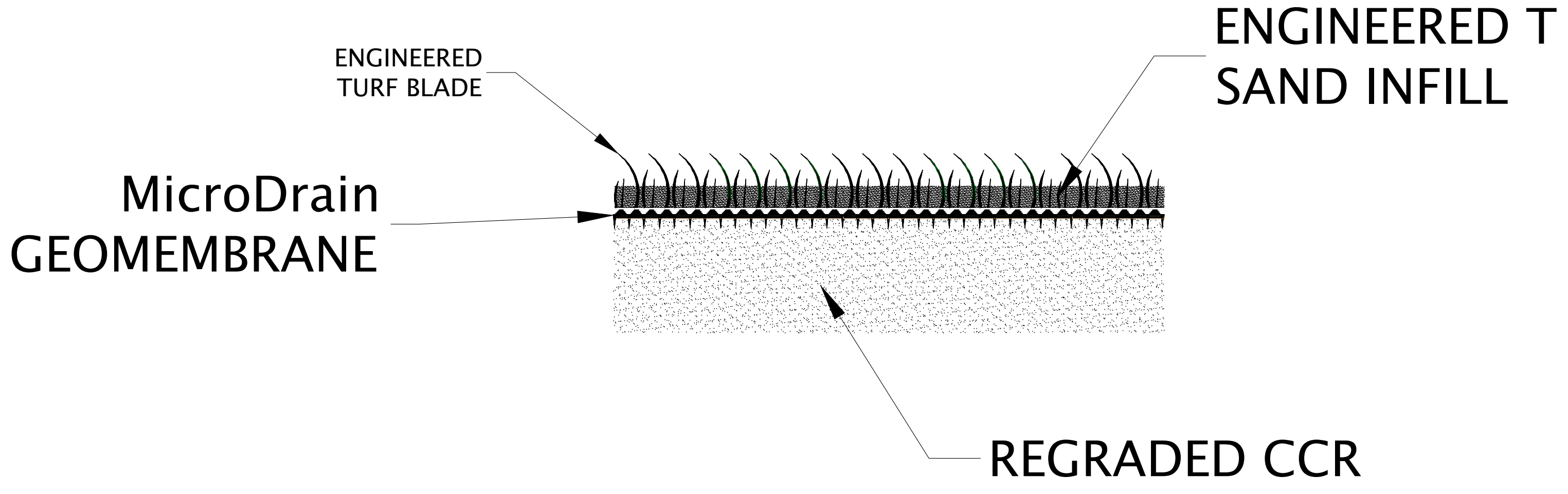
EROSION CONTROL MATERIAL SHALL BE PLACED IN CONTACT WITH THE SOIL OVER A PREPARED SEEDBED.

ALL ANCHOR SLOTS SHALL BE STAPLED AT APPROXIMATELY 12" INTERVALS.



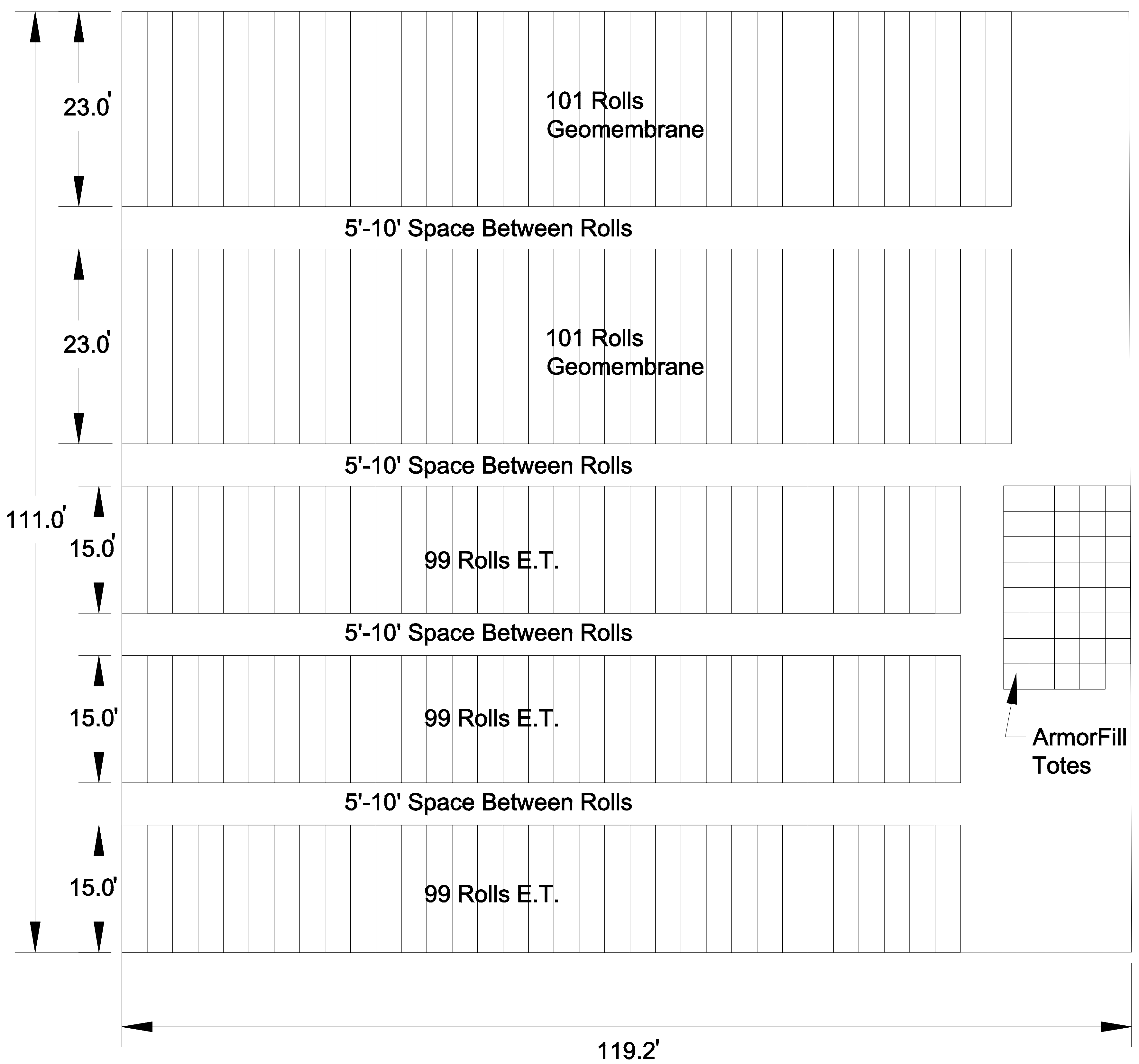
DETAIL 1 DETAIL 2 DETAIL 3 STAPLE DETAIL PUSH PIN DETAIL

G
6
EROSION CONTROL BLANKET
DETAIL
N.T.S.

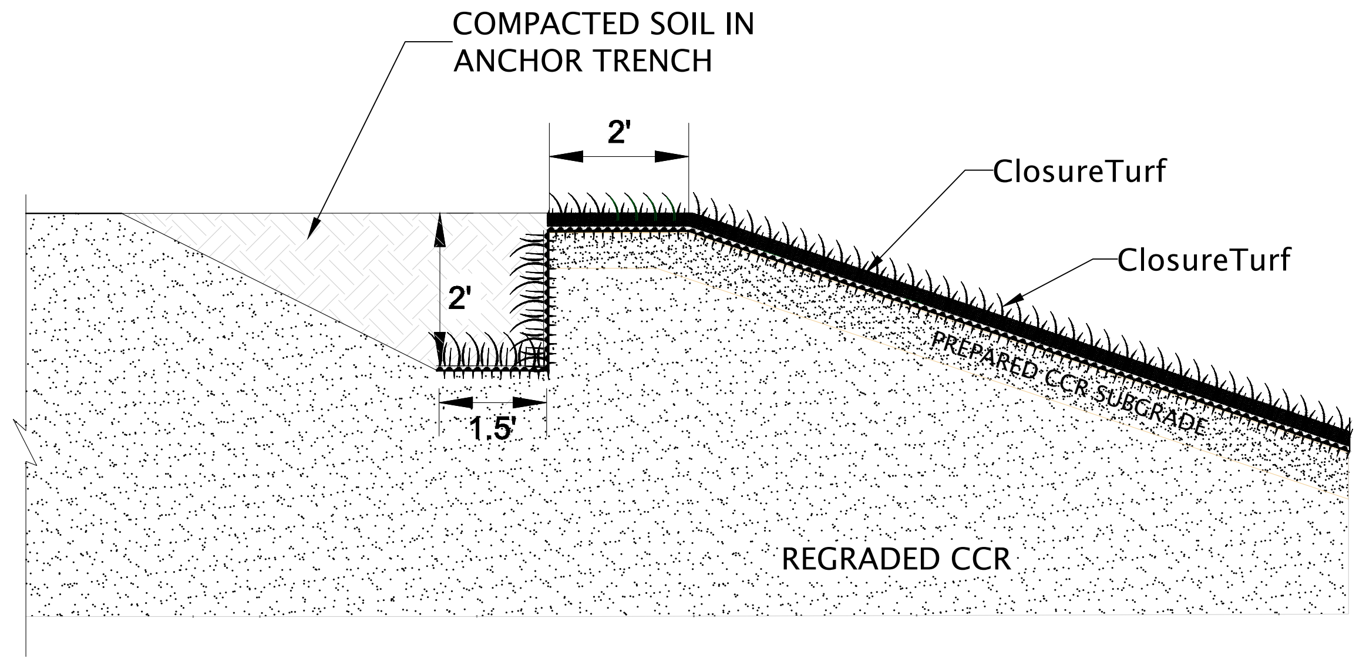


F
6
ClosureTurf COVER SYSTEM DETAIL
DETAIL
N.T.S.

202 Roll Geomembrane Layout
Stacked 3 High Max.



294 Roll Engineered Turf Layout
Stacked 3 High Max.
Roll Diameter is Approx. 3 ft.



H
6
ANCHOR TRENCH
DETAIL
N.T.S.

w:\projects\midwest generation\attorney-client privilege\quarry closure considerations\drawings\lsq prelim design 2016.dwg

0 100'
APPROXIMATE SCALE

GENERAL NOTES

ATTORNEY-CLIENT PRIVILEGE WORK PRODUCT

MAP GENERATED BY SIDWELL COMPANY FROM AN AERIAL PHOTO DATED MAY 2014.

540 ——	EXISTING CCR CONTOURS
540 ——	EXISTING TOPOGRAPHIC CONTOURS
——	EXISTING FENCE
——	EXTENT OF SURFACE WATER
○	EXISTING TREE
	EXISTING CLUSTER OF TREES/VEGETATION
——	EXISTING SLUICE PIPES
540 ——	PROPOSED CCR MAJOR CONTOURS
538 ——	PROPOSED CCR MINOR CONTOURS
▨	PROPOSED GRAVEL ROADS

NO.	REVISION	DATE

PROJECT FIRM AND ADDRESS

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19620.4

SHEET TITLE
DETAILS

DRAWING DATE
01/19/22

DRAWING SCALE
See Barscales

SHEET NO.
6

ATTACHMENT 6
FACILITY COMPONENT PLANS AND SPECIFICATIONS

Attachment 6 – No Attachment

ATTACHMENT 7
CLOSURE CONSTRUCTION

Attachment 7-1 – Final Closure Plan

FINAL CLOSURE PLAN
LINCOLN STONE QUARRY
JOLIET #9 STATION
JANUARY 2022

1.0 Introduction
[845.720(a)(1)(A)]

Midwest Generation, LLC (Midwest Generation) currently operates the natural gas-fired generating station, referred to as Joliet #9 Station, located in Joliet, Illinois ("Site" or "generating station"). Midwest Generation converted the generating station from coal to natural gas in 2016. As part of the previous coal-fired operations, the station operated Lincoln Stone Quarry (LSQ) to manage/store the coal combustion residuals (CCR) created at the generating station as part of the electricity generating process. LSQ consists of an inactive West Filled Area (WFA), the formerly active Main Quarry, and the North Quarry. Decant water from the Main Quarry is gravity drained to the North Quarry. The North Quarry is not used to manage/store CCR but rather as a settling pond that is used to treat the water discharged from the Main Quarry.

The LSQ is operated and permitted as a landfill regulated by Illinois Environmental Protection Agency (EPA) Bureau of Land under 35 Ill. Adm. Code, Subtitle G, Part 811. It has been permitted as a landfill since approximately 1976. The operations are still subject to the conditions and requirements of its landfill Operating Permit No. 1994-241-LFM Modification No. 24. In 2015, the LSQ was also determined to be regulated under the newly passed Federal Register, Environmental Protection Agency, 40 CFR Parts 257.94 and 257.95 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule dated April 17, 2015 (Federal CCR Rule) and subsequent amendments. The LSQ operations also fall under the newly promulgated Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule). LSQ is not currently in service, and no liquids or wastewater is directed into it.

As required by 845.700(b), Midwest Generation will be closing LSQ. A preliminary closure plan was submitted as part of the Joliet #9 Lincoln Stone Quarry operating permit application and is finalized as part of submitting the construction permit application to execute the closure of LSQ. This final closure plan has been executed in accordance with 845.720(b), which includes completing a closure alternatives analysis. Pursuant to 845.710, a closure alternatives analysis was completed prior to selecting the closure method that will be used for LSQ and described in this final closure plan. The closure alternatives analysis was performed to evaluate the closure methods involving closure by removal and closure in place and is included as part of this final closure plan in Attachment 1.

The closure alternatives analysis report evaluated various scenarios that involved either closure by removal or closure in place. The scenarios evaluated are listed as follows:

- Scenario 1: Closure by removal to an off-site landfill;
- Scenario 2: Closure by removal to an on-site landfill;
- Scenario 3: Closure in place with a IEPA prescribed soil final cover system;

- Scenario 4: Closure in place with an alternate final cover system;
- Scenario 5: Closure in place by consolidating the CCR and covering with a final cover system;
- Scenario 6: Closure in place with hydraulic controls;
- Scenario 7: Closure in place with hydraulic containment;
- Scenario 8: Closure in place with a wet closure.

The closure alternatives analysis identified that closure in place provides both short- and long-term protection to groundwater and surface water along with ensuring overall protection to the public health, welfare, and safety. Therefore, Midwest Generation has selected to close LSQ in place and construct an alternative final cover system (Scenario 4) as the closure method. This closure plan has been prepared in accordance with 35 Ill. Adm Code 845.720(b) and 845.750 for LSQ and describes the schedule and steps necessary for closure and methods for compliance with closure requirements.

2.0 Closure Narrative [845.720(a)(1)(A)]

The closure of LSQ will be accomplished by leaving the CCR in place and covering with a final cover system in accordance with 35 Ill. Adm. Code 845.750. The closure will achieve the closure performance standards in accordance with 845.750(a) and listed as follows:

1. Control, minimize, or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

2. Preclude the probability of future impoundment of water, sediment, or slurry;

3. Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

4. Minimize the need for further maintenance of the CCR surface impoundment; and

5. Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.

3.0 Closure with CCR Left in Place [845.720(a)(1)(C)]

LSQ will be closed by leaving the CCR in place in accordance with 845.750. As required, a final cover system (FCS) will be installed over the CCR in accordance with 845.750(c).

The following construction activities will be conducted to execute the closure in place in accordance with 845.750:

- Site Clearing and Decommissioning;
- Dewatering;
- Regrade and Compact CCR;
- Install Underdrain System; and
- Install Final Cover System;

Each of these items are discussed in detail in the following paragraphs.

3.1 Site Clearing and Decommissioning of Sluice Pipelines

Vegetation will be removed from the site to execute the closure. Trees and grass from the east side of the WFA and other areas around LSQ as needed will be removed and disposed of either onsite or offsite. The topsoil and clay on the WFA will be scraped to expose the existing CCR material and stockpiled. This will allow the east portion of the WFA to be regraded to lessen the existing slope and assist in creating the desired elevations needed to install the FCS.

Three sluice pipelines enter LSQ from under Patterson Road along the west side of the WFA. Two sluice pipelines run along the west and south sides of the WFA and then discharge into the southwest corner of the Main Quarry. The third sluice pipeline runs along the north side of the WFA and discharges into the northwest corner of the Main Quarry. Abandoned portions of the former sluice pipelines still exist along the southern perimeter of the Main Quarry.

The FCS will connect to the contours of the existing grade of LSQ and the WFA along the southwest and northwest corners of the Main Quarry. This will require the sluice pipes in these areas to be removed to accommodate the proposed grade of the FCS to be tied into the existing grade. These removed portions of the sluice pipelines will be hauled from the site to a disposal facility or a salvage yard. The remaining portions of the sluice pipelines can be left in place as long as they do not interfere with the closure activities.

3.2 Dewatering

The Main Quarry will be dewatered to an extent to allow the CCR to be regraded and compacted. The Main Quarry discharge pipes will be used to dewater LSQ by gravity to the inlet elevation of the pipes, which is approximately 527.5 feet amsl. At the point where the discharge pipes have dewatered the Main Quarry to the maximum extent possible, the remaining water will be artificially pumped from the Main Quarry through the discharge pipes. The discharge pipes from the Main Quarry drain by gravity into the settling pond located inside the North Quarry, from which the water is then pumped to the Des Plaines River. The discharge to the Des Plaines River is a NPDES regulated outfall. Continuing to pump the water through the discharge pipes will allow this water to be discharged using LSQ’s existing NPDES discharge permit. As much of the water as possible will be pumped from the Main Quarry to expose the CCR. This is necessary to regrade and compact the CCR to minimize settling and allow it to support the FCS.

3.3 Regrade and Compact CCR

The CCR in LSQ will be regraded to a relatively uniform elevation to allow for the placement of the FCS. In general, the majority of the CCR is located in three different places: 1) in the southern portion of the Main Quarry, 2) the WFA and 3) a pile located on the east side of the Main Quarry. The CCR in the southern portion of the Main Quarry will be redistributed over the entire surface area of the Main Quarry to achieve a relatively uniform elevation. The CCR in the WFA has already been covered and will remain covered in place, except for the east slope, which will be regraded to lessen the existing slope and allow for the placement of the FCS. The FCS will then be placed over the CCR in the Main Quarry and the regraded eastern slope of the WFA. CCR from the upper portion of the east pile will be redistributed along with the other CCR in the Main Quarry to form the surface on which the FCS will be placed. This CCR will be distributed over the entire extent of the Main Quarry with the surface sloping towards the existing drainage pipes for the Main Quarry.

The CCR will be compacted to stabilize it prior to placement of the FCS and to reduce the potential for future settling. Due to the sandy composition of the CCR, most settlement will occur during regrading and compaction with time dependent settling of the CCR expected to be insignificant.

3.4 Underdrain

A Groundwater Impact Assessment (GIA) was performed on the groundwater flow system for LSQ in response to the mining operations at Vulcan Quarry. The approved GIA numerical groundwater model was used to evaluate the rebound of the water table once Vulcan Quarry mining to the southeast was ceased along with their ongoing dewatering operations. The model estimated that once Vulcan Quarry ceased mining and the groundwater levels around the Main Quarry returned to passive levels, the water level in the Main Quarry would reach an approximate elevation of 540 ft amsl. In order to address this situation an underdrain system will be installed in the Main Quarry.

The underdrain system will be installed to assist in controlling the flow of groundwater that enters the bottom of the Main Quarry. If the water level within the Main Quarry rises to an approximate 540 ft amsl elevation, this projected water level would be higher than the proposed elevation of the FCS and this would put upward pressure on the FCS. In order to prevent the water level from rising too high and causing upward pressure on the FCS an underdrain system will be installed. The underdrain system will create an outlet for rising groundwater and will prevent any uplifting pressure on the FCS. This portion of the underdrain system will be installed near the existing discharge pipes and consists of five (5) pipes arrayed evenly as a half circle, as shown on Sheet 3. Each pipe is four (4) inches in diameter and three of the pipes are approximately 150 feet long and two of the pipes are approximately 700 feet long. The longer pipes extent toward the south and southwest. The pipes will connect to the existing Main Quarry discharge pipes. The location and configuration would allow the water to be discharged without the need for pumping.

3.5 Installation of the Final Cover System

The closure of LSQ will consist of installing the FCS over the regraded CCR. The FCS will comply with 35 Ill. Adm. Code 845.750(c). The FCS will be the ClosureTurf cover system created by Watershed Geo, LLC, which uses a geomembrane low permeability layer and synthetic turf with a specialized sand infill as the final protective layer. The geomembrane low permeability layer will be installed in accordance with the manufacturer's recommendations. The final protective layer will be constructed to protect the geomembrane from UV damage, minimize erosion, and control stormwater runoff.

ClosureTurf consists of a structured geomembrane overlain by engineered synthetic turf infilled with s specialized sand. The proposed structured geomembrane that will be used is MicroDrain, which is a 50-mil high-density polyethylene (HDPE) structured geomembrane that combines a studded drain surface on the top side and spiked friction surface on the bottom side into one geomembrane liner. The geomembrane will be deployed with the spike side down and the stud side up on top of the regraded CCR. The geomembrane will be deployed perpendicular to the slope elevation contours and the deployment method will protect the geomembrane as well as the regraded CCR. Adequate anchoring will be used, such as sand bags, to prevent uplift by wind during the deployment of the geomembrane. The edges of each geomembrane section are overlapped in the downgrade direction a minimum of three inches to form the seam that is then welded together. Welding is performed by either extrusion welding or hot wedge welding depending on manufacturer's recommendations and as construction of the geomembrane dictates.

Since LSQ does not have a bottom/sidewall liner to tie the FCS into, the geomembrane will abut the vertical rock sidewalls. The slope of the geomembrane will follow the slope of the regraded CCR, which is sloped away from the intersection between the vertical rock sidewalls and the Geomembrane to minimize the potential for infiltration.

The geomembrane will be covered with engineered synthetic turf. The engineered synthetic turf is green and replaces the need for an erosion layer and vegetation while providing a natural look and feel of grass and protecting the geomembrane from extreme weather. The engineered turf will be installed in accordance with the manufacturer's recommendations and equipment used during the installation will not damage the turf or the underlying geomembrane. The engineered synthetic turf will be rolled out on top of the geomembrane starting from the highest slope to the lowest slope. The engineered turf will be deployed so that the filaments of the engineered turf are pointed upslope and the edges of each section touch each other so the seams can be joined together. The turf will be laid substantially smooth and it will be secured with sandbags at the top of any slope after it is deployed. The engineered synthetic turf will cover all of the geomembrane and will follow the same slope as the geomembrane. The sections of the engineered turf are joined together either by sewing with polyester thread or by fusion seaming with a fusion welder.

A specialized sand infill will be placed between the blades of the engineered synthetic turf after the turf is in place on top of the geomembrane. The sand infill will be spread with a minimum thickness of 0.5 inches and a maximum thickness of 0.75 inches using conveyor systems and/or express blowers. The infill will be driven into the space between the synthetic blades and the sand will meet ASTM C-33-03 for fine aggregates. The infill thickness will be checked at approximately

100-foot grid intervals. The sand infill installation will be done as to not damage or displace previously installed ClosureTurf components and the placement will not occur with snow or ice on the engineered turf.

An anchor trench will be used on the top of the slope of the regraded WFA to anchor the ClosureTurf system. The anchor trench will bury the top slope edge of the geomembrane and engineered turf beneath two feet of soil to ensure it does not slide down the regraded slope. The soil that is placed in the anchor trench will be compacted to prevent the potential pullout of the geomembrane and engineered turf. QA/QC testing will be performed on the ClosureTurf cover system as part of the installation.

The FCS will be installed at and below the perimeter rim elevation of LSQ with the FCS sloping inward. Thus, all the runoff from the FCS will drain inward towards the existing discharge pipes. Runoff from adjacent local drainage areas will be drained into the Main Quarry and directed toward the existing discharge pipes, which will convey the runoff to the North Quarry settling pond. The existing discharge pipes are two 20" diameter metal pipes. The existing discharge pipes from the Main Quarry discharge to the settling pond in the North Quarry, from which the water is pumped to the Des Plaines River. The settling pond, and the North Quarry itself, also are below the surrounding ground surface.

The ClosureTurf final cover system uses a geomembrane liner as the low permeability layer control, minimize, or eliminate, to the maximum extent possible, the post-closure infiltration of liquids in the CCR below. The geomembrane's hydraulic flux must be equivalent or superior to a 3-foot layer of soil with a hydraulic conductivity of $1x10^{-7}$ cm/sec. The comparison of the two liners was done based on the liquid flow rate through an area for each layer type. The calculations and their results are shown in Attachment 5-2, which show that the geomembrane with a liquid flow rate of $7.74x10^{-10}$ $cm^3/s/cm^2$ provides a greater reduction compared to the earthen material with a liquid flow rate of $1.15x10^{-7}$ $cm^3/s/cm^2$.

4.0 Maximum Inventory of CCR [845.720(a)(1)(D)]

The maximum inventory of CCR ever on-site is based upon the current quantity of CCR in LSQ, which is approximately 4,300,000 cubic yards (CY). The estimated maximum inventory of CCR that will be covered by the FCS is approximately 2,573,000 CY.

5.0 Largest Area of CCR Requiring a Final Cover [845.720(a)(1)(E)]

The FCS will cover a maximum area of approximately 46 acres.

6.0 Closure Schedule [845.720(a)(1)(F)]

Implementation of closure, as described, is estimated to require forty-three months. Closure completion is estimated to occur by the end of 2026. The initial closure activity is applying for and obtaining an IEPA construction permit and the final closure step is submitting a closure report and closure certification with the closure construction activities occurring in between. Once the closure construction is complete, an acceptance report will be submitted to IEPA. The total time to execute the closure activities is estimated to be approximately forty-three (43) months. An estimated schedule of anticipated closure activities is summarized in the table below:

Table – Closure-in-Place Major Milestone Schedule

Closure Activity	Schedule
Complete Closure Construction Documents and Obtain IEPA Closure Construction Permit	15 Months
Site Clearing and Demolition of Sluice Pipelines	3 Months
Dewatering	5 Months
Regrade and Compact CCR	7 Months
Installation of the Final Cover System	7 Months
Closure Certification and Report	6 Months

7.0 Initiation and Completion of Closure Activities [845.730 & 845.760]

Closure activities will commence when one or more of the following conditions have occurred:

- No later than 30 days after the date on which the CCR unit received the known final receipt of CCR or non-CCR waste;
- No later than 30 days after the removal of the known final volume of CCR for the purpose of beneficial use;
- Within two years of the last receipt of waste for a unit that has not received CCR or non-CCR waste; or
- Within two years of the last removal of CCR material for the purposes of beneficial use.

Upon completion of the IEPA approved closure activities, a closure report and closure certification will be submitted to IEPA in accordance with 845.760(e). The closure report will contain the following information, 1) engineering and hydrogeology reports, including monitoring well completion reports and boring logs, all CQA reports, certifications, and designations of CQA officers-in-absentia required by Section 845.290; 2) photographs, including time, date and location information of the photographs, of the final cover system and groundwater collection system, if applicable, and any other photographs relied upon to document construction activities; 3) a written summary of closure requirements and completed activities as stated in the closure plan and in Part 845; and 4) any other information relied upon by the qualified professional engineer in making the closure certification.

In accordance with 845.760(f), notification of closure of a CCR unit will be made within 30 days of IEPA's approval of the submitted closure report and closure certification. The notification will include certification from a qualified professional engineer, as required by 845.760(e)(2) and will be placed in the facility's operating record.

8.0 Closure Plan Amendments [845.720(a)(3) & 845.720(b)(4)]

This Closure Plan will be amended in accordance with 845.720(a)(3) if a change in the operation of LSQ would substantially affect the content of this Closure Plan or if unanticipated events necessitate revision of the plan. If a change in operation requires amendment to the Closure Plan, the plan will be amended no later than 60 days prior to the change in operation being implemented. If an unexpected event occurs that requires amendment of the Closure Plan, the plan will be amended within 60 days of the unexpected event or within 30 days of the unexpected event if the event occurs after closure activities have commenced. Amendments to this Closure Plan will be certified by a professional engineer registered in the State of Illinois in accordance with 845.720(a)(4).

If this final Closure Plan requires revisions after closure activities have started for LSQ, then Midwest Generation will submit a request to modify the construction permit within 60 days following the triggering event.

9.0 Professional Engineer's Certification [845.720(a)(4)]

This Closure Plan for Joliet #9/Lincoln Stone Quarry has been prepared to meet the requirements of 845.720(b).

1/19/22
Joshua D. Davenport, P.E.
Illinois Professional Engineer

SEAL

JOSHUA D. DAVENPORT
062-061945

Attachment 7-2 – Closure Alternatives Analysis

LINCOLN STONE QUARRY CLOSURE ALTERNATIVE ANALAYSIS

Submitted to

Midwest Generation

Submitted by

Geosyntec
consultants

engineers | scientists | innovators

January 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

AACE	Association for the Advancement of Cost Engineering
AGQS	Applicable Groundwater Quality Standards
bgs	below ground surface
CO_2	Carbon Dioxide
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
COIPs	Constituents of Potential Interest
CQA	Construction Quality Assurance
CY	Cubic Yard
°F	Degrees Fahrenheit
ft^3	Cubic Feet
ft AMSL	feet above mean sea level
GIA	Groundwater Impact Assessment
GMZ	Groundwater Management Zone
IAC	Illinois Administrative Code
ICA	Interim Corrective Actions
IEPA	Illinois Environmental Protection Agency
lb	Pounds
lbs/yd^3	Pounds per Cubic Yard
LLDPE	Linear Low-Density Polyethylene
MCY	Million Cubic Yards
MNA	Monitored Natural Attenuation
MSW	municipal solid waste
USEPA	United States Environmental Protection Agency
ZOA	Zone of Attenuation

EXECUTIVE SUMMARY

The Lincoln Stone Quarry (LSQ) consists of three units, the West Fill Area (WFA) which has a soil cover, the Main Quarry and the North Quarry. The Main Quarry is currently inactive and requires closure since the existing Joliet # 9 and #29 power plant units have been converted to natural gas. The Main Quarry is approximately 43 acres in size and approximately 150 feet in depth and contains approximately 2.6 million cubic yards (cy) of coal combustion residuals (CCRs). The WFA is approximately 17 acres in size and contains approximately 1.7 million cy of CCRs. The North Quarry did not accept waste materials and therefore does not require closure.

Geosyntec developed and evaluated eight different closure approaches or alternatives at the LSQ: (1) Closure by Removal of CCRs to an existing off-site permitted landfill, (2) Closure by Removal of CCRs to a new on-site landfill, (3) Closure in Place with IEPA Prescribed Final Cover, (4) Closure in Place with Alternate Final Cover System, (5) Consolidate and Close in Place, (6) Closure in Place with Hydraulic Controls, (7) Closure in Place with Hydraulic Containment, and (8) Closure in Place with a Wet Cap.

All closure scenarios were assessed for several different factors including short and long-term effectiveness in controlling future releases to the environment, risk to nearby receptors, groundwater and surface water protection, and cost. Additional factors such as: actuarial risk (i.e., worker safety and vehicle safety) and greenhouse gas assessments were further evaluated to define impacts on public safety and the environment. **Table ES-1** provides a summary of the closure scenario factors including costs.

Scenario 1 “Closure by Removal to an Existing Off-Site Landfill” had the highest accident rate (vehicle and worker safety) and greenhouse gas footprint. Scenario 1 was also assessed to be impractical due to the lack of available nearby permitted airspace, cost, dewatering challenges, accident potential, lack of transportation infrastructure, and significant greenhouse gas footprint that results from removal of 4.3 million cubic yards of CCR to an off-site landfill. Continued operation of the current groundwater extraction system would also be required to address residual groundwater quality in the GMZ and potential seepage from the WFA. Lastly, groundwater modeling indicates that the required dewatering of the LSQ would impact (i.e. dry out) nearby private water wells.

Scenario 2 “Closure in Place to a New On-Site Landfill” and Scenario 8 “Closure in Place with Wet Cap” were also assessed to not be implementable. For Scenario 2, there was not on-site property available or nearby property for purchase for a new landfill. Scenario 8 was assessed as not implementable due to the difficultly to get regulatory approval for a “wet” cap design.

The Closure in Place scenarios (Scenario Nos. 3 -7) eliminated the removal of over 4.3 million cubic yards of CCR and therefore, reduce accident potential and greenhouse gas emissions by an order of magnitude when compared to Closure by Removal scenarios. Additionally, by eliminating stormwater recharge through the CCR waste mass via final cover placement, a more effective inward groundwater hydraulic gradient condition will be obtained after closure thereby addressing existing and future groundwater quality.

Various closure in place scenario alternatives were completed. For example, Scenario 5 “Consolidate and Close in Place” reduced the closure footprint, thereby reduced the volume of CCRs requiring regrading and final cover area placement, which resulted in the most cost effective Closure in Place scenarios that are deemed implementable. Scenarios 6 and 7 (hydraulic control and containment) provides additional and redundant engineered control systems for groundwater protection. The closure in place scenarios would require continued operation of the current groundwater extraction system to address residual groundwater quality in the southern groundwater management zone (GMZ) and potential seepage from the WFA.

When all factors were considered, the Closure in Place scenarios provided both short- and long-term effectiveness in the prevention of future releases to groundwater and surface water sources and provide the best protection to public health, welfare and safety when other factors such as greenhouse gas emissions, worker safety and traffic safety were assessed. Based on the most recent information availability, Scenario 4 “Closure in Place with Alternate Final Cover” is the preferred closure scenario because this scenario will have the lowest potential impact to the environment while ensuring protection to public health, welfare and safety.

SECTION 1

INTRODUCTION

1.1 Terms of Reference

This report was prepared by Geosyntec Consultants (Geosyntec) for the Lincoln Stone Quarry (LSQ) near Joliet, Illinois at the request of Midwest Generation, LLC. (Midwest Generation). This report was authored by Mr. Jesse P. Varsho, P.E., P.G. (Illinois), Ms. Megan Martz and Ms. Megan Kilian, and it was reviewed by Mr. Phil Harvey, P.G. (Illinois) and Dr. Ryan Fimmen, all Geosyntec.

1.2 Background and Scope of Work

The LSQ is owned and operated by Midwest Generation and occupies approximately 120 acres on the south side of the Des Plaines River in Joliet, Illinois. LSQ is geologically located in dolomite bedrock. The LSQ is located at the Joliet #9 Generating Station at 1601 South Patterson Road.

The purpose of this report is to present the results of a closure alternatives analysis for the LSQ. For each closure option the risk, effectiveness of controlling future releases, and the implementation process was evaluated and discussed. Finally, a Class 4 cost estimate under Association for the Advancement of Cost Engineering (AACE) Classification Standard was completed. This closure alternative analysis generally follows the methodology described in the 35 Illinois Administrative Code (IAC) 845.710 regulations.

As noted above, as part of this assignment, Geosyntec reviewed the previous closure plan and associated groundwater impact assessment (GIA) model for the Landfill to identify if the assumptions used in these analyses are reasonable and represent current and/or anticipated future site conditions, and if the analyses are technically appropriate.

1.3 Limitations of Report

As requested by Midwest Generation, the focus of this alternative closure evaluation is on identifying and evaluating closure scenarios based on several different criteria. Therefore, the scope of services conducted by Geosyntec did not involve a detailed review of all LSQ's operations, environmental data, and systems. Geosyntec's conclusions and recommendations are considered preliminary and may be revised based on additional data or new information that becomes available.

The following information, as summarized in Section 11, was relied upon by Geosyntec in performing its evaluation and preparing this report. Other than developing our own independent cost estimate, as explained in Section 10.5, Geosyntec did not independently validate the accuracy of the information contained in these documents.

SECTION 2

SITE INFORMATION

2.1 General Site Information

Midwest Generation currently operates two natural gas-fired generating stations, located in unincorporated Will County near Joliet, Illinois. The LSQ has operated as a disposal facility for bottom ash/boiler slag from the two formerly coal-fired generating stations (Joliet Stations #9 and #29) since circa 1962. The overall disposal facility consists of an inactive portion referred to as the WFA, the North Quarry that did not receive CCR, and the inactive bottom ash/slag disposal area referred to as the Main Quarry as shown on **Figure 2-1**. LSQ is operating under an Illinois Environmental Protection Agency (IEPA) solid waste landfill Permit Number 1994-241-LFM, Modification No. 24, dated June 11, 2018 [IEPA, 2018].

Initial disposal activities began in the WFA, approximately 14 acres in size, and included disposal of fly ash, bottom ash, and slag. The WFA ceased accepting CCRs in approximately 1975 and the area was leveled to drain stormwater and vegetated. In the early 1980's, the existing soil cap was enhanced with additional two feet of soil [IPCB, 1996].

The North Quarry (also referred to as the Lower Quarry) is located north of the Main Quarry and contains a settling pond and pumping system for discharging water to the Des Plaines River. The North Quarry did not accept waste materials and therefore does not require closure.

The consolidated CCR waste volumes within the Main Quarry are estimated at 2.6 million cubic yards (MCY) and 1.7 MCY for the WFA for a total CCR volume of 4.3 MCY. Analysis and discussion of Closure in Place scenarios utilize the total CCR volume in design and cost calculations provided herein, however for the Closure by Removal scenarios a volume bulking or swell factor of 30 percent was applied to the consolidated CCR volume based on the grain size distribution (i.e. silts and sands) of the CCR [Coduto, 1998]. The estimated waste volume can reasonably be expected to expand upon excavation, dewatering, and loading for transport to the selected landfill. The expanded volume is estimated at 5.6 MCY for Closure by Removal design and cost calculations.

2.2 Permit History

The operating permit for the LSQ was renewed with Modification No. 24, dated June 11, 2018. That current permit was due to expire May 21, 2019 but is still considered active as the permit renewal application was submitted in a timely manner. Relevant permit modifications include for LSQ include:

- Permit Log No. 2019-059, pending; for renewal of the current operating permit;

- Permit Log No. 2018-105, approved 3/13/2018; approved the annual assessment report of the interim corrective action (ICA) as required by permit conditions.
- Permit Log No. 2012-113, approved 4/3/2012; approved the construction quality acceptance (CQA) report for the expanded ICA extraction wells at the facility;
- Permit Log No. 2011-15, approved 4/1/2011; approved the expansion of the existing ICA extraction well system along the southside of the facility; and
- Permit Log No. 2009-443, approved 9/3/2009; approved the installation of ICA extraction wells in the southwest corner of the facility.

2.3 Adjusted Standard

On Aug. 15, 1996, the Pollution Control Board granted the prior owner of the Quarry an adjusted standard from certain operating and closure requirements of 35 Ill. Adm. Code 811 and 814 due to the unique nature of the Quarry ("Adjusted Standard" or "Order", AS 96-9). Condition 7 of the Adjusted Standard provided for two methods for the Main Quarry's closure. The two methods were either wet closure for which no final cover was required or, dry closure by installation of a two-stage cover system consisting of two feet of soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec overlain by four inches of topsoil. (Ex. 1, Order, Condition 7, pp. 22-23) [IPCB, 1996].

In 2015, the U.S.EPA promulgated the Coal Combustion Residual ("CCR") Rules, 40 CFR 257. Under the CCR rules, as it is currently drafted, all CCR impoundments utilizing a "closure in place" scenario are to be closed via dry closure. Because the Main Quarry may be defined as a "CCR Impoundment" as defined in the Federal CCR rules, the Main Quarry may be closed via dry closure with a two-stage cover system [NRG, 2016].

2.4 Environmental Controls

2.4.1 Liner and Leachate Collection Systems

The requirement for a liner system, leachate drainage, collection, and management system does not apply to the Main Quarry as stated in Order and Opinion of the IPCB, AS-96-9, dated August 15, 1996 [IPCB, 1996].

2.4.2 Groundwater Monitoring System

Groundwater quality and flow conditions for the facility are monitored on a quarterly basis through an approved groundwater monitoring well network consisting of both detection wells and assessment wells, which cover all four sides of the facility. A map illustrating the locations of the monitoring wells is provided as **Figure 2-1**.

Most of the groundwater monitoring locations consist of “well clusters” with two to three wells per cluster. The “WT”, “S” and “D” nomenclature on **Figure 2-1** indicates at what level or depth below groundwater surface (bgs), a particular well is screened. “WT” stands for a well screened across the water table. “S” stands for a well screened within the “shallow” bedrock zone. “D” stands for a well screened within the “deep” bedrock zone.

The operating permit for the facility requires quarterly groundwater quality monitoring for pH, specific conductance, temperature, water level, ammonia, arsenic, boron, cadmium, chloride, fluoride, manganese, molybdenum, potassium, selenium, sodium, sulfate, total dissolved solids, total organic carbon and zinc. In addition, barium, copper, iron, lead, mercury and nitrate are monitored on an annual basis. The results of each round of groundwater monitoring are compared against applicable groundwater quality standards (AGQSs) or background levels that were developed for the facility and included in its permit. Certain monitored parameters have been detected at various on-site monitoring wells above the respective AGQSs including permit well locations G46S, G47S and G48S located at the southeast side of the landfill [KPRG, 2010].

2.4.3 Stormwater Management

Current surface water control features include earthen berms, discharge piping, Main Quarry bedrock walls, and vegetated perimeter lands of the Quarry. Surface water discharges to the Des Plaines River (via the North Quarry), and is regulated by NPDES Permit Number IL0002216, which a timely renewal application was submitted prior to the current expiration date of October 31, 2019 (Aptim, 2019). Discussion of anticipated future stormwater management features under closed conditions is presented in detail in Section 9.2.

2.4.4 Permitted Final Cover System

The closure plan for the Quarry has been revised to accommodate the requirements in the federal CCR rule, 40 CFR Part 257. The revised closure plan was included in the permit renewal application [KPRG, 2019b]. It is noted that the revised closure plan includes a standard dry closure final cover and wet closure as currently approved by the existing operating permit and existing Adjusted Standard (AS-96-9, dated August 15, 1996), as well as a proposed alternate final cover synthetic turf system called ClosureTurf®.

Proposed alternate closure scenarios within the permit-approved dry, wet, and synthetic turf closure systems are discussed further in Section 4 of this report.

2.4.5 Groundwater Extraction System and Groundwater Management Zone (GMZ)

Pursuant to Permit Modification Nos. 12 and 13, dated December 1, 2009 and July 1, 2010, respectively, IEPA required Interim Corrective Actions (ICA) to address the reversal of flow within the lower Silurian dolomite adjacent to the southern portion of the landfill, and an interim Groundwater Management Zone (GMZ) to define and monitor groundwater concentrations of boron, molybdenum, arsenic, and sulfate that exceeded the respective AGQSs in the area proximal to the south/southeastern corner of the Main Quarry. Migration of the constituents of potential interest (COPIs) to the southeast is related to the reversal of groundwater flow (normally northerly, inward gradient) due to increased pumping at the nearby Laraway Quarry. The ICA consists of two main components [KPRG, 2020]:

- A twelve well groundwater extraction system along the southern edge of the Main Quarry and WFA has been operating since February 2012. The objective of this pumping system is to establish a sufficient hydraulic trough between the Main Quarry/WFA and the southern LSQ property boundary to capture water moving from the facility to the south and to re-establish an inward hydraulic gradient from the south property boundary to the north. The extraction system has been performing adequately.

- Assessment groundwater quality monitoring on a quarterly basis for the full list of permit-specified G1 and G2 parameters from both on-site and off-site monitoring wells. The objectives of the monitoring are to define the extent of migration to the southeast for the interim GMZ and to evaluate the effectiveness of the extraction wells system operation on water quality along the southeast perimeter of the landfill.

SECTION 3

GEOLOGIC AND HYDROGEOLOGIC SETTING

3.1 Regional Geologic Setting

Regional and site-specific data documents fractures in the Silurian dolomite. This is consistent in describing a primary joint set that is vertical and oriented about N52E and N40W. The N40W joints are described as “more distinct”. Natural spacing between the joint sets ranges from 3 to more than 10 feet, and joint apertures are described as less than 1/16th-inch. Bedding plane fractures are also noted. Descriptions from the quarry walls and from cores obtained during drilling show significant clay infilling of the vertical joints and bedding plane fractures. Evidence of water movement through fractures is interpreted from iron staining and mineralization (primarily calcite, with some pyrite and marcasite) [KPRG & Geo-Hydro, Inc., 2013].

Additional fracturing is observed at the quarry wall and the fractures/joints at the wall tend to be more open. This is interpreted to be a localized phenomenon that is the result of the blasting and unloading from quarry operations. This effect does not appear to extend greater than about 10 or 15 feet away from the quarry wall [KPRG, 2013].

3.2 Site Geology

3.2.1 Unconsolidated Units

Surface soils around the LSQ facility are comprised of approximately 30 feet of unconsolidated glacial overburden (the thickness varies across the site).

3.2.2 Bedrock

Dolomite beneath the facility is divided into a “shallow” Silurian zone and a “deep” Ordovician zone. These two more permeable zones are separated by a lower permeability shale (Brainard Shale). The shallow zone dolomite is approximately 140 – 150 feet thick, placing the contact between the base of the dolomite and the top of the shale at approximately 430 – 440 feet above mean sea level (ft MSL). The thickness of the Brainard Shale is approximately 10 feet, with its base elevation ranging from approximately 420 – 430 feet MSL. The deep zone dolomite is 30 – 40 feet thick, placing the contact between the base of the deep zone and the underlying Scales Shale regional aquitard at an elevation of approximately 380 – 400 feet MSL.

The deepest portions of the LSQ Main Quarry lie at an elevation of approximately 477 feet MSL, which is within the Silurian dolomite zone and above the Brainard Shale low permeability zone.

Previous hydrogeologic evaluations have interpreted a horizon of higher permeability within the Silurian dolomite. The higher permeability zone extends from approximately 500 feet MSL down to 430 feet MSL and is partially penetrated by the LSQ. This increased permeability feature assists in the understanding an interpretation of existing groundwater flow conditions beneath the site. [KPRG & Geo-Hydro, Inc., 2013].

The Silurian dolomite is divided into four units identified as a weathered bedrock rind, Joliet Formation dolomite, Kankakee Formation dolomite and the Elwood/Wilhelmi dolomite. Beneath the Silurian dolomite is the Ordovician age Maquoketa Group consisting of the Brainerd Shale, Fort Atkinson dolomite and the Scales Shale. The Scales Shale unit is a recognized regional aquitard, which hydraulically isolates the deeper bedrock aquifers from the shallower units [KPRG, 2020].

3.2.3 Mining Operations

Prior to being used as a disposal facility for bottom ash/boiler slag beginning in 1960's, limestone bedrock was mined from the Quarry. The overall size of the Quarry is approximately 2,250 feet by 1,230 feet in plan area (total plan area of approximately 66 acres). The overall plan area of the Quarry consists of the WFA, the Main Quarry, access roads, and undisturbed land along the perimeter. The plan area of the WFA is approximately 14 acres and the Main Quarry is approximately 43 acres, with the remaining 9 acres consisting of the access roads and undisturbed land. The approximate top elevation of the Quarry ranges from 582 feet MSL along the north, 596 feet MSL along the east, 590 feet MSL along the west, and 608 feet MSL along the south. The bottom of the quarry ranges from 477 feet MSL along the northeast portion to 520 feet MSL along the northwest portion. The southern portion of the Quarry is around 495 MSL, with higher elevations (500 to 520 feet MSL) along the perimeter [KPRG, 2019].

The Laraway Quarry facility is located directly southeast of the LSQ facility and is continuing to expand quarry operations within its permitted limits. The associated depression of the local groundwater table will continue to be a factor in controlling the inward groundwater gradient at the LSQ facility until operations at the Laraway Quarry are complete and groundwater can return to its natural elevation and northerly flow direction.

3.3 Site Hydrogeology

Groundwater beneath the facility occurs under unconfined water table conditions. The monitoring wells screened across the interface between the unsaturated and saturated zones are referred to above as the "WT-series" or "water table wells." The base of the Main Quarry is at elevations ranging from approximately 494 to 477 feet MSL, which is within the lower portion of the Silurian Dolomite. The deeper portion of the Main Quarry is on the south side of the facility and the shallower portion is toward the north. Shallow zone (or S-series) monitoring wells are screened at elevations at or just below the base of the Main Quarry.

The Brainerd Shale is a lower permeability zone, which hydraulically separates the overlying Silurian dolomite from the Fort Atkinson dolomite. Deep zone (or D-series) monitoring wells at the facility are screened within the Fort Atkinson dolomite. Both water level and chemistry data from the deep zone wells indicate that the Brainerd Shale provides separation between the shallow and deep zones. Groundwater flow within the deep zone is to the west. [KPRG, 2020]

3.3.1 Groundwater Flow

Groundwater flow near and under the Main Quarry would naturally be to the north and toward the Des Plaines River. However, the static water level in the Main Quarry is generally maintained at an elevation of 540 to 550 ft MSL which is below the natural water table of the surrounding deposits. This surface water level is maintained in the Main Quarry by a stormwater pipe that drains the Main Quarry to the north into the Southeast Pond, which eventually drains to the Des Plaines River. Accordingly, there is an existing inward gradient from the shallow deposits into the Main Quarry without the influence of the nearby Laraway Quarry which is discussed below.

Field observations during drilling, formation packer testing at various depth intervals, and down-hole geophysical logging conducted by previous consultants have identified that the lower portion of the Silurian dolomite is more permeable than the upper portion of the dolomite. Ongoing dewatering operations within the Laraway Quarry (approximately 1,000 feet to the southeast) over the last 18 years have affected the natural flow conditions within the area such that it created a component of groundwater flow away from the eastern half of the south side of the Main Quarry to the southeast, toward Laraway Quarry. This water is drawn through the defined higher permeability materials within the lower portion of the Silurian dolomite. Flow at the water table has continued to move to the north and discharges to the Main Quarry in accordance with permit requirements. The Laraway Quarry dewatering operations have not affected the natural inward gradient into the Main Quarry from the east and the south at the water table. The amount of overburden between Laraway Quarry and the Main Quarry allows sufficient storage at the water table level [KPRG, 2020].

3.3.2 Groundwater Quality

Since the start of expanded extraction system pumping on February 16, 2012, quarterly groundwater quality data has been obtained from wells G38S, G39S, G45S, G46WT, G46S, G47WT, G47S, G48WT, G48S, and T01S through T11S. The samples were analyzed for the full list of G1 and G2 parameters specified in the current operating permit. The 2019 sampling data from permit wells along the southern perimeter of the LSQ and off-site assessment wells to the south are summarized in Section 6.2 of this report. It is noted that detections of constituents (including COPIs boron, molybdenum, arsenic, and sulfate) in off-site monitoring wells above the established AGQS are contained within the IEPA approved GMZ established as part of the overall ICA as discussed above [KPRG, 2020].

3.3.3 Previous and Current Groundwater Controls

As discussed in Section 2.4.5, the existing ICA include a groundwater extraction system consisting of 12 wells (X101 – X112). The wells are generally constructed to a depth of approximately 142 to 146 feet bgs, with 40 feet of 0.032-inch slot screen. This results in screened pumping intervals of approximately 444 feet MSL to 484 feet MSL. This screened interval coincides with the higher permeability zone within the lower portion of the Silurian dolomite and intercepts the base of the southern boundary of the Main Quarry.

The operation of the ICA extraction well system is regularly affected by scaling and mineralization related to the natural geochemical reaction between the CCR leachate (including COPIs boron, molybdenum, arsenic, and sulfate) and the minerals in the Silurian dolomite as groundwater circulates through. An existing O&M plan routinely assesses system components, and provides guidance on cleaning, repair, and replacement schedules for scaled pumps and conveyance lines.

SECTION 4

PROPOSED ALTERNATE CLOSURE SCENARIOS

This section provides a high-level summary of potential alternate closure scenarios that were evaluated; additional detail regarding the level of effort required to implement a given closure scenario is provided in Section 9.

4.1 Closure by Removal

The Closure by Removal scenarios consider levels of effort necessary to excavate existing CCR waste from the Main Quarry and relocate it to a permitted landfill facility. The source removal approach is intended to mitigate potential near-term impacts to human health and the environment via the groundwater exposure pathway, as well as minimize long-term management needs associated with post-closure stewardship at the LSQ facility. High-level work scope summaries of the two Closure by Removal scenarios are provided below, and the associated cost estimates are provided in **Appendix D**.

4.1.1 Existing Off-Site MSW Landfill

Closure by Removal with material placement at an existing off-site municipal solid waste (MSW) landfill involves dewatering and maintaining the depressed hydraulic conditions at the Main Quarry, excavation, loading, transport, and disposal of 5.6 MCY of CCR material (existing in-place 4.3 MCY plus 30% expansion factor).

Based upon a review of the 2020 Landfill Capacity Report [IEPA, 2021], there are two off-site permitted active landfills in Will County: Laraway Recycling & Disposal and/or Prairie View Recycling & Disposal. These facilities may be able to accept some or all of the CCRs from the Lincoln Stone Quarry. The next nearest out of county landfill is the Livingston Landfill located over 50 miles from the LSQ. Additional discussion of available landfill disposal capacity is provided in Section 9.1.2.

4.1.2 Modes of Transport

The recent approved Illinois regulations related to CCR closure alternatives, Illinois Administrative Code (IAC) 845.710, requires the assessment various forms of transport for the closure by removal scenarios. The various transport modes to be included in the closure alternatives include rail, barge, trucks or a combination of these transportation modes. Each of these transport modes are discussed below:

4.1.2.1 Rail Transport

Rail may be advantageous as a transport mode since it minimizes the need for trucks to transport CCRs on public roadways, and therefore, minimizes the potential impacts to public roadways and associated users. In order to transport CCRs from the LSQ two transfer stations would have to be sited, permitted, designed, and operated. The first transfer station would have to be located at the LSQ facility and would transfer CCRs from haul trucks to a rail car. The second transfer station would have to be located near the proposed disposal facility to order to transfer the CCR from the rail cars to a haul trucks for disposal at the third-party off-site disposal facility.

Based on Geosyntec's experience at designing similar facilities and the anticipated CCR volumes and rates, we estimate the necessary transfer station building size would be on the order of 25,000 to 30,000 square feet. Other necessary infrastructure that would be necessary would include a rail spur to stage loading or unloading of rail cars and then connect to the rail line. The size of the rail spur, based on Geosyntec previous experience, would be on the order of 2,500 feet by 300 feet (750,000 sq. feet or approximately 17 acres).

In reviewing the available areas at the LSQ facility, there is not sufficient area for the rail transfer station at the Main Quarry or WFA (i.e., land south of Patterson Road). For potential areas on the North Quarry (i.e., land north of Patterson Road), the vast majority of the area is needed to support stormwater management after closure of the facility and therefore is not available for development. Additionally, a road crossing and associated permit would be necessary to cross the public Patterson Road and would create an additional public hazard due to the significant volumes of trucks crossing over the road.

Lastly, Geosyntec is not aware of any active rail transfer stations in Illinois or adjacent states. Therefore, it would take a minimum of three years, most likely closer to five years, to site, permit, design and construct a rail transfer station at the disposal site which would unnecessarily extend the closure schedule.

Due to the above-mentioned factors, closure by removal via rail transport was assessed to be unfeasible at LSQ and therefore was eliminated from further discussion.

4.1.2.2 Barge Transport

Similar to the rail transport mode, barge transport would require development of two transfer stations; one at the LSQ facility and one near the third-party off-site disposal facility. Unlike rail, there could still be significant truck hauling on public roads in order to transport the CCR from the barge to proposed disposal facility. A similar sized transfer station building would be required to transfer the CCRs from the haul trucks to the barge (approximately 25,000 square feet) but the rail spur would not be required, but the barge transfer station would have to be located adjacent to the Des Plaines River. Additionally, multiple permits would be required to cross Patterson Road and the existing multiple rail lines.

In reviewing the available area adjacent to Des Plaines River, there is not significant area for development of a barge transfer station due to the presence of the existing, multiple rail lines. Similar to the rail transfer station, Geosyntec is not aware of any active or permitted barge transfer stations in Illinois or adjacent states. Therefore, it would take a minimum of three years, most likely closer to five years, to site, permit, design and constructed a rail transfer station near the disposal site which would unnecessarily extend the closure schedule.

Due to the above-mentioned factors, closure by removal via barge transport was assessed to be unfeasible at LSQ and therefore was eliminated from further discussion.

4.1.2.3 Truck Transport

Truck transport is feasible at the LSQ because it does not require additional infrastructure or permits; and therefore, will be the transport mode that will be evaluated for the closure by removal scenarios.

4.1.3 New On-site CCR Landfill

Tasks associated with Closure by Removal with material placement at a new on-site landfill are the same as those associated with placement at an existing off-site landfill noted previously, with additional considerations for developing a new landfill, including but not limited to:

- Siting (estimated 45 acres required to place 4.3 MCY of CCR material, notwithstanding soil borrow and landfill operational needs)
- Financing and purchasing property (if necessary)
- Landfill zoning, permitting, designing
- Landfill construction and operation
- Engineering and environmental compliance
- Financial assurance and closure, post-closure responsibilities

It is understood that as of the completion of this report, there is no land in the vicinity of the LSQ facility currently owned by Midwest Generation or adjacent parcels available for purchase that would suffice for a new landfill development.

4.2 Closure In-Place

The Closure In-Place scenarios consider levels of effort necessary to implement approved final closure systems at the LSQ facility as the CCR waste currently exists *in-situ*. The intent of this type of approach is to mitigate risks associated with dewatering and excavating the waste, transporting the CCR waste through multiple additional communities, and disposing of the CCR waste in a MSW landfill environment while preserving the protection of human health and the environment in the vicinity of the LSQ facility. The proposed final CCR grades are shown in **Figure 4-1**. High-level work scope summaries of the two Closure in Place scenarios are provided below, and the associated cost estimates are provided in **Appendix C**. With the exception of Closure Scenario 8 (Wet Closure), the closure in-place scenario cost estimates included the WFA.

4.2.1 IEPA Prescribed Final System

For the purposes of this evaluation, Geosyntec utilized the prescribed final cover system as required by 35 IAC 811 or the pending 35 IAC 845 regulations. The IEPA prescribed final cover system consists of (from bottom to top): 1 foot recompacted cohesive soil layer, 40 mil linear low-density polyethylene (LLDPE), geocomposite drainage layer and 3 feet of protective cover soils with the upper 6-inches capable of supporting vegetation.

A drainage system consisting of a series of "finger drains" would be installed under the final cover system to address groundwater seepage that enters the CCR waste mass. The collected groundwater seepage would be discharged to the North Quarry [KPRG, 2019b]

4.2.2 Alternate Final Cover System

As discussed in Section 2, the LSQ was a previous stone quarry and therefore the availability of on-site soils for final cover system construction is limited. To minimize the need to develop an off-site burrow pit, Geosyntec evaluated an alternate final cover system (ClosureTurf®) that minimizes the need for off-site soils.

ClosureTurf® is a three-component system comprised of (bottom to top): structured geomembrane, engineered turf, and a specialized sand infill. The engineered turf component gives the system its natural look and feel of grass while protecting the geomembrane from extreme weather conditions for the long term while minimize the need to perform maintenance of conventional soil caps.

The sand infill component is placed between the blades of the engineered turf and allows the system to be driven on by maintenance vehicles while also providing additional protection from weathering. ClosureTurf® is subtitle D compliant and is can be installed in a quick and efficient manner.

4.3 Consolidate and Close in Place

Each Closure in Place scenario will include some level of effort to consolidate and grade the existing CCR material to prepare it for the final cover system (and associated structural fill, as needed). The Consolidate and Close in Place scenarios will incorporate the greatest level of earthworks effort with respect to the existing CCR, as the intent is to minimize the need for imported structural fill.

Determining structural and chemical stability of the material directly below any final cover system is crucial to evaluate long-term durability of the system. It is feasible that the existing CCR material meets structural and chemical specifications for a final cover system – if this is the case (to be determined via a thorough sampling and analysis plan), it could minimize the volume of imported structural fill that would need to be purchased and placed prior to installing the final cover system. The proposed consolidate CCR waste footprint and grades are shown on **Figure 4-2**. Once the existing CCR is consolidated, either the prescribed final cover system (Section 4.2.1) or alternate final cover system (Section 4.2.2) could be utilized.

4.4 Closure In-Place with Hydraulic Controls or Containment

4.4.1 Hydraulic Control via Pumping (Groundwater or Leachate Pumping)

Under this closure scenario, liquid or leachate extraction wells would be installed in the CCR waste in order to enhance the natural inward gradient conditions at the LSQ. The leachate extraction wells would be installed approximately 60 feet into the waste mass at a density of one (1) well per acre, in order to lower liquid levels in the CCR waste mass. Pumped water or leachate would be discharged through the facility's NPDES permit. A conceptual layout of the proposed leachate extraction system is illustrated on **Figure 4-3**.

4.4.2 Hydraulic Containment

Another potential method for providing additional groundwater protection at the LSQ is hydraulic containment. Hydraulic containment at the LSQ would involve installing a hydraulic barrier to slow the movement of groundwater and associated contaminants from the Main Quarry and WFA. For unconsolidated units (i.e. soils) a bentonite slurry wall would be installed within the soil mass.

For consolidated units (i.e. rock) the primary pathways for groundwater movement are through facture patterns in the dolomite bedrock. For this case, the bedrock fractures would be sealed through the addition of grout injection via either vertical or angle rock borings. Since the vast majority of the Main Quarry is located in dolomite bedrock, this closure alternative would focus on hydraulic containment via grouting of the dolomite bedrock fractures as shown on **Figure 4-4**.

4.4.3 Wet Closure

Other containment systems, mainly sediment caps, allow for "wet closure" as an alternative which involves installation of a physical barrier system (typically engineered sand or other physically durable but transmissive material) that fully caps the containments below the natural water table, while also allowing natural reduction and/or oxidation processes to continue. Benefits of this type of system include low ongoing cap system O&M, minimal stormwater and water table controls, and minimal risk of exposure for human health and the environment.

4.5 Post-Closure Care

All closure scenarios will be required to develop and implement closure and post-closure care plans that discuss the activities required during post-closure care since CCRs will remain in place at either the WFA and/or Main Quarry. The post-closure care plan will describe the maintenance, sampling and inspection programs for appropriate function of all of the engineering control systems installed at the LSQ during the post-closure care period.

The anticipated post-closure care period for the LSQ is 30 years. The proposed end use of the LSQ will be a natural area of passive open space. The proposed end use will complement and provide a buffer with the current land uses and natural features (e.g., the Des Plaines River) that surround the property.

SECTION 5

EXPOSURE ASSESSMENT

5.1 Conceptual Exposure Model (CEM)

Land and water uses around the LSQ under both current and reasonably anticipated future conditions were used to develop a conceptual exposure model (CEM) that identifies potentially complete exposure pathways by which receptors could come into contact with constituents of potential interest (COPIs) (i.e. CCR and CCR leachate). The components of a complete exposure pathway are as follows:

- source or release from a source;
- mechanisms of release and transport;
- exposure media (i.e., a point-of-contact); and
- receptor and exposure route.

Based on constituent source and transport considerations and existing chemical data, potentially impacted exposure media at the Facility are: (i) on-site soil and CCR materials; (ii) on-site groundwater; (iii) sediment and surface water of the Des Plaines River; and (iv) off-site groundwater. This section presents relevant information on the LSQ facility and surrounding area to identify potential receptors and exposure routes for each of the potentially impacted exposure media. Exposure routes include existing, near-term, and short-term human receptors along with ecological habitats.

5.1.1 Surrounding Land, Groundwater, and Surface Water Uses/Designations

A desktop survey of land and water use conditions was conducted to identify potential receptors within a one-mile radius of the Facility, hereafter reviewed to as the “area of interest.” This desktop survey included (i) a review of the zoning within the area of interest, (ii) the identification of wetlands and surface water bodies using the US Fish and Wildlife Service Wetlands Mapper, (iii) the identification of potential water supply sources using online resources, and (iv) a focused online search to locate potential threatened and endangered species within the vicinity of the Facility.

5.1.1.1 Land Use

The 120-acre LSQ facility and the surrounding Joliet #9 Station is zoned for agricultural and industrial land uses[1]. Land use and zoning surrounding the Station is variable. Within a one-mile radius, zoning is primarily residential to the northeast, industrial to the north, northwest, and south; and municipal to the southeast. North of the industrial area to the north is the Des Plaines River. Other key land uses are discussed below:

- The Des Plaines River serves as both a stormwater and groundwater "sink."
- The land uses within the 0.5-mile radius are heavily developed with some green corridors along the Des Plaines River corridor or buffers to previous or existing mining activities.
- The vast majority (>70 percent) of the land uses within the 0.5 miles radius are either industrial (storage yards and aggregate) or mining activities.
- Residential land uses are present north east of the LSQ but make up less than 30 percent of the land uses within a 0.5-mile radius.

5.1.1.2 Groundwater Use and Public Water Supply

There are numerous potential private and public groundwater receptors surrounding LSQ. There are approximately 32 private wells within the subdivision to the east of the quarry. The wells within this subdivision have an average depth of 193 feet and are screened within the limestone aquifer.

Additionally, there are two public water supply wells located at 1703 S. Chicago St (east of LSQ). These public water supply wells service the Modern Mobile Home Park located to the East of Lincoln Stone Quarry and access the Devonian-Silurian Dolomite aquifer. IEPA Public Water Supply No. 20385 has a depth of 350 feet and a pumping rate of 30 gpm, while IEPA Public Water Supply No. 20386 has a depth of 300 feet and a pumping rate of 18 gpm. An exhibit showing the location of water wells in the vicinity of the LSQ is provided in **Appendix B**.

Previous and existing groundwater potentiometric maps and three-dimensional groundwater modeling has demonstrated that there has not been any groundwater movement from the LSQ towards the residential neighborhood located to the northeast of LSQ [KPRG, 2019a].

5.1.1.3 Wetlands

Based on review of national wetland maps and GIS data viewer, no wetlands were identified in the vicinity of the LSQ. Wetlands were mapped within the Main Quarry due to the presence of

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[1] https://www.willcountyillinois.com/County-Offices/Administration/GIS-Division/GIS-Data-Viewer

standing water, but site visits verified that the standing water in the Main Quarry should not be classified as a wetland [NRG, 2018].

5.1.2 Potential Receptors and Exposure Media

Receptors with potentially complete exposure pathways to CCR constituents at or in the vicinity of the LSQ facility are described below. These receptors were identified based on the current setting and existing/anticipated future land uses at the LSQ facility and surrounding area. Importantly, the presence of a receptor does not indicate exposure is occurring. Three groups of human receptors are identified:

- Current receptors, which are also representative of long-term future receptors in the event no action is taken at the LSQ facility, which is unlikely;
- Near-term future receptors, who represent receptors potentially present at or in the vicinity of the Facility during closure activities;
- Long-term future receptors, who represent receptors potentially present at or in the vicinity of the Facility once closure is completed.

5.1.2.1 Current Human Receptors

Human receptors with potentially complete exposure pathways to CCR constituents at or in the vicinity of the LSQ under current conditions, are described below.

- Current Station Workers: Full-time workers are employed at the Joliet #9 Station to support natural gas power generation. Job duties for most full-time workers are carried out within the Station buildings. Some specialized workers may come into contact with CCR material at the Main Quarry during intermittent monitoring, inspection, or maintenance activities but these workers receive specialty training and are required to use personal protective equipment to limit exposure. Potable water at the Station is supplied by a deep well that is screened well below the upper most aquifer (dolomite bedrock) therefore, Station worker exposure to groundwater as potable water is an incomplete exposure pathway.
- Current Contractors: Current contractors may perform inspections, periodic maintenance, and environmental sampling in the vicinity of the LSQ but these workers receive specialty training and are required to use personal protective equipment to limit exposure.
- Current Trespassers: There is a possibility that non-authorized receptors may access the Facility by trespassing from the north (Patterson Road) or east (South Brandon Road) but access is restricted through signage, perimeter fencing and security. Nonetheless, the possibility of on-site trespassing cannot be excluded under current conditions.

- Current Off-Facility Recreationalists: The portion of the adjacent Des Plaines River is used for commercial transport (i.e. barges) and therefore recreational uses are limited. Swimming has not been observed in the vicinity of the Facility and, given the industrial setting and lack of wadable access, is therefore unlikely. There are fish consumption advisories for the Des Plaines River in Will County based on non-site-related constituents [polychlorinated biphenyls (PCBs)][2]; however, recreational angling may occur. Recreational activities are generally associated with intermittent shorter-term exposures to environmental media, relative to workers.

- Current Off-Facility Residents: There is a residential neighborhood northeast of the Main Quarry. Groundwater flows northwest beneath the LSQ; thus, residences to the northeast are not downgradient of the LSQ. As shown in **Appendix B**, there are approximately 32 private drinking water well(s) within an 0.5-mile. Other private wells were identified east of the Site at varying distances within the 1-mile radius, but these are either unlikely to be downgradient of the LSQ facility, are served by municipal water, and/or are not classified for drinking water use.

5.1.2.2 Near-Term Future Human Receptors

Human receptors with potentially complete exposure pathways to CCR constituents at or in the vicinity of the Facility during closure (i.e., in the near-term future), are described below. The receptors identified below include those that may be directly or indirect exposed to CCR constituents as well as receptors that may be at risk of injury or other incident due to closure-related activities (e.g., construction).

- Landfill Closure Contractors involved in the near-term future closure have the greatest potential for direct contact with CCR material while directing the excavation and movement of CCR material, but these workers will receive specialty training and will be required to use personal protective equipment to limit exposure. Other contractors, such as those performing periodic inspection and monitoring activities may also have incidental contact. Station employee project oversight personnel, third party construction oversight personnel, or regulatory inspectors would fall under the other contractor category.

- Truck drivers will haul CCR material off-site and haul fill and cover material into the LSQ facility during closure, but these workers will receive specialty training and will be required to use personal protective equipment to limit exposure.

- Highway users could be affected if CCR materials are transported on public roads if a traffic accident were to occur. In the event of an accident, any spillage would be removed from the road as part of incident response. Any routine or accidental exposures would be transitory and highway users would be unlikely to have direct contact with the material.

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[2] http://www.idph.state.il.us/envhealth/fishadv/desplainesriver.htm

As discussed in Section 4, rail or barge transport modes for CCR removal were assessed to be non-feasible at the LSQ.

5.1.2.3 Long-Term Future Receptors are Current Human Receptors

Human receptors with potentially complete exposure pathways to CCR constituents at or in the vicinity of the LSQ facility after closure is completed, are described below.

- Future Station Workers: Similar to current conditions, full-time workers are expected to be employed at the Joliet #9 Station. No completed exposure pathways are anticipated for these receptors under post-closure conditions.

- Future Contractors: As with current conditions, contractors may be present at the Facility in the future to perform inspections, periodic maintenance, and environmental sampling. However, with the exception of intrusive (subsurface) activities, closure will substantially reduce, if not eliminate, the potential for future contractors to be exposed to CCR constituents. These contractors would also receive specialty training and will be required to use personal protective equipment to further limit exposure.

- Future Trespassers: There is a possibility that non-authorized receptors may access the Facility by trespassing from the north (Patterson Road) or east (South Brandon Road). Closure will substantially reduce, if not eliminate, the potential for future trespassers to be exposed to CCR constituents.

- Future Off-Facility Recreationalists: The adjacent Des Plaines River will likely continue to be used for commercial and recreation uses, accordingly there is a potential for exposure to CCR constituents if they migrate to the river.

- Future Off-Facility Residents: Development of the LSQ for residential use represents an exceedingly small possibility that does not warrant further consideration. Groundwater flows northwest beneath the LSQ; thus, residences to the northeast are not downgradient of the LSQ facility.

  As shown in **Appendix B**, there are approximately 32 private drinking water well(s) within an 0.5-mile. Other private wells were identified east of the Site at varying distances within the 1-mile radius, but these are either unlikely to be downgradient of the LSQ facility, are served by municipal water, and/or are not classified for drinking water use. Based on the City of Joliet and Will County GIS Data Viewer websites, any non-developed properties within 1.0 miles of the LSQ are not zoned as residential.

5.1.2.4 Ecological Habitat and Receptors

The LSQ and surrounding Joliet Station are developed/disturbed and provide ecological habitat that is limited in both extent and quality. Some areas of on-site CCR management units may support emergent vegetation that may attract wildlife; however, based on planned closure activities, the LSQ facility is likely to be dominated by maintained grasses and provide limited habitat quantity and quality. Similarly, ecological habitat in surrounding residential, industrial, and municipal use areas is currently limited in both extent and quality and is not expected to change in the future.

North of the facility, the Des Plaines River and associated riparian habitat does provide habitat that supports a variety of ecological receptors, including plants, invertebrates, fish, and aquatic-dependent wildlife (e.g., piscivorous birds and mammals).

Geosyntec requested an EcoCAT report (**Appendix A**) for the LSQ facility. The EcoCAT report reviews databases from the Illinois Department of Natural Resources to identify threatened and endangered (T&E) species potentially present in the vicinity of the Facility and are discussed in more detail below.

- Killifish – the proposed closure scenarios will not impact water quality associated with the Illinois River and therefore the LSQ will not have an impact on the Killifish population. The existing NPDES permit requires testing and reporting to ensure that the facility will not have an adverse effect on surface water quality.

- Osprey – the proposed closure options will not disturb existing wildlife habitat for this species.

SECTION 6

RISK AND EFFECTIVENESS ASSESSMENT

6.1 Screening Level Risk Evaluation Objectives and Methods

This section describes a framework for a site-specific risk-based approach to evaluate the analytical data for environmental media in the context of potential human and ecological receptors that may be exposed to CCR constituents associated with the Facility. Direct exposure to CCR materials is currently controlled through institutional and engineering controls and planned closure activities will render this pathway incomplete in the long-term. Therefore, this framework primarily addresses groundwater and surface water media that could be affected by the potential migration and transport of CCR leachate associated with the LSQ facility, with an emphasis on potential human and ecological receptors that could be exposed to these constituents in groundwater and downgradient surface water bodies.

Potential risks to human and ecological receptors exposed to COPIs are quantitatively evaluated using a screening-level approach that compares estimates of exposure (i.e., reported concentrations) to estimates of effect (i.e., media-specific screening levels). This approach is a commonly used to screen for the potential for risk and to evaluate if additional assessment is required.

6.1.1 Exposure Estimates for COPIs

For this evaluation, exposure estimates are based on the following analytical data:

- Groundwater data from compliance wells (G31, G33, G41, and G42) collected between 2017 and 2019 and analyzed for the parameters listed in previous reports [KPRG, 2020a].
- Outfall water data from NPDES outfalls 001 (Circ Water), 003 (R&Y Pond), and 005 (Quarry (Ash Pond)) collected between 2017 and 2019 and analyzed for the parameters listed in previous reports [NRG, 2020].

Analytical results collected between 2017 and 2019 were selected as representative of current and future conditions. Multiple quarterly sampling events were considered to minimize the potential that seasonal fluctuations in concentrations affect the results of this evaluation.

For both human and ecological receptors, the initial screening step compares maximum detected COPI concentrations to health-based screening levels. If maximum detected concentrations are less than applicable screening levels, the COPI is excluded from further evaluation. Notably, there is no direct exposure (i.e. ingestion) to groundwater from the compliance wells (wells are locked) or water collected from the outfalls (located within secured fence area). Rather, human and ecological receptors are potentially present in downgradient locations where decreased concentrations are expected due to a combination of physical and chemical attenuation processes. Therefore, exceedance of a screening level does not indicate a potential for risk, only the need for additional evaluation. Further, the objective of this evaluation is to rank relative risks for the purposes of selecting a closure approach.

6.1.2 Effects Estimates for COPIs

Effects values for the COPI evaluation are based on the protection of human or ecological receptors. Screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate a potential risk exists but indicate that further evaluation is warranted.

Preliminary, health-based screening levels represent the lowest of the following:

- Illinois Water Quality Standards (WQS) based on chronic endpoints for aquatic life and human health; and

- Illinois Administrative Code (IAC) 620 Class I Potable Use Groundwater Standards.

In the absence of a WQS or IAC, the AGQS or the acceptable limit defined in the permit is used as a point-of-comparison. The AGQS was only used as the screening level for evaluating molybdenum in groundwater and oil and grease concentrations measured in NPDES outfall water.

6.2 Potential Toxicity Hazards for Human Receptors

Baseline protectiveness and long-term protectiveness evaluations considered theoretical health risks from exposure to COPIs present in environmental media at and in the vicinity of the Facility. Short-term protectiveness evaluations considered two major categories of potentially adverse outcomes: theoretical health risks from exposure to COPIs present in environmental media at and in the vicinity of the Facility and risks of injuries or fatalities to workers and the community from remediation-related activities.

With respect to the existing exposure risks at the LSQ, COPIs present in surface water and groundwater are considered de minimis risk due to existing institutional and engineering controls at the facility, on-going monitoring of surface water conditions, groundwater plume behavior, and the location of the impacts relative to potential receptors (public and private water wells). Examples of institutional controls include documented groundwater use restrictions which is currently placed for permitted groundwater management zone at the LSQ. Engineering controls examples include groundwater extraction wells (currently installed at the LSQ) to reduce the exposure to downgradient human receptors from groundwater.

Surface water analytical data collected as part of NPDES compliance monitoring indicates no exceedances of permitted concentration standards. Any surface water criteria exceedances are related to groundwater quality in southern GMZ, and accordingly are not applicable to the surface water exposure route. Groundwater samples from locations north of the Main Quarry are below surface water screening levels, therefore there is no risk of groundwater discharge to surface water causing exceedances of surface water criteria [KPRG, March 2020].

Groundwater analytical data collected as part of the overall LSQ's groundwater assessment monitoring plan indicates that the facility's COPIs (boron, molybdenum, arsenic, and sulfate) are being effectively managed by the groundwater ICA extraction system, and despite occasional short-term fluctuations in individual groundwater well concentrations, the long-term trends indicate an overall decrease in COPI concentrations and areal extent of COPIs within the GMZ.

The COPI groundwater plume is delineated and controlled by the extraction system and is generally decreasing in extent and concentration. Additionally, the COPI concentrations that exceed respective AGQSs are located on the south and southeast sides of the Main Quarry, which are not upgradient of private or public water wells within the vicinity of the LSQ facility, and therefore not complete exposure pathways [KPRG, March 2020].

6.3 Risk of Incidents

Protecting the health and safety of contract workers and the general public is a major concern during implementation of remedial actions [USEPA, 1988]. As such, the potential for remediation-related incidents is a critical component of evaluating short-term risks for potential closure alternatives. In contrast to typical regulatory health risk assessment methodologies that incorporate theoretical assumptions to evaluate potential risks associated with exposures to chemicals in the environment (e.g., cancer risk from exposure to carcinogenic constituents), the risk of incident assessment develops actual or expected risks based on empirical data derived from incident rates from similar activities.

The risk of incident assessment, also referred to as actuarial risk assessment, calculates the probability that an injury or fatality will occur during a given remedial alternative. Actuarial risks, such as the probability of a middle-aged man dying during the next year (as used to set life insurance rates), are the most ideal available estimates because they are based on actual observations of such an event and are therefore highly accurate [USEPA, 2001].

For each closure alternative, labor and transportation projections were calculated (e.g., number of hours worked and trucks entering/exiting the facility) and these projections were evaluated using statistical data on injury and fatality rates for traffic accidents involving large trucks and construction activities based on the following references.

- Bureau of Labor Statistics (BLS). 2006. Injuries, Illnesses, and Fatalities in Construction, 2004. Compensation and Working Conditions. May 2006.
- BLS. 2013. Current Population Survey. Census of Fatal Occupational Injuries. Available at: http://www.bls.gov/iif/oshcfoi1.htm#2011. Accessed 8/15/2013.
- United States Department of Transportation (USDOT). 2003. An Analysis of Fatal Large Truck Crashes. National Highway Traffic Safety Administration. DOT HS 809 569. June 2003.
- USDOT. 2012. Large Truck and Bus Crash Facts. Federal Motor Carrier Safety Administration Analysis Division. FMCSA-RRA-12-023. August 2012.

6.3.1 Results of Vehicle Accidents

Vehicle accident frequency for three different types of accidents (property damage, personnel injury and fatalities) for the various closure scenarios is summarized in **Table 6-1**. Intuitively, those scenarios that require greater mileage to execute correspond to the highest potential for vehicle accidents. The Closure by Removal scenarios generate the highest potential accident rate; the calculated accident rates for closure scenarios 1 and 2 are more than four times higher the vehicle accident rates for scenarios 3 through 8.

6.3.2 Results for Worker Accidents

Worker accident frequency for the alternative closure scenarios is summarized in **Table 6-2**. Like the vehicle accident calculations, those scenarios that require greater hours to execute correspond to the highest potential for worker accidents. The Closure by Removal scenarios generate the highest potential accident rate – the calculated worker accident rates for scenarios 1 and 2 are more than seven times higher the rates for closure scenarios 3 through 8.

6.4 Greenhouse Gas Evaluation

Greenhouse Gas Evaluation for the closure scenarios is represented by the level of effort associated with main vehicle components for each of the work scopes: CCR removal/regrading and transportation, liner/cap soil borrow and placement, and geosynthetic material delivery and placement. Methodology summaries for each component of the overall greenhouse gas impact calculation are discussed below.

CCR removal/regrading refers to activities conducted to remove the CCR material from the Main Quarry and transport it to another landfill (on-site or off-site) and regrading of the existing CCR waste mass to prepare the subgrade for final capping activities. Liner/cap soil borrow and placement refers to vehicle usage associated with excavation of soil material from borrow areas for use in the liner or capping systems, as applicable. Lastly, geosynthetic delivery and placement relates to vehicle usage associated with transporting and installing these materials.

The quantity of diesel fuel consumed was estimated based upon hours of operation for the heavy equipment (bulldozers, scrapers, etc.). Estimated diesel consumption values and corresponding CO_2 generation rates are provided in **Table 6-3**. Facility-specific fuel consumption data for earthworks operations are not applicable to the LSQ facility as typical closure activities do not involve earthworks equipment or tasks.

The diesel fuel consumed by the dump trucks and flatbed tractor trailers used to transport the excavated CCR material, soil, and geosynthetics were estimated using the hauling distance between origin and destination. Estimated diesel consumption values are provided in **Table 6-3**.

As anticipated, the Closure by Removal scenarios generate the highest estimated greenhouse gas emission rates per cubic yard of CCR material managed. The increased truck miles required to transport the CCR material from LSQ to either an off-site or on-site landfill combined with the elevated heavy equipment hours of operation required to excavate the CCR material result in greenhouse gas generation rates (kg CO_2 per CY) that are more than six times higher than those for each of the six Closure In-Place scenarios. Maintenance and replacement impacts were not specifically calculated for each piece of equipment within each scenario; those impacts can be assumed to scale with mileage and hours of operation impacts.

SECTION 7

EFFECTIVENESS OF CONTROLLING FUTURE RELEASES

7.1 Closure Timelines

Depending upon the selected closure scenario, the time for closure is estimated to range from two years (Closure in Place) to fourteen years (Closure by Removal) as detailed in **Table 7-1**. Siting a new on-site landfill would likely require an additional three to four years to procure and purchase the necessary real estate (landfill and soil borrow), complete the regulatory permitting process, develop detailed design and construction specs, and mobilize the resources necessary to construct and operate an active landfill facility capable of receiving the expanded 5.6 MCY of CCR waste removed from the LSQ facility.

Given the extended timeline and level of effort required to execute the Closure by Removal scenarios, the potential for future releases associated with transporting CCR waste over the road to an off-site landfill facility is likely to be compounded by several elements. Factors including but not limited to the number of transport trucks, the miles covered, the communities encountered, and efficacy of dewatering activities each have bearing on the potential for future releases. Out of an abundance of caution, if selected, the Closure by Removal scenarios would benefit from a comprehensive robust risk analysis and accompanying work plan to account for and mitigate factors associated with transporting 5.6 MCY of CCR material through the greater Chicagoland area.

Conversely, the Closure in Place scenarios do not require those same factors to be considered, as any work associated with CCR waste transport would be confined to the existing LSQ facility. Given the inherent additional levels of protection against potential future releases provided by the Closure in Place scenarios, these scenarios would also benefit from a work plan to coordinate internal transportation procedures associated with CCR waste management, though this work plan scope would likely be simplified as compared to that recommended for the Closure by Removal approach.

7.2 Technical Guidance

7.2.1 USEPA's Presumptive Remedy

Preferred technologies for common site remedy corrective actions based on previous performance are referred to as presumptive remedies by the USEPA. The objective of presumptive remedies is to use past experiences to streamline site investigation activities and speed up the implementation of corrective actions. The USEPA has selected containment as the presumptive remedy for CERCLA municipal landfills due to the volume and heterogeneity of the waste [USEPA, 1993].

LSQ's closure scenarios 3 through 8 which utilize the Closure in Place strategy are consistent with the USEPA presumptive remedy of containment for CERCLA municipal landfills. The LSQ is not a CERCLA municipal landfill but is permitted as a landfill within the IEPA municipal solid waste landfill (MSWLF) program. The LSQ shares many of the same environmental concerns (i.e. leachate impacting groundwater, impacted stormwater run-off and physical waste migration) as a CERCLA municipal landfill, with the exception of landfill gas generation, therefore containment is the appropriate presumptive remedy at the LSQ.

7.2.2 Illinois FIRST Abandoned Landfill Program

In 1999, Illinois lawmakers included $65 million budget into the Illinois FIRST program to address problems at 33 of the state's worst abandoned landfills which were located in 21 counties across Illinois. Problems encountered at the abandoned landfills included erosion of cover, exposed garbage, and groundwater and surface water contamination [IEPA, 2000].

The proposed corrective actions to stabilize and close the abandoned landfills included capping and grading the entire waste mass with two to three feet of soil cover, vegetation of the soil cover, and installation of stormwater drainage controls. The proposed IEPA goals for closure of the 33 abandoned landfills were to stabilize the landfill by minimizing stormwater infiltration and migration of waste, accommodate settlement, and facilitate long-term maintenance.

LSQ's closure scenarios 3 through 8, which utilize the Closure in Place strategy, are consistent with the IEPA approach for the closure of the state's 33 worst abandoned landfills. Additionally, the LSQ Closure in Place scenarios will include leachate removal and groundwater monitoring programs over a 30-year post-closure care period.

7.3 <u>Extent of Containment Practices will Reduce Future Releases</u>

The Closure by Removal scenarios will remove the CCR waste mass, and therefore will remove the source of potential future releases from only the Main Quarry. The Closure in Place scenarios will reduce future releases through the following actions:

- Prevent direct physical contact with CCRs;
- Minimize stormwater infiltration and resulting contaminant leaching to ground water;
- Control surface water run-on and run-off and thereby minimize erosion to the final cover system; and
- Collect and treat existing or potential future extracted groundwater and leachate and contain existing contaminant plumes and prevent future migration.

7.4 Treatment Technologies

At this time, it is not anticipated that supplemental treatment technologies will be utilized to treat the CCR waste mass in either the Closure by Removal or Closure in Place scenarios. Leachate and extracted groundwater will continue to be managed and discharged through the LSQ's NPDES permit for the Closure in Place scenarios.

7.5 Long-Term Reliability of Engineering and Institutional Controls

Closure by Removal will remove the waste mass and therefore the "source" of potential contamination from the Main Quarry and WFA, and accordingly will not rely on engineering or institutional controls. Note that Closure by Removal will not address the existing groundwater impacts in the GMZs.

Closure in Place will rely on the following engineering and institutional controls:

- Engineering Controls
    - Landfill Final Cover System
    - Groundwater Extraction System
    - Natural Hydraulic Gradients
- Institutional controls
    - Groundwater Management Zone
    - NPDES monitoring
    - Deed Restriction

The proposed institutional controls for the LSQ have been implemented at many other facilities in the state of Illinois and have demonstrated long-term reliability in minimizing the risk to human health and the environment via groundwater exposure pathways.

The proposed engineering controls such as the final cover system have been utilized at hundreds of solid waste facilities across the United States since the 1980s. The solid waste industry along with support from the USEPA and state agencies has demonstrated the long-term reliability and effectiveness of the proposed final cover system in waste containment and minimizing leachate generation. Reducing leachate generation is the most effective way to eliminate the need for future corrective actions related to groundwater protection.

SECTION 8

GROUNDWATER PROTECTION AND ASSOCIATED GROUNDWATER MODELING

8.1 Overview of Current Permitted GIA Models

The groundwater impact assessment (GIA) model is a regulatory requirement under 35 IAC 811. The GIA model is a contaminant transport model that takes the landfill design and operations and the site specific hydrogeologic conditions to model groundwater concentrations over time. The GIA model predicts groundwater concentrations 100 feet from the waste boundary [zone of attenuation (ZOA)] 100 years after the landfill is closed. The predicted groundwater concentrations, 100 years after closure, are then compared to existing groundwater quality standards (AGQS). The regulations under 35 IAC 811 require that the predicated groundwater concentrations are less than or equal to the existing groundwater (i.e. AGQS).

The LSQ has a permitted GIA model that has been approved by the IEPA as part of the regulatory permit renewal process. As part of the permit renewal process, LSQ was required to review existing groundwater and landfill conditions and compare those conditions to modeled conditions in the GIA model. If the GIA model conditions are different, LSQ was required to update the GIA Model. The most recent update was approved as Modification No. 21 to Permit No. 1994-241-LFM, dated 14 August 2015.

8.2 Conceptual Site Model

8.2.1 Geologic Units

The conceptual site model that was developed and permitted at the LSQ models the Silurian and Ordovician age units. The Silurian unit consists of four different dolomite formations: bedrock rind, Joliet formation, Kankakee formation and the Elwood/Wilhelimi formation. The Silurian unit is underlain by the Ordovician age unit - the Maquoketa Group - that consists of the following formations: Brainard Shale formation, Fort Atkinson dolomite formation, and the Scales Shale formation. The Scales Shale formation acts as the regional aquitard and the base of the conceptual site model [KPRG & Geo-Hydro, Inc., 2013].

As discussed in Section 2 and shown on **Figure 2-2**, the deepest elevation of the LSQ is approximately 477 feet mean sea level (feet MSL) and the southern half invert of the LSQ quarry is in direct contact with the Elwood/Wilhelmi Dolomite and the northern half invert is in contact with the Kankakee Dolomite formation.

8.2.2 Uppermost Aquifer

The current permitted GIA and associated conceptual site model was developed and modeled so that the primary contaminate transport was through dolomite aquifer (i.e. uppermost aquifer). The

GIA Model assumed that there were two water separate bearing units: (1) shallow dolomite zone, and (2) deep dolomite zone which are separated by the Brainard Shale [KPRG & Geo-Hydro, Inc., 2013].

8.2.2.1 Shallow Dolomite Zone

The elevations of the shallow dolomite zone range between 585 to 445 feet MSL with an approximate thickness of 140 to 150 feet. Groundwater flow, along the north and west portions of the facility, generally flows south to north eventually discharging to the Des Plaines River. Beginning around 1993, groundwater flow in the south east portion of the facility started to exhibit a shift of groundwater flow to the south-southeast direction. This revised groundwater flow is associated with dewatering activities occurring at the Laraway Quarry. Additional information for this this unit is summarized in Section 3.2.

8.2.2.2 Deep Zone

The elevations of the deep dolomite zone range between 435 to 400 feet MSL with an approximate thickness of 30 to 40 feet. Groundwater flow in the deep dolomite zone in the south east portion of the facility started to exhibit to the south and southeast flow direction. Additional information for this this unit is summarized in Section 3.2.

8.2.3 Groundwater Model Software and Transport Modeling Mechanisms

The permitted GIA model utilizes a three-dimensional software Visual MODFLOW® Version 4.1 which allows the user to represent physical conditions at the site along with the capacity to model site conditions over time. The Visual MODFLOW® software package included the containment transport program MT3D (Mass Transport in 3 Dimensions) to simulate mass transport from the LSQ as required by GIA regulations.

Advective flux, hydrodynamic/mechanical dispersion and diffusion were the various containment transport mechanisms that were utilized within the permitted GIA model. The model conservatively did not include source reduction, biologic decay or soil/rock sorption or other decay process and therefore overestimates groundwater concentrations [KPRG & Geo-Hydro, Inc., 2013].

8.2.4 Leachate Quality

As discussed in Section 2.1, the WFA was operated prior to the Main Quarry and accepted fly ash, bottom ash and slag. Leachate quality at the WFA was based on both CCR characterization borings and pore water samples collected over time. The Main Quarry leachate quality was based on sampling taken at the NPDES permitted outfall location and includes precipitation, groundwater flow into the North Quarry and extracted groundwater. The leachate quality is different at the WFA versus the Main Quarry due to the type of CCRs accepted and the type of coal burned [KPRG & Geo-Hydro, Inc., 2013].

8.3 Summary of Groundwater Modeling of Proposed Closure Alternative Scenarios

A numerical groundwater flow model (Model) was created for Midwest Generation Joliet #9 Station Lincoln Stone Quarry and the surrounding area as part of the GIA completed in 2013 as part of the landfill permit renewal (BAS, 2022). The Model was reviewed and approved by Illinois EPA for use in support of engineering evaluations of corrective action/closure alternatives.

The Model was updated slightly to use a more recent version of MODFLOW (MODFLOW-NWT), to define the current quarry water levels in the Main Quarry and Boyd's Quarry, to simulate current pumping rates in the groundwater extraction well system, and to improve the calibration to measured, recent water levels at the site. The updated calibrations confirm that the model continues to replicate the observed northward hydraulic gradient toward the river at the water table, and a south-eastern component of groundwater flow toward Laraway Quarry in the permeable horizon in the shallow dolomite.

The updated, calibrated steady state flow model simulated 100 years of chemical transport from LSQ. Four conceptual corrective action/closure scenarios were evaluated in support of the engineering analysis of alternatives and are presented in the Numerical Groundwater Flow Model [KPRG, 2022]. The four conceptual scenarios were:

- Conceptual Closure Alternative 1 – Complete dewatering of the LSQ to facilitate the direct removal of the CCR materials for off-site landfill disposal which models Closure Scenarios 1 and 2).
- Conceptual Closure Alternative 2 – In-place closure with regrading of the CCR materials and subsequent capping to preclude direct infiltration of precipitation through unsaturated CCR materials which models Closure Scenarios 3, 4, and 5.
- Conceptual Closure Alternative 3 – Same as Closure Alternative 2 but with the addition of hydraulic containment with the placement of a low permeability barrier along the east and south sides of the LSQ which models Closure Scenario 7.
- Conceptual Closure Alternative 4 – Same as Closure Alternative 2 but with the addition of hydraulic controls with the installation and operation of 47 extraction wells within the LSQ which models Closure Scenario 6.

The general conclusions from the groundwater modelling for each of the conceptual closure alternatives are:

- Conceptual Closure Alternative 1 more quickly reduces the relative impacts in the shallow dolomite groundwater system, but the required drawdown will negatively affect private well performance which may result in dewatering private residential wells dry east of LSQ.
- Conceptual Closure Alternatives 2, 3 and 4 do not negatively affect private well performance and will not cause dewatering of residential wells.

- Conceptual Alternatives 2, 3 and 4 have similar short-term reduction in constituent concentrations. Alternatives 3 and 4 provide for some additional long-term performance improvement in constituent concentrations in existing groundwater.
- Regardless of the conceptual alternative evaluated, meeting proposed groundwater protection standards for various constituents will take time, and therefore implementation of institutional controls such as GMZs and property deed restrictions for water use will be required. These institutional controls have already been implemented has been shown to be protective of public health, welfare and safety related to groundwater exposure.

Based upon the conclusions of the Numerical Groundwater Flow Model [BAS, 2022], dewatering of the Main Quarry as a component of the Closure by Removal scenarios (alternate closure scenarios 1 and 2) will negatively impact the nearby residential water wells by causing a long-term drawdown of natural water levels, which presents an implementation concern for the LSQ. The Closure In-Place scenarios (alternate closure scenarios 3 through 8) do not require dewatering within the Main Quarry, and therefore will not negatively impact the nearby residential water wells.

8.4 Summary of Fate and Transport of Contaminants over Time

Both the revised GIA Model [KPRG & Geo-Hydro, Inc., 2013] and additional GIA information submittal [KPRG, 2013] modeled several hydrogeologic scenarios such as preexisting conditions (no Laraway Quarry pumping), Laraway Quarry pumping, ICA groundwater extraction, cessation of Laraway Quarry pumping and passive closed conditions. The evaluation of alternative closure scenarios has only included continued ICA pumping or the passive closed condition scenarios.

For the ICA pumping scenario, the twelve groundwater extraction wells were modeled and calibrated to match current groundwater extraction and groundwater quality conditions. Additionally, once the Laraway Quarry ceases dewatering activities, the ICA pumping activities can stop since an inward gradient will redevelop in the southeast corner of the Main Quarry [KPRG, 2013].

Under this passive closed scenario (i.e. facility no longer accepting waste), the Main Quarry was modeled with a recharge of 4.5 in/yr (i.e. background rainfall precipitation and no landfill cover), the ICA groundwater extraction wells were turned off, and the Laraway Quarry pumping had ceased. Results of this GIA model scenario demonstrated that 100-years after closure, 30 of the 42 groundwater monitoring locations meet all groundwater quality standards, including all wells south of the Main Quarry. The remaining 12 groundwater monitoring locations were located between the LSQ and the Des Plaines River within the zone of attenuation established by the LSQ's adjusted standard [KPRG, 2013]. Per the LSQ's adjusted standard:

> "Groundwater quality at or beyond the zone of attenuation for the Joliet/Lincoln Quarry Site shall be maintained at each constituent's background concentration (p. 22)."

Therefore, groundwater wells within the zone of attenuation do not have to meet background quality standards and will instead serve as sentinel wells to monitor the efficacy of the extraction well system as a control on concentrations at the downgradient edge of the zone of attenuation.

8.5 Assessment of Impact of Proposed Closure Alternates to Permitted GIA Model

8.5.1 Assessment of Closure by Removal Scenarios

The Closure by Removal scenarios (alternate closure scenarios 1 and 2) will remove the source of leachate from the Main Quarry and WFA. This will have a positive impact on the permitted GIA results by reducing the majority of the source material and increasing groundwater flow distances to the southern groundwater management zone. ICA pumping will be required until the existing groundwater quality returns to required groundwater standards to address existing groundwater quality. Closure by Removal scenarios would remove the source of groundwater quality exceedances, but ICA pumping would have to continue to address groundwater quality exceedances present in the existing groundwater north and south of the LSQ.

8.5.2 Assessment of Closure in Place Scenarios

The Closure in Place scenarios (alternate closure scenarios 3 through 7) include installation of a final cover system that will reduce the rainfall recharge from 4.5 in/yr to less than 0.1 in/yr. This will reduce the hydraulic head levels within the Main Quarry thereby enhancing the inward gradient conditions that LSQ was designed for. The ICA pumping will continue to the extent that the current south to southeast gradient is influenced by the Laraway Quarry or until groundwater conditions within the GMZ have reached applicable groundwater standards.

As discussed in Section 8.3, groundwater modelling for the closure in-place scenarios with leachate extraction provides some limited improvements to existing groundwater quality as compared to no leachate extraction.

8.6 Potential Corrective Actions

8.6.1 Hydraulic Controls

As discussed in Section 8.3 the results of GIA model (i.e., fate and transport of contaminants over time) are significantly influenced by the hydraulic gradients around the LSQ. The LSQ was designed and permitted as an inward gradient landfill, in contrast to modern landfills with liner and leachate collection systems. Therefore, the primary hydraulic control system for groundwater protection is gradient control.

Under alternate closure scenarios 6 and 7, we have included additional hydraulic or gradient controls to provide a “belt and suspenders” approach to groundwater protection. The implementation of these hydraulic controls is discussed in more detail in Section 9.

8.6.2 MNA/Geochemistry

In general, Monitored Natural Attenuation (MNA) is a feasible remedial alternative to groundwater impacts at sites with demonstrated source control, dilute plumes, and known plume behavior. These factors provide the basis for determining the aquifer's capacity to successfully remediate the constituents of concern to concentrations below applicable clean up levels.

MNA is often favorable at sites impacted with constituents which are reactive with the native groundwater and/or lithology such that their mobility is limited. For reactive inorganic species, geochemistry of the groundwater and constituents of concern is often controlled by pH and Oxidation-Reduction Potential (ORP). This is particularly true for inorganic species with multiple oxidation states (e.g., selenium, cobalt, and arsenate), as oxidation state determines which aqueous species a constituent will react with. Interaction with different aqueous species can change the overall charge of the constituent of concern, subsequently affecting its sorption and precipitation behavior. Changes in pH and ORP over time can also affect the reversibility of MNA processes, potentially shifting the reaction toward dissolution instead of precipitation.

Other groundwater geochemistry factors affecting the efficacy of MNA include the presence of other constituents which can affect the overall attenuation via processes such as coprecipitation or competitive sorption/desorption.

Based upon the known source characteristics (i.e., leachate quality), and the known plume behavior (inward gradient controlled by extraction wells), the potential for MNA to be beneficial at the LSQ site appears favorable but would be reliant on maintaining those conditions until clean-up levels are reached. Statistical analysis is recommended to better estimate that timeline.

8.6.3 In-Situ Groundwater Treatment

Based on the low levels of inorganic concentrations, site geologic and hydrogeologic conditions (i.e. fracture hydrogeologic flow) and the lateral and vertical extent of groundwater plumes, in-situ groundwater treatment is not practicable or feasible at LSQ.

SECTION 9

CLOSURE ALTERNATIVES IMPLEMENTING EVALUATION

9.1 Closure by Removal (Scenarios 1 and 2)

9.1.1 CCR Excavation and Removal Criteria

"CCR removal" refers to the process of verifying and documenting that the CCR has been removed from the ash pond. The vast majority of material in the Main Quarry is bottom ash referred to here as CCR. The CCR removal verification is based on removing visible CCR until dolomite bedrock is encountered.

During CCR removal activities, stormwater run-on into the Main Quarry will be minimized to the extent practicable through the use of berms along the perimeter of the Main Quarry. A phasing plan will be developed during the closure design that describes how stormwater diversion will be constructed to manage stormwater run-on and run-off during CCR removal and site restoration activities. Water management during CCR removal at LSQ will be conducted to ensure compliance with LSQ water quality permits.

The time needed for CCR excavation is estimated to be between four to five years and will vary be based on many site-specific factors including access into and out of the ash pond, haul routes, dewatering methods, detailed CCR excavation and final restoration phasing plans, the excavation working face size, and excavation and hauling methods. In addition, LSQ will establish methods for observing, monitoring, and documenting CCR excavation and compliance with the approved Closure Plan.

9.1.2 Availability of Nearby Landfill Airspace

Geosyntec evaluated Chicagoland MSW landfill airspace inventory based on the 2019 Landfill Capacity Report [IEPA, 2021]. Pertinent MSW landfills within 20 miles of the LSQ facility as related to the Closure by Removal scenarios include:

- Laraway Recycling & Disposal facility (Laraway RDF) – 6.67 MCY available airspace (Jan 1, 2021),
  - 5.0 years of life expectancy based upon estimated filling rate,
- Prairie View Recycling & Disposal Facility (Prairie View RDF) – 13.99 MCY available airspace (Jan 1, 2021), and
  - 17.0 years of life expectancy based upon estimated filling rate.

The proposed schedule for closure by removal and placement at an existing landfill (Scenario 2) is over 7 years, therefore, the Laraway RDF is not a practical option for disposal since it has less than 5 years of disposal capacity which will be used by its existing customer base. Will County has a capacity guarantee of 20 years with the Prairie View RDF and therefore, has limited ability to take on new source of waste during the anticipated LSQ closure schedule [Will County, 2017].

The next nearest active permitted landfill is the Livingston Landfill that is located over 50 miles from the LSQ. While there are nearby landfills to the LSQ that have available airspace, the airspace is contractually obligated (Prairie View RDF) to other entities such as Will County or there is not enough airspace available (Laraway Landfill) during the anticipated closure schedule.

9.1.3 Availability of On-Site Landfill

Calculations indicate approximately 30 acres of useable permitted land would be needed to construct a new on-site landfill capable of accommodating the volume of CCR material to be removed from the Main Quarry. An additional 20 acres would be necessary to allow for property line setbacks, operational buildings and infrastructure, and landfill engineering and compliance management systems (leachate, access, compliance monitoring, etc.). Per discussions with LSQ facility representatives and review of aerial and land use maps, there is no owned land totaling approximately 50 contiguous acres in the vicinity of the LSQ Main Quarry, therefore construction of an on-site landfill is not an option.

9.1.4 Co-Disposal with MSW

Several different heat-generating mechanisms exist in most MSW landfills that include both biological and chemical reactions. Barlaz and Benson (2018) summarize potential exothermic chemical reactions in MSW landfills which include:

- Anaerobic metal corrosion of aluminum and iron;
- Hydration and carbonation of MSW (incinerator) combustion ash or CCR; and
- Acid-base neutralization.

Based on measured in-situ waste mass temperatures, typical MSW landfill heat generation is dominated by anerobic decomposition (i.e., methanogenesis); but, for example, if significant volumes of industrial waste such as CCR or aluminum waste is placed in a MSW landfill, then chemical reactions may become a more dominant heat-generating mechanism and may cause elevated temperatures. Elevated temperatures at MSW landfills may lead to significant compliance issues such as: odors, air emissions, elevated temperatures, poor leachate quality and settlement. Because of these concerns with co-disposal of MSW with CCR and associated heat generation, third-party landfills may place limits on the volume of CCR they accept or may not accept any volume of CCRs.

9.1.5 Dewatering

Dewatering will include removing water using a variety of methods, including but not limited to passive, gravity-based methods (e.g., rim ditches) and/or active dewatering methods (e.g., pumps and well points) as needed to allow for CCR excavation and transportation. The groundwater flow volume and the difficulty of dewatering will increase with depth due to the increase in static head (i.e., increased depth) acting on the pump and associated impacts on the pump performance curves (i.e., higher heads decrease pump flow rates. Additional dewatering activities, such as cutoff walls, may be needed to address the increase in groundwater flow.

Based upon the results of Conceptual Closure Alternative 1 in the Numerical Groundwater Flow Model [BAS, 2022], dewatering the Main Quarry to facilitate removal of CCR materials is possible but impractical due to impacts on nearby residential water wells. There are four residential well locations within 500 feet east of the Main Quarry. Per the Model, “the two locations closer to Boyd’s Quarry show declining water levels of about 11 feet, whereas the two locations further from Boyd’s Quarry show higher water level drawdowns approaching 30 feet from dewatering of LSQ. These drawdowns will have the unintended consequence of negatively affecting private well performance and/or result in some wells going dry.”

For the closure by removal scenarios, dewatering water will be managed and discharged in accordance with the LSQ’s approved National Pollutant Discharge Elimination System (NPDES) Industrial Wastewater Discharge Individual Permit IL0002216 [IEPA, 2014].

9.1.6 Necessary Permits or Approvals from Other Agencies

For the closure by removal scenarios, additional permits or approvals that may be required include:

- Local or state permits for a new road entrance and/or traffic improvements on Patterson Road;
- Modification of existing third-party off-site landfill permit for waste acceptance of CCRs; and
- New or modification of existing NDPES permit to address CCR dewatering discharge.

9.2 Closure In-Place (Scenarios 3 through 8)

9.2.1 Necessary Permits or Approvals from Other Agencies

At this time the following permits or approvals may be required for the closure in-place scenarios:

- Modification of existing LSQ IEPA BOL permit for proposed alternate final cover system (i.e., ClosureTurf®) for closure scenario 4;

- Modification of existing LSQ IEPA BOL permit for revised final landform for closure scenario 5 (consolidate and close in-place);
- Modification of existing LSQ IEPA BOL permit and potential NPDES permit for additional leachate extraction wells and discharge for closure scenario 6 (consolidate and close in-place);
- Modification of existing LSQ IEPA BOL permit for revised final landform for closure scenario 5 (hydraulic control); and
- Local permit for installation of borings and associated grout injection for closure scenario 7 (hydraulic containment).

9.2.2 Post-Closure Inspection and Maintenance Program

Areas that have received final cover will be inspected a minimum of once per quarter. Any eroded or damaged areas in the final cover will be promptly repaired. The erosion of the final cover (if a ClosureTurf® is not utilized) from the surfaces of the landfill where vegetation has not yet been established will be controlled and repaired. Additional detail on the maintenance program for the final cover will be contained in permitted closure and post-closure care plan [KPRG, 2019b].

9.3 Consolidate and Closure in Place (Scenario 5)

9.3.1 Limited Dewatering and Waste Excavation

One of the advantages for the consolidate and closure in place scenario (Scenario 5) is that the need for dewatering and waste excavation is minimized by consolidating the area of CCR waste placement. By consolidating the area of waste placement, this also minimizes the volume of CCR waste to be regraded in order to develop positive grades for the final cover.

9.3.2 Slope Stability

In order to consolidate the CCR in the Main Quarry, steeper slopes will be required than current conditions. A detailed slope stability analysis will have to be performed to verify that these slopes will be stable under the proposed grading plan. Based on Geosyntec's experience at other CCR closures, 4 horizontal to 1 vertical (H:V) slopes can be developed with adequate factors of safety for slope stability.

9.4 Closure In-Place with Hydraulic Controls

9.4.1 Leachate Pumping for Inward Gradient Control

As discussed in Sections 2 and 3, the LSQ was designed as an inward gradient landfill. An inward gradient landfill maintains liquid levels in the waste mass lower than the surrounding groundwater elevations. Therefore, groundwater flows into the waste mass, minimizing impacts to off-site groundwater quality. Under this closure scenario, liquid or leachate extraction wells would be installed in through the final cover and into the CCR waste mass at a density of one well per acre to lower the liquid levels in CCR waste mass. The approximate average depth of the leachate extraction wells would be 60 feet.

The leachate extraction wells would be installed using drilling techniques for wet sand deposits such as mud rotary or sonic drilling. A specialty well screen and well pack would be installed to minimize the potential of clogging due to the coarse grain bottom ash present in the Main Quarry. A down-hole electronic or pneumatic pump would be installed to lower liquid levels. Pump water or leachate would be discharged through the facility's NPDES permit.

9.4.2 Closure In-Place with Hydraulic Containment – Grouting

Under this closure scenario, the bedrock fractures would be sealed with grout and thereby creating a low permeability "grout curtain" around the southern edge of the LSQ. This closure scenario would be implemented by installation of vertical or angle rock cores and the application of pressurized grout.

The effectiveness of the grout curtain will depend on several factors such as orientation of existing bedrock fracture pattern, chemical capability of the grout and intake rate of grout into the fractures. Additional rows of rock core "lines" can be installed should the initial "line" of grouted rock cores require supplemental grout. Once the grout is installed, the CCR can be dewatered, relocated and final cover applied.

There are several case studies in the Chicagoland area where grout was utilized to minimize inflow or outflow from previous bedrock quarries, this technology has not evaluated based on the unique site-specific conditions (i.e., bedrock fractures due to weathering and blasting) at the LSQ; therefore, an extensive pilot testing program would be required to verify that this technology would be feasible and implementable.

9.4.3 Wet Closure

Wet closure is a technically viable option and has the potential to enhance natural attenuation processes as a remedy for groundwater migrating through and downgradient of the LSQ facility. While wet closure is considered an effective and protective means to close and maintain the Main Quarry, it is understood to be a generally unfavorable closure alternative scenario given the current local regulatory and political climate.

9.5 Class IV Cost Estimate

Geosyntec performed a Class IV cost estimate, per AACE classification standard, for each of the eight closure scenarios. A Class IV cost estimate under the AACE classification standards includes the following primary and secondary characteristics (AACE 2016):

- Maturity Level of Project Definition Deliverables: 1 to 15%;
- End Usage (i.e. typical purpose of estimate): Study or Feasibility
- Methodology[3]: Parametric models
- Expected Accuracy Range: L: -15% to -20%
  H: +20% to 50%

Summary of the cost estimates for each of the eight closure scenarios are provided on **Tables 9-1 through 9-8**. Detailed cost estimates with quantities and unit rates are presented in **Appendix A**. At this time, quantities and unit rates used to develop the cost estimates are considered preliminary and are intended for discussion purposes. As additional information becomes available either through discovery or additional analysis, the cost estimates and timelines will be refined accordingly. Development of the draft cost estimates was intentionally broad, so that any subsequent refinement would not result in substantial change to the overall projected costs relative to the other closure scenarios.

In general, the Closure in Place scenarios provide the most cost- and time-efficient approaches. Line items with the greatest effective weight on the overall project cost and timeline include location and volume off-site soil borrow, volume of CCR for regrading and off-site CCR disposal.

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[3] Geosyntec cost estimate methodology included detailed unit costs with take-offs which is more similar to a Class 2 cost estimate methodology.

SECTION 10

CONCULSIONS

Geosyntec has evaluated two different closure approaches for the LSQ: Closure by Removal and Closure in Place. The two Closure by Removal scenarios that were assessed are: (1) removal of CCRs to an existing off-site permitted landfill, and (2) removal of CCRs to a new on-site landfill. For the Closure in Place approach, six different closure scenarios were evaluated: (3) IEPA Prescribed Final Cover, (4) Alternate Final Cover System, (5) Consolidate and Close in Place, (6) Closure in Place with Hydraulic Controls and (7) Closure in Place with Hydraulic Containment, and (8) Closure in Place with Wet Cap. Each of the closure scenarios were evaluated for the following factors:

- Magnitude and reduction of existing risks;
- Risk to nearby receptors, including the environment and community;
- Short and long-term effectiveness in controlling future releases;
- Groundwater protection;
- Protection to surrounding surface water;
- Time for closure and post-closure care;
- Long-term reliability of the engineering and institutional controls;
- Potential need for future corrective actions;
- Implementation; and
- Cost.

All closure scenarios were assessed on the short and long-term effectiveness in controlling future releases to the environment and risk to nearby receptors. The remaining closure factors (groundwater and surface water protection, long-term reliability, future corrective actions, implementation and cost) are summarized for each closure scenario in **Table ES-1**. Geosyntec also performed an actuarial risk and greenhouse assessments to further define impacts from the various closure scenarios on public health and the environment.

Scenario 1 “Closure by Removal” was evaluated as not implementable due to the lack of available nearby permitted landfill airspace. There are two nearby landfills with permitted airspace, but the permitted airspace is either guaranteed under contract to another entity (Prairie View RDF to Will County) or the landfill operating life (Laraway RDF) is less than the Scenario 1 closure schedule. Dewatering the Main Quarry to facilitate removal of CCR materials is impractical due to drawdown impacts on nearby residential private water wells. Additionally, Scenario 1 had the highest vehicle and worker accident rate and greenhouse gas footprint. Lastly, the current ICA groundwater extraction system would still be required to be operated for Scenario 1 to address existing groundwater quality in the southern GMZ. Therefore, Scenario 1 should not be considered as a closure approach at the LSQ due to the lack of nearby permitted airspace, cost, dewatering challenges and impacts on nearby residential water wells, accident (worker and vehicle) potential and significant greenhouse gas footprint. Other transportation modes such as rail and barge were assessed to be non-feasible due to the lack of available area to build the necessary on-site transfer station facility and lack of transfer station infrastructure for disposal at an off-site third-party disposal facility.

Closure Scenarios 2 and 8 should also be excluded from further consideration due to the following reasons. Scenario 2 "Closure in Place at New On-Site Landfill" was not implementable because there is not nearby property available for purchase or development for a new on-site landfill. The lowest cost, accident potential and greenhouse gas emissions were Scenario 8 "Closure in Place with Wet Cap" but this closure scenario is, more likely than not, not implementable due to challenges in receiving regulatory approval for a "wet" cap design.

The Closure in Place scenario (Scenario No. 3) eliminated the removal of over 4.3 MCY of CCR and instead proposes to install a final cover system over the CCRs. The final cover system will effectively eliminate the infiltration of stormwater into the waste mass, thereby, significantly reducing leachate generation. The reduction in leachate generation will reduce the leachate head or driving force from the LSQ and therefore, create a more effective inward hydraulic gradient condition which will provide protection to local and regional groundwater resources. Additionally, the proposed final cover will eliminate and potential impacts to nearby surface water resources.

Various Closure in Place scenario alternatives (Scenario Nos. 4 -8) were assessed which included, alternate final cover systems (ClosureTurf® and wet), consolidate and close, and additional environmental control systems. For example, Scenario 5 "Consolidate and Close in Place" reduced the closure footprint, thereby reduced the volume of CCRs requiring regrading and final cover placement and therefore, was the most cost effective of the Closure in Place scenarios. Scenarios 6 and 7 (hydraulic control and containment) provides an additional and redundant engineered control system for groundwater protection. Each of these Closure in Place scenario alternatives provide equivalent levels of protection to the public and environment receptors as Scenario No. 3.

Lastly, when all factors are considered, the Closure by Removal scenarios were not implementable due to limits on either nearby permitted waste disposal airspace, lack of transfer station infrastructure for rail or barge transport or available property to develop a new landfill. Additionally, the Closure by Removal scenarios would have larger impacts, as compared to the Closure in Place scenarios, to the environment in the form of greenhouse gas emissions and human health in the form of worker safety and vehicle accidents. Based on site specific conditions and groundwater modelling, Closure in Place Scenario 4 "Closure in Place with Alternate Final Cover" is the recommended closure scenario because this scenario provides both short- and long-term protection to groundwater and surface water resources along with ensuring overall protection to the public health, welfare and safety.

SECTION 11

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TABLES

Table ES-1
Summary of Closure Alternatives at Lincoln Stone Quarry

Closure Scenario	Closure Cost Estimate ($ million)	Post-Closure Cost Estimate ($ million)	Groundwater Protection	Surface Waters Protection	Implementation	Notes
Closure by Removal Scenarios						
Scenario 1 – Closure by Removal at Existing Off-Site Landfill	466.99	0.05	Current ICA extraction system would be required to be operated to manage current groundwater in permitted GMZs. Operate until Laraway Quarry operations cease or until GWQS met within the GMZ	Surface water would be protected through removal of the CCR from Main Quarry and West Fill Area (WFA)	Nearby landfills have limited airspace that may not be available due to capacity commitments or limited site life (< 5 years), increase risk to vehicle and work accidents to significant CCR volume handing. Alternate transportation methods (i.e. barge or rail) to remote landfills is not feasible due to: (1) lack of on-site area to building transfer facility and (2) lack of existing infrastructure to transfer transported CCR to remote landfill. Required dewatering of the LSQ has a high probability of causing nearby private water wells to run dry.	Highest greenhouse gas footprint for all of the closure scenarios.
Scenario 2 – Closure by Removal at New On-Site Landfill	121.20	5.08			Not feasible, no land available on-site or nearby to develop an on-site landfill.	
Closure in Place Scenarios						
Scenario 3 – Closure in Place with IEPA Prescriptive Final Cover	27.14	5.09	Current ICA extraction system would be required to operate until Laraway Quarry ceases operations or until GWQS are met within the GMZ. Final cover system would reduce leachate head in Main Quarry thereby improving inward gradient conditions.	The proposed final cover system would isolate CCRs from stormwater and thereby providing protection to surface waters.	Similar closure scenario has been implemented at hundreds of landfills and CCR surface impoundments.	Current permitted closure plan for LSQ.
Scenario 4 – Closure in Place with Alternate Final Cover	23.59	3.64				Alternate final cover system would be a ClosureTurf® or equivalent system.
Scenario 5 – Consolidate and Close with IEPA Prescriptive Final Cover	22.54	5.09			Standard of practice for closure of CCR surface impoundments.	Minimizes volume of off-site soils required to reach final surface grades.
Scenario 6 – Closure in Place with IEPA Prescriptive Final Cover w/ Hydraulic Controls	27.74	7.80	Inward gradient conditions would be enhanced through leachate removal and elimination of stormwater percolation.		Requires installation of 60-foot leachate extraction wells with a density of 1 well per acre. Specialty well pack will be required to address well screen clogging issues.	Requires increased leachate and groundwater extraction during post-closure.
Scenario 7 – Closure in Place with IEPA Prescriptive Final Cover w/ Hydraulic Containment	37.12	5.09	Groundwater flow from Main Quarry would be significantly reduced due to installation of low permeability wall along southern edge of the Main Quarry.		Effectiveness will be dependent on fracture pattern and grout combability. Additional "lines" can be installed to reduce permeability.	Have been implemented at one to two quarry sites for stormwater management in the Chicagoland area to minimize groundwater infiltration.
Scenario 8 – Closure in Place with IEPA Prescriptive Final Cover – "Wet Closure"	16.17	5.09	Groundwater protection would be provided by enhanced MNA. ICA extraction system would be needed for residual plume		High unlikely to receive regulatory approval.	Standard of practice to address impacted sediment sites where material is left in place.

Table 6-1: Accident Frequency for Lincoln Stone Quarry Closure Alternatives							
Closure Scenario	**Total On-Site Miles**	**On-Site Miles per Year**	**Total Off-Site Miles**	**Off-Site Miles per Year**	**Trucking Accidents involving Property Damage (1)**	**Trucking Accidents Involving Personnel Injury (3)**	**Truck Crash Fatalities (4)**
SCENARIO 1: Closure by Removal and Placement at an Existing Landfill	169,400	14,463	3,388,000	289,261	3.36	0.15119	0.05194
SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill	1,711,783	121,158	664,400	47,025	2.24	0.10099	0.03469
SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design	48,843	25,507	305,400	159,484	0.34	0.01506	0.00517
SCENARIO 4: Closure in Place with Alternate Final Cover Design	40,605	15,842	49,600	19,351	0.09	0.00384	0.00132
SCENARIO 5: Consolidate and Close in Place	41,351	15,134	234,973	85,999	0.27	0.01175	0.00403
SCENARIO 6: Close in Place with Hydraulic Controls	48,963	15,016	306,000	93,846	0.34	0.01509	0.00518
SCENARIO 7: Close in Place with Hydraulic Containment	48,843	3,457	305,400	21,616	0.34	0.01506	0.00517
SCENARIO 8: Close in Place with "Wet" Cap	2,150	152	43,000	3,043	0.05	0.00192	0.00066

Assumptions

1. Sources: United States Department of Transportation (USDOT), (see Section 11 "References" for USDOT 2012)
3. A accident rate of 94.2 accidents per 100 million vehicle miles involving property damage (USDOT 2012).
3. A injury rate of 4.25 injuries per 100 million vehicle miles (USDOT 2012).
3. A fatality rate of 1.46 deaths per 100 million vehicle miles (USDOT 2012).
4. Refer to Appendix C for calculation of total on-site and off-site miles

Table 6-2: Worker Accident Frequency for Lincoln Stone Quarry Closure Alternatives			
Closure Scenario	No. of Days	Total Hours (4)	Recordable Worker Accidents/Cases (1,2,3)
SCENARIO 1: Closure by Removal and Placement at an Existing Landfill	2,915	562,900	4.785
SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill	2,891	492,300	4.185
SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design	489	34,500	0.293
SCENARIO 4: Closure in Place with Alternate Final Cover Design	530	39,200	0.333
SCENARIO 5: Consolidate and Close in Place	441	31,400	0.267
SCENARIO 6: Close in Place with Hydraulic Controls	579	37,400	0.318
SCENARIO 7: Close in Place with Hydraulic Containment	669	40,300	0.343
SCENARIO 8: Close in Place with "Wet" Cap	197	16,800	0.143

Assumptions

1. Sources: U.S. Bureau of Labor Statistics (BLS), U.S. Department of Labor (see Section 11 "References" for BLS 2006 and 2013)
2. The incidence rates represent the number of injuries and illnesses per 100 full-time equivalent workers and were calculated as: (N/EH) x 200,000, where N = number of injuries and illness, EH = total hours worked by all employees during the calendar year.
3. A incidence rate of 1.7 per 200,000 hours (see note 2) was assumed for heavy and civil engineering construction (NAICS code 237).
4. Refer to Appendix C for calculation of total worker hours.

Table 6-3: Greenhouse Gas Emissions Estimates for Lincoln Stone Quarry Closure Alternatives				
Closure Scenario	**Total Miles (On- & Off-Site)**	**Total Hours (Heavy Equip)**	**Total Impact (kg CO2)**	**Impact Rate (kg CO2 per CY CCR)**
SCENARIO 1: Closure by Removal and Placement at an Existing Landfill	3,557,400	400,500	40,868,099	15.72
SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill	2,376,183	327,900	32,972,291	12.68
SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design	354,243	10,800	1,336,849	0.51
SCENARIO 4: Closure in Place with Alternate Final Cover Design	90,205	7,100	749,171	0.29
SCENARIO 5: Consolidate and Close in Place	276,323	9,900	1,181,454	0.45
SCENARIO 6: Close in Place with Hydraulic Controls	354,963	11,400	1,393,885	0.54
SCENARIO 7: Close in Place with Hydraulic Containment	354,243	4,400	735,446	0.28
SCENARIO 8: Close in Place with "Wet" Cap	45,150	3,000	322,946	0.12

Assumptions

1. 6.5 operating hours per day per vehicle was utilized to calculate the total hours of heavy equipment; refer to Appendix C for summary of number of
2. Heavy equipment was assumed to have an average travel speed of 11.2 miles per gallon (2011 HINO 268/268A spec literature).
3. Heavy equipment was assumed to average 60 miles per operating hour.
4. Heavy equipment was assumed to average 6.5 gallons per operating hours.
5. One gal of diesel fuel consumed equals 10.18 kg of CO_2 (USEPA emissions conversion)
6. Reference data from AMCOL Report, Tables A.2 and A.3, unless otherwise referenced.

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
Date: September 30, 2021

Created By:	TWW	07/09/20
Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	9/30/2021

Appendix D - Estimated Schedule Critical Path Items

Table 7-1: Closure Scenarios' Schedule
Critical Path Working Days

Tasks	**00.50**	**01.00 - 06.00**		**07.20**	**07.50**	**07.00, 08.00, 09.00**	**10.00**	**11.00**			
Scenario	**Siting/ Permitting**	**Mob**	**Dewatering, Erosion, Demolition, Etc.**	**CCR Excavation to Landfill**	**Ash Recontouring**	**Liner & Cap Installation [4, 5]**	**Hydraulic Control/ Containment**	**Turf and Grasses[6]**	**Days**	**Months**	**Years**
SCENARIO 1: Closure by Removal and Placement at an Existing Landfill	180	10	120	2795	0	0	0	0	3,105	140.6	11.7
SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill	1095	10	120	2150	0	600	0	21	3,996	169.5	14.1
SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design	0	10	120	0	114	234	0	21	499	23.0	1.9
SCENARIO 4: Closure in Place with Alternate Final Cover Design	180	10	120	0	114	10	0	285	720	30.8	2.6
SCENARIO 5: Consolidate and Close in Place	365	10	120	0	67	234	0	21	816	32.8	2.7
SCENARIO 6: Closure in Place with Hydraulic Control	365	10	120	0	114	234	90	21	954	39.1	3.3
SCENARIO 7: Closure in Place with Hydraulic Containment	365	10	120	0	114	234	180	21	1,044	43.3	3.6
SCENARIO 8: Closure in Place Wet Closure	365	10	0	0	60	132	0	5	572	21.6	1.8

Notes:

1 Assumes 6 months of dewatering prior to earthwork.
2 Assumes Tasks 03.00 - 06.00 occur during the initial dewatering.
3 Assumes ditching and access roads are installed during earthwork.
4 Scenario 2 requires construction of both a bottom, leachate and final cover systems.
5 ClosureTurf installation was assumed to be 10,000 sq. feet per day.
6 Turf and Grasses Installation time includes: soil prep, soil amendments, erosion control measures, seed application.
7 Please refer to Appendix C (for hauling rates for soil) and Appendix D (for construction production rates).

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Revised By:	REW	09/30/21

COST SUMMARY

Table 9-1

SCENARIO 1: Closure by Removal and Placement at an Existing Landfill

Task		COST	
01.00	Mobilization / Demobilization	$ 352,000	
02.00	Dewatering and Temp. SW Management	$ 8,261,000	
03.00	Erosion and Sediment Controls	$ 278,000	
04.00	Instrumentation	$ 20,000	
05.00	Demolition	$ 233,000	
06.00	Site Clearing	$ -	
07.00	Earthwork	$ 334,233,000	
08.00	Geosynthetics	$ -	
09.00	Pond Closure - Ditch and Apron Construction	$ -	
10.00	Hydraulic Control / Containment	$ -	
11.00	Turf and Grasses	$ -	
12.00	SW Management Features - New Landfill	$ -	
	Sub Total Cost	**$ 343,377,000**	
	Contingency	$ 103,013,000	30%
	Design and Engineering Fees[1]	$ 3,434,000	1%
	Owners Costs	$ 17,169,000	5%
	Closure Scenario Subtotal	**$ 466,993,000**	
	30-year Post-Closure	$ 50,000	
	Closure & PCC Scenario Total	**$ 467,043,000**	

Note: 1. This this scenario design and engineering fees were reduced to 1% due to the high cost of waste transport and disposal that would impact design and engineering fees

Table 9-2

SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill

Task		COST	
00.50	Siting and IEPA Permitting	$ 2,725,000	
01.00	Mobilization / Demobilization	$ 356,000	
02.00	Dewatering and Temp. SW Management	$ 7,199,000	
03.00	Erosion and Sediment Controls	$ 315,000	
04.00	Instrumentation	$ 20,000	
05.00	Demolition	$ 80,000	
06.00	Site Clearing	$ 1,018,000	
07.00	Earthwork	$ 59,663,000	
08.00	Geosynthetics	$ 11,324,000	
09.00	Pond Closure - Ditch and Apron Construction	$ -	
10.00	Hydraulic Control / Containment	$ -	
11.00	Turf and Grasses	$ 611,000	
12.00	SW Management Features - New Landfill	$ 273,000	
	Sub Total Cost	**$ 83,584,000**	30%
	Contingency	$ 25,075,000	10%
	Design and Engineering Fees	$ 8,358,000	5%
	Owners Costs	$ 4,179,000	
	Scenario Total	**$ 121,196,000**	
	30-year Post-Closure	***$ 5,083,000***	
	Closure & PCC Scenario Total	**$ 126,279,000**	

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
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Revised By:	REW	09/30/21

COST SUMMARY

Table 9-3

SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design

	Task		COST	
01.00	Mobilization / Demobilization	$	245,000	
02.00	Dewatering and Temp. SW Management	$	486,000	
03.00	Erosion and Sediment Controls	$	220,000	
04.00	Instrumentation	$	26,000	
05.00	Demolition	$	80,000	
06.00	Site Clearing	$	251,000	
07.00	Earthwork	$	9,970,000	
08.00	Geosynthetics	$	6,407,000	
09.00	Pond Closure - Ditch and Apron Construction	$	157,000	
10.00	Hydraulic Control / Containment	$	-	
11.00	Turf and Grasses	$	878,000	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**18,720,000**	
	Contingency	$	5,616,000	30%
	Design and Engineering Fees	$	1,872,000	10%
	Owners Costs	$	936,000	5%
	Scenario Total	**$**	**27,144,000**	
	30-year Post-Closure	**$**	**5,085,000**	
	Closure & PCC Scenario Total	**$**	**32,229,000**	

Table 9-4

SCENARIO 4: Closure in Place with Alternate Final Cover Design

	Task		COST	
01.00	Mobilization / Demobilization	$	253,000	
02.00	Dewatering and Temp. SW Management	$	518,000	
03.00	Erosion and Sediment Controls	$	223,000	
04.00	Instrumentation	$	26,000	
05.00	Demolition	$	80,000	
06.00	Site Clearing	$	48,000	
07.00	Earthwork	$	6,521,000	
08.00	Geosynthetics	$	-	
09.00	Pond Closure - Ditch and Apron Construction	$	157,000	
10.00	Hydraulic Control / Containment	$	-	
11.00	Turf and Grasses	$	8,440,000	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**16,266,000**	
	Contingency	$	4,880,000	30%
	Design and Engineering Fees	$	1,627,000	10%
	Owners Costs	$	813,000	5%
	Scenario Total	**$**	**23,586,000**	
	30-year Post-Closure	**$**	**3,639,000**	
	Closure & PCC Scenario Total	**$**	**27,225,000**	

Table 9-5

SCENARIO 5: Consolidate and Close in Place

Task			COST	
01.00	Mobilization / Demobilization	$	243,000	
02.00	Dewatering and Temp. SW Management	$	571,000	
03.00	Erosion and Sediment Controls	$	220,000	
04.00	Instrumentation	$	26,000	
05.00	Demolition	$	80,000	
06.00	Site Clearing	$	251,000	
07.00	Earthwork	$	7,924,000	
08.00	Geosynthetics	$	5,305,000	
09.00	Pond Closure - Ditch and Apron Construction	$	157,000	
10.00	Hydraulic Control / Containment	$	-	
11.00	Turf and Grasses	$	765,000	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**15,542,000**	
	Contingency	$	4,663,000	30%
	Design and Engineering Fees	$	1,554,000	10%
	Owners Costs	$	777,000	5%
	Scenario Total	**$**	**22,536,000**	
	30-year Post-Closure	**$**	**5,085,000**	
	Closure & PCC Scenario Total	**$**	**27,621,000**	

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
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Revised By:	REW	09/30/21

COST SUMMARY

Table 9-6
SCENARIO 6: Closure in Place with Hydraulic Control

Task		COST		
01.00	Mobilization / Demobilization	$	245,000	
02.00	Dewatering and Temp. SW Management	$	553,000	
03.00	Erosion and Sediment Controls	$	220,000	
04.00	Instrumentation	$	26,000	
05.00	Demolition	$	80,000	
06.00	Site Clearing	$	251,000	
07.00	Earthwork	$	9,970,000	
08.00	Geosynthetics	$	6,407,000	
09.00	Pond Closure - Ditch and Apron Construction	$	157,000	
10.00	Hydraulic Control / Containment	$	345,000	
11.00	Turf and Grasses	$	878,000	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**19,132,000**	
	Contingency	$	5,740,000	30%
	Design and Engineering Fees	$	1,913,000	10%
	Owners Costs	$	957,000	5%
	Scenario Total	**$**	**27,742,000**	
	30-year Post-Closure	***$***	***7,763,000***	
	Closure & PCC Scenario Total	**$**	**27,742,000**	

Table 9-7
SCENARIO 7: Closure in Place with Hydraulic Containment

Task		COST		
01.00	Mobilization / Demobilization	$	245,000	
02.00	Dewatering and Temp. SW Management	$	486,000	
03.00	Erosion and Sediment Controls	$	220,000	
04.00	Instrumentation	$	26,000	
05.00	Demolition	$	80,000	
06.00	Site Clearing	$	251,000	
07.00	Earthwork	$	9,970,000	
08.00	Geosynthetics	$	6,407,000	
09.00	Pond Closure - Ditch and Apron Construction	$	157,000	
10.00	Hydraulic Control / Containment	$	6,878,000	
11.00	Turf and Grasses	$	878,000	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**25,598,000**	
	Contingency	$	7,679,000	30%
	Design and Engineering Fees	$	2,560,000	10%
	Owners Costs	$	1,280,000	5%
	Scenario Total	**$**	**37,117,000**	
	30-year Post-Closure	***$***	***5,085,000***	
	Closure & PCC Scenario Total	**$**	**37,117,000**	

Table 9-8
SCENARIO 8: Closure in Place Wet Closure

Task		COST		
01.00	Mobilization / Demobilization	$	232,000	
02.00	Dewatering and Temp. SW Management	$	280,000	
03.00	Erosion and Sediment Controls	$	30,000	
04.00	Instrumentation	$	-	
05.00	Demolition	$	50,000	
06.00	Site Clearing	$	48,000	
07.00	Earthwork	$	10,366,000	
08.00	Geosynthetics	$	-	
09.00	Pond Closure - Ditch and Apron Construction	$	144,000	
10.00	Hydraulic Control / Containment	$	-	
11.00	Turf and Grasses	$	-	
12.00	SW Management Features - New Landfill	$	-	
	Sub Total Cost	**$**	**11,150,000**	
	Contingency	$	3,345,000	30%
	Design and Engineering Fees	$	1,115,000	10%
	Owners Costs	$	558,000	5%
	Scenario Total	**$**	**16,168,000**	
	30-year Post-Closure	***$***	***5,085,000***	
	Closure & PCC Scenario Total	**$**	**21,253,000**	

FIGURES

LEGEND

———	EXISTING MINOR CONTOUR (1-FT INTERVAL)
———	EXISTING MAJOR CONTOUR (5-FT INTERVAL)
— WL —— WL —	APPROXIMATE ORDINARY HIGH WATER MARK
——◄——◄——	EXISTING SLUICE PIPES
⊗ GS20S	MONITORING WELL
● X102	EXTRACTION WELLS

NOTE:

1. FIGURE ADAPTED FROM AUTOCAD DRAWING "EXISTING SITE CONDITIONS" FROM KPRG.

EXISTING SITE CONDITIONS
LINCOLN STONE QUARRY
JOLIET,IL

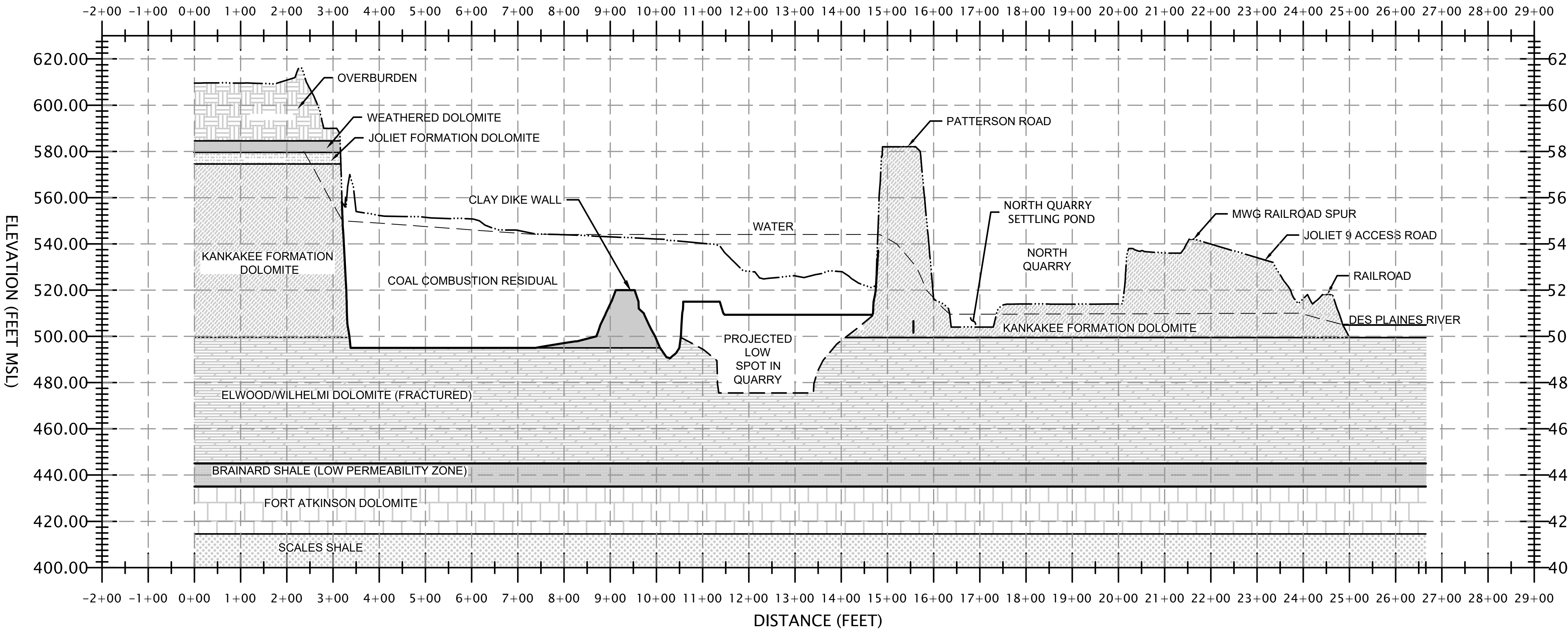
Geosyntec consultants

FIGURE 2-1

PROJECT NO: CHE8420

OCTOBER 2021

J:\DWG\NNRG\LSQ\CHE8404-001 EXISTING CONDITION - Last Saved by: MKatelieva on 7/29/20



NOTE:

1. FIGURE ADAPTED FROM "LINCOLN STONE QUARRY AREA CROSS-SECTION" DATED 2/17/2020, PREPARED BY KPRG.

GEOLOGIC CROSS SECTION
LINCOLN STONE QUARRY
JOLIET,IL

Geosyntec consultants

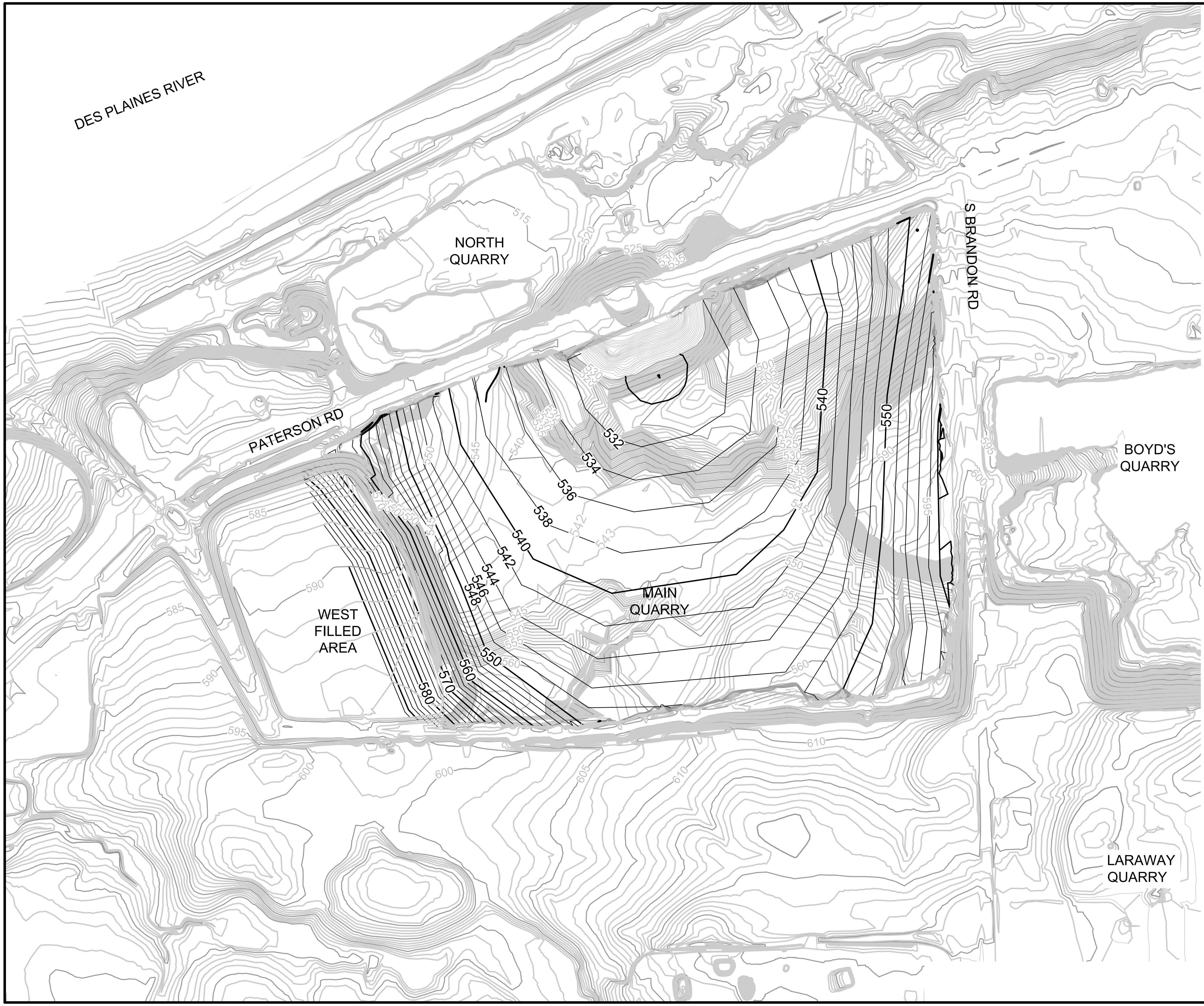
PROJECT NO: CHE8420

OCTOBER 2021

FIGURE

2-2

J:\DWG\NINRG\LSQ\FIGURE 3-1 GEOLOGICAL CROSS SECTION - Last Saved by: JVarsho on 7/29/20



LEGEND

EXISTING MINOR CONTOUR (1-FT INTERVAL)

EXISTING MAJOR CONTOUR (5-FT INTERVAL)

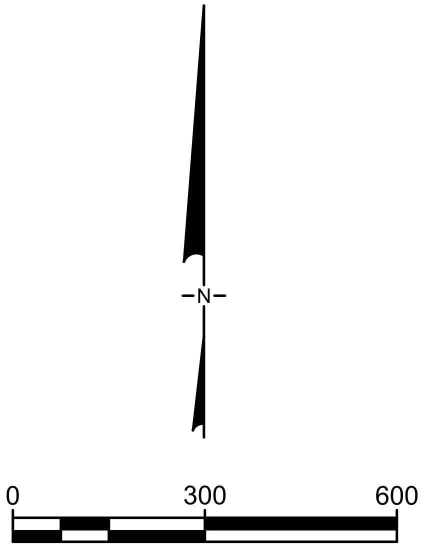
PROPOSED CCR FINAL GRADE MAJOR CONTOUR (5- FT INTERVAL)

PROPOSED CCR FINAL GRADE MINOR CONTOUR (1- FT INTERVAL)

←←← EXISTING SLUICE PIPES

NOTE:

1. FIGURE ADAPTED FROM AUTOCAD DRAWING "PROPOSED GRADING PLAN" FROM KPRG.



SCALE IN FEET

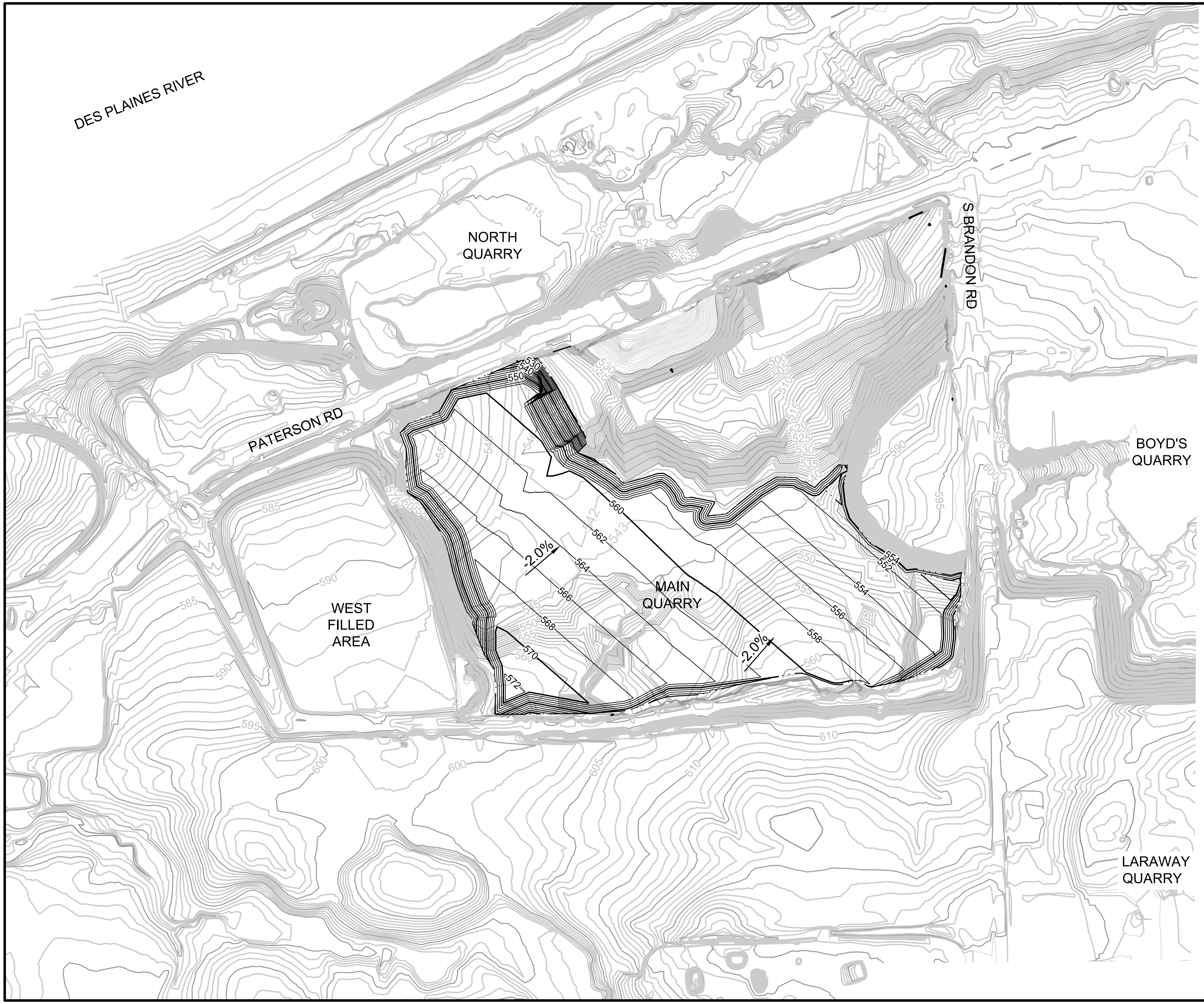
SCENARIO 3
CLOSURE IN PLACE FINAL CCR GRADES
LINCOLN STONE QUARRY
JOLIET,IL

Geosyntec consultants

FIGURE
4-1

PROJECT NO: CHE8420
OCTOBER 2021

J:\DWG\NNRG\LSQ\FIGURE 4-1 SCENARIO 3 - Last Saved by: JVarsho on 7/29/20



LEGEND

───	EXISTING MINOR CONTOUR (1-FT INTERVAL)
───	EXISTING MAJOR CONTOUR (5-FT INTERVAL)
───	PROPOSED CCR FINAL GRADE MAJOR CONTOUR (5- FT INTERVAL)
───	PROPOSED CCR FINAL GRADE MINOR CONTOUR (1- FT INTERVAL)
─◄──◄─	EXISTING SLUICE PIPES

VOLUME: **CCR PROPOSED GRADE**

BASE SURFACE EG	
COMPARISON SURFACE	CCR GRADING
CUT VOLUME	2000.07 CU. YD.
FILL VOLUME	443349.41 CU. YD.
NET VOLUME	441349.34 CU. YD.<FILL>

VOLUME: **CCR DISPOSAL VOLUME**

BASE SURFACE BOTTOM OF ASH	
COMPARISON SURFACE: EG	
CUT VOLUME	1701.55 CU. YD.
FILL VOLUME	386922.69 CU. YD.
NET VOLUME	385221.14 CU. YD.<FILL

0 300 600
SCALE IN FEET

N

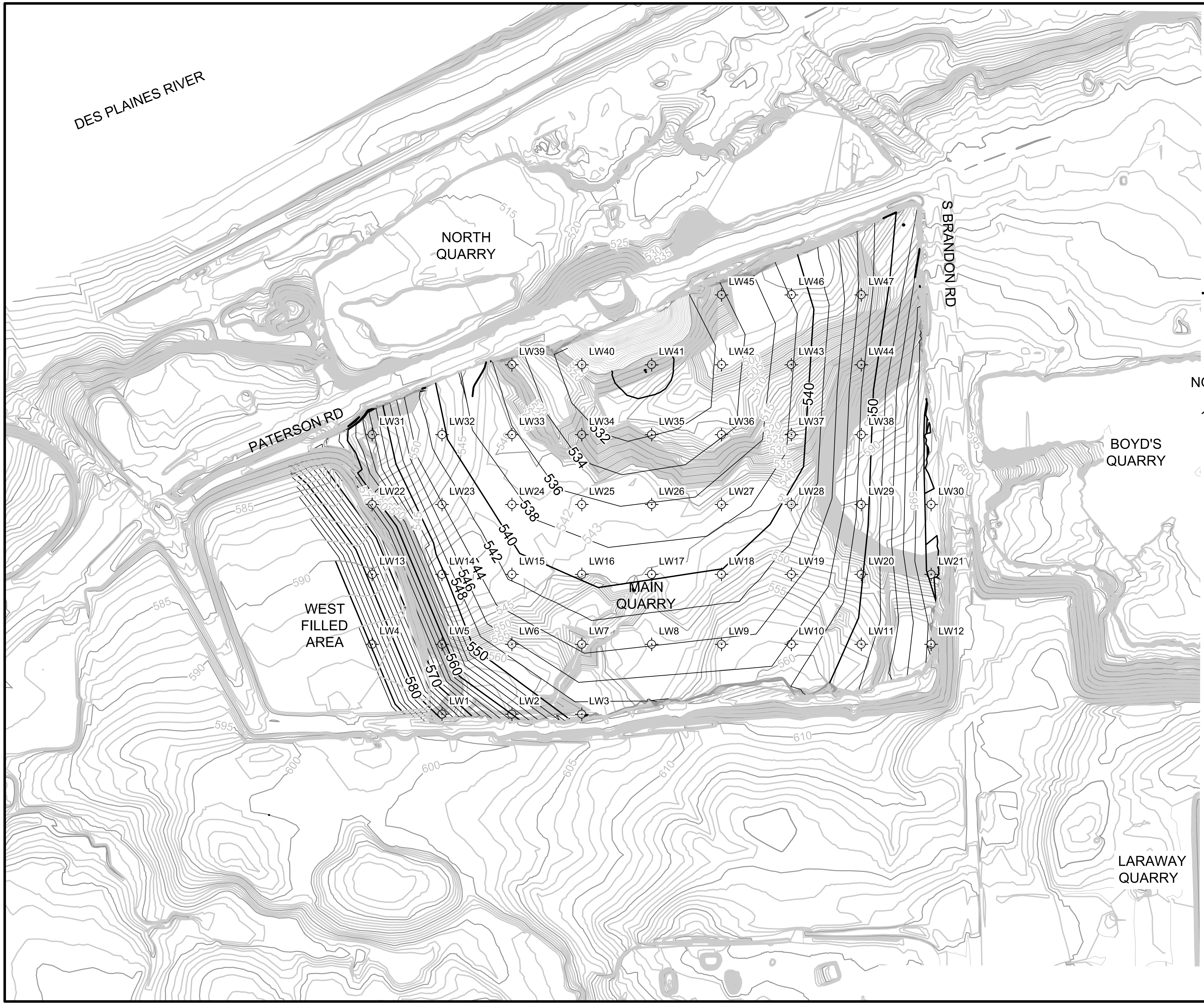
SCENARIO 5
CONSOLIDATE AND CLOSURE IN PLACE
LINCOLN STONE QUARRY
JOLIET,IL

Geosyntec
consultants

FIGURE
4-2

PROJECT NO: CHE8420
OCTOBER 2021

J:\DWG\NNRG\LSQ\FIGURE 4-2 GRADING - Last Saved by: JVarsho on 7/29/20



LEGEND

EXISTING MINOR CONTOUR (1-FT INTERVAL)

EXISTING MAJOR CONTOUR (5-FT INTERVAL)

PROPOSED CCR FINAL GRADE MAJOR CONTOUR (5- FT INTERVAL)

PROPOSED CCR FINAL GRADE MINOR CONTOUR (1- FT INTERVAL)

EXISTING SLUICE PIPES

LW135 LEACHATE EXTRACTION WELL

NOTE:

1. FIGURE ADAPTED FROM AUTOCAD DRAWING "PROPOSED GRADING PLAN" FROM KPRG.

N

0 300 600

SCALE IN FEET

SCENARIO 6
CLOSURE IN PLACE WITH HYDRAULIC CONTROLS
LINCOLN STONE QUARRY
JOLIET,IL

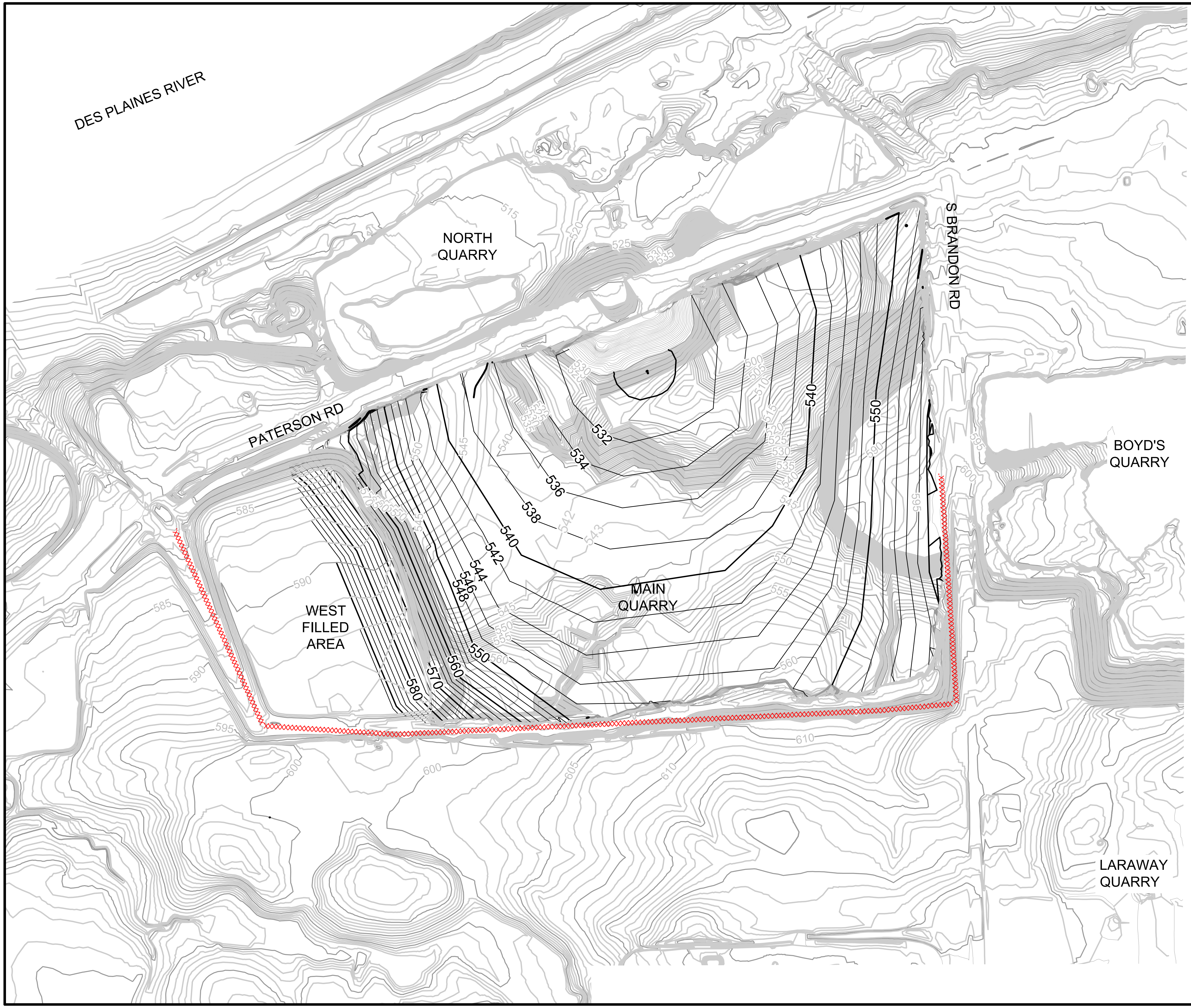
Geosyntec consultants

FIGURE 4-3

PROJECT NO: CHE8420

OCTOBER 2021

J:\DWG\NNRG\LSQ\FIGURE 4-3 SCENARIO 6 - Last Saved by: JVarsho on 7/29/20



LEGEND

EXISTING MINOR CONTOUR (1-FT INTERVAL)

EXISTING MAJOR CONTOUR (5-FT INTERVAL)

PROPOSED CCR FINAL GRADE MAJOR CONTOUR (5- FT INTERVAL)

PROPOSED CCR FINAL GRADE MINOR CONTOUR (1- FT INTERVAL)

EXISTING SLUICE PIPES

PROPOSED DOLOMITE GROUT WALL

NOTE:

1. FIGURE ADAPTED FROM AUTOCAD DRAWING "PROPOSED GRADING PLAN" FROM KPRG.

N

0 300 600

SCALE IN FEET

SCENARIO 7
CLOSURE IN PLACE WITH HYDRAULIC CONTAINMENT
LINCOLN STONE QUARRY
JOLIET,IL

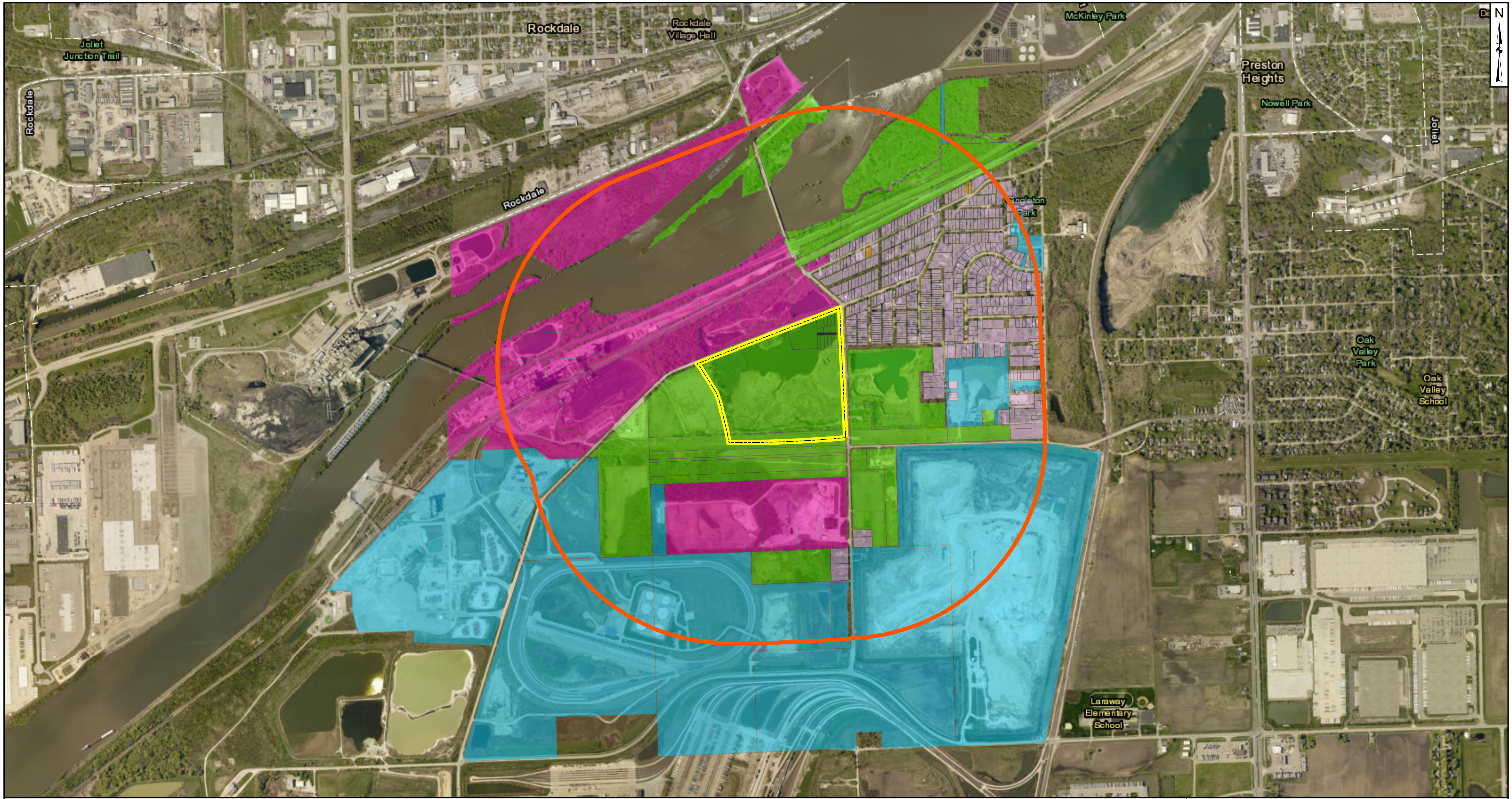
Geosyntec
consultants

FIGURE
4-4

PROJECT NO: CHE8420

OCTOBER 2021

J:\DWG\NNRG\LSQ\FIGURE 4-4 SCENARIO 7 - Last Saved by: JVarsho on 7/29/20



Legend

- 🟩 Agricultural
- 🟨 Commercial
- 🟪 Industrial
- 🟦 Municipal
- ⬜ Residential
- - - - Site Boundary
- 🟥 1/2 Mile Buffer

Notes

- Land use zoning data provided by Will County Illinois GIS Division
- Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

700 350 0 700
Feet

Land Use Map

Lincoln Stone Quarry
1601 S. Patterson Road
Joliet, Illinois

Geosyntec
consultants

Columbus, Ohio

October 2021

Figure
5-1

Z:\DWG\N\NRG\LSQ\mxds\Landuse Map.mxd. HDuff. 8/3/2020. CHE8420.

APPENDICES

Appendix A

EcoCAT

EcoCAT
Ecological Compliance Assessment Tool

Applicant: Geosyntec Consultants
Contact: Megan Martz
Address: 1420 Kensington Road
Oak Brook, IL 60523

IDNR Project Number: 2100952
Date: 07/17/2020

Project: LSQ
Address: 1601 S. Patterson Rd., Joliet

Description: Closure planning for Lincoln Stone Quarry

Natural Resource Review Results

This project was submitted for information only. It is not a consultation under Part 1075.

The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

Markgraf Quarry INAI Site
Banded Killifish *(Fundulus diaphanus)*
Banded Killifish *(Fundulus diaphanus)*
Osprey *(Pandion haliaetus)*

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Will

Township, Range, Section:
35N, 10E, 20
35N, 10E, 21
35N, 10E, 28
35N, 10E, 29

IL Department of Natural Resources Contact
Impact Assessment Section
217-785-5500
Division of Ecosystems & Environment

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

Terms of Use

By using this website, you acknowledge that you have read and agree to these terms. These terms may be revised by IDNR as necessary. If you continue to use the EcoCAT application after we post changes to these terms, it will mean that you accept such changes. If at any time you do not accept the Terms of Use, you may not continue to use the website.

1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

Security

EcoCAT operates on a state of Illinois computer system. We may use software to monitor traffic and to identify unauthorized attempts to upload, download, or change information, to cause harm or otherwise to damage this site. Unauthorized attempts to upload, download, or change information on this server is strictly prohibited by law.

Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

EcoCAT
Ecological Compliance Assessment Tool

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

EcoCAT Receipt

Project Code 2100952

APPLICANT	DATE
Geosyntec Consultants Megan Martz 1420 Kensington Road Oak Brook, IL 60523	7/17/2020

DESCRIPTION	FEE	CONVENIENCE FEE	TOTAL PAID
EcoCAT Consultation	$ 25.00	$ 1.00	$ 26.00

TOTAL PAID $ 26.00

Illinois Department of Natural Resources
One Natural Resources Way
Springfield, IL 62702
217-785-5500
dnr.ecocat@illinois.gov

Appendix B

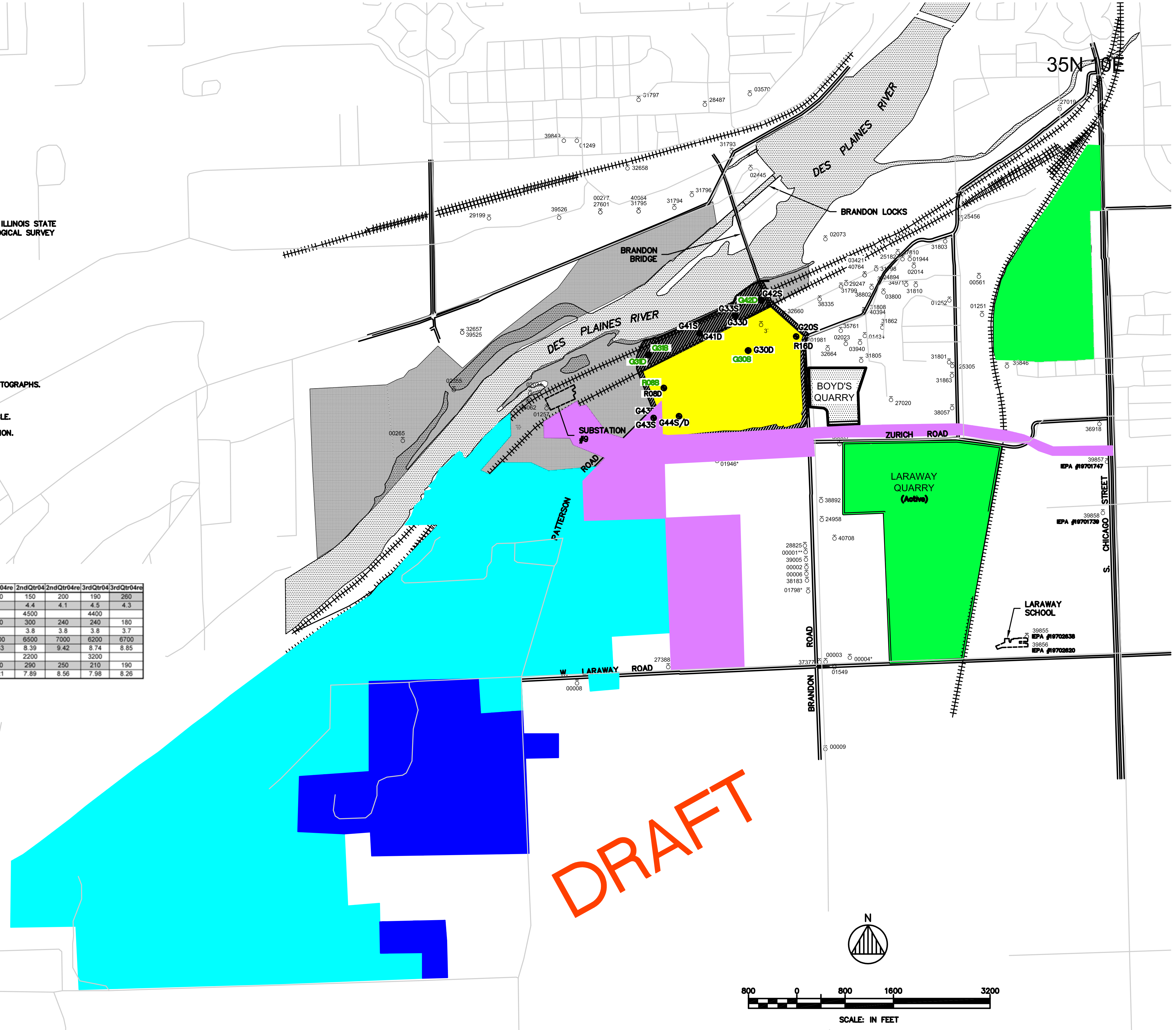
Residential Well Survey

EXPLANATION

- ● **R32S** GROUNDWATER MONITORING WELL WITH PARAMETERS EXCEEDING AGQS AND CLASS I STANDARDS
- ● G43S GROUNDWATER MONITORING WELL
- ⊙ S501 SURFACE WATER MONITORING POINT
- ▨ ZOA
- ░ WATER BODY
- ♁ APPROXIMATE LOCATION OF WATER WELLS IDENTIFIED BY ILLINOIS STATE WATER SURVEY (ISWS) WELL LOGS, ILLINOIS STATE GEOLOGICAL SURVEY (ISGS) WELL LOGS OR BY ISGS QUESTOR SYSTEM DATA.

NOTES:

1. QUARRY BOUNDARIES ARE APPROXIMATE TAKEN FROM AERIAL PHOTOGRAPHS.
2. WELL LOCATIONS HAVE NOT BEEN FIELD VERIFIED.
3. DATA FOR WELLS WITHIN THE 1 MILE RADIUS ARE LOCATED IN TABLE.
4. * – ADDRESS DOES NOT MATCH LOG QUARTER SECTION INFORMATION.



Well	Parameter	Units	Class I	AGQS	1stQtr03	2ndQtr03	3rdQtr03	4thQtr03	4thQtr03re	1stQtr04	1stQtr04re	2ndQtr04	2ndQtr04re	3rdQtr04	3rdQtr04re
G30S	Chloride, dissolved	mg/L	200	144.29	110	140	140	160	160	150	170	150	200	190	260
G31D	Fluoride, dissolved	mg/L	4	1.73	4.9	4.8	4.6	3.9	3.8	6.3	5	4.4	4.1	4.5	4.3
G31S	Boron, dissolved	ug/L	2000	5924.16	5700	6100	5300	4400		4600		4500		4400	
G38S	Chloride, dissolved	mg/L	200	144.29	82	330	220	200	170	180	250	300	240	240	180
G42D	Fluoride, dissolved	mg/L	4	1.73	3.3	4.2	4	4.5	4.7	3.6	4	3.8	3.8	3.8	3.7
R08S	Boron, dissolved	ug/L	2000	5924.16	7700	6900	7300	7200	6300	7000	6900	6500	7000	6200	6700
R08S	pH (Field)	units	6.5-9.0	6.14-8.56	9.12	8.9	8.84	9.16	8.34	9.28	9.33	8.39	9.42	8.74	8.85
R32S	Boron, dissolved	ug/L	2000	5924.16	7200	5900	4400	3700		3500		2200		3200	
R32S	Chloride, dissolved	mg/L	200	144.29	67	<100	250	210	220	190	230	290	250	210	190
R32S	pH (Field)	units	6.5-9.0	6.14-8.56	9.16	8.73	8.13	7.91	8.11	8.31	8.21	7.89	8.56	7.98	8.26

Note: A shaded cell indicates the result is greater than the Class I and AGQS standard.

PROPERTY EXPLANATION

- 🟨 LINCOLN STONE QUARRY
- ░ MIDWEST GENERATION
- 🟦 OLIN
- 🟪 COMMONWEALTH EDISON
- 🟩 VULCAN MATERIALS CO.
- 🟦 LARAWAY RDF

REVISIONS

NO.	DATE	DESCRIPTION	BY

ANDREWS ENVIRONMENTAL ENGINEERING INC.
3535 Mayflower Blvd., Springfield, IL 62711
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN

APPROVED BY: LLM
DESIGNED BY: LLM
DRAWN BY: LJE

RESIDENTIAL WELL ANALYSIS
PLANS PREPARED FOR
MIDWEST GENERATION, LLC
JOLIET, WILL COUNTY, ILLINOIS

DATE: NOVEMBER 2004
PROJECT ID: 2002-124
FILE: J:\\DWG\POT...11-10-04
SHEET NUMBER:
FIG. 2

Appendix C

Mileage, Workhours and Greenhouse Gas Calculations

Appendix C - Mileage Calculations

SCENARIO 1: Closure by Removal and Placement at an Existing Landfill

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	338,800	0.5	10	169,400	14,463	3,388,000	289,261	Relocation of 3.4 Million CY, Assumes a 16.5 CY dump truck, 10 roundtrip miles to Laraway Landfill
Subtotal				***169,400***	***14,463***	***3,388,000***	***289,261***	

SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	338,800	5	0	1,694,000	119,899	0	0	Relocation of 3.4 Million CY, Assumes a 16.5 CY dump truck
Bottom Liner Placement	13,200	0.5	10	6,600	467	132,000	9,343	3 foot thick clay layer over 30 acres (193,600 CY), 16.5 CY dump truck
LCS	4,400	0.5	20	2,200	156	88,000	6,229	1 foot sand layer over 30 acres (193,600 CY), 16.5 CY dump truck
HDPE	19	1.5	2,200	29	2	41,800	2,959	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geotextiles	38	1.5	2,200	57	4	83,600	5,917	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Final Cover Soil	17,600	0.5	10	8,800	623	176,000	12,457	4 foot thick cover over 30 acres (193,600 CY), 16.5 CY dump truck
LLDPE	19	1.5	2,200	29	2	41,800	2,959	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geocomposite	46	1.5	2,200	69	5	101,200	7,163	24 rolls per truck, 12 x 150 panel dimensions, manufacture in Houston (Solomax)
Subtotal				***1,711,783***	***121,158***	***664,400***	***47,025***	

SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	40,300	1	0	40,300	21,045	0	0	Relocation of 664,000 CY of CCR, Assumes a 16.5 CY dump truck
Final Cover Soil	16,900	0.5	10	8,450	4,413	169,000	88,254	4 foot thick cover over 43 acres (193,600 CY), 16.5 CY dump truck
LLDPE	18	1.5	2,200	27	14	39,600	20,680	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geocomposite	44	1.5	2,200	66	34	96,800	50,550	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Subtotal				***48,843***	***25,507***	***305,400***	***159,484***	

SCENARIO 4: Closure in Place with Alternate Final Cover Design

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	40,300	1	0	40,300	15,723	0	0	Relocation of 664,000 CY of CCR, Assumes a 16.5 CY dump truck
Closure Turf	23	1.5	2,000	35	13	46,000	17,947	12 rolls per truck, 23 x 300 panel dimensions, manufacture in Georgetown, South Carolina
0.5-inch sand infill	180	1.5	20	270	105	3,600	1,405	local quarry - 20 mile roundtrip
Subtotal				***40,605***	***15,842***	***49,600***	***19,351***	

SCENARIO 5: Consolidate and Close in Place

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	34,810	1	0	34,810	12,740	0	0	Relocation 573,300 CY of CCR, Assumes a 16.5 CY dump truck
Final Cover Soil	12,937	0.5	10	6,469	2,367	129,373	47,350	4 foot thick cover over 33 acres (193,600 CY), 16.5 CY dump truck
LLDPE	14	1.5	2,200	21	8	30,800	11,273	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geocomposite	34	1.5	2,200	51	19	74,800	27,376	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Subtotal				***41,351***	***15,134***	***234,973***	***85,999***	

Appendix C - Mileage Calculations

SCENARIO 6: Close in Place with Hydraulic Controls

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	40,300	1	0	40,300	12,359	0	0	Relocation 573,300 CY of CCR, Assumes a 16.5 CY dump truck
Final Cover Soil	16,900	0.5	10	8,450	2,591	169,000	51,830	4 foot thick cover over 43 acres (193,600 CY), 16.5 CY dump truck
LLDPE	18	1.5	2,200	27	8	39,600	12,145	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geocomposite	44	1.5	2,200	66	20	96,800	29,687	24 rolls per truck, 12 x 150 panel dimensions, manufacture in Houston (Solomax)
Drilling and Piping	120	1	5	120	37	600	184	Assumes 120 days for drilling and piping, driller staying within 5 miles during field activities
Subtotal				***48,963***	***15,016***	***306,000***	***93,846***	

SCENARIO 7: Close in Place with Hydraulic Containment

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
CCR Removal & Placement	40,300	1	0	40,300	2,852	0	0	Relocation 573,300 CY of CCR, Assumes a 16.5 CY dump truck
Final Cover Soil	16,900	0.5	10	8,450	598	169,000	11,962	4 foot thick cover over 43 acres (193,600 CY), 16.5 CY dump truck
LLDPE	18	1.5	2,200	27	2	39,600	2,803	12 rolls per truck, 22 x 400 panel dimensions, manufacture in Houston (Solomax)
Geocomposite	44	1.5	2,200	66	5	96,800	6,851	24 rolls per truck, 12 x 150 panel dimensions, manufacture in Houston (Solomax)
Drilling and Grouting	200	1	5	200	14	1,000		Assumes 200 days for drilling and grouting, driller staying within 5 miles during field activities
Subtotal				***48,843***	***3,457***	***305,400***	***21,616***	

SCENARIO 8: Close in Place with "Wet" Cap

Activity	No. of Trucks	On-Site Roundtrip (miles)	Off-Site Roundtrip (miles)	Total On-Site Miles	On-Site Miles per Year	Total Off-Site Miles	Off-Site Miles per Year	Notes
Barrier Soil Cap	4,300	0.5	10	2,150	152	43,000	3,043	12-inch sand "wet" cap
Subtotal				***2,150***	***152***	***43,000***	***3,043***	

Appendix C - Hourly Calculation

Number of Hours Per Day	8 hours	Number of hours per 8-hour shift
Number of Equipment Hours Per Day	6.5 hours	

SCENARIO 1: Closure by Removal and Placement at an Existing Landfill

Activity	No. of Days	No. of Employees	Total Hours	Pieces of Heavy Equipment per Day	Equipment Hours	Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	2795	25	559,000	22	399,685	twenty trucks for CCR relocation + two loaders
Ash Recontouring	0	0	0	0	0	
Liner/Cap Installation	0	0	0	0	0	
Hydraulic Control/ Containment	0	0	0	0	0	
Turf and Grasses	0	0	0	0	0	
Subtotal	***2915***		***562,900***	***100***	***400,500***	

SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	2150	25	430,000	22	307,450	twenty trucks for CCR relocation + two loaders
Ash Recontouring	0	0	0	0	0	
Liner/Cap Installation	600	12	57,594	5	19,498	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	0	0	0	0	0	
Turf and Grasses	21	5	840	1	137	Hydromulch sprayer
Subtotal	***2891***		***492,300***	***100***	***327,900***	

SCENARIO 3: Closure In-Place with IEPA Prescribed Final Cover Design

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	0	0	0	0	0	
Ash Recontouring	114	8	7,327	3	2,232	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	234	12	22,441	5	7,597	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	0	0	0	0	0	
Turf and Grasses	21	5	840	1	137	Hydromulch sprayer
Subtotal	***489***		***34,500***	***100***	***10,800***	

SCENARIO 4: Closure In-Place with Alternate Final Cover Design

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	0	0	0	0	0	
Ash Recontouring	114	8	7,327	3	2,232	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	10	8	648	5	329	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	0	0	0	0	0	
Turf and Grasses	285	12	27,360	2	3,705	Closureturf Installation (2 pieces of heavy equipment: lull and sand sprayer)
Subtotal	***530***		***39,200***	***100***	***7,100***	

Appendix C - Hourly Calculation

Number of Hours Per Day 8 hours Number of hours per 8-hour shift

SCENARIO 5: Consolidate and Close In-Place

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	0	0	0	0	0	
Ash Recontouring	67	8	4,270	3	1,301	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	234	12	22,441	5	7,597	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	0	0	0	0	0	
Turf and Grasses	21	5	840	1	137	Hydromulch sprayer
Subtotal	***441***		***31,400***	***100***	***9,900***	

SCENARIO 6: Close in Place with Hydraulic Controls

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	0	0	0	0	0	
Ash Recontouring	114	8	7,327	3	2,232	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	234	12	22,441	5	7,597	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	90	4	2,880	1	585	one piece of equipment (driller rig for extraction wells in waste mass)
Turf and Grasses	21	5	840	1	137	Hydromulch sprayer
Subtotal	***579***		***37,400***	***100***	***11,400***	

SCENARIO 7: Close in Place with Hydraulic Containment

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	120	4	3,840	1	780	Pumping system is equilavent to one heavy piece of equipment
CCR Excavation to Landfill	0	0	0	1	0	
Ash Recontouring	114	8	7,327	1	744	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	234	12	22,441	1	1,519	Liner Construction on average is 5 pieces of eqiupment (excavator, 2 dump trucks, compactor, smooth drum roller)
Hydraulic Control/ Containment	180	4	5,760	1	1,170	one piece of equipment (driller rig)
Turf and Grasses	21	5	840	1	137	Hydromulch sprayer
Subtotal	***669***		***40,300***	***100***	***4,400***	

SCENARIO 8: Close in Place with "Wet" Cap

Activity	No. of Days	No. of Employees	Total Hours			Notes
Dewatering	0	4	0	0	0	
CCR Excavation to Landfill	0	0	0	0	0	
Ash Recontouring	60	8	3,840	3	1,170	3 pieces of equipment (dozer, excavator and dump truck)
Liner/Cap Installation	132	12	12,713	2	1,721	2 pieces of equipment (floating platform and sand launcher)
Hydraulic Control/ Containment	0	4	0	0	0	
Turf and Grasses	5	5	200	1	33	areas outside of waste footprpint for site restoration
Subtotal	***197***		***16,800***	***100***	***3,000***	

Appendix D

Cost Estimate Calculations

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
Date: September 30, 2021

Created By:	TWW	07/09/20
Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	09/30/21

Available Site Data

Appendix D - Impoundment Summary			
Item	**Quantity**	**Unit**	**Notes**
Full Quarry Area	57	AC	
West Fill Area (WFA)	14	AC	
Main Quarry Area + WFA	57	AC	43 acres Main Quarry plus 14 acres WFA
Quarry Area to be Cleared	10	AC	
Vol. of Coal Ash	4,300,000	CY	Land Permit Renewal (2/18/19) 2.6MCY +1.7MCY (WFA)
WFA Volume	1,700,000	CY	
Regrading/Relocated CCR Volume for In-Place Closure	511,000	CY	
Perimeter Length	7,900	LF	WFA added
Dike Volume	0	CY	No dikes
Dewatering Duration	6	MO	Prior to the start of earthwork
Borrow Area	20	AC	Assumes a 10 ft deep excavation for Scenarios 3, 5, 6, and 7
Borrow Perimeter	1,000	LF	
IEPA Pond Closure Cover Elements			
Compacted Earth Layer	1	FT	1-ft thick with a hydraulic conductivity of 1x10^{-7} cm/sec or less
Protective Cover Layer	2	FT	2-ft thick soil with the capability to support vegetation
Volume required for Closure Soil	331,060	CY	
Existing Groundwater Monitoring Wells	39	EA	
Existing Groundwater Extraction Wells	12	EA	
Pond Consolidate and Close in Place Summary			
Item	**Quantity**	**Unit**	**Notes**
Consolidation Area	33	AC	
Consolidated Perimeter Length	3,700	FT	
Relocated CCR Volume	387,000	CY	
New Landfill Summary			
Item	**Quantity**	**Unit**	**Notes**
New Landfill Area	45	AC	Estimated
New Landfill Area Perimeter	5,600	LF	
New Landfill Length	1,400	LF	
New Landfill Width	1,400	LF	
Landfill Invert (below ground surface)	30	FT	
Landfill Height (above ground surface)	70	FT	
IEPA Landfill Liner and Final Cover Elements			35 IAC 811
Compacted Earth Layer	3	FT	1-ft thick low permeability liner
HDPE Geomembrane	60	mil	
Final Cover Barrier Layer	1	FT	1-ft thick with a hydraulic conductivity of 1x10^{-7} cm/sec or less
LLDPE Geomembrane	40	mil	
Protective Cover Layer	3	FT	36-in thick soil with the capability to support vegetation

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Appendix D - Production Rates

Hauling Scenario	No. Trucks	CY	Wait (mins)	MPH	Cycle (mins)	CY/Day	Daily Production (tons/day)	Reference
Coal Ash to Existing Landfill	20	16.5	15	20	20	99	2,000	RS Means 3123 2320 3078
Coal Ash to New Landfill	20	16.5	15	40	40	132	2,600	RS Means 3123 2320 3078
Borrow to New Landfill (Onsite)	10	16.5	15	20	6	231	2,300	RS Means 3123 2320 6040
Borrow to New Landfill (Offsite)	10	16.5	15	40	20	165	1,700	RS Means 3123 1643 5500 + 3123 2320 3080
Recontouring (Onsite)	10	34	15	5	1	578	5,800	RS Means 3123 2320 6040
Borrow for Closure (Onsite)	10	16.5	15	20	6	231	2,300	RS Means 3123 2320 6040
Borrow for Closure (Offsite)	10	16.5	15	40	20	165	1,700	RS Means 3123 2320 3080

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Appendix D - Estimated Schedule Critical Path Items

Table 7-1: Closure Scenarios' Schedule
Critical Path Working Days

Tasks	00.50	01.00 - 06.00		07.20	07.50	07.00, 08.00, 09.00	10.00	11.00			
Scenario	**Siting/ Permitting**	**Mob**	**Dewatering, Erosion, Demolition, Etc.**	**CCR Excavation to Landfill**	**Ash Recontouring**	**Liner & Cap Installation (4, 5)**	**Hydraulic Control/ Containment**	**Turf and Grasses(6)**	**Days**	**Months**	**Years**
SCENARIO 1: Closure by Removal and Placement at an Existing Landfill	180	10	120	2795	0	0	0	0	3,105	140.6	11.7
SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill	1095	10	120	2150	0	600	0	21	3,996	169.5	14.1
SCENARIO 3: Closure in Place with IEPA Prescribed Final Cover Design	0	10	120	0	114	234	0	21	499	23.0	1.9
SCENARIO 4: Closure in Place with Alternate Final Cover Design	180	10	120	0	114	10	0	285	720	30.8	2.6
SCENARIO 5: Consolidate and Close in Place	365	10	120	0	67	234	0	21	816	32.8	2.7
SCENARIO 6: Closure in Place with Hydraulic Control	365	10	120	0	114	234	90	21	954	39.1	3.3
SCENARIO 7: Closure in Place with Hydraulic Containment	365	10	120	0	114	234	180	21	1,044	43.3	3.6
SCENARIO 8: Closure in Place Wet Closure	365	10	0	0	60	132	0	5	572	21.6	1.8

Notes:

1 Assumes 6 months of dewatering prior to earthwork.
2 Assumes Tasks 03.00 - 06.00 occur during the initial dewatering.
3 Assumes ditching and access roads are installed during earthwork.
4 Scenario 2 requires construction of both a bottom, leachate and final cover systems.
5 ClosureTurf installation was assumed to be 10,000 sq. feet per day.
6 Turf and Grasses Installation time includes: soil prep, soil amendments, erosion control measures, seed application.
7 Please refer to Appendix C (for hauling rates for soil) and Appendix D (for construction production rates).

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Appendix D: Unit Rates

Appendix D: Unit Rates

Task		Unit	Unit Rate ($/unit)	Unit Cost Reference[1,2]	Notes / Assumptions
01.00	**Engineering and Contingency**				
01.01	Design and Engineering Fees	%	10%	Past project experience	For the Closure by Removal and Placement at an Existing Landfill (Scenario 1) this was reduced to 1% due to the high cost of waste transport and disposal that would impact design and engineering fees
01.02	Owners Cost	%	5%	Past project experience	
01.03	Contingency	%	30%	Past project experience	
01.00	**Mobilization / Demobilization**				
01.01	Mobilization	LS	$100,000	Past project experience	
01.02	Demobilization	LS	$100,000	Past project experience	
01.03	Construction Trailer	EA	$12,161	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	MO	$1,000.00	Past project experience	Utilities and maintenance
01.05	Construction Entrances	EA	$5,000.00	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				
02.01	Dewatering Sumps	EA	$25,000.00	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	MO	$50,000.00	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	MO	$5,000.00	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	LF	$148.00		Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	LF	$267.50		Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	LF	$387.00		Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	EA	$2,915.19	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	YR	$50,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				
03.01	Erosion and Sediment Controls	LS	$75,000.00	2020 project bids	
03.02	Erosion Control Blankets	SY	$2.20	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the perimeter
03.03	Silt Fence	LF	$2.19	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	EA	$1,700.00	Past project experience	Installation and Removal
03.05	EPSC Maintenance	MO	$1,500.00	Past project experience	
04.00	**Instrumentation**				
04.01	Piezometer Installation	EA	$2,000.00	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	EA	$500.00	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	EA	$2,500.00	N/A	
04.04	Monitoring Well Extension	EA	$500.00	N/A	
04.05	Settlement Plates	EA	$500.00	2020 project bids	1 per ~20 acres
05.00	**Demolition**				
05.01	Piezometer Abandonment	EA	$3,000.00	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	EA	$3,000.00	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	LS	$50,000.00	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				

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06.01	Stripping Topsoil and Vegetation, Quarry	CY	$4.72	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	AC	$4,821.30	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	CY	$4.72	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	AC	$6,366.48	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	CY	$4.72	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	AC	$6,366.48	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				
07.10	**Dust Control**				
07.11	Water Truck	MO	$14,101.86	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				
07.21	Coal Ash Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	LCY	$4.21	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle, 30% swell
	Coal Ash Hauling to Existing Landfill	LCY	$4.21	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle, 30% swell
07.23	Coal Ash Spreading	LCY	$2.07	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	ECY	$0.28	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	MO	$5,903.51	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	TON	$58.29	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				
07.31	Landfill Excavation	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.32	Landfill Excavation Soil Hauling	BCY	$2.90	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle, 10% swell
07.33	Clay Layer Borrow Excavation and Loading (On-site)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10% swell
07.34	Clay Layer Borrow Excavation and Loading (On-site)	LCY	$8.76	RS Means 3123 1643 5500 + 3123 2320 3080	
07.35	Clay Layer Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	ECY	$1.76	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	SY	$0.25	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				
07.41	Clay Layer Borrow Pit Purchase	BCY	$2.50	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10% swell
	Clay Layer Borrow Hauling (Offsite)	LCY	$7.37	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle, 10% swell
07.44	Clay Layer Borrow Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	ECY	$1.76	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10% swell
	Protective Layer Borrow Hauling (Offsite)	LCY	$7.37	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle, 10% swell
07.48	Protective Layer Borrow Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	ECY	$0.96	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				
07.51	Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10% recontouring
07.52	Hauling	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30% swell
07.53	Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	ECY	$0.28	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink

07.55	Moisture Conditioning	MO	$5,903.51	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				
07.61	Borrow Soil	BCY	$2.50	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30% swell
	Clay Layer Hauling (Offsite)	LCY	$7.37	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle, 10% swell
07.64	Clay Layer Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	ECY	$1.76	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30% swell
	Protective Layer Hauling (Offsite)	LCY	$7.37	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle, 10% swell
07.68	Protective Layer Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	ECY	$0.96	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	CY	$130.00	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				
07.71	Excavation and Loading	BCY	$1.39	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	LCY	$4.14	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10% swell
07.73	Spreading	LCY	$2.45	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	ECY	$0.96	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				
07.81	Access Road - Closure	SY	$10.39	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide / perimeter
07.82	Access Road - Borrow	SY	$10.39	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide / perimeter
07.83	Access Road - Landfill	SY	$10.39	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide / perimeter
08.00	**Geosynthetics**				
08.10	**Landfill and Closure Cap Geosynthetic Components**				
08.11	40-mil double sided textured LLDPE Geomembrane	SF	$0.81	2020 project bids	
08.12	Double-Sided Tri-place Geocomposite	SF	$1.32	2020 project bids	
08.13	Anchor Trench - Closure Cap	LF	$9.27	2020 project bids	
08.20	**Landfill Bottom Liner Geosynthetic Components**				
08.21	60-mil double sided textured HDPE Geomembrane	SF	$0.85	2020 project bids	
08.22	Double-Sided Tri-place Geocomposite	SF	$1.32	2020 project bids	
08.23	Anchor Trench - Landfill Bottom Liner	LF	$9.27	2020 project bids	
08.24	Geotextile (Cushion 8 oz/yd2)	SF	$0.30	Project Bids	Woven, heavy duty, 600 lb. tensile strength
08.25	Geotextile - (Filter 4 oz/yd2)	SF	$0.25	Project Bids	
08.30	**Leachate Collection and Transmission System**				
08.31	Leachate Collection System (1 foot thick)	CY	$16.00		
08.32	6-inch SDR 11 HDPE Pipe	LF	$9.50		
08.33	Gravel Trench for V-Trench	LF	$26.00		Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4 oz/SY), Underlying
08.34	Leachate Sumps	EA	$5,000.00	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	EA	$8,500.00		
08.36	Leachate Transmission Piping (2x4 HDPE)	LF	$4.50		Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	LF	$78.00		
08.38	Leachate Vault and Control Panel	EA	$25,000.00		
08.39	Leachate Vault Utilities	LF	$24.55	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill

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08.40	Above Grade Leachate Storage Tank	EA	$500,000	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	Gal	$0.001	Project Costs	On-site discharge through NPDES permit (cost for pumps)
08.42	Leachate Treatment (Off-site)	Gal	$0.070	Project Costs	Discharge to WWTP, 40-mile one way travel
09.00	**Pond Closure - Ditch and Apron Construction**				
09.01	Geotextile Fabric	SY	$2.55	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	LCY	$71.19	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	TON	$38.70	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	LCY	$4.89	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				
10.01	Borehole Drilling for Bedrock Fractures	LF	$75.00	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth (USACOE, 2017)
10.02	Grouting of Bedrock Fractures	CY	$70.79	RS Means 3173 1310 0820	
10.03	Leachate Discharge Piping	LF	$6.50	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	VLF	$85.00	Project Bids	
11.00	**Turf and Grasses**				
11.01	Hydroseed and Mulch	SY	$2.25	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	SF	$2.44	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	TON	$50.00	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	TON	$341.00	Past project experience	7 lbs/SF
11.05	Anchor Trench	LF	$9.27	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	AC	$30,000.00	Past project experience	In place of seeding
11.07	Soil Amendments	AC	$500.00	Past project experience	To support vegetative growth

Project: Lincoln Stone Quarry Closure Alternatives
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Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	09/30/21

Task Breakdown and Cost

Appendix D: Post Closure Unit Rates

Task		Quantity	Unit	Unit Rate ($/unit)	Cost Per Year	Years	Total Cost	Unit Cost Reference[1,2]	Notes / Assumptions
14.00	**Cover Maintenance**				**$21,691.35**				
14.01	Years 1 - 10 (1% of cover area)	2,759	cy	$4.39	$12,111.13	10	$121,111	Past project experience	
14.02	Years 10 - 30 (0.5% of cover area)	1,089	cy	$4.39	$4,780.22	20	$95,604	Past project experience	
14.03	Quarterly Cover Inspections	4	Event	$1,200.00	$4,800.00	30	$144,000	Past project experience	
15.00	**Vegetation Maintenance**				**$21,375.00**				
15.01	Years 1 - 10 (1% of cover area)	57	Acre	$15,000.00	$8,550.00	10	$85,500	Past project experience	
15.02	Years 20 - 30 (0.5% of cover area)	57	Acre	$15,000.00	$4,275.00	20	$85,500	Past project experience	
15.03	Mowing	57	Acre	$150.00	$8,550.00	30	$256,500	Past project experience	
15.00	**Clean Closure Groundwater Monitoring**	**5**	**wells**		**$10,000.00**				
15.01	Collection and Reporting	4	Event	$250.00	$5,000.00	5	$25,000	Past project experience	
15.02	Quarterly Analytical Lab Testing	4	Event	$250.00	$5,000.00	5	$25,000	Past project experience	
15.03	Semi-Annual Analytical Lab Testing	0	Event	$250.00	$0.00	5	$0	Past project experience	
16.00	**Landfill Groundwater Monitoring**	**39**	**wells**		**$66,500.00**				
16.01	Collection and Reporting	4	Event	$250.00	$39,000.00	30	$1,170,000	Past project experience	
16.02	Quarterly Analytical Lab Testing	2	Event	$250.00	$19,500.00	30	$585,000	Past project experience	
16.03	Semi-Annual Analytical Lab Testing	2	Event	$1,000.00	$8,000.00	30	$240,000	Past project experience	
17.00	**Leachate Management**				**$141,000.00**				
17.01	Leachate Pump and Control Panel Maint.	1	Year	$15,000.00	$15,000.00	30	$450,000		
17.02	Leachate Generation	73,000,000	$ per Gallon	$0.001	$73,000.00	30	$2,190,000	Off-site disposal	200,000 gallons per day for inward gradient control
17.03	Leachate Line Cleaning & Jetting	1	Year	$3,000.00	$3,000.00	30	$90,000	Past project experience	Jetting every 5 years ($15,000 every 5 years)
17.04	ICA Dewatering Extraction System O&M	1	Year	$50,000.00	$50,000.00	30	$1,500,000	Past project experience	Jetting every 5 years ($15,000 every 5 years)
18.00	**Miscellaneous Maintenance**								
18.01	Misc. Maintenance	1	Year	$25,000.00	$25,000.00	30	$750,000	Past project experience	Includes boundary and access control maintenance, stormwater management system and monitoring well replacement

Total Cost	**$5,083,216**	
Total Cost Per Year	***$169,441***	Scenario Closure In Place
Total Cost Per Year *Acre	**$3,766**	
Total Cost Per Year	***$258,774***	Scenario Closure In Place with Leachate Removal
Total Cost Per Year	***$10,000***	Scenario Closure by Removal
Total Cost Per Year	***$169,441***	Scenario Closure by Removal by On-site New Landfill
Total Cost Per Year	***$121,300***	Scenario Closure In Place - ClosureTurf

[1] RSMeans data based on Site Work and Landscape, 2020, Joliet, IL, Standard Union, Total O&P

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SCENARIO 1: Closure by Removal and Placement at an Existing Landfill

Task		Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference^{1,2}	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$352,000**		
01.01	Mobilization	1	LS	$100,000.00	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000.00	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,160.60	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	135	MO	$1,000.00	$135,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	1	EA	$5,000.00	$5,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$8,261,000**		
02.01	Dewatering Sumps	10	EA	$25,000.00	$250,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	135	MO	$50,000.00	$6,750,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	135	MO	$5,000.00	$675,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	12	YR	$50,000.00	$586,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$278,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	0	SY	$2.20	$0	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	0	LF	$2.19	$0	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	0	EA	$1,700.00	$0	Past project experience	Installation and Removal
03.05	EPSC Maintenance	135	MO	$1,500.00	$203,000	Past project experience	0
04.00	**Instrumentation**				**$20,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	0	EA	$500.00	$0	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	0	EA	$500.00	$0	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$233,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	51	EA	$3,000.00	$153,000	Past project experience	Monitoring and Extraction Wells
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$0**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	0	AC	$4,821.30	$0	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$334,233,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$334,046,000**		
07.21	Coal Ash Excavation and Loading	4,300,000	BCY	$1.39	$5,977,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	5,590,000	LCY	$4.21	$23,534,000	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment

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07.26	Landfill Disposal Tipping Fee	5,224,500	TON	$58.29	$304,535,000	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$0**		
07.51	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$0**		
07.61	Borrow Soil	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$187,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$0**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$0**		
08.11	40-mil double sided textured LLDPE Geomembrane	0	SF	$0.81	$0	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0

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08.13	Anchor Trench - Closure Cap	0	LF	$9.27	$0	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				$0		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				$0		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" -
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
08.42	Leachate Treatment (Off-site)	0	Gal	$0.07	$0	Project Costs	Discharge to WWTP, 40-mile one way travel
09.00	**Pond Closure - Ditch and Apron Construction**				$0		
09.01	Geotextile Fabric	0	SY	$2.55	$0	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	0	TON	$38.70	$0	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	0	LCY	$4.89	$0	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				$0		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	12	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				$0		
11.01	Hydroseed and Mulch	0	SY	$2.25	$0	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	0	AC	$500.00	$0	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				$0		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$50,000**		
13.01	Annual Care	5	YR	$10,000.00	$50,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$343,377,000**	**DOES NOT INCLUDE 30-YEAR POST CLOSURE**	
				Contingency	**$103,013,000**	**30%**	
				Design and Engineering Fees	**$3,434,000**	**1%** Reduced from other scenarios due to the high cost of waste disposal	

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
Date: September 30, 2021

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Reviewed By:	DK	07/21/20
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Owners Costs	**$17,169,000**	**5%**
Scenario Total	**$466,993,000**	

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Revised By:	REW	09/30/21

SCENARIO 2: Closure by Removal and Placement at a New CCR Landfill

	Task	Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference^{1,2}	Notes / Assumptions
00.50	**Siting and IEPA Permitting**				**$2,725,000**		
01.51	Land Acquisition	75	ACRES	$12,000.00	$900,000	Will County Survey	75 acres for 30 acre waste footprint and associated ancillary facilities (buffer, screening berms, SW, etc.)
01.52	Local Siting	1	EA	$1,200,000.00	$1,200,000	Project Experience	
01.53	IEPA Permitting	1	EA	$150,000.00	$150,000	Project Experience	
01.54	CQA Documentation	30	AC	$10,000.00	$300,000	Project Experience	CQA oversight, surveying and reporting
01.55	IEPA Annual Reporting	8	YR	$20,000.00	$160,000	Project Experience	Closure Cost Estimate, Groundwater monitoring, Annual Report
01.56	Closure Certification	1	EA	$15,000.00	$15,000	Project Experience	
01.00	**Mobilization / Demobilization**				**$356,000**		
01.01	Mobilization	1	LS	$100,000.00	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000.00	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,160.60	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	134	MO	$1,000.00	$134,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$7,199,000**		
02.01	Dewatering Sumps	10	EA	$25,000.00	$250,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	114	MO	$50,000.00	$5,675,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	114	MO	$5,000.00	$568,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	14	YR	$50,000.00	$706,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$315,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	0	SY	$2.20	$0	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	13,500	LF	$2.19	$30,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	5	EA	$1,700.00	$9,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	134	MO	$1,500.00	$201,000	Past project experience	0
04.00	**Instrumentation**				**$20,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	0	EA	$500.00	$0	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	0	EA	$500.00	$0	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$1,018,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	43,556	CY	$4.72	$206,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	54	AC	$4,821.30	$260,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	44,000	CY	$4.72	$208,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	54	AC	$6,366.48	$344,000	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$59,663,000**		
07.10	**Dust Control**				**$1,890,000**		
07.11	Water Truck	134	MO	$14,101.86	$1,890,000	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental

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07.20	**Coal Ash Excavation to Landfill**				**$43,077,000**		
07.21	Coal Ash Excavation and Loading	4,300,000	BCY	$1.39	$5,977,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	5,590,000	LCY	$4.21	$23,534,000	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	5,590,000	LCY	$2.07	$11,571,000	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	4,300,000	ECY	$0.28	$1,204,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	134	MO	$5,903.51	$791,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$11,533,000**		
07.31	Landfill Excavation	2,177,778	BCY	$1.39	$3,027,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.32	Landfill Excavation Soil Hauling	2,177,778	BCY	$2.90	$6,316,000	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	261,333	LCY	$4.14	$1,082,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	261,333	LCY	$2.45	$640,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	235,200	ECY	$1.76	$414,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	217,778	SY	$0.25	$54,000	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$2,847,000**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	72,600	BCY	$1.39	$101,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	79,860	LCY	$4.14	$331,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	79,860	LCY	$2.45	$196,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	72,600	ECY	$1.76	$128,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	217,800	BCY	$1.39	$303,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	239,580	LCY	$4.14	$992,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	239,580	LCY	$2.45	$587,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	217,800	ECY	$0.96	$209,000	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$0**		
07.51	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.53	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$0**		
07.61	Borrow Soil	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Clay Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Protective Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$316,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /

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07.83	Access Road - Landfill	12,444	SY	$10.39	$129,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$11,324,000**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$5,052,000**		
08.11	40-mil double sided textured LLDPE Geomembrane	2,352,000	SF	$0.81	$1,905,000	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	2,352,000	SF	$1.32	$3,095,000	2020 project bids	0
08.13	Anchor Trench - Closure Cap	5,600	LF	$9.27	$52,000	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$6,440,000**		
08.21	60-mil double sided textured HDPE Geomembrane	2,352,000	SF	$0.85	$1,999,000	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	2,352,000	SF	$1.32	$3,095,000	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	5,600	LF	$9.27	$52,000	2020 project bids	0
08.24	Geotextile (Cushion 8 oz/yd2)	2,352,000	SF	$0.30	$706,000	Project Bids	Woven, heavy duty, 600 lb. tensile strength
08.25	Geotextile - (Filter 4 oz/yd2)	2,352,000	SF	$0.25	$588,000	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$2,362,000**		
08.31	Leachate Collection System (1 foot thick)	79,852	CY	$16.00	$1,278,000		
08.32	6-inch SDR 11 HDPE Pipe	4,200	LF	$9.50	$40,000		
08.33	Gravel Trench for V-Trench	4,200	LF	$26.00	$109,000		Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	3	EA	$5,000.00	$15,000	sumps every 500 feet, length 2,100 feet	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	6	EA	$8,500.00	$51,000		
08.36	Leachate Transmission Piping (2x4 HDPE)	8,400	LF	$4.50	$38,000		Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	540	LF	$78.00	$42,000		
08.38	Leachate Vault and Control Panel	3	EA	$25,000.00	$75,000		
08.39	Leachate Vault Utilities	8,400	LF	$24.55	$206,000		
08.40	Above Grade Leachate Storage Tank	1	EA	$500,000.00	$500,000	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	8,211,662	Gal	$0.001	$8,000	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$0**		
09.01	Geotextile Fabric	0	SY	$2.55	$0	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	0	TON	$38.70	$0	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	0	LCY	$4.89	$0	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$0**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	14	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$611,000**		
11.01	Hydroseed and Mulch	261,600	SY	$2.25	$589,000	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	45	AC	$500.00	$22,000	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$273,000**		
12.01	Soil Excavation for Detention Basin	26,000	BCY	$1.39	$36,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	15,600	SY	$2.25	$35,000	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	1	EA	$10,000.00	$10,000	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	2	EA	$387.00	$1,000	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	2,074	BCY	$1.39	$3,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	2,074	LCY	$2.18	$5,000	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	5,600	LF	$0.40	$2,000	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	18,667	SY	$0.25	$5,000	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	10,370	CY	$3.50	$36,000	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	5,600	LF	$25.00	$140,000	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap

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13.00	**30-year Post-Closure**				**$5,083,000**		
13.01	Annual Care	30	YR	$169,440.53	$5,083,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$83,584,000**	**DOES NOT INCLUDE 30-YEAR POST CLOSURE**	
				Contingency	**$25,075,000**	**30%**	
				Design and Engineering Fees	**$8,358,000**	**10%**	
				Owners Costs	**$4,179,000**	**5%**	
				Scenario Total	**$121,196,000**		

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Revised By:	REW	09/30/21

SCENARIO 3: Closure In-Place with IEPA Prescribed Final Cover Design

Task		Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference^{1,2}	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$245,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	23	MO	$1,000.00	$23,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$486,000**		
02.01	Dewatering Sumps	3	EA	$25,000.00	$75,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	6	MO	$50,000.00	$286,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	6	MO	$5,000.00	$29,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	2	YR	$50,000.00	$96,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$220,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	26,000	SY	$2.20	$57,000	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	8,900	LF	$2.19	$19,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	20	EA	$1,700.00	$34,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	23	MO	$1,500.00	$35,000	Past project experience	0
04.00	**Instrumentation**				**$26,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	10	EA	$500.00	$5,000	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	2	EA	$500.00	$1,000	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$251,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	16,000	CY	$4.72	$76,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	20	AC	$6,366.48	$127,000	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$9,970,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment

07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$5,365,000**		
07.51	Excavation and Loading	511,000	BCY	$1.39	$710,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	664,000	LCY	$4.14	$2,749,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	664,000	LCY	$2.45	$1,627,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	511,000	ECY	$0.28	$143,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	23	MO	$5,903.51	$136,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$4,395,000**		
07.61	Borrow Soil	276,000	BCY	$2.50	$690,000	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	92,000	BCY	$1.39	$128,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	101,200	LCY	$7.37	$746,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	101,200	LCY	$2.45	$248,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	92,000	ECY	$1.76	$162,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	184,000	BCY	$1.39	$256,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	202,400	LCY	$7.37	$1,492,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	202,400	LCY	$2.45	$496,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	184,000	ECY	$0.96	$177,000	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$210,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	2,222	SY	$10.39	$23,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$6,407,000**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$6,407,000**		
08.11	40-mil double sided textured LLDPE Geomembrane	2,979,504	SF	$0.81	$2,413,000	2020 project bids	0

08.12	Double-Sided Tri-place Geocomposite	2,979,504	SF	$1.32	$3,921,000	2020 project bids	0
08.13	Anchor Trench - Closure Cap	7,900	LF	$9.27	$73,000	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$157,000**		
09.01	Geotextile Fabric	4,500	SY	$2.55	$11,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,500	TON	$38.70	$135,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,300	LCY	$4.89	$11,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$0**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	0	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$878,000**		
11.01	Hydroseed and Mulch	373,000	SY	$2.25	$839,000	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	77	AC	$500.00	$39,000	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$5,085,000**		
13.01	Annual Care	30	YR	$169,500.00	$5,085,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$18,720,000**		

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
Date: September 30, 2021

Created By:	TWW	07/09/20
Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	09/30/21

Contingency	**$5,616,000**	**30%**
Design and Engineering Fees	**$1,872,000**	**10%**
Owners Costs	**$936,000**	**5%**
Closure Scenario Total	**$27,144,000**	

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
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Created By:	TWW	07/09/20
Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	09/30/21

SCENARIO 4: Closure In-Place with Alternate Final Cover Design

	Task	Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference[1,2]	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$253,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	31	MO	$1,000.00	$31,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$518,000**		
02.01	Dewatering Sumps	3	EA	$25,000.00	$75,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	6	MO	$50,000.00	$286,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	6	MO	$5,000.00	$29,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	3	YR	$50,000.00	$128,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$223,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	26,000	SY	$2.20	$57,000	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	8,900	LF	$2.19	$19,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	20	EA	$1,700.00	$34,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	25	MO	$1,500.00	$38,000	Past project experience	0
04.00	**Instrumentation**				**$26,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	10	EA	$500.00	$5,000	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	2	EA	$500.00	$1,000	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$48,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$6,521,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor

Project: Lincoln Stone Quarry Closure Alternatives
Task: Alternatives Cost Analysis
Client: Midwest Generation, LLC (MWG)
Proj. No. CHE8420
Date: September 30, 2021

Created By:	TWW	07/09/20
Reviewed By:	DK	07/21/20
Approved By:	JPV	10/13/21
Revised By:	JPV	02/17/21
Revised By:	REW	09/30/21

07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$5,377,000**		
07.51	Excavation and Loading	511,000	BCY	$1.39	$710,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	664,000	LCY	$4.14	$2,749,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	664,000	LCY	$2.45	$1,627,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	511,000	ECY	$0.28	$143,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	25	MO	$5,903.51	$148,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$957,000**		
07.61	Borrow Soil	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	92,000	BCY	$1.39	$128,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	101,200	LCY	$4.14	$419,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	101,200	LCY	$2.45	$248,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	92,000	ECY	$1.76	$162,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$187,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$0**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$0**		
08.11	40-mil double sided textured LLDPE Geomembrane	0	SF	$0.81	$0	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0

08.13	Anchor Trench - Closure Cap	0	LF	$9.27	$0	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$157,000**		
09.01	Geotextile Fabric	4,500	SY	$2.55	$11,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,500	TON	$38.70	$135,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,300	LCY	$4.89	$11,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$0**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	0	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$8,440,000**		
11.01	Hydroseed and Mulch	0	SY	$2.25	$0	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	2,979,600	SF	$2.44	$7,270,000	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	6,400	TON	$50.00	$320,000	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	2,280	TON	$341.00	$777,000	Past project experience	7 lbs/SF
11.05	Anchor Trench	7,900	LF	$9.27	$73,000	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	0	AC	$500.00	$0	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$3,639,000**		
13.01	Annual Care	30	YR	$121,300.00	$3,639,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$16,266,000**		
				Contingency	**$4,880,000**	**30%**	
				Design and Engineering Fees	**$1,627,000**	**10%**	
				Owners Costs	**$813,000**	**5%**	
				Closure Scenario Total	**$23,586,000**		

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Revised By: JPV 02/17/21
Revised By: REW 09/30/21

SCENARIO 5: Consolidate and Close In-Place

Task		Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference[1,2]	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$243,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	21	MO	$1,000.00	$21,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$571,000**		
02.01	Dewatering Sumps	10	EA	$25,000.00	$250,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	3	MO	$50,000.00	$167,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	3	MO	$5,000.00	$17,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	3	YR	$50,000.00	$137,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$220,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	26,000	SY	$2.20	$57,000	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	8,900	LF	$2.19	$19,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	20	EA	$1,700.00	$34,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	23	MO	$1,500.00	$35,000	Past project experience	0
04.00	**Instrumentation**				**$26,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	10	EA	$500.00	$5,000	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	2	EA	$500.00	$1,000	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$251,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	16,000	CY	$4.72	$76,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	20	AC	$6,366.48	$127,000	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$7,924,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor

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07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$4,084,000**		
07.51	Excavation and Loading	387,000	BCY	$1.39	$538,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	503,000	LCY	$4.14	$2,082,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	503,000	LCY	$2.45	$1,232,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	387,000	ECY	$0.28	$108,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	21	MO	$5,903.51	$124,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$3,630,000**		
07.61	Borrow Soil	228,000	BCY	$2.50	$570,000	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	76,000	BCY	$1.39	$106,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	83,600	LCY	$7.37	$616,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	83,600	LCY	$2.45	$205,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	76,000	ECY	$1.76	$134,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	152,000	BCY	$1.39	$211,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	167,200	LCY	$7.37	$1,232,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	167,200	LCY	$2.45	$410,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	152,000	ECY	$0.96	$146,000	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$210,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	2,222	SY	$10.39	$23,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$5,305,000**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$5,305,000**		
08.11	40-mil double sided textured LLDPE Geomembrane	2,460,874	SF	$0.81	$1,993,000	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	2,460,874	SF	$1.32	$3,239,000	2020 project bids	0

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08.13	Anchor Trench - Closure Cap	7,900	LF	$9.27	$73,000	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$157,000**		
09.01	Geotextile Fabric	4,500	SY	$2.55	$11,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,500	TON	$38.70	$135,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,300	LCY	$4.89	$11,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$0**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	0	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$765,000**		
11.01	Hydroseed and Mulch	325,000	SY	$2.25	$731,000	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	67	AC	$500.00	$34,000	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$5,085,000**		
13.01	Annual Care	30	YR	$169,500.00	$5,085,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$15,542,000**		
				Contingency	**$4,663,000**	**30%**	
				Design and Engineering Fees	**$1,554,000**	**10%**	
				Owners Costs	**$777,000**	**5%**	
				Closure Scenario Total	**$22,536,000**		

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SCENARIO 6: Closure In-Place with Hydraulic Control

Task		Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference^{1,2}	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$245,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	23	MO	$1,000.00	$23,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$553,000**		
02.01	Dewatering Sumps	3	EA	$25,000.00	$75,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	6	MO	$50,000.00	$286,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	6	MO	$5,000.00	$29,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	3	YR	$50,000.00	$163,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$220,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	26,000	SY	$2.20	$57,000	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	8,900	LF	$2.19	$19,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	20	EA	$1,700.00	$34,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	23	MO	$1,500.00	$35,000	Past project experience	0
04.00	**Instrumentation**				**$26,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	10	EA	$500.00	$5,000	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	2	EA	$500.00	$1,000	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$251,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	16,000	CY	$4.72	$76,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	20	AC	$6,366.48	$127,000	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$9,970,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor

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07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$5,365,000**		
07.51	Excavation and Loading	511,000	BCY	$1.39	$710,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	664,000	LCY	$4.14	$2,749,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	664,000	LCY	$2.45	$1,627,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	511,000	ECY	$0.28	$143,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	23	MO	$5,903.51	$136,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$4,395,000**		
07.61	Borrow Soil	276,000	BCY	$2.50	$690,000	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	92,000	BCY	$1.39	$128,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	101,200	LCY	$7.37	$746,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	101,200	LCY	$2.45	$248,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	92,000	ECY	$1.76	$162,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	184,000	BCY	$1.39	$256,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	202,400	LCY	$7.37	$1,492,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	202,400	LCY	$2.45	$496,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	184,000	ECY	$0.96	$177,000	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$210,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	2,222	SY	$10.39	$23,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$6,407,000**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$6,407,000**		
08.11	40-mil double sided textured LLDPE Geomembrane	2,979,504	SF	$0.81	$2,413,000	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	2,979,504	SF	$1.32	$3,921,000	2020 project bids	0

Project: Lincoln Stone Quarry Closure Alternatives
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08.13	Anchor Trench - Closure Cap	7,900	LF	$9.27	$73,000	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$157,000**		
09.01	Geotextile Fabric	4,500	SY	$2.55	$11,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,500	TON	$38.70	$135,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,300	LCY	$4.89	$11,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$345,000**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	15,800	LF	$6.50	$103,000	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	2,850	VLF	$85.00	$242,000	Project Bids	43 wells (1 per acre) at 50 feet depth
11.00	**Turf and Grasses**				**$878,000**		
11.01	Hydroseed and Mulch	373,000	SY	$2.25	$839,000	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	77	AC	$500.00	$39,000	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$7,763,000**		
13.01	Annual Care	30	YR	$258,773.86	$7,763,000	Past project experience	Includes monitoring, maintenance, inspections

Sub Total	**$19,132,000**	
Contingency	**$5,740,000**	**30%**
Design and Engineering Fees	**$1,913,000**	**10%**
Owners Costs	**$957,000**	**5%**
Closure Scenario Total	**$27,742,000**	

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SCENARIO 7: Closure In-Place with Hydraulic Containment

Task		Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference[1,2]	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$245,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	23	MO	$1,000.00	$23,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$486,000**		
02.01	Dewatering Sumps	3	EA	$25,000.00	$75,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	6	MO	$50,000.00	$286,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	6	MO	$5,000.00	$29,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	2	YR	$50,000.00	$96,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$220,000**		
03.01	Erosion and Sediment Controls	1	LS	$75,000.00	$75,000	2020 project bids	0
03.02	Erosion Control Blankets	26,000	SY	$2.20	$57,000	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	8,900	LF	$2.19	$19,000	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	20	EA	$1,700.00	$34,000	Past project experience	Installation and Removal
03.05	EPSC Maintenance	23	MO	$1,500.00	$35,000	Past project experience	0
04.00	**Instrumentation**				**$26,000**		
04.01	Piezometer Installation	10	EA	$2,000.00	$20,000	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	10	EA	$500.00	$5,000	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	2	EA	$500.00	$1,000	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$80,000**		
05.01	Piezometer Abandonment	10	EA	$3,000.00	$30,000	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$251,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	16,000	CY	$4.72	$76,000	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	20	AC	$6,366.48	$127,000	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$9,970,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf
07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor

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07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$5,365,000**		
07.51	Excavation and Loading	511,000	BCY	$1.39	$710,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	664,000	LCY	$4.14	$2,749,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
07.53	Spreading	664,000	LCY	$2.45	$1,627,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	511,000	ECY	$0.28	$143,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	23	MO	$5,903.51	$136,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$4,395,000**		
07.61	Borrow Soil	276,000	BCY	$2.50	$690,000	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	92,000	BCY	$1.39	$128,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Clay Layer Hauling (Offsite)	101,200	LCY	$7.37	$746,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	101,200	LCY	$2.45	$248,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	92,000	ECY	$1.76	$162,000	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	184,000	BCY	$1.39	$256,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 30%
	Protective Layer Hauling (Offsite)	202,400	LCY	$7.37	$1,492,000	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	202,400	LCY	$2.45	$496,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	184,000	ECY	$0.96	$177,000	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	0	CY	$130.00	$0	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle, 10%
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$210,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	2,222	SY	$10.39	$23,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$6,407,000**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$6,407,000**		
08.11	40-mil double sided textured LLDPE Geomembrane	2,979,504	SF	$0.81	$2,413,000	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	2,979,504	SF	$1.32	$3,921,000	2020 project bids	0
08.13	Anchor Trench - Closure Cap	7,900	LF	$9.27	$73,000	2020 project bids	0

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08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0
08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$157,000**		
09.01	Geotextile Fabric	4,500	SY	$2.55	$11,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,500	TON	$38.70	$135,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,300	LCY	$4.89	$11,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$6,878,000**		
10.01	Borehole Drilling for Bedrock Fractures	52,667	LF	$75.00	$3,950,000	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth (USACOE, 2017)
10.02	Grouting of Bedrock Fractures	41,357	CY	$70.79	$2,928,000	RS Means 3173 1310 0820	100 feet depth, 12-inch diameter
10.03	Leachate Discharge Piping	0	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$878,000**		
11.01	Hydroseed and Mulch	373,000	SY	$2.25	$839,000	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	77	AC	$500.00	$39,000	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$5,085,000**		
13.01	Annual Care	30	YR	$169,500.00	$5,085,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$25,598,000**		
				Contingency	**$7,679,000**	**30%**	
				Design and Engineering Fees	**$2,560,000**	**10%**	
				Owners Costs	**$1,280,000**	**5%**	
				Closure Scenario Total	**$37,117,000**		

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SCENARIO 8: Closure In-Place Wet Closure

	Task	Quantity	Unit	Unit Rate ($/unit)	Cost ($)	Unit Cost Reference^{1,2}	Notes / Assumptions
01.00	**Mobilization / Demobilization**				**$232,000**		
01.01	Mobilization	1	LS	$100,000	$100,000	Past project experience	0
01.02	Demobilization	1	LS	$100,000	$100,000	Past project experience	0
01.03	Construction Trailer	1	EA	$12,161	$12,000	RS Means 0152 1320 0020	Office trailer, furnished, 20'x8'
01.04	Construction Facilities	10	MO	$1,000.00	$10,000	Past project experience	Utilities and maintenance
01.05	Construction Entrances	2	EA	$5,000.00	$10,000	Past project experience	Installation and removal
02.00	**Dewatering and Temp. SW Management**				**$280,000**		
02.01	Dewatering Sumps	1	EA	$25,000.00	$25,000	2020 project bids	Include sump excavation and installation
02.02	Dewatering and Maintenance	3	MO	$50,000.00	$150,000	2020 project bids	Includes pump operation, piping, etc.
02.03	Temporary Stormwater Management Controls	3	MO	$5,000.00	$15,000	2020 project bids	Ditching, diversion berms, ponds, lagoons, maintenance
02.04	18-Inch DR17 HDPE Storm Drain Pipe	0	LF	$148.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.05	24-Inch DR17 HDPE Storm Drain Pipe	0	LF	$267.50	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.06	30-Inch DR17 HDPE Storm Drain Pipe	0	LF	$387.00	$0	0	Includes Excavation, Pipe, Bedding, and Backfill
02.07	Culvert Inlet Headwall	0	EA	$2,915.19	$0	RS Means 3342 1313 0540	Concrete, 30 degree skewed wingwall, 24"
02.08	GW Extraction System Operation	2	YR	$50,000.00	$90,000	Assume cost covered under current operation	12 wells are in place along southern boundary
03.00	**Erosion and Sediment Controls**				**$30,000**		
03.01	Erosion and Sediment Controls	1	LS	$15,000.00	$15,000	2020 project bids	0
03.02	Erosion Control Blankets	0	SY	$2.20	$0	RS Means 3125 1416 0020	Just mesh, stapled, 100 SY, 4' wide, assumes 30-ft of the
03.03	Silt Fence	0	LF	$2.19	$0	RS Means 3125 1416 1000/1305	3-ft high, slope (less than 3H:1V)
03.04	Rock Check Dams	0	EA	$1,700.00	$0	Past project experience	Installation and Removal
03.05	EPSC Maintenance	10	MO	$1,500.00	$15,000	Past project experience	0
04.00	**Instrumentation**				**$0**		
04.01	Piezometer Installation	0	EA	$2,000.00	$0	Past project experience	Assume 10 piezometers
04.02	Piezometer Extension	0	EA	$500.00	$0	Past project experience	Raising piezometers for filling operations
04.03	Monitoring Well Installation	0	EA	$2,500.00	$0	N/A	0
04.04	Monitoring Well Extension	0	EA	$500.00	$0	N/A	0
04.05	Settlement Plates	0	EA	$500.00	$0	2020 project bids	1 per ~20 acres
05.00	**Demolition**				**$50,000**		
05.01	Piezometer Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes piezometers can be pulled
05.02	Monitoring Well Abandonment	0	EA	$3,000.00	$0	Past project experience	Assumes monitoring wells will not be impacted
05.03	Sluice Pipelines	1	LS	$50,000.00	$50,000	Limited data available	Existing buried sluice pipelines
06.00	**Site Clearing**				**$48,000**		
06.01	Stripping Topsoil and Vegetation, Quarry	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.02	Clear and Grub, Quarry	10	AC	$4,821.30	$48,000	RS Means 3111 1010 0020	Clear and grub up to 6-inch trees
06.03	Stripping Topsoil and Vegetation, Borrow Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.04	Clear and Grub, Borrow Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
06.05	Stripping Topsoil and Vegetation, New Landfill Site	0	CY	$4.72	$0	RS Means 3114 1323 1430	300' haul w/200HP dozer, remove and stockpile onsite
06.06	Clear and Grub, New Landfill Site	0	AC	$6,366.48	$0	RS Means 3111 1010 0160	Clear and grub brush and stumps
07.00	**Earthwork**				**$10,366,000**		
07.10	**Dust Control**				**$0**		
07.11	Water Truck	0	MO	$14,101.86	$0	RS Means 0154 3340 6950	2 6,000 gallon capacity water truck rental
07.20	**Coal Ash Excavation to Landfill**				**$0**		
07.21	Coal Ash Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, 200,000 CY plus
07.22	Coal Ash Hauling to New Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
	Coal Ash Hauling to Existing Landfill	0	LCY	$4.21	$0	RS Means 3123 2320 3078	16.5 CY Truck, 15 min. wait, 40 MPH speed, 10 mile cycle,
07.23	Coal Ash Spreading	0	LCY	$2.07	$0	RS Means 3123 2317 0020	spread dumped material with dozer, no compaction
07.24	Coal Ash Compaction	0	ECY	$0.28	$0	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.25	Coal Ash Moisture Conditioning	0	MO	$5,903.51	$0	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.26	Landfill Disposal Tipping Fee	0	TON	$58.29	$0	Analysis of MSW Landfill Tipping Fees-April 2019, Published 2019, rev. 10/31/19, EREF-D&P/TIP FEES (2018 Illinois average in Table 3 + Midwest Annual Avg. Incr. % in Table 2)	Assumes average tipping fee with average annual increase and an in place unit weight of 90 pcf

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Revised By:	JPV	02/17/21

07.30	**Landfill Bottom Liner**				**$0**		
07.31	Landfill Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.32	Landfill Excavation Soil Hauling	0	BCY	$2.90	$0	RS Means 3123 2320 3028	16.5 CY Truck, 15 min. wait, 20 MPH speed, 1 mile cycle,
07.33	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.34	Clay Layer Borrow Excavation and Loading (On-site)	0	LCY	$8.76	$0	RS Means 3123 1643 5500 + 3123 2320 3080	0
07.35	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.36	Clay Layer Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes
07.37	Clay Layer Fine-Finish Grading	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
07.40	**Landfill Final Cover**				**$0**		
07.41	Clay Layer Borrow Pit Purchase	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.42	Clay Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.43	Clay Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Clay Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.44	Clay Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.45	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.46	Protective Layer Borrow Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.47	Protective Layer Borrow Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Protective Layer Borrow Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.48	Protective Layer Borrow Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.49	Protective Layer Borrow Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.50	**Coal Ash Recontouring**				**$1,160,000**		
07.51	Excavation and Loading	100,000	BCY	$1.39	$139,000	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor, assumes 10%
07.52	Hauling	130,000	LCY	$4.14	$538,000	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.53	Spreading	130,000	LCY	$2.45	$319,000	RS Means 3123 2317 0020	Dumped and spread by dozer
07.54	Compaction	100,000	ECY	$0.28	$28,000	RS Means 3123 2323 5060	12" lifts, 2 passes, riding, vibrating roller, 30% shrink
07.55	Moisture Conditioning	23	MO	$5,903.51	$136,000	RS Means 0154 3320 1500/0154 3340 7300	Rental/Operating cost of tractor and disc attachment
07.60	**Closure Cap**				**$9,019,000**		
07.61	Borrow Soil	0	BCY	$2.50	$0	acrevalue.com, doubled cost for development	Common earth, assume purchase land, 5 ft/AC
07.62	Clay Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.63	Clay Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Clay Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.64	Clay Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.65	Clay Layer Borrow Compaction	0	ECY	$1.76	$0	RS Means 3123 2323 5640	Sheepsfoot roller, 6-inch lifts, 4 passes, 10% shrink
07.66	Protective Layer Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.67	Protective Layer Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
	Protective Layer Hauling (Offsite)	0	LCY	$7.37	$0	RS Means 3123 2320 3080	16.5 CY Truck, 15 min. wait, 40 MPH speed, 20 mile cycle,
07.68	Protective Layer Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.69	Protective Layer Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.70	Wet or Sediment Cap	69,373	CY	$130.00	$9,019,000	Project Costs	12-inch sand cap
07.70	**Soil Contouring Fill / Regrading**				**$0**		
07.71	Excavation and Loading	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
07.72	Hauling (Onsite)	0	LCY	$4.14	$0	RS Means 3123 2320 6040	34 CY Truck, 15 min. wait, 5 MPH speed, 1 mile cycle,
07.73	Spreading	0	LCY	$2.45	$0	RS Means 3123 2317 0020	Dumped and spread by dozer
07.74	Compaction	0	ECY	$0.96	$0	RS Means 3123 2323 5600	Sheepsfoot roller, 6-inch lifts, 2 passes, 10% shrink
07.80	**Access Roads**				**$187,000**		
07.81	Access Road - Closure	18,000	SY	$10.39	$187,000	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.82	Access Road - Borrow	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
07.83	Access Road - Landfill	0	SY	$10.39	$0	RS Means 3132 1916 1510/3211 2323 0100	6-inch base coarse, 600-lb. woven geotextile, 20-ft wide /
08.00	**Geosynthetics**				**$0**		
08.10	**Landfill and Closure Cap Geosynthetic Components**				**$0**		
08.11	40-mil double sided textured LLDPE Geomembrane	0	SF	$0.81	$0	2020 project bids	0
08.12	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.13	Anchor Trench - Closure Cap	0	LF	$9.27	$0	2020 project bids	0
08.20	**Landfill Bottom Liner Geosynthetic Components**				**$0**		
08.21	60-mil double sided textured HDPE Geomembrane	0	SF	$0.85	$0	2020 project bids	0
08.22	Double-Sided Tri-place Geocomposite	0	SF	$1.32	$0	2020 project bids	0
08.23	Anchor Trench - Landfill Bottom Liner	0	LF	$9.27	$0	2020 project bids	0

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08.25	Geotextile - (Filter 4 oz/yd2)	0	SF	$0.25	$0	Project Bids	0
08.30	**Leachate Collection and Transmission System**				**$0**		
08.31	Leachate Collection System (1 foot thick)	0	CY	$16.00	$0	0	0
08.32	6-inch SDR 11 HDPE Pipe	0	LF	$9.50	$0	0	0
08.33	Gravel Trench for V-Trench	0	LF	$26.00	$0	0	Leachate Collection "V" Notch Drain "Burrito Wrap" - Includes Granular Fill, Geotextile Envelope (Nonwoven 4
08.34	Leachate Sumps	0	EA	$5,000.00	$0	20' x 20' x 3'	Double Lined with Rock
08.35	Leachate Sump Pumps (2 per sump)	0	EA	$8,500.00	$0	0	0
08.36	Leachate Transmission Piping (2x4 HDPE)	0	LF	$4.50	$0	0	Woven, heavy duty, 600 lb. tensile strength
08.37	Leachate Riser Pipe (18" SDR 17 HDPE)	0	LF	$78.00	$0	0	0
08.38	Leachate Vault and Control Panel	0	EA	$25,000.00	$0	0	0
08.39	Leachate Vault Utilities	0	LF	$24.55	$0	RS Means 337119175840	4 conduits in 5" diameter PVC conduit with backfill
08.40	Above Grade Leachate Storage Tank	0	EA	$500,000.00	$0	MIG Project Costs	50,000 gallon tank
08.41	Leachate Treatment (On-site)	0	Gal	$0.00	$0	Project Costs	On-site discharge through NPDES permit (cost for pumps)
09.00	**Pond Closure - Ditch and Apron Construction**				**$144,000**		
09.01	Geotextile Fabric	4,100	SY	$2.55	$10,000	RS Means 3132 1916 1510	Woven, heavy duty, 600 lb. tensile strength, perimeter length x 4-ft, 4 aprons, 1 borrow apron, 4 landfill aprons
09.02	Riprap	0	LCY	$71.19	$0	RS Means 3137 1310 0100	Machine placed for slope protection
09.03	Riprap	3,200	TON	$38.70	$124,000	RS Means 3137 1310 0370	300 lb. average, dumped, perimeter length x 4-ft, 20x50 ft aprons
09.04	Riprap Hauling	2,100	LCY	$4.89	$10,000	RS Means 3123 2320 3066	16.5 CY Truck, 15 min. wait, 35 MPH speed, 10 mile cycle
10.00	**Hydraulic Control / Containment**				**$0**		
10.01	Borehole Drilling for Bedrock Fractures	0	LF	$75.00	$0	Project Costs	one-line grout curtain on 5-foot spacing, 100 foot depth
10.02	Grouting of Bedrock Fractures	0	CY	$70.79	$0	RS Means 3173 1310 0820	0
10.03	Leachate Discharge Piping	0	LF	$6.50	$0	Project Bids	2"x4" buried in common earth
10.04	Vertical Leachate Extraction Wells	0	VLF	$85.00	$0	Project Bids	0
11.00	**Turf and Grasses**				**$0**		
11.01	Hydroseed and Mulch	0	SY	$2.25	$0	RS Means 3292 1913 1100	includes lime, fertilizer, seed, & fiber mulch
11.02	Closure Turf	0	SF	$2.44	$0	Past project experience	Engineered Synthetic Turf (CT), 40 mil MicroSpike
11.03	Manufactured Sand - Typical Infill	0	TON	$50.00	$0	Past project experience	120 Tons/AC
11.04	HydroBinder - Downchutes Infill	0	TON	$341.00	$0	Past project experience	7 lbs/SF
11.05	Anchor Trench	0	LF	$9.27	$0	2020 project bids	Perimeter trench
11.06	Sod, Temp Irrigation and Maintenance	0	AC	$30,000.00	$0	Past project experience	In place of seeding
11.07	Soil Amendments	0	AC	$500.00	$0	Past project experience	To support vegetative growth
12.00	**SW Management Features - New Landfill**				**$0**		
12.01	Soil Excavation for Detention Basin	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.02	Basin Vegetation	0	SY	$2.25	$0	RS Means 3292 1913 1100	Bluegrass, hydro or air seeding, with mulch and fertilizer
12.03	Basin Outlet Structure	0	EA	$10,000.00	$0	Past project experience	Outlet structure and associated discharge piping
12.04	Culverts (30-inch)	0	EA	$387.00	$0	Past project experience	Includes Excavation, Pipe, Bedding, and Backfill
12.05	Perimeter Stormwater Ditch/Road Excavation	0	BCY	$1.39	$0	RS Means 3123 1643 5500	4.5 CY Excavator, 90% fill factor
12.06	Perimeter Stormwater Ditch/Road Fill	0	LCY	$2.18	$0	RS Means 312323145440	Backfill, structural, clay, 300 H.P. dozer, 300' haul
12.07	Perimeter Stormwater Ditch Grading	0	LF	$0.40	$0	RS Means 312319100200	Cut Drainage Ditch, Clay and Till, 10' w x 3'-4' deep
12.08	Fine Grading of Perimeter Stormwater Ditch	0	SY	$0.25	$0	RS Means 3122 1610 3300	gentle slope grading
12.09	Terrace Berms	0	CY	$3.50	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grades
12.10	Drainage Downchutes	0	LF	$25.00	$0	Past project experience	Borrow/Load, Haul, Place, Fine Grade, Rip-Rap
13.00	**30-year Post-Closure**				**$5,085,000**		
13.01	Annual Care	30	YR	$169,500.00	$5,085,000	Past project experience	Includes monitoring, maintenance, inspections
				Sub Total	**$11,150,000**		
				Contingency	**$3,345,000**	**30%**	
				Design and Engineering Fees	**$1,115,000**	**10%**	
				Owners Costs	**$558,000**	**5%**	
				Closure Scenario Total	**$16,168,000**		

Attachment 7-3 – Final Post-Closure Plan

POST-CLOSURE PLAN
LINCOLN STONE QUARRY
JOLIET #9 STATION
JANUARY 2022

1.0 Introduction

This post-closure plan has been prepared in accordance with 35 Ill. Adm. Code 845.780 for Lincoln Stone Quarry (LSQ) at the Joliet #9 Station, operated by Midwest Generation, LLC (Midwest Generation), in Joliet, IL. Currently, LSQ is a landfill being operated under Illinois Environmental Protection Agency Permit No. 1994-241-LFM, Modification No. 24. The closure of LSQ will be accomplished by leaving the coal combustion residual (CCR) in place and covering with a final cover system in accordance with 845.750. The closure will achieve the closure performance standards in accordance with 845.750(a). This post-closure plan describes the steps necessary for post-closure and methods for compliance with post-closure requirements for the LSQ. The post-closure care period will begin once the construction completion report documenting the closure of LSQ and the closure certification has been approved by the Illinois Environmental Protection Agency (IEPA). The post-closure care period will begin once Midwest Generation has placed a certified notification of closure as required by 845.780(f) in Joliet #9's operating record. This post-closure care plan is based upon the regulatory requirement to maintain and monitor the site for 30 years after closure.

2.0 Post-Closure Monitoring and Maintenance Requirements [845.780(b)]

The post-closure monitoring and maintenance activities will be performed in compliance with 845.780(b). The post-closure care will consist of the following:

- Maintaining the integrity and effectiveness of the final cover system (FCS), including making repairs as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover.

- Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of Subpart F.

3.0 Final Cover System Monitoring & Maintenance Description [845.780(d)(1)(A)]

Annual inspections for settlement, subsidence, erosion or other damage through-out the post closure care period. Corrective measures will be implemented if any of the above conditions are observed and any repairs made to the FCS will be repaired in accordance with the manufacturer's recommendations. If rips/tears to the engineered turf and/or geomembrane are noted, then they will be repaired by an approved ClosureTurf installer. Erosion of the sand infill that causes the engineered turf backing to become exposed will be brushed back into the exposed turf backing areas.

4.0 Groundwater Monitoring [845.780(b)(2)]

Groundwater monitoring will be performed in accordance with 35 Ill Adm. Code 845 Subpart F for the duration of the post-closure period. Groundwater sampling will be conducted quarterly during the first five years of the post-closure period and groundwater elevations will be collected monthly. After the five years, the groundwater monitoring may be reduced to semi-annually if approved by IEPA.

5.0 Post-Closure Care Contact Information [845.780(d)(1)(B)]

Environmental Specialist
Joliet #9 Generating Station
1601 S. Patterson Road
Joliet, IL 60436
815-207-4918

6.0 Planned Uses of the Property [845.780(d)(1)(C)]

LSQ will be not developed during the post-closure care period. LSQ will be inactive during the post-closure care period, and it will only be accessed to perform groundwater monitoring or inspections, as noted above. The groundwater monitoring will not involve access to the FCS. Access to the FCS for inspections will be kept to a minimum.

7.0 Post-Closure Plan Amendments [845.780(d)(3)]

This Post-Closure Plan will be amended in accordance with 845.780(d)(3) if a change in the operation of LSQ would substantially affect the content of this Post-Closure Plan or if unanticipated events necessitate revision of the plan. If a change in operation requires amendment to the Post-Closure Plan, the plan will be amended no later than 60 days prior to the change in operation being implemented. If an unexpected event occurs that requires amendment of the Closure Plan, the plan will be amended within 60 days of the unexpected event or within 30 days of the unexpected event if the event occurs after post-closure activities have commenced. Amendments to this Post-Closure Plan will be certified by a professional engineer registered in the State of Illinois in accordance with §845.780(d)(4).

8.0 Professional Engineer's Certification [845.780(d)(4)]

This Post-Closure Plan for Joliet #9/Lincoln Stone Quarry has been prepared to meet the requirements of 35 Ill. Adm. Code 845.780(d)(1).

1/18/22

Joshua D. Davenport, P.E.
Illinois Professional Engineer

SEAL

JOSHUA D. DAVENPORT
062-061945

ATTACHMENT 8
GROUNDWATER MODELING REPORT

REPORT

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Joliet No. 9 Lincoln Stone Quarry
Joliet, Illinois

Submitted to:

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

and:

Midwest Generation, LLC
Joliet Generating Station No. 9
1800 Channahon Road
Joliet, IL 60436

Prepared by:

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

January 28, 2022

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Joliet No. 9 Lincoln Stone Quarry
Joliet, Illinois

BAS Project Number 21141301

Submitted to:

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

and:

Midwest Generation, LLC
Joliet Generating Station No. 9
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January 28, 2022

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Dacey Zelman-Fahm
Senior GIS Analyst/*BAS Groundwater Consulting Inc.*

Distribution List

Midwest Generation, LLC

KPRG and Associates, Inc.

Executive Summary

A numerical groundwater flow model was created for Midwest Generation Joliet #9 Station Lincoln Stone Quarry and the surrounding area as part of the GIA completed in 2013 in support of the landfill permit renewal. The model was reviewed and approved by Illinois EPA for use in support of engineering evaluations of corrective action/closure alternatives. The GIA model was updated slightly to use a more recent version of MODFLOW (MODFLOW-NWT), to define the current quarry water levels in Main Quarry and Boyd's Quarry, to simulate current pumping rates in the extraction well system, and to improve the calibration to measured, recent water levels at the site. The updated calibrations confirm that the model continues to replicate the observed northward hydraulic gradient toward the river at the water table, and a southeastern component of flow toward Laraway Quarry in the more permeable horizon in the shallow dolomite.

The updated, calibrated steady state flow model simulated 100 years of advective transport of a surrogate mass from LSQ. Four conceptual corrective action/closure alternatives were evaluated in support of the engineering analysis of alternatives.

The following general conclusions are forwarded for consideration in the overall engineering evaluations of corrective action/closure alternatives:

- Conceptual Closure Alternative 1 more quickly reduces the relative impacts in the shallow dolomite groundwater system and will negatively affect private well performance including resulting in dewatered residential wells east of LSQ.
- Conceptual Closure Alternatives 2, 3 and 4 do not negatively affect private well performance and will not cause dewatering of residential wells.
- Conceptual Alternatives 2, 3 and 4 have similar short-term reduction in constituent concentrations. Alternatives 3 and 4 provide for some additional long-term performance improvement in some constituent concentrations.
- Regardless of the conceptual alternative evaluated, meeting proposed GWPSs for various constituents will take time and therefore institutional controls such as GMZs and property deed restrictions for water use will be required.

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Table of Abbreviations

Abbreviation	Definition
amsl	Above mean sea level
CCR	Coal Combustion Residuals
ft/d	Feet per day
GIA	Groundwater Impact Assessment
GMZ	Groundwater Management Zone
gpm	Gallons per minute
GWPS	Groundwater Protection Standard
HFB	Horizontal Flow Barrier
in/yr	Inches per year
LSQ	Lincoln Stone Quarry
mg/l	Milligrams per liter
TDS	Total Dissolved Solids
WFA	West Filled Area
%	Percent

1.0 INTRODUCTION

This report documents the results of numerical groundwater flow modeling of groundwater flow near the Lincoln Stone Quarry Landfill (LSQ) at the Midwest Generation, LLC (Midwest Generation) Joliet Generating Station No 9. 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

A numerical groundwater flow model was originally developed for the LSQ and vicinity, including the active Main Quarry and the older, inactive West Filled Area (WFA), as part of a Groundwater Impact Assessment (GIA) for permit renewal (KPRG, 2013a), (KPRG, 2013b). Significant site characterization was done at that time along with extensive model development and the model was reviewed and approved by the Illinois Environmental Protection Agency (EPA) for use as a predictive tool in support of engineering evaluations of corrective action/closure alternatives. The model was calibrated to current water level elevations, general flow directions, and hydraulic gradients, as well as to the migration trends seen in the measured concentrations of constituents in monitoring wells surrounding the site. The calibrated model replicated the general, regional, and local flow directions from the south and east to the north and west towards the Des Plaines River. The model also replicates the westward hydraulic gradient from Boyd's Quarry located east of LSQ; an inward gradient to Main Quarry that is maintained with control of the water level in the Main Quarry. A key goal of the model calibration was to also replicate the observed south-southeasterly component of groundwater flow from the south perimeter of the LSQ facility toward Laraway Quarry located approximately 1,000 feet south of LSQ. This reversed hydraulic gradient was first observed circa 2003 in response to dewatering activities at Laraway Quarry, in the higher permeability horizon of the shallow dolomite unit that exists at, and just beneath, the base of the LSQ. The calibrated model reproduced the southeasterly component of flow from the southern side of LSQ in the shallow dolomite unit and not at the water table above, consistent with field documented flow patterns.

The purpose of the numerical groundwater modeling presented in this report was to update the time-varying parameters of the model without changing the overall structure or base calibration of the model. The model calibration was confirmed, and the updated model was used to evaluate four potential closure alternatives. This report provides a discussion of the model parameters that have been modified for current conditions and presents the results of the model simulations of the four conceptual closure/corrective action alternatives being considered by the engineering assessment. The reader is referred to the original modeling reports for a full discussion of the initial model development and calibration (KPRG, 2013a) (KPRG, 2013b).

3.0 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Section 4.0: Modifications to the Model – This section provides a discussion of the changes and updates that were made to the numerical groundwater model.
- Section 5.0: Predictive Model Scenarios of Closure Alternatives – This section provides results of predictive analyses that were used to evaluate changes to the water table, groundwater flow paths, and contaminant concentrations from four potential closure alternatives.
- Section 6.0: Conclusions – This section provides a summary of the modeling and predictive analysis.
- Section 7.0: 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 MODIFICATIONS TO THE MODEL

The overall, active area of the groundwater model is shown on Figure 1. The model covers a region from Laraway Quarry to the Des Plaines River, about one mile east of LSQ, and about 1.5 miles west of LSQ to the Former Olin Ponds. The model has 10 layers and a non-uniform grid spacing that ranges from 12.5 to 100 feet. The model layers represent the subsurface materials from the unconsolidated overburden at the surface, through the weathered and shallow dolomite, the Brainard Shale, the deeper Ft. Atkinson Dolomite, and the Scales Shale. The model domain, grid, and layering were not changed for this model update and the reader is referred to the GIA modeling report for details on the model development and calibration (KPRG, 2013a) (KPRG, 2013b). Additionally, the overall modeled parameters were not changed from those presented in the initial GIA modeling report. The parameters that were modified are documented here.

Modifications made to the modeled parameters include:

- Main Quarry – the constant head boundary condition used to represent the Main Quarry in model layers 1 through 4 was updated to an elevation of 539.87 feet above mean sea level (ft amsl), to reflect recent (2nd quarter 2021) operating conditions.
- Boyd's Quarry – the constant head boundary condition used to represent Boyd's Quarry to the east of Main Quarry was updated to an elevation of 550.19 ft amsl, to reflect recent (2nd quarter 2021) operating conditions.
- MODFLOW-NWT – updated the model code to MODFLOW-NWT, a more recent update of MODFLOW than used in the GIA modeling effort. MODFLOW-NWT has advanced capabilities, especially regarding how dry model cells are treated, over MODFLOW-2000, the MODFLOW version used in the GIA modeling effort.

- MT3D-USGS – the transport modeling code was likewise updated to MT3D-USGS, a version of MT3DMS that is compatible with MODFLOW-NWT. The GIA modeling effort used MT3DMS to simulate the advective transport of contaminants from LSQ.

- Interceptor wells – the interceptor wellfield, consisting of twelve extraction wells (X101 through X112) along the southern perimeter of LSQ were simulated in the model to represent current conditions, using an average of the active pumping rates from 2020.

- Recharge – recharge in the uplands area was increased from 4.5 inches per year (in/yr) to 5.1 in/yr to improve calibration to measured water levels in monitoring wells at the site. Mean annual precipitation in the seven years since the GIA modeling was conducted (36 in/yr for 2014 through 2000) was higher than the seven years prior to the GIA modeling (34.7 in/yr for 2007 through 2013), which supports a higher background recharge rate in the uplands area. The updated recharge value is consistent with the reported range of expected values (1 to 7 inches) (KPRG, 2013a).

- Hydraulic Conductivity – the modeled values of hydraulic conductivity were adjusted to improve the calibration to the updated measured water levels in monitoring wells at the site, particularly the shallow water table wells. The following changes were made to the modeled values of hydraulic conductivity:

  - Model layer 1: The modeled value of horizontal hydraulic conductivity was lowered from 0.1418 ft/d to 0.01418 ft/d throughout much of the layer and beneath the river, to improve (raise) any underestimated water levels in the water table monitoring wells. Additionally, the vertical hydraulic conductivity was simulated with a value 10 times lower than the horizontal hydraulic conductivity value, consistent with the observations of the southeasterly hydraulic gradient in the permeable horizon in the shallow dolomite at the base of the Main Quarry that is not seen in the water table monitoring wells, indicating that interaction between the shallow portion of the saturated zone and the permeable portion of the shallow dolomite is limited. To further improve calibration on the east side of the Main Quarry near water table monitoring well G45WT, an area of higher hydraulic conductivity (isotropic value of 1.418E-01 ft/d) was simulated (Figure 2).

  - Model layer 2: The modeled values of horizontal and vertical hydraulic conductivity were raised from 2.84 ft/d and 2.84E-04 ft/d, respectively to 4.26 ft/d and 4.26E-04 ft/d, respectively to further improve model calibration.

  - Model layers 3 through 5: The modeled values of horizontal and vertical hydraulic conductivity were increased by approximately 50 percent to improve model calibration. The modeled values of horizontal and vertical hydraulic conductivity beneath the river were modeled with the same values as in model layer 1.

  - Model layer 6: The modeled value of hydraulic conductivity was increased from an isotropic value of 4.8E-01 ft/d to 1 ft/d to improve model calibration.

  - Model layers 7 through 10: The modeled values of horizontal and vertical hydraulic conductivity were increased by approximately 50 percent to improve model calibration.

The model calibration results of these changes are discussed in the next section.

4.1 Model Calibration

The updated model calibration is shown on Figures 3 through 6. The match to recent 2021 measured water level elevations in shallow and deep dolomite monitoring wells is comparable to the 2013 GIA modeling effort and improved in the water table wells. A scatter plot of the measured and modeled water levels in each calibration target (monitoring well) is shown on Figure 3 and shows that the calibration targets generally fall close to the 1:1 line, and fall within the 95 percent interval, like the 2013 GIA modeling results. A few of the locations with larger, over-estimated deviations from the measured value are in the T series wells south of LSQ. The recent 2021 water levels for these wells are generally lower than water levels measured in 2020.

Contours of the updated modeled water levels are shown on Figures 4 and 5 for the shallow saturated water table interval (model layer 1) and the shallow dolomite (model layer 5). The overall trends in the groundwater flow directions and magnitude are well matched by the model, comparable to the results from the 2013 GIA model calibration. The hydraulic gradient in model layer 1 is to the north- northwest from LSQ toward the river. There is a groundwater divide south of LSQ indicating that groundwater flow directions are not toward Laraway Quarry at the water table, consistent with the conceptual model presented in the GIA modeling report (KPRG, 2013b). Figure 5 shows modeled water level contours in the shallow dolomite (model layer 5). Although the overall flow direction from LSQ is toward the river, there is a component of flow toward Laraway Quarry from the south/southeast side of LSQ as a result of dewatering operations at Laraway Quarry. This is consistent with the conceptual model presented in the GIA modeling report (KPRG, 2013b). This is further demonstrated with contours of a surrogate mass shown on Figure 6. Transport modeling was performed on the updated, calibrated, steady-state groundwater flow model by use of a surrogate constituent at LSQ. A constant source concentration of “1” was assigned to LSQ including the Main Quarry and the WFA. The mass was transported with advection and dispersion with the same assumed parameters as in the 2013 GIA modeling (uniform dispersivity tensors of 1 foot, and effective porosity of 6 percent (%)). The surrogate mass shows a component of transport toward Laraway Quarry from the south/southeast side of LSQ, consistent with the conceptual model.

5.0 PREDICTIVE MODEL SCENARIOS OF CLOSURE ALTERNATIVES

Predictive contaminant transport model runs were conducted to help assess the potential impacts to the groundwater quality for four conceptual corrective action/closure alternatives.

The calibrated, steady state groundwater flow model was used as the basis for a 100-year transport simulation of a surrogate constituent from LSQ, as described in the previous section. The surrogate constituent was simulated by introducing a concentration in groundwater of “1” within the Main Quarry and WFA, consistent with the 2013 GIA modeling. The surrogate constituent was defined using a constant source boundary condition and forward tracked for 100 years. The resulting groundwater impact plume is shown on Figure 6 for model layer 5 to represent the upper shallow dolomite unit and the base of the Main Quarry which is where the primary groundwater impacts are associated. Therefore, model layer 5 will be the focus of evaluations. The surrogate mass extends downgradient from LSQ toward the river, and discharges to the river through an upward hydraulic gradient. This plume was the starting condition for the predictive model scenarios of the conceptual closure alternatives.

The closure alternatives were evaluated through the extent and magnitude of the surrogate concentrations after 25-, 50-, and 100-years post-closure compared to the initial (starting) concentrations, in the upper shallow dolomite at the base of the main quarry (model layer 5). The percent decrease in the surrogate concentrations from the starting concentrations was calculated through the 100-year simulation for each closure alternative, at five representative monitoring well locations in the shallow dolomite:

- G47S on the southeast corner of LSQ near interceptor well X103,
- G30S downgradient of the Main Quarry,
- G31S downgradient of the northwest corner of the Main Quarry and WFA near the Des Plaines River,
- R08S downgradient of the WFA, and
- T08S located southeast of LSQ between LSQ and Laraway Quarry.

These wells were selected to provide a representative transect across the area of impacted groundwater from southeast to northwest. 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. An initial concentration was assigned at each of these five monitoring well locations for these specific constituents of concern that have been detected above proposed Groundwater Protection Standards (GWPSs) presented in the Application for Initial Operating Permit – Joliet #9 Lincoln Stone Quarry submitted to Illinois EPA on October 31, 2021 (MWG, 2021):

- Boron,
- Calcium,
- Sulfate,
- Arsenic,
- Lithium, and
- Molybdenum.

The initial concentrations for each of these six constituents at each of the five monitoring wells was selected from 2nd quarter 2021 analytical results at these locations, which are provided in Table 1. 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 for Boron in monitoring well G47S is 6.1 milligrams per liter (mg/l) (Table 1). The initial, relative surrogate concentration in monitoring well G47S is 0.65 (relative to the source concentration of "1") (Figure 6). The decrease in the surrogate concentration throughout the 100-year closure alternative 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 6.1 mg/l to yield a curve of decreasing Boron concentrations for the closure alternative. The resulting concentrations for each constituent of concern in each monitoring well was compared to the proposed GWPSs for each constituent. The proposed GWPSs are presented on each closure alternative's concentration graphs and in Table 1.

5.1 Closure Alternative 1

Closure Alternative 1 simulates the dewatering of Main Quarry and removal of the source of mass (CCR) from LSQ. Main Quarry was simulated with a dewatering schedule over one year, followed by twelve years at a dewatered level of 477 feet, and followed with a recovery period to 100 years. The constant source of a surrogate mass at LSQ was removed, to represent the removal of source materials. Drain boundary conditions were used to simulate the one-year dewatering schedule in four, 90-day periods in Main Quarry. The drain elevations representing the quarry water level at the start of each 90-day period were:

- Period 1, 539.87 ft amsl (same as the current conditions)
- Period 2, 524.37 ft amsl
- Period 3, 508.87 ft amsl
- Period 4, 493.36 ft amsl

The next modeled period was 12 years long during which Main Quarry was held at a dewatered elevation of 480 ft amsl. The engineering designs specified a dewatered elevation of 477 ft amsl, but to follow with the layering of the model and to avoid over-estimating the dewatered area, the lowest dewatering level was set at 480 ft amsl. Following this 13-year dewatering period, the drain boundary conditions representing the dewatering stages in Main Quarry were removed and the water level within the quarry was allowed to refill with water through a relatively high value of hydraulic conductivity and storage assigned to represent the quarry void space. Recharge was added over the footprint of Main Quarry at the average annual precipitation rate of 36 in/yr to represent direct rainfall.

The results of Closure Alternative 1 are shown on Figures 7 through 12 and in Appendix A. Figure 7 shows a model run for Alternative 1 that was presented at the public meetings on December 8 and 9, 2021. The model result reflects a steady state flow model with the Main Quarry held at 477 ft.

Since that time, additional modeling refinements have been developed as discussed in Section 4.0 above and have resulted in improved model calibration and sensitivity and the results of the refined model runs are provided in on Figures 8 through 12 and Appendix A, however, the relative conclusions remain the same. The modeled water levels in and beneath (model layer 5) Main Quarry for the transient closure alternative of dewatering and refilling are shown on Figure 8. The quarry is dewatered to 480 ft amsl over one year and held at this dewatered level for 12 years. During this time there is an upward hydraulic gradient from beneath the quarry, of about 25 feet. The quarry refills to an elevation of approximately 531 ft amsl, levelling off at about 20 years (7 years to refill). Once the quarry has stabilized, there is a re-established downward vertical hydraulic gradient to the underlying bedrock.

The distribution of the surrogate constituent is shown for 25 years post-closure on Figure 9. By 25 years, the mass in the shallow dolomite aquifer is limited to the area downgradient of the WFA at concentrations of 10 to 30 percent of the source concentration of “1”. By 50 years, the plume of dissolved contaminants has flushed through the shallow dolomite aquifer (model layer 5) to the river, so no figures were included beyond 25 years.

Model results indicate that the surrogate contaminant flushes through the shallow dolomite from an initial relative concentration of about 65 percent of the source concentration of “1” within approximately 5 years southeast of LSQ at G47S (Figure 10). Further to the southeast in monitor well T08S, relative concentrations decrease from about 60 percent to 0 within 35 years. Just downgradient of LSQ to the north/northeast at monitor well G30S, relative concentrations are predicted to drop from approximately 70 percent to 0 within about 5 to 10 years.

Relative concentrations west and northwest of LSQ show that the mass flushes through the shallow dolomite but at a slower rate, consistent with where the model indicates mass remains (Figure 9). Both monitoring wells G31S and R08S show declining concentrations during the 13 years of dewatering at the quarry, as the hydraulic gradient is reversed from the north. After dewatering as the quarry fills with water and the hydraulic gradient re-establishes toward the river, mass that was drawn toward the quarry again passes through these two locations to flush through to the river.

The following paragraphs describe the impacts of Closure Alternative 1 on the concentrations of specific constituents of concern in five monitoring wells that were selected to provide a representative transect across the area of impacted groundwater from southeast to northwest (wells T08S, G47S, G30S, R08S and G31S). The method of this evaluation was described at the beginning of Section 5 and the concentration graphs are provided in Appendix A.

Boron concentrations decrease below the proposed GWPS of 2 mg/l in all five monitoring wells. Boron concentrations fall below the proposed GWPS on the south and north/northeast sides of LSQ the fastest, within about 3 years at monitoring wells G30S and G47S. Further south, concentrations fall below the proposed GWPS in monitoring well T08S within about 20 years. On the west and northwest side of LSQ, Boron concentrations fall below the proposed GWPS within approximately 20 to 25 years (Figure A1).

Calcium concentrations fall from initial concentrations of 150 mg/l and 140 mg/l in monitoring wells G31S and R08S, respectively, to below the proposed GWPS of 138.4 mg/l relatively quickly, within approximately 3 years post-closure (Figure A2). Calcium concentrations are currently below the proposed GWPS for the other monitoring wells monitored in this analysis; therefore, graphs were not prepared for those wells.

Sulfate concentrations decrease below the proposed GWPS of 400 mg/l in all five monitoring wells relatively quickly, within about 3 to 5 years (Figure A3). The initial sulfate concentrations in the five wells range from 430 to 470 mg/l (Table 1).

Arsenic concentrations decrease below the proposed GWPS of 0.01 mg/l from an initial concentration of 0.04 mg/l in monitoring well G47S within approximately 3 years post-closure. Arsenic concentrations fall from an initial concentration of 0.017 mg/l to below the proposed GWPS within about 9 years post-closure in monitoring well T08S (Figure A4). Arsenic is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Lithium concentrations decrease below the proposed GWPS of 0.042 mg/l from an initial concentration of 0.097 mg/l in monitoring well G31S, within about 24 years post-closure, from an initial concentration of 0.15 mg/l in monitoring well R08S within about 19 years, and from an initial concentration of 0.05 mg/l in monitoring well G47S within about 3 years (Figure A5). Lithium is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Molybdenum concentrations decrease below the proposed GWPS of 0.1 mg/l in monitoring well G47S south of LSQ within approximately 3 years post-closure from an initial concentration of 0.48 mg/l (Figure A6). Molybdenum concentrations decrease below the proposed GWPS in monitoring well T08S from an initial concentration of 0.71 mg/l within about 23 years. Molybdenum concentrations decrease below the proposed GWPS on the west and northwest side of LSQ in both monitoring wells G31S and R08S within approximately 36 and 19 years, respectively, from initial concentrations of 0.7 mg/l and 0.37 mg/l, respectively. Molybdenum is already below the proposed GWPS in monitoring well G30S, so no graph is provided for this monitoring well.

The impact of dewatering the quarry on water levels to the east of LSQ was evaluated by looking at contours of water level decline (drawdown). Drawdown was calculated as the decrease in water level elevation from the steady state model calibrated water levels that represent today’s water table in model layer 1 and the potentiometric surface in the shallow dolomite in model layer 5. Model results show no noticeable decline in the shallow water table in model layer 1 at the end of 1 year of dewatering to the east of LSQ (Figure 11, left frame). Conversely, model results show that dewatering LSQ will cause about 2 to 4 feet of decline in the water level in the shallow dolomite (model layer 5), at approximately 1,000 feet east of LSQ near Cecelia Avenue (Figure 11, right frame) and much greater drawdowns approaching the dewatering pumping center at LSQ. Graphs of drawdown over time are shown on Figure 12 for four residential well locations east of, and within about 500 feet of, LSQ. The two locations closer to Boyd's Quarry show declining water levels of about 11 feet, whereas the two locations further from Boyd's Quarry show higher water level drawdowns approaching 30 feet from dewatering of LSQ. These drawdowns will have the unintended consequence of negatively affecting private well performance and/or result in some wells going dry.

5.2 Closure Alternative 2

Closure Alternative 2 simulates a cap-in-place scenario. The constant source concentration was removed from model layer 1 in the Main Quarry and WFA to simulate the removal of the source materials at the surface with the placement of a cap which will preclude precipitation infiltration through the unsaturated portion of the CCR. The source remains in model layers 2 through 4 which include the saturated CCR materials below the water table. To simulate the cap, the constant head boundary condition was removed from Main Quarry and recharge through LSQ was reduced by three orders of magnitude from the calibrated model recharge rates (9 in/yr to 0.009 in/yr). It was assumed that the extraction wells would remain active and were simulated at the average, active rate from 2020.

The results of Closure Alternative 2 are shown on Figures 13 through 15 and Appendix B. The distribution of the surrogate constituent is shown for 25, 50, and 100-years post-closure. By 25 years, the plume of dissolved contaminants has begun to shrink laterally from the LSQ, and downgradient concentrations have decreased from approximately 90 to 50 percent of the source concentration of "1" (Figure 13). Concentrations have mostly stabilized by 50 years, and the plumes shown for years 50 and 100 on Figure 14.

Model results indicate that the relative concentrations of a surrogate contaminant drop from 70 to 50 percent of the source concentration of "1" relatively quickly (within approximately 3 years) southeast of LSQ at G47S, then stabilize at a relative concentration of approximately 50 percent, or about a 20 percent decrease (Figure 15). Further to the southeast in monitor well T08S, relative concentrations decrease approximately 30 percent, to a relative concentration of about 30 percent. Just downgradient of LSQ to the north/northeast at monitor well G30S, relative concentrations are predicted to be relatively stable at about 65 to 70 percent of the source concentrations.

Relative concentrations west and northwest of LSQ show greater decreases post-closure in the model scenario for Closure Alternative 2 than elsewhere near the LSQ (Figure 15). Relative concentrations decrease by approximately 50 to 60 percent by about 50 years in monitoring wells R08S and G31S, as also seen in the figures of plume extent (Figures 13 and 14) that show the plume shrink by 50 years, particularly to the west of LSQ.

The following paragraphs describe the impacts of Closure Alternative 2 on the concentrations of specific constituents of concern in five monitoring wells. The method of this evaluation was described at the beginning of Section 5 and the concentration graphs are provided in Appendix B.

Boron concentrations decrease below the proposed GWPS of 2 mg/l in monitoring well G31S from a starting concentration of 4.6 mg/l within approximately 35 years (Figure B1). Boron concentrations decrease in monitoring well R08S, from 7.6 mg/l to approximately 3.2 mg/l, and in monitoring well T08S from 7.4 mg/l to approximately 3.4 mg/l.

Calcium concentrations fall from an initial concentration of 150 mg/l in monitoring well R08S to below the proposed GWPS of 138.4 mg/l relatively quickly, within approximately 2 years post-closure, and from 140 mg/l in monitoring well G31S to below the proposed GWPS within approximately 5 years (Figure B2). Calcium concentrations are currently below the proposed GWPS for the other monitoring wells monitored in this analysis; therefore, graphs were not prepared for those wells.

Sulfate concentrations quickly decrease below the proposed GWPS of 400 mg/l in monitoring wells G31S, G47S, R08S, and T08S, within approximately 2 to 10 years post-closure (Figure B3). The sulfate concentrations in monitoring well G47S stabilize just below the proposed GWPS level. The relatively stable concentrations remain in G30S.

Arsenic concentrations decrease to just below the proposed GWPS of 0.01 mg/l from an initial concentration of 0.017 mg/l in monitoring well T08S, within approximately 11 years post-closure. The relatively stable concentrations in monitoring well G47S remain at a concentration of approximately 0.034 mg/l (Figure B4). Arsenic is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Lithium concentrations decrease below the proposed GWPS of 0.042 mg/l from an initial concentration of 0.097 mg/l in monitoring well G31S, within about 35 to 38 years post-closure (Figure B5). The relatively stable concentrations in monitoring well G47S remain just at the proposed GWPS at a concentration of about 0.042 mg/l. Lithium concentrations fall from an initial concentration of 0.15 mg/l and remain at approximately 0.065 mg/l. Lithium is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Molybdenum concentrations decrease in monitoring wells G31S, R08S, and T08S but remain above 0.1 mg/l (Figure B6). The relatively stable concentrations in monitoring well G47S remain above 0.1 mg/l (Figure B6). Molybdenum is already below the proposed GWPS in monitoring well G30S, so no graph is provided for this monitoring well.

5.3 Closure Alternative 3

Closure Alternative 3 represents closure in place with hydraulic containment. The same adjustments from Closure Alternative 2 were made in Closure Alternative 3, along with the addition of a low permeability barrier wall along the south and east sides of LSQ, from land surface through the bottom of model layer 8, to represent a depth of at least 430 feet and termination within the Brainard Shale. The interceptor wellfield was simulated in this Closure Alternative at the average pumping rate for 2020. The low permeability barrier wall was simulated with the Horizontal Flow Barrier (HFB) package as shown on Figures 16 and 17.

The results of Closure Alternative 3 are shown on Figures 16 through 18 and Appendix C. The distribution of the surrogate constituent is shown for 25, 50, and 100-years post-closure. By 25 years, the plume of dissolved contaminants has shrunk laterally from the LSQ. The mass is mostly contained to the LSQ and has decreased toward the river with the reduction in regional flow through the area. Concentrations have also decreased south of LSQ as mass is restricted by the low permeability barrier wall. Concentrations mostly stabilize by 25 years, and the plumes shown for years 50 and 100 on Figure 17 are similar. Closure Alternative 3 results were evaluated in the same five shallow dolomite monitoring well locations as Closure Alternative 2, and are shown on Figure 18 and Appendix C.

As in Closure Alternative 2, relative concentrations of a surrogate constituent are relatively steady in monitoring well G47S located along the southern perimeter of LSQ. Further to the southeast in monitor well T08S, relative concentrations decrease to a relative concentration of about 0 percent.

Relative concentrations of a surrogate constituent in monitoring well G30S on the north side of LSQ decreases rapidly from approximately 70 percent of the source concentration of “1” to approximately 0 within about 8 to 10 years (Figure 18). The addition of a barrier wall to reduce groundwater flow through LSQ coupled with decreased flux through LSQ from the simulated cap (reduced recharge rate), and ongoing operation of the extraction wells are attributed to these reductions in concentrations.

On the west/northwest side of LSQ, relative concentrations in monitoring wells G31S and R08S also decrease substantially from their starting relative concentrations of approximately 85 percent and 100 percent of the source concentration of “1”.

The following paragraphs describe the impacts of Closure Alternative 3 on the concentrations of specific constituents of concern in five monitoring wells. The method of this evaluation was described at the beginning of Section 5 and the concentration graphs are provided in Appendix C.

Boron concentrations decrease below the proposed GWPSs of 2 mg/l in monitoring well G30S within approximately 2 years, and in monitoring wells G31S, R08S, and T08S within approximately 18 to 25 years (Figure C1). Boron concentrations are relatively steady in monitoring well G47S as this well is inside the modeled barrier wall (i.e. north of the wall).

Calcium concentrations fall slightly from an initial concentration of 140 mg/l in monitoring well R08S and 150 mg/l in monitoring well G31S to below the proposed GWPS of 138.4 mg/l within a couple of years (Figure C2). Calcium concentrations are currently below the proposed GWPS for the other monitoring wells used in this analysis; therefore, graphs were not prepared for those wells.

Sulfate concentrations quickly decrease below the proposed GWPS of 400 mg/l in monitoring wells R08S and G30S, within approximately 1 to 2 years post-closure, and below the proposed GWPS in monitoring wells G31S and T08S within about 5 years (Figure C3). The relatively stable concentrations in monitoring well G47S remain as this well is inside the modeled barrier wall.

Arsenic concentrations fall from an initial concentration of 0.017 mg/l in monitoring well T08S to below the proposed GWPS within about 15 years (Figure C4). Arsenic concentrations remain fairly steady in monitoring well G47S (Figure C4). Arsenic is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Lithium concentrations decrease below the proposed GWPS of 0.042 mg/l from an initial concentration of 0.097 mg/l in monitoring well G31S, and from an initial concentration of 0.14 mg/l in monitoring well R08S, within about 18 to 20 years post-closure (Figure C5). The relatively stable concentrations in monitoring well G47S on the south side of LSQ remain slightly above 0.054 mg/l. Lithium is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Molybdenum concentrations decrease below the proposed GWPS of 0.1 mg/l in monitoring well R08S within about 18 years, in monitoring wells G31S and T08S within about 35 to 38 years (Figure C6). Molybdenum concentrations remain fairly steady above 0.1 mg/l in monitoring well G47S. Molybdenum is already below the proposed GWPS in monitoring well G30S, so no graph is provided for this monitoring well.

5.4 Closure Alternative 4

Closure Alternative 4 represents closure in place with hydraulic controls. The same adjustments from Closure Alternative 2 were made in Closure Alternative 4, along with the addition of 47 extraction wells within LSQ, as per the conceptual engineering design (Geosyntec, 2021). The wells were simulated as 60 feet deep, and each pumped a maximum of 7.5 gallons per minute (gpm). The model adjusts the pumping rate downward as needed if the model cell containing the well borehole goes dry. As a result, the total pumping rate achieved by the wellfield was approximately 80 gpm.

The results of Closure Alternative 4 are shown on Figures 19 through 21 and Appendix D. The distribution of the surrogate constituent is shown for 25, 50, and 100-years post-closure. By 25 years, the plume of dissolved contaminants has been reduced in size toward and within LSQ. Downgradient concentrations toward the river have decreased from maximum relative concentrations of approximately 90 percent to 20 percent (relative to the source concentration of “1”) (Figure 19). The surrogate plume is contained to the west and east to the property boundary, and only slightly extends to the southeast past the interceptor wells toward Laraway Quarry. As previously discussed in Section 5.1 for Closure Alternative 1, these results reflect some model run refinements since the results presented during the noted public meetings but the relative conclusions remain the same.

Concentrations mostly stabilize by 25 years, and the plumes shown for years 50 and 100 on Figure 20 are very similar to the plume shown for year 25. Closure Alternative 4 results were evaluated in the same five shallow dolomite monitoring well locations as Closure Alternative 2, and are shown on Figure 21 and Appendix D.

The addition of dewatering wells within LSQ resulted in improved reduction in surrogate concentrations in the monitoring wells than with only the cap-in-place closure alternative (Closure Alternative 2). Concentrations adjacent to LSQ show rapidly declining concentrations over the first few years post-closure, with relative concentrations dropping by 30 to 50 percent within about 3 years in monitoring wells G30S and G47S, respectively (Figure 21). South of LSQ, relative concentrations of a surrogate constituent in monitoring well T08S decrease gradually to a relative concentration of about 0 within about 40 years.

On the west and northwest sides of LSQ relative concentrations decline more slowly than on the southeast side of LSQ (Figure 21). Relative concentrations in monitoring wells G31S and R08S decrease approximately 90 to 95 percent, falling to a relative concentration of less than 10 percent of the source concentration of “1” within approximately 50 to 60 years (Figure 21).

The following paragraphs describe the impacts of Closure Alternative 4 on the concentrations of specific constituents of concern in five monitoring wells. The method of this evaluation was described at the beginning of Section 5 and the concentration graphs are provided in Appendix D.

Boron concentrations decrease to, or below, the proposed GWPS of 2 mg/l in all the monitoring wells except at well G30S to the north of the Main Quarry. Boron concentrations at this well fall approximately 50 percent within about 3 years but may remain slightly above than the proposed GWPS. South of LSQ, boron concentrations fall to or below the proposed GWPS within approximately 2 to 10 years in monitoring wells G47S and T08S, respectively. West and northwest of the WFA boron concentrations fall below the proposed GWPS in 20 to 30 years in monitoring wells G31S and R08S (Figure D1).

Calcium concentrations fall from an initial concentration of 150 mg/l in monitoring well G31S and 140 mg/l in monitoring well R08S below the proposed GWPS of 138.4 mg/l within approximately 2 years (Figure D2). Calcium concentrations are currently below the proposed GWPS for the other monitoring wells used in this analysis; therefore, graphs were not prepared for those wells.

Sulfate concentrations quickly decrease below the proposed GWPS of 400 mg/l within approximately 1- to 2-years around LSQ in monitoring wells G47S, G30S, T08S, and R08S (Figure D3). Concentrations fall below the proposed GWPS within about 5 years in monitoring well G31S north of the WFA.

Arsenic concentrations decrease below the proposed GWPS of 0.01 mg/l on the southeast side of LSQ within approximately 2 years post-closure from an initial concentration of 0.017 mg/l in monitoring well T08S. Concentrations on the north side of LSQ likewise show a rapid decrease over the first couple of year post-closure but then remain at a steady level (Figure D4). Arsenic is already below the proposed GWPS in the other three monitoring wells used in this analysis, and therefore no graphs were provided for those wells.

Lithium concentrations decrease below the proposed GWPS of 0.042 mg/l from an initial concentration of 0.05 mg/l on the southeast side of LSQ in monitoring well G47S, within about 2 years post-closure (Figure D5). Lithium concentrations decrease more slowly on the northwest side of LSQ and fall below the proposed GWPS within approximately 20 to 25 years post-closure in monitoring wells G31S and R08S. Lithium is already below the proposed GWPS in monitoring wells G30S and T08S, and therefore no graphs were provided for those wells.

Molybdenum concentrations fall below the proposed GWPS of 0.1 mg/l southeast of LSQ, in monitoring well T08S within approximately 15 years post-closure (Figure D6). The molybdenum concentrations at monitoring well G47S reach a steady concentration slightly above 0.1 mg/l. West and northwest of LSQ concentrations fall more slowly, falling below the proposed GWPS within approximately 28 to 40 years in monitoring wells G31S and R08S. Molybdenum is already below the proposed GWPS in monitoring well G30S, so no graph is provided for this monitoring well.

6.0 CONCLUSIONS

A numerical groundwater flow model was created for Midwest Generation Joliet #9 Station Lincoln Stone Quarry and the surrounding area as part of the GIA completed in 2013 as part of the landfill permit renewal. The model was reviewed and approved by Illinois EPA for use in support of engineering evaluations of corrective action/closure alternatives. The GIA model was updated slightly to use a more recent version of MODFLOW (MODFLOW-NWT), to define the current quarry water levels in Main Quarry and Boyd’s Quarry, to simulate current pumping rates in the extraction well system, and to improve the calibration to measured, recent water levels at the site. The updated calibrations confirm that the model continues to replicate the observed northward hydraulic gradient toward the river at the water table, and a southeastern component of flow toward Laraway Quarry in the permeable horizon in the shallow dolomite.

The updated, calibrated steady state flow model simulated 100 years of advective transport of a surrogate mass from LSQ. Four conceptual corrective action/closure alternatives were evaluated in support of the engineering analysis of alternatives. The four conceptual alternatives were:

- Conceptual Closure Alternative 1 – Complete dewatering of the LSQ to facilitate the direct removal of the CCR materials for off-site landfill disposal.

- Conceptual Closure Alternative 2 – In-place closure with regrading of the CCR materials and subsequent capping to preclude direct infiltration of precipitation through unsaturated CCR materials.

- Conceptual Closure Alternative 3 – Same as Closure Alternative 2 but with the addition of hydraulic containment with the placement of a low permeability barrier along the east and south sides of the LSQ.

- Conceptual Closure Alternative 4 – Same as Closure Alternative 2 but with the addition of hydraulic controls with the installation and operation of 47extraction wells within the LSQ.

The following general conclusions are forwarded for consideration in the overall engineering evaluations of corrective action/closure alternatives:

- Conceptual Closure Alternative 1 more quickly reduces the relative impacts in the shallow dolomite groundwater system and also will negatively affect private well performance including resulting in dewatered residential wells east of LSQ.
- Conceptual Closure Alternatives 2, 3 and 4 do not negatively affect private well performance and will not cause dewatering of residential wells.
- Conceptual Alternatives 2, 3 and 4 have similar short-term reduction in constituent concentrations. Alternatives 3 and 4 provide for some additional long-term performance improvement in some constituent concentrations.
- Regardless of the conceptual alternative evaluated, meeting proposed GWPSs for various constituents will take time and therefore institutional controls such as GMZs and property deed restrictions for water use will be required.

7.0 REFERENCES

Geosyntec. (2021). *Draft Lincoln Stone Quarry Closure Alternative Analysis.*

KPRG. (2013a). *Revised Groundwater Impact Assessment, Lincoln Stone Quarry Landfill, Addendum to IEPA Application Logs 2004-052 and 2009-213, Volume 1.*

KPRG. (2013b). *Revised Groundwater Impact Assessment, Lincoln Stone Quarry Landfill, Addendum to IEPA Application Logs 2004-052 and 2009-213, Volume 2.*

Midwest Generation (MWG). (2021). *Application for Initial Operating Permit, Joliet #9, Lincoln Stone Quarry, Submitted to the Illinois EPA, October 31, 2021.*

Signature Page

BAS Groundwater Consulting Inc.

Betsy Semmens

Betsy Semmens, RG
President/BAS Groundwater Consulting

TABLES

Table 1: Initial Concentrations and Proposed Groundwater Protection Standards Used in Model Scenarios of Closure Alternatives - June 2021 Data

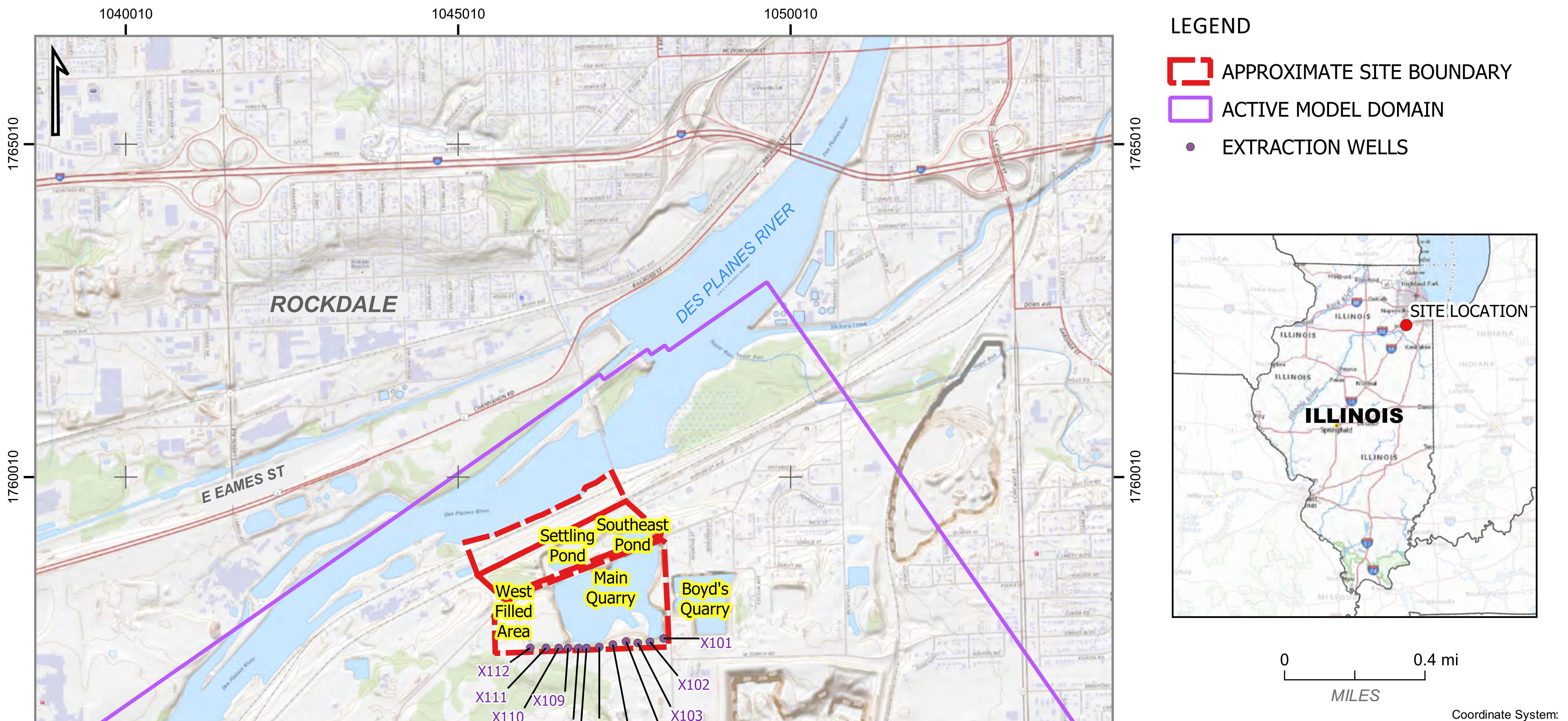
Well No.	Boron	Calcium	Sulfate	Arsenic	Lithium	Molybdenum	TDS
G47S	**6.1**	12	**470**	**0.04**	**0.05**	**0.48**	1000
G30S	**5.9**	61	**470**	<0.017	0.024	0.017	1100
R08S	**7.6**	**140**	**430**	0.001	**0.15**	**0.37**	810
G31S	**4.6**	**150**	**460**	0.004	**0.097**	**0.7**	1000
T08S	**7.4**	33	**450**	**0.017**	0.035	**0.71**	990
Proposed GWPS	2	138.4	400	0.01	0.042	0.1	1200

Notes:

Concentrations are in milligrams per liter

Bold where above the Proposed Groundwater Protection Standard (GWPS)

FIGURES



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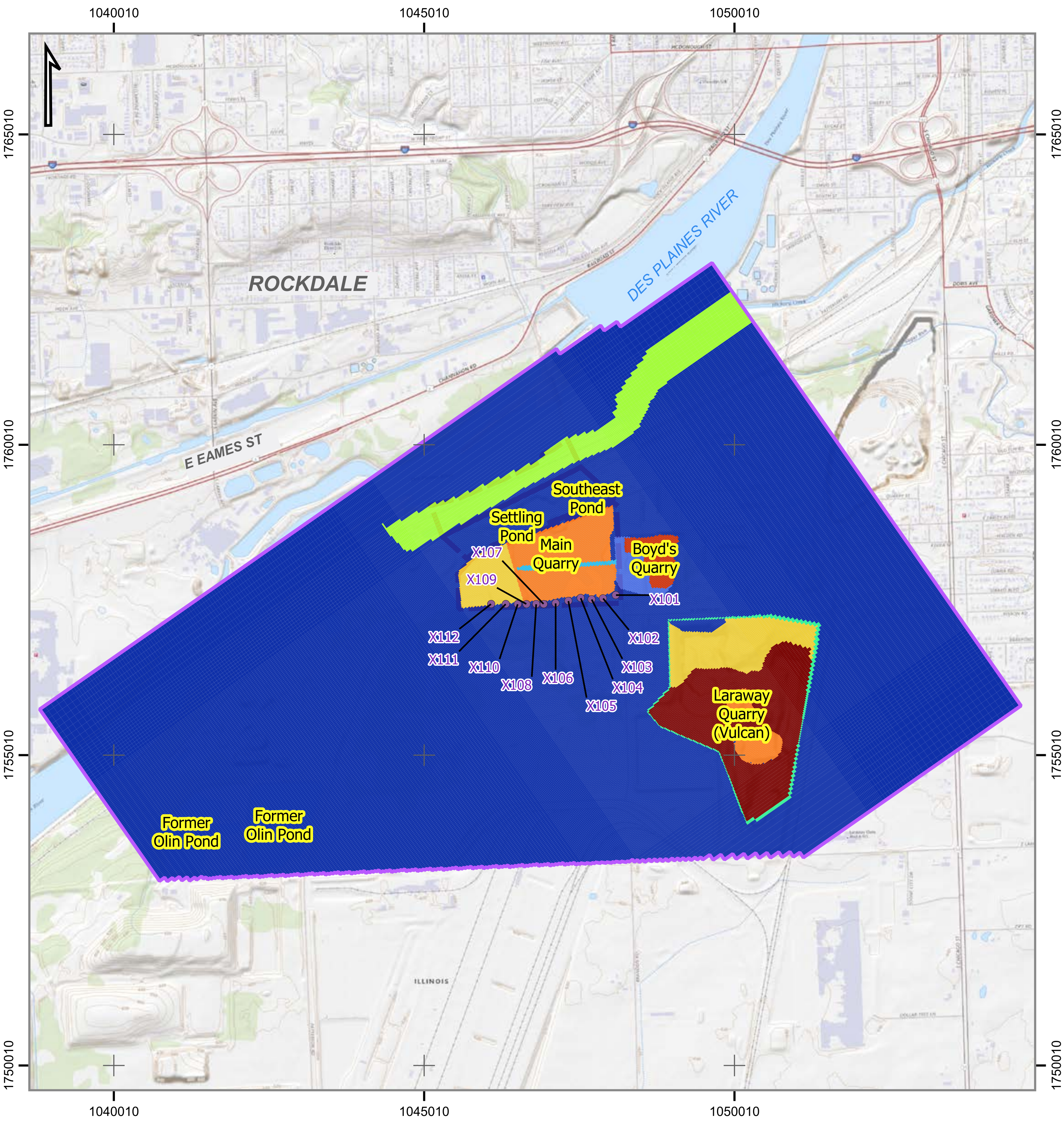
KPRG

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
PROJECT
AREA

SCALE AT ANSI A 1:26,500	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201	FIGURE: **1**		



LEGEND

- 🟥 APPROXIMATE SITE BOUNDARY
- ☐ ACTIVE MODEL DOMAIN
- ● EXTRACTION WELLS

UPDATED MODEL CALIBRATED HYDRAULIC CONDUCTIVITY, LAYER 1

- 🟦 0 - 0.01
- 🟦 0.01 - 0.14
- 🟦 0.14 - 0.57
- 🟩 0.57 - 1.42
- 🟩 1.42 - 2.83
- 🟨 2.83 - 3.7
- 🟧 3.7 - 5.67
- 🟥 5.67 - 28.35
- 🟫 28.35 - 283.5

0 0.4 mi

MILES

Coordinate System:
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Project File:
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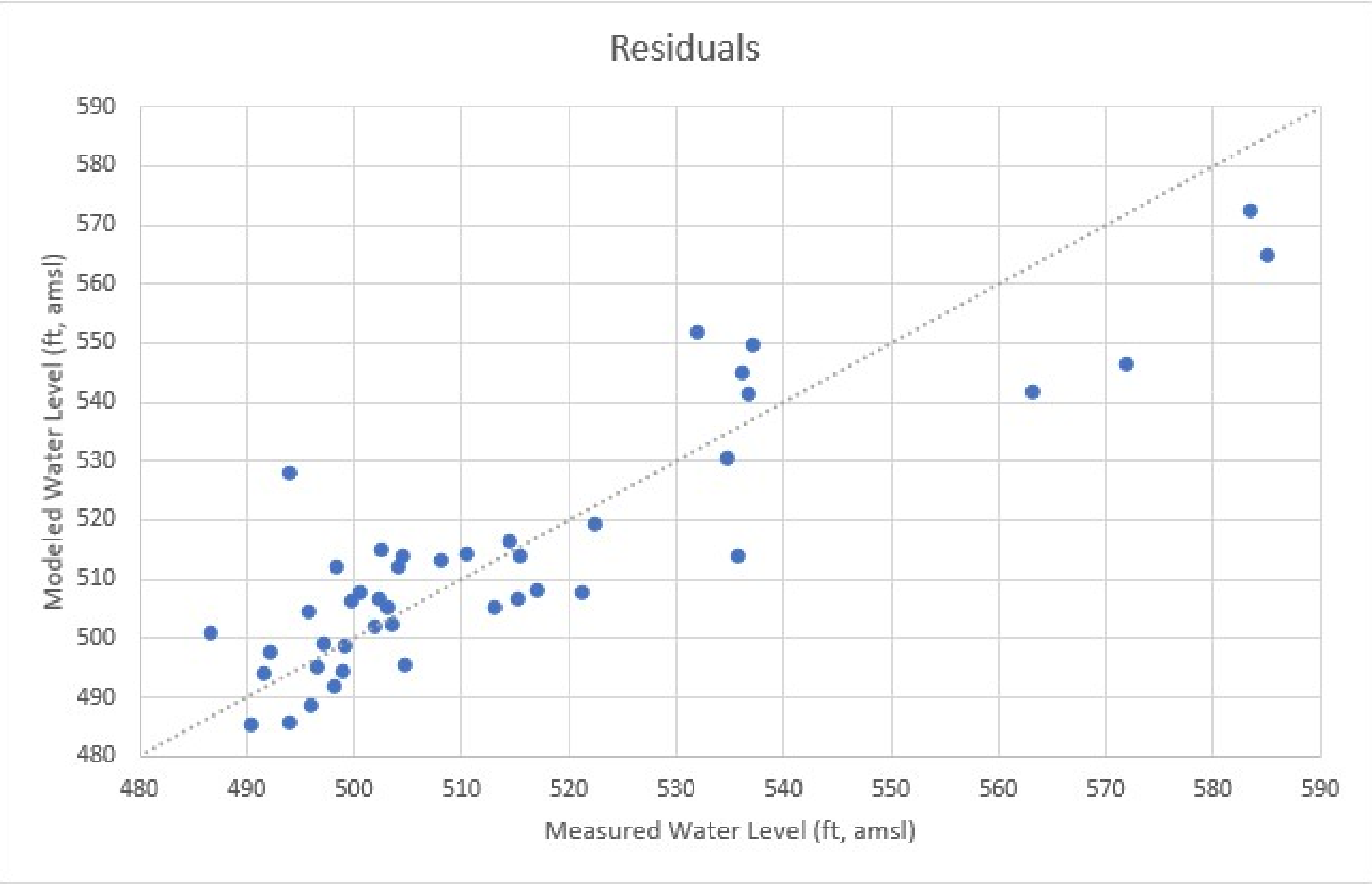
TITLE **UPDATED MODEL CALIBRATED HYDRAULIC CONDUCTIVITY, LAYER 1**

SCALE AT ANSI A 1:26,500	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. 21141201	*FIGURE:* **2**		



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SCALE AT ANSI A

DRAWN DZF 01/28/2022

CHECKED BAS 01/28/2022

BAS PROJECT No.
21141201

FIGURE:
3

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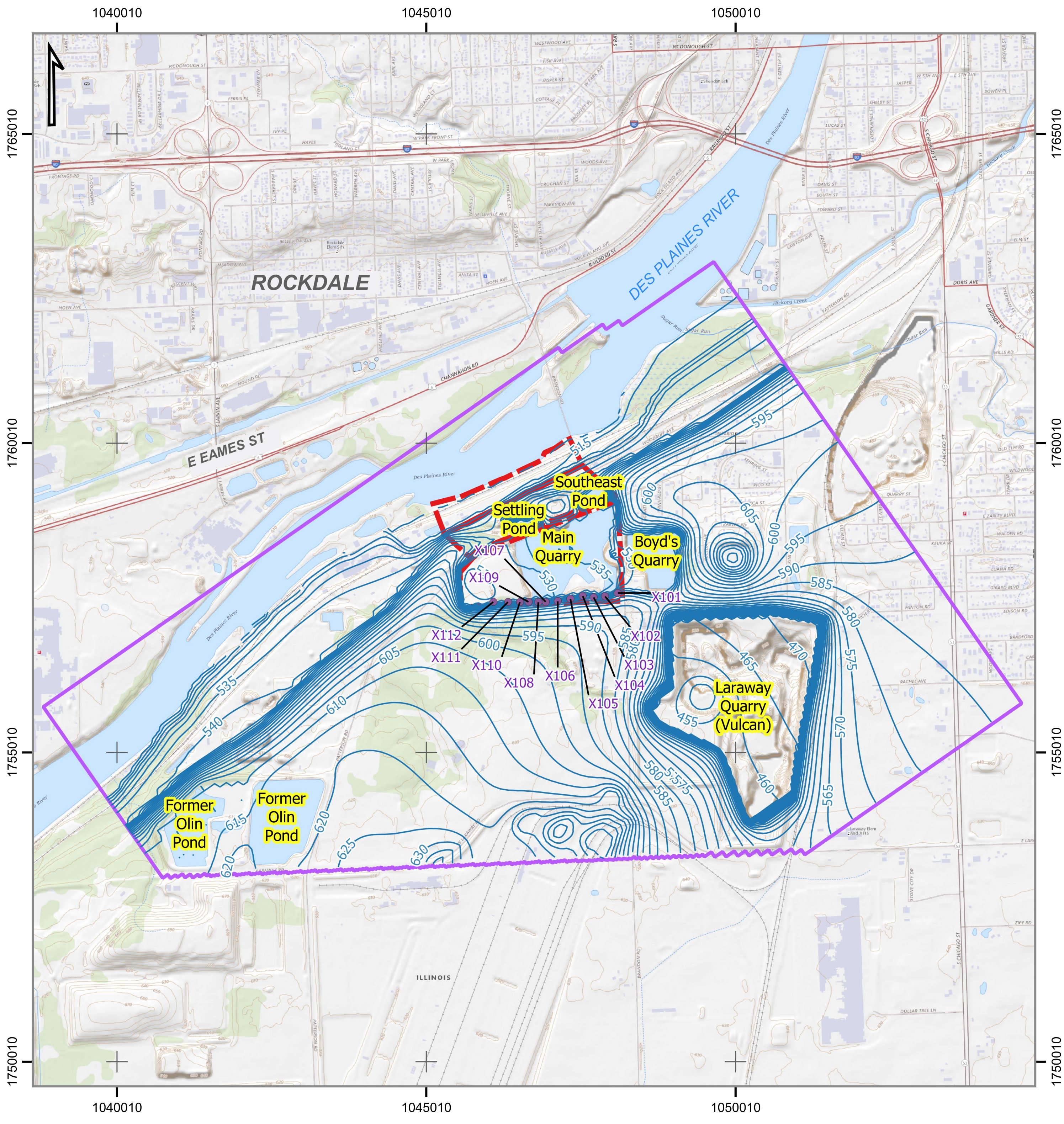
TITLE
UPDATED MODEL CALIBRATION SCATTER PLOT

Project File: Figure3_UpdatedModelCalibrationScatterPlot.qgz



LEGEND

🟥 APPROXIMATE SITE BOUNDARY

🟪 ACTIVE MODEL DOMAIN

● EXTRACTION WELLS

— UPDATED MODEL CALIBRATED GROUNDWATER ELEVATION CONTOURS (5 FT INTERVALS)

0 0.4 mi

MILES

Coordinate System:
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Project File:
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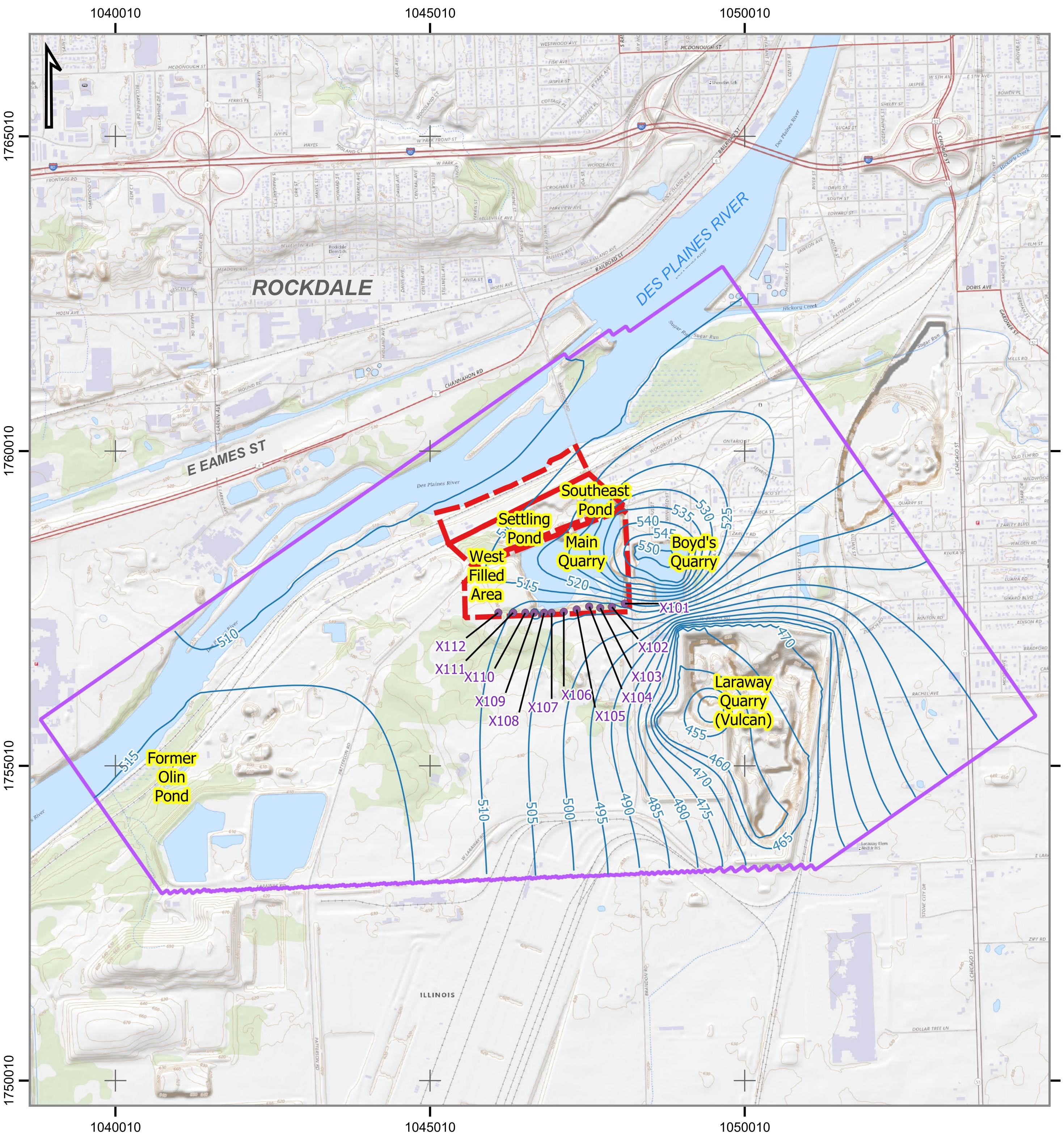
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**UPDATED MODEL CALIBRATED GROUNDWATER ELEVATION CONTOURS, LAYER 1**

SCALE AT ANSI A 1:26,500	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201	FIGURE: **4**		



LEGEND

🟥	APPROXIMATE SITE BOUNDARY
🟪	ACTIVE MODEL DOMAIN
●	EXTRACTION WELLS
—	UPDATED MODEL CALIBRATED GROUNDWATER ELEVATION CONTOURS (5 FT INTERVALS)

0 0.4 mi

MILES

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
ure5_UpdatedModelCalibratedGroundwaterElevationContours_Layer5.qgz

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TITLE
UPDATED MODEL CALIBRATED GROUNDWATER ELEVATION CONTOURS, LAYER 5

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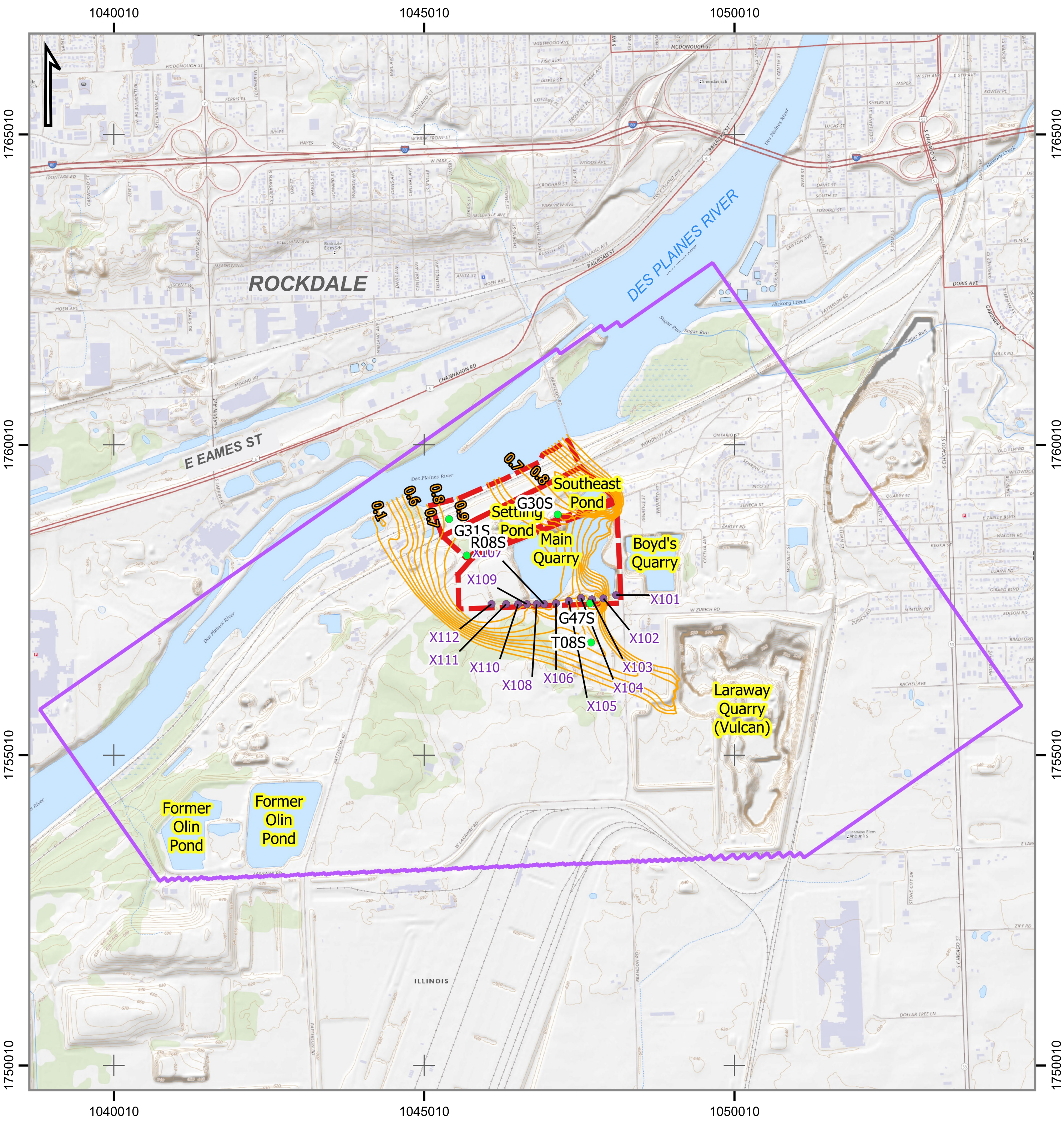
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201	FIGURE: **5**		



LEGEND

🟥 APPROXIMATE SITE BOUNDARY

▭ ACTIVE MODEL DOMAIN

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

0 0.4 mi
MILES

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure6_InitialConcentrationsForScenarios_Layer5.qgz

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1601 S. PATTERSON RD., JOLIET, IL

TITLE
INITIAL CONCENTRATIONS FOR
ALTERNATIVE, LAYER 5

SCALE AT ANSI A	DRAWN	DZF	01/28/2022
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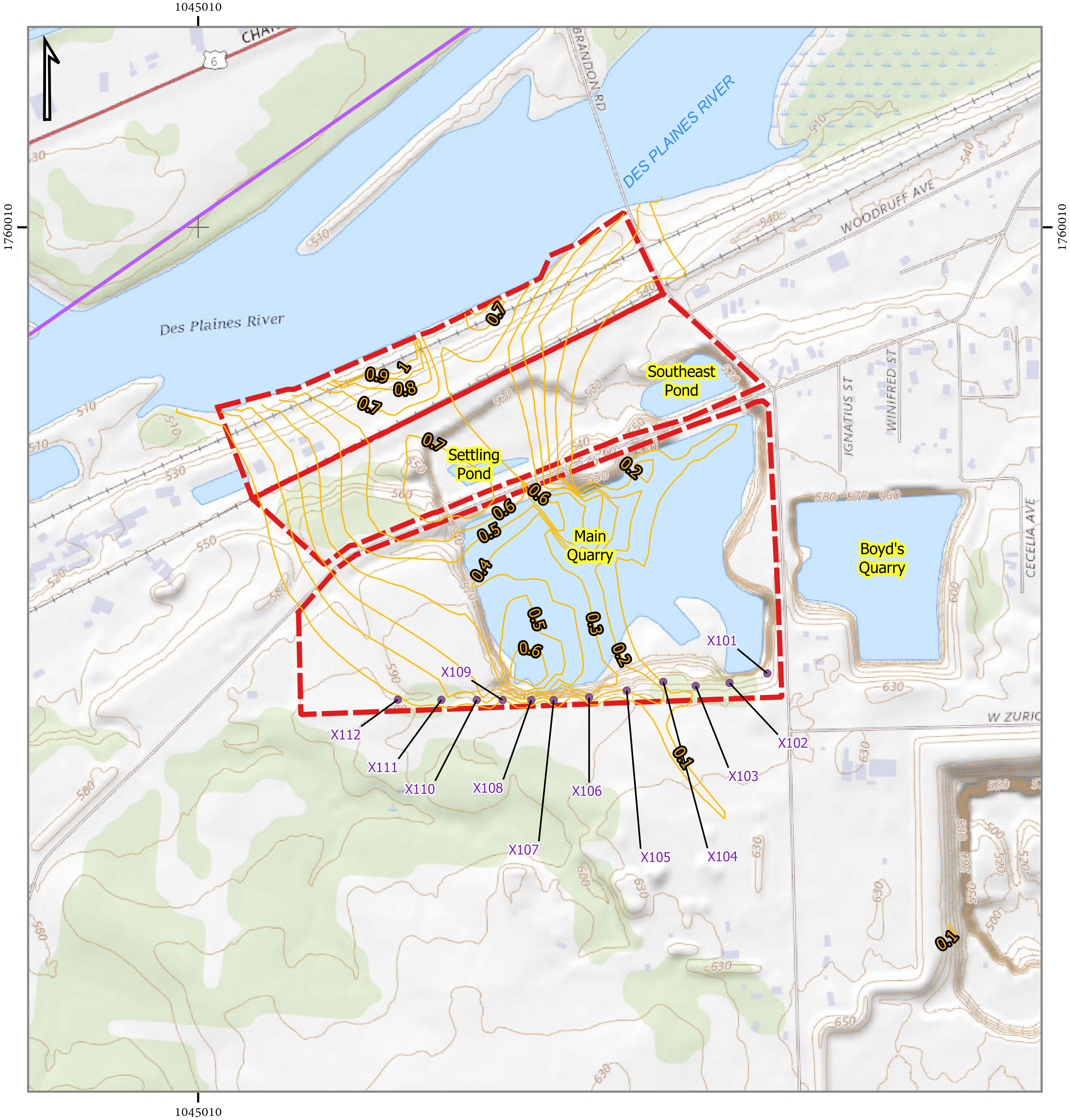
BAS PROJECT No.
21141201

FIGURE:
6



LEGEND

▭ APPROXIMATE SITE BOUNDARY

▭ ACTIVE MODEL DOMAIN

● EXTRACTION WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

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Project File:
Figure7_Scenario1_30YearPlumeDistributionSteadyStateModel.qgz

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TITLE
ALTERNATIVE 1, 30-YEAR PLUME DISTRIBUTION, STEADY STATE MODEL

SCALE AT ANSI A	*DRAWN*	*DZF*	01/28/2022
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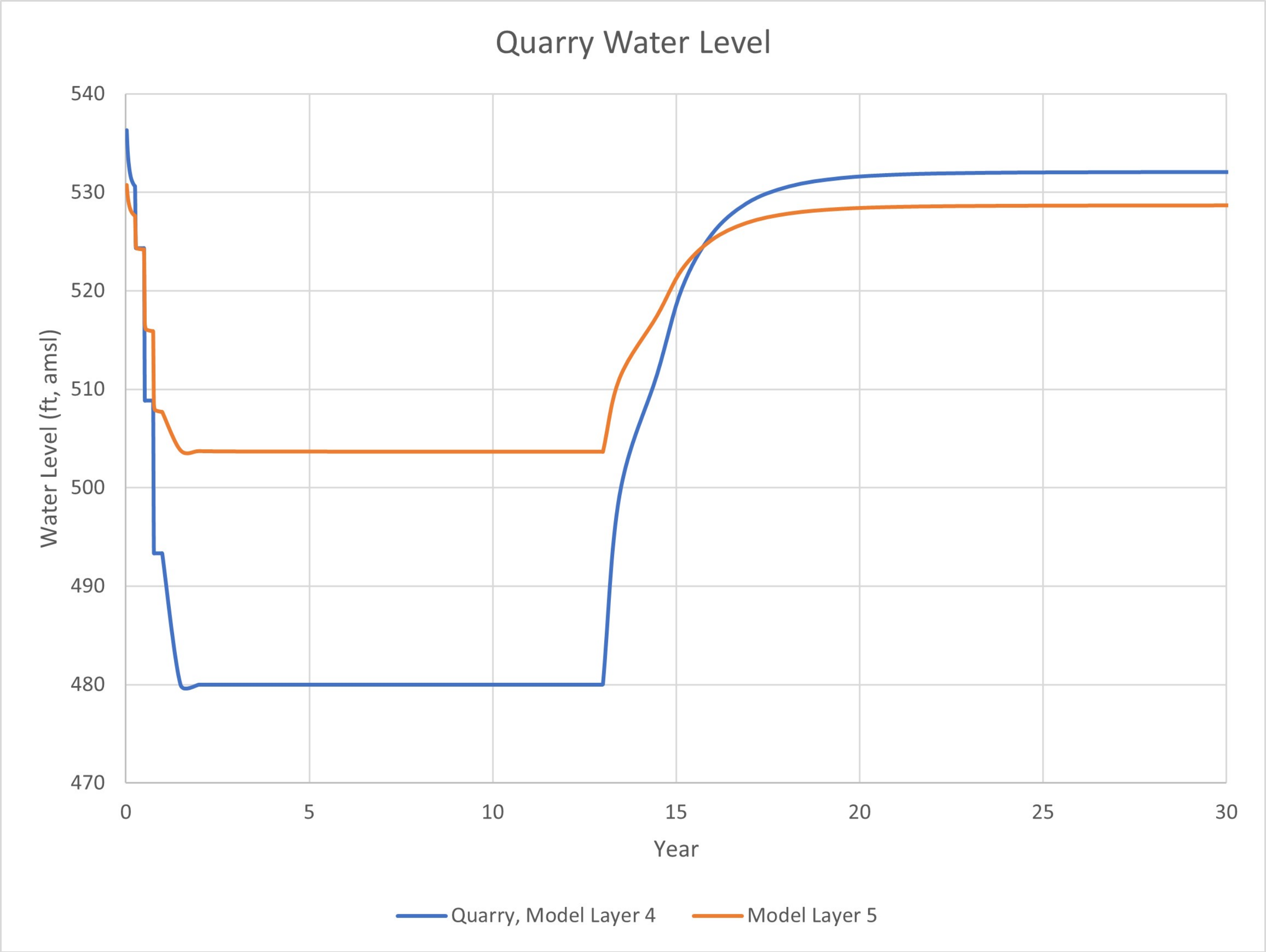
BAS PROJECT No. 21141201

FIGURE: **7**



BAS GROUNDWATER CONSULTING

KPRG

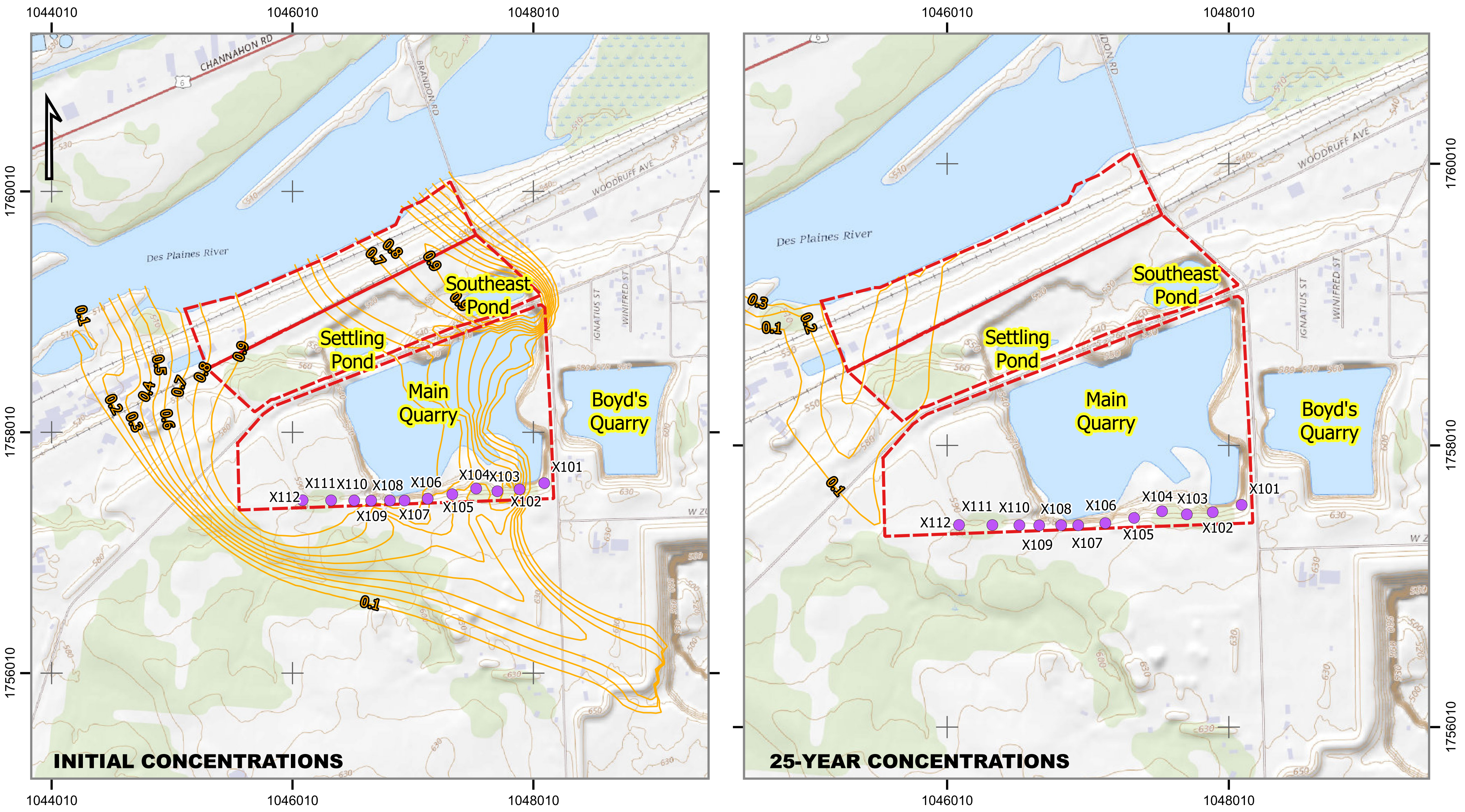
SCALE AT ANSI A	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		FIGURE: 8	

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
MODELED WATER LEVEL IN MAIN QUARRY, ALTERNATIVE 1

Project File: Figure8_ModeledWaterLevelInMainQuarry_Scenario1.qgz



LEGEND

🟥 APPROXIMATE SITE BOUNDARY

● EXTRACTION WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

BAS GROUNDWATER CONSULTING

KPRG

0 600 1,200 ft

FEET

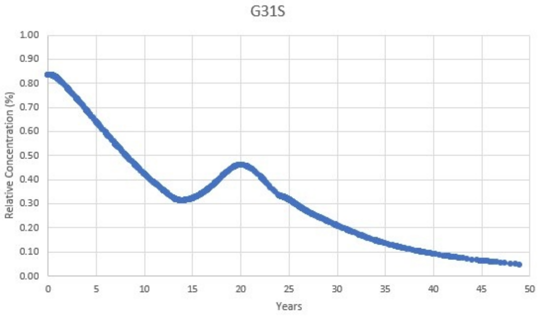
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure9_25YearPlumeDistributions_UpdatedModel.qgz

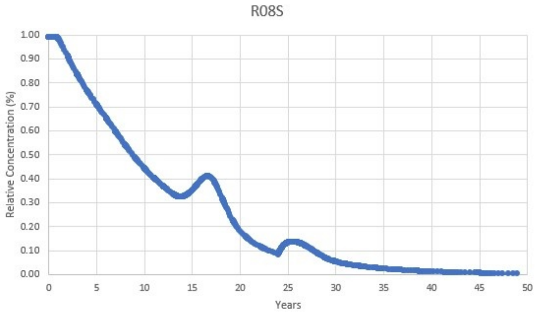
CLIENT
MIDWEST GENERATION, LLC

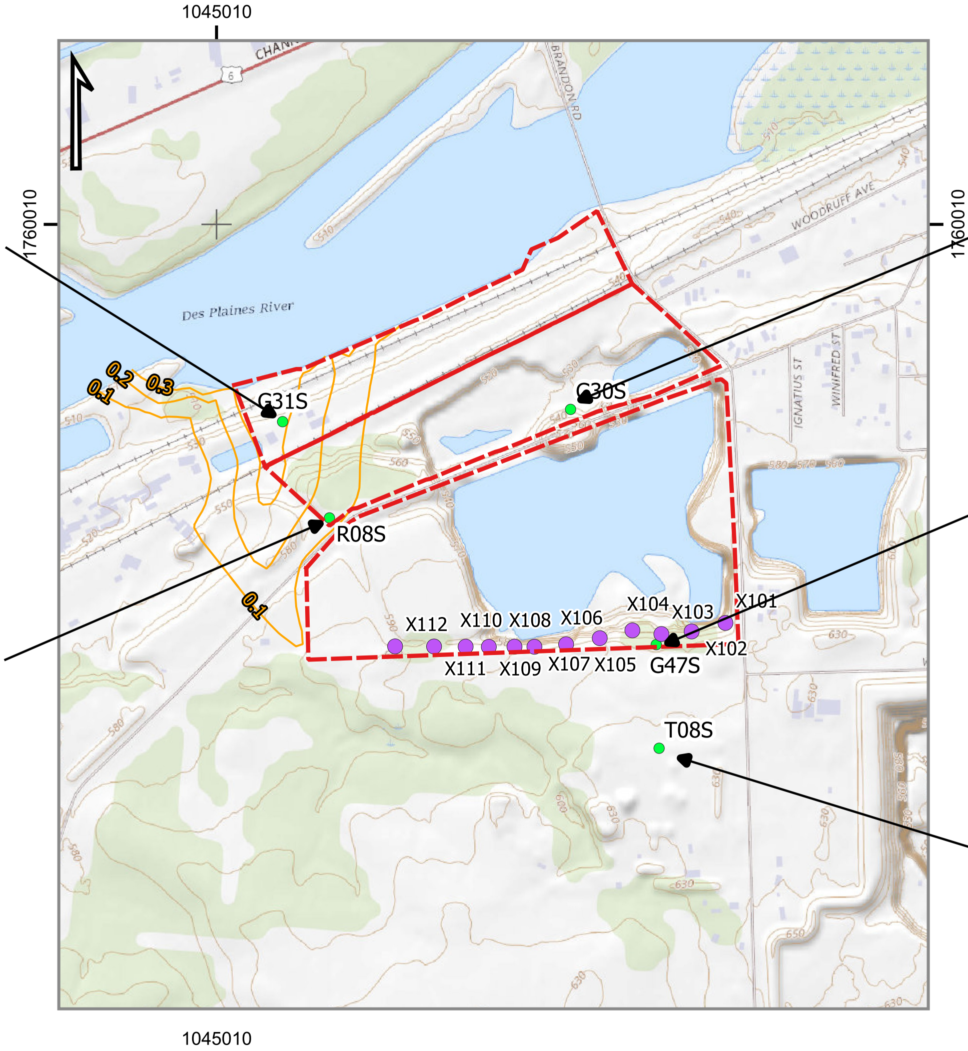
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

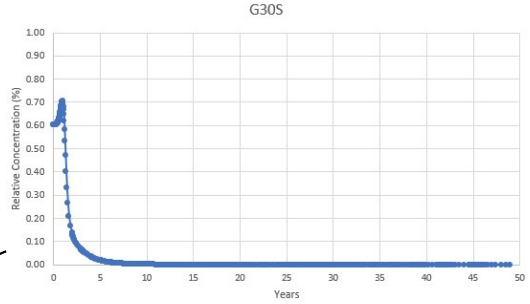
TITLE
ALTERNATIVE 1, 25-YEAR PLUME DISTRIBUTION, UPDATED MODEL

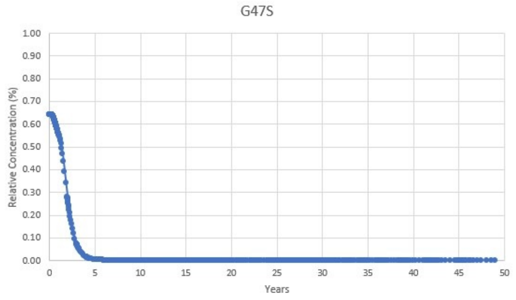
SCALE AT ANSI A 1:14,034	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201	FIGURE: **9**		

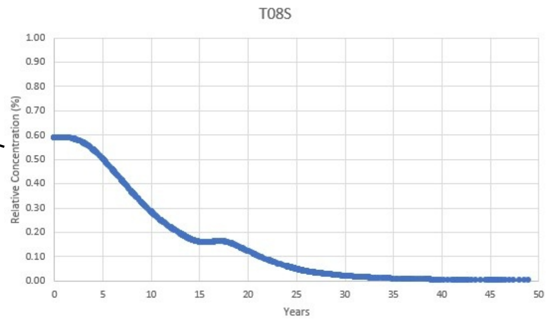












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭	PROPERTY BOUNDARY
●	MONITORING WELL LOCATION
●	EXTRACTION WELLS
—	RELATIVE SURROGATE CONCENTRATIONS MODEL LAYER 5

BAS GROUNDWATER CONSULTING

K P R G

0 0.1 0.2 mi

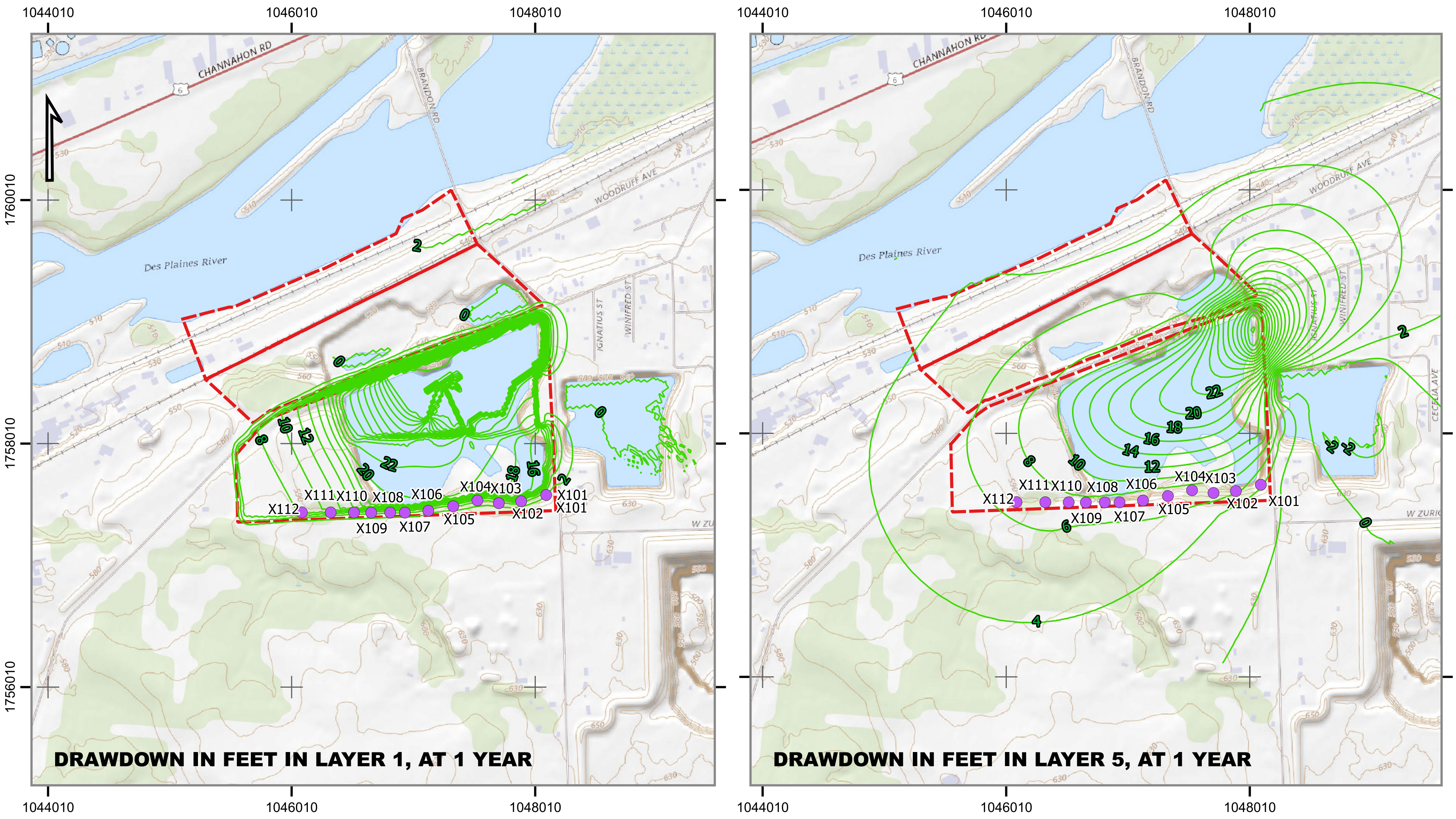
MILES

Coordinate System:

Project File: Figure10_Scenario1_ConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 1, CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*	*FIGURE:* **10**		



LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

— DRAWDOWN

Run transient flow model, stepping Main Quarry down to 477 feet over 1 year in four quarterly steps

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11_Scenario1_Drawdown_1Year.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

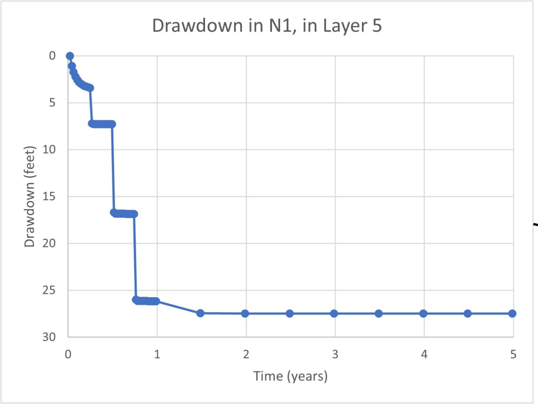
TITLE
ALTERNATIVE 1, DRAWDOWN AT 1 YEAR

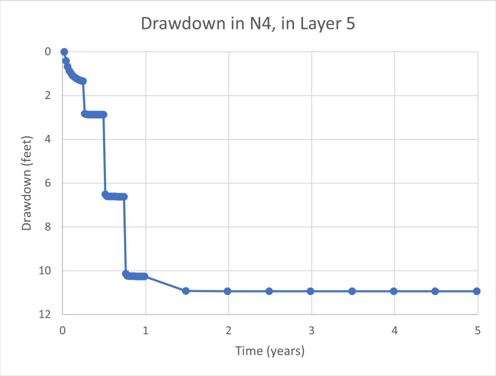
SCALE AT ANSI A
1:14,000

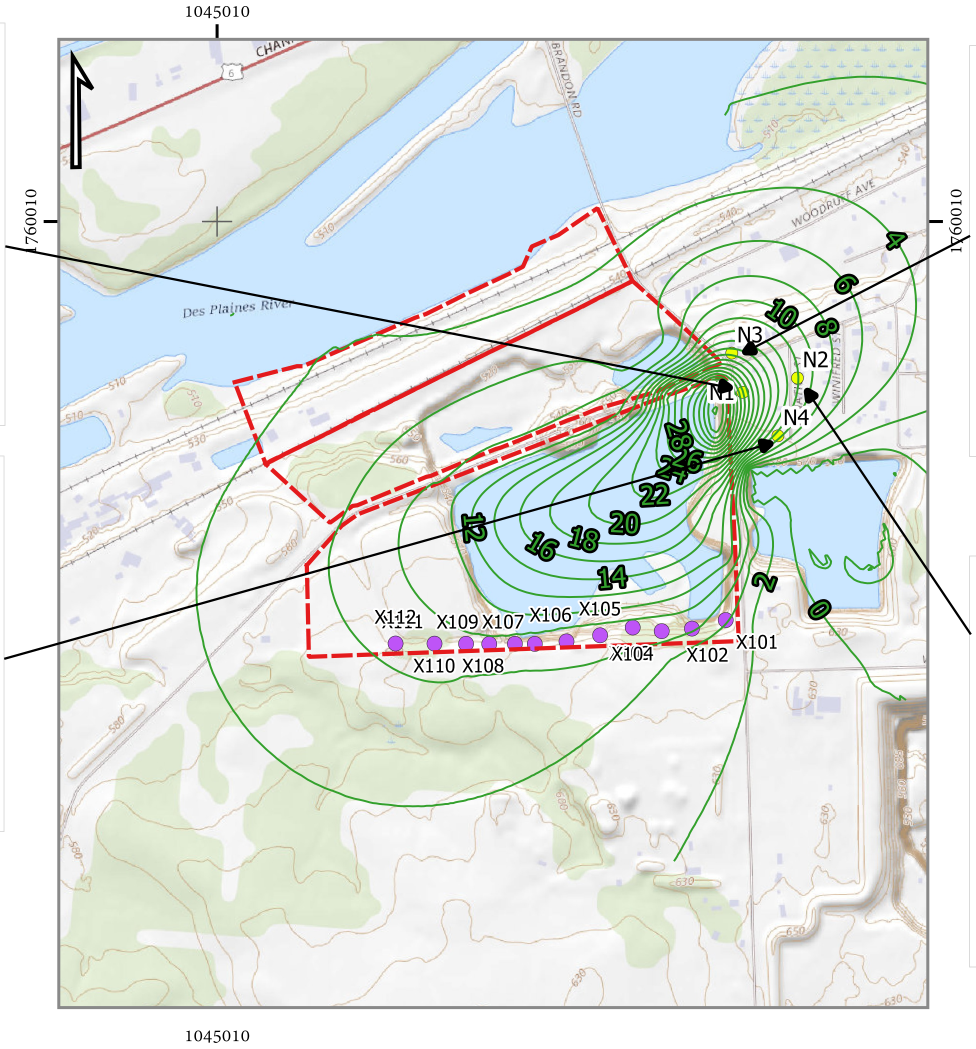
DRAWN DZF 01/28/2022
CHECKED BAS 01/28/2022

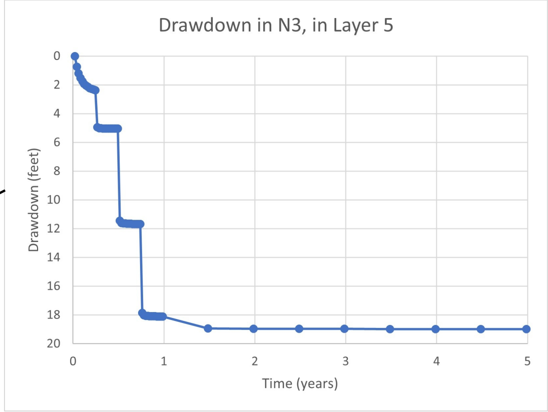
BAS PROJECT No.
21141201

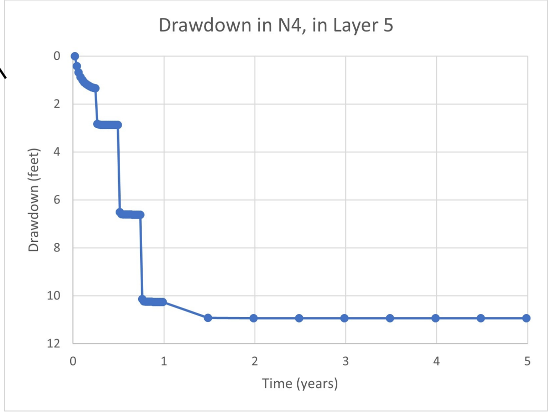
FIGURE:
11











RUN TRANSIENT FLOW MODEL, STEPPING MAIN QUARRY DOWN TO 477 FEET OVER 1 YEAR IN FOUR QUARTERLY STEPS

DRAWDOWN IN FEET IN LAYER 5, AT 1 YEAR

LEGEND

🟥	PROPERTY BOUNDARY
●	NEIGHBORHOOD MONITORING POINT
●	EXTRACTION WELLS
—	DRAWDOWN

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

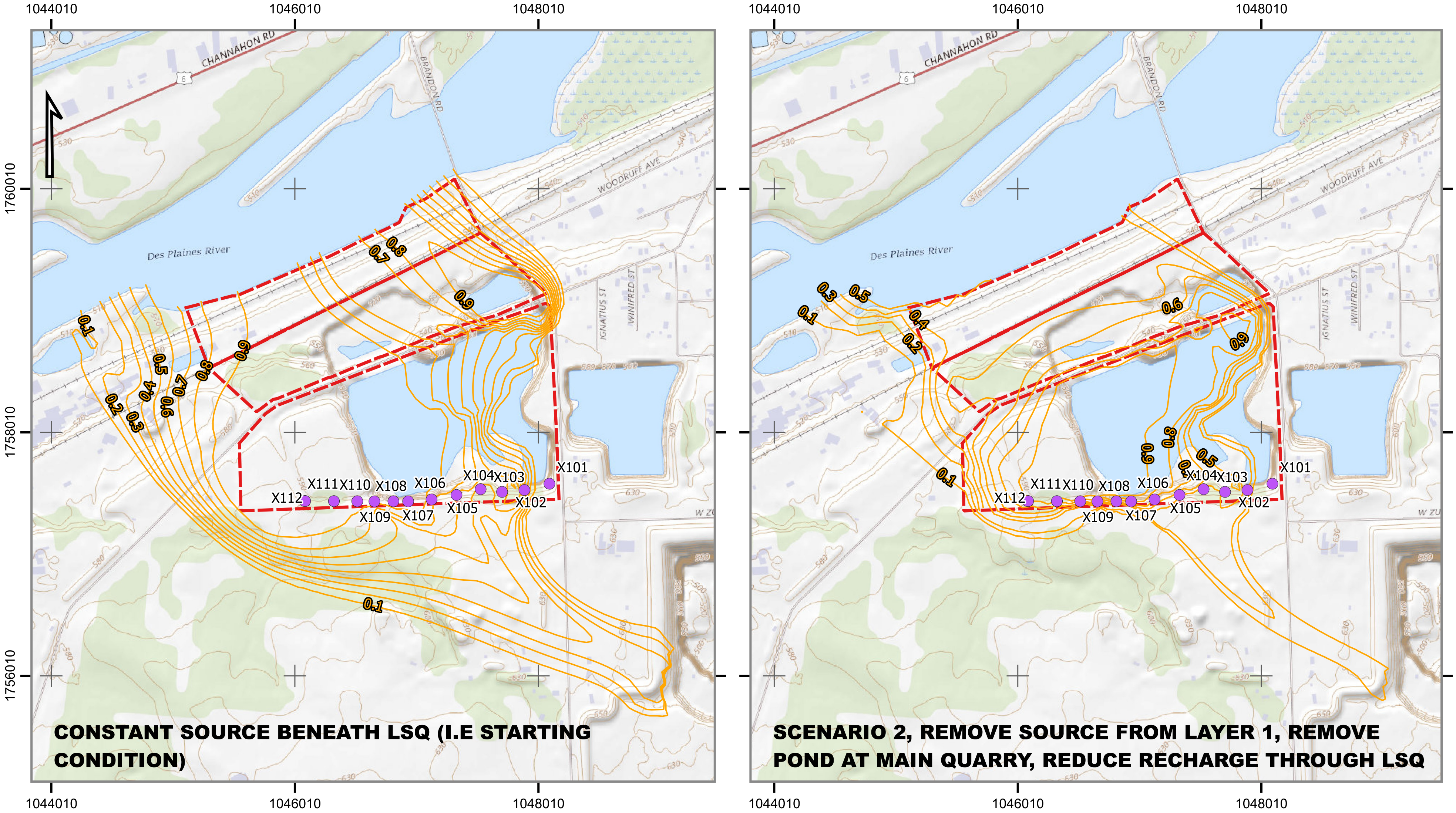
Coordinate System:
Project File: Figure12_Scenario1_DrawdownOverTime.qgz

CLIENT MIDWEST GENERATION, LLC

SITE JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE **ALTERNATIVE 1, DRAWDOWN OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*	*FIGURE:* **12**		



CONSTANT SOURCE BENEATH LSQ (I.E STARTING CONDITION)

SCENARIO 2, REMOVE SOURCE FROM LAYER 1, REMOVE POND AT MAIN QUARRY, REDUCE RECHARGE THROUGH LSQ

LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

Results shown for model layer 5, below base of Main Quarry

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

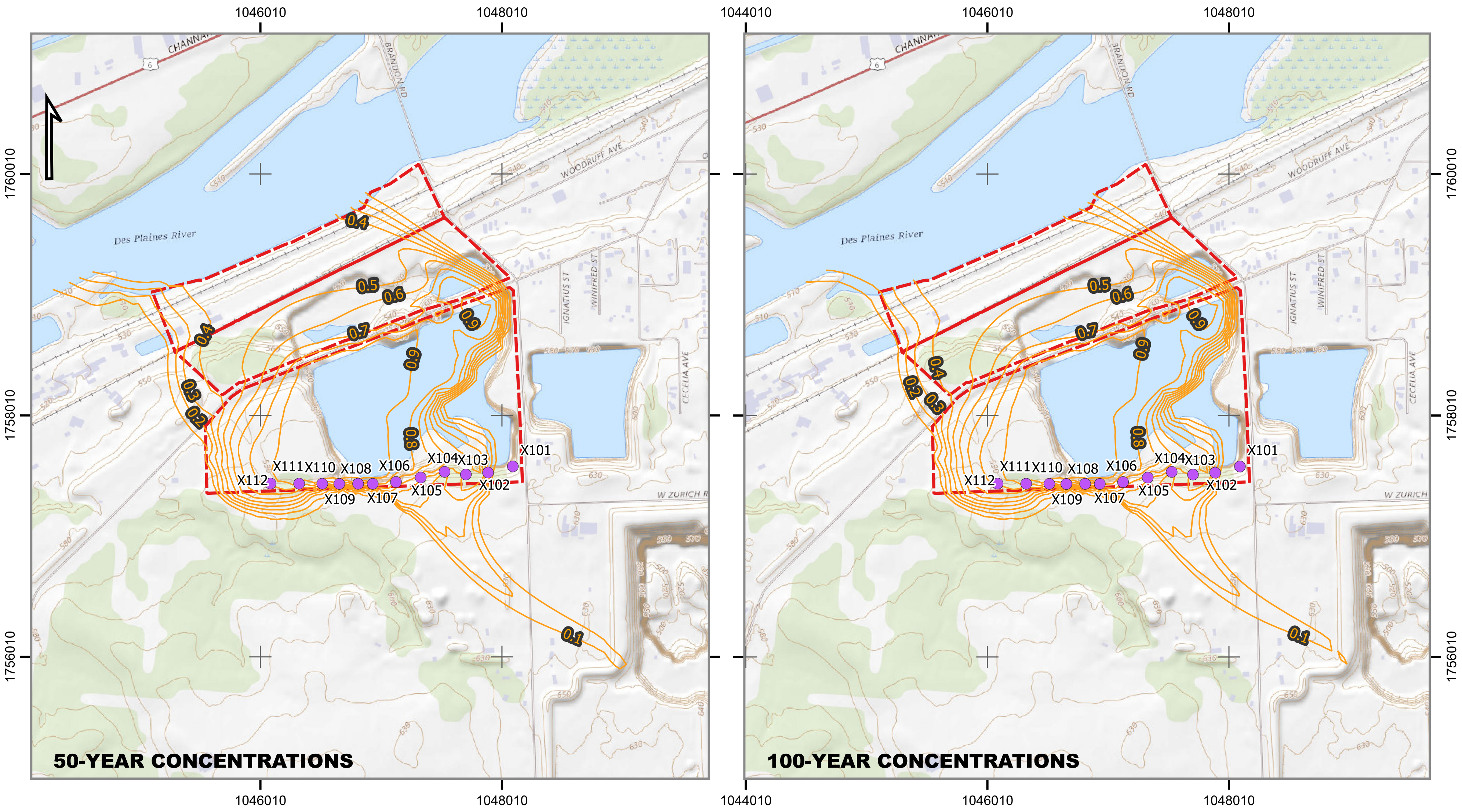
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure13_Scenario2_25YearPlumeDistribution_UpdatedModel.qgz

CLIENT
MIDWEST GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
ALTERNATIVE 2, 25-YEAR PLUME DISTRIBUTION, UPDATED MODEL

SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		FIGURE: **13**	



LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

Results shown for model layer 5, below base of Main Quarry

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
igure14_Scenario2_50and100YearPlumeDistributions_UpdatedModel.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
ALTERNATIVE 2, 50 AND 100-YEAR PLUME DISTRIBUTIONS, UPDATED MODEL

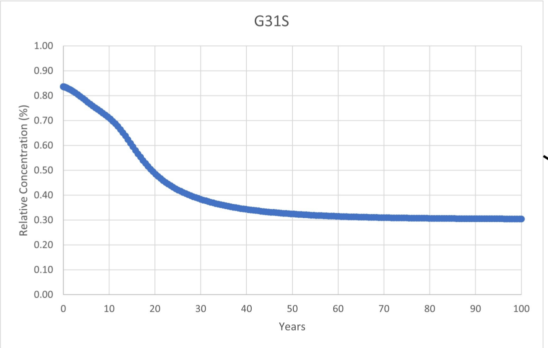
SCALE AT ANSI A
1:14,000

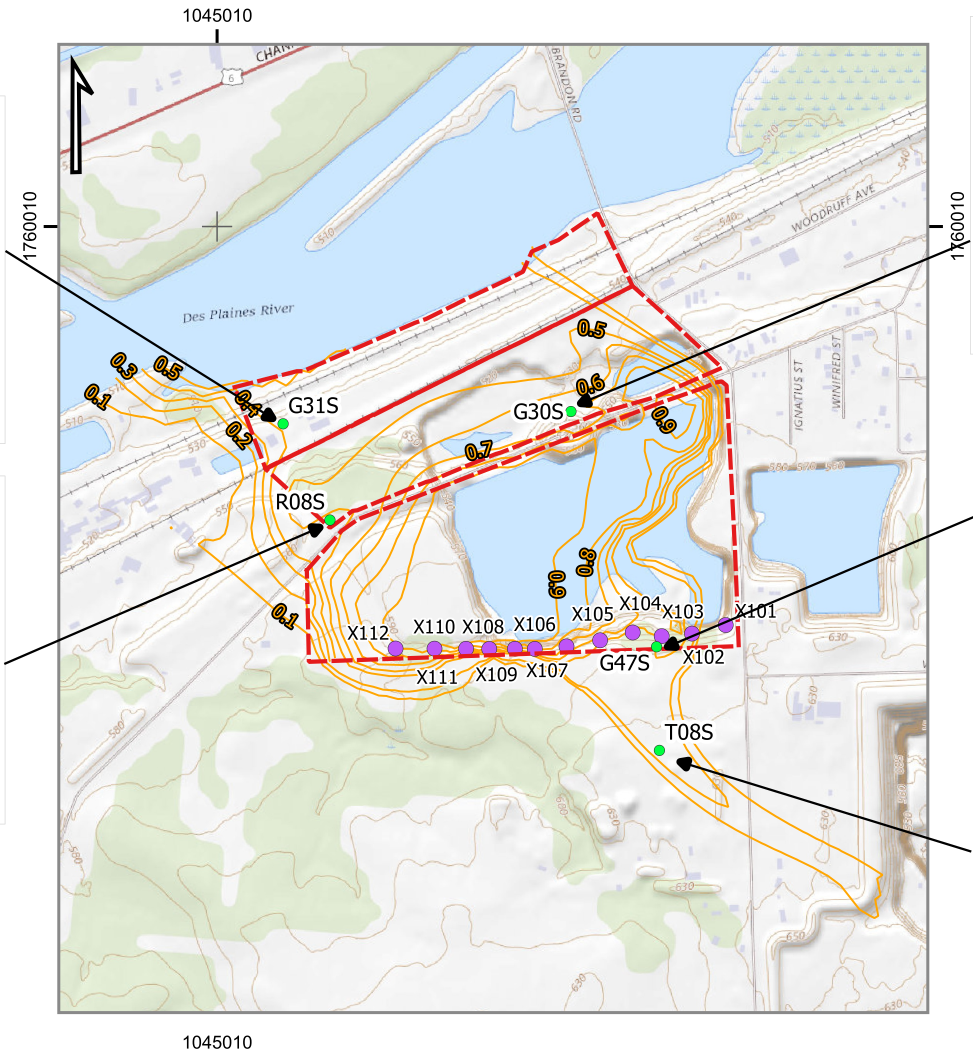
DRAWN DZF 01/28/2022

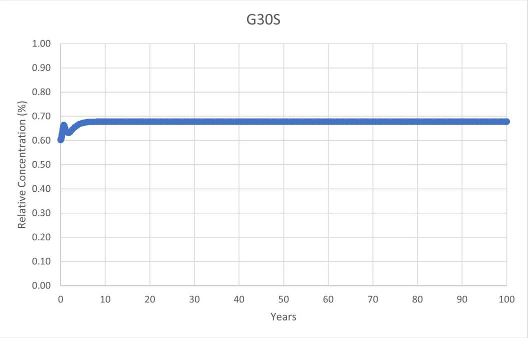
CHECKED BAS 01/28/2022

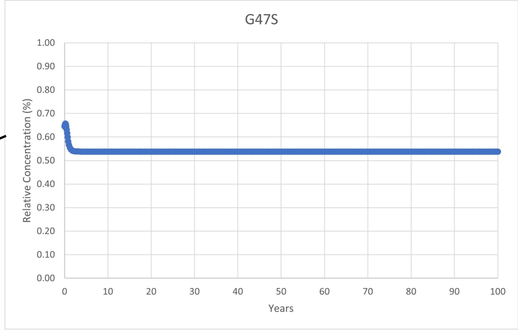
BAS PROJECT No.
21141201

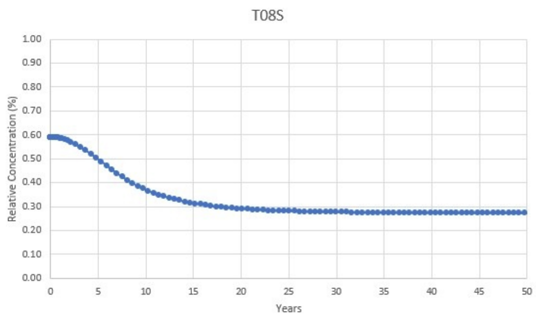
FIGURE:
14











STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- ▭ PROPERTY BOUNDARY
- ● EXTRACTION WELL
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

BAS GROUNDWATER CONSULTING

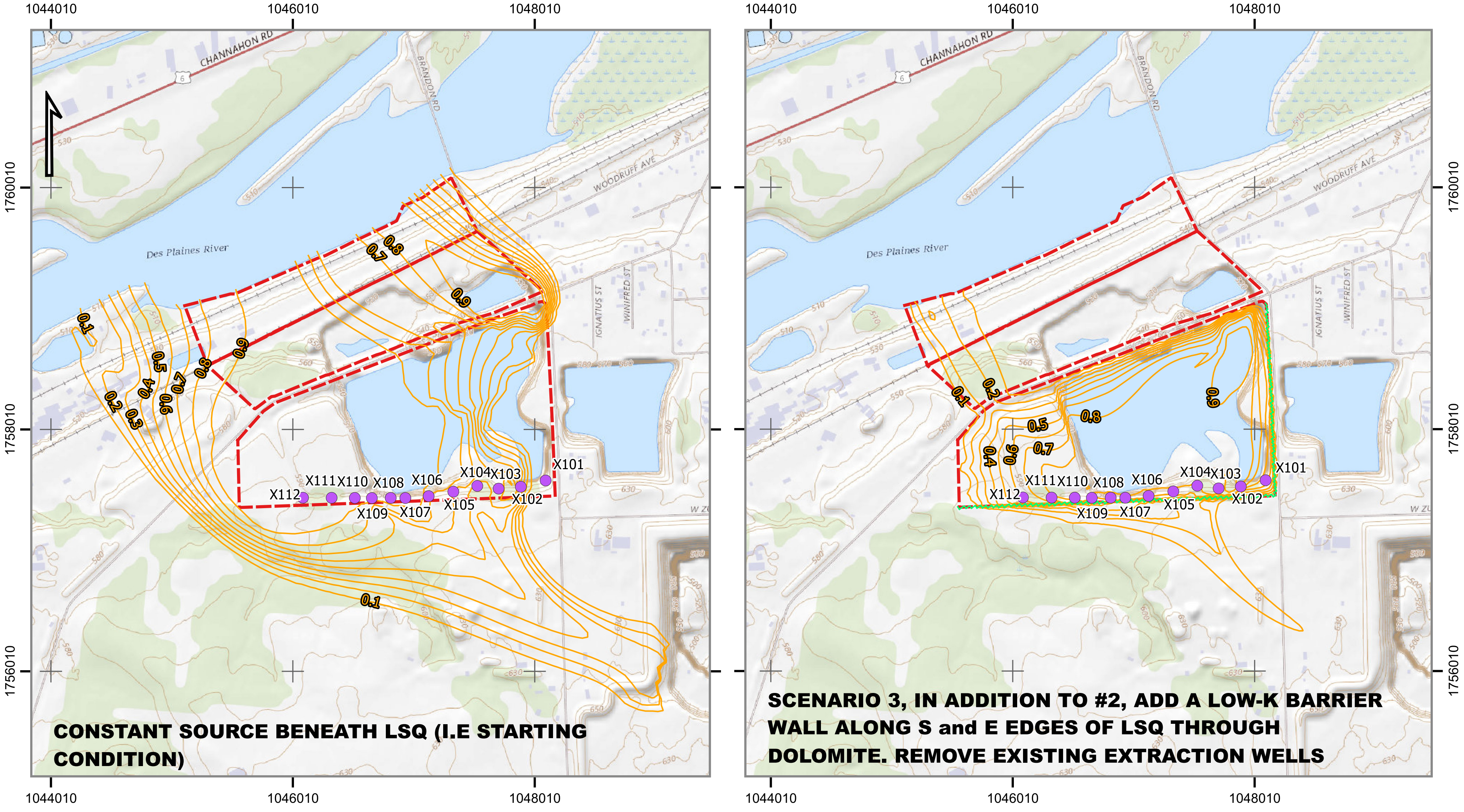
KPRG

0 700 1,400 ft
FEET

Coordinate System:
Project File: Figure15_Scenario2_ConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 2, CONCENTRATIONS OVER TIME**

SCALE AT ANSI A	*DRAWN*	DZF	01/28/2022
1:14,000	*CHECKED*	BAS	01/28/2022
BAS PROJECT No. 21141201	*FIGURE:* **15**		



CONSTANT SOURCE BENEATH LSQ (I.E STARTING CONDITION)

SCENARIO 3, IN ADDITION TO #2, ADD A LOW-K BARRIER WALL ALONG S and E EDGES OF LSQ THROUGH DOLOMITE. REMOVE EXISTING EXTRACTION WELLS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- — RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5
- — LOW PERMEABILITY BARRIER

Results shown for model layer 5, below base of Main Quarry

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

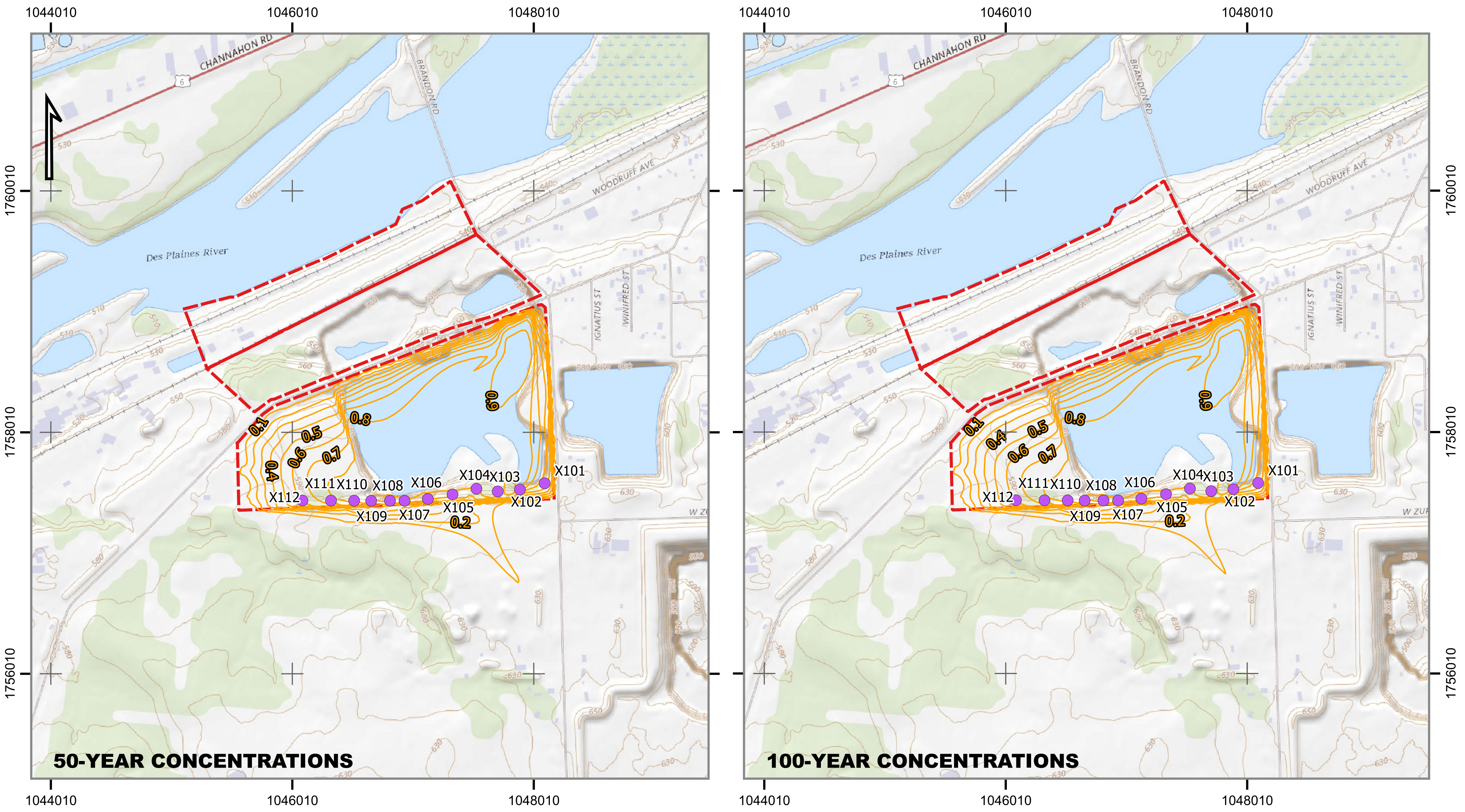
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure16_Scenario3_25YearPlumeDistribution_UpdatedModel.qgz

CLIENT
MIDWEST GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
ALTERNATIVE 3, 25-YEAR PLUME DISTRIBUTION, UPDATED MODEL

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*		*FIGURE:* **16**	



LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

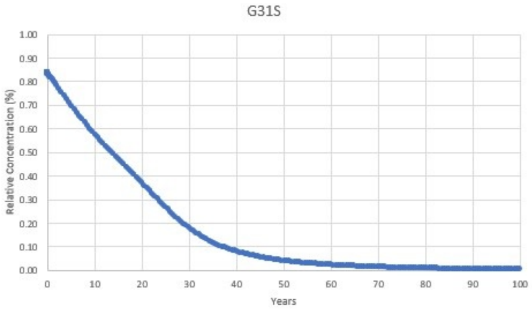
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
igure17_Scenario3_50and100YearPlumeDistributions_UpdatedModel.qgz

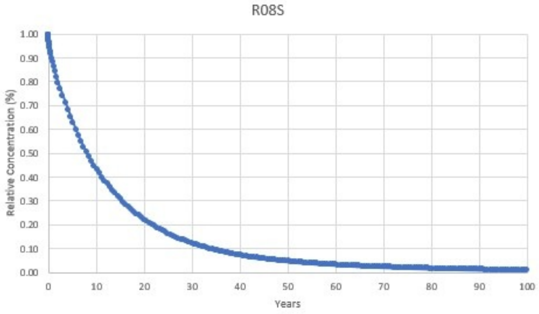
CLIENT
MIDWEST
GENERATION, LLC

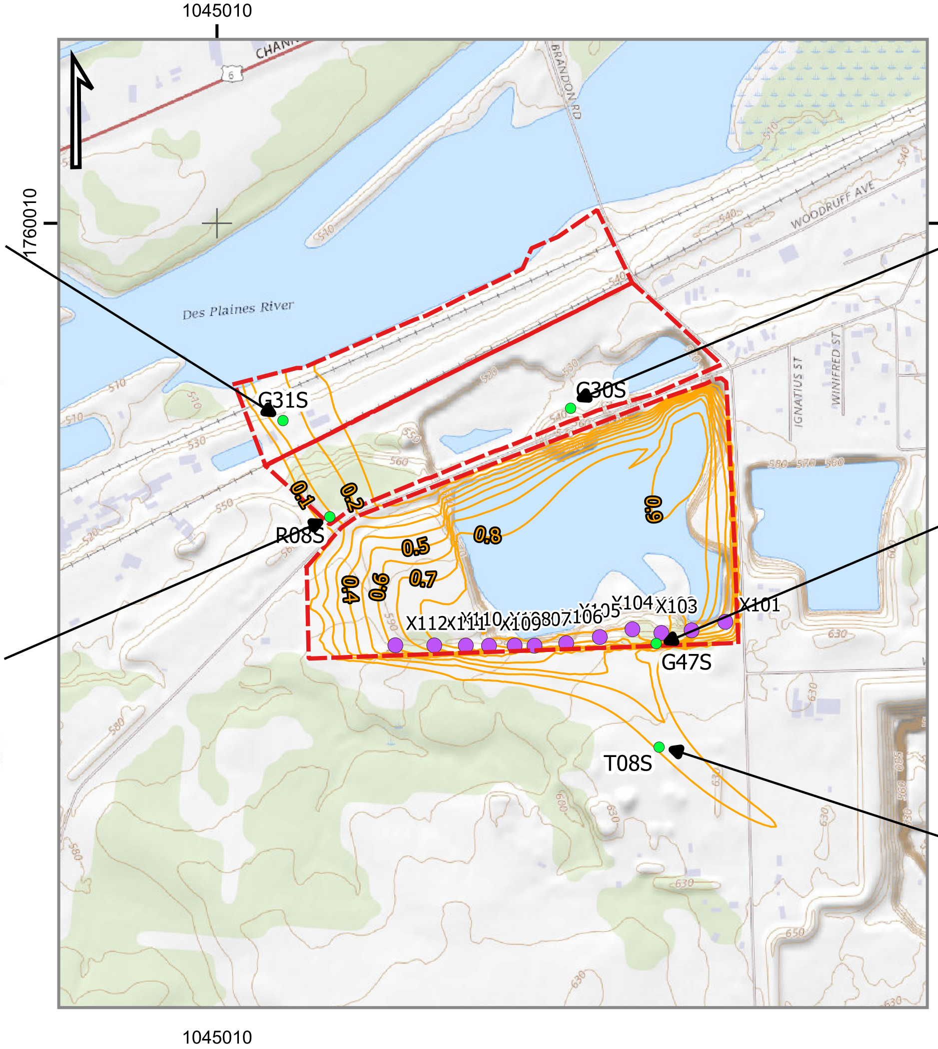
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

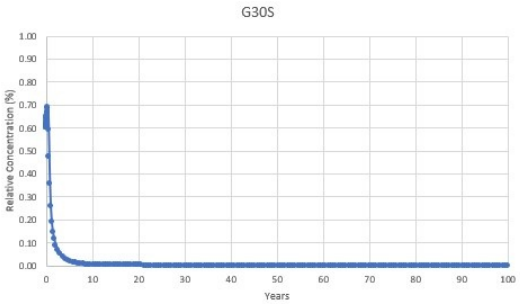
TITLE
ALTERNATIVE 3, 50 AND 100-YEAR PLUME DISTRIBUTIONS, UPDATED MODEL

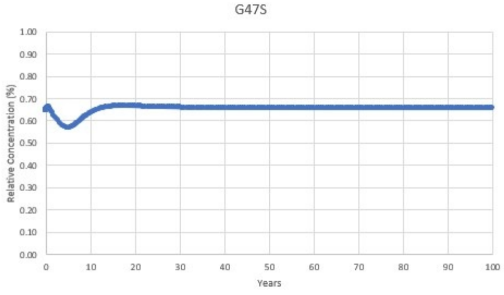
SCALE AT ANSI A 1:14,000	*DRAWN*	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201			*FIGURE:* **17**

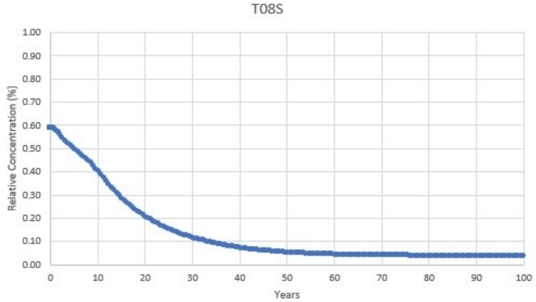












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELL

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

BAS GROUNDWATER CONSULTING

K P R G

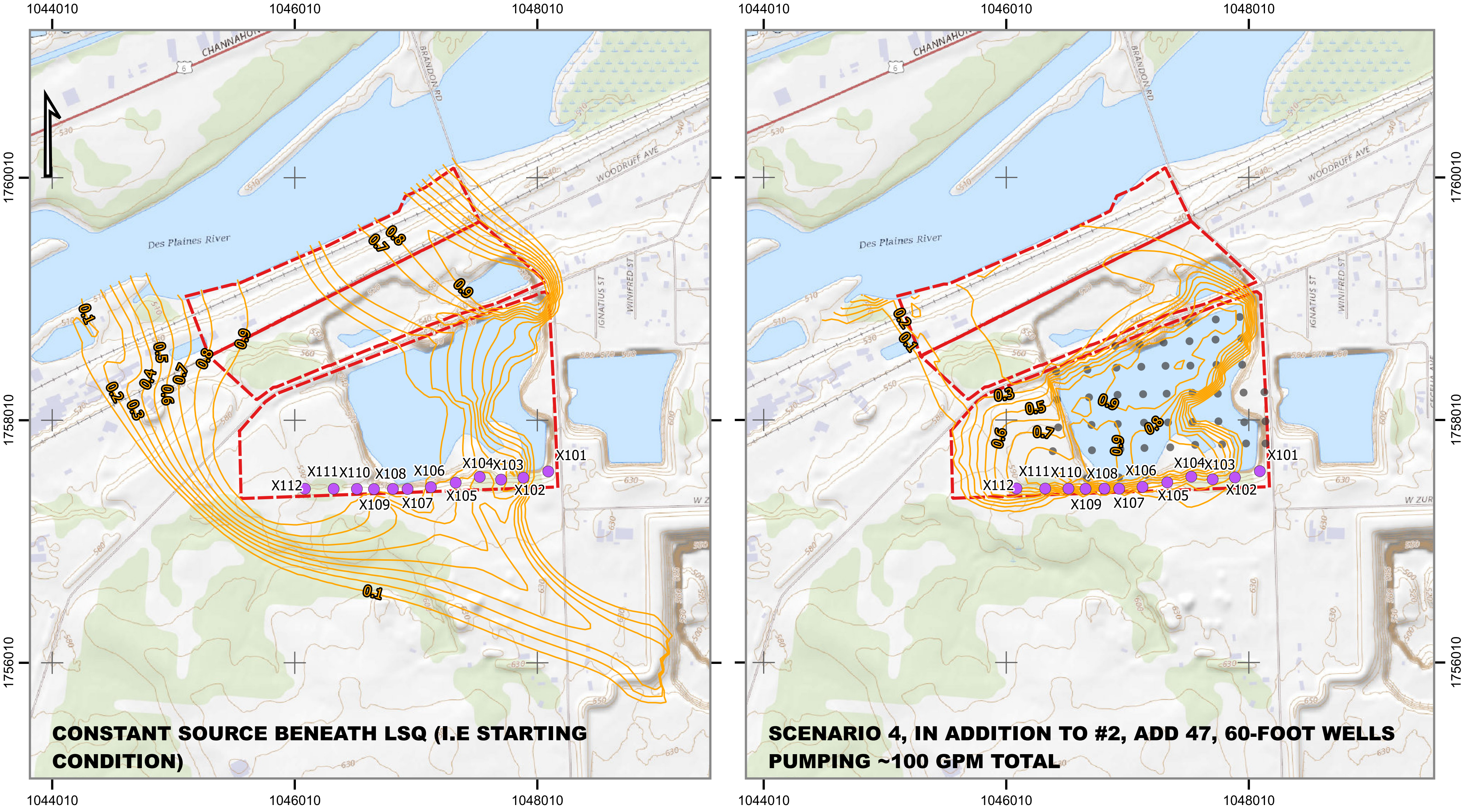
0 700 1,400 ft

FEET

Coordinate System:
Project File: Figure18_Scenario3_ConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 3, CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*			*FIGURE:* **18**



LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

● PROPOSED DEWATERING WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

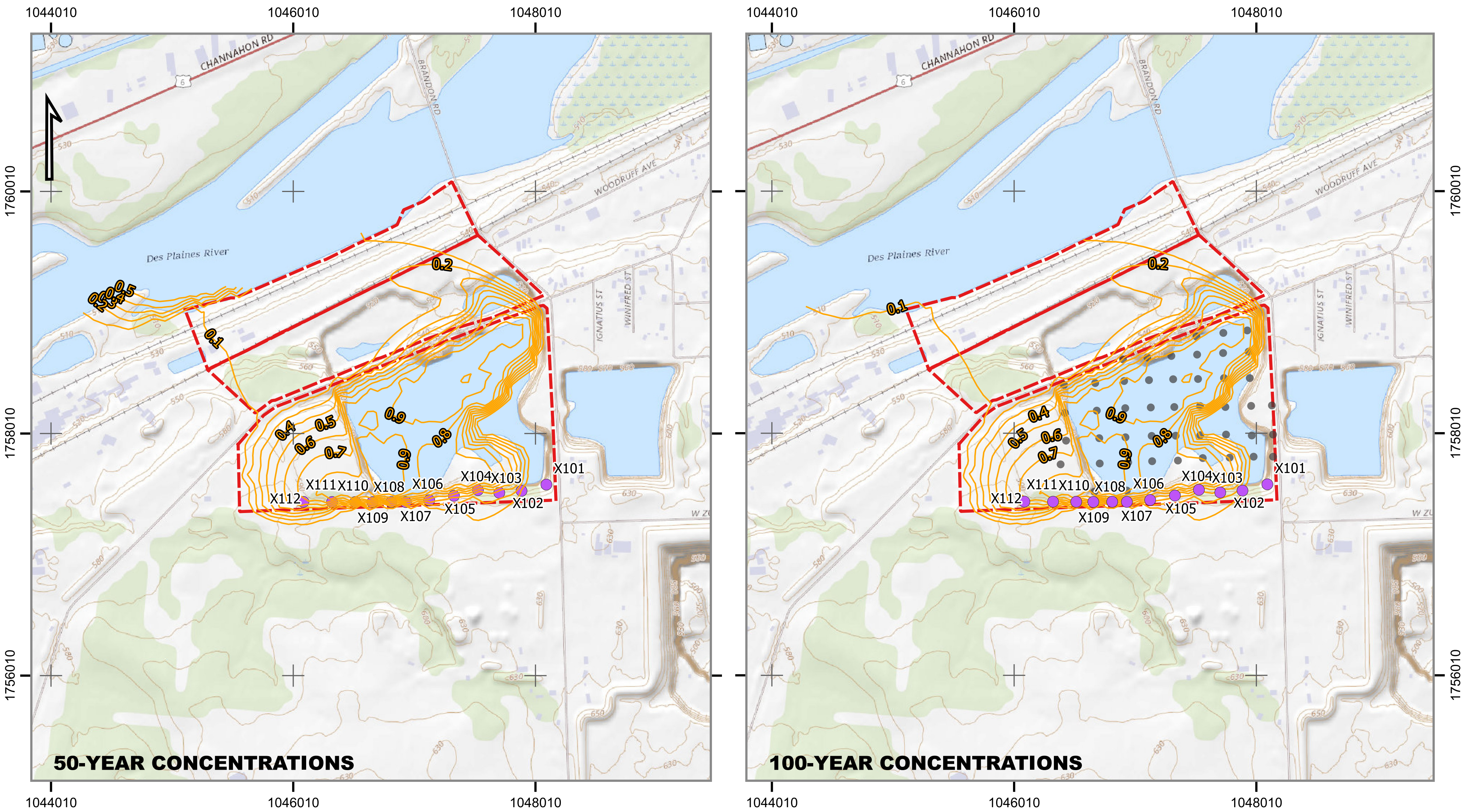
Results shown for model layer 5, below base of Main Quarry

0 700 1,400 ft
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
Figure19_Scenario4_25YearPlumeDistribution_UpdatedModel.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, 25-YEAR PLUME DISTRIBUTION, UPDATED MODEL**

SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		FIGURE: **19**	



LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

● PROPOSED DEWATERING WELLS

— RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

Results shown for model layer 5, below base of Main Quarry

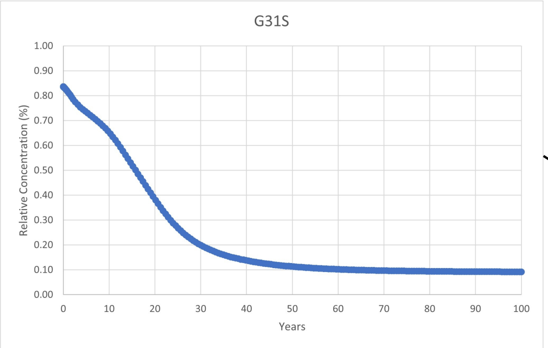
0 700 1,400 ft

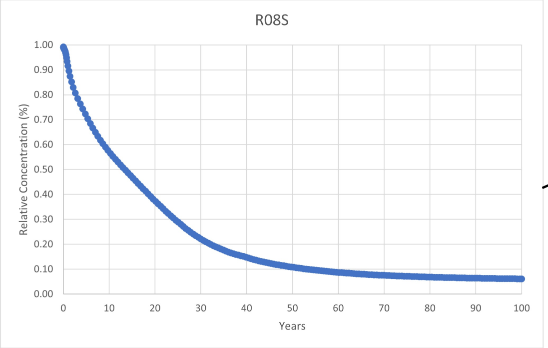
FEET

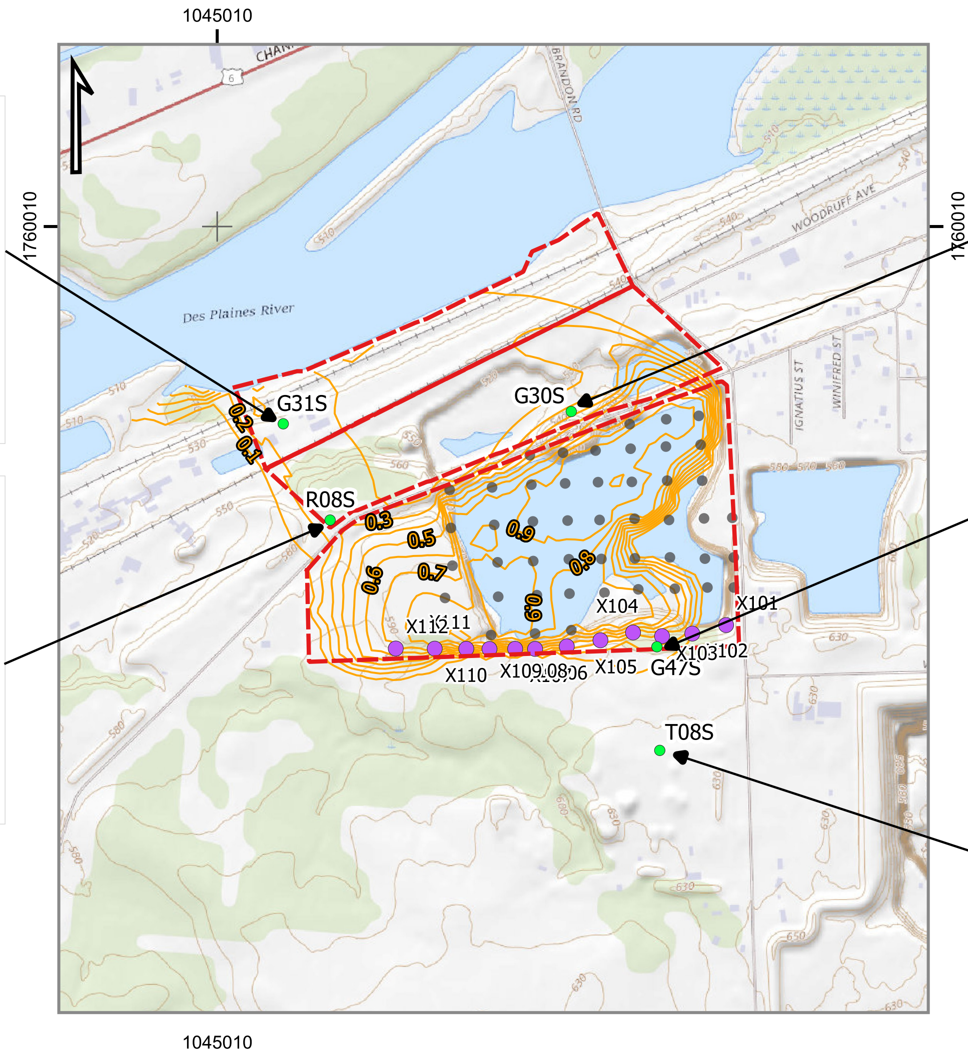
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File:
igure20_Scenario4_50and100YearPlumeDistributions_UpdatedModel.qgz

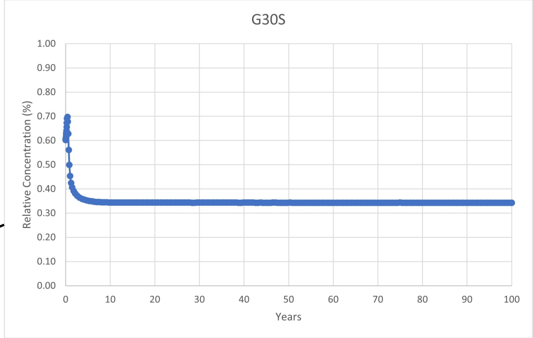
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, 50 AND 100-YEAR PLUME DISTRIBUTIONS, UPDATED MODEL**

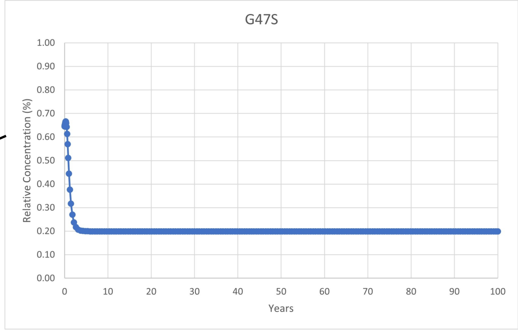
SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		FIGURE: **20**	

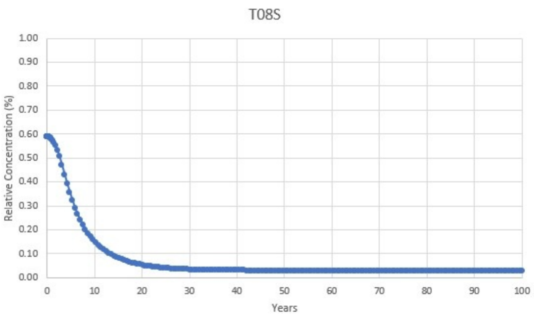












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
●	PROPOSED DEWATERING WELLS
—	RELATIVE SURROGATE CONCENTRATIONS, MODEL LAYER 5

BAS GROUNDWATER CONSULTING

K P R G

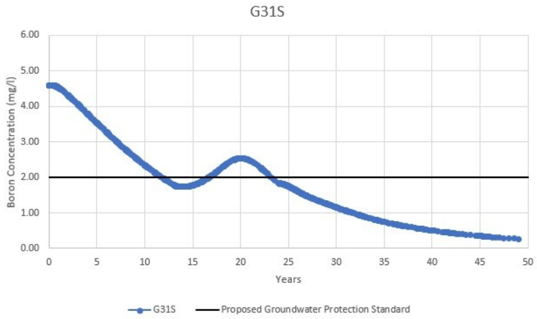
0 700 1,400 ft

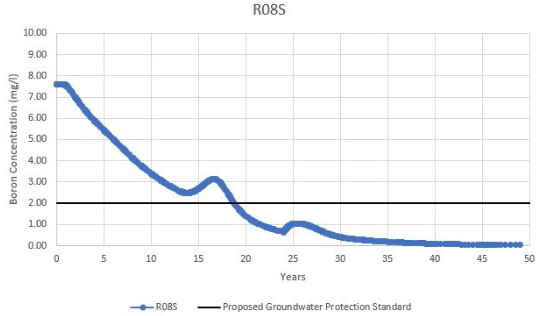
FEET

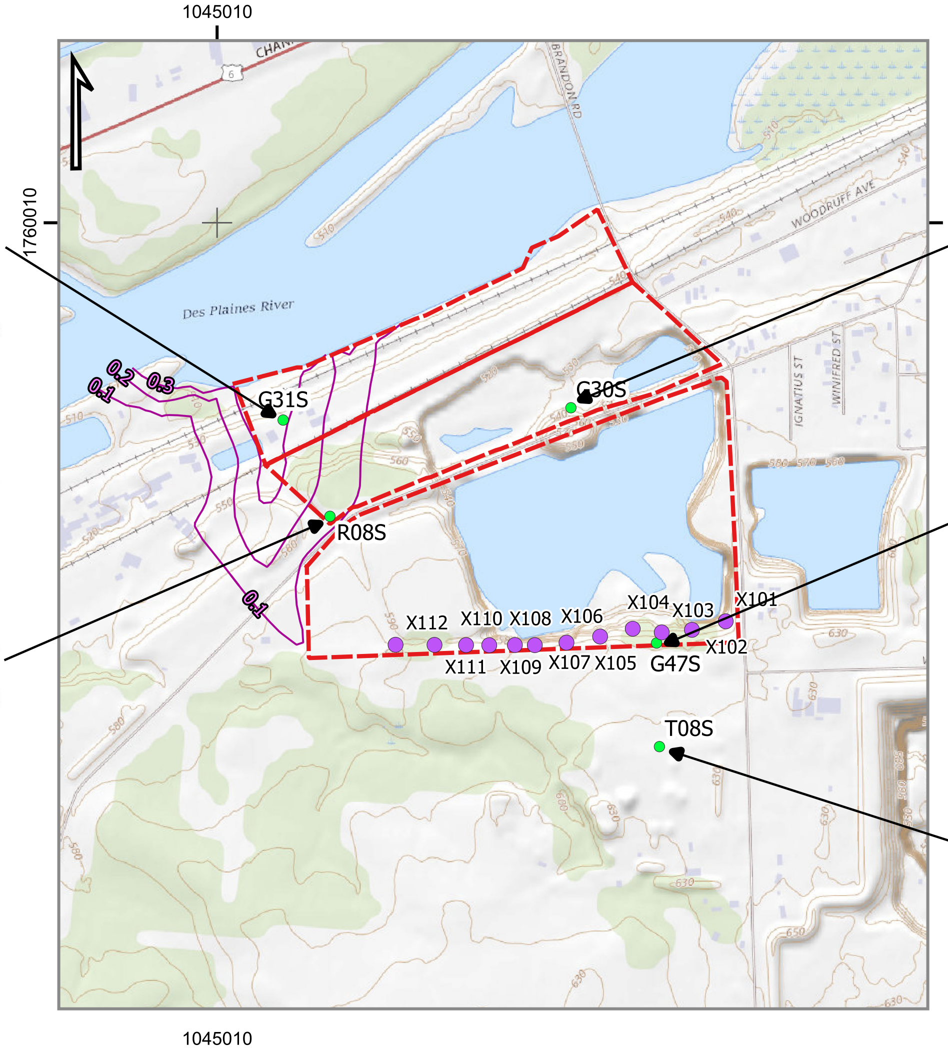
Coordinate System:
Project File: Figure21_Scenario4_ConcentrationsOverTime.qgz

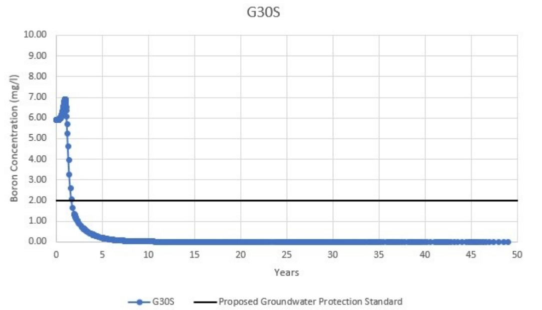
CLIENT	MIDWEST GENERATION, LLC		
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL		
TITLE	**ALTERNATIVE 4, CONCENTRATIONS OVER TIME**		
SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*	*FIGURE:* **21**		

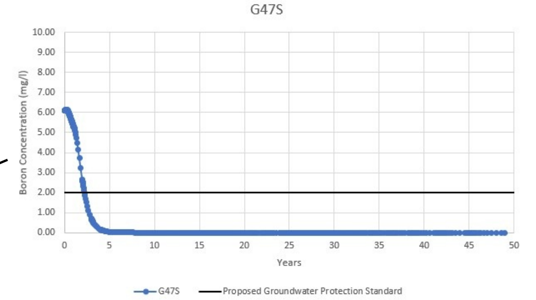
APPENDIX A
ALTERNATIVE 1 CONCENTRATION GRAPHS

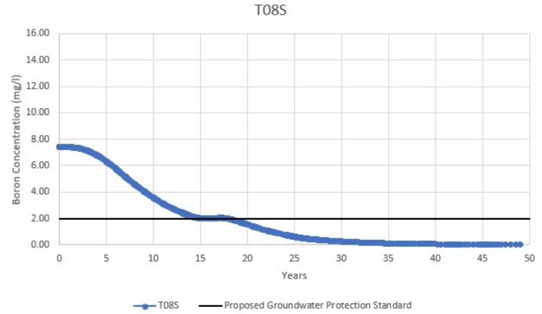












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft

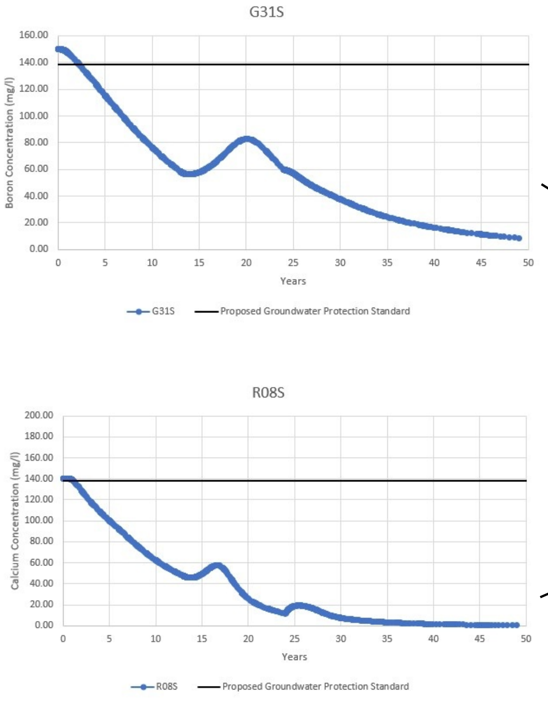
FEET

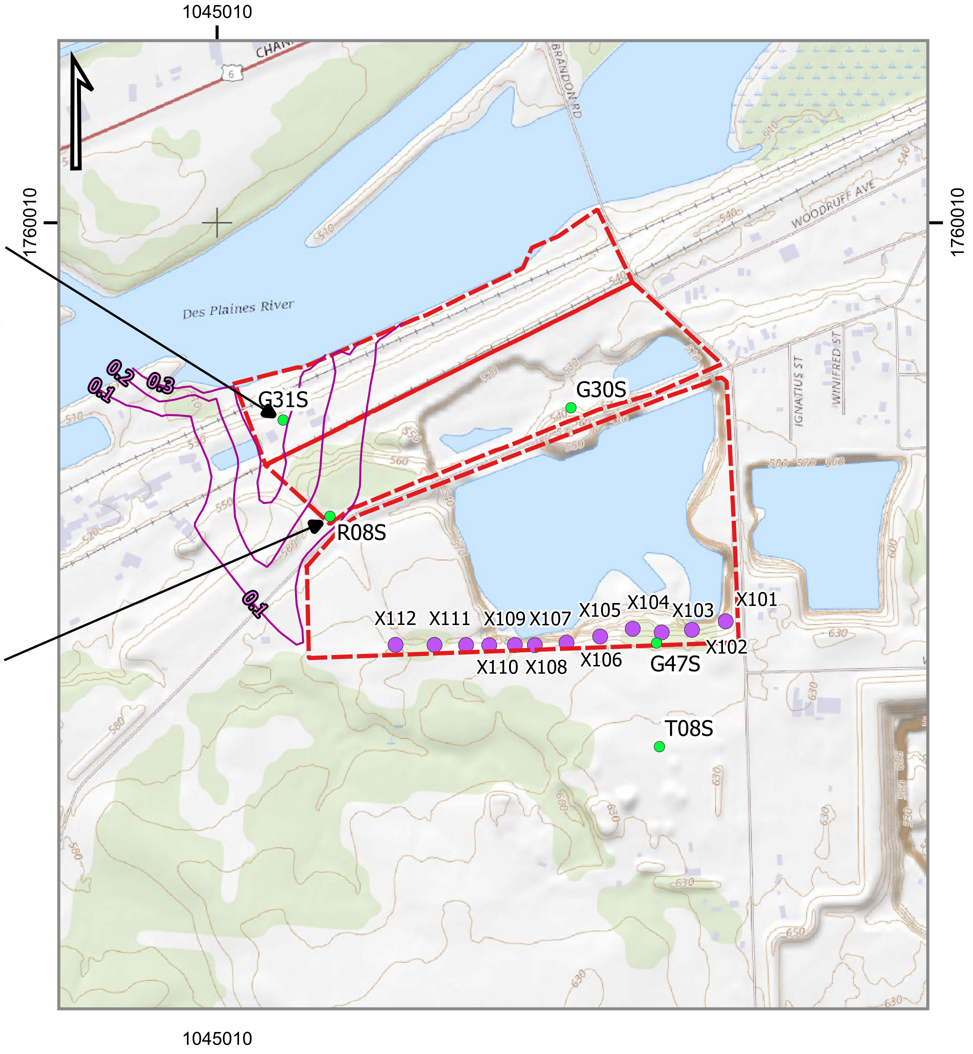
Coordinate System:

Project File: AppendixA1_Scenario1_BoronConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 1, BORON CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*			*APPENDIX:* **A1**





STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

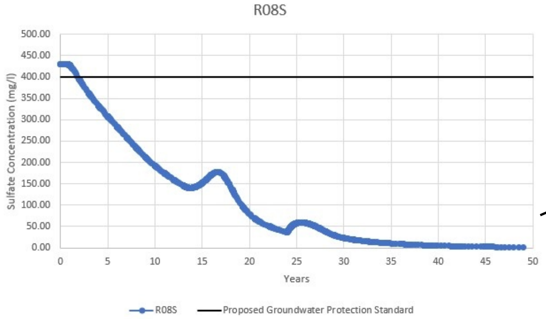
Coordinate System:
Project File:
AppendixA2_Scenario1_CalciumConcentrationsOverTime.qgz

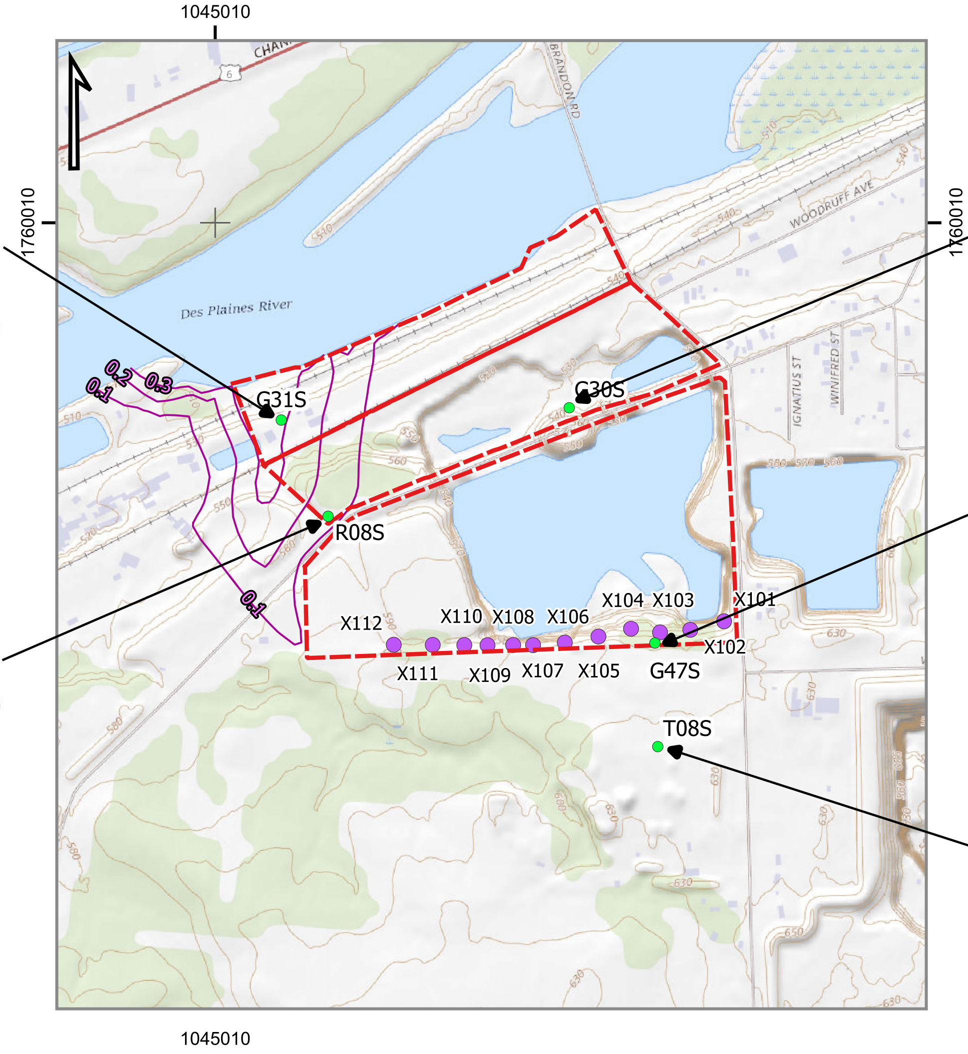
CLIENT
MIDWEST
GENERATION, LLC

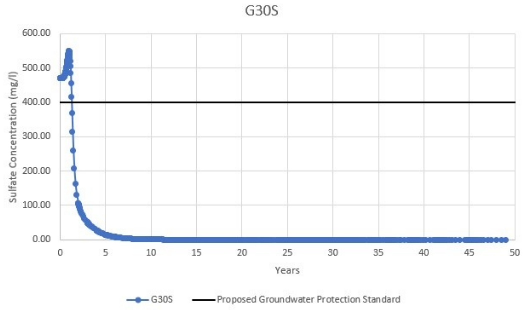
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

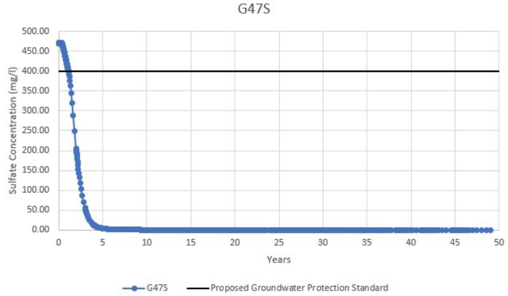
TITLE
ALTERNATIVE 1, CALCIUM CONCENTRATIONS OVER TIME

SCALE AT ANSI A	*DRAWN*	*DZF*	*01/28/2022*
1:14,000	*CHECKED*	*BAS*	*01/28/2022*
BAS PROJECT No. *21141201*		*APPENDIX:* **A2**	









STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- ▭ PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

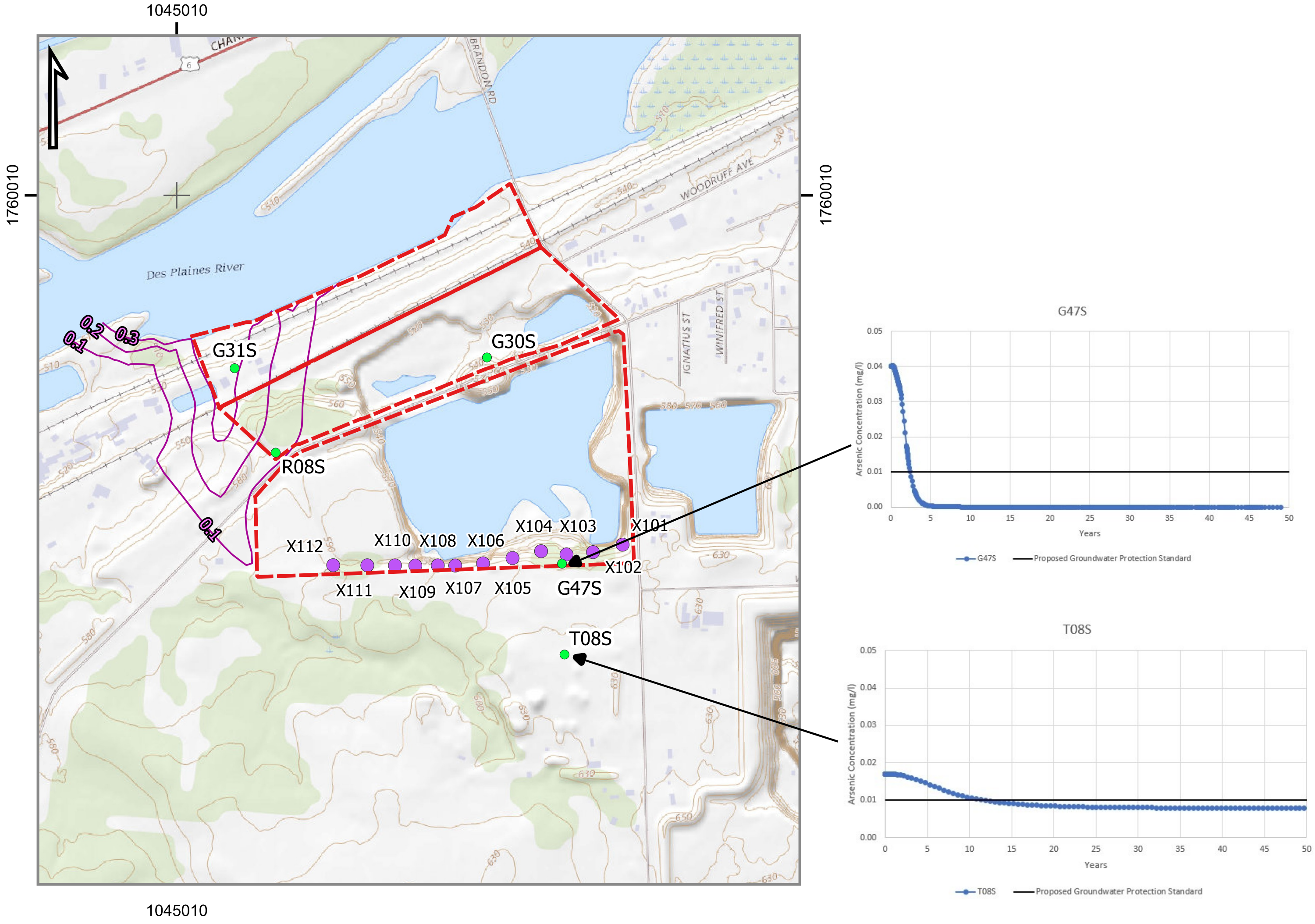
Coordinate System:
Project File:
AppendixA3_Scenario1_SulfateConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 1, SULFATE CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	*01/28/2022*
	CHECKED	*BAS*	*01/28/2022*
BAS PROJECT No. *21141201*	*APPENDIX:* **A3**		

STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS



LEGEND

⬚	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

Coordinate System:
Project File:
AppendixA4_Scenario1_ArsenicConcentrationsOverTime.qgz

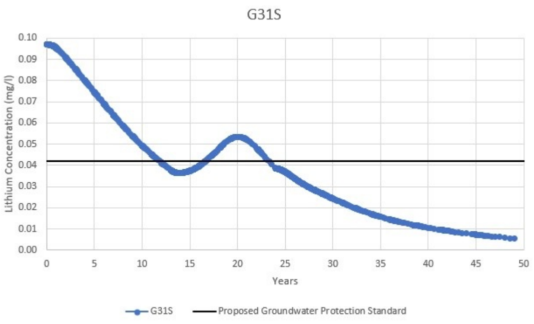
CLIENT
MIDWEST
GENERATION, LLC

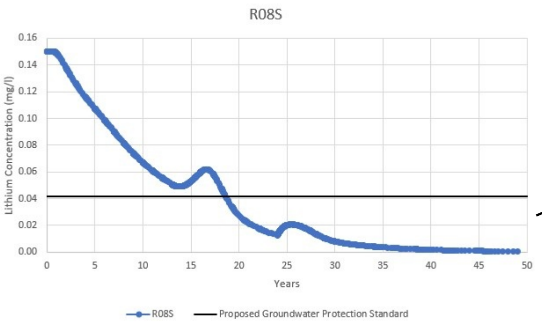
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

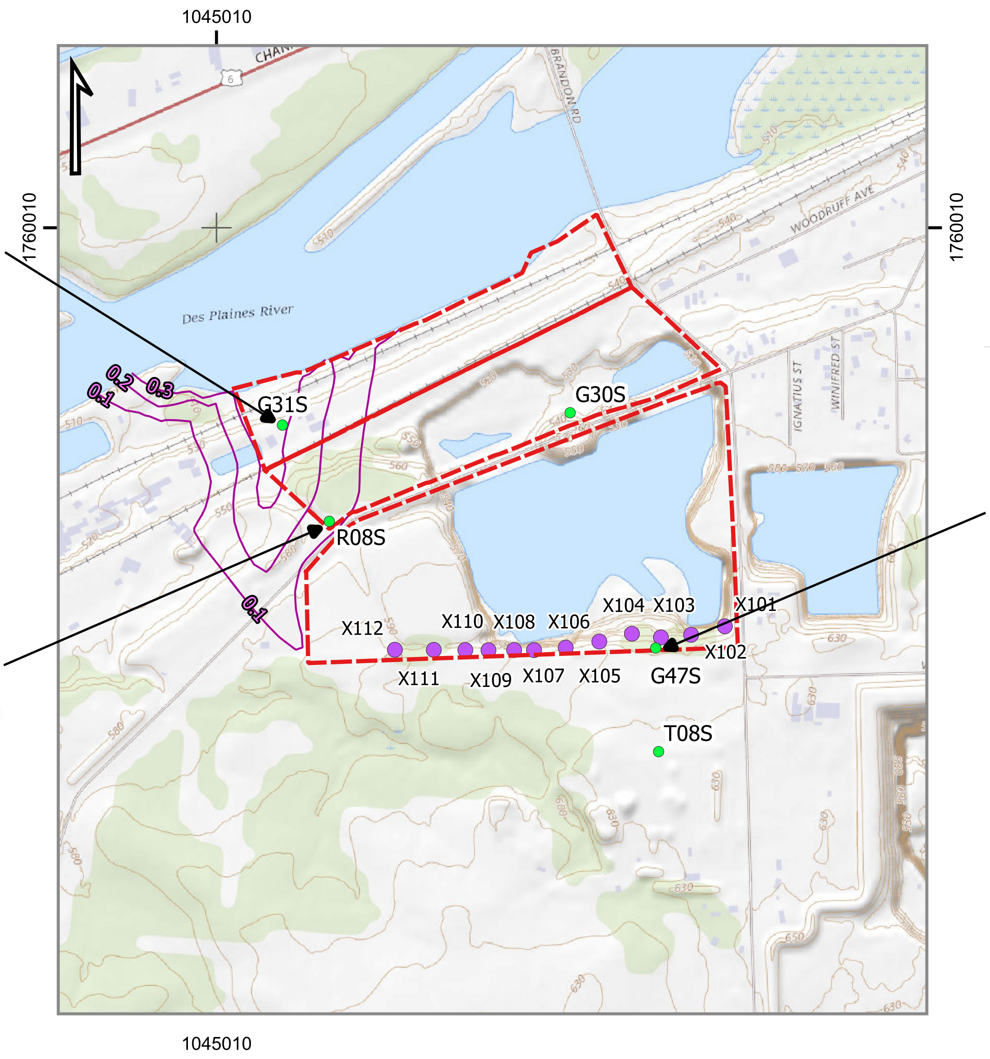
TITLE
ALTERNATIVE 1, ARSENIC CONCENTRATIONS OVER TIME

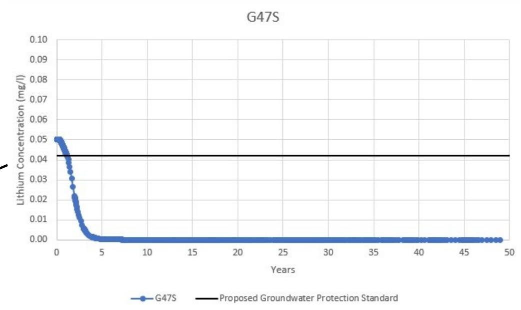
SCALE AT ANSI A	DRAWN	DZF	01/28/2022
1:14,000	CHECKED	BAS	01/28/2022

BAS PROJECT No.	APPENDIX:
21141201	**A4**









STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥 PROPERTY BOUNDARY
● EXTRACTION WELLS
● MONITORING WELL LOCATION
— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

Coordinate System:
Project File:
AppendixA5_Scenario1_LithiumConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

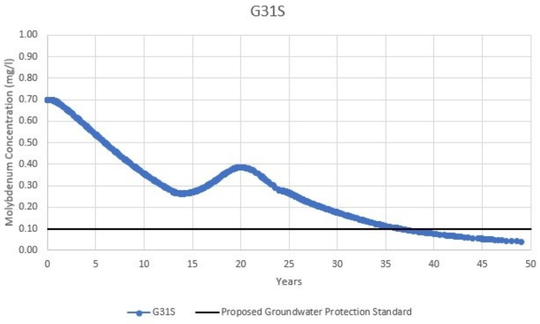
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

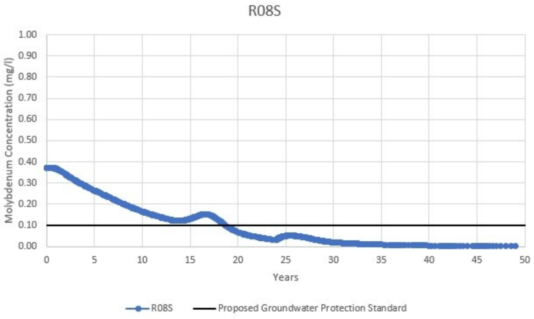
TITLE
ALTERNATIVE 1, LITHIUM CONCENTRATIONS OVER TIME

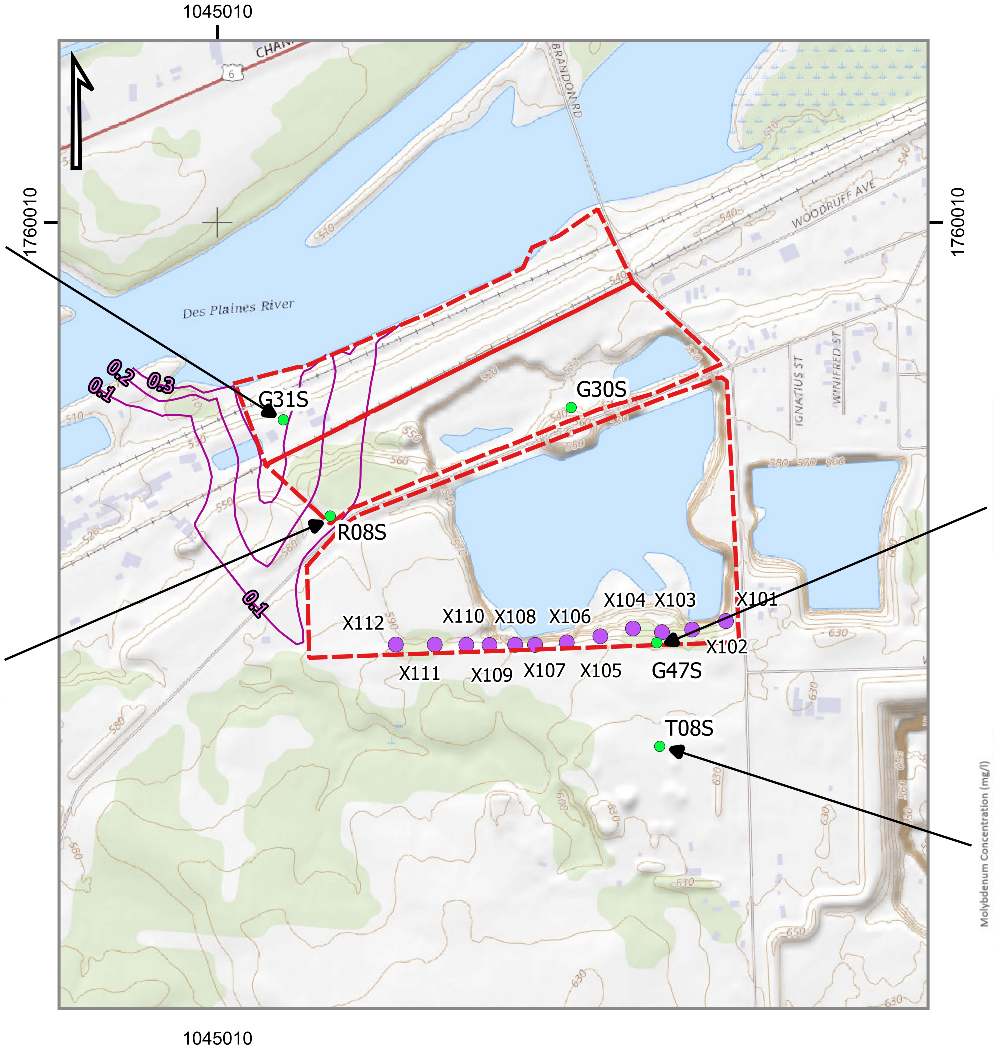
SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022

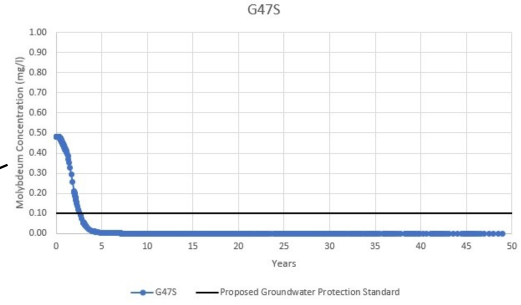
BAS PROJECT No.
21141201

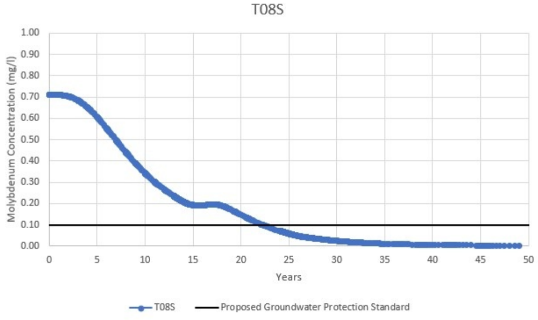
APPENDIX:
A5











STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

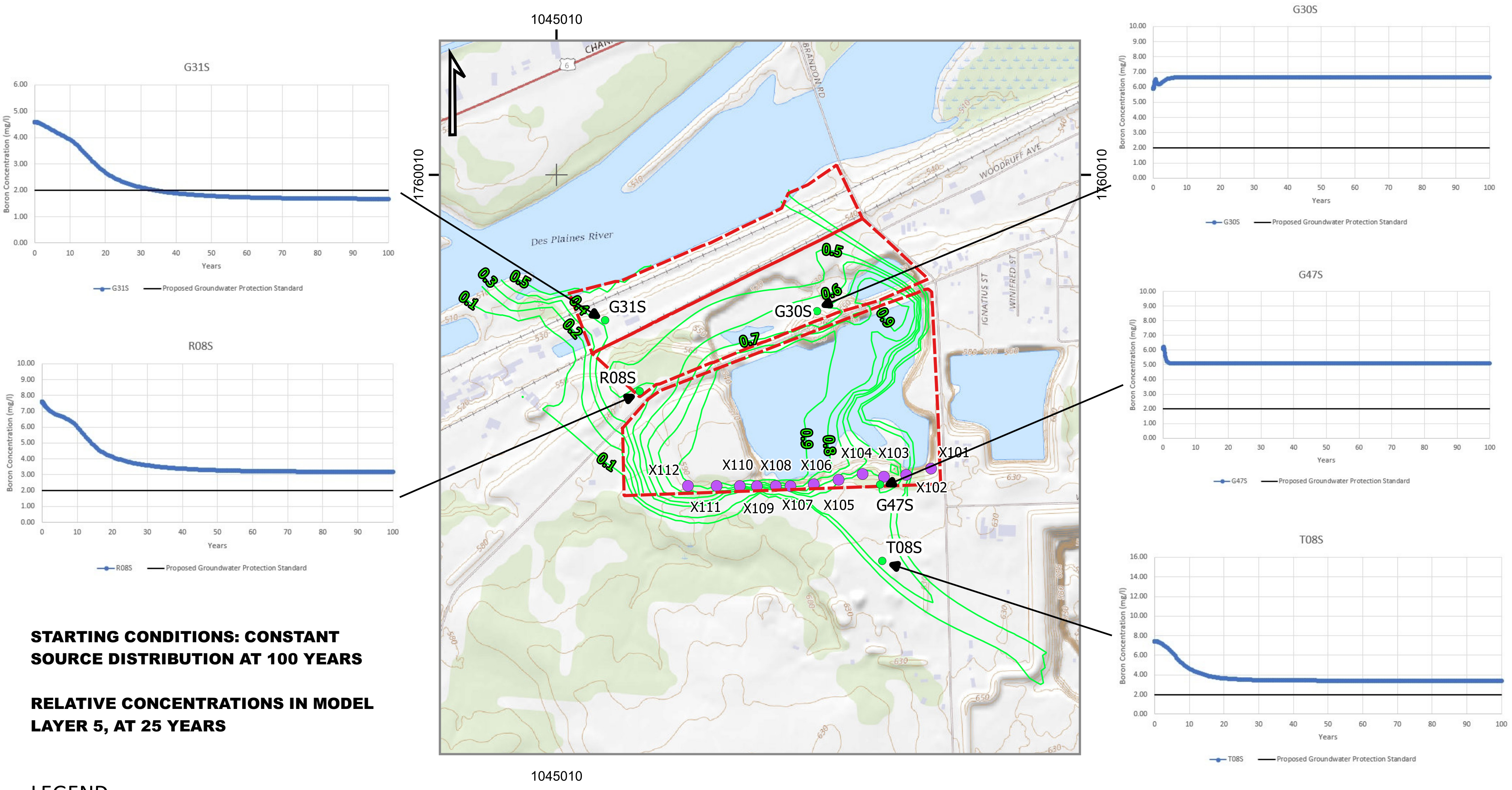
FEET

Coordinate System:
Project File: AppendixA6_Scenario1_MolyConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 1, MOLYBDENUM CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		APPENDIX: **A6**	

APPENDIX B
ALTERNATIVE 2 CONCENTRATION GRAPHS



STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

FEET

Coordinate System:

Project File: AppendixB1_Scenario2_BoronConcentrationsOverTime.qgz

CLIENT

MIDWEST GENERATION, LLC

SITE

JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

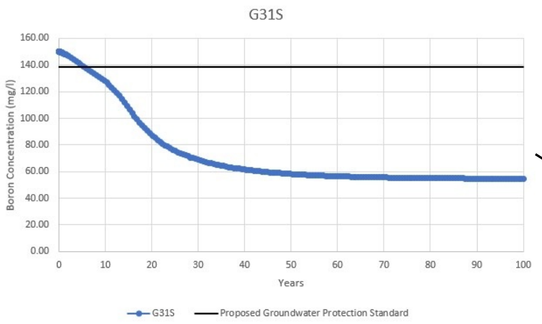
TITLE

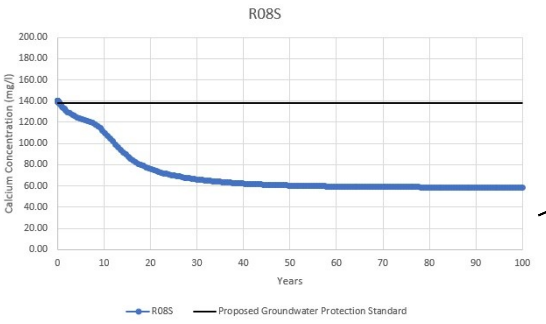
ALTERNATIVE 2, BORON CONCENTRATIONS OVER TIME

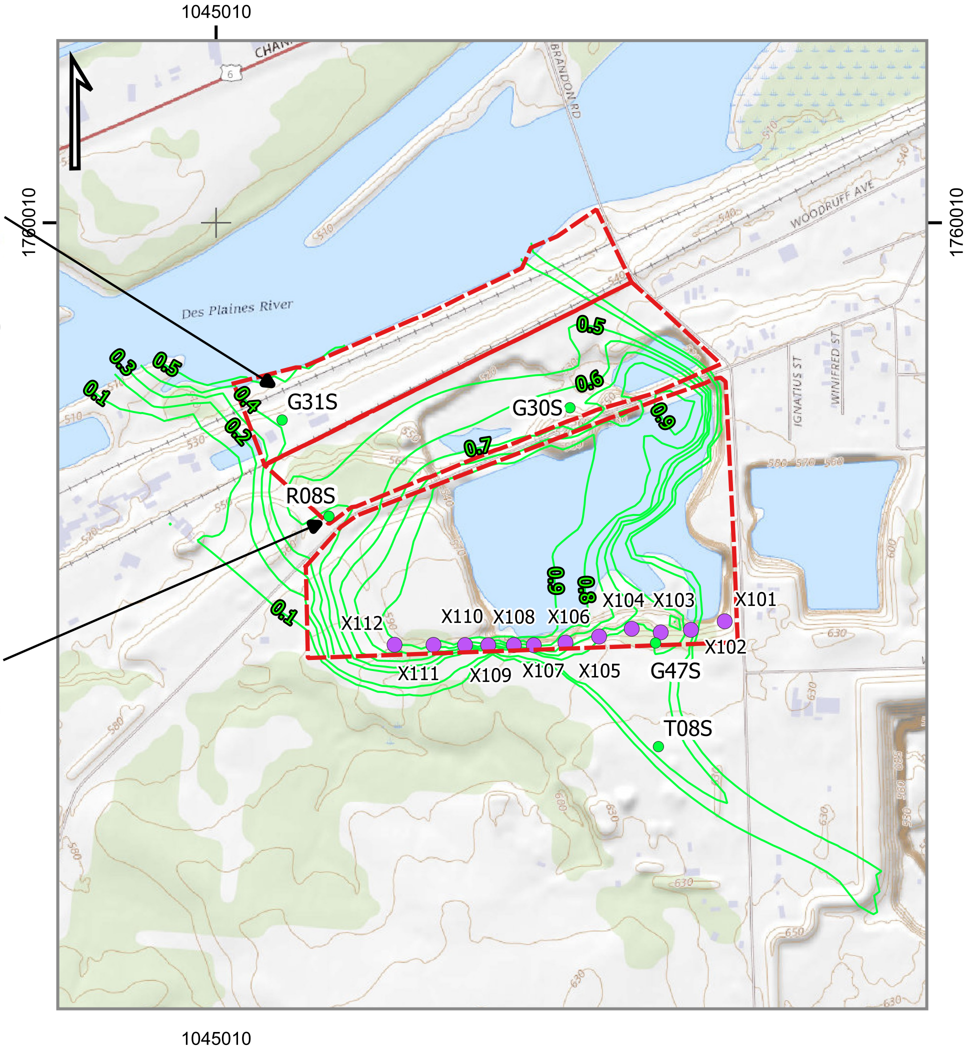
SCALE AT ANSI A	*DRAWN*	*DZF*	01/28/2022
1:14,000	*CHECKED*	*BAS*	01/28/2022

BAS PROJECT No. *21141201*

APPENDIX: **B1**







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

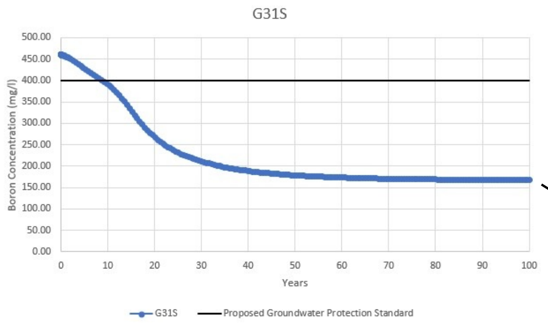
0 700 1,400 ft

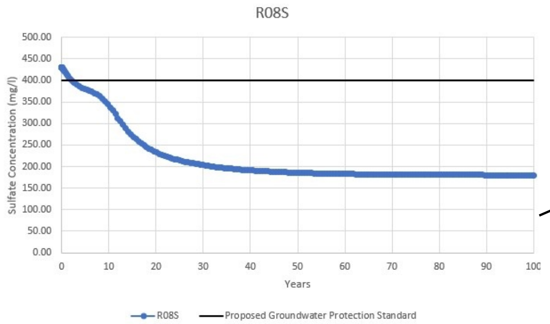
FEET

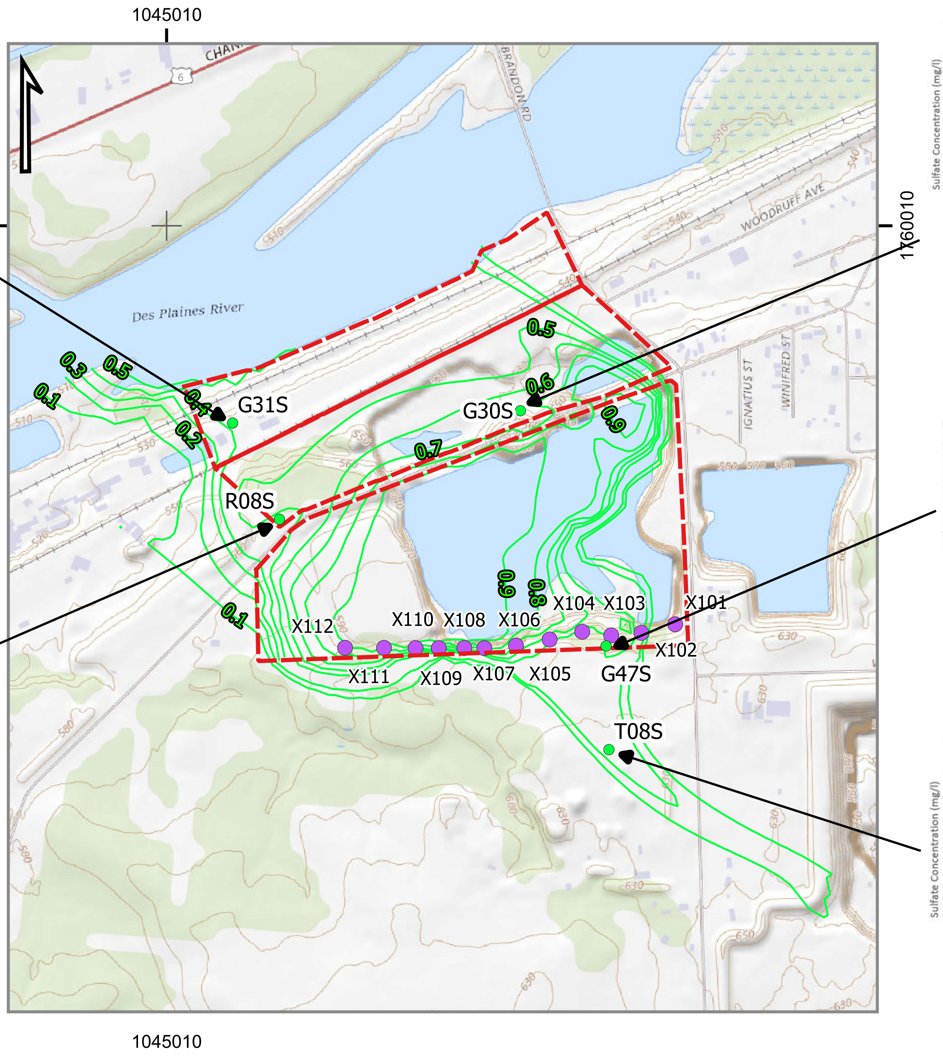
Coordinate System:
Project File:
AppendixB2_Scenario2_CalciumConcentrationsOverTime.qgz

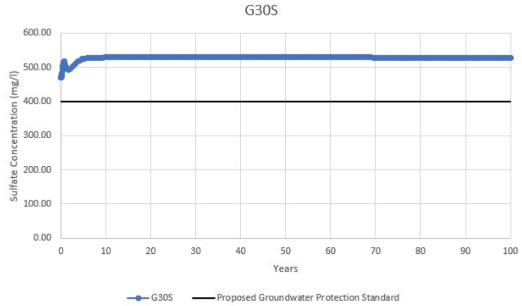
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 2, CALCIUM CONCENTRATIONS OVER TIME**

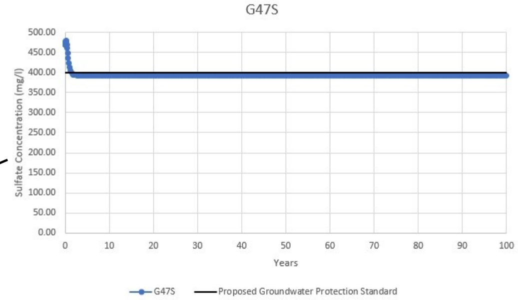
SCALE AT ANSI A	*DRAWN*	*DZF*	01/28/2022
1:14,000	*CHECKED*	*BAS*	01/28/2022
BAS PROJECT No.		*APPENDIX:*	
21141201		**B2**	

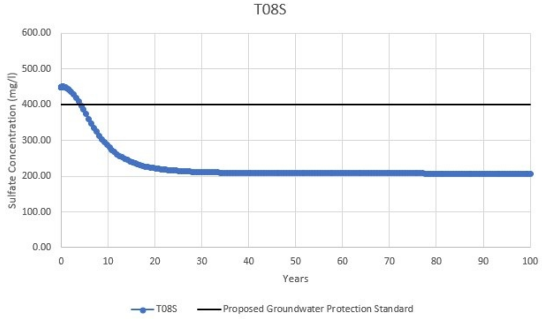












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft

FEET

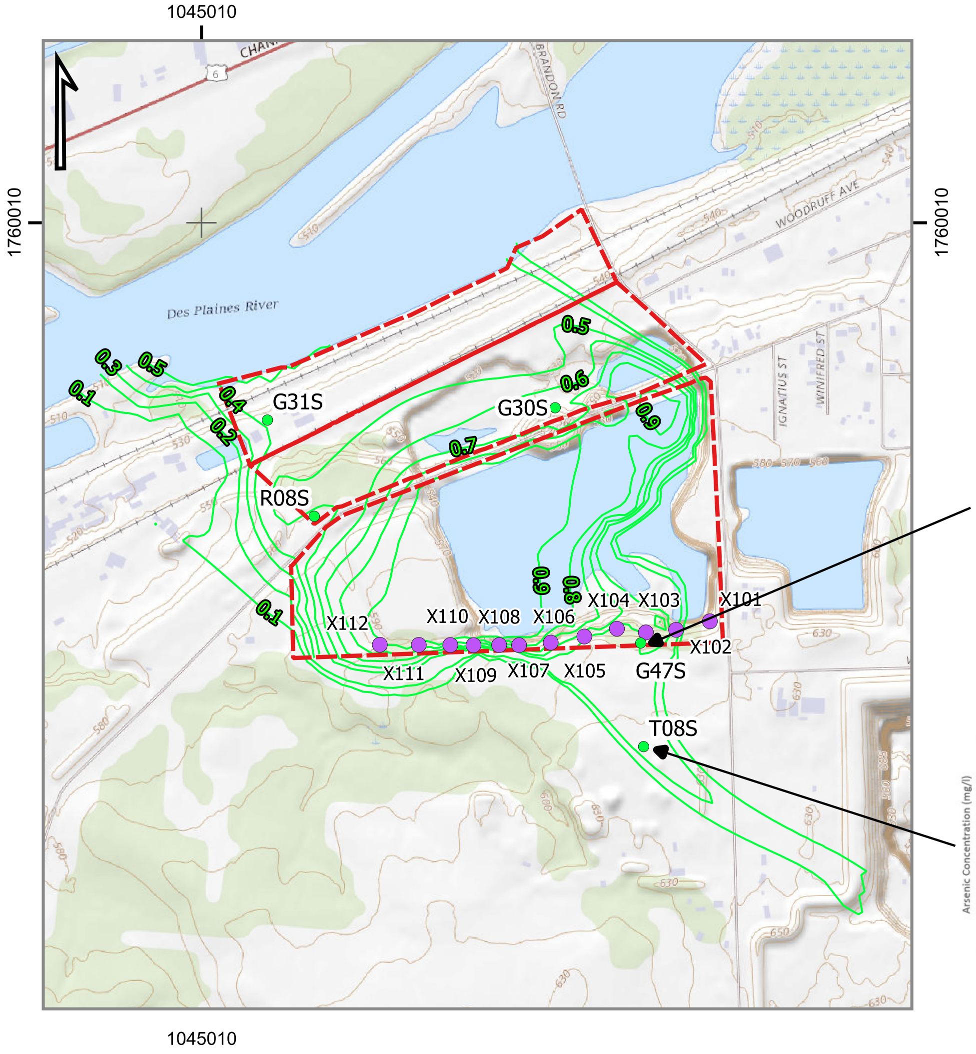
Coordinate System:
Project File:
AppendixB3_Scenario2_SulfateConcentrationsOverTime.qgz

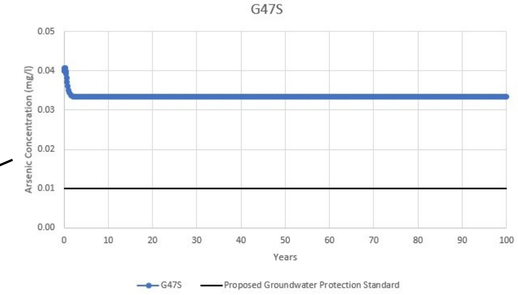
CLIENT
MIDWEST GENERATION, LLC

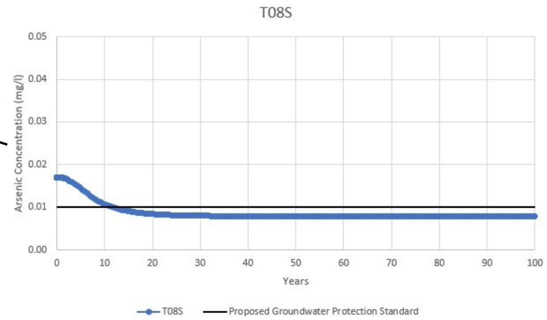
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
ALTERNATIVE 2, SULFATE CONCENTRATIONS OVER TIME

SCALE AT ANSI A 1:14,000	*DRAWN*	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. *21141201*		*APPENDIX:* **B3**	







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

0 700 1,400 ft
FEET

Coordinate System:
Project File:
AppendixB4_Scenario2_ArsenicConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

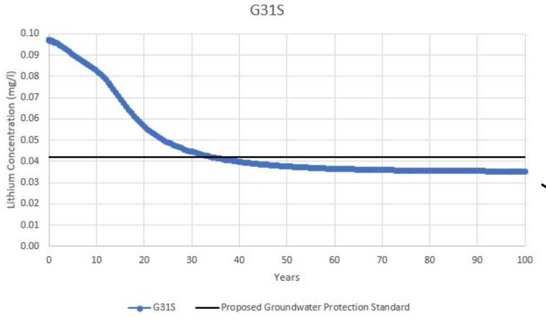
TITLE
ALTERNATIVE 2, ARSENIC CONCENTRATIONS OVER TIME

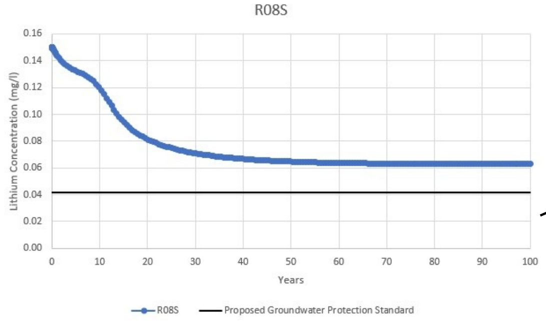
SCALE AT ANSI A
1:14,000

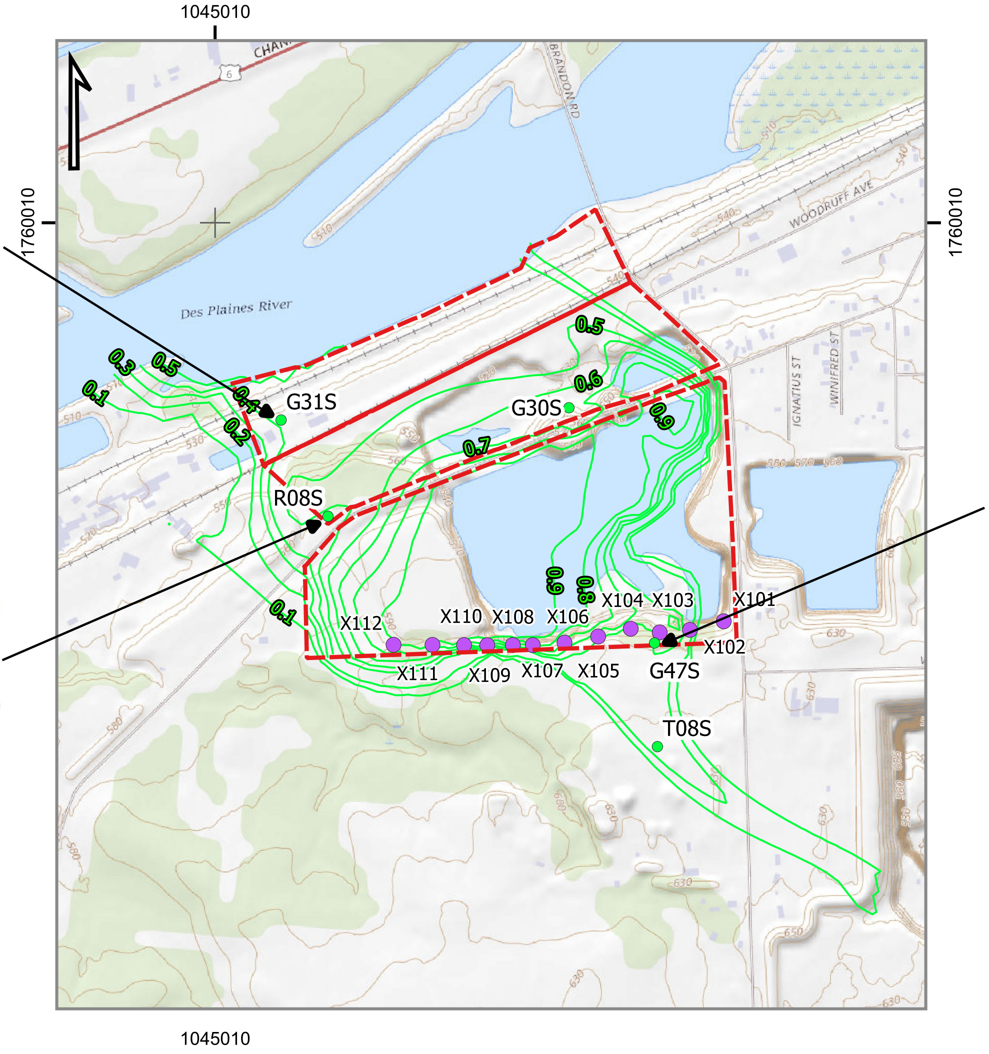
DRAWN	*DZF*	01/28/2022
CHECKED	*BAS*	01/28/2022

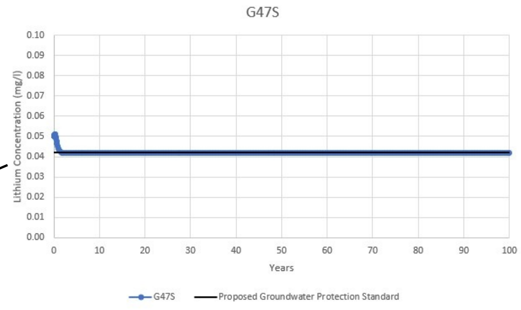
BAS PROJECT No.
21141201

APPENDIX:
B4









STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

⬚	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

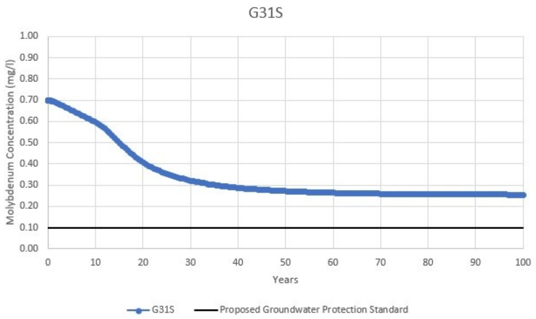
0 700 1,400 ft

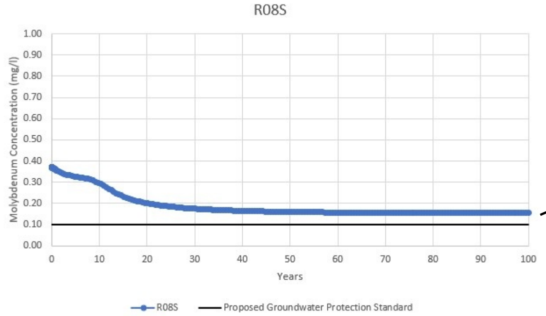
FEET

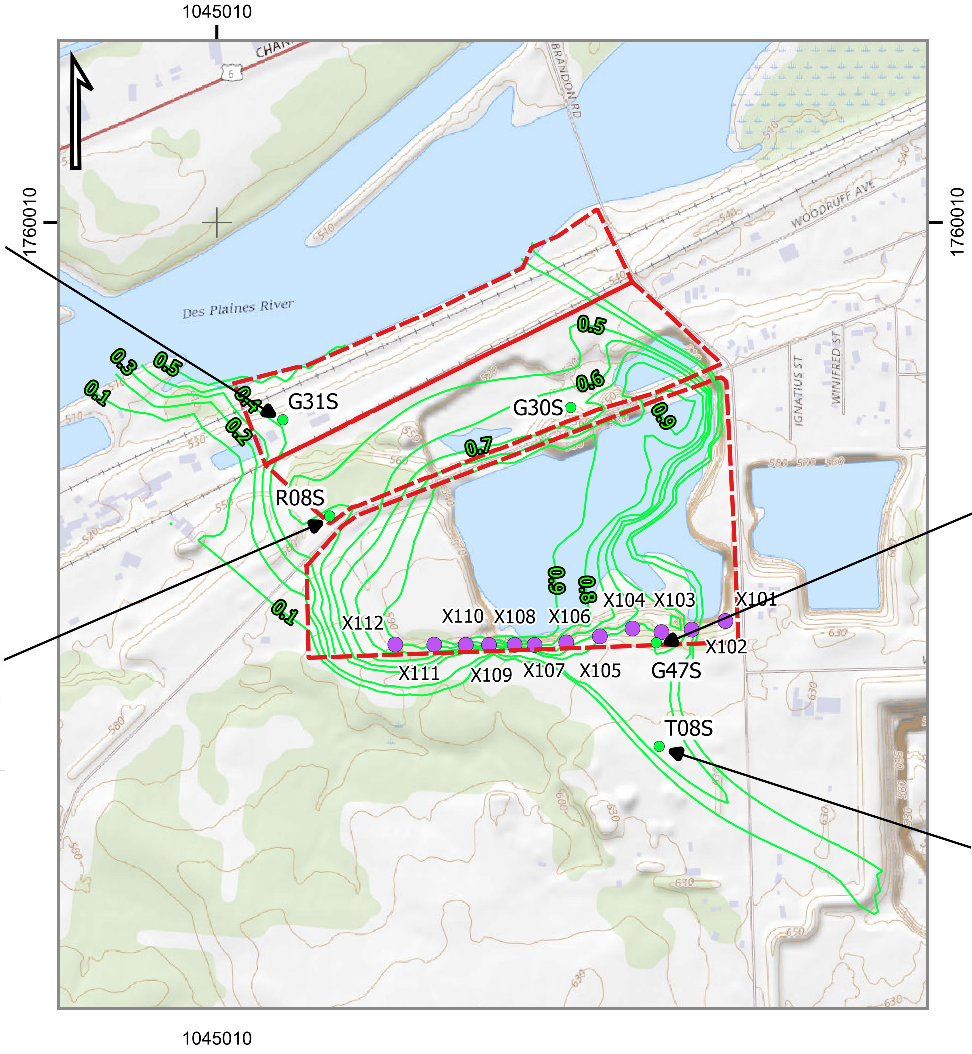
Coordinate System:
Project File:
AppendixB5_Scenario2_LithiumConcentrationsOverTime.qgz

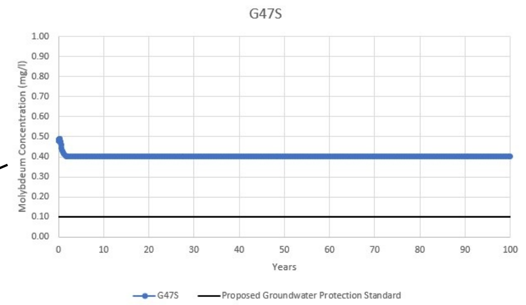
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 2, LITHIUM CONCENTRATIONS OVER TIME**

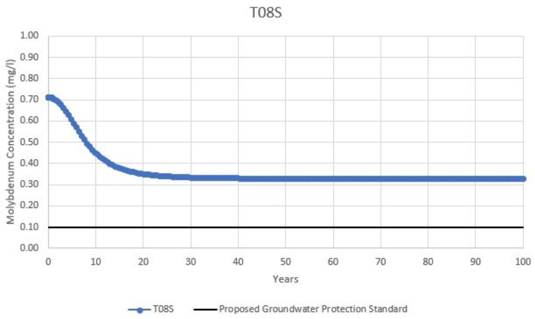
SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*		*APPENDIX:* **B5**	











STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

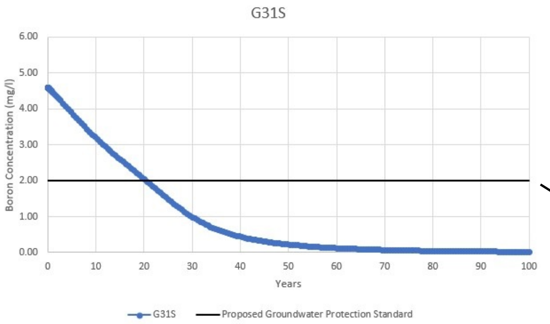
0 700 1,400 ft
FEET

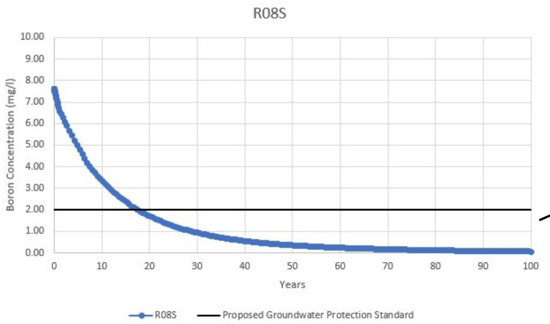
Coordinate System:
Project File: AppendixB6_Scenario2_MolyConcentrationsOverTime.qgz

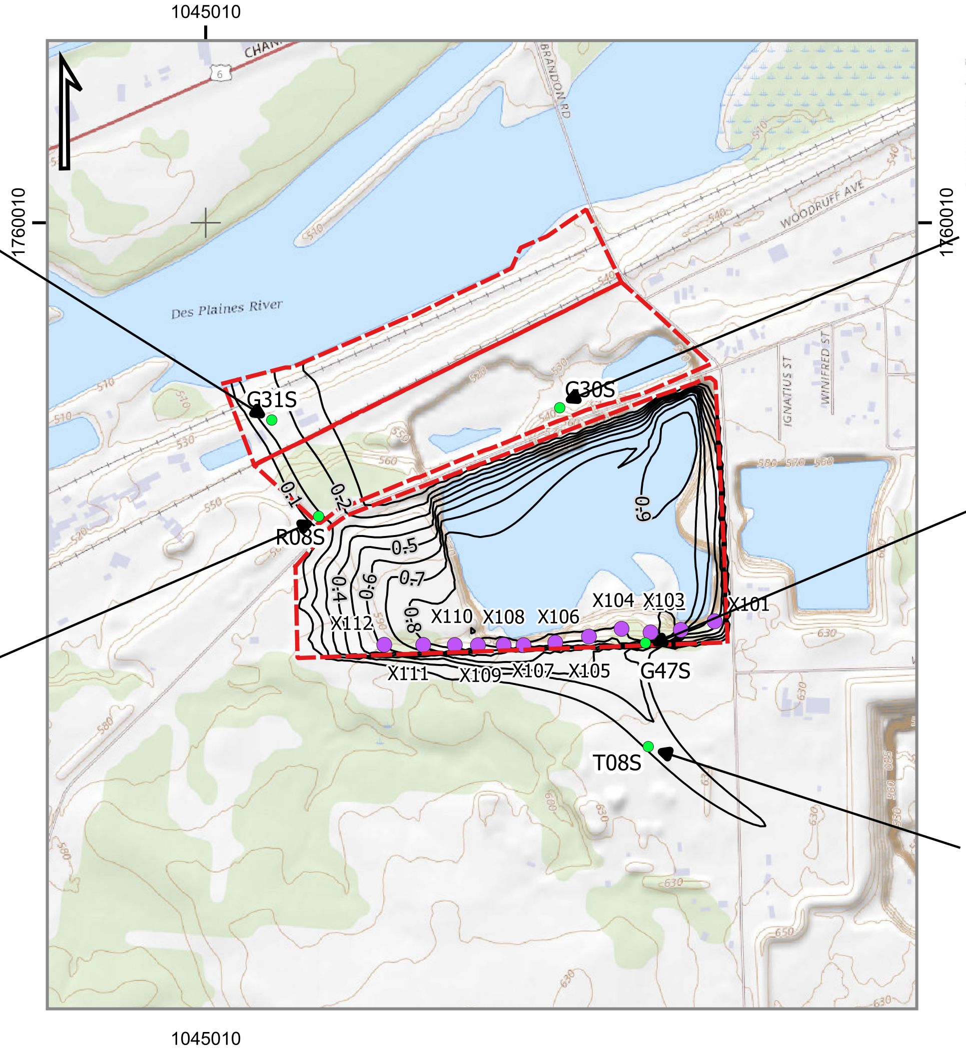
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 2, MOLYBDENUM CONCENTRATIONS OVER TIME**

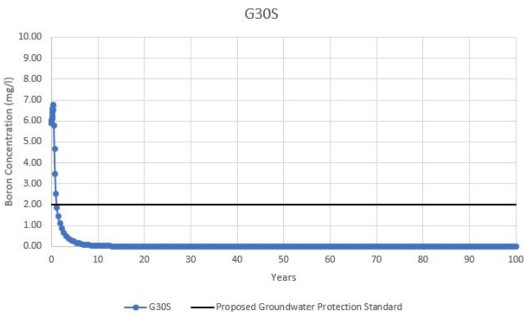
SCALE AT ANSI A	*DRAWN*	*DZF*	01/28/2022
1:14,000	*CHECKED*	*BAS*	01/28/2022
BAS PROJECT No.		*APPENDIX:*	
21141201		**B6**	

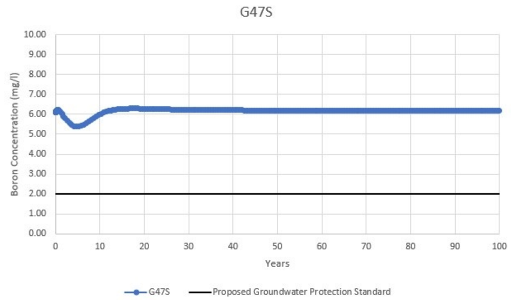
APPENDIX C
ALTERNATIVE 3 CONCENTRATION GRAPHS

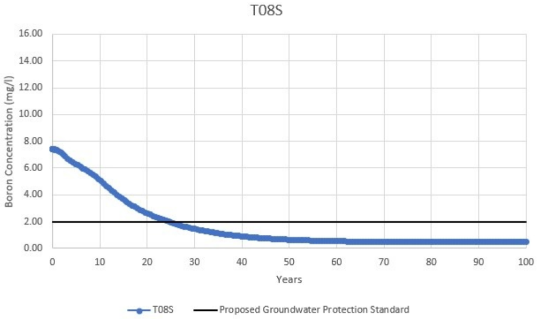












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

Coordinate System:
Project File: AppendixC1_Scenario3_BoronConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

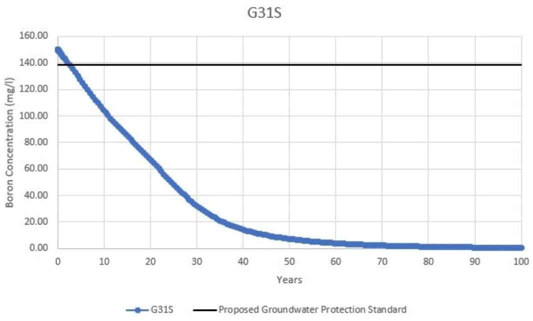
TITLE
ALTERNATIVE 3, BORON CONCENTRATIONS OVER TIME

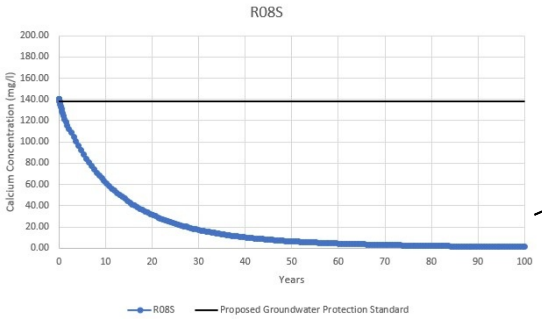
SCALE AT ANSI A
1:14,000

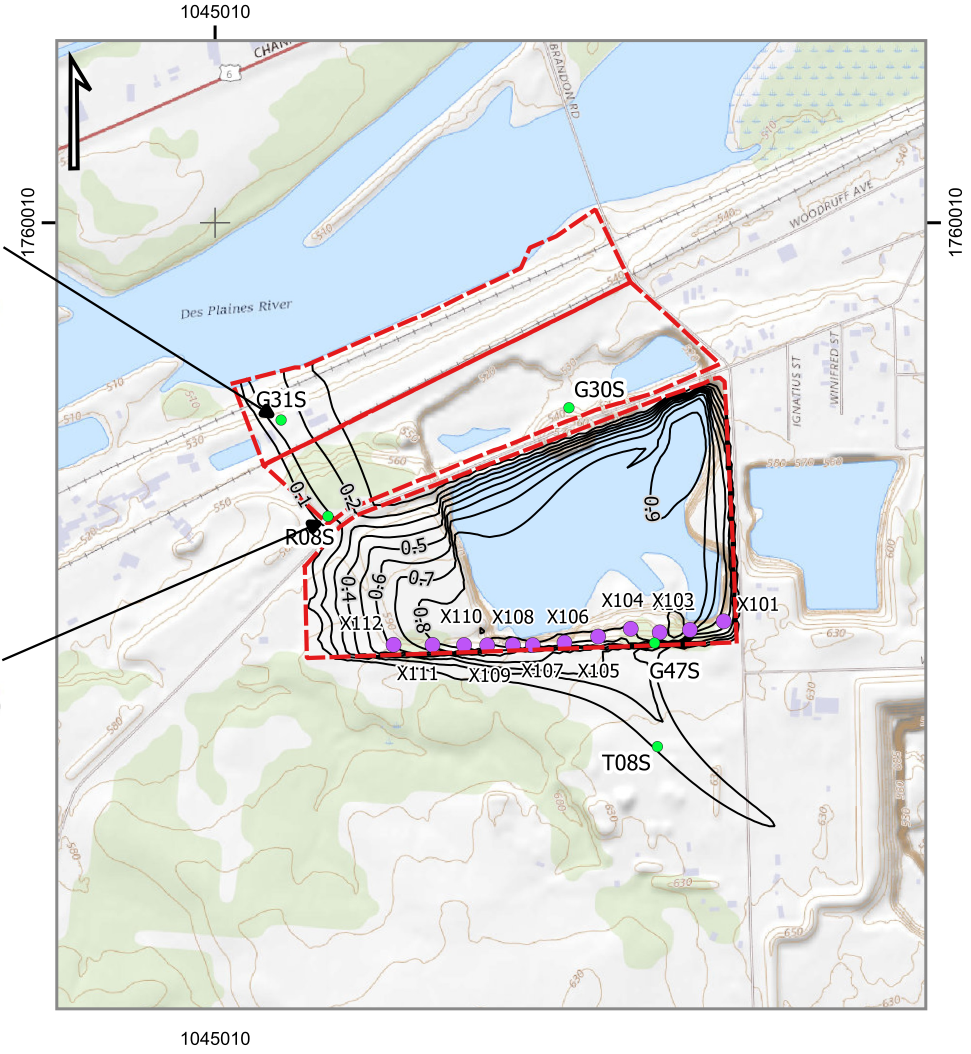
DRAWN DZF 01/28/2022
CHECKED BAS 01/28/2022

BAS PROJECT No.
21141201

APPENDIX:
C1







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- ▭ PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- —— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- —— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft

FEET

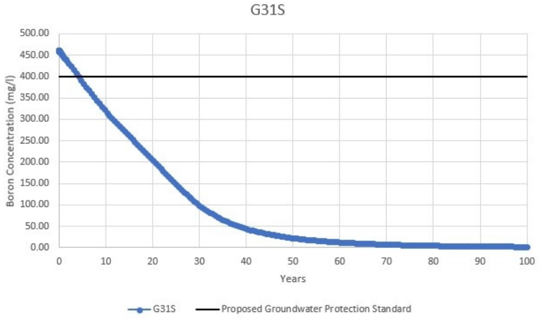
Coordinate System:
Project File:
AppendixC2_Scenario3_CalciumConcentrationsOverTime.qgz

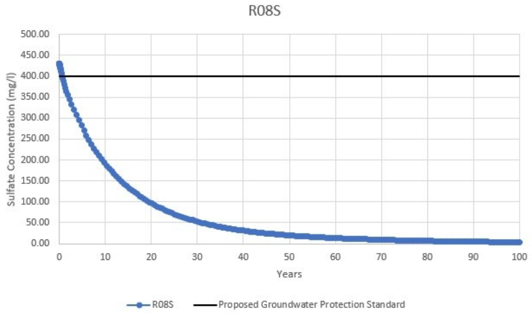
CLIENT
MIDWEST
GENERATION, LLC

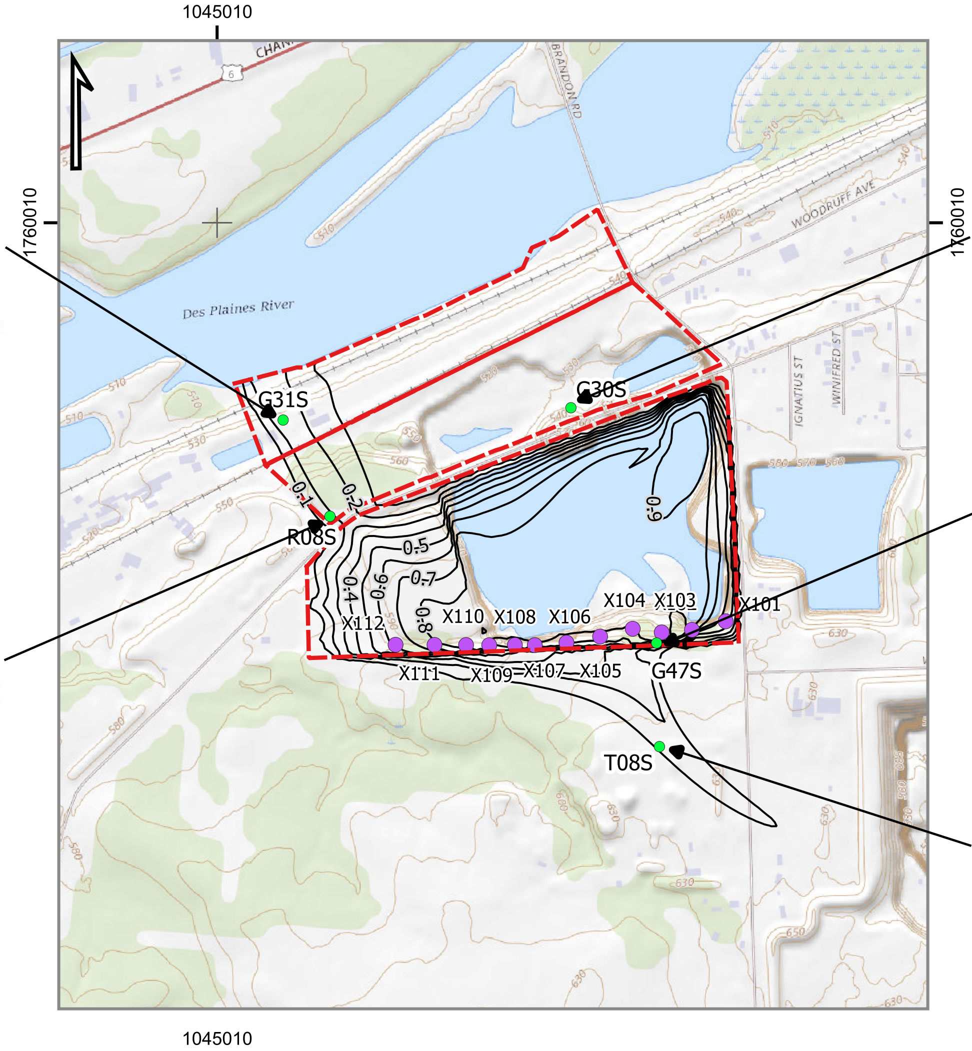
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

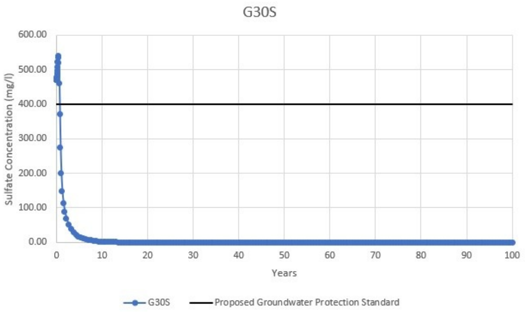
TITLE
ALTERNATIVE 3, CALCIUM CONCENTRATIONS OVER TIME

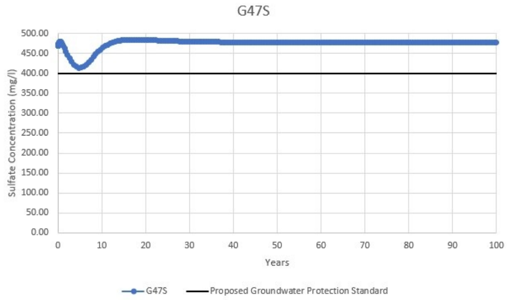
SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		APPENDIX: **C2**	

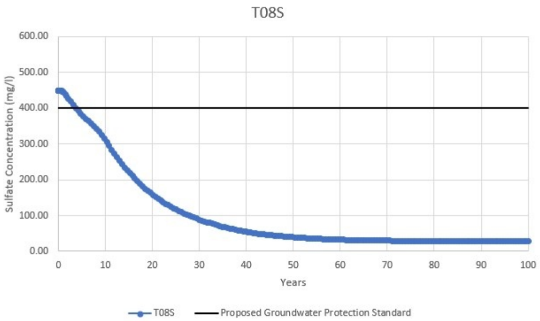












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft

FEET

Coordinate System:
Project File:
AppendixC3_Scenario3_SulfateConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

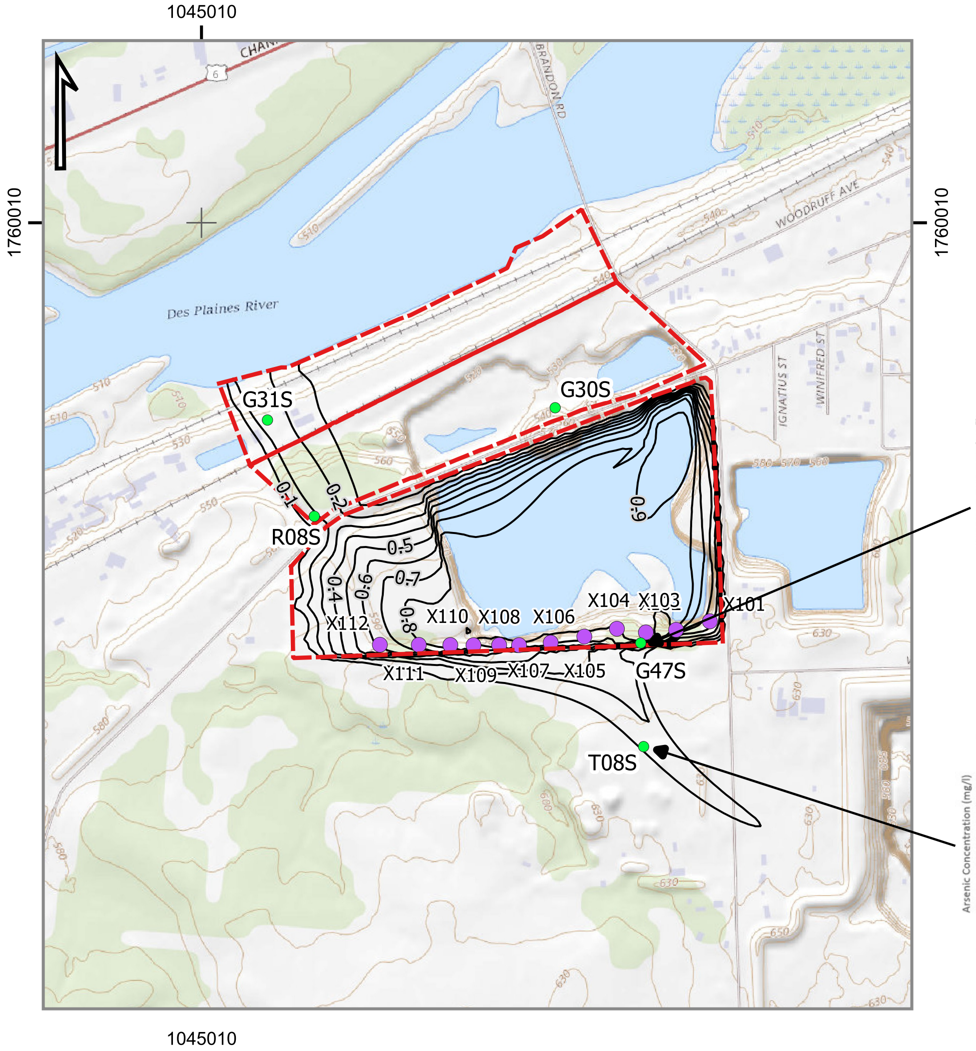
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

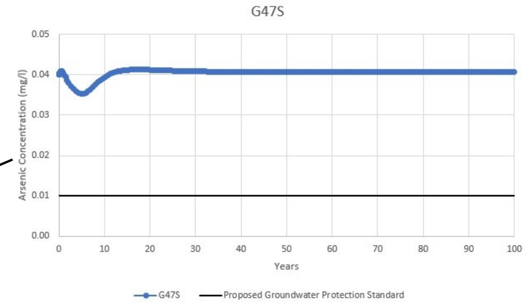
TITLE
ALTERNATIVE 3, SULFATE CONCENTRATIONS OVER TIME

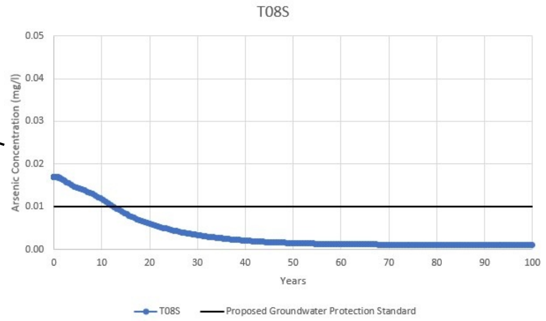
SCALE AT ANSI A	*DRAWN*	DZF	01/28/2022
1:14,000	*CHECKED*	BAS	01/28/2022

BAS PROJECT No.
21141201

APPENDIX:
C3







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

⬚ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

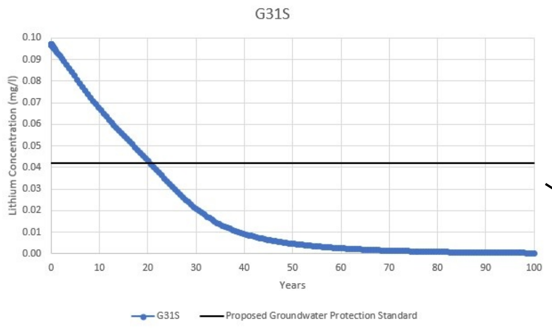
KPRG

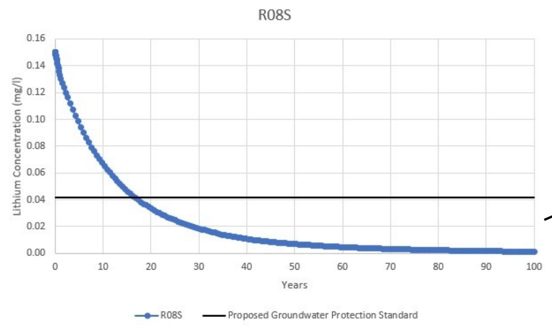
0 700 1,400 ft
FEET

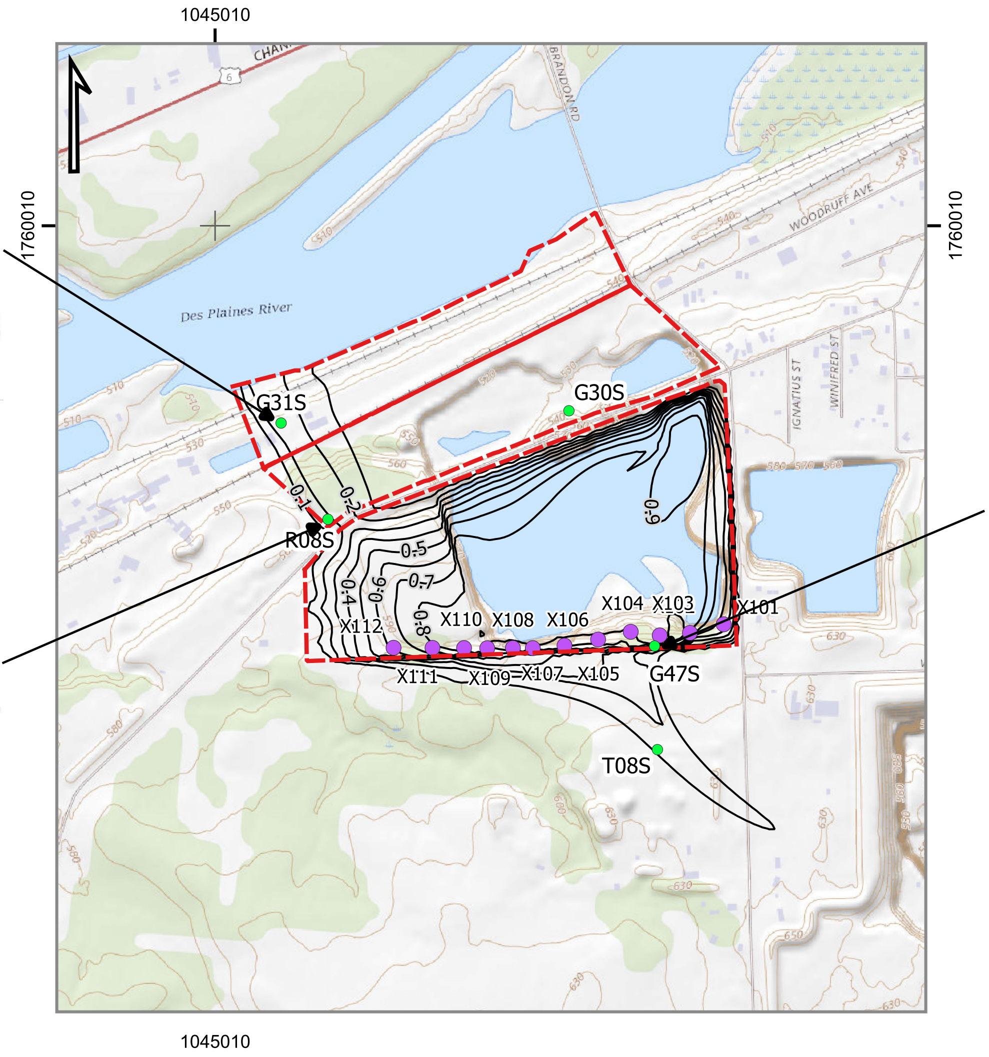
Coordinate System:
Project File:
AppendixC4_Scenario3_ArsenicConcentrationsOverTime.qgz

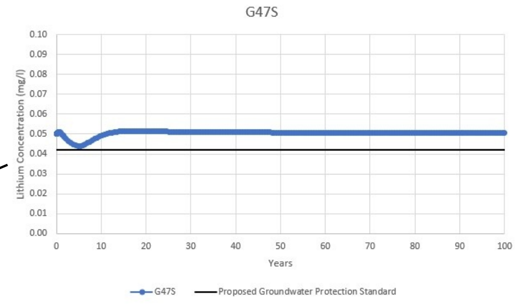
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 3, ARSENIC CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*		*APPENDIX:* **C4**	









STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

▭ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

FEET

Coordinate System:
Project File:
AppendixC5_Scenario3_LithiumConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

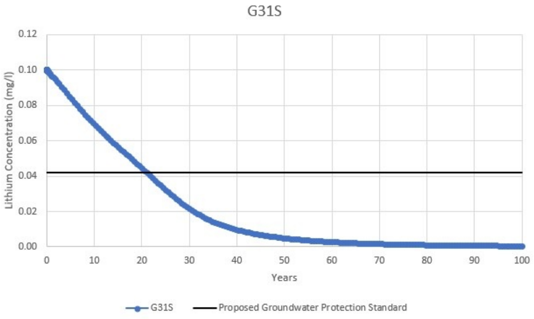
TITLE
ALTERNATIVE 3, LITHIUM CONCENTRATIONS OVER TIME

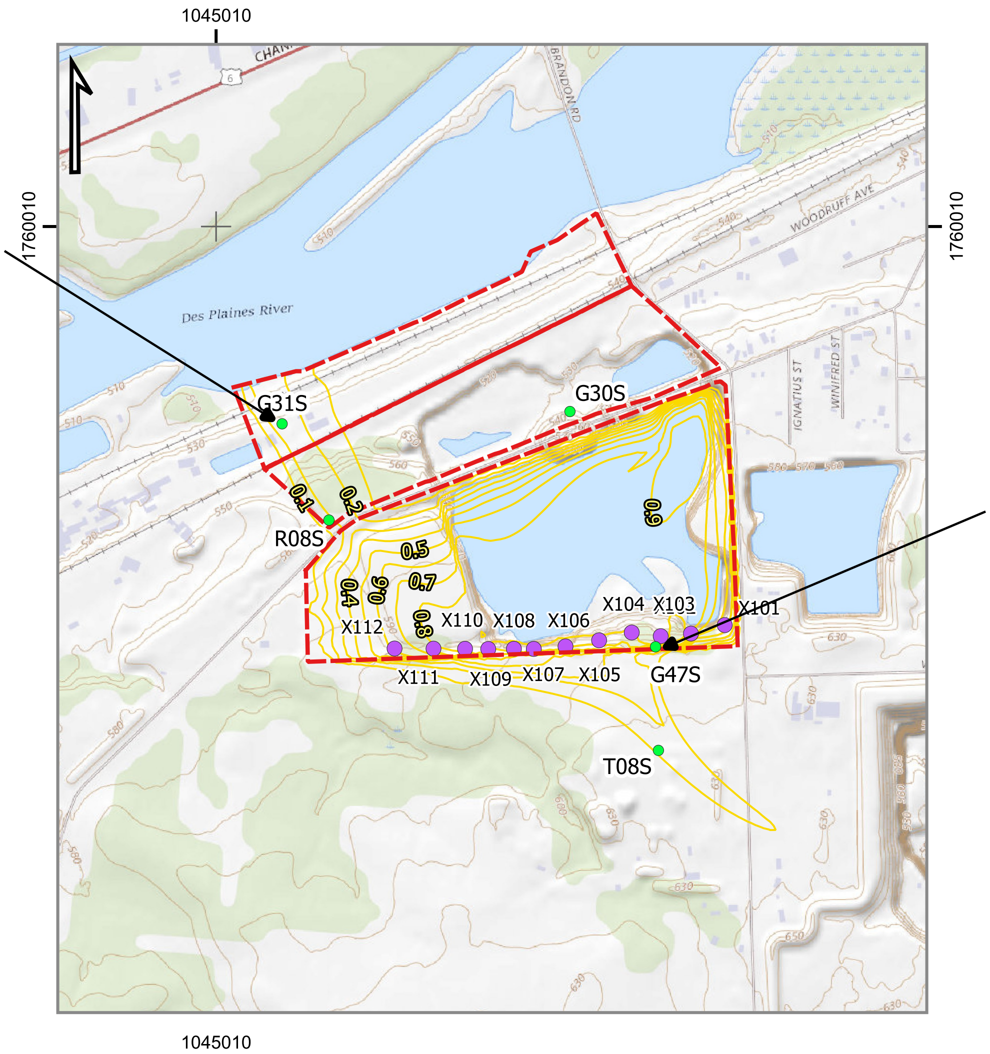
SCALE AT ANSI A
1:14,000

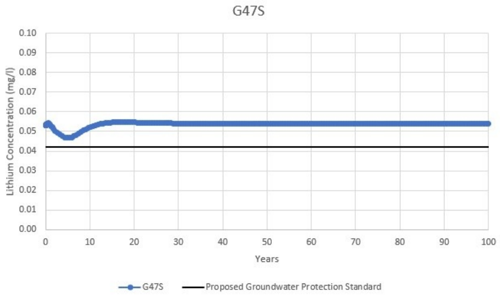
DRAWN DZF 01/28/2022
CHECKED BAS 01/28/2022

BAS PROJECT No.
21141201

APPENDIX:
C5







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 1, AT 5 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — LITHIUM CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft
FEET

DRAFT

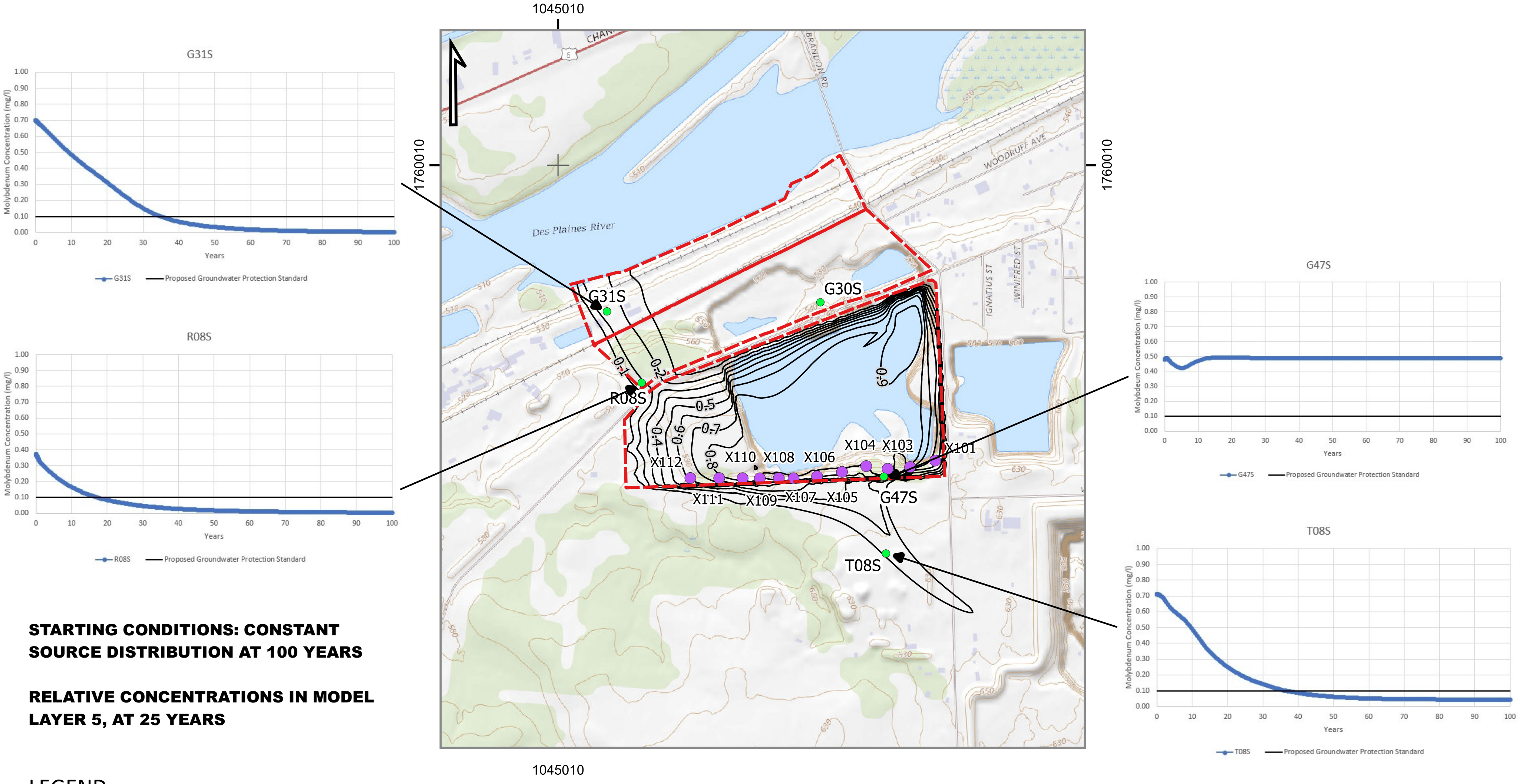
Coordinate System:
Project File:
AppendixC5_Scenario3_LithiumConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
SCENARIO 3, LITHIUM
CONCENTRATIONS OVER TIME

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/21/2022
	CHECKED	*BAS*	01/21/2022
BAS PROJECT No. *21141201*		*APPENDIX:* **C5**	



STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

⬚ PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

Coordinate System:
Project File: AppendixC6_Scenario3_MolyConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

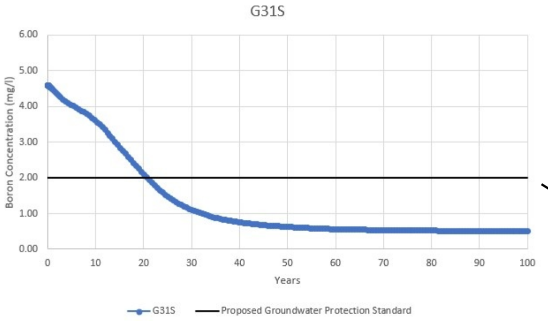
TITLE
ALTERNATIVE 3, MOLYBDENUM CONCENTRATIONS OVER TIME

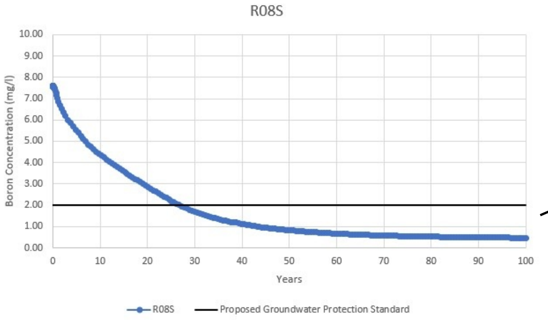
SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022

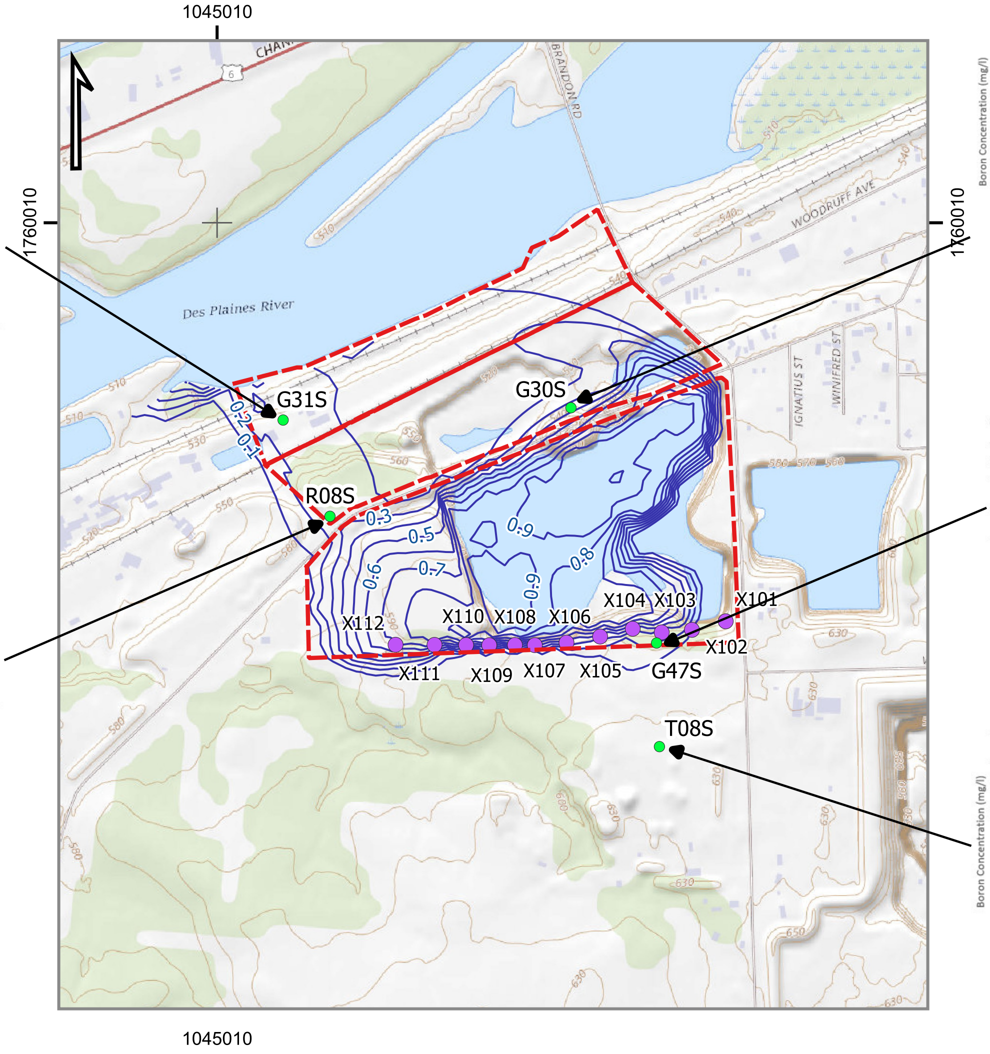
BAS PROJECT No.
21141201

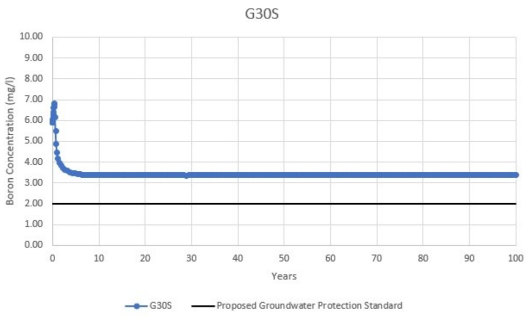
APPENDIX:
C6

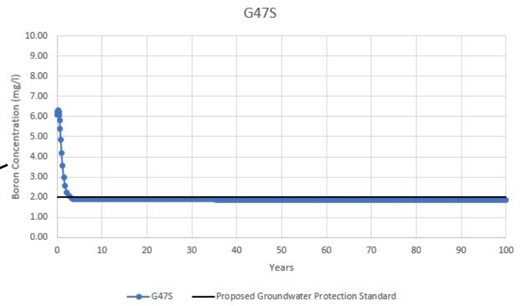
APPENDIX D
ALTERNATIVE 4 CONCENTRATION GRAPHS

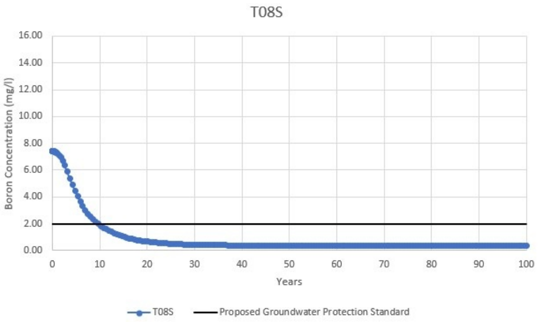












STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

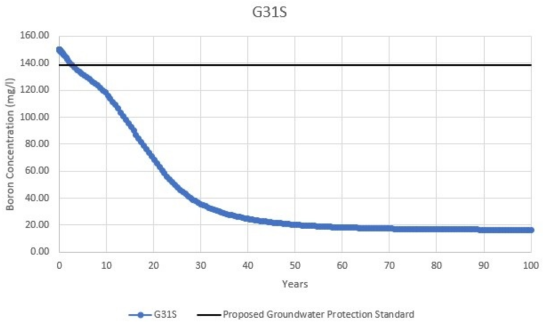
K P R G

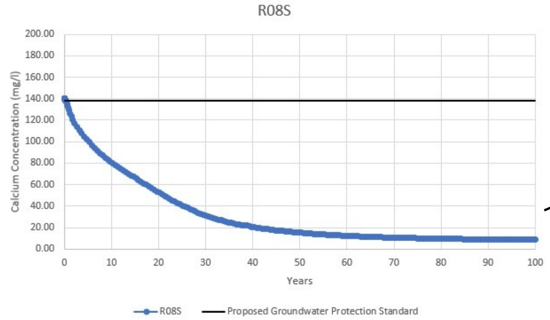
0 700 1,400 ft
FEET

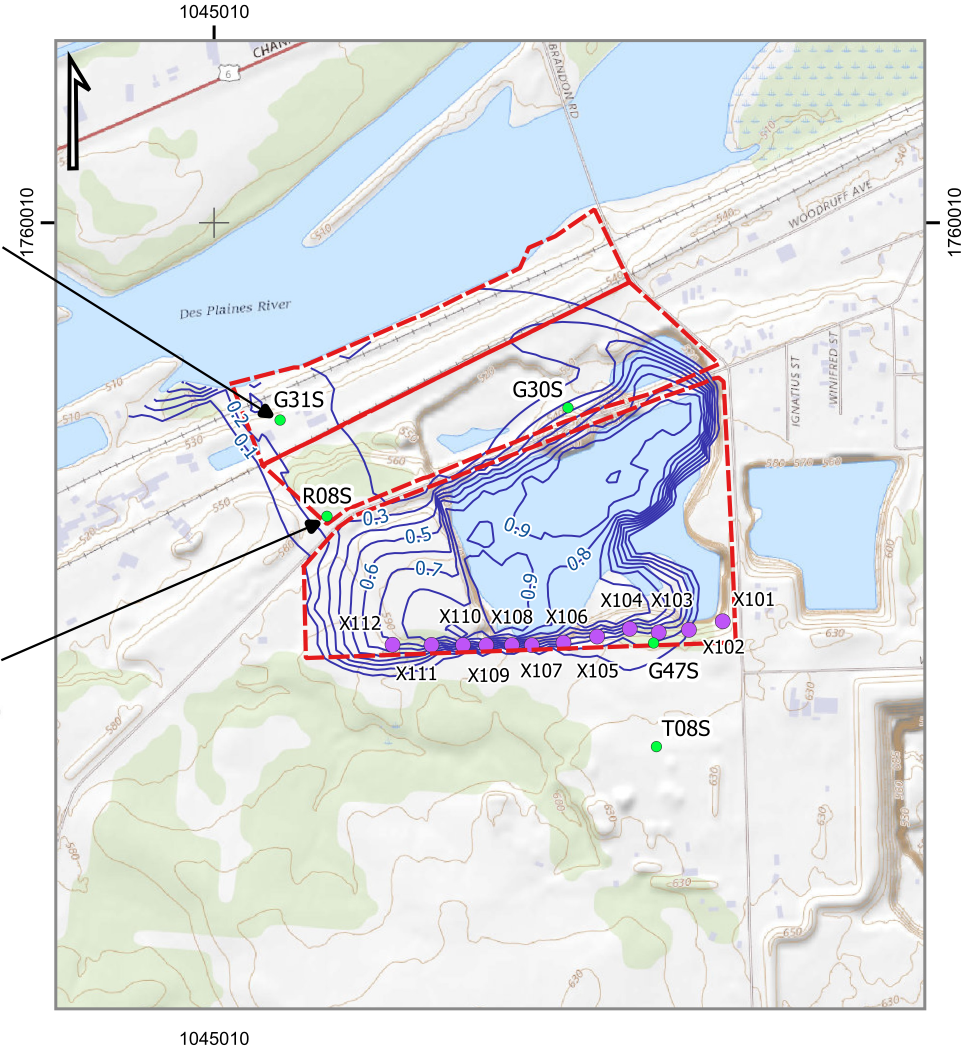
Coordinate System:
Project File: AppendixD1_Scenario4_BoronConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, BORON CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*	*APPENDIX:* **D1**		







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- 🟥 PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

- — PROPOSED GROUNDWATER PROTECTION STANDARD

0 700 1,400 ft
FEET

Coordinate System:
Project File:
AppendixD2_Scenario4_CalciumConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

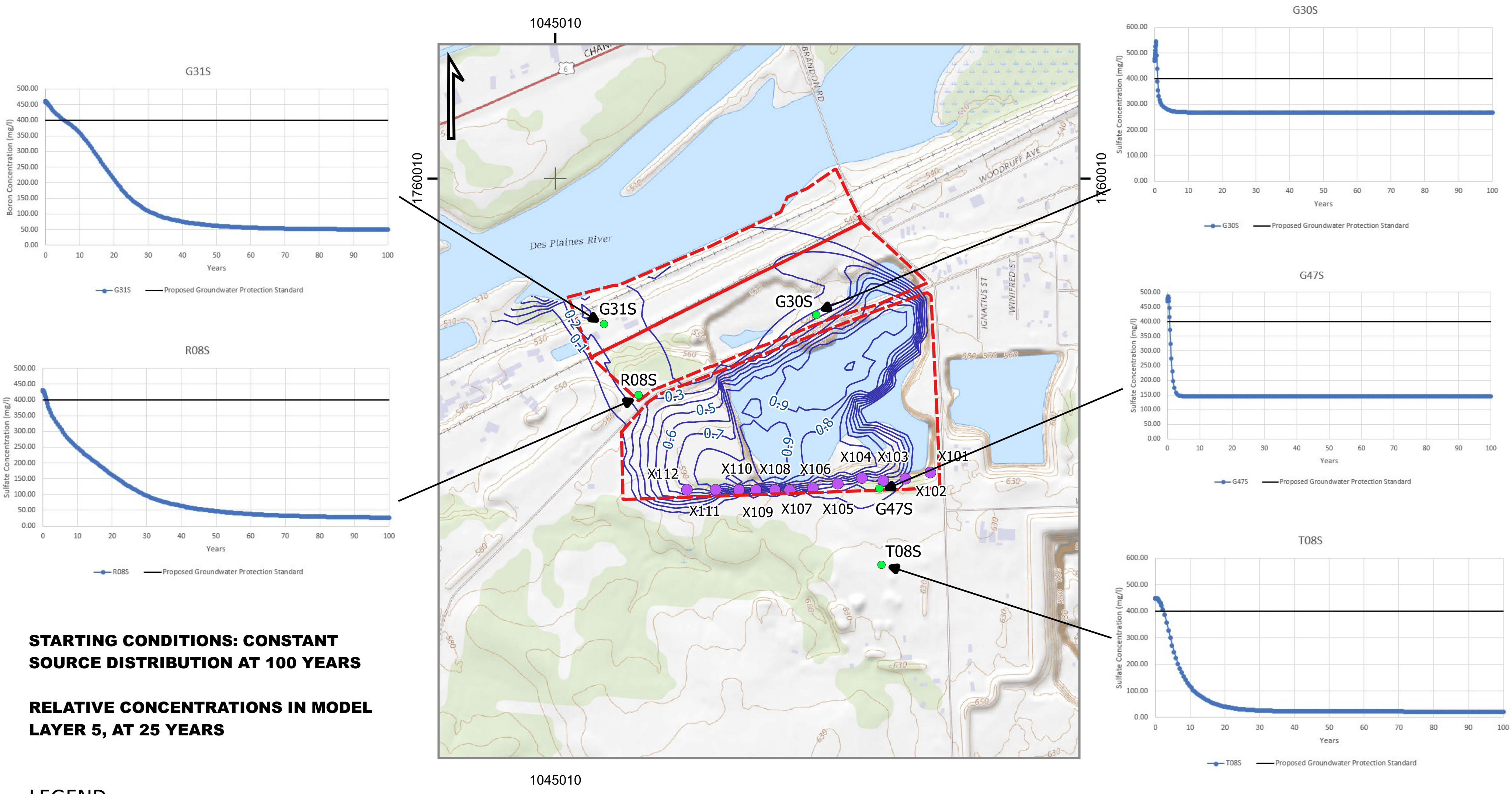
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

TITLE
ALTERNATIVE 4, CALCIUM CONCENTRATIONS OVER TIME

SCALE AT ANSI A	DRAWN	DZF	01/28/2022
1:14,000	CHECKED	BAS	01/28/2022

BAS PROJECT No.
21141201

APPENDIX:
D2



STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥 PROPERTY BOUNDARY

● EXTRACTION WELLS

● MONITORING WELL LOCATION

— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

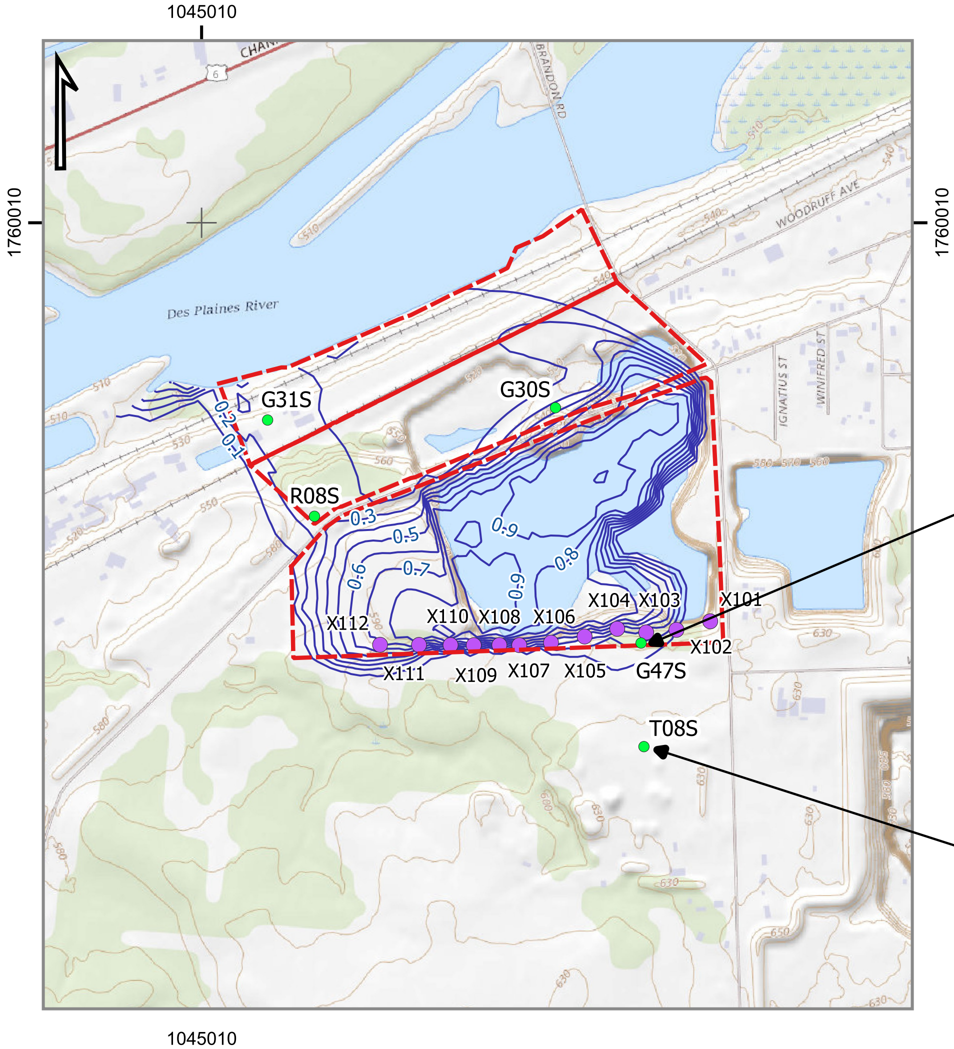
— PROPOSED GROUNDWATER PROTECTION STANDARD

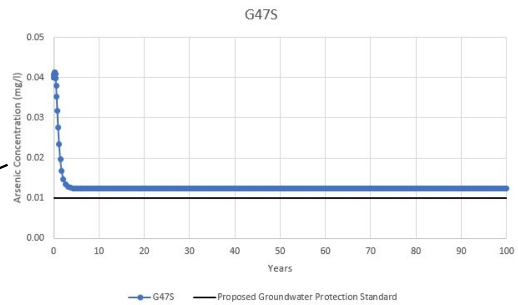
0 700 1,400 ft
FEET

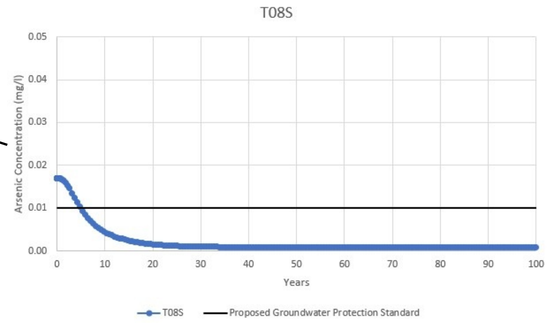
Coordinate System:
Project File:
AppendixD3_Scenario4_SulfateConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, SULFATE CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	*01/28/2022*
	CHECKED	*BAS*	*01/28/2022*
BAS PROJECT No. *21141201*			*APPENDIX:* **D3**







STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

- PROPERTY BOUNDARY
- ● EXTRACTION WELLS
- ● MONITORING WELL LOCATION
- — RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

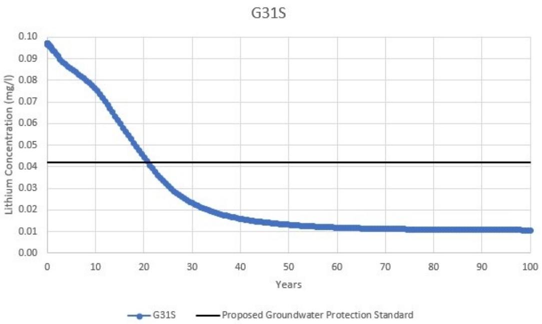
0 700 1,400 ft

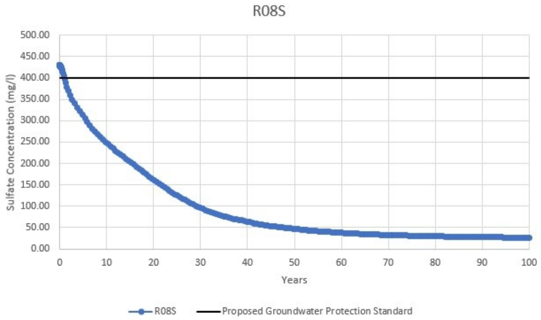
FEET

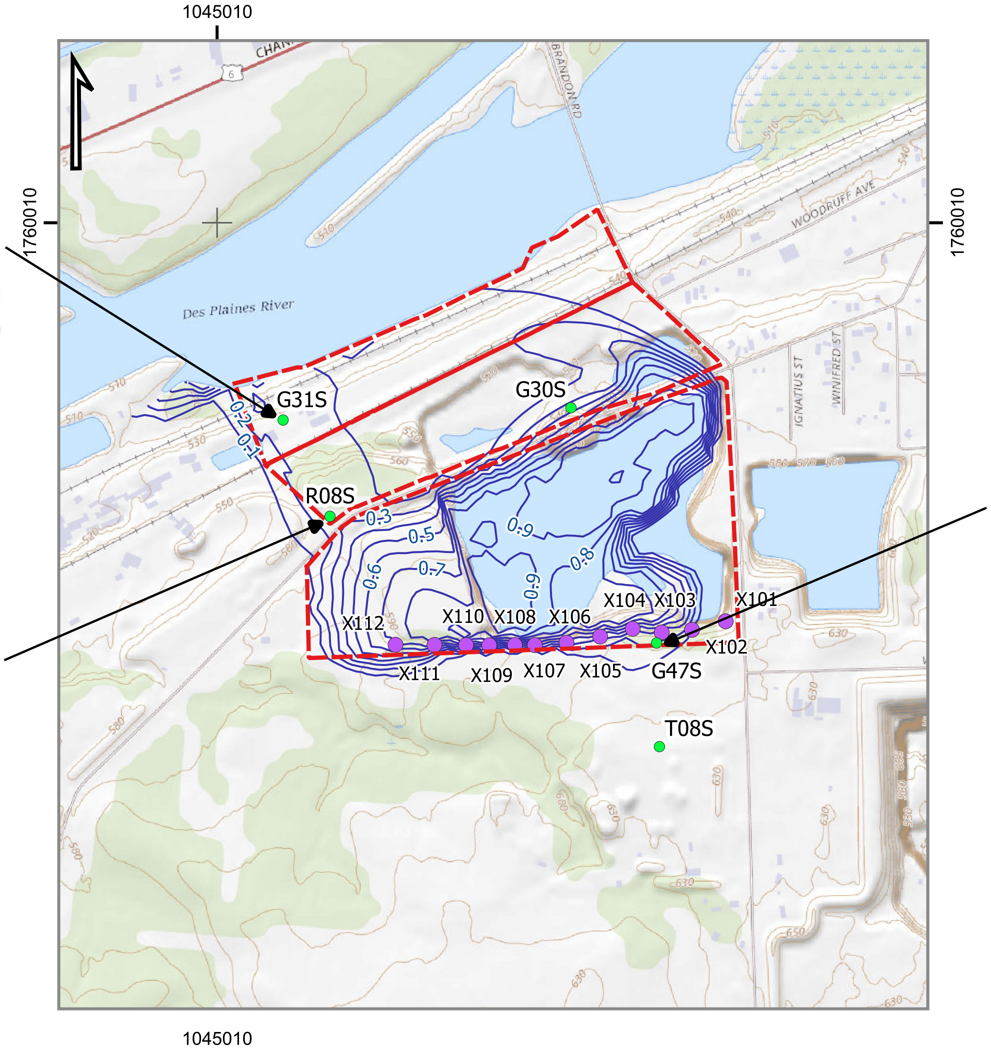
Coordinate System:
Project File:
AppendixD4_Scenario4_ArsenicConcentrationsOverTime.qgz

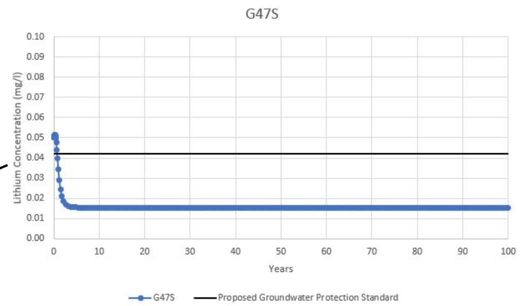
CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, ARSENIC CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/28/2022
	CHECKED	BAS	01/28/2022
BAS PROJECT No. 21141201		APPENDIX: **D4**	









STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥	PROPERTY BOUNDARY
●	EXTRACTION WELLS
●	MONITORING WELL LOCATION
—	RELATIVE SURROGATE CONCENTRATIONS

GRAPH

—	PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

K P R G

0 700 1,400 ft

FEET

Coordinate System:
Project File:
AppendixD5_Scenario4_LithiumConcentrationsOverTime.qgz

CLIENT
MIDWEST
GENERATION, LLC

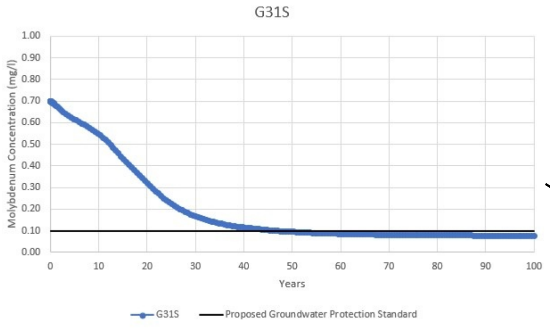
SITE
JOLIET 9, LINCOLN STONE QUARRY
1601 S. PATTERSON RD., JOLIET, IL

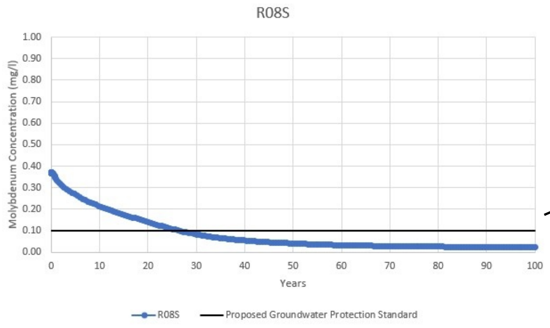
TITLE
ALTERNATIVE 4, LITHIUM CONCENTRATIONS OVER TIME

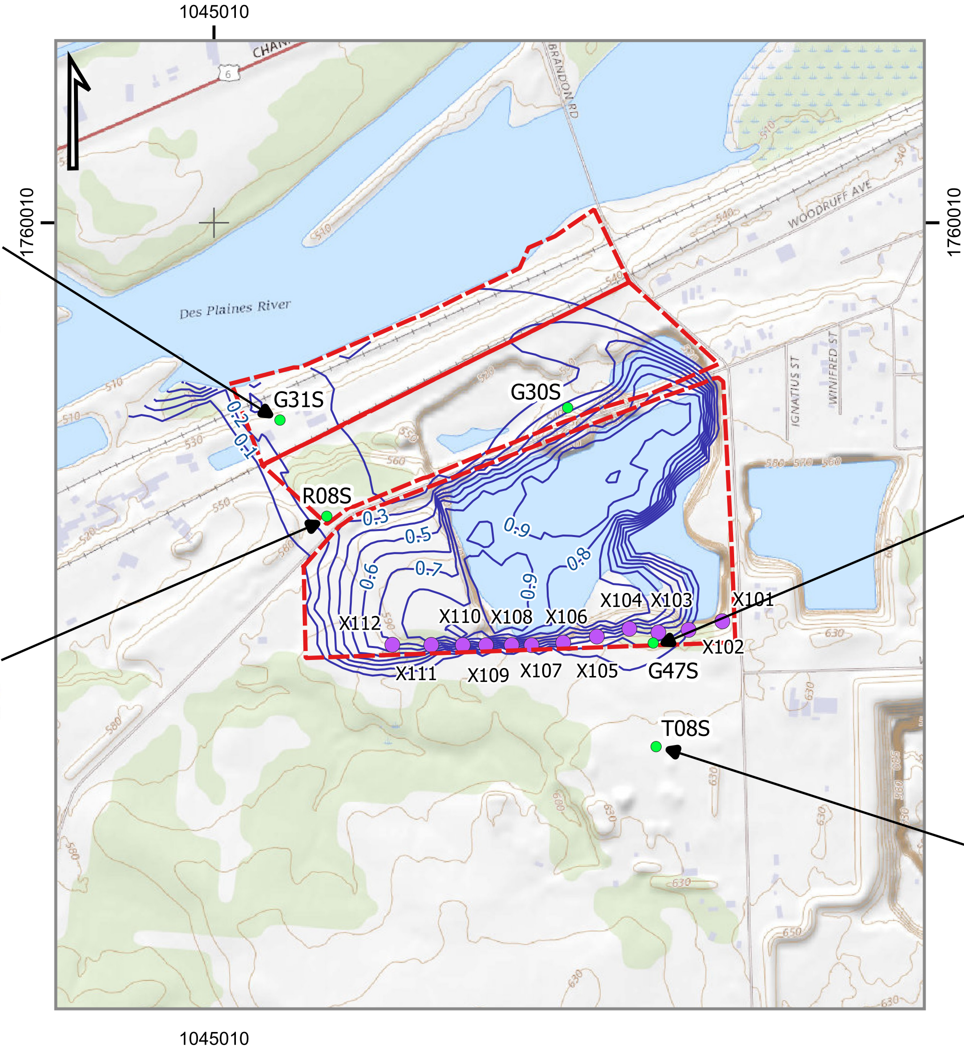
SCALE AT ANSI A	DRAWN	DZF	01/28/2022
1:14,000	CHECKED	BAS	01/28/2022

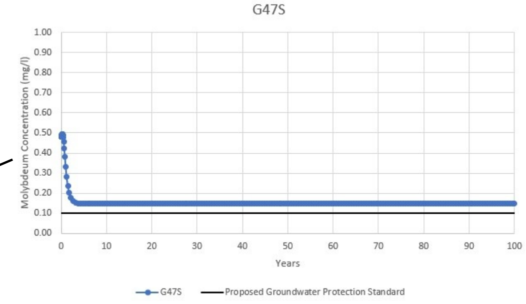
BAS PROJECT No.
21141201

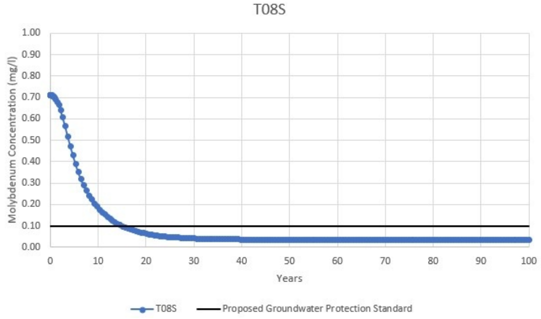
APPENDIX:
D5











STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

RELATIVE CONCENTRATIONS IN MODEL LAYER 5, AT 25 YEARS

LEGEND

🟥 PROPERTY BOUNDARY
● EXTRACTION WELLS
● MONITORING WELL LOCATION
— RELATIVE SURROGATE CONCENTRATIONS

GRAPH

— PROPOSED GROUNDWATER PROTECTION STANDARD

BAS GROUNDWATER CONSULTING

KPRG

0 700 1,400 ft
FEET

Coordinate System:
Project File: AppendixD6_Scenario4_MolyConcentrationsOverTime.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	JOLIET 9, LINCOLN STONE QUARRY 1601 S. PATTERSON RD., JOLIET, IL
TITLE	**ALTERNATIVE 4, MOLYBDENUM CONCENTRATIONS OVER TIME**

SCALE AT ANSI A 1:14,000	*DRAWN*	*DZF*	01/28/2022
	CHECKED	*BAS*	01/28/2022
BAS PROJECT No. *21141201*		*APPENDIX:* **D6**	

BAS GROUNDWATER CONSULTING

basgroundwater.com

ATTACHMENT 9
GROUNDWATER MONITORING INFORMATION

Attachment 9-1 – Boring Logs

HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG Replacement R08S

R08SD

Sheet No. 1/5

Date 4/6/93

PROJECT JOLIET/LINCOLN QUARRY S44 (R08S) Installed adjacent to this hole.

Hole No. R108 /R08D/S

Feature East of Cav? to N of west fill

Coordinates: N

E

Core Sizes —

Angle (from Horizontal) VERTICAL

Bearing —

Date Started 4/6/93

Date Completed 4/7/93

Total Depth 208'

Ground Elevation 5?–

Rock Elevation

Overburden Thickness 23'

Ground–Water Elevation

Logged by J E GRIGGS

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
0		NO SAMPLE	NO SAMPLE	Logged from cuttings 0-23': FILL	NO SAMPLE	NO SAMPLE	NO SAMPLE		DRILLING SITE 8.5' SW OF G108 0-208': 6" Air Hammer Gardner Denver Rig Completed as a nested well pair. PVC wells installed at 120' and 204'
10									
20				23' - 43': DOLOMITE; pinkish gray; fresh angular chips; green sticky shale					
30									
40									

HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

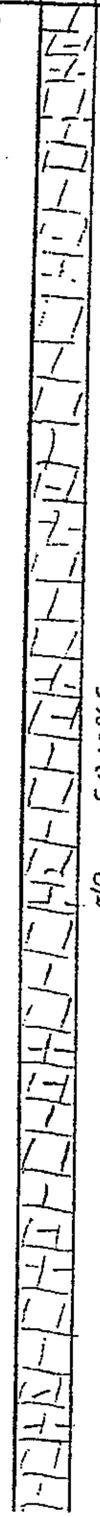
KO22/D
Sheet No. 2 of 6
Date 4/7/93

PROJECT JOLIET/LINCOLN QUARRY 54446

Hole No. R108
Feature East of Coal Pile N. of west Fill
Coordinates: N
E
Core Sizes –

Angle (from Horizontal) VERTICAL
Bearing –
Date Started 4/6/93
Date Completed 4/7/93
Total Depth 208

Ground Elevation
Rock Elevation
Overburden Thickness 23'
Ground–Water Elevation
Logged by JEGRIGGS



Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.—Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
40				43'-87': DOLOMITE; light gray; fresh angular chips; green sticky shale					
50									
60		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
70									
80									

HES HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

KOE S/D
Sheet No. 3 of 6
Date 4/7/93

PROJECT JOLIET/LINCOLN QUARRY E444G

Hole No. R108
Feature East of Coal Pile N of West Fill
Coordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/6/93
Date Completed 4/7/93
Total Depth 208'

Ground Elevation
Rock Elevation
Overburden Thickness 23'
Ground—Water Elevation
Logged by JE GRIGGS

Depth (Elevation)	Graphic Log Lithology	Graphic Log Structure	Graphic Log Attitude	Classification and Physical Condition	C.R.— Graphic	Core Rec. %	RQD %			Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
80										
90				87'-125': DOLOMITE; light gray; fresh angular chips; green sticky shale; white chert						
100		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE			
110										

HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 4 of 6
Date 4/7/93

PROJECT JOLIET (LINCOLN QUARRY 5444G

Hole No. R108
Feature East of Coal Pit, N. of West Fill
Coordinates: N
E
Core Sizes —
Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/6/93
Date Completed 4/7/93
Total Depth 208'
Ground Elevation
Rock Elevation
Overburden Thickness 23'
Ground–Water Elevation
Logged by JEGRIGGS

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
120									
				125'-160': DOLOMITE; mostly dark gray; fresh angular chips; black shale					
130									
140		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
150									

HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 5 OF 6
Date 4/7/93

PROJECT JOLIET/LINCOLN QUARRY 5444G

Hole No. R108
Feature Tail of Coal Pile, N. of West Fill
Coordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/6/93
Date Completed 4/7/93
Total Depth 208'

Ground Elevation
Rock Elevation
Overburden Thickness 23'
Ground–Water Elevation
Logged by JE 601665

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
160				160'–168'; SHALE; black; fresh angular chips					
170				168'–202'; DOLOMITE; light gray; fresh angular chips; green sticky shale					
180		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
190									
200									

HES HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 6 of 6
Date 4/7/93

PROJECT JOLIET/LINCOLN QUARRY 54446

Hole No. R108
Feature East of Coal Pile, N. of Wed Fill
Coordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/6/93
Date Completed 4/7/93
Total Depth 208'

Ground Elevation
Rock Elevation
Overburden Thickness 23'
Ground–Water Elevation
Logged by JE GRIGGS

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
200				202'-208': SHALE; green and black; green sticky					
210				END OF BORING 208'					

Illinois Environmental Protection Agency

Well Completion Report

Site Number: 1978090001 County: Will

(R08S)

Site Name: Midwest Generation - Lincoln Quarry, Joliet, IL

Well #: A08S

State Plane Coordinate: X 1758220 Y 1045679 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Borehole #: A08S

Surveyed by: Jacob & Hefner Associates

IL Registration #: 35-003247

Drilling Contractor: Layne Northwest

Driller: R. Treptow

Consulting Firm: KPRG and Associates, Inc.

Geologist: P. Allenstein

Drilling Method: Core / Air Rotary

Drilling Fluid (Type): none

Logged By: P. Allenstein

Date Started: 02/02/06 Date Finished: 02/06/06

Report Form Completed By: P. Allenstein

Date: 03/01/06

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite Grout

Installation Method: tremie pump

Setting Time: ____

Type of Bentonite Seal - - Granular, Pellet, [✓ Slurry]
(Choose One)

Installation Method: ____

Setting Time: ____

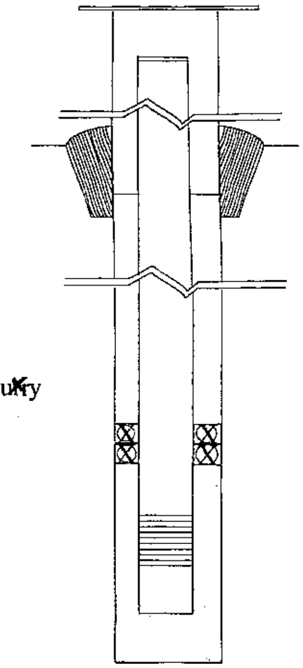
Type of Sand Pack: Filter Sand

Grain Size: 5 (Sieve Size)

Installation Method: gravity

Type of Backfill Material: none
(if applicable)

Installation Method: ____



Elevations (MSL)*	Depths (BGS)	(.01ft.)
	-3.2	Top of Protective Casing
578.109	-3.0	Top of Riser Pipe
575.606	0.0	Ground Surface
	2.0	Top of Annular Sealant
		Static Water Level (After Completion)
		Top of Seal
469.606	106	Top of Sand Pack
465.606	110	Top of Screen
455.606	120	Bottom of Screen
455.606	120	Bottom of Well
455.606	120	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIAL
(Choose one type of material for each area)

Protective Casing	SS304, SS316, PTFE, PVC, or [✓ Other]
Riser Pipe Above W.T.	SS304, SS316, PTFE, [✓ PVC], or Other
Riser Pipe Below W.T.	SS304, SS316, PTFE, [✓ PVC], or Other
Screen	SS304, SS316, PTFE, [✓ PVC], or Other

CASING MEASURMENTS

Diameter of Borehole (inches)	7
ID of Riser Pipe (inches)	2
Protective Casing Length (feet)	5
Riser Pipe Length (feet)	113
Bottom of Screen to End Cap (feet)	0.5
Screen Length (1st slot to last slot) (feet)	10
Total Length of Casing (feet)	123
Screen Slot Size **	0.010

**Hand-Slotted Well Screens are Unacceptable

HES HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

K1SD

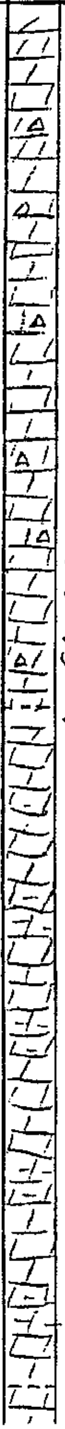
Sheet No. 1 of 5
Date 4/5/93

PROJECT JOLIET /LINCOLN QUARRY 54446

Hole No. R16 — G205 Clustered
…ature SE Corner of N. Quarry
…oordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/5/93
Date Completed 4/6/93
Total Depth 190.5'

Ground Elevation
Rock Elevation
Overburden Thickness NONE
Ground–Water Elevation
Logged by JEGRIGGS



Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
0				Logged from cuttings 0–20': DOLOMITE; light gray; fresh angular chips; some white chert					DRILLING SITE ≈ 7' SE OF LOCATION G16 0–190.5': 6" Air hammer Gardner-Denver RIG Completed as a nested well pair. PVC wells installed at 134' and 188'.
10									
20		NO SAMPLE	NO SAMPLE	20'–39': DOLOMITE, pinkish gray; fresh angular chips; green sticky shale	NO SAMPLE	NO SAMPLE	NO SAMPLE		
30									
40									

HES HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 2 of 5
Date 4/5/93

PROJECT JOLIET/LINCOLN QUARRY 5444G

Hole No. R16
ature SE Corner of N. Quarry
ordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/5/93
Date Completed 4/6/93
Total Depth 190.5'

Ground Elevation
Rock Elevation
Overburden Thickness NONE
Ground–Water Elevation
Logged by JEGRIGGS

Depth (Elevation)	Graphic Log			Classification and Physical Condition	C.R.–Graphic	Core Rec, %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
	Lithology	Structure	Attitude						
40				39'– 78': DOLOMITE; light gray; fresh angular chips; green sticky shale					
50									
60		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
70									
80				78'– 114'; DOLOMITE; light gray; fresh angular chips; green sticky shale; white chert					

HES HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 3 of 5
Date 4/5/93

PROJECT JOLIET/LINCOLN QUARRY 5444G

Hole No. R16
ature SE Corner of N. Quarry
oordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/5/93
Date Completed 4/6/93
Total Depth 190.5

Ground Elevation
Rock Elevation
Overburden Thickness NONE
Ground–Water Elevation
Logged by JEGRIGGS

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.—Graphic	Core Rec. %	RQD %			Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
80										
90										
		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE			
100										
110										
				114' – 146': DOLOMITE; mostly dark gray; fresh angular chips; black shale						
120										

HES HARZA
ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

Sheet No. 4 of 5
Date 4/6/93

PROJECT JOLIET/LINCOLN QUARRY [illegible]

Hole No. R16
ture SE Corner of N. Quarry
rdinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/5/93
Date Completed 4/6/93
Total Depth 202.5'

Ground Elevation
Rock Elevation
Overburden Thickness NONE
Ground–Water Elevation
Logged by JE GRIGGS

Depth (Elevation)	Structure	Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
120								
130								
140	NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
			146'-154': SHALE, black; fresh angular chips					
150								
			154'-187': DOLOMITE, light gray; fresh angular chips; green sticky shale					
160								

HARZA ENVIRONMENTAL SERVICES, INC.

GEOLOGIC LOG

[illegible]
Sheet No. 5 of 5
Date 4/6/93

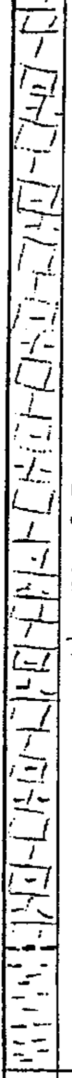
PROJECT JOLIET/LINCOLN QUARRY

Hole No. R16
ature SE Corner of N. Quarry
oordinates: N
E
Core Sizes —

Angle (from Horizontal) VERTICAL
Bearing —
Date Started 4/5/93
Date Completed 4/6/93
Total Depth 190.5'

Ground Elevation
Rock Elevation
Overburden Thickness NONE
Ground–Water Elevation
Logged by J E GRIGGS

Depth (Elevation)	Graphic Log: Lithology	Graphic Log: Structure	Graphic Log: Attitude	Classification and Physical Condition	C.R.–Graphic	Core Rec. %	RQD %		Remarks (Sample Data, Water Levels, Drilling Characteristics etc.)
160									
170									
		NO SAMPLE	NO SAMPLE		NO SAMPLE	NO SAMPLE	NO SAMPLE		
180									
				187–190.5': SHALE, green and black; green sticky					
190									
				END OF BORING 190.5'					
200									



ATTACHMENT 8

Illinois Environmental Protection Agency

Well Completion Report

Site #: 1978990001 County: Will Well #: G20S

Site Name: Joliet/Lincoln Quarry Grid Coordinate: Northing 1,759,155.3 Easting 1,048,014.7

Drilling Contractor: TSC Date Drilled Start: 9/8/93

Driller: Greg Donovan Geologist: John Pyrich Date Completed: 9/10/93

Drilling Method: Mud Rotary Drilling Fluids (type): Bentonite

Annular Space Details

Type of Surface Seal: Concrete

Type of Annular Sealant: High Solids Bentonite Grout

Amount of cement: # of bags ______ lbs. per bag ______

Amount of bentonite: # of bags ______ lbs. per bag ______

Type of Bentonite Seal (Granular, Pellet): Pellet

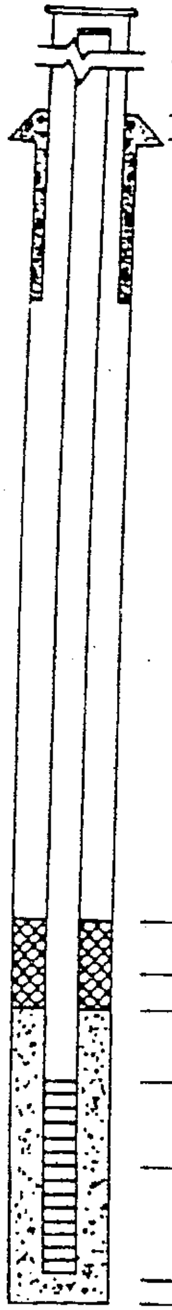
Amount of bentonite: # of Bags ______ lbs. per bag ______

Type of Sand Pack: Silica Sand

Source of Sand: Colorado

Amount of Sand: # of bags ______ lbs. per bag ______

Elevations — .01 ft.



	MSL Top of Protective Casing
580.23	MSL Top of Riser Pipe
2.73	ft. Casing Stickup
577.5	MSL Ground Surface
3	ft. Top of annular sealant
117	ft. Top of Seal
3	ft. Total Seal Interval
120	ft. Top of Sand
123	ft. Top of Screen
10	ft. Total Screen Interval
133	ft. Bottom of Screen
140	ft. Bottom of Borehole

Well Construction Materials

	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser coupling joint			40	
Riser pipe above w.t.			40	
Riser pipe below w.t.			40	
Screen			40	
Coupling joint screen to riser			40	
Protective casing				Steel

Measurements

to .01 ft. (where applicable)

Riser pipe length	125.73
Protective casing length	5
Screen length	10
Bottom of screen to end cap	0.5
Top of screen to first joint	10
Total length of casing	-
Screen slot size	10
% of openings in screen	1.6
Diameter of borehole (in)	6-3/4
ID of riser pipe (in)	2

Completed by: ______ Surveyed by ______ Ill. registration # ______

HARZA

GEOLOGIC LOG

BOREHOLE NUMBER
92-5
G305

PROJECT NUMBER 5444 6
CLIENT Commonwealth Edison
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1758877.989
(E) 1047147.728
LOGGED BY John E. Griggs
DATE STARTED 9/23/92 DATE COMPLETED 9/24/92

WEATHER
TOTAL DEPTH 144.0 SOIL THICKNESS 6.0'
GROUND SURFACE ELEVATION 522.1' MSL
SHEET 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AD=After Drilling		
Depth (Ft)		
Time		
Date		

ELEV (FT)	DEPTH (FT)	SAMPLE NUMBER	RECOVERY %
520.0	0 0		
510 0	-10 0	1	100
		2	97
500 0	-20 0		
		3	100
490 0	-30 0		
		4	100
480 0	-40 0		
		5	99
470 0	-50 0		
		6	100
460 0	-60 0		
		7	100
450 0	-70 0		
		8	100
440 0	-80 0		
		9	100
430 0	-90 0		
		10	100
	-100 0		

RQD %

DESCRIPTION

FILL 0 - 6 0' NOT SAMPLED gravel fill, debris from quarry operations

DOLOMITE SHALEY 8 8 - 26 4 light gray, shale partings green. thin bedded <0 1' to 0 9', shale partings very thin <1/4" thick, irregularly spaced, shale is sticky. rock breaks along partings with light hammer blow.
10 0'-22 3' broken along shale partings, likely during drilling, max 0 6', min 0 05', several thin vuggy zones lined with calcite and pyrite crystals. most shale partings spaced 0 2'. core segments have ground against each other at breaks during coring (ends show rotation).
22 3'-26 4' broken across shale partings and vuggy zones, max 1 0', min 0 1'. more porous and vuggy than above. vugs lined with calcite crystals. dark green speckles in rock. occasional fossils. vug openings up to 0 1', some clay infilling in vuggy zones

DOLOMITE CHERTY 26 4' - 79 5' shaley. light gray, chert white, shale green. chert nodules spaced 2 5' to 6 0', most <0 7', irregularly spaced, fossiliferous, chalky locally. shale partings spaced <0 1' to 0 3', <1/4" thick, irregularly spaced, sticky, chert scratched with knife, chalky locally
26 4'- 41 5' mostly broken along shale partings and chert nodules, max 0 7', min <0 1'. chert nodules <0 1' to 0 3' in diameter. dolomite vuggy, openings up to 0 5", most <1/4", lined with calcite and pyrite crystals. occasional fossils
41 5'- 79 5 broken along shale partings and chert nodules, max 1 3', min <0 1', chert nodules <0 1' to 0 2' in diameter. shale partings more numerous, thinner and wavey. vugs less common than above, lined with calcite and pyrite crystals. fossils

DOLOMITE SHALEY 79 5' - 93 2' light to dark gray, shale black. shale partings irregularly spaced up to 0 15', very thin, wavey, dense. occasional vugs lined with calcite and pyrite crystals. broken along shale partings max 2 5', min 0 1'. occasional fossils. shale partings predominant toward bottom

SHALE 93 2' - 100 2' dolomitic. black to greenish, black toward bottom. dolomite light gray, very thin bedded, <0 1' to 0 2' thick, spaced 0 4' to 0 9', dense. friable, can break easily with hands. broken along shale partings, max 1 2', min <0 1'. occasional fossils
98 0' color change from black to green across bedding planes

LITHOLOGY

COMMENTS

Drilling site 60' north of quarry wall at east end of bridge in North Quarry

0-6' 4 25" OD SSA
6'-8 8' NW casing with bit
8 8'- 144 0' NX

Mobile B51 rig modified with new driver head equivalent to B80

Coring rate ranged between 20' and 30' per hour

Return fluid initially milky

Completed as a nested pair of PVC wells installed at 60' and 132'

HARZA

GEOLOGIC LOG

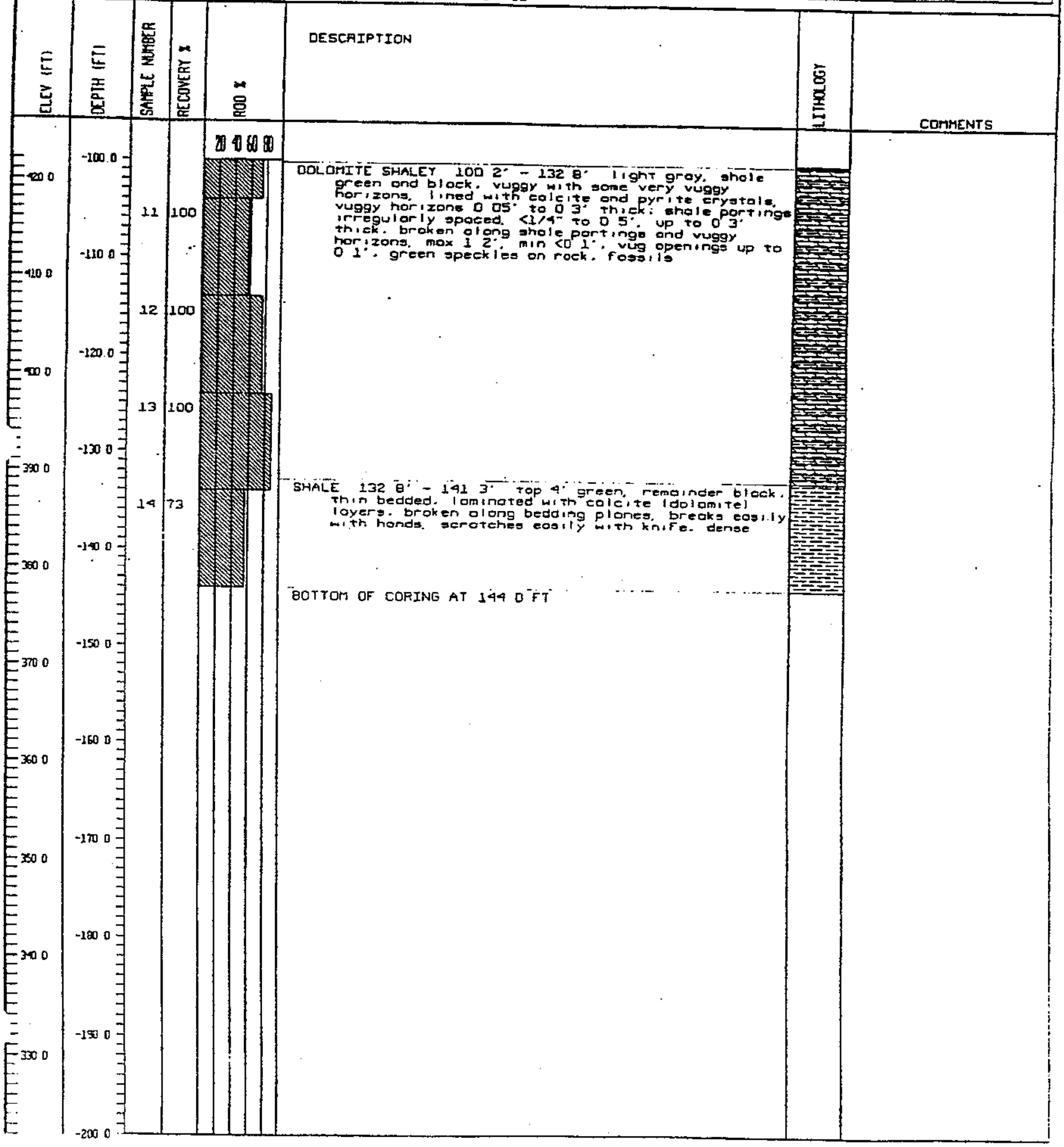
BOREHOLE NUMBER
92-5

G305

PROJECT NUMBER 5444 6
CLIENT Commonwealth Edison
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1758877.989
(E) 1047147.728
LOGGED BY John E. Griggs
DATE STARTED 9/23/92 DATE COMPLETED 9/24/92

WEATHER
TOTAL DEPTH 144.0 ~~SOIL~~ THICKNESS 6.0'
GROUND SURFACE ELEVATION 522.1' MSL
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)		
	WD=While Drilling	AD=After Drilling
Depth (Ft)		
Time		
Date		



SAMPLE NUMBER	RECOVERY %
11	100
12	100
13	100
14	73

DESCRIPTION

DOLOMITE SHALEY 100 2' - 132 8' light gray, shale green and black, vuggy with some very vuggy horizons, lined with calcite and pyrite crystals, vuggy horizons 0 05' to 0 3' thick; shale partings irregularly spaced, <1/4" to 0 5', up to 0 3' thick, broken along shale partings and vuggy horizons, max 1 2', min <0 1', vug openings up to 0 1', green speckles on rock, fossils

SHALE 132 8' - 141 3' top 4' green, remainder black, thin bedded, laminated with calcite (dolomite) layers, broken along bedding planes, breaks easily with hands, scratches easily with knife, dense

BOTTOM OF CORING AT 144 0 FT

ATTACHMENT B

Illinois Environmental Protection Agency

Well Completion Report

Site #: 1978090001 County: Will Well #: 92-5S G-30S

Site Name: Joliet/Lincoln Quarry Grid Coordinate: Northing 1,758,876.0 Easting 1,047,147.7

Drilling Contractor: TSC Date Drilled Start: 9/23/92

Driller: Greg Donovan Geologist: John E. Griggs Date Completed: 10/8/92

Drilling Method: NX Core/Rotary Drilling Fluids (type): Water

Annular Space Details

Type of Surface Seal: Concrete

Type of Annular Sealant: High Solids Bentonite Grout

Amount of cement: # of bags ___ lbs. per bag ___

Amount of bentonite: # of bags ___ lbs. per bag ___

Type of Bentonite Seal (Granular, Pellet): Pellet

Amount of bentonite: # of Bags ___ lbs. per bag ___

Type of Sand Pack: Silica Sand

Source of Sand: Colorado

Amount of Sand: # of bags ___ lbs. per bag ___

Well Construction Materials

	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser coupling joint			40	
Riser pipe above w.t.			40	
Riser pipe below w.t.			40	
Screen			40	
Coupling joint screen to riser			40	
Protective casing				Steel

Measurements

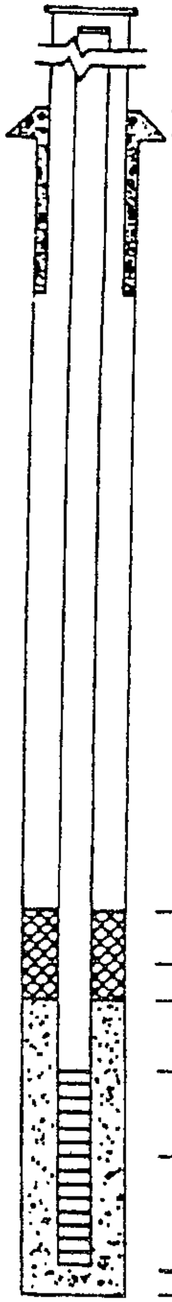
to .01 ft. (where applicable).

Riser pipe length	52.16
Protective casing length	5
Screen length	10
Bottom of screen to end cap	0.5
Top of screen to first joint	10
Total length of casing	–
Screen slot size	10
% of openings in screen	1.6
Diameter of borehole (in)	6
ID of riser pipe (in)	2

Elevations — .01 ft.

		MSL Top of Protective Casing
	524.26	MSL Top of Riser Pipe
	2.16	ft. Casing Stickup
	522.1	MSL Ground Surface
	3	ft. Top of annular sealant

Note: 92-5D installed in same boring



	45	ft. Top of Seal
	3	ft. Total Seal Interval
	48	ft. Top of Sand
	50	ft. Top of Screen
	10	ft. Total Screen Interval
	60	ft. Bottom of Screen
	144	ft. Bottom of Borehole

Completed by: ___ Surveyed by: ___ Ill. registration # ___

G31S/D

HARZA

GEOLOGIC LOG

BOREHOLE NUMBER
G310

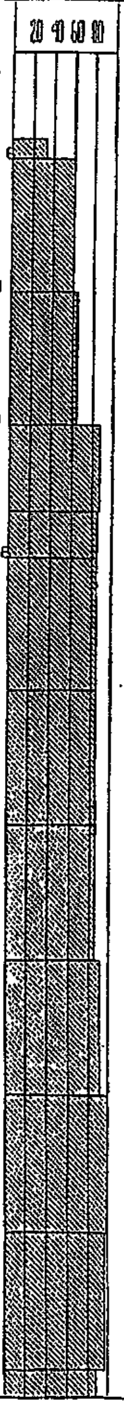
PROJECT NUMBER 15448 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1758807.242
(E) 1045388.601
LOGGED BY Jeff Dickson
DATE STARTED 07/30/99 DATE COMPLETED 08/03/99

WEATHER
TOTAL DEPTH 155 0' SOIL THICKNESS 6 5'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 1 OF 2

STATIC WATER LEVEL (SLS)	WD=While Drilling	AD=After Drilling
Depth (Ft)		
Time		
Date		

ELEV (FT)	DEPTH (FT)	SAMPLE NUMBER	RECOVERY %
0 0	0 0		
		1	
		2	86
10 0	-10 0		
		3	100
20 0	-20 0		
		4	100
30 0	-30 0		
		5	100
		6	85
40 0	-40 0		
		7	100
50 0	-50 0		
		8	100
60 0	-60 0		
		9	100
70 0	-70 0		
		10	100
80 0	-80 0		
		11	100
90 0	-90 0		
		12	100
	-100 0		

RQD %



DESCRIPTION

GLACIAL DRIFT 0 - 6 5' NOT SAMPLED overburden, gravel with dark yellow-brown silty clay

DOLOMITE 6 5' - 48' dolomitized bioclastic calcarenite, oxidized yellow-orange, broken at top due to the weathering, thin wavy laminations with shale partings, fossiliferous, vugy where fossiliferous
11 5' 6" fracture with oxidized sides and some clay
13 0' many fossils showing modic porosity
20 0' white gray dolomite, thin laminations with green shale partings, fossiliferous
39 0'-48 0' white gray dolomite with green shale partings, rock easily breaks along partings

DOLOMITE CHERTY 48' - 85' shaley, white to light gray dolomite, chert white, shale green, chert nodules spaced <0 1' to 1', most <0 5', irregularly spaced, fossiliferous, shale partings spaced <0 1' to 0·3', <1/4" thick, irregularly spaced

DOLOMITE SHALEY 85' - 98 5' chert nodules discontinue, rock becomes more shaley, color change from light gray to gray as clay content increases with depth

SHALE 98 5' - 122 8' dolomitic, gray-green and change

LITHOLOGY

COMMENTS

0' - 6 5' 3 1/4" ID Auger blind drill
6 5' - 155 0' NX core
Mobile Gus Pech 750 air rotary rig with potable water fluid
Coring rate ranged between 15' and 20' per hour
Reamed with 5 7/8" rotary bit to 156' using potable water fluid
Installed PVC well at 155'

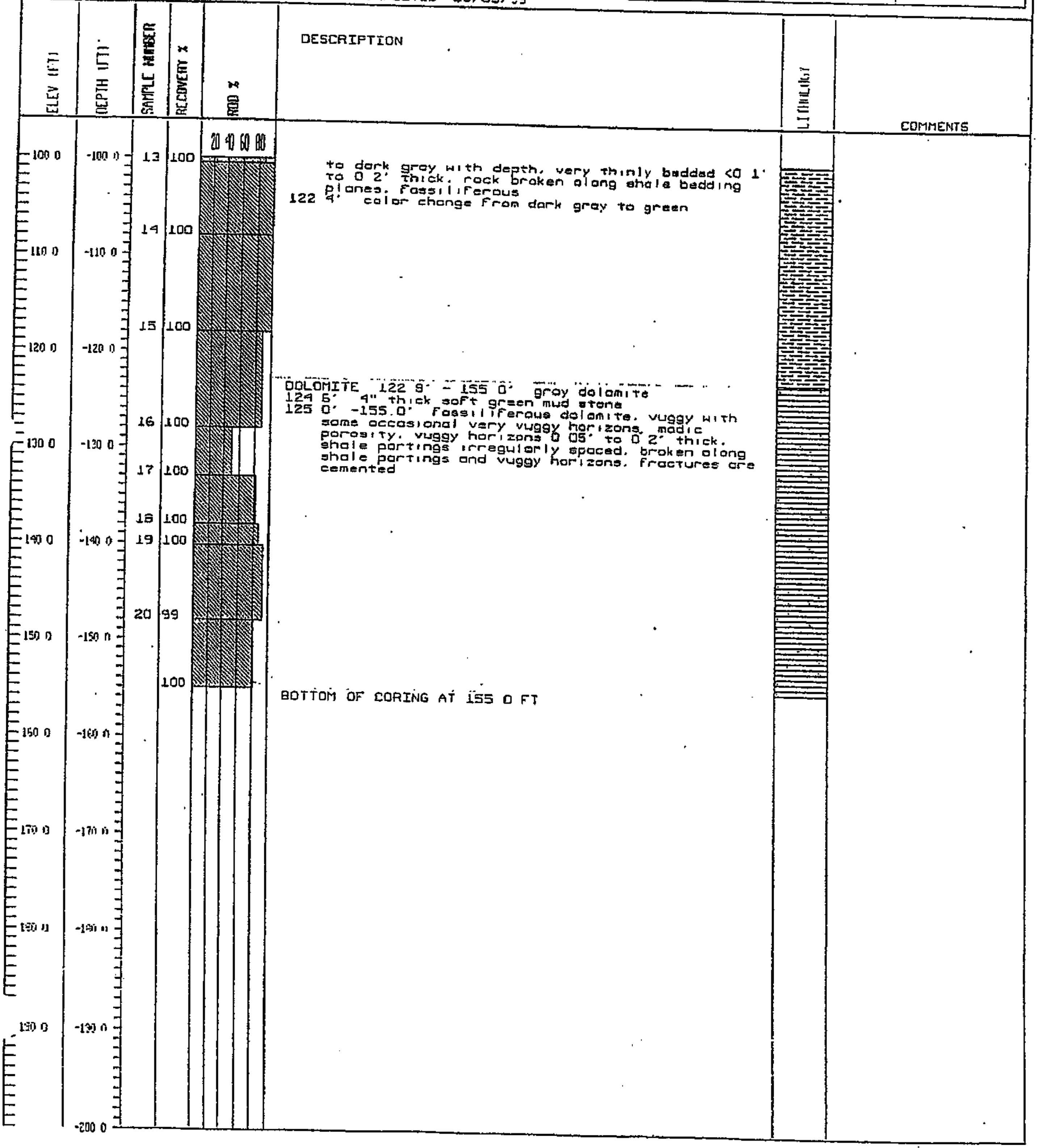
G31 5/D

HARZA | **GEOLOGIC LOG** | BOREHOLE NUMBER G310

PROJECT NUMBER 15448 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1758807.242
(E) 1045388.601
LOGGED BY Jeff Dickson
DATE STARTED 07/30/99 DATE COMPLETED 08/03/99

WEATHER
TOTAL DEPTH 155 0' SOIL THICKNESS 6 5'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)		
	WD=While Drilling	AD=After Drilling
Depth (Ft)		
Time		
Date		



SAMPLE NUMBER	RECOVERY %
13	100
14	100
15	100
16	100
17	100
18	100
19	100
20	99
	100

DESCRIPTION

to dark grey with depth, very thinly bedded <0 1' to 0 2' thick, rock broken along shale bedding planes. fossiliferous
122 4' color change from dark gray to green

DOLOMITE 122 9' - 155 0' gray dolomite
124 6' 4" thick soft green mud stone
125 0' -155.0' fossiliferous dolomite. vuggy with some occasional very vuggy horizons, modic porosity. vuggy horizons 0 05' to 0 2' thick. shale partings irregularly spaced. broken along shale partings and vuggy horizons. fractures are cemented

BOTTOM OF CORING AT 155 0 FT

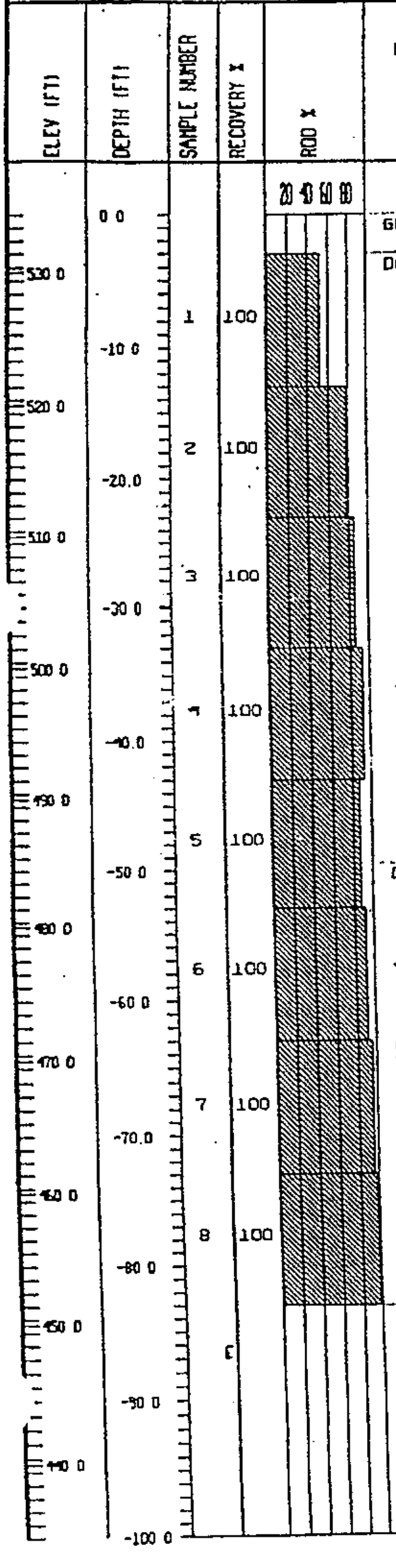
HARZA	GEOLOGIC LOG	BOREHOLE NUMBER 93-12

(R325)

PROJECT NUMBER 5444 6
CLIENT Commonwealth Edison
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1758706.812
(E) 1045763.421
LOGGED BY John Pyrich
DATE STARTED 9/1/93 DATE COMPLETED 9/3/93

WEATHER
TOTAL DEPTH 83.0' ~~SOIL~~ THICKNESS 3.0'
GROUND SURFACE ELEVATION 534.41' MSL
SHEET 1 OF 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AD=After Drilling		
Depth (Ft)		
Time		
Date		



DESCRIPTION

GLACIAL DRIFT 0 - 3 0' NOT SAMPLED brown, silty clay

DOLOMITE SHALEY 3 0' - 49 5' light gray, shale green, thin bedded <0 1' to 0 4', shale partings thin <1/4" thick, irregularly spaced, shale is sticky, rock breaks along partings with light hammer blow, occasional fossils, occasional vuggy horizons, openings up to 0 05', lined with calcite and pyrite crystals
5 9' color change from light gray to pinkish

DOLOMITE CHERTY 49 5' - 83 0' shaley, light gray, chert white, shale green, chert nodules spaced <0 1' to 1 0', most <0 8', irregularly spaced, fossiliferous, chalky locally, shale partings spaced <0 1' to 0 3', <1/4" thick, irregularly spaced, sticky
49 5'- 62 0' broken along shale partings and chert nodules, max 0 7', min <0 1', chert nodules <0 1' to 0 2' in diameter, dolomite vuggy, openings up to 0 1', most <1/4", lined with calcite and pyrite crystals, occasional fossils
62 0'-83' dolomite less vuggy, shale wavey
77 6' dolomite darker and denser

BOTTOM OF CORING AT 83 0 FT

LITHOLOGY

COMMENTS

Drilling site 57' west of 6th wooden utility pole, west of Brandon, 15' inside fence

0-3' 5 7/8" OD SSA
3'-83' NX core with clear water

GUS PECH GP 1100 ATV rig

Coring rate ranged between 20' and 30' per hour

Return fluid initially milky

Reamed with 6 3/4" rotary bit to 77' using Super Gel X with GUS PECH GP 1100 ATV rig

Installed PVC well at 77'

Illinois Environmental Protection Agency

Well Completion Report

SITE #: 1978090001 COUNTY: Will WELL #: R32S

SITE NAME: Joliet/Lincoln Quarry Ash Landfill BOREHOLE #: R32S

STATE PLANE COORDINATE: N 1758697.521 E 1045764.711 (or) LATITUDE ___°___'___" LONGITUDE ___°___'___"

SURVEYED BY: Mark Wood ILL REGISTRATION #: 0352958

DRILLING CONTRACTOR: Testing Service Corporation DRILLER: Bruce Alexander

CONSULTING FIRM: Harza Engineering Company GEOLOGIST: Hoss Najjar-Pour

DRILLING METHOD: Air Rotary DRILLING FLUIDS (TYPE): Potable Water

LOGGED BY: Hoss Najjar-Pour DATE STARTED: 8/10/99 DATE FINISHED: 8/11/99

REPORT FORM COMPLETED BY: Hoss Najjar-Pour DATE: 9/3/99

ANNULAR SPACE DETAILS

TYPE OF SURFACE SEAL: Concrete

TYPE OF UPPER SEALANT: Bentonite Pellet

INSTALLATION METHOD: Surface Pour

SETTING TIME: 30 min.

TYPE OF ANNULAR SEALANT: High Solids Bentonite Grout

INSTALLATION METHOD: Tremie Pipe

SETTING TIME: 30 min.

TYPE OF BENTONITE SEAL - GRANULAR PELLET CHIPS

INSTALLATION METHOD: Surface Pour

SETTING TIME: 30 min.

TYPE OF FINE SAND PACK: Washed Silica Sand

GRAIN SIZE: 20-40 (SIEVE SIZE)

INSTALLATION METHOD: Surface Pour

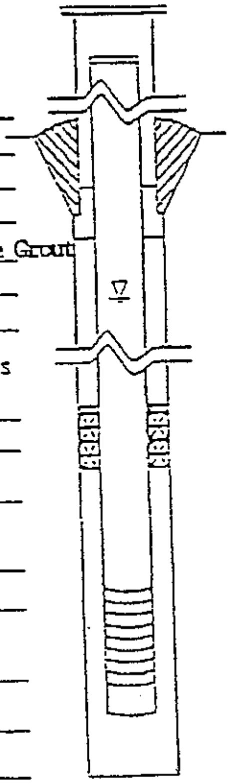
TYPE OF SAND PACK: Washed Silica Sand

GRAIN SIZE: 10-20 (SIEVE SIZE)

INSTALLATION METHOD: Surface Pour

TYPE OF BACKFILL MATERIAL: Washed Silica Sand (IF APPLICABLE)

INSTALLATION METHOD: Surface Pour



ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
		TOP OF RISER PIPE
	0.00	GROUND SURFACE
	0.5	TOP OF UPPER SEALANT
	3.0	TOP OF ANNULAR SEALANT
	2.05	WATER LEVEL (TOC) (AFTER COMPLETION) DATE: 8/20/99
	60.5	TOP OF SEAL
	63.0	TOP OF FINE SANDPACK
	65.0	TOP OF SANDPACK
	67.0	TOP OF SCREEN
	77.0	BOTTOM OF SCREEN
	77.5	BOTTOM OF WELL
	78.0	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS
(CIRCLE ONE)

PROTECTIVE CASING	SS304	SS316	PTFE	PVC	OTHER: steel
RISER PIPE ABOVE W.T.	SS304	SS316	PTFE	[✓ PVC]	OTHER:
RISER PIPE BELOW W.T.	SS304	SS316	PTFE	[✓ PVC]	OTHER:
SCREEN	SS304	SS316	PTFE	[✓ PVC]	OTHER:

REMARKS: Refer to boring log for well 93-12 for description of geologic materials encountered

CASING MEASUREMENTS

DIAMETER OF BOREHOLE	(in)	6
ID OF RISER PIPE	(in)	2
PROTECTIVE CASING LENGTH	(ft)	5
RISER PIPE LENGTH	(ft)	
BOTTOM OF SCREEN TO END CAP	(ft)	0.5
SCREEN LENGTH (1st SLOT TO LAST SLOT)	(ft)	10
TOTAL LENGTH OF CASING	(ft)	5
SCREEN SLOT SIZE *	(in)	0.01

*HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

G335/D

HARZA

GEOLOGIC LOG

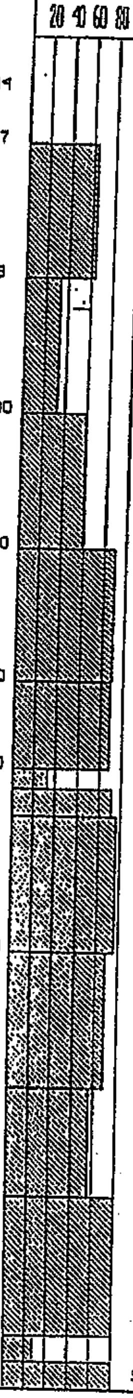
BOREHOLE NUMBER
G330

PROJECT NUMBER 15448G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1759485.478
(E) 1046925.246
LOGGED BY J. Dickson
DATE STARTED 7/19/99 DATE COMPLETED 7/22/99

WEATHER
TOTAL DEPTH 155.0' SOIL THICKNESS 4.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AD=After Drilling		
Depth (ft)		
Time		
Date		

ELEV (FT)	DEPTH (FT)	SAMPLE NUMBER	RECOVERY %
0.0	0.0		
		1	84
		2	97
10.0	-10.0		
		3	98
20.0	-20.0		
		4	100
30.0	-30.0		
		5	100
40.0	-40.0		
		6	100
50.0	-50.0		
		7	100
		8	88
		9	93
60.0	-60.0		
		10	100
70.0	-70.0		
		11	100
80.0	-80.0		
		12	100
	-90.0		
		13	70
		14	100
	-100.0		



DESCRIPTION

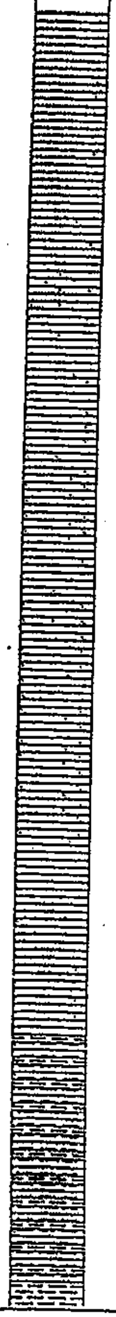
GLACIAL DRIFT 0 - 4.0' NOT SAMPLED dark-brown silty clay

DOLOMITE 4.0' - 80.0' dolomitized bioclastic calcarenite, very highly weathered and broken on top, occasional green shale, some fractures and vugs ranging from 1 mm to 5mm, bedding is very wavy with green shale partings, fossiliferous locally, chert nodules are irregularly shaped and increase with depth
60.0' -80.0' shaly, very thinly bedded, rock breaks along bedding planes

DOLOMITE SHALEY 80.0' - 98.0' very thinly bedded, fossiliferous, rock separates along beds with green shale partings, rock breaks along thin partings with light hammer blows, chert less abundant, fossiliferous locally, some vugs 1~3mm in diameter with pyrite and calcite filling
87.0' -98.0' chert almost absent, some corals, occasional pyrite filled vugs, rock breaks along partings with light tap of hammer

SHALE 98.0' - 119.5' dolomitic shale, gray, very

LITHOLOGY



COMMENTS

0-4.0' 3 7/8" air rotary
4.0' -155.0' NX core
mobile Gus Pech 750 rig
coring rate ranged 15' and 20' per hour with potable water fluid
Reamed with 5 7/8" bit to depth of 156'
Installed PVC well at 155'

G 33 S/D

HARZA

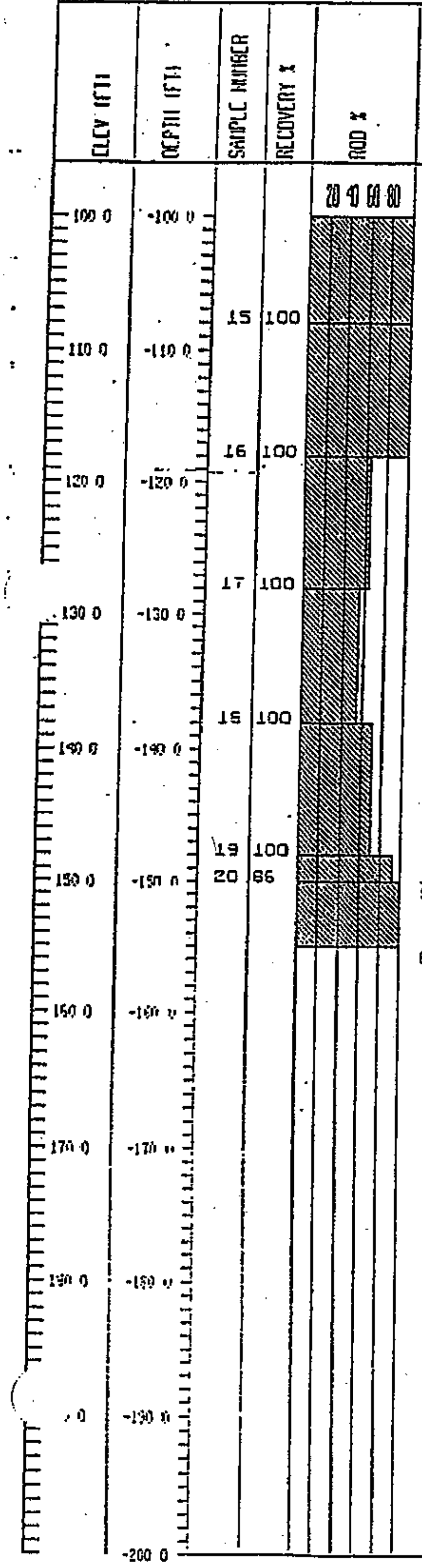
GEOLOGIC LOG

BOREHOLE NUMBER
G330

PROJECT NUMBER 15498G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1759485.478
(E) 1046925.246
LOGGED BY J. Dickson
DATE STARTED 7/19/99 DATE COMPLETED 7/22/99

WEATHER
TOTAL DEPTH 155.0' SOIL THICKNESS 4.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)		
	WD=While Drilling	AD=After Drilling
Depth (Ft)		
Time		
Date		



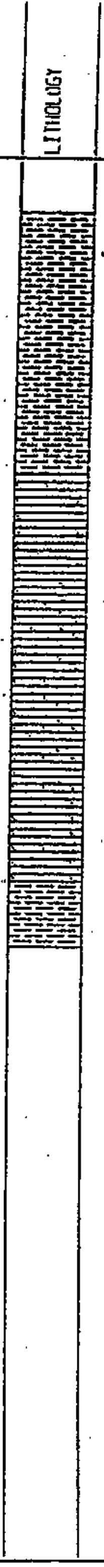
DESCRIPTION

competant, thin partings, gray, shale becomes becomes black with increase in depth
118 0' - 119 5' shale, greenish

DOLOMITE 119 5' -150 0' bioclastic calcarenite, very vuggy locally with modic porosity. fossiliferous, shale partings with irregular bedding, fractured locally and mostly cemented
127 0' -127 25' very thin laminated shale
130 0' -131 0' texture change; few fossils; highly fractured and cemented
140 0' - 148 0' dolomite is alternating between bioclastic calcarenite and thin bedded siltstone with green shale lenses, occasional fractures and mostly are cemented
148 0' -150 0' 2' vertical fracture and partially recemented

SHALE 150 0' - 155 0' green at top 1' and becoming black to very dark brown, thinly bedded and easily breaks along bedding planes, fossiliferous

BOTTOM OF CORING AT 155.0 FT



COMMENTS

HARZA

GEOLOGIC LOG

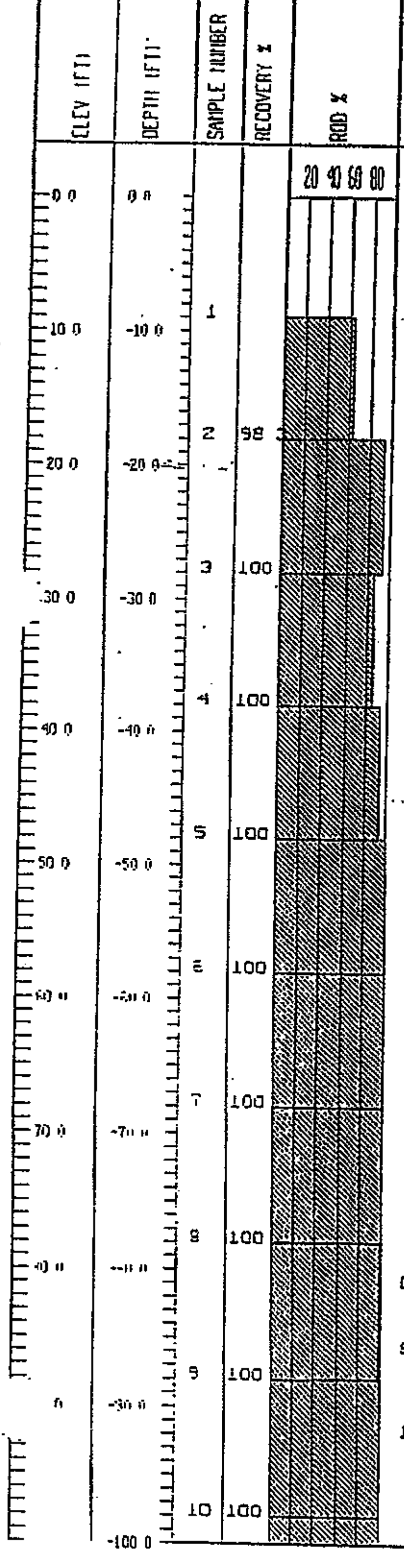
BOREHOLE NUMBER
G410 /G415

PROJECT NUMBER 15448 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1759183.828
(E) 1046293.576
LOGGED BY Jeff Dickson
DATE STARTED 07/23/99 DATE COMPLETED 07/27/99

WEATHER
TOTAL DEPTH 155.0' SOIL THICKNESS 9.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AD=After Drilling		
Depth (ft)		
Time		
Date		

SAMPLE NUMBER	RECOVERY %
1	
2	98
3	100
4	100
5	100
6	100
7	100
8	100
9	100
10	100



DESCRIPTION

GLACIAL DRIFT 0 - 9 0' NOT SAMPLED gravel with dark-yellow brown silty clay

DOLOMITE 9' - 45' dolomitized bioclastic calcarenite, very highly weathered at upper surface, reddish-yellow iron color, vuggy and highly broken, dolomite is white-gray in color, some vertical stress fractures-cemented; the remaining portion of run is more competent showing thin laminations, shale partings, green, 1-2 mm thick; rock easily breaks along shale partings, fossiliferous
20 0' - 29 0' some grayish-white with many laminations, few vugs, rock separates along wavy bedding planes filled with green shale, 1-2 mm thick
29 0' - 39.0' with wavy shaley partings, occasional zones with fossils, 0 1'-0 3' thick showing modic porosity, rock breaks along bedding/fractures, filled with green shale
39 0' - 45 0' white gray dolomite, thinly laminated, larger coral zones, vugs associated with coral zones, 4-5 mm in diameter

DOLOMITE CHERTY 45' - 80' shaley, chert, irregular nodules up to 2" thick, gray-white, dolomite wavy and laminated, thin shale parting, green, fossiliferous, many coral zones with modic porosity, rock easily breaks along partings
73 7' - 74 7' shale lense
77 5' - 78 5' vertical fracture, filled with green shale

DOLOMITE SHALEY 80' - 113' dark gray cherty shaley dolomite, fossiliferous, increase in coral, vuggy where coral exist, 1-3mm in diameter, very wavy laminations, more shaley, chert nodules fewer
89 0' - 100 0' shaley dolomite with lenses of fossils chert nodules discontinue, rock becomes more shale rock very competent, core breaks along wavy bedding, fossiliferous, fossils exhibit modic porosity
100 0' - 113 0' shaley dolomite with fossiliferous zones, lenses 1/2" thick separated by very wavy laminations of dark gray shale and lighter dolomite, occasional irregular fractures

COMMENTS

0' - 9' 3 1/4" ID Auger blind drill
9' - 155 0' NX core
Mobile Gus Pech 750 air rotary rig with potable water fluid
Coring rate ranged between 15' and 20' per hour
Reamed with 5 7/8" rotary bit to 156' using potable water fluid
Installed PVC well at 155'

HARZA

GEOLOGIC LOG

BOREHOLE NUMBER G410 / G41S

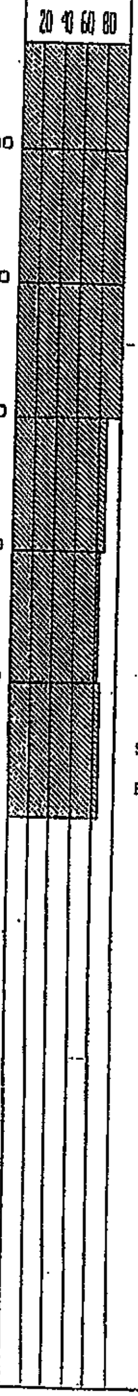
PROJECT NUMBER 15448 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1759183.828
(E) 1046293.576
LOGGED BY Jeff Dickson
DATE STARTED 07/23/99 DATE COMPLETED 07/27/99

WEATHER
TOTAL DEPTH 155.0' SOIL THICKNESS 9.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)		
	WD=While Drilling	AD=After Drilling
Depth (ft)		
Time		
Date		

ELEV (FT)	DEPTH (FT)	SAMPLE NUMBER	RECOVERY %
100.0	-100.0		
		11	100
110.0	-110.0		
		12	100
120.0	-120.0		
		13	100
130.0	-130.0		
		14	100
140.0	-140.0		
		15	100
150.0	-150.0		
			100
160.0	-160.0		
170.0	-170.0		
180.0	-180.0		
190.0	-190.0		
	-200.0		

RQD %



DESCRIPTION

SHALE 113 0' - 121 2' dark gray thinly laminated mudstone and shale, occasionally mottled. Fossil zone discontinued.
120 7'-121 2 abrupt change from very dark gray shale to green softer shale

DOLOMITE 122 5' - 154 5' bioclastic calcarenite dolomite, fossiliferous, very vuggy with modic porosity, wavy thin laminations, shale partings, green, occasional stress fractures, cemented
136 5' - 137' very vuggy
137 5' - 138 5' rock highly broken
145.5' - 146 5' clay filled, green, vertical fracture
150.5' - 151 5' very fossiliferous, vuggy
152 0' - 153 0' very fossiliferous, vuggy
153 5' - 154 0' fossiliferous, vuggy

SHALE black

BOTTOM OF CORING AT 155 0 FT

LITHOLOGY

COMMENTS

HARZA

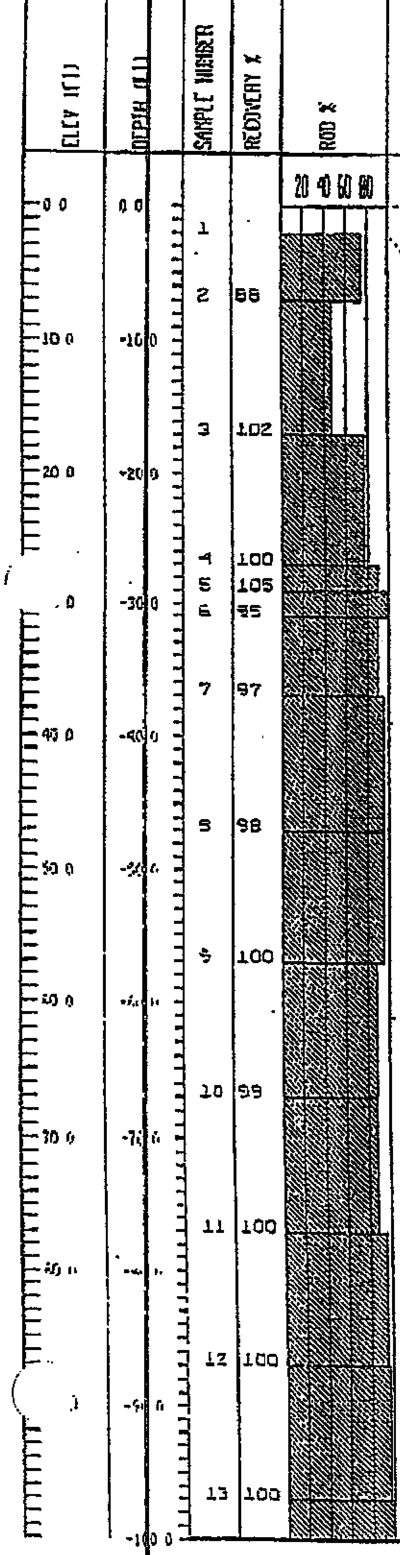
GEOLOGIC LOG

BOREHOLE NUMBER /
G92D /G425

PROJECT NUMBER 15998 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES. (N) 1759757.912
(E) 1047377.300
LOGGED BY Hoss Najjar-Pour
DATE STARTED 08/03/99 DATE COMPLETED: 08/09/99

WEATHER·
TOTAL DEPTH 155.0' SOIL THICKNESS. 2.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AD=After Drilling		
Depth (Ft)		
Time		
Date		



SAMPLE NUMBER	RECOVERY %
1	·
2	86
3	102
4	100
5	105
6	95
7	97
8	98
9	100
10	99
11	100
12	100
13	100

DESCRIPTION

GLACIAL DRIFT 0 - 2.0' NOT SAMPLED· gravel up to 2" in diameter with brown sand

DOLOMITE 2 0' - 39.0' dolomitized bioclastic calcarenite, light gray pinkish; occasional thin laminated bedding, shale partings, green, fossiliferous, vugs <1/4" in diameter; rock easily breaks along partings
17.0' - 39.0' dolomite, gray, irregular laminations, shale partings, green, fossiliferous, vugs associated with fossil horizons; rock easily breaks along partings

DOLOMITE CHERTY 39' - 79' shaley, white to light gray dolomite, chert white, chert nodules mostly <0 5', fossiliferous; vugs <1/8" in diameter; occasional wavy irregular laminations, shale partings, green

DOLOMITE SHALEY 74' - 103 7' chert nodules discontinue, rock becomes more shaley, less fossiliferous with occasional vugs of <1/8" in diameter
82' - 103 7' dark gray shaley dolomite, color changes from light gray to dark gray as clay content increases with depth

COMMENTS

0' - 2' 3 1/4" ID Auger blind drill
2' - 155 0' NX core
Mobile Gus Pech 750 air rotary rig with potable water fluid
Coring rate ranged between 15' and 20' per hour
Reamed with 5 7/8" rotary bit to 151' using potable water fluid
Installed PVC well at 150'

HARZA

GEOLOGIC LOG

BOREHOLE NUMBER
G420/G425

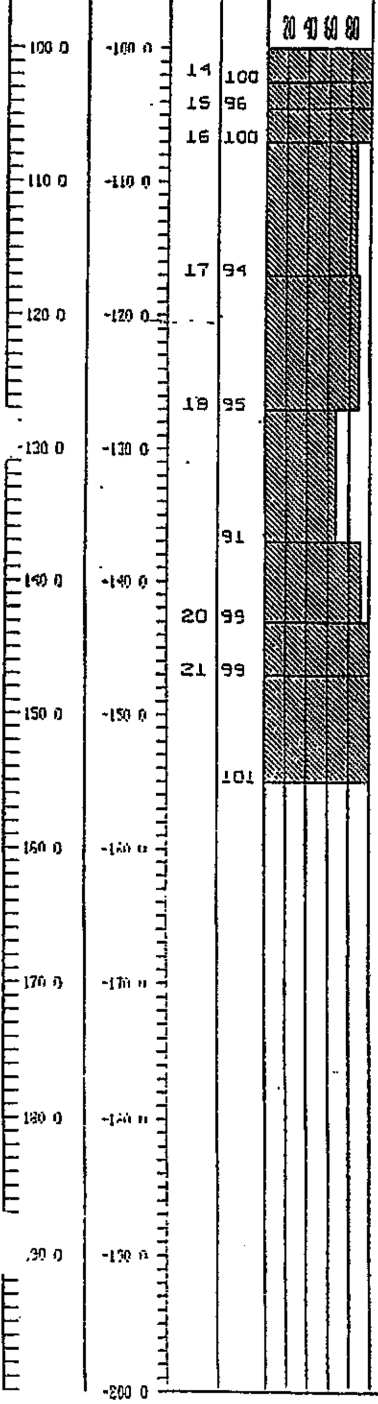
PROJECT NUMBER 15448 G
CLIENT ComEd
PROJECT NAME Joliet/Lincoln Quarry Ash Landfill
DRILLING COMPANY Testing Service Corporation
CORE SIZE NX
ANGLE 90 BEARING
COORDINATES (N) 1759757.912
(E) 1047377.300
LOGGED BY Hoss Najjar-Pour
DATE STARTED 08/03/99 DATE COMPLETED 08/09/99

WEATHER
TOTAL DEPTH 155.0' SOIL THICKNESS 2.0'
GROUND SURFACE ELEVATION pending (MSL)
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)
WD=While Drilling AD=After Drilling

Depth (Ft)		
Time		
Date		

SAMPLE NUMBER	RECOVERY %
14	100
15	96
16	100
17	94
18	95
	91
20	99
21	99
	101



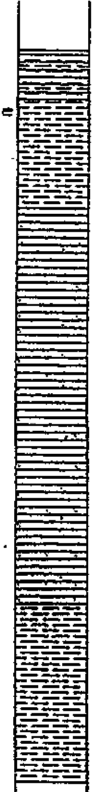
DESCRIPTION

SHALE 103.7' - 111.9' dolomitic, dark gray, increase in clay content with depth

DOLOMITE 111.9' - 141.6' white gray dolomite, fossiliferous, vuggy, some occasional very vuggy horizons: modic porosity

SHALE 141.6' - 155.0' dark gray dolomitic shale, rock is competent, occasional vugs with calcite filling

BOTTOM OF CORING AT 155.0 FT



COMMENTS

Andrews Environmental Engineering, Inc.
3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124/2003-125

Location:
Coord. System: Site Grid
Northing: 57679.8
Easting: 45567.6

Boring Information:
Boring No.: G44D
Well No.: G44S
Surf. Elev.: 585.14

Depth Information:
Total: 209.3
Auger:
Core:

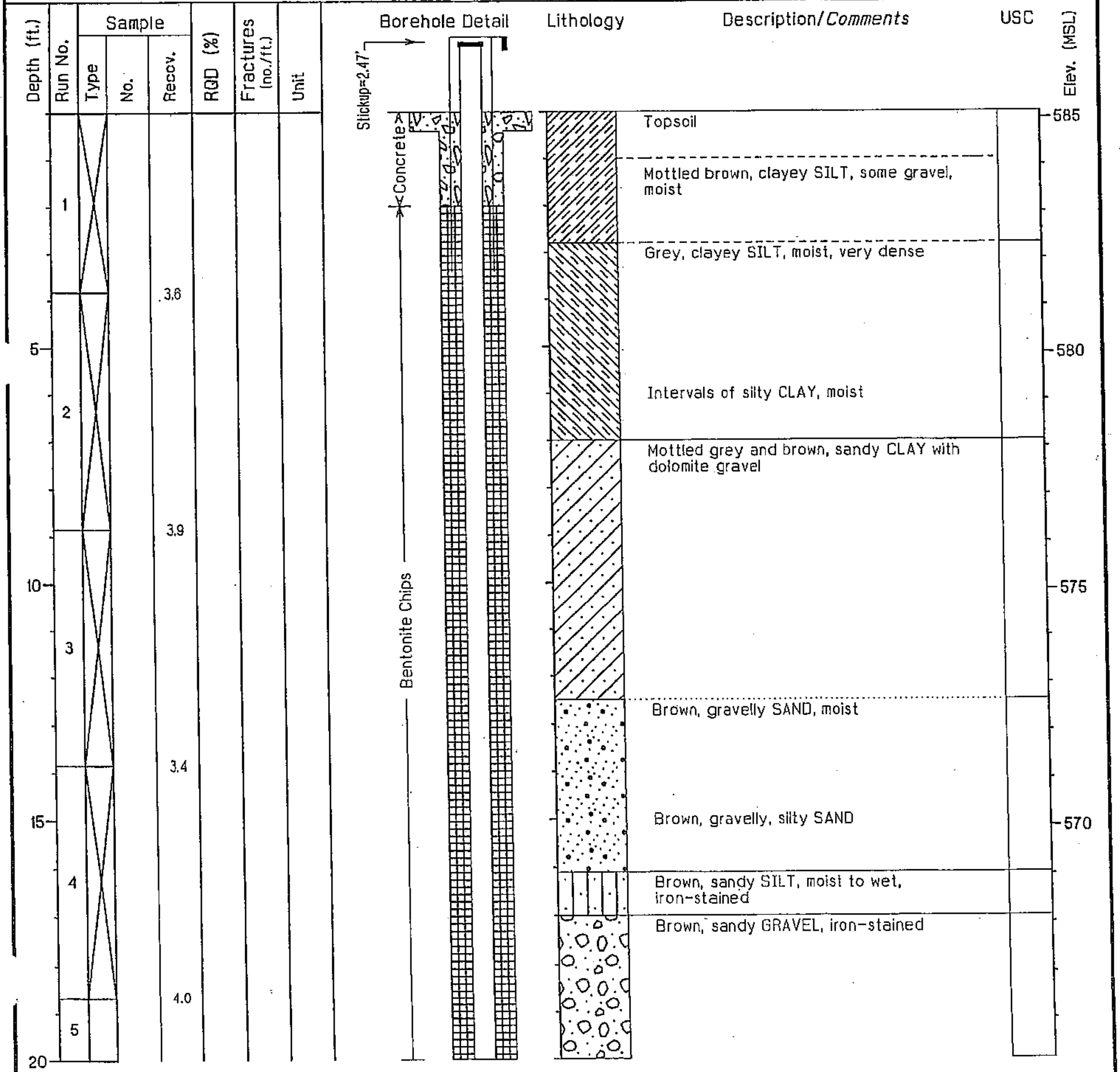
Dates:
Start: 7/19/2004
Finish: 7/21/2004

Weather:
Sunny, hot

Drilling Contractor:
Name: Raimonde Drilling Corp.
City: Elmwood Park, Illinois
Equipment: CME 55 - 8 ¼" HSA

Personnel:
Geologist: L. Janczak
Driller: D. Stefenson
Helper (s):

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ◿ - Shelby Tube ▮ - Core ☐ - Blind Drill



Description/*Comments*

Topsoil

Mottled brown, clayey SILT, some gravel, moist

Grey, clayey SILT, moist, very dense

Intervals of silty CLAY, moist

Mottled grey and brown, sandy CLAY with dolomite gravel

Brown, gravelly SAND, moist

Brown, gravelly, silty SAND

Brown, sandy SILT, moist to wet, iron-stained

Brown, sandy GRAVEL, iron-stained

NOTES:

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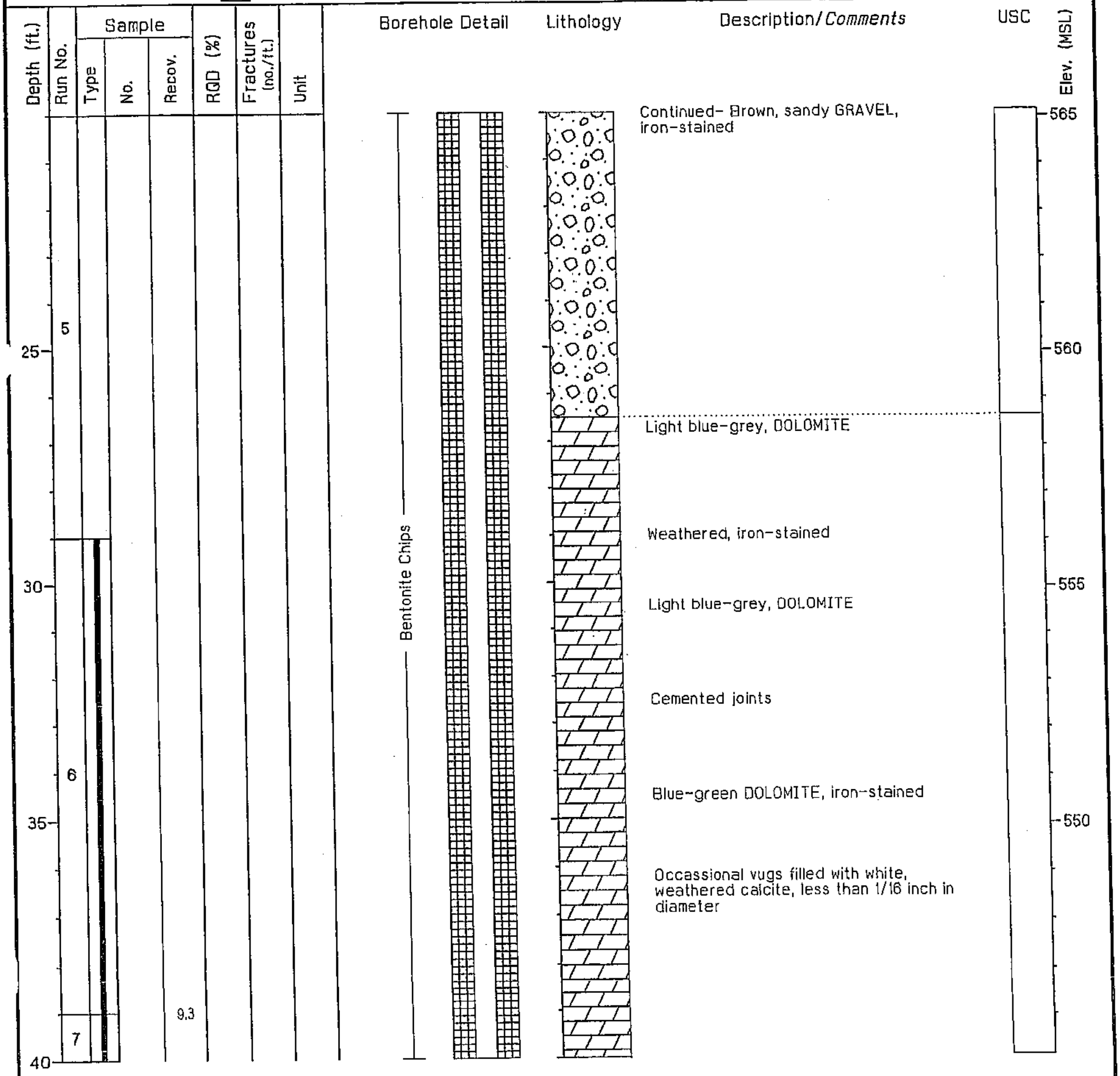

Continued- Brown, sandy GRAVEL, iron-stained

Light blue-grey, DOLOMITE

Weathered, iron-stained

Light blue-grey, DOLOMITE

Cemented joints

Blue-green DOLOMITE, iron-stained

Occassional vugs filled with white, weathered calcite, less than 1/16 inch in diameter

NOTES:

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3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

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Easting: 45567.6

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Well No.: G44S
Surf. Elev.: 585.14

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Auger:
Core:

Dates:
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Finish: 7/21/2004

Weather:
Sunny, hot

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Equipment: CME 55 - 8 ¼" HSA

Personnel:
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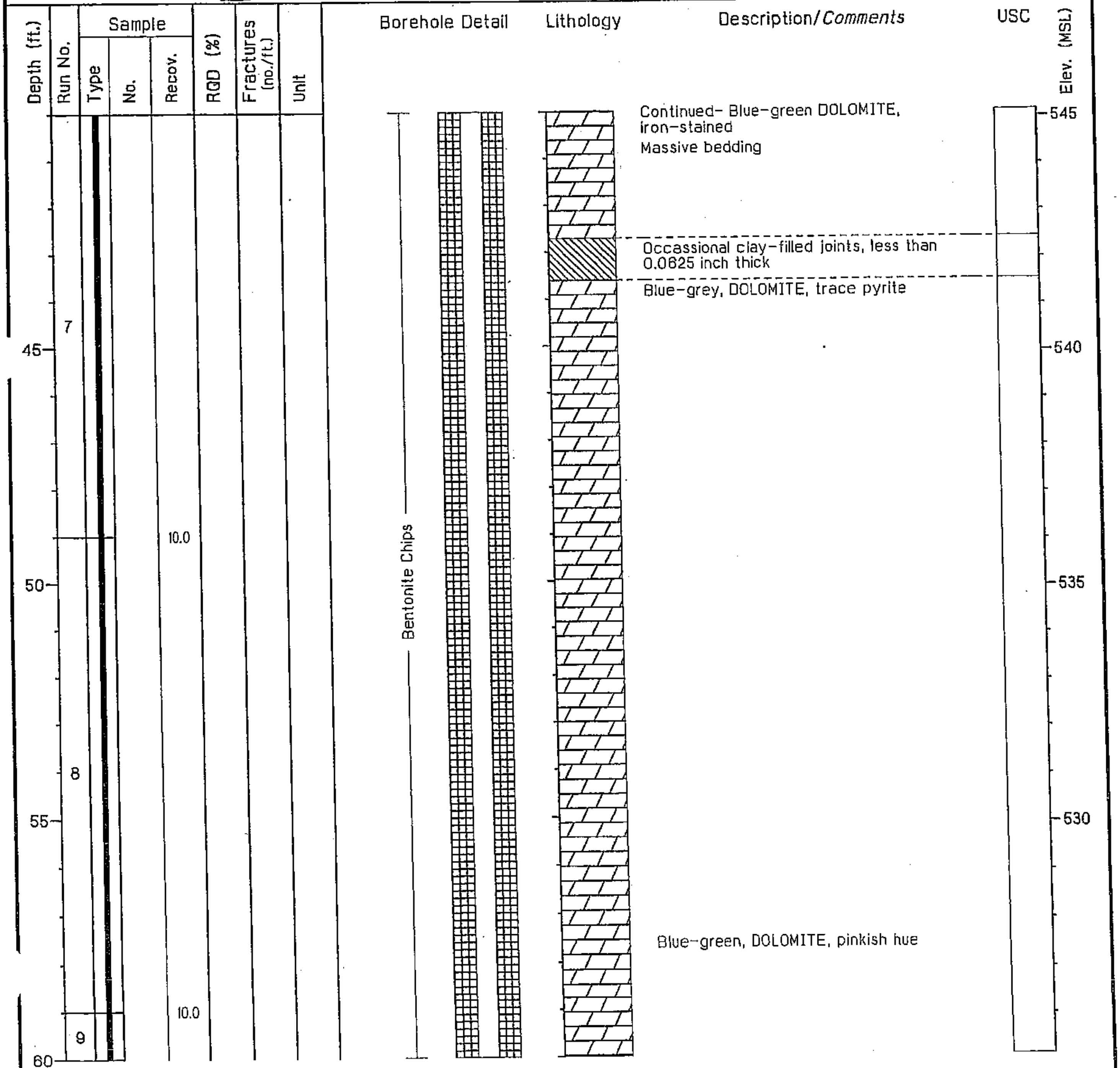
Driller: D. Stefenson
Helper (s):

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ▨ - Shelby Tube ▮ - Core ☐ - Blind Drill



Continued- Blue-green DOLOMITE, iron-stained
Massive bedding

Occassional clay-filled joints, less than 0.0625 inch thick

Blue-grey, DOLOMITE, trace pyrite

Blue-green, DOLOMITE, pinkish hue

NOTES:

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Easting: 45567.6

Weather:
Sunny, hot

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Driller: D. Stefenson
Helper (s):

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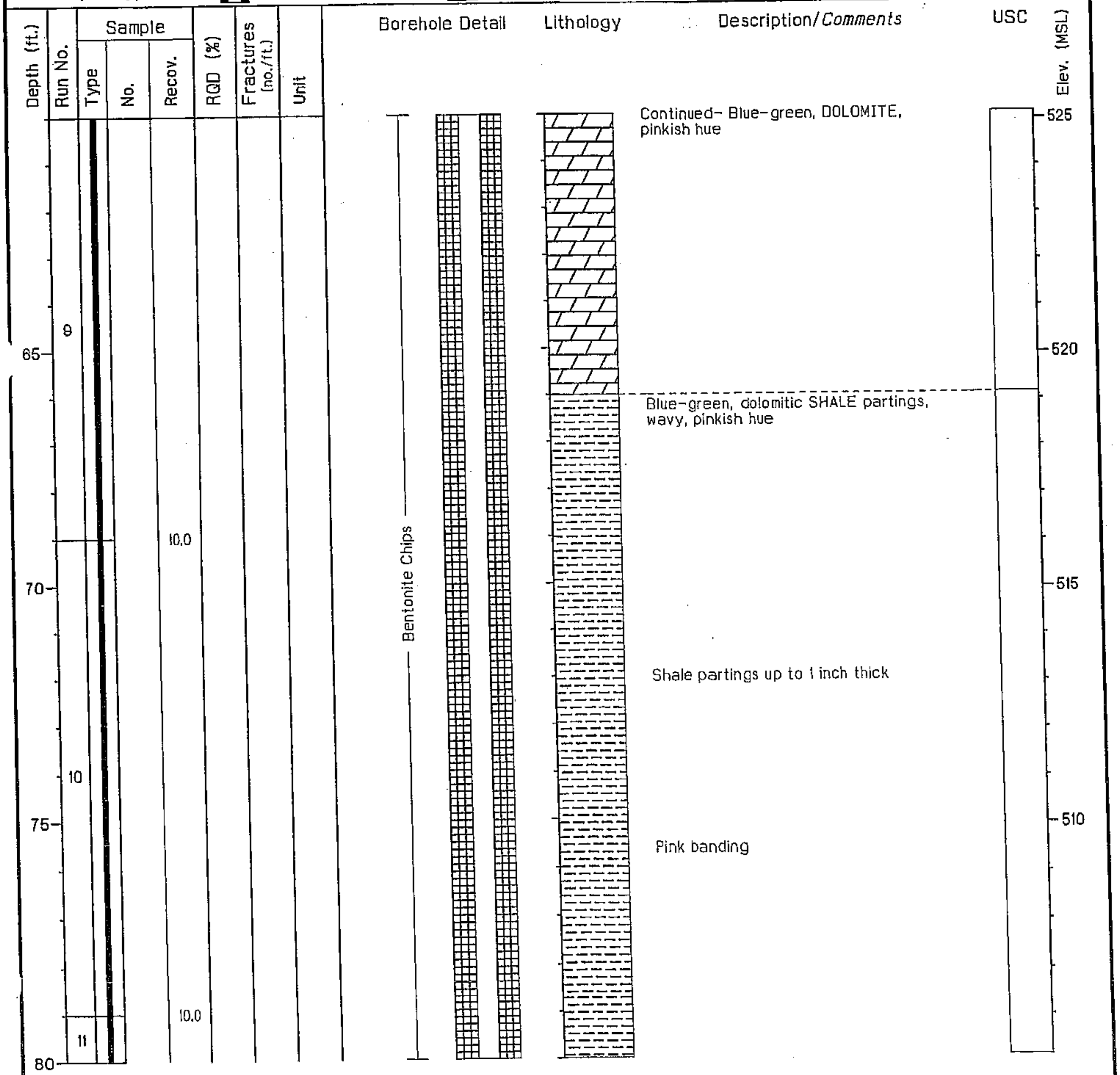

Continued- Blue-green, DOLOMITE, pinkish hue

Blue-green, dolomitic SHALE partings, wavy, pinkish hue

Shale partings up to 1 inch thick

Pink banding

NOTES:

Andrews Environmental Engineering, Inc.

3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

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Easting: 45567.6

Boring Information:
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Well No.: G44S
Surf. Elev.: 585.14

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Sunny, hot

Depth Information:
Total: 209.3
Auger:
Core:

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Personnel:
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Driller: D. Stefenson
Helper (s):

Dates:
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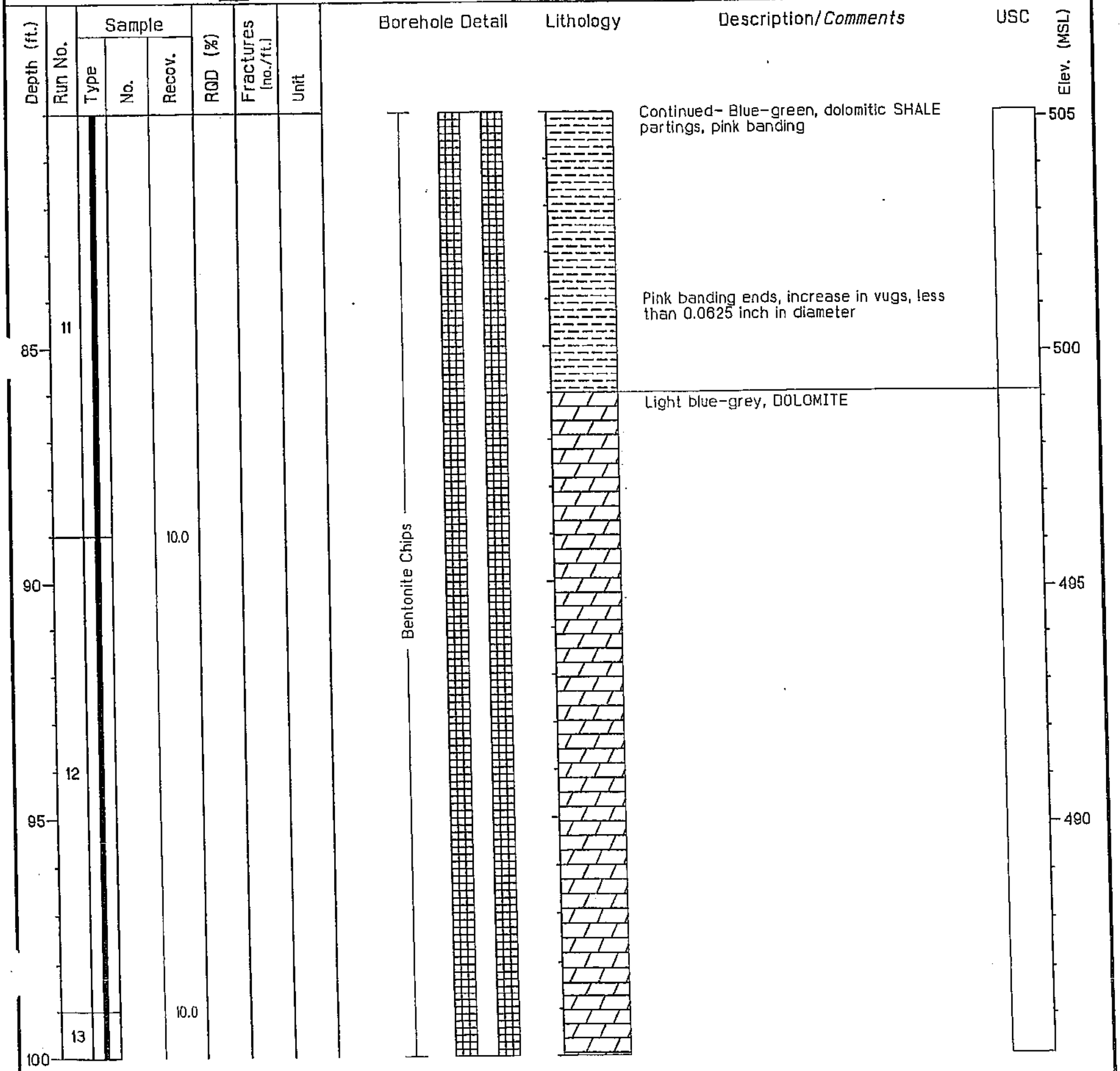
Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ▨ - Shelby Tube ▮ - Core ☐ - Blind Drill



Continued- Blue-green, dolomitic SHALE partings, pink banding

Pink banding ends, increase in vugs, less than 0.0625 inch in diameter

Light blue-grey, DOLOMITE

NOTES:

Field Boring Log

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AEEI No.: 2002-124/2003-125

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Northing: 57679.8
Easting: 45567.6

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Boring No.: G44D
Well No.: G44S
Surf. Elev.: 585.14

Depth Information:
Total: 209.3
Auger:
Core:

Dates:
Start: 7/19/2004
Finish: 7/21/2004

Weather:
Sunny, hot

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Driller: D. Stefenson
Helper (s):

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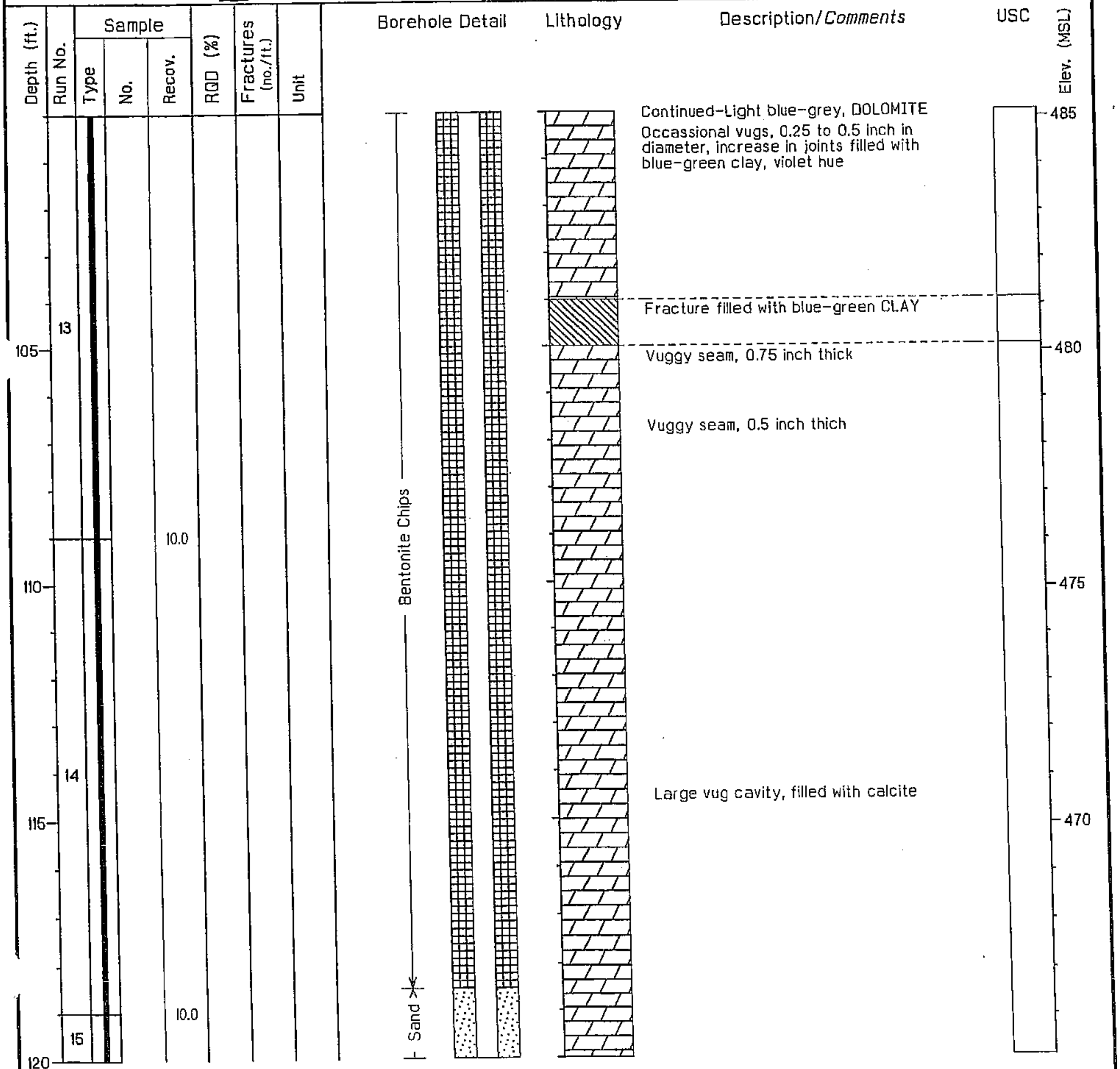

Continued-Light blue-grey, DOLOMITE
Occassional vugs, 0.25 to 0.5 inch in diameter, increase in joints filled with blue-green clay, violet hue

Fracture filled with blue-green CLAY

Vuggy seam, 0.75 inch thick

Vuggy seam, 0.5 inch thich

Large vug cavity, filled with calcite

NOTES:

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3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

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AEEI No.: 2002-124/2003-125

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Northing: 57679.8
Easting: 45567.6

Weather:
Sunny, hot

Boring Information:
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Well No.: G44S
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Helper (s):

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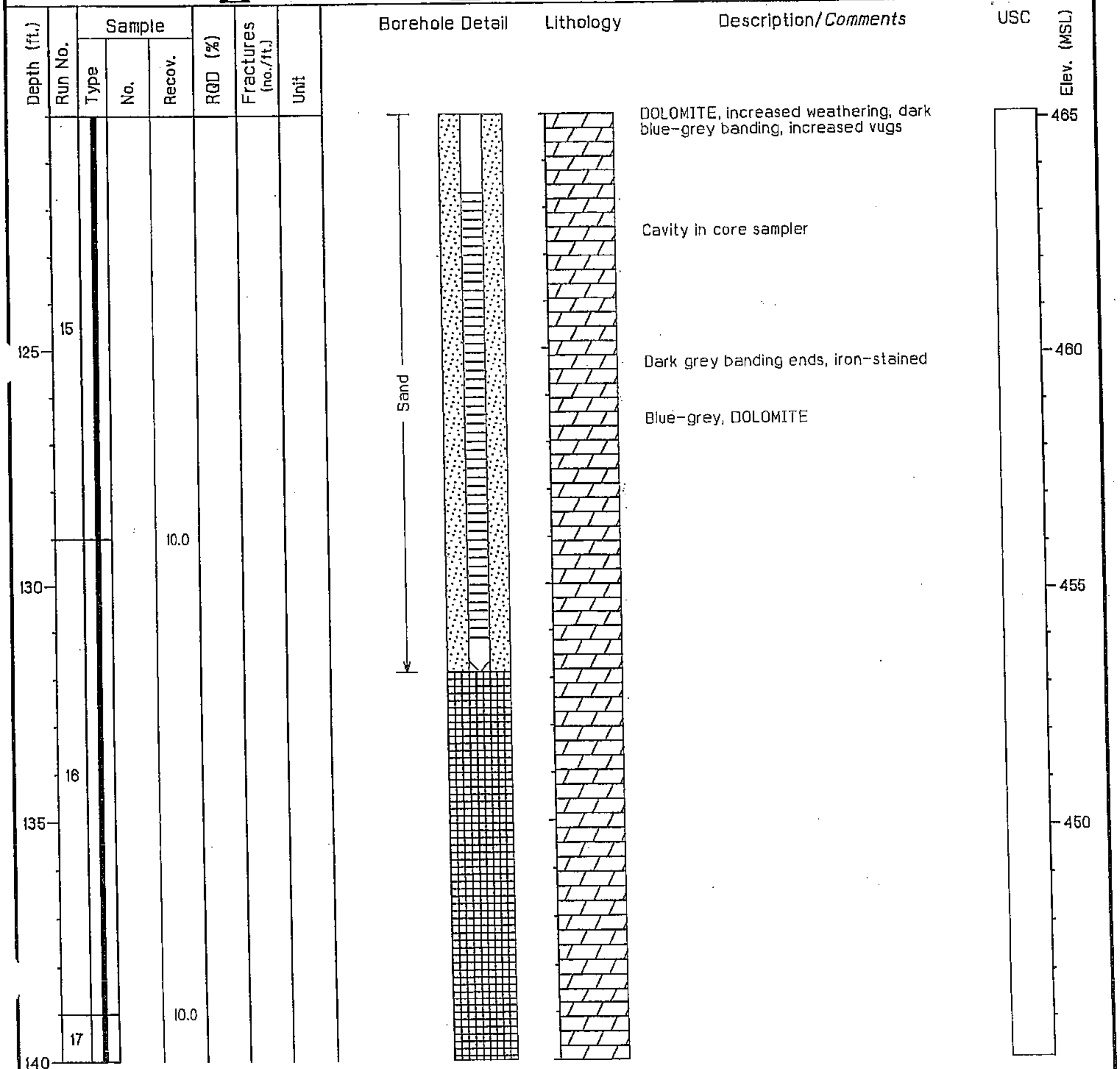

DOLOMITE, increased weathering, dark blue-grey banding, increased vugs

Cavity in core sampler

Dark grey banding ends, iron-stained

Blue-grey, DOLOMITE

NOTES:

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Easting: 45567.6

Weather:
Sunny, hot

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Helper (s):

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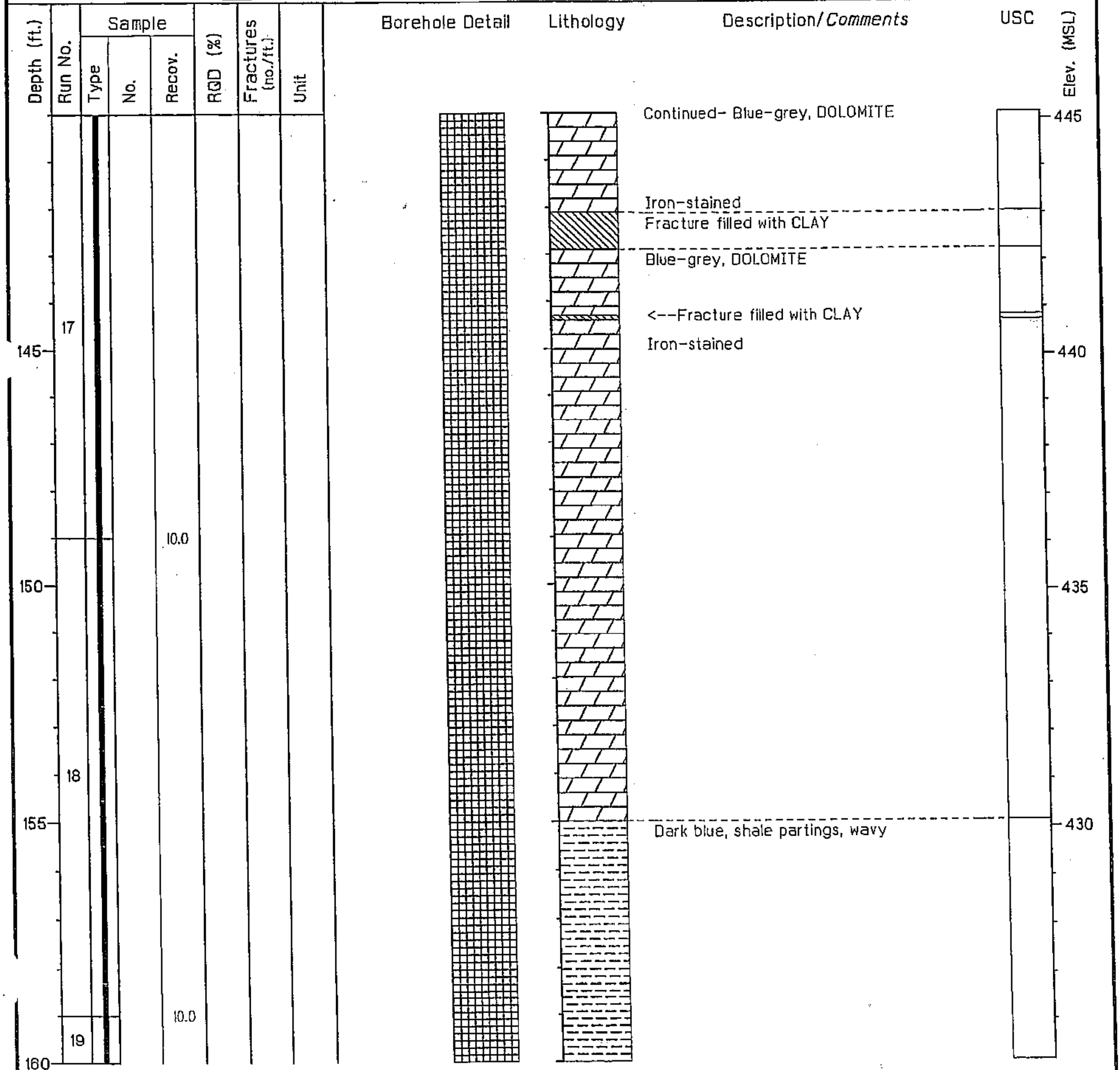

Continued- Blue-grey, DOLOMITE

Iron-stained
Fracture filled with CLAY

Blue-grey, DOLOMITE

<--Fracture filled with CLAY

Iron-stained

Dark blue, shale partings, wavy

NOTES:

Field Boring Log

Site Information:
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Boring Information:
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Well No.: G44S
Surf. Elev.: 585.14

Weather:
Sunny, hot

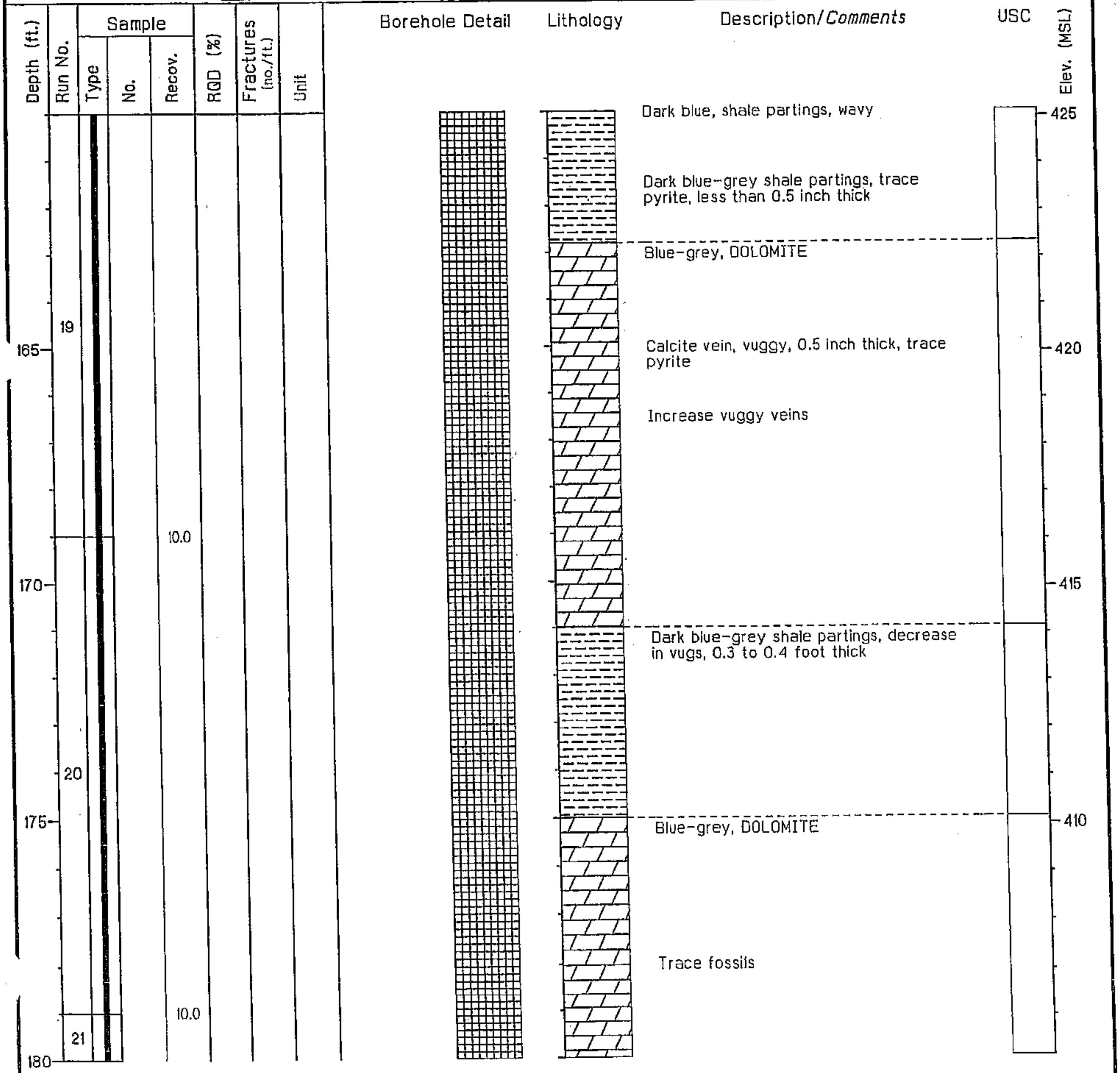
Depth Information:
Total: 209.3
Auger:
Core:

Drilling Contractor:
Name: Raimonde Drilling Corp.
City: Elmwood Park, Illinois
Equipment: CME 55 - 8 ¼" HSA

Personnel:
Geologist: L. Janczak
Driller: D. Stefenson
Helper (s):

Dates:
Start: 7/19/2004
Finish: 7/21/2004

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ◪ - Shelby Tube ▮ - Core ☐ - Blind Drill



Dark blue, shale partings, wavy

Dark blue-grey shale partings, trace pyrite, less than 0.5 inch thick

Blue-grey, DOLOMITE

Calcite vein, vuggy, 0.5 inch thick, trace pyrite

Increase vuggy veins

Dark blue-grey shale partings, decrease in vugs, 0.3 to 0.4 foot thick

Blue-grey, DOLOMITE

Trace fossils

NOTES:

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3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

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Location: Joliet, Illinois
County: Will
Site No.: 1978090001
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Location:
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Easting: 45567.6

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Sunny, hot

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Personnel:
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Driller: D. Stefenson
Helper (s):

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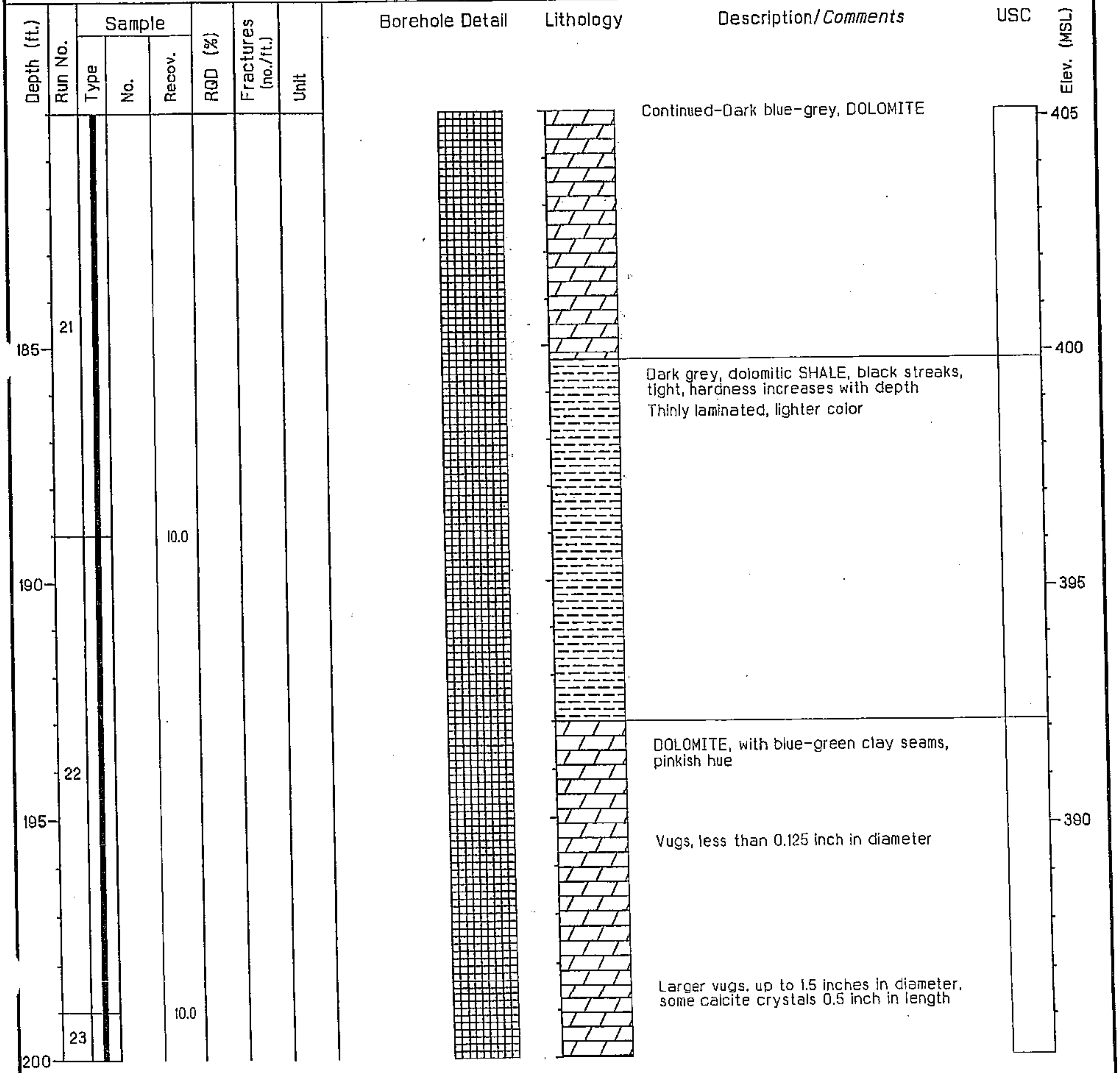

Continued-Dark blue-grey, DOLOMITE

Dark grey, dolomitic SHALE, black streaks, tight, hardness increases with depth
Thinly laminated, lighter color

DOLOMITE, with blue-green clay seams, pinkish hue

Vugs, less than 0.125 inch in diameter

Larger vugs, up to 1.5 inches in diameter, some calcite crystals 0.5 inch in length

NOTES:

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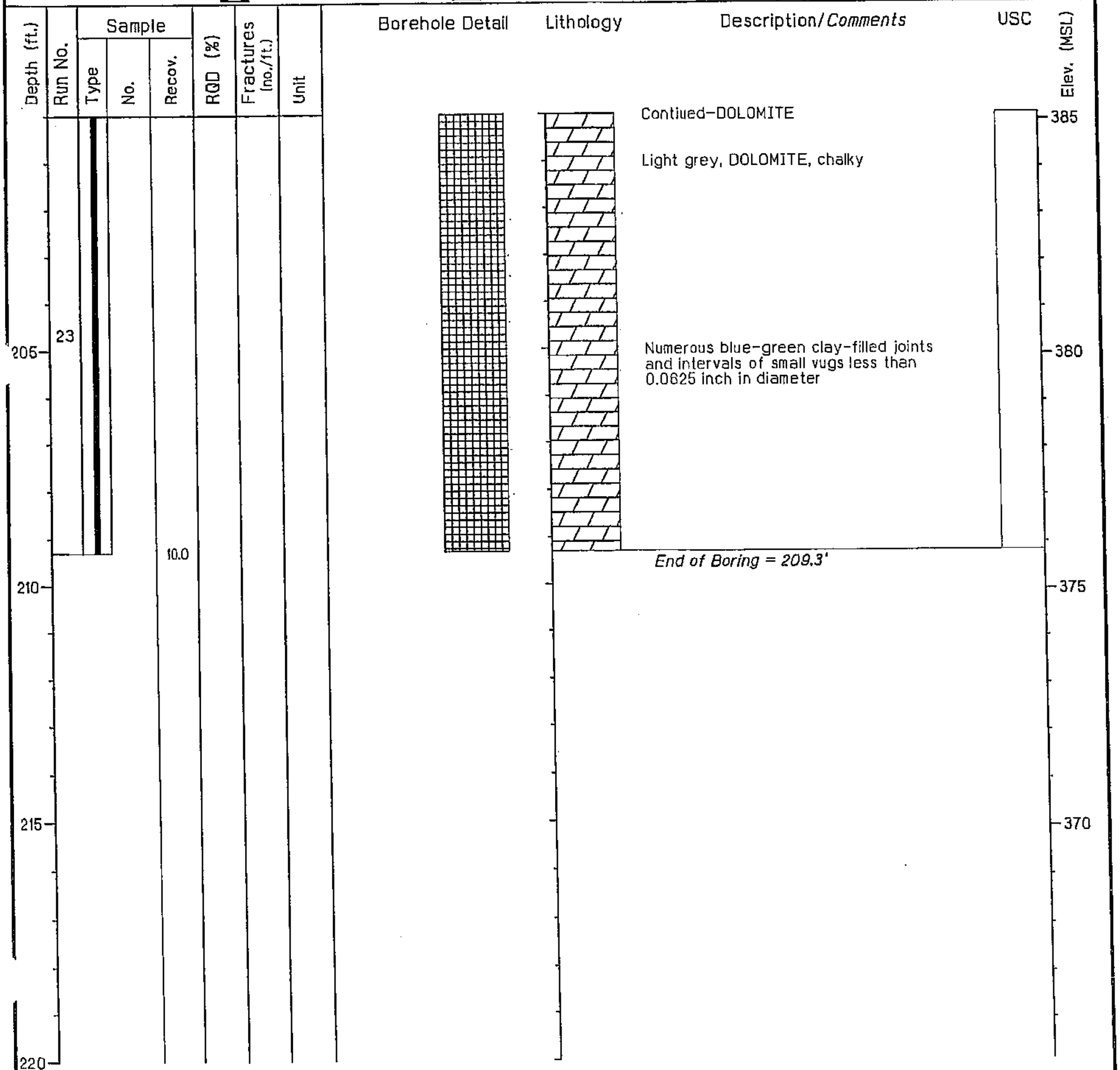


Contiued-DOLOMITE

Light grey, DOLOMITE, chalky

Numerous blue-green clay-filled joints and intervals of small vugs less than 0.0625 inch in diameter

End of Boring = 209.3'

NOTES:

Illinois Environmental Protection Agency

Well Completion Report

Site #: 1978090001 County: Will Well #: G44S

Site Name: Joliet/Lincoln Stone Quarry Borehole #: G44S

Coordinates: X 45568.1 Y 57679.8 (or) Latitude: ° ' " Longitude: ° ' "

Surveyed by: Peter Campbell, Andrews Environmental Engineering, Inc. IL Registration #:

Drilling Contractor: Raimonde Drilling Corp. Consulting Firm: AEEI

Driller: D. Stefenson Geologist: S. Radulovic

Drilling Method: Hollow stem auger/rotary Logged by: S. Radulovic

Drilling Fluids (type): water for reaming Report Form Completed by: S. Radulovic

Date Well Started: 07/19/2004 Date Well Finished: 07/23/2004 Date Form Completed: 07/30/2004

ANNULAR SPACE DETAILS

Type of surface seal: Concrete

Type of annular sealant: Bentonite chips

Installation method: Free drop

Setting time: 24+ hours

Type of bentonite seal – Granular, [✓ Chips] (circle one)

Installation method: Free drop

Setting time: 24+ hours

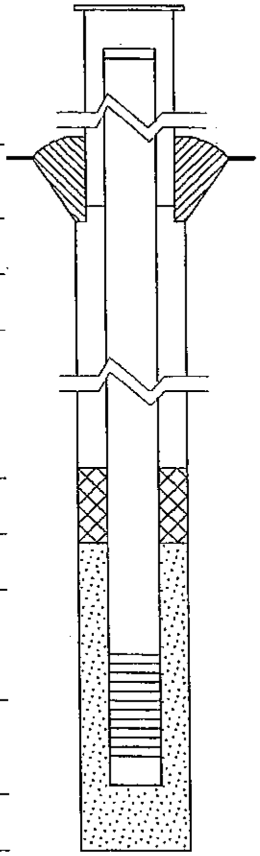
Type of sand pack: Quartz Sand

Grain size: 10/30 (sieve size)

Installation method: Free drop

Type of backfill material: Bentonite Chips (if applicable)

Installation method: Free drop



ELEVATION (MSL)@	DEPTH (BGS)*	(0.01 ft)
587.03	-1.89	Top of Protective Casing
586.52	-1.38	Top of Riser Pipe
585.14	.00	Ground Surface
583.14	2.00	Top of Annular Sealant
n/a	n/a	Static Water Level Measured on (after completion)
583.14	2.00	Top of Seal
466.64	118.50	Top of Sandpack
463.46	121.68	Top of Screen
453.97	131.17	Bottom of Screen
453.26	131.88	Bottom of Well
376.11	209.03	Bottom of Borehole

@ Referenced to a National Geodetic Vertical Datum

* positive (+) values below GS, negitive (-) values above GS

Notes: Nested well pair G44D/G44S are installed in the same borehole.

CASING MEASUREMENTS

Diameter of Borehole (in)	8.0
ID of Riser Pipe (in)	2.0
Protective Casing Length (ft)	5.0
Riser Pipe Length (ft)	123.06
Bottom of Screen to End Cap (ft)	.71
Screen Length (1st slot to last slot) (ft)	9.49
Total Length of Casing (ft)	133.26
Screen Slot Size*	#10 (0.01")

*Hand-slotted well screens are unacceptable.

WELL CONSTRUCTION MATERIALS

(circle one)

Protective Casing	SS304, SS316, PTFE, PVC or [✓ Other:]
Riser Pipe Above W.T.	SS304, SS316, PTFE, [✓ PVC] or Other:
Riser Pipe Below W.T.	SS304, SS316, PTFE, [✓ PVC], or Other:
Screen	SS304, SS316, PTFE, [✓ PVC], or Other:

(AE950315)

Andrews Environmental Engineering, Inc.
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Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

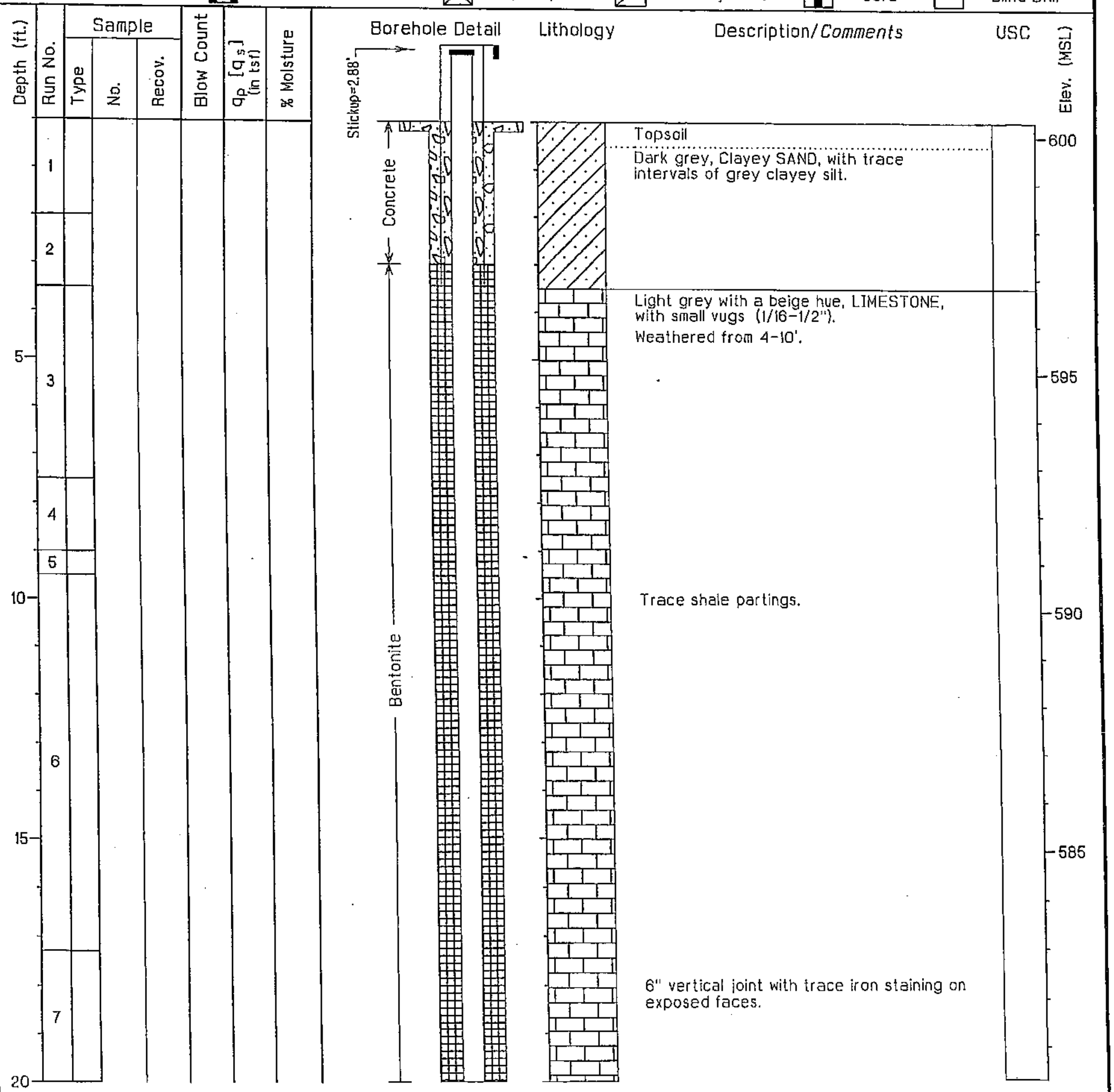
Dates:
Start: 11/2/2004
Finish: 11/4/2004

Weather:
Sunny/60 deg F

Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ▨ - Shelby Tube ▮ - Core ☐ - Blind Drill



Topsoil

Dark grey, Clayey SAND, with trace intervals of grey clayey silt.

Light grey with a beige hue, LIMESTONE, with small vugs (1/16-1/2").
Weathered from 4-10'.

Trace shale partings.

6" vertical joint with trace iron staining on exposed faces.

NOTES: Geological descriptions obtained from the boring log for G45D.

Andrews Environmental Engineering, Inc.
3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Weather:
Sunny/60 deg F

Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

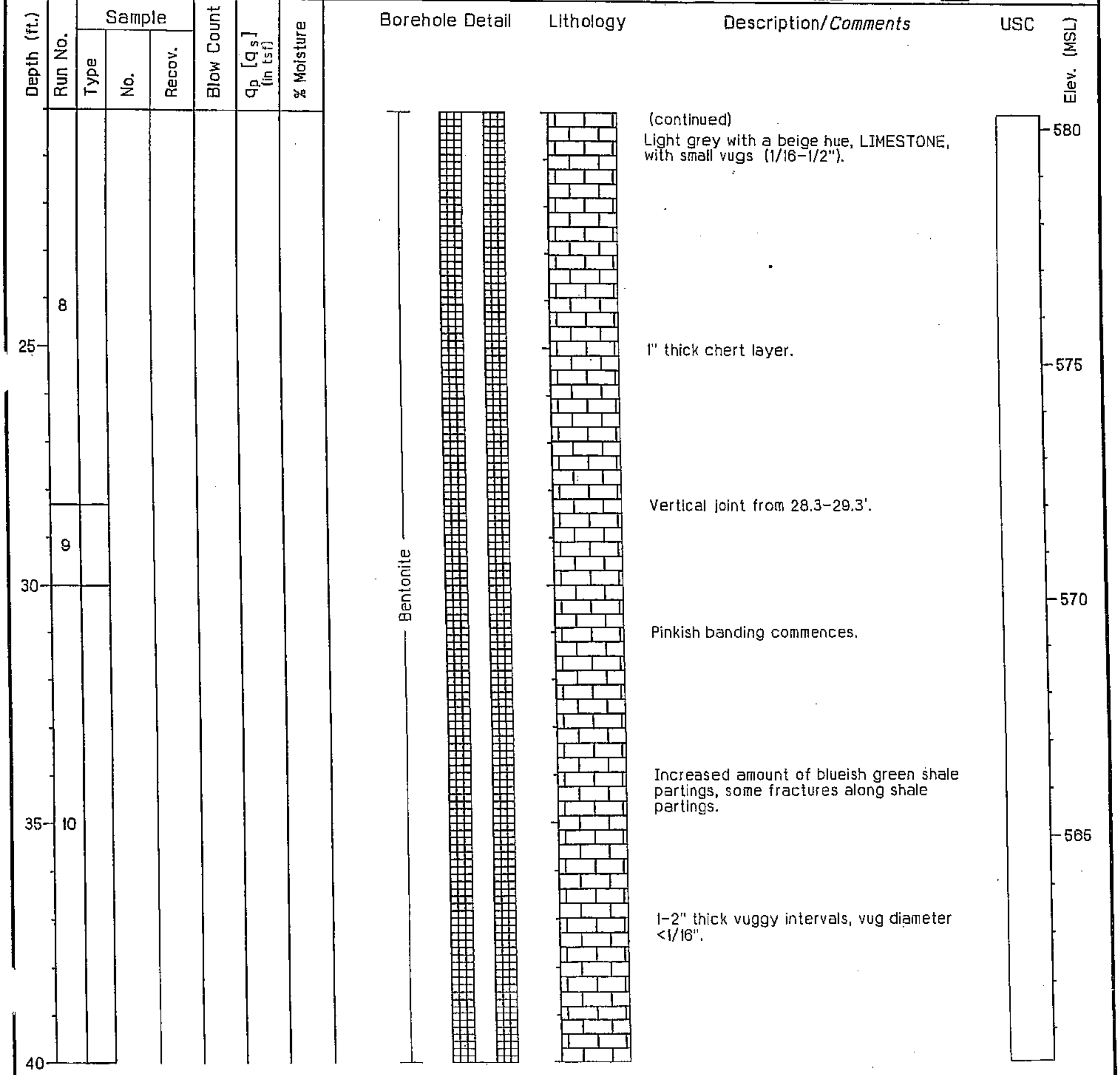
Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s): .

Dates:
Start: 11/2/2004
Finish: 11/4/2004

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ◿ - Shelby Tube ▯ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)



(continued)
Light grey with a beige hue, LIMESTONE, with small vugs (1/16-1/2").

1" thick chert layer.

Vertical joint from 28.3-29.3'.

Pinkish banding commences.

Increased amount of blueish green shale partings, some fractures along shale partings.

1-2" thick vuggy intervals, vug diameter <1/16".

NOTES: Geological descriptions obtained from the boring log for G45D.

Andrews Environmental Engineering, Inc.
3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

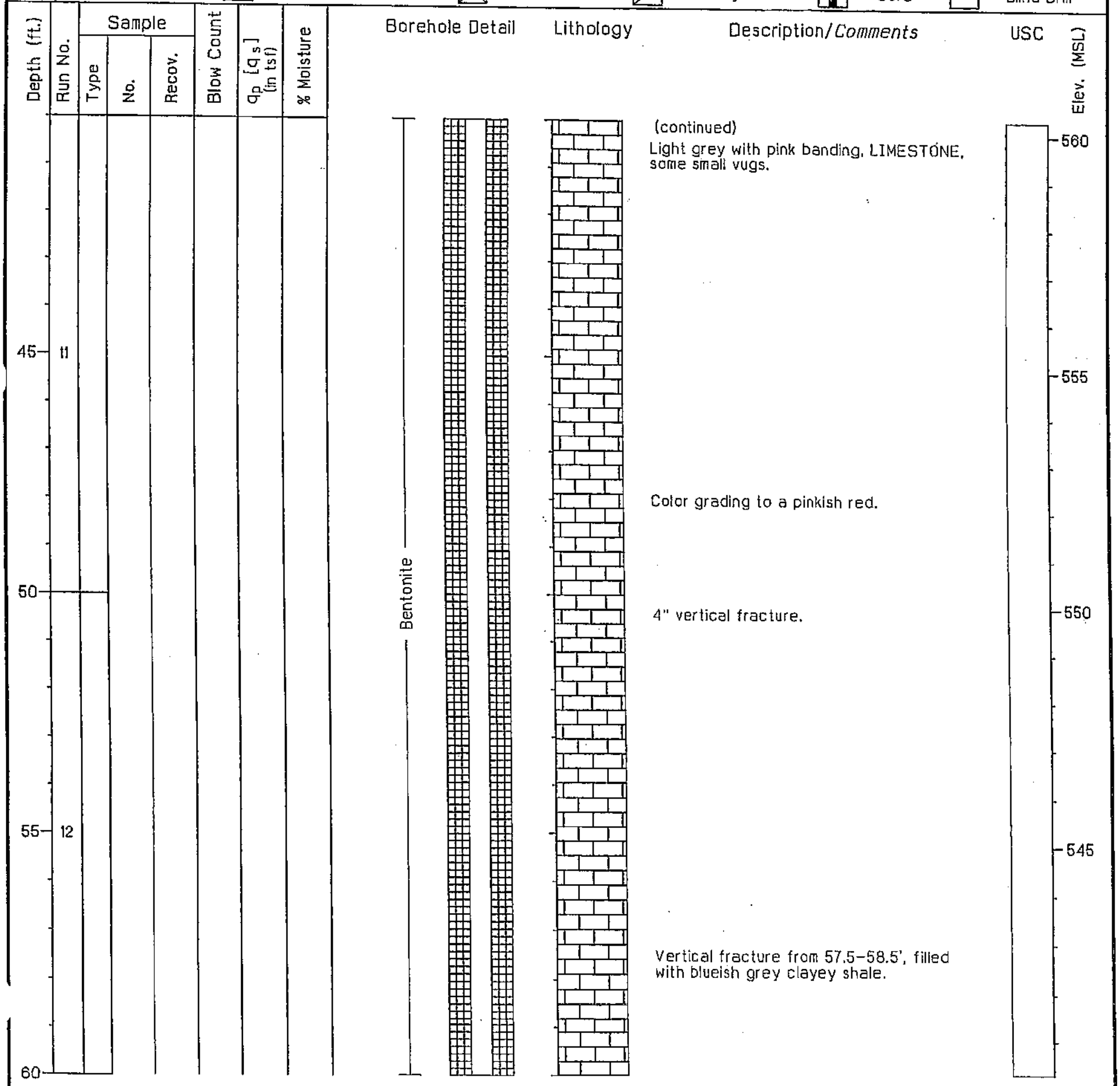
Weather:
Sunny/60 deg F

Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Dates:
Start: 11/2/2004
Finish: 11/4/2004

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ▧ - Shelby Tube ▮ - Core ☐ - Blind Drill



(continued)
Light grey with pink banding, LIMESTONE, some small vugs.

Color grading to a pinkish red.

4" vertical fracture.

Vertical fracture from 57.5-58.5', filled with blueish grey clayey shale.

NOTES: Geological descriptions obtained from the boring log for G45D.

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

Dates:
Start: 11/2/2004
Finish: 11/4/2004

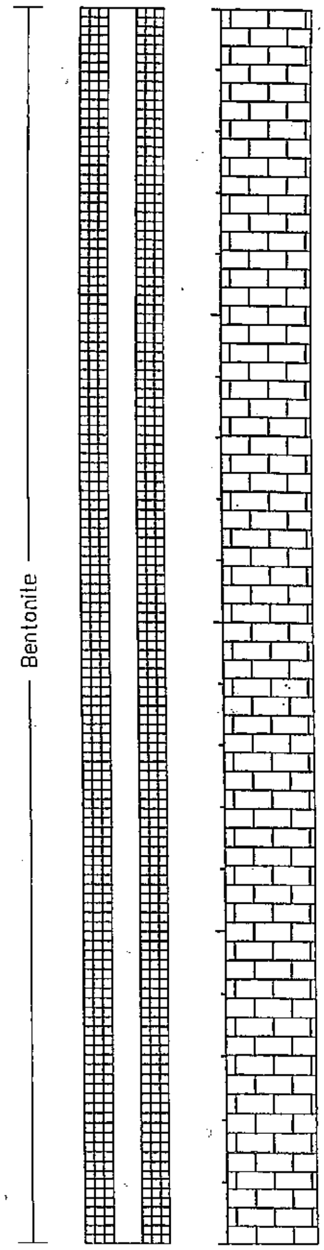
Weather:
Sunny/60 deg F

Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ◿ - Shelby Tube ▯ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	qp [qs] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
								Bentonite		(continued) Pinkish, LIMESTONE, some small vugs. Vertical fractures from 60.6-62.3', filled with blueish grey clayey shale and pyrite.		540
65	13									Vertical fractures from 65.0-65.8', filled with blueish grey clayey shale and pyrite.		535
										Vertical fractures from 67.2-68.2', filled with blueish grey clayey shale and pyrite.		
70										Vuggy intervals up to 1" thick.		530
										Closed vertical joint.		
75	14											525
80												



NOTES: Geological descriptions obtained from the boring log for G45D.

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Weather:
Sunny/60 deg F

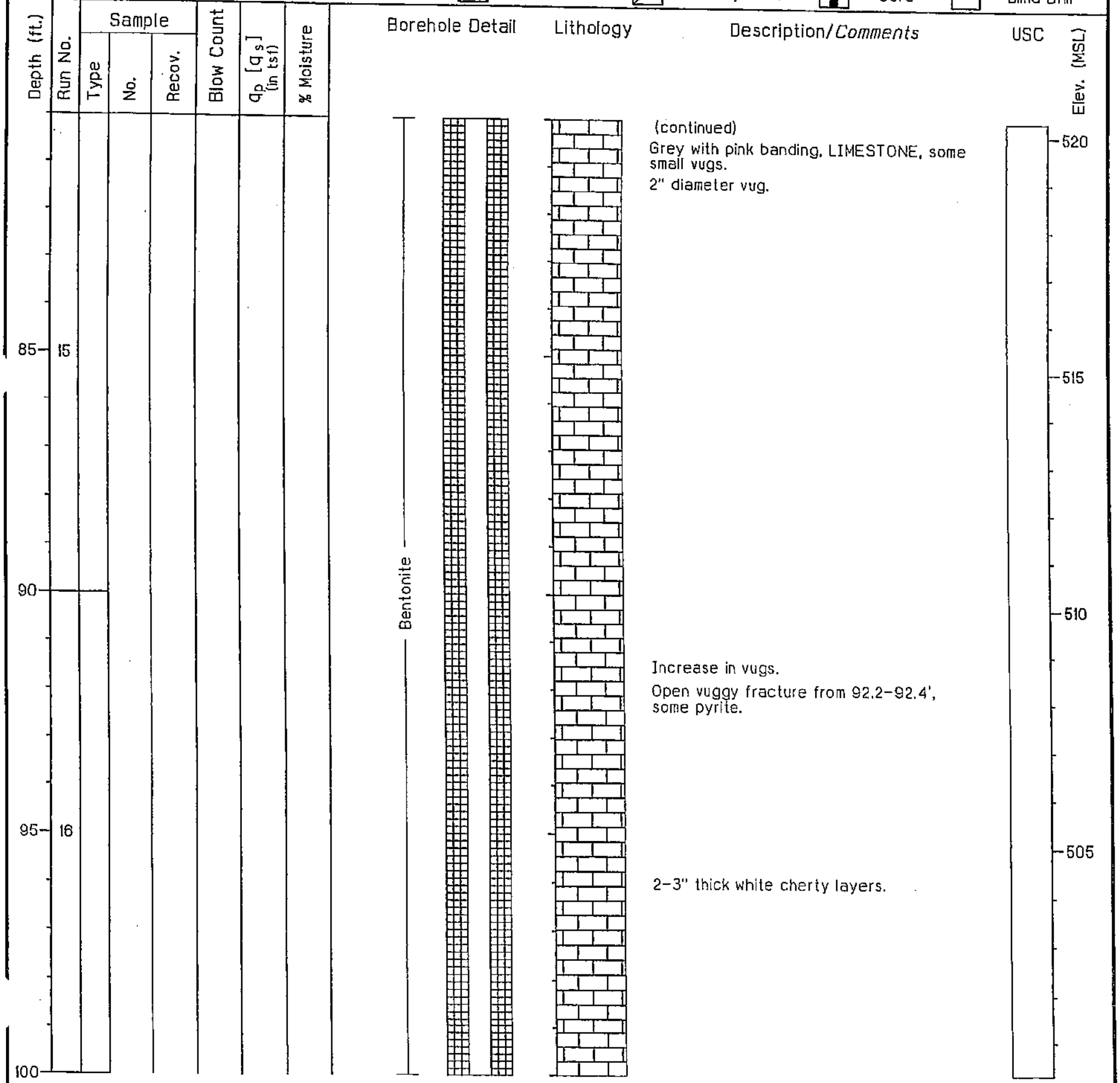
Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Dates:
Start: 11/2/2004
Finish: 11/4/2004

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ◩ - Shelby Tube ▮ - Core ☐ - Blind Drill



(continued)
Grey with pink banding, LIMESTONE, some small vugs.
2" diameter vug.

Increase in vugs.
Open vuggy fracture from 92.2-92.4', some pyrite.

2-3" thick white cherty layers.

NOTES: Geological descriptions obtained from the boring log for G45D.

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

Weather:
Sunny/60 deg F

Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

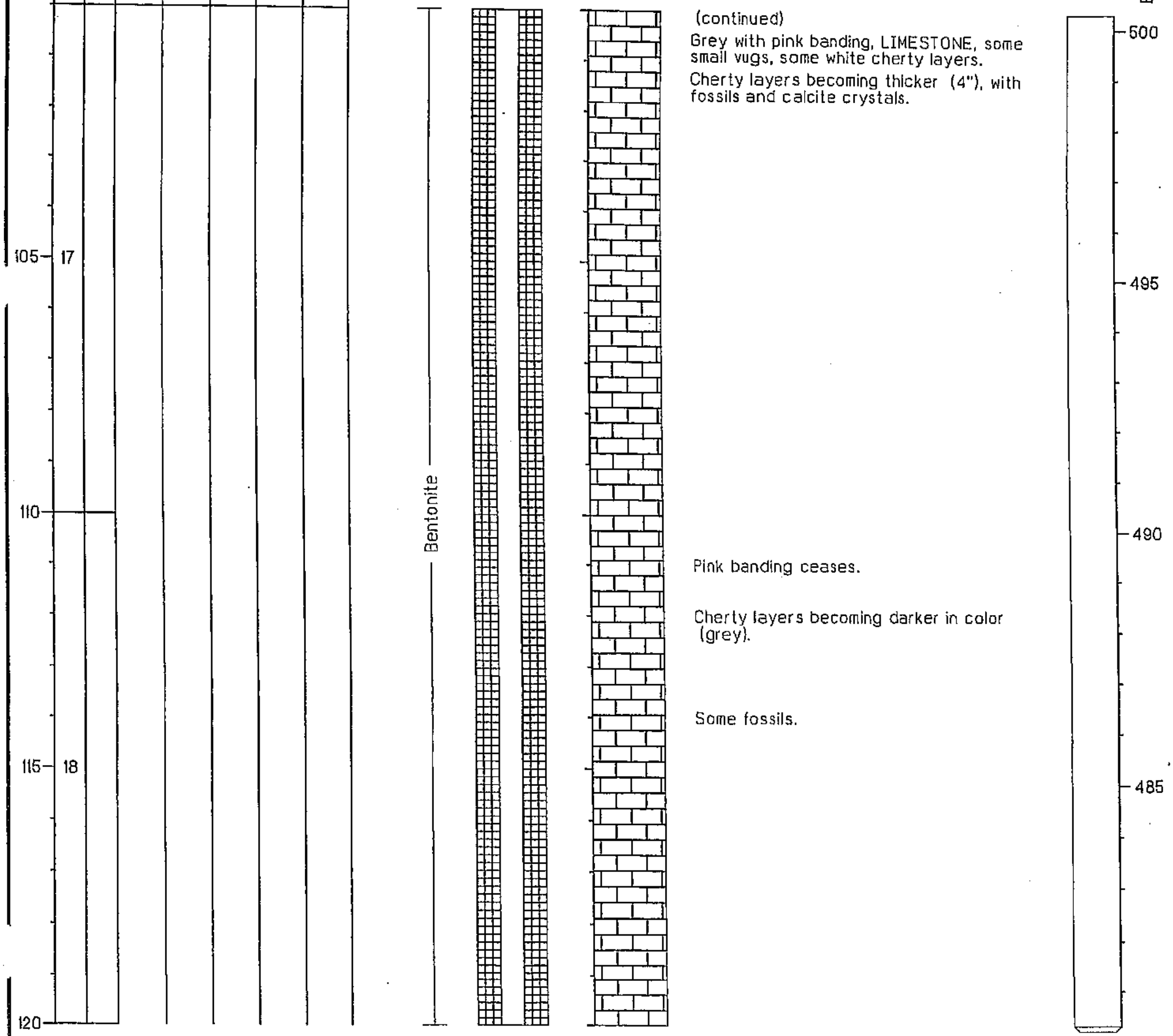
Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Dates:
Start: 11/2/2004
Finish: 11/4/2004

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)



(continued)

Grey with pink banding, LIMESTONE, some small vugs, some white cherty layers.

Cherty layers becoming thicker (4"), with fossils and calcite crystals.

Pink banding ceases.

Cherty layers becoming darker in color (grey).

Some fossils.

NOTES: Geological descriptions obtained from the boring log for G45D.

Andrews Environmental Engineering, Inc.
3535 Mayflower Boulevard, Springfield, IL 62707 (217) 787-2334

Field Boring Log

Site Information:
Name: Joliet/Lincoln Stone Quarry
Location: Joliet, Illinois
County: Will
Site No.: 1978090001
AEEI No.: 2002-124

Location:
Coord. System: Site Grid
Northing: 58057.56
Easting: 48125.64

Weather:
Sunny/60 deg F

Boring Information:
Boring No.: G45S
Well No.: G45S
Surf. Elev.: 600.30

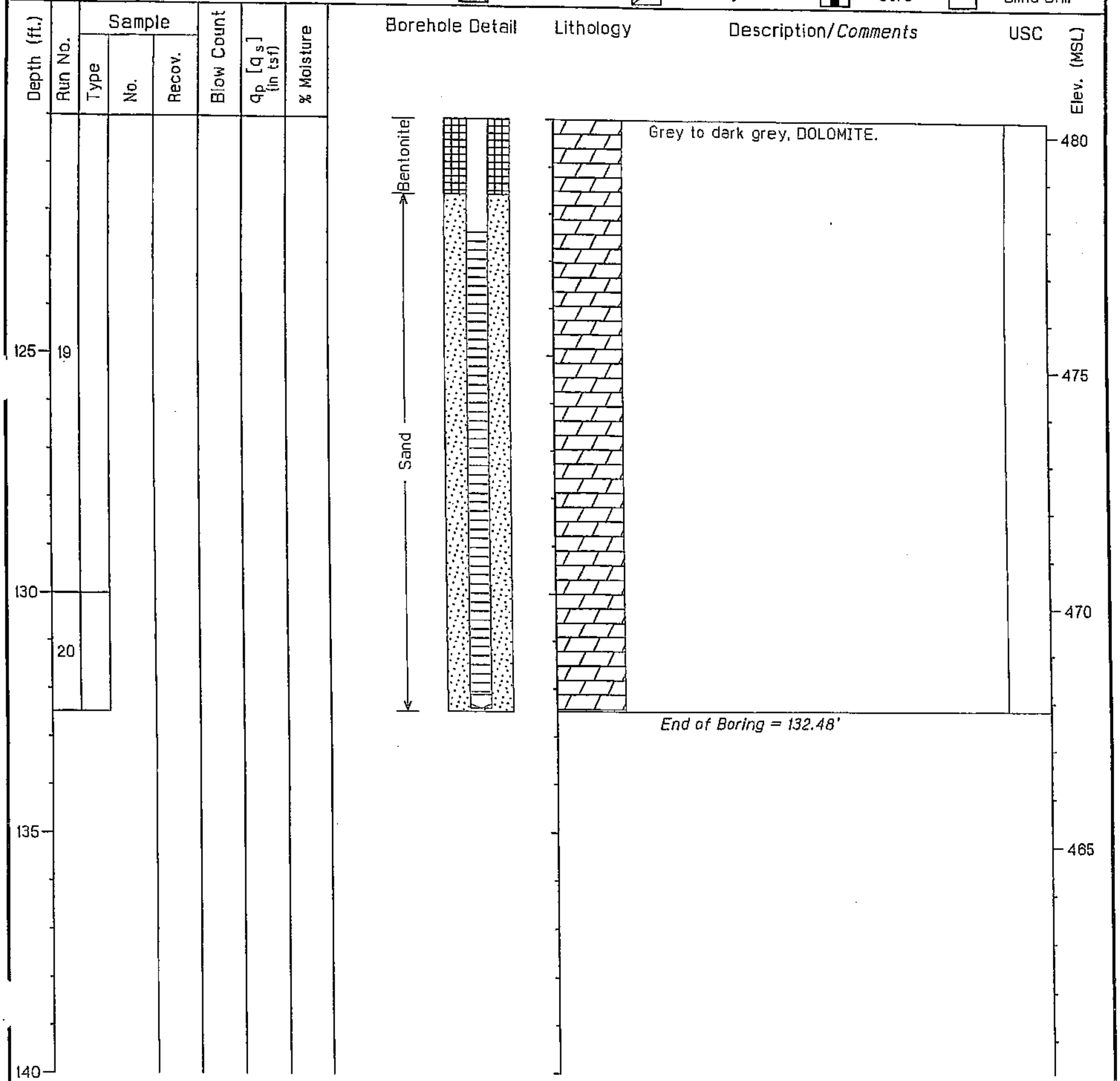
Depth Information:
Total: 132.48
Auger: 4.0
Core: 132.48

Dates:
Start: 11/2/2004
Finish: 11/4/2004

Drilling Contractor:
Name: RD-n-P Drilling, Inc.
City: Crown Point, Indiana
Equipment: HQ Core

Personnel:
Geologist: S. Radulovic
Driller: D. Eger
Helper (s):

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ▨ - Shelby Tube ▮ - Core ☐ - Blind Drill



Grey to dark grey, DOLOMITE.

End of Boring = 132.48'

NOTES: Geological descriptions obtained from the boring log for G45D.

Illinois Environmental Protection Agency

Well Completion Report

Site #: 1978090001
County: Will
Well #: G45S

Site Name: Joliet/Lincoln Stone Quarry
Borehole #: G45S

Coordinates: X 48125.64 Y 58057.56 (or) Latitude: ° ' " Longitude: ° ' "

Surveyed by: Andrews Environmental Engineering, Inc.
IL Registration #:

Drilling Contractor: RD-n-P Drilling, Inc.
Consulting Firm: AEEI

Driller: D. Eger
Geologist: S. Radulovic

Drilling Method: HQ core
Logged by: S. Radulovic

Drilling Fluids (type): water for reaming
Report Form Completed by: S. Holland

Date Well Started: 11/02/2004
Date Well Finished: 11/04/2004
Date Form Completed: 12/30/2004

ANNULAR SPACE DETAILS

Type of surface seal: Concrete

Type of annular sealant: Bentonite

Installation method: Tremi

Setting time: 24+ hours

Type of bentonite seal – Granular, [✓ Chips] (circle one)

Installation method: Free drop

Setting time: 24+ hours

Type of sand pack: Quartz Sand

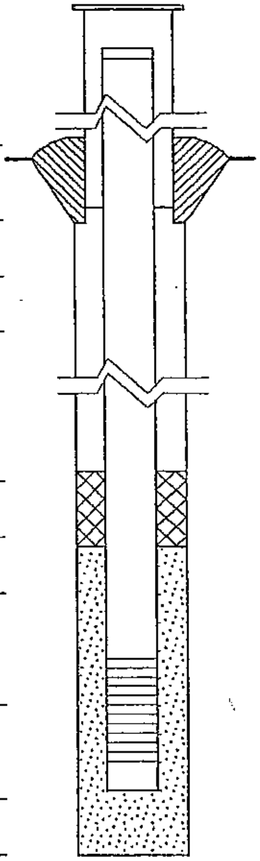
Grain size: 10/30 (sieve size)

Installation method: Free drop

Type of backfill material: na (if applicable)

Installation method: na

Notes:



ELEVATION (MSL)*	DEPTH (BGS)*	(0.01 ft)
n/a	n/a	Top of Protective Casing
603.18	-2.88	Top of Riser Pipe
600.30	.00	Ground Surface
600.30	.00	Top of Annular Sealant
n/a	n/a	Static Water Level Measured on (after completion)
597.30	3.00	Top of Seal
478.70	121.60	Top of Sandpack
477.90	122.40	Top of Screen
468.18	132.12	Bottom of Screen
467.82	132.48	Bottom of Well
467.82	132.48	Bottom of Borehole

* Referenced to a National Geodetic Vertical Datum
* positive (+) values below GS, negitive (-) values above GS

CASING MEASUREMENTS

Diameter of Borehole (in)	3.7
ID of Riser Pipe (in)	2.0
Protective Casing Length (ft)	5.0
Riser Pipe Length (ft)	125.28
Bottom of Screen to End Cap (ft)	.36
Screen Length [1st slot to last slot] (ft)	9.72
Total Length of Casing (ft)	135.36
Screen Slot Size*	#10 (0.01")

*Hand-slotted well screens are unacceptable.

WELL CONSTRUCTION MATERIALS

(circle one)

Protective Casing	SS304, SS316, PTFE, PVC or [✓ Other:]
Riser Pipe Above W.T.	SS304, SS316, PTFE, [✓ PVC] or Other:
Riser Pipe Below W.T.	SS304, SS316, PTFE, [✓ PVC] or Other:
Screen	SS304, SS316, PTFE, [✓ PVC] or Other:

(AE950315)

K P R G
ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G46D/S

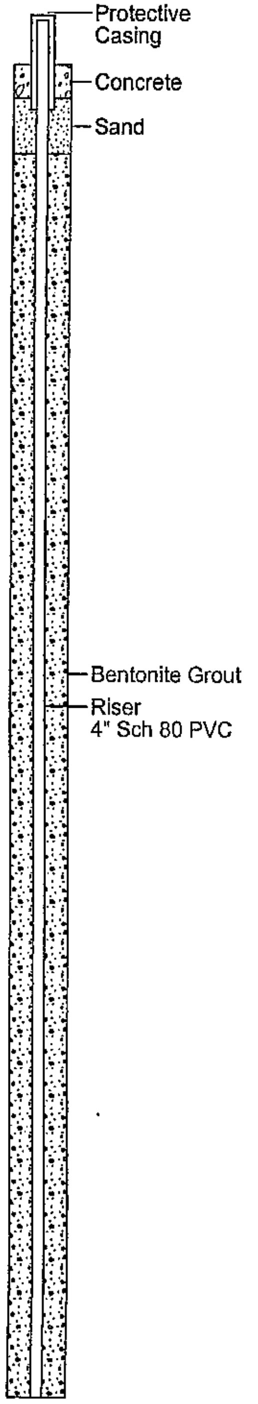
(Page 1 of 4)

Date Started	: 01/30/06
Date Well Set	: 02/17/06
Coring Tools	: 10' HQ conv. circ.
Reaming Tools	: 7.5" Tri-Cone w/ stab
Drill Rig	: DrillTech D40
Driller Name/Co	: R. Treptow / Layne

Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 598.290 feet above MSL
TOC Elev.	: 600.870 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757410.291
Coordinate E	: 1046479.383
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 598	DESCRIPTION	% RQD	% Recovery
0	598			
		Overburden was blind drilled to 25 feet. Cuttings logged for general lithology.		
5	593			
		CLAY/ SILTY CLAY, brown. Dry.		
10	588			
15	583			
20	578	SAND, brown, mostly medium, some fine and coarse and silt, some gravel. Moist.		
		DOLOMITE, weathered.		
25	573			
		DOLOMITE, highly fractured, heavy iron staining.		
			34	
30	568	DOLOMITE, white, some very light green hues, fine grained, slightly fractured (horz), some pits, no vugs.		
35	563			
		- highly fractured 37-42, tight to extremely narrow, sediment infilling - vertical fracture, tight, pyrite and green/gray argilaceous sediment infilling - 0.15' chert, fractured, some pyrite	16.5	
40	558			
45	553	DOLOMITE, white, some light green/blue hues, fine grained, horz fractures every 0.1', tight with sediment and pyrite infilling, some white chert, some pits		
			100	
50	548			
55	543			
			71.5	
		- begin pink, increase occurance of green/blue hue		
60				

Well Diagram: G46D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G46D/S

(Page 2 of 4)

Date Started : 01/30/06
Date Well Set : 02/17/06
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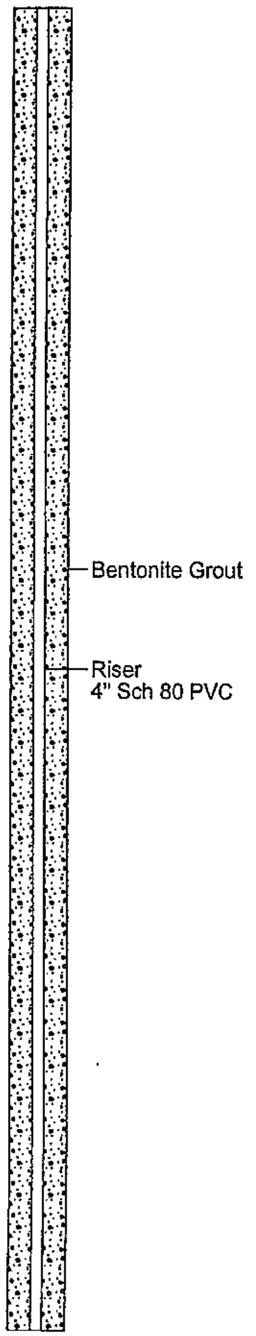
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 598.290 feet above MSL
TOC Elev. : 600.870 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757410.291
Coordinate E : 1046479.383
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 598	DESCRIPTION	% RQD	% Recovery
60	538		71.5	
		- 0.3' fracture zone, horz, sediment filled, extremely narrow		
65	533			
			89	
70	528	DOLOMITE, pink, fine grained, some pits, no vugs, sediment filled fractures horz, wavy, very narrow, occ balck stain, oval-shaped - 0.2' darker layer, fractured, very narrow		
75	523			
			100	
80	518	- highly fractured zone 80-83, tight, sediment infilling		
85	513	DOLOMITE, white with light pink hue, trace to little pits, layers with many fractures, wavy tight to very narrow, sediment infilling, trace fossils		
		- vert frac, very narrow	84.5	
90	508	- large vug, with pyrite on bottom - fractures with trace pyrite, sediment infilling - large cross fracture, sediment infilling		
95	503			
		- trace pyrite near vert fracture - chert, fossil vug mod soft	75.1	
100	498	- pitted, vuggy fossiliferous layer (0.1') - highly fract, horz and vert, tight to very narrow, trace pyrite, little sediment infilling		
105	493	-begin layers of darker and lighter pink - vug, trace pyrite		
			92.4	
110	488			
115	483			
			98	
		- fractured, horz and vert, tight - fractured, narrow		
120				

Well Diagram: G46D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G46D/S

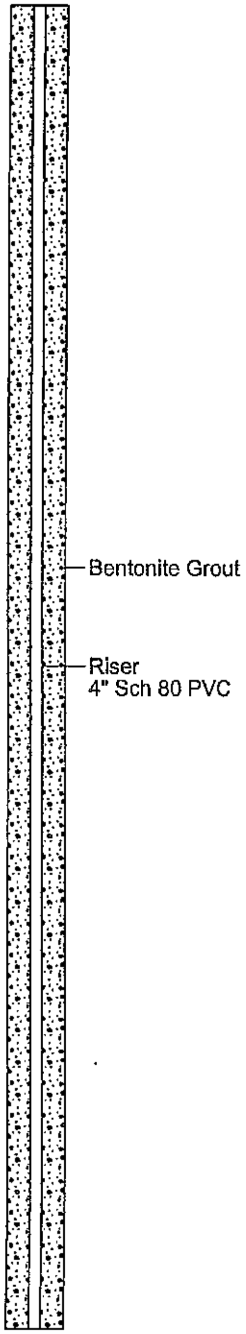
(Page 3 of 4)

Date Started	: 01/30/06
Date Well Set	: 02/17/06
Coring Tools	: 10' HQ conv. circ.
Reaming Tools	: 7.5" Tri-Cone w/ stab
Drill Rig	: DrillTech D40
Driller Name/Co	: R. Treptow / Layne

Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 598.290 feet above MSL
TOC Elev.	: 600.870 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757410.291
Coordinate E	: 1046479.383
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 598	DESCRIPTION	% RQD	% Recovery
120	478	DOLOMITE, white to light gray, fine grained, pitted, some fossils, horz fracs sediment filled, tight to very narrow, some chert - white with darker centers, some laminations, little to trace pyrite	98	
125	473		74.3	
130	468	DOLOMITE, light gray with light green, fine grained, trace to no pits, horz frac wavy, sediment, tight to very narrow, fossils, chert - white to light gray with little pyrite		
135	463		100	
140	458	DOLOMITE, gray to dark gray, fine grained, some wavy bedding, trace pits and vugs, chert - light gray with some thin bedding, some fractures, tight to very narrow, sediment infilling with little pyrite		
145	453	- pitted layer - cross fracture	98.2	
150	448			
155	443		95.3	
160	438	- 0.1' fossiliferous zones, light gray (occ every 2 feet) - 0.12' thin bedding lamination		
165	433		94.3	
170	428	- fractured, horz and cross, tight, some sediment infilling - cross frac, 174-175.8, very narrow		
175	423	- fractures continue to 185, some displacement (<0.02'), tight - also becomming mostly dark gray	100	
180				

Well Diagram: G46D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G46D/S

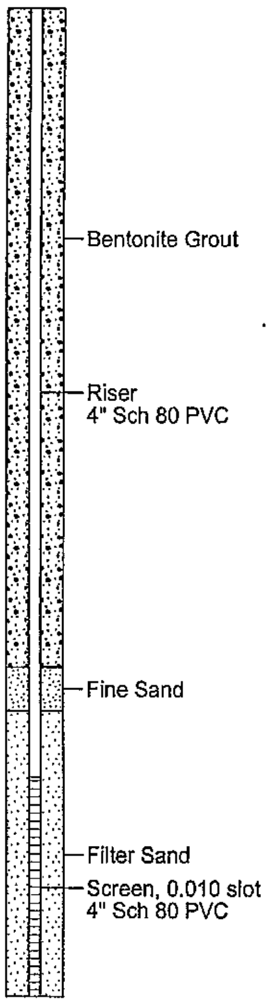
(Page 4 of 4)

Date Started	: 01/30/06
Date Well Set	: 02/17/06
Coring Tools	: 10' HQ conv. circ.
Reaming Tools	: 7.5" Tri-Cone w/ stab
Drill Rig	: DrillTech D40
Driller Name/Co	: R. Treptow / Layne

Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 598.290 feet above MSL
TOC Elev.	: 600.870 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757410.291
Coordinate E	: 1046479.383
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 598	DESCRIPTION	% RQD	% Recovery
180	418		100	
		- transistion zone, DOLOMITE / MUDDY DOLOMITE		
185	413			
		MUDDY DOLOMITE, dark gray, platey becomming massive, black platlets, uniform, no visible grains	100	
190	408			
		- becoming near black		
		192.15-192.7 - SHALE, green, moderately soft, laminated 192.7-193.21 - DOLOMITIC SHALE, light gray, laminated gray, frac with pyrite 193.21-193.81 - transistion into FOSSILIFEROUS DOLOMITE 193.81-194.05 - DOLOMITIC SHALE, gray, laminated dark, frac with pyrite	100	
195	403			
		FOSSILIFEROUS DOLOMITE, white, pourous, vuggy, intensely fractured, some pyrite and quartz in vugs - at 196.05, void with quartz and pyrite crystals	64.3	
200	398			
		- begin horz frac, narrow, sediment, some black platelets		
205	393			
		- large vuggy layer, some pyrite and quartz	35.7	
210	388			
		- begin darker to light gray - void large pyrite, some calcite		
215	383	- begin white		
220	378			
225	373			
		End of Boring at 225 feet.		
230	368	Boring cored to 225, reamed to 225, well set at 225.		
235	363			
240				

Well Diagram: G46D



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ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G47D/S

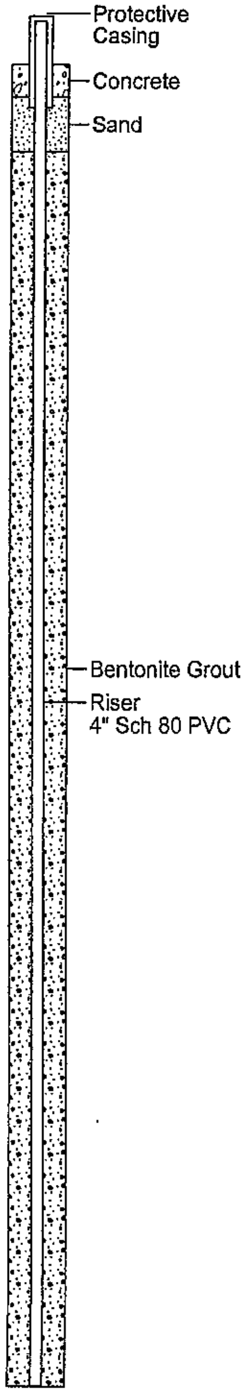
(Page 1 of 4)

Date Started	: 01/24/06
Date Well Set	: 02/17/06
Coring Tools	: 10' HQ conv. circ.
Reaming Tools	: 7.5" Tri-Cone w/ stab
Drill Rig	: DrillTech D40
Driller Name/Co	: R. Treptow / Layne

Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 609.454 feet above MSL
TOC Elev.	: 611.902 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757455.119
Coordinate E	: 1047666.224
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 609	DESCRIPTION	% RQD	% Recovery
0	609			
		Overburden was blind drilled to 25.5 feet.		
		Cuttings logged for general lithology.		
5	604			
		CLAY / SILTY CLAY, brown. Dry.		
10	599			
15	594			
20	589			
		DOLOMITE, weathered.		
25	584			
		DOLOMITE, white, trace iron staining mostly on fractures, fractured, tight, jagged, fine to medium grained, some pits	25.7	
30	579			
		- no iron staining		
		- begin blue/green hue		
35	574			
		- begin trace chert - some pyrite, some large chert nodules	72.9	
40	569			
45	564			
			73.6	
50	559			
		- cresent shaped frac, narrow, pyrite, brown staining		
55	554			
		- 55.5-57.5 fractured, horz, wavy, sediment infilling with pink hue	84.8	
60				

Well Diagram: G47D



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GEOLOGIC LOG OF G47D/S

(Page 2 of 4)

Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

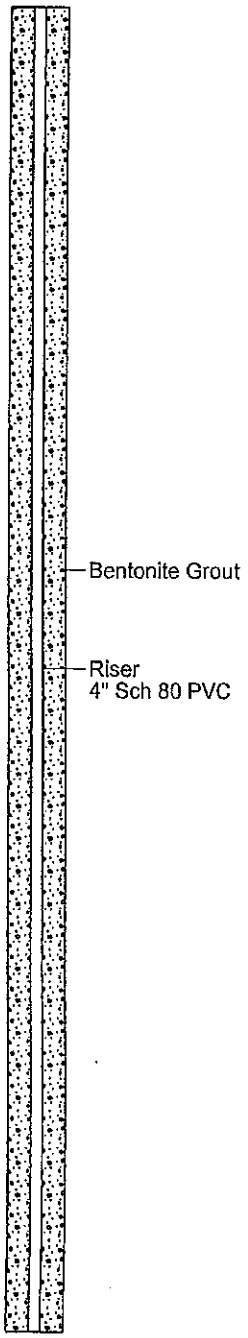
Project No. 21805

Date Started : 01/24/06
Date Well Set : 02/17/06
Coring Tools : 10' HQ conv. circ.
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 609.454 feet above MSL
TOC Elev. : 611.902 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757455.119
Coordinate E : 1047666.224
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 609	DESCRIPTION	% RQD	% Recovery
60	549			
			84.8	
65	544			
		DOLOMITE, light pink, some lighter pink, fine grained, fractures, tight, horz wavy, some vert, with sediment and some pyrite infilling, trace to no pits or vugs	58.6	
70	539			
		- begin dark pink		
75	534			
		- some iron staining in bands	67.1	
80	529			
		- fractured zone, horz, sediment infilling		
85	524	DOLOMITE, white, fine grained, little pits, trace to no vugs or pyrite, little frac horz, tight, some sediment infilling - fractured zone - begin trace to no frac or pits		
			70.3	
90	519			
		- some pyrite - fractured zone		
95	514			
			24.2	
100	509			
105	504			
			49.4	
110	499			
		- some horz frac, sediment infilling		
115	494			
		begin - vugs and fossils, calcite, no pyrite, some layers with increase pits and small vugs	75.1	
120				

Well Diagram: G47D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G47D/S

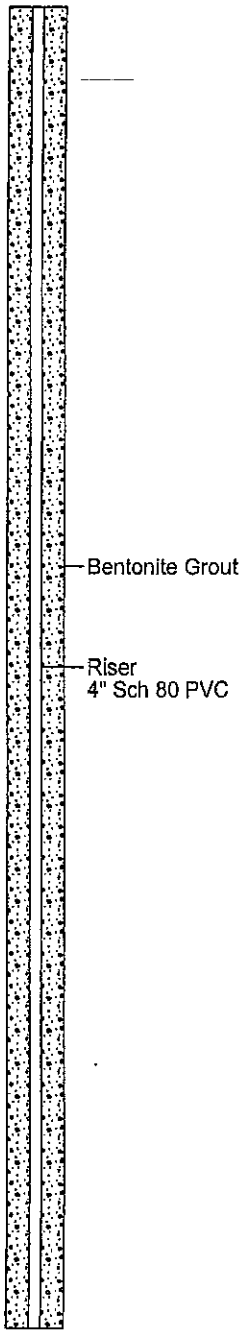
(Page 3 of 4)

Date Started : 01/24/06
Date Well Set : 02/17/06
Coring Tools : 10' HQ conv. circ.
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 609.454 feet above MSL
TOC Elev. : 611.902 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757455.119
Coordinate E : 1047666.224
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 609	DESCRIPTION	% RQD	% Recovery
120	489			
		DOLOMITE, gray, large chert - white with dark gray and little to trace pyrite, some vugs with pyrite on bottom	75.1	
125	484	- several layers highly broken chert		
		DOLOMITE, white to light gray, some light green/blue, few layers with pits, horz wavy frac, sediment infilling, little chert, some pyrite in chert	88.8	
130	479			
135	474			
			100	
140	469			
		DOLOMITE, gray, fine grained, some chert, occ bedding, horz frac with black sediment infilling, occ cherty layers, trace pyrite usually in chert, little fossils, trace to no pits or vugs		
145	464			
			96.5	
150	459			
		begin - little to no chert		
155	454	- some bedding gray to light gray, dark gray sediment in horz frac		
			100	
		- 0.1' fossiliferous layer, pits, little pyrite		
160	449			
165	444			
			85.8	
170	439			
175	434			
			100	
180				

Well Diagram: G47D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G47D/S

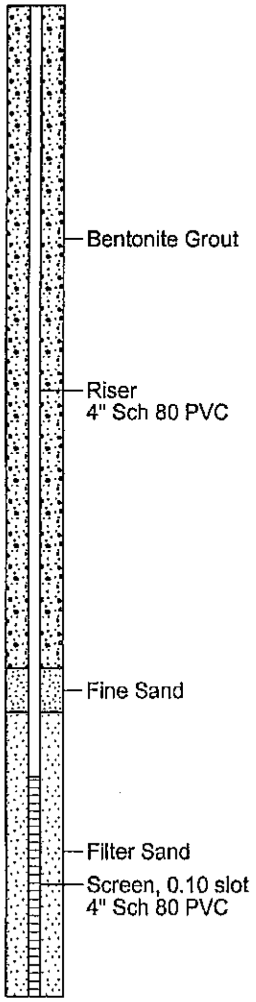
(Page 4 of 4)

Date Started : 01/24/06
Date Well Set : 02/17/06
Coring Tools : 10' HQ conv. circ.
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 609.454 feet above MSL
TOC Elev. : 611.902 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757455.119
Coordinate E : 1047666.224
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 609	DESCRIPTION	% RQD	% Recovery
180	429		100	
		- becoming darker		
185	424	- 0.3' transitional layer		
			100	
		MUDDY DOLOMITE, dark gray, thin black platlets, no frac, no chert		
190	419			
		193.9-194.15 - SHALE, light green, mod hard, thin bed 194.15-195.3 - DOLOMITIC SHALE, lighter, some pits with pyrite 195.3-195.5 - DOLOMITIC SHALE, dark gray, upper hard, lower soft		
195	414			
		FOSSILIFEROUS DOLOMITE, white, upper foot light green hues, pitted, vuggy, pyrite, calcite and quartz in vugs and voids - large crystal layer at 197, quartz and pyrite - horz frac, sediment at 200'		
200	409			
205	404	begin - little vugs and pits		
			43.9	
		- 0.7' horz frac, mostly pyrite		
210	399			
		DOLOMITE, gray and black (peppered), thin black platelets and beds, vuggy, pitted, calcite quartz and pyrite throughout		
215	394			
		DOLOMITE, light gray, some pits and vugs, calcite quartz and pyrite, horz frac with green soft argillaceous sediment infilling	54.2	
220	389			
		- some black platelets		
			94.0	
225	384			
		End of Boring at 225 feet.		
230	379			
235	374			
240				

Well Diagram: G47D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G48D/S

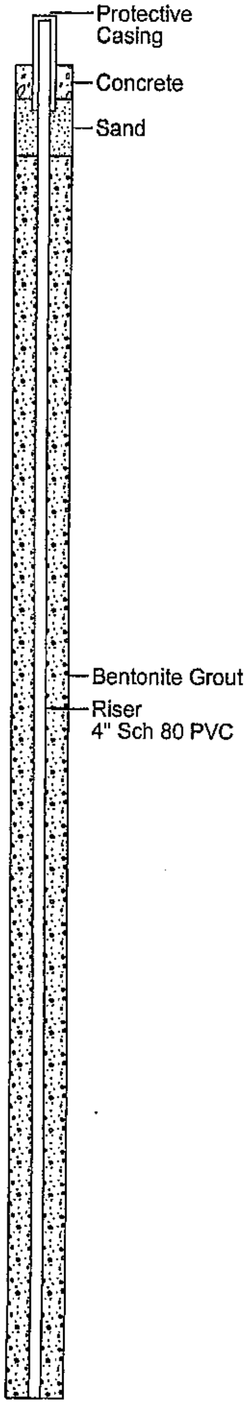
(Page 1 of 4)

Date Started	: 12/19/05
Date Well Set	: 02/17/06
Coring Tools	: 10' HQ conv. circ.
Reaming Tools	: 7.5" Tri-Cone w/ stab
Drill Rig	: DrillTech D40
Driller Name/Co	: R. Treptow / Layne

Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 617.778 feet above MSL
TOC Elev.	: 620.530 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757481.301
Coordinate E	: 1048124.052
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 617	DESCRIPTION	% RQD	% Recovery
0	617	Overburden was blind drilled to 40. Cuttings logged for general lithology.		
5	612	CLAY / SILTY CLAY, brown. Dry.		
10	607			
15	602			
20	597			
25	592			
30	587			
		SAND, brown, fine to medium, some silt and gravel.		
35	582	GRAVEL, brown, fine to medium, some sand and silt.		
		DOLOMITE, weathered.		
40	577	DOLOMITE, white to light gray, fine grained, trace pits		
45	572	- greenish hue		
		- dark gray layer	43.6	
50	567	DOLOMITE, green/gray to light gray with pink hue, colors in blending layers ,few vugs, less pits, several pyrite filled frac vert and horz, tight, some horz frac, dark gray sediment and pyrite infilling, some wavy		
55	562		23.8	
60				

Well Diagram: G48D



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KPRG and Associates, Inc.

Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G48D/S

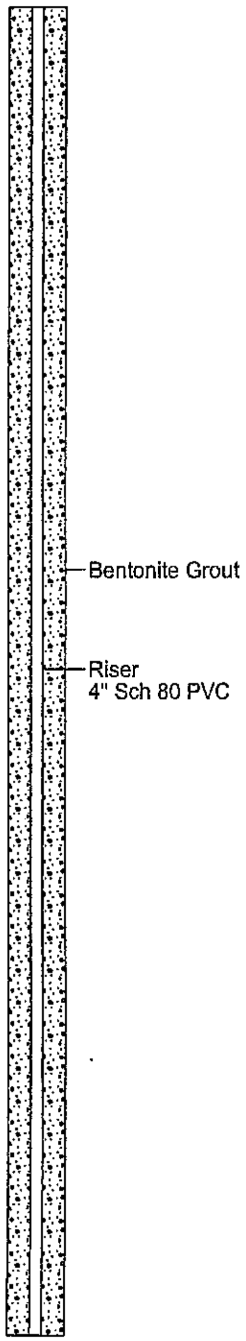
(Page 2 of 4)

Date Started : 12/19/05
Date Well Set : 02/17/06
Coring Tools : 10' HQ conv. circ.
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 617.778 feet above MSL
TOC Elev. : 620.530 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757481.301
Coordinate E : 1048124.052
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 617	DESCRIPTION	% RQD	% Recovery
60	557	- coloring becoming more distinct - pink hue is darker 62-64, vert frac, pyrite, vugs have calcite and pyrite	23.8	
65	552			
		- light and dark gray, trace to no pink, pitted 67-70	15.3	
70	547	- pink resumes, some chert, tight fracs		
75	542	- light pink		
			84.9	
		DOLOMITE, light gray with green/gray, vuggy, cherty, trace pyrite		
80	537	- 79-80 cross frac, 1.0', some vugs with pyrite, trace to no green hue - some wavy frac		
		- 0.35' vert frac, tight, no pyrite		
85	532	- 1.0' vert frac, tight, some pyrite		
			67.5	
		- 88-90 - wavy horz frac zone, vug with pyrite		
90	527	- 89-92 - no pyrite		
95	522	begin gray, increase wavy horz frac, some vugs with calcite, little vert frac		
			13.4	
100	517	- 0.05 layer pitted, vuggy, fossiliferous, white - becoming lighter		
105	512			
			22.7	
110	507	DOLOMITE, gray with pink hue, fine grained, layers with darker shade, little pits and vugs, some with pyrite		
115	502			
			69.7	
120				

Well Diagram: G48D



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Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

Project No. 21805

GEOLOGIC LOG OF G48D/S

(Page 3 of 4)

Date Started	: 12/19/05
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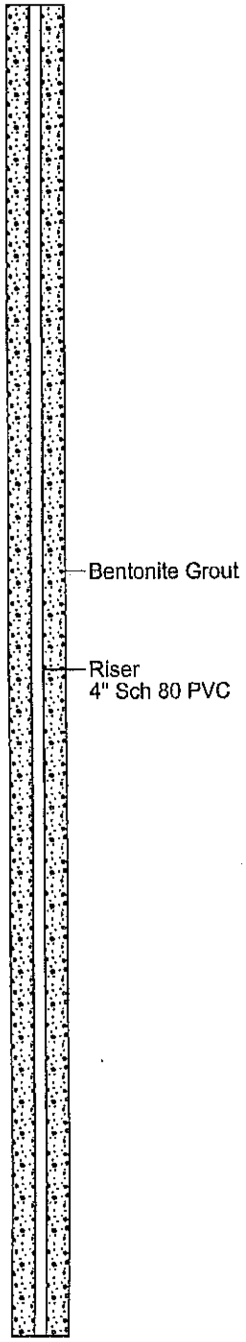
Total Boring Depth	: 225.0 feet
Well Bottom Depth	: 225.0 feet
Surface Elev.	: 617.778 feet above MSL
TOC Elev.	: 620.530 feet above MSL
Groundwater Elev.	: xxx feet above MSL
Riser Material	: 4" Sch 80 PVC
Screen Material	: 4" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757481.301
Coordinate E	: 1048124.052
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 617	DESCRIPTION	% RQD	% Recovery
120	497	DOLOMITE, white to light gray with light green, trace to no vugs or pits or pyrite, less chert, some oval shaped, trace fossils	69.7	
125	492		41.3	
130	487			
135	482	DOLOMITE, gray, layers of fine bedding, fine grained, trace pyrite, some chert, little to no fossils	61.0	
140	477	- 141.7 to 142.2 - light brown - 0.3' dark gray cherty layer		
145	472		100	
150	467	DOLOMITE, gray, fine grained, some bedding, no vugs, little to no pits, trace pyrite in horz frac		
155	462		55.1	
160	457	- 0.02' vug, pyrite		
165	452		71.1	
170	447	- becoming muddy and platey, uniform, no vugs or pits		
175	442		100	
180				

Well Diagram: G48D



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GEOLOGIC LOG OF G48D/S

(Page 4 of 4)

Midwest Generation, LLC
Station # 9 - Lincoln Quarry
Joliet, Illinois

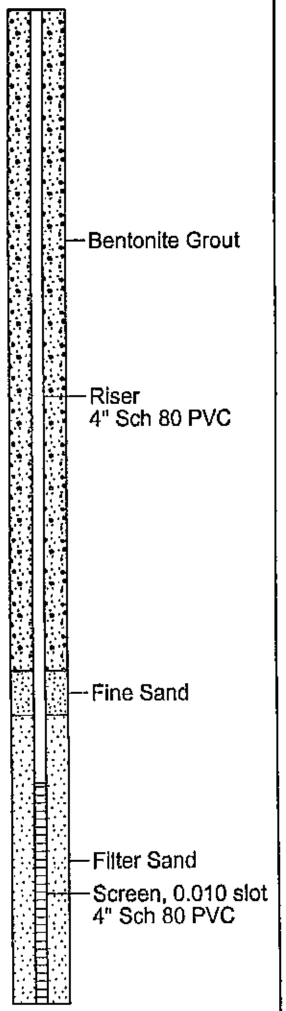
Project No. 21805

Date Started : 12/19/05
Date Well Set : 02/17/06
Coring Tools : 10' HQ conv. circ.
Reaming Tools : 7.5" Tri-Cone w/ stab
Drill Rig : DrillTech D40
Driller Name/Co : R. Treptow / Layne

Total Boring Depth : 225.0 feet
Well Bottom Depth : 225.0 feet
Surface Elev. : 617.778 feet above MSL
TOC Elev. : 620.530 feet above MSL
Groundwater Elev. : xxx feet above MSL
Riser Material : 4" Sch 80 PVC
Screen Material : 4" Sch 80 PVC, 0.010 slot
Coordinate N : 1757481.301
Coordinate E : 1048124.052
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 617	DESCRIPTION	% RQD	% Recovery
180	437	MUDDY DOLOMITE, dark gray, platey	100	
185	432	186.05-187.2 - DOLOMITIC SHALE, light green/gray 187.2-189.0 - transistion layer, alt upper and lower	100	
190	427	FOSSILIFEROUS DOLOMITE, white, vuggy, pitted, highly fractured, some pyrite and sediment infilling, some quartz		
195	422		31.2	
200	417	- horz and vert frac, very narrow, some sediment and pyrite infilling		
205	412	- 205 to 211 - little to trace vugs	31.7	
210	407		48.9	
215	402			
220	397	SHALE, light green/gray, platey, mod hard MUDDY DOLOMITE, dark gray, white sediment/crystal filled frac, tight, some wavy lamination		
225	392	End of Boring at 225 feet.		
230	387			
235	382			
240				

Well Diagram: G48D



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Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

GEOLOGIC LOG OF T01S

(Page 1 of 2)

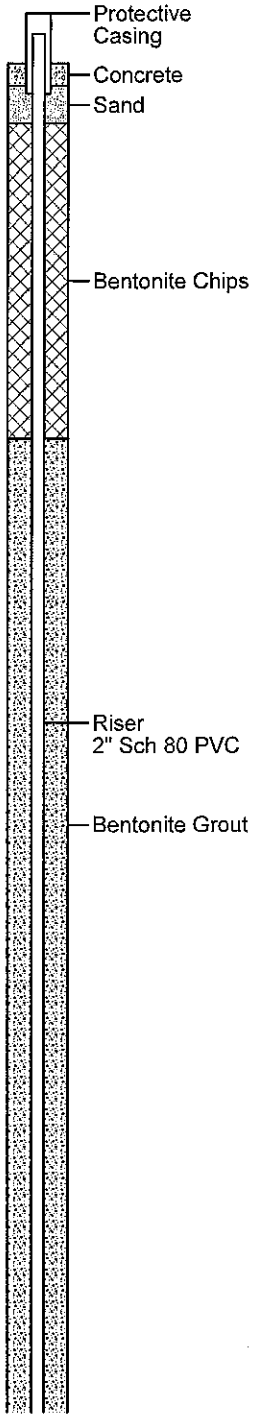
Date Started : 06/14/2010
Date Well Set : 06/16/2010
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 167.0 feet
Well Bottom Depth : 165.0 feet
Surface Elev. : 619.00 feet above MSL
TOC Elev. : 621.46 feet above MSL

Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757503.340
Coordinate E : 1048268.702
Logged By : C. Higgins

Depth in Feet	Surf. Elev. 619.00	DESCRIPTION	% RQD	% Recovery
0	619			
5	614	Boring drilled through overburden to set temporary 6" casing.		
10	609			
15	604			
20	599			
25	594			
30	589			
35	584			
40	579			
		Top of Bedrock at 45 feet.		
45	574	Gray DOLOMITE, weathered		
50	569	Gray to White DOLOMITE		
55	564			
		Gray DOLOMITE, little, green		
60	559			
		Gray DOLOMITE, some Tan, trace Green		
65	554			
		Gray and Pink DOLOMITE, some Green		
70	549			
		Pink and Green DOLOMITE,little chert		
75	544	Light Brown DOLOMITE, some Pink and Green, trace chert		
80	539	- trace Black SAND		
85	534			
		Dark Gray DOLOMITE, trace Pink		
90		- trace Green		

Well Diagram: T01S



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KPRG and Associates, Inc.

GEOLOGIC LOG OF T01S

(Page 2 of 2)

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

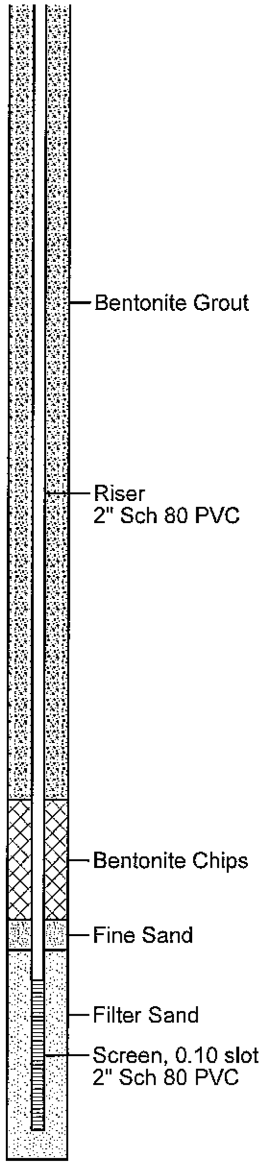
Date Started : 06/14/2010
Date Well Set : 06/16/2010
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 167.0 feet
Well Bottom Depth : 165.0 feet
Surface Elev. : 619.00 feet above MSL
TOC Elev. : 621.46 feet above MSL

Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757503.340
Coordinate E : 1048268.702
Logged By : C. Higgins

Depth in Feet	Surf. Elev. 619.00	DESCRIPTION	% RQD	% Recovery
90	529			
95	524	Brown and Gray DOLOMITE, trace Green		
100	519	Brown and Gray DOLOMITE, some Pink and Green, trace chert		
105	514	- increase chert		
110	509			
115	504			
120	499	Light Brown to Tan DOLOMITE, trace chert		
125	494	- increase chert		
130	489	Light Brown and Gray DOLOMITE, cherty		
135	484			
140	479			
145	474			
150	469			
155	464			
160	459	Dark Gray DOLOMITE		
165	454			
170	449	End of Boring at 167 feet.		
175	444			
180				

Well Diagram: T01S



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ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

GEOLOGIC LOG OF T02S

(Page 1 of 2)

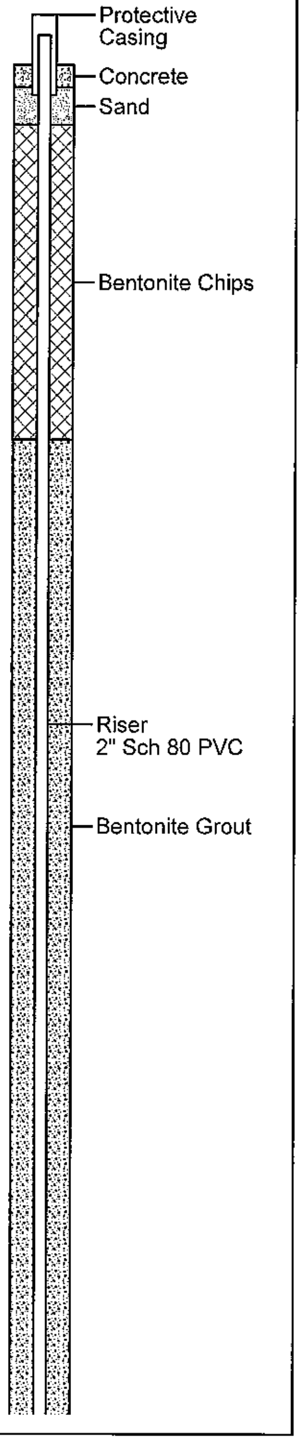
Date Started : 04/27/2010
Date Well Set : 04/27/2010
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 171.0 feet
Well Bottom Depth : 170.0 feet
Surface Elev. : 623.79 feet above MSL
TOC Elev. : 626.15 feet above MSL

Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1756750.288
Coordinate E : 1048104.390
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 623.79	DESCRIPTION	% RQD	% Recovery
0	623	Boring drilled through overburden to set temporary 6" casing.		
5	618			
10	613			
15	608			
20	603			
25	598			
30	593			
35	588			
40	583			
45	578			
50	573			
55	568	Top of Bedrock at 55 feet. Boring reamed to 62 feet in order to set air hammer.		
60	563	Light Brown DOLOMITE, some Rust, weathered		
65	558			
70	553	White to Light Gray DOLOMITE, some chert, less competent		
75	548			
80	543	Tan DOLOMITE, moderately competent		
85	538	Light Gray with Greenish Gray DOLOMITE		
90				

Well Diagram: T02S



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KPRG and Associates, Inc.

GEOLOGIC LOG OF T02S

(Page 2 of 2)

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

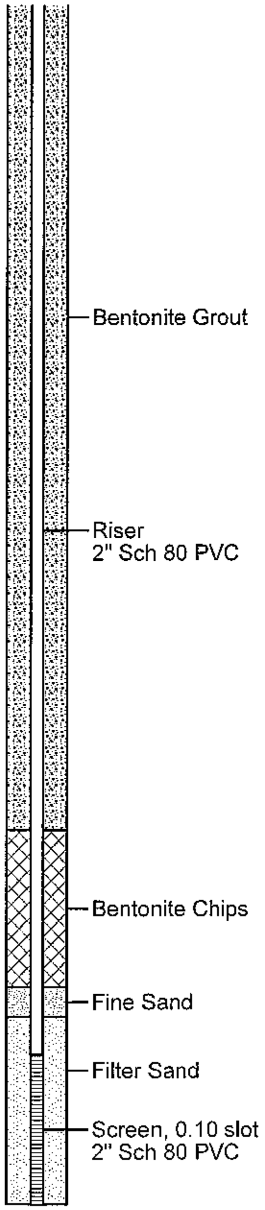
Project No. 11306.11

Date Started	: 04/27/2010
Date Well Set	: 04/27/2010
Coring Tools	: Not cored
Drilling Tools	: 4.75 Air Hammer
Drill Rig	: Atlas Copco TH60
Driller Name/Co	: D. Jones / Layne

Total Boring Depth	: 171.0 feet
Well Bottom Depth	: 170.0 feet
Surface Elev.	: 623.79 feet above MSL
TOC Elev.	: 626.15 feet above MSL
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1756750.288
Coordinate E	: 1048104.390
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 623.79	DESCRIPTION	% RQD	% Recovery
90	533	Darker Greenish Gray DOLOMITE, trace Light Pink, competent		
95	528	Greenish Gray and Pink DOLOMITE		
100	523			
105	518	White DOLOMITE, some Pink, cherty, moderately competent		
110	513	Pink DOLOMITE, trace White, moderately to less competent		
115	508	Light Brown DOLOMITE, trace Greenish Gray, moderately to less competent		
120	503			
125	498	- loss circulation, no recovery		
130	493	- some cohesive clay infilling		
135	488			
140	483	Light Brown DOLOMITE, trace to no Greenish Gray, moderately competent		
145	478	- little recovery		
150	473			
155	468	Light Brown DOLOMITE, with Chert, less competent		
160	463	- less Chert		
165	458	Fracture at 166 feet - 6" to 10" No recovery		
170	453	End of Boring at 171 feet.		
175	448			
180				

Well Diagram: T02S



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ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

GEOLOGIC LOG OF T03S

(Page 1 of 2)

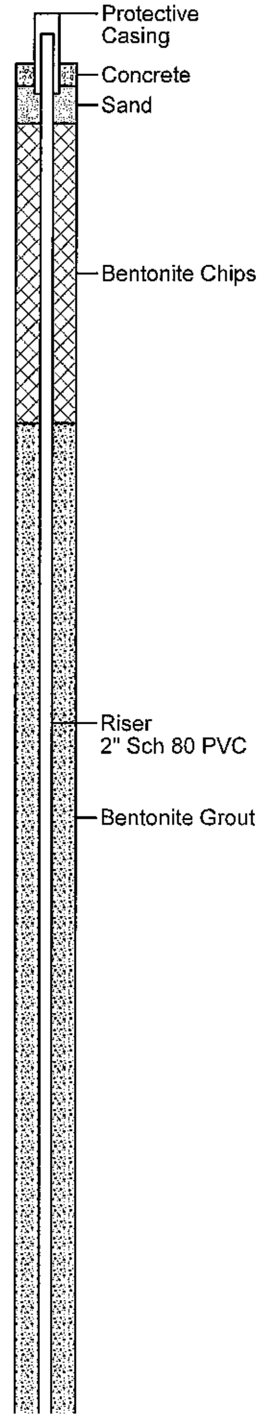
Date Started : 04/28/2010
Date Well Set : 04/29/2010
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 172.0 feet
Well Bottom Depth : 170.0 feet
Surface Elev. : 627.22 feet above MSL
TOC Elev. : 629.65 feet above MSL

Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1755962.898
Coordinate E : 1048165.667
Logged By : R. Gnat

Depth in Feet	Surf. Elev. 627.22	DESCRIPTION	% RQD	% Recovery
0	627			
5	622	Boring drilled through overburden to set temporary 6" casing.		
10	617			
15	612			
20	607			
25	602			
30	597			
35	592			
40	587			
45	582			
50	577			
55	572	Top of Bedrock at 54 feet. Boring reamed to 62 feet in order to set air hammer.		
60	567			
65	562	Light Gray DOLOMITE, moderately competent to weathered		
70	557			
75	552			
80	547	Light Gray DOLOMITE, some Blue Green matrix, less competent		
85	542			
90				

Well Diagram: T03S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

GEOLOGIC LOG OF T03S

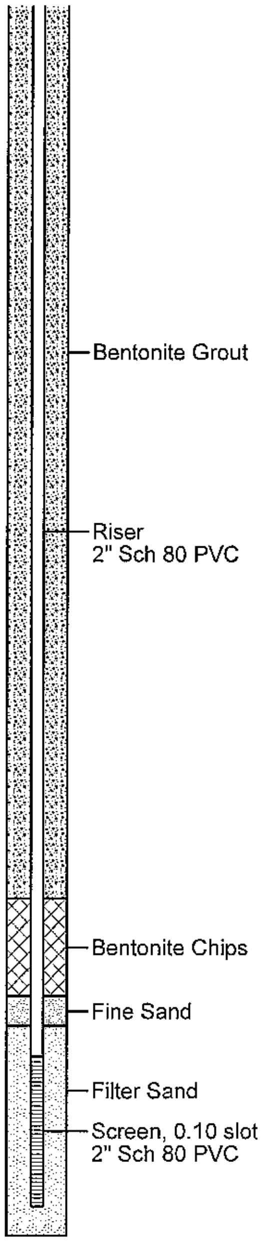
(Page 2 of 2)

Date Started	: 04/28/2010
Date Well Set	: 04/29/2010
Coring Tools	: Not cored
Drilling Tools	: 4.75 Air Hammer
Drill Rig	: Atlas Copco TH60
Driller Name/Co	: D. Jones / Layne

Total Boring Depth	: 172.0 feet
Well Bottom Depth	: 170.0 feet
Surface Elev.	: 627.22 feet above MSL
TOC Elev.	: 629.65 feet above MSL
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1755962.898
Coordinate E	: 1048165.667
Logged By	: R. Gnat

Depth in Feet	Surf. Elev. 627.22	DESCRIPTION	% RQD	% Recovery
90	537	Tan, Dark Gray and Light Gray DOLOMITE, moderately competent		
95	532	Dark Gray to Gray DOLOMITE, no Tan, some shaley chips		
100	527	Dark Gray and Tan DOLOMITE, some shaley chips		
105	522	Brown and some Gray DOLOMITE		
110	517	Brown and Dark Greenish Gray DOLOMITE, some gray, competent to moderately competent		
115	512			
120	507	Light Gray DOLOMITE, competent		
125	502			
130	497	Gray, tan and Dark Greenish Gray DOLOMITE, moderately competent		
135	492			
140	487	Light Gray to Tan DOLOMITE, competent - no Tan, Cherty		
145	482			
150	477	Tan DOLOMITE, some Chert, moderately competent		
155	472			
160	467	White to Light Gray DOLOMITE, Cherty, moderately competent - fractured, Gray		
165	462			
170	457			
175	452	End of Boring at 172 feet.		
180				

Well Diagram: T03S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

GEOLOGIC LOG OF T04S

(Page 1 of 2)

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

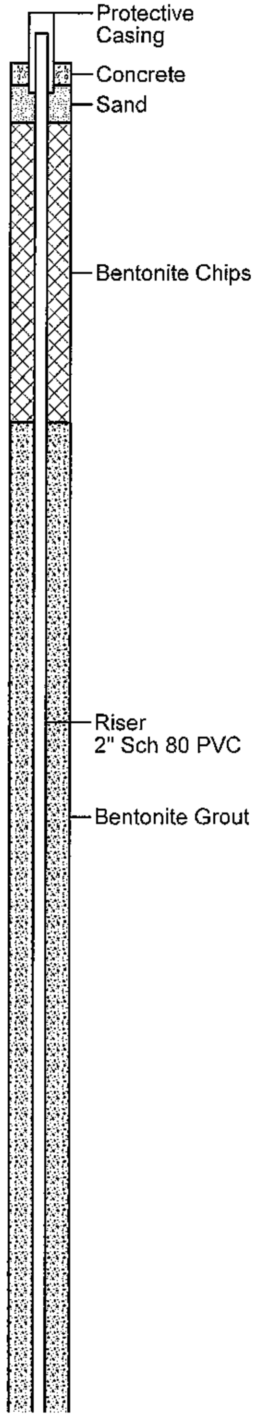
Project No. 11306.11

Date Started	: 04/20/2010
Date Well Set	: 04/21/2010
Coring Tools	: Not cored
Drilling Tools	: 4.75 Air Hammer
Drill Rig	: Atlas Copco TH60
Driller Name/Co	: D. Jones / Layne

Total Boring Depth	: 171.5 feet
Well Bottom Depth	: 170.0 feet
Surface Elev.	: 628.63 feet above MSL
TOC Elev.	: 631.07 feet above MSL
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1756411.076
Coordinate E	: 1048857.472
Logged By	: C. Higgins

Depth in Feet	Surf. Elev. 628.63	DESCRIPTION	% RQD	% Recovery
0	628			
5	623	Boring drilled through overburden to set temporary 6" casing.		
10	618			
15	613			
20	608			
25	603			
30	598			
35	593			
40	588			
45	583			
50	578	Top of Bedrock at 52 feet.		
55	573	Gray to Tan DOLOMITE, weathered to moderately competent, some gray clay infilling		
60	568	Tan to Light Gray DOLOMITE, moderately competent		
65	563	- some orange/rust		
70	558	- trace to some chert		
75	553			
80	548	Greenish Gray DOLOMITE		
85	543	- no Green		
90				

Well Diagram: T04S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.11

GEOLOGIC LOG OF T04S

(Page 2 of 2)

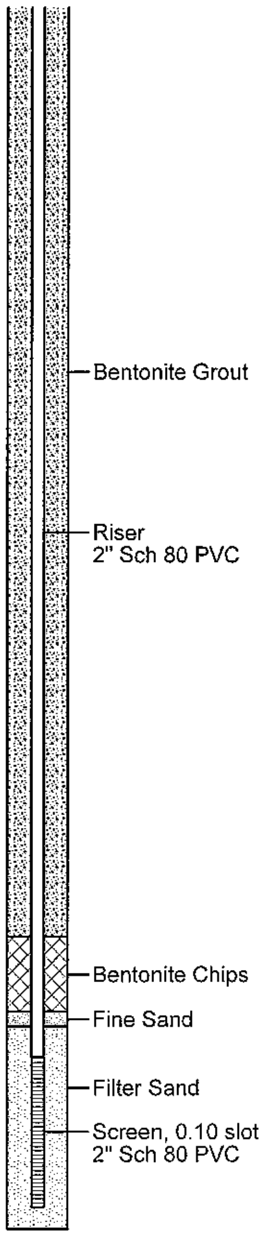
Date Started : 04/20/2010
Date Well Set : 04/21/2010
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 171.5 feet
Well Bottom Depth : 170.0 feet
Surface Elev. : 628.63 feet above MSL
TOC Elev. : 631.07 feet above MSL

Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1756411.076
Coordinate E : 1048857.472
Logged By : C. Higgins

Depth in Feet	Surf. Elev. 628.63	DESCRIPTION	% RQD	% Recovery
90	538			
95	533			
100	528	Green and Brown DOLOMITE		
105	523			
110	518	Brown, Dark Brown and Greenish Gray DOLOMITE, trace Chert		
115	513			
120	508			
125	503	Greenish Gray DOLOMITE, some Light Brown		
130	498			
135	493	Brown DOLOMITE, trace Chert		
140	488			
145	483	Brown with trace Greenish Gray DOLOMITE, trace Chert		
150	478			
155	473			
160	468	Brown DOLOMITE, trace Chert		
165	463	Brown DOLOMITE, Cherty		
170	458			
175	453	End of Boring at 171.5 feet.		
180				

Well Diagram: T04S



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GEOLOGIC LOG OF T05S

(Page 1 of 2)

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

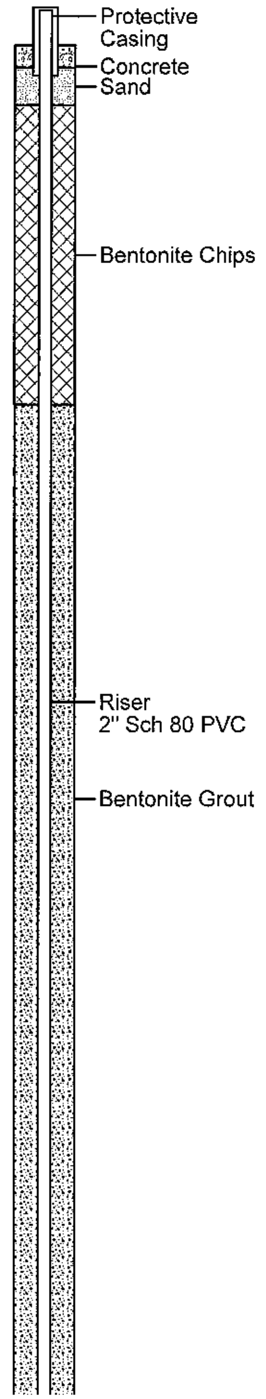
Project No. 11306.15

Date Started : 02/08/2012
Date Well Set : 02/09/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 177.0 feet
Well Bottom Depth : 175.0 feet
Surface Elev. : 620.97 feet above MSL
TOC Elev. : 623.35 feet above MSL
Groundwater Elev. : not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757056.894
Coordinate E : 1048117.832
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 620.97	DESCRIPTION	% RQD	% Recovery
0	620			
5	615	Unconsolidated overburden blind-drilled.		
10	610			
15	605			
20	600			
25	595			
30	590			
35	585			
40	580			
45	575			
50	570	Bedrock at 52 feet.		
55	565	Tan DOLOMITE, tace light pink, blue/green argillaceous		
60	560	Tan DOLOMITE, trace pyrite		
65	555			
70	550	Tan DOLOMITE, some pink, trace chert		
75	545	Brown DOLOMITE, some tan with green argillaceous		
80	540	White DOLOMITE, trace gray		
85	535	Pink DOLOMITE, trace chert		
90				

Well Diagram: T05S



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ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T05S

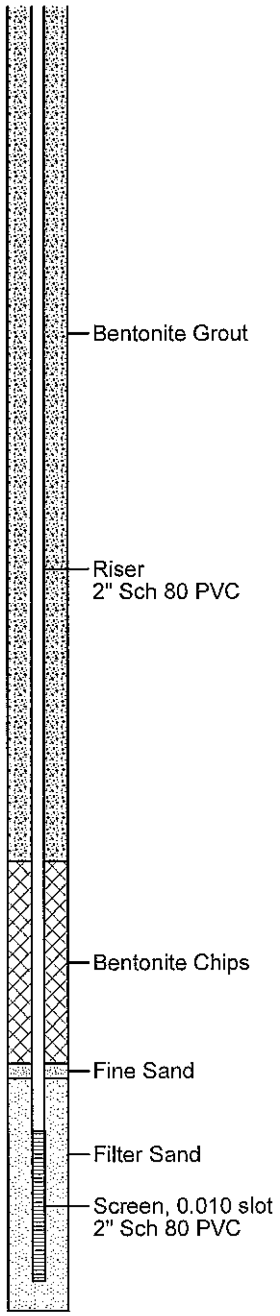
(Page 2 of 2)

Date Started : 02/08/2012
Date Well Set : 02/09/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 177.0 feet
Well Bottom Depth : 175.0 feet
Surface Elev. : 620.97 feet above MSL
TOC Elev. : 623.35 feet above MSL
Groundwater Elev. : not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757056.894
Coordinate E : 1048117.832
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 620.97	DESCRIPTION	% RQD	% Recovery
90	530	White DOLOMITE, light yellow hue		
95	525	White DOLOMITE, light green hue		
100	520			
105	515	Tan DOLOMITE, trace blue/gray		
110	510	Blue/gray DOLOMITE		
115	505	Tan DOLOMITE, trace blue/gray		
120	500			
125	495			
130	490	Tan DOLOMITE, cherty		
135	485			
140	480	Gray DOLOMITE, trace chert and quartz		
145	475			
150	470			
155	465			
160	460			
165	455			
170	450			
175	445			
		End of boring at 177 feet.		
180				

Well Diagram: T05S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T06S

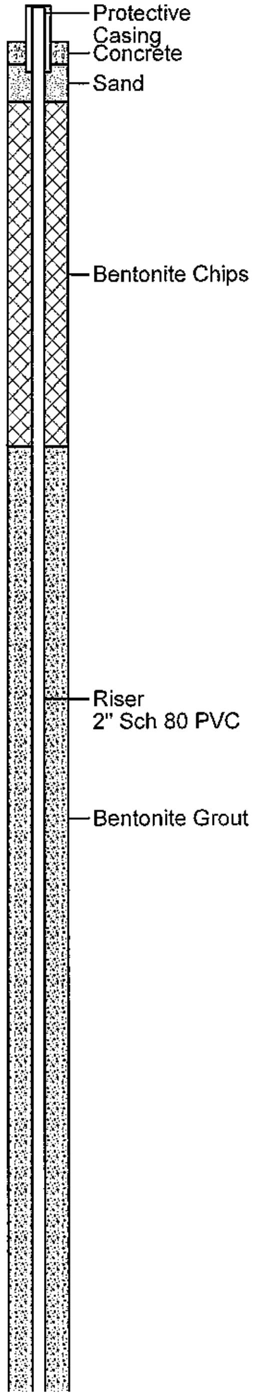
(Page 1 of 2)

Date Started : 02/10/2012
Date Well Set : 02/13/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 175.0 feet
Well Bottom Depth : 173.0 feet
Surface Elev. : 618.58 feet above MSL
TOC Elev. : 620.94 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757090.355
Coordinate E : 1047415.925
Logged By : A. Jakubowski

Depth in Feet	Surf. Elev. 618.58	DESCRIPTION	% RQD	% Recovery
0	618			
5	613	Unconsolidated overburden blind-drilled.		
10	608			
15	603			
20	598			
25	593			
30	588			
35	583			
40	578			
45	573	Bedrock at 47 feet		
50	568	Light brown DOLOMITE		
55	563	Light gray/white DOLOMITE, trace light brown		
60	558	Tan DOLOMITE, trace light brown		
65	553	Light gray DOLOMITE, trace tan		
70	548	Light blue/green DOLOMITE		
75	543	Dark blue/green DOLOMITE, trace tan, quartz and pyrite		
80	538	Pink and blue/green DOLOMITE		
85	533	Brown with blue/green DOLOMITE, trace pink		
90				

Well Diagram: T06S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

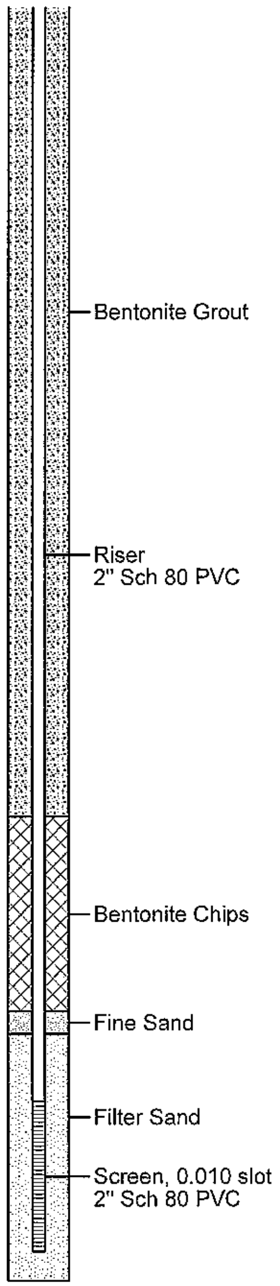
GEOLOGIC LOG OF T06S
(Page 2 of 2)

Date Started : 02/10/2012
Date Well Set : 02/13/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 175.0 feet
Well Bottom Depth : 173.0 feet
Surface Elev. : 618.58 feet above MSL
TOC Elev. : 620.94 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757090.355
Coordinate E : 1047415.925
Logged By : A. Jakubowski

Depth in Feet	Surf. Elev. 618.58	DESCRIPTION	% RQD	% Recovery
90	528	Pink with white/light gray DOLOMITE		
95	523	Blue/green DOLOMITE, some pink, trace tan/brown		
100	518	Blue/green DOLOMITE, trace tan		
105	513	Blue/green DOLOMITE, some pink, trace tan		
110	508	Light pink DOLOMITE, some tan, trace chert and blue/green		
115	503	Light tan DOLOMITE, trace blue/green		
120	498	Tan DOLOMITE, some blue/green		
125	493			
130	488	- less blue/green		
135	483			
140	478	Light tan DOLOMITE, cherty, trace pyrite		
145	473			
150	468	Green/blue DOLOMITE, some tan		
155	463	Green/blue DOLOMITE, trace tan and chert		
160	458	- no chert		
165	453	Dark gray DOLOMITE		
170	448	Dark gray DOLOMITE, trace pyrite		
175	443	End of boring at 175 feet.		
180				

Well Diagram: T06S



ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T07S

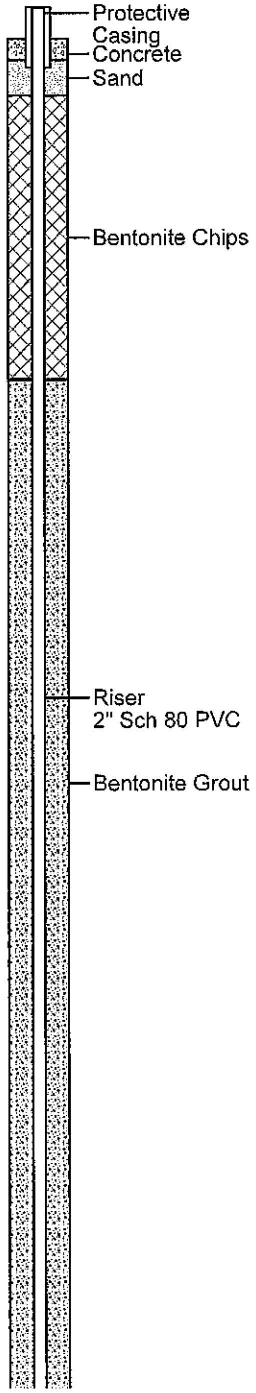
(Page 1 of 2)

Date Started	: 02/14/2012
Date Well Set	: 02/16/2012
Coring Tools	: Not cored
Drilling Tools	: 4.75 Air Hammer
Drill Rig	: Atlas Copco TH60
Driller Name/Co	: D. Jones / Layne

Total Boring Depth	: 180.0 feet
Well Bottom Depth	: 178.0 feet
Surface Elev.	: 623.98 feet above MSL
TOC Elev.	: 626.20 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1756776.672
Coordinate E	: 1047262.579
Logged By	: A. Jakubowski

Depth in Feet	Surf. Elev. 623.98	DESCRIPTION	% RQD	% Recovery
0	623	Unconsolidated overburden blind-drilled.		
5	618			
10	613			
15	608			
20	603			
25	598			
30	593			
35	588			
40	583			
45	578			
50	573			
55	568	Bedrock at 55 feet		
60	563	Light tan DOLOMITE, trace brown		
65	558			
70	553	Light tan and white DOLOMITE		
75	548	Tan DOLOMITE, trace pyrite		
80	543	- increase pyrite		
85	538	Blue/green DOLOMITE, some light tan		
90	533	Pink and tan DOLOMITE, some blue/green, trace white		
95				

Well Diagram: T07S



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ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T07S

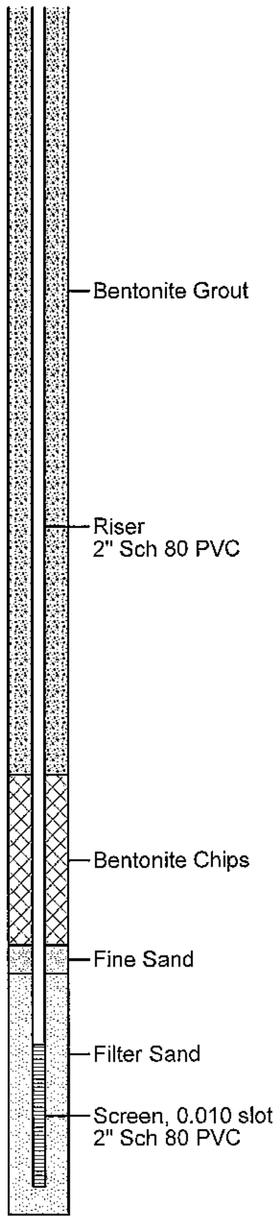
(Page 2 of 2)

Date Started : 02/14/2012
Date Well Set : 02/16/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 180.0 feet
Well Bottom Depth : 178.0 feet
Surface Elev. : 623.98 feet above MSL
TOC Elev. : 626.20 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1756776.672
Coordinate E : 1047262.579
Logged By : A. Jakubowski

Depth in Feet	Surf. Elev. 623.98	DESCRIPTION	% RQD	% Recovery
95	528	Light tan and blue/green DOLOMITE, trace pink and white		
100	523	Pink DOLOMITE, trace tan and blue/green		
105	518	Light tan DOLOMITE, some brown, trace blue/green		
110	513	Tan DOLOMITE, trace blue/green		
115	508			
120	503	Gray DOLOMITE, some blue/green		
125	498	Tan DOLOMITE, trace blue/green		
130	493			
135	488	- trace chert		
140	483	- no chert		
145	478	Tan DOLOMITE, cherty		
150	473	Brown and tan DOLOMITE, some chert, trace pyrite		
155	468	- no pyrite		
160	463	Dark and medium gray DOLOMITE		
165	458	- some chert, trace pyrite		
170	453	Dark gray DOLOMITE		
175	448	- trace pyrite		
180	443	End of boring at 180 feet		
185	438			
190				

Well Diagram: T07S



ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T08S

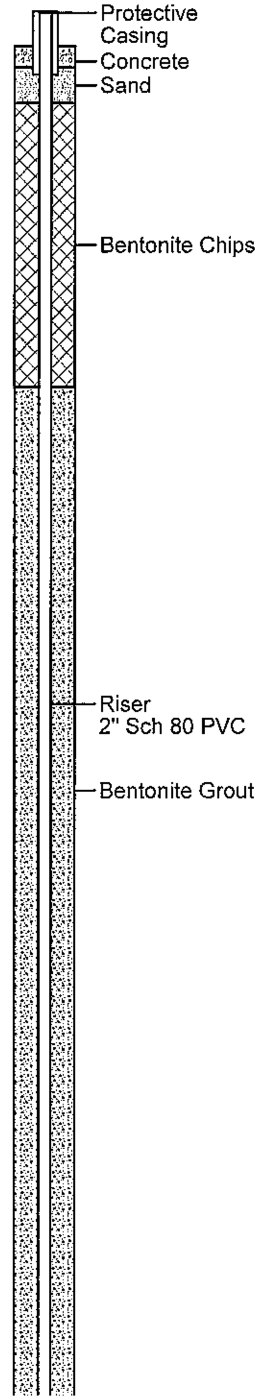
(Page 1 of 2)

Date Started : 02/01/2012
Date Well Set : 02/06/2012
Coring Tools : Not cored
Drilling Tools : 4.75 Air Hammer
Drill Rig : Atlas Copco TH60
Driller Name/Co : D. Jones / Layne

Total Boring Depth : 181.0 feet
Well Bottom Depth : 180.0 feet
Surface Elev. : 625.00 feet above MSL
TOC Elev. : 627.38 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1756815.956
Coordinate E : 1047687.785
Logged By : K. VanAllen

Depth in Feet	Surf. Elev. 625.00	DESCRIPTION	% RQD	% Recovery
0	625			
		Unconsolidated overburden blind-drilled.		
5	620			
10	615			
15	610			
20	605			
25	600			
30	595			
35	590			
40	585			
45	580			
50	575			
55	570	Bedrock at 56.5 feet.		
60	565	Tan and light gray DOLOMITE, trace brown		
65	560			
70	555	Light gray DOLOMITE		
75	550			
80	545			
		- trace medium gray dolomite		
85	540	Blue/green, pink, and light gray DOLOMITE		
90	535			
95				

Well Diagram: T08S



ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 11306.15

GEOLOGIC LOG OF T08S

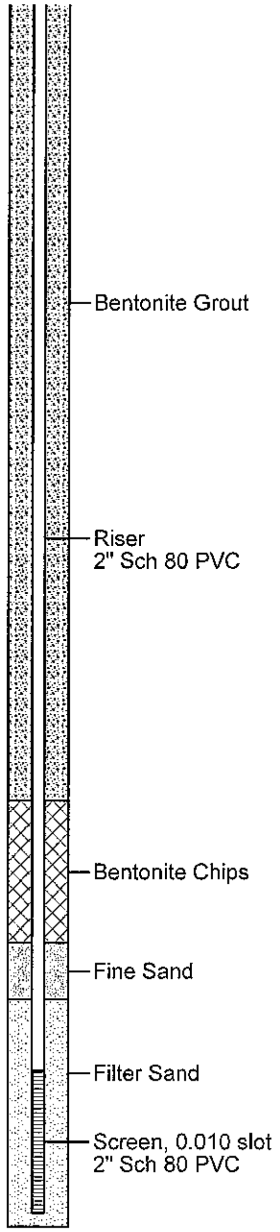
(Page 2 of 2)

Date Started	: 02/01/2012
Date Well Set	: 02/06/2012
Coring Tools	: Not cored
Drilling Tools	: 4.75 Air Hammer
Drill Rig	: Atlas Copco TH60
Driller Name/Co	: D. Jones / Layne

Total Boring Depth	: 181.0 feet
Well Bottom Depth	: 180.0 feet
Surface Elev.	: 625.00 feet above MSL
TOC Elev.	: 627.38 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1756815.956
Coordinate E	: 1047687.785
Logged By	: K. VanAllen

Depth in Feet	Surf. Elev. 625.00	DESCRIPTION	% RQD	% Recovery
95	530	Reddish brown DOLOMITE, trace green/gray		
100	525	Dark pink/gray DOLOMITE, trace blue/gray		
105	520			
110	515	Blue/green DOLOMITE, trace dark pink/gray		
115	510	Light gray/pink DOLOMITE		
120	505			
125	500	Light pink/gray-tan DOLOMITE, trace green/gray		
130	495	Blue/green DOLOMITE, trace light pink/gray		
135	490	Light pink/gray-tan DOLOMITE		
140	485	- occasional white chert		
145	480	Tan DOLOMITE, some chert		
150	475	- trace white chert		
155	470	Tan and gray/green DOLOMITE, some chert		
160	465	- no chert		
165	460	Light gray DOLOMITE		
170	455	Medium gray and white DOLOMITE		
175	450	Light blue/green and white DOLOMITE		
180	445	- less white dolomite		
		End of boring at 181 feet		
185	440			
190				

Well Diagram: T08S



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KPRG and Associates, Inc.

Midwest Generation, LLC
Lincoln Stone Quarry
Joliet, Illinois

Project No. 18713

GEOLOGIC LOG OF T09S

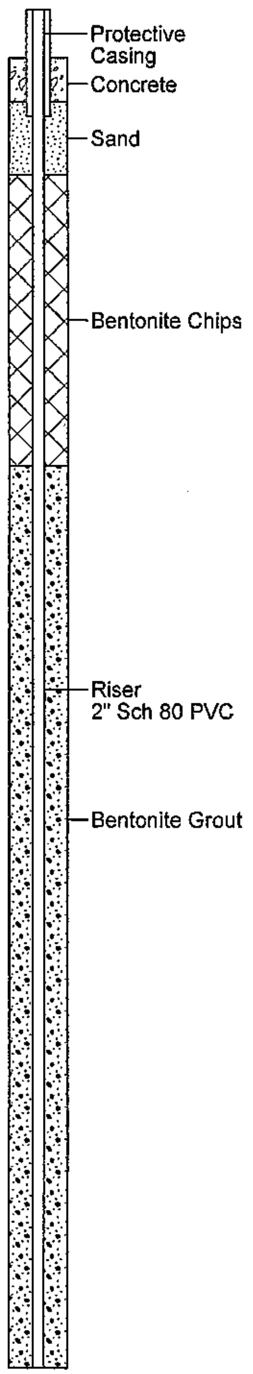
(Page 1 of 4)

Date Started : 10/18/2013
Date Well Set : 10/24/2013
Coring Tools : NQ Double Wall 10' Barrel
Drilling Tools : 6" Air Hammer
Drill Rig : Mobile B61/Gus Pech
Driller Name/Co : D. Mahurin/D. Jones/ Layne

Total Boring Depth : 158.0 feet
Well Bottom Depth : 155.7 feet
Surface Elev. : 600.70 feet above MSL
TOC Elev. : 603.39 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757070.03
Coordinate E : 1046676.53
Logged By : C. Higgins

Depth in Feet	Surf. Elev. 600.7	DESCRIPTION	% RQD	% Recovery
0	601	Brown SILTY SAND, fine grained, dense, dry, few rootlets, trace clay	NA	47
5	596	Brown and gray, fine GRAVEL with trace silt and clay, loose, dry,		
		Dark brown SANDY SILT, light brown mottling, fine grained, trace clay, dry - 6-8 mottling, iron stain - 9.5 brown silt seam, dry	NA	100
10	591	Brown SILTY CLAY, some fine to coarse sand, slightly moist	NA	100
		Gray SILTY CLAY, trace fine sand, moist		
15	586	Gray CLAY, trace silt and fine sand, slightly moist, very stiff	NA	70
		Brown SILTY CLAY, trace fine sand, moderately dense, slightly moist		
20	581	Brown CLAYEY SAND, fine grained, dense, moist		
		Light brown fine SAND, slightly moist, dense	NA	100
		Brown fine SAND, well sorted, moist, loose		
		Brown SANDY SILT, fine to coarse, dolomite gravel and cobbles, very moist		
25	576	Brown CLAY with fine to coarse sand, fine gravel, wet, very soft	NA	42
		White DOLOMITE, tan hue, pits, chert nodules - 27-28 vert frac		
30	571	White DOLOMITE, tan hue, pits (decrease downwards) - iron stain in horiz frac	NA	86
35	566	White DOLOMITE, tan hue, few pits	97	100
40	561	- 40-45 blue/gray hue, few white chert nodules - 41-45 iron stain - gray/blue clay infill in horiz frac, trace vugs		
45				

Well Diagram: T09S
TOC Elev: 603.39



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GEOLOGIC LOG OF T09S

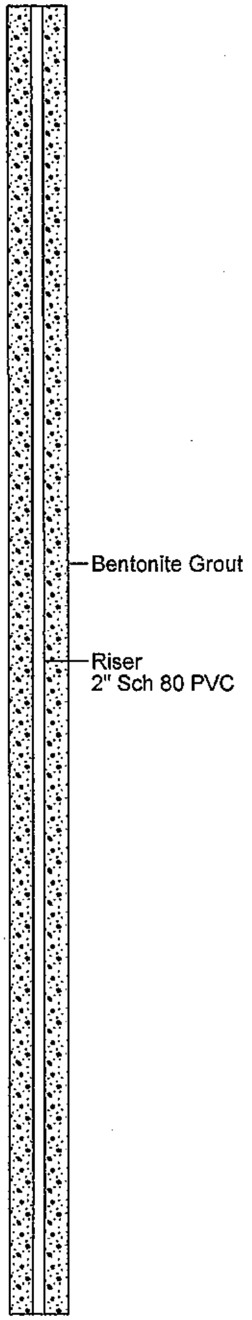
(Page 2 of 4)

Date Started : 10/18/2013
Date Well Set : 10/22/2013
Coring Tools : NQ Double Wall 10' Barrel
Drilling Tools : 6" Air Hammer
Drill Rig : Mobile B61/Gus Pech
Driller Name/Co : D. Mahurin/D. Jones/ Layne

Total Boring Depth : 158.0 feet
Well Bottom Depth : 155.7 feet
Surface Elev. : 600.70 feet above MSL
TOC Elev. : 603.39 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757070.03
Coordinate E : 1046676.53
Logged By : C. Higgins

Depth in Feet	Surf. Elev. 600.7	DESCRIPTION	% RQD	% Recovery
45	556	White DOLOMITE, light blue hue - 45-47 iron stain, vert frac, pits - 47-50 cherty - trace clay infill in frac		
50	551		95	99
55	546	Tan DOLOMITE, faint pink and green/blue mottling, trace pits, trace black chert		
		Tan DOLOMITE, pink/green hue, trace vugs		
60	541		92	100
		- 61-65 gray clay in frac		
65	536	Tan DOLOMITE, green hue, trace pits, gray clay in horiz frac		
70	531		81	100
		- 74-75 pyrite in vert frac		
75	526	White DOLOMITE, tan/green hue, clay and fine sand in horiz frac, few pits		
80	521		93	100
		- 82-85 pyrite in horiz frac		
85	516	Tan DOLOMITE, vuggy, light gray clay in horiz frac		
		Tan DOLOMITE, trace purple vugs	93	100
90				

Well Diagram: T09S
TOC Elev: 603.39



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GEOLOGIC LOG OF T09S

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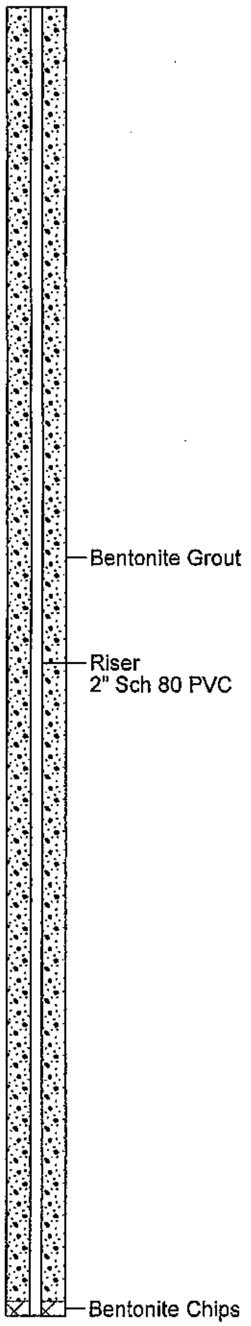
Date Started	: 10/18/2013
Date Well Set	: 10/22/2013
Coring Tools	: NQ Double Wall 10' Barrel
Drilling Tools	: 6" Air Hammer
Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/ Layne

Total Boring Depth	: 158.0 feet
Well Bottom Depth	: 155.7 feet
Surface Elev.	: 600.70 feet above MSL
TOC Elev.	: 603.39 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757070.03
Coordinate E	: 1046676.53
Logged By	: C. Higgins

Depth in Feet	Surf. Elev. 600.7	DESCRIPTION	% RQD	% Recovery
90	511	Tan DOLOMITE, trace purple vugs		
		- vert frac infill with clay and silt	93	100
95	506	Tan/green DOLOMITE, vuggy - 95-97 bands of vugs/solution cavity - green clay infill of horiz frac		
100	501		94	97
105	496	Tan DOLOMITE, green hue, vuggy - 105-106 gray/white clay and silt infill in horiz frac		
110	491	- 110-112 1" vuggy bands	97	99
115	486	Tan DOLOMITE, green hue - 117 vugs with remineralization		
120	481	- 120-122 few chert nodules throughout wavy, horiz frac	96	100
125	476	Tan/gray DOLOMITE, with blue/green, vuggy, chert nodules, pyrite in vugs		
130	471		98	98
		- 133.5 iron stain in frac		
135				

Well Diagram: T09S
TOC Elev: 603.39



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GEOLOGIC LOG OF T09S

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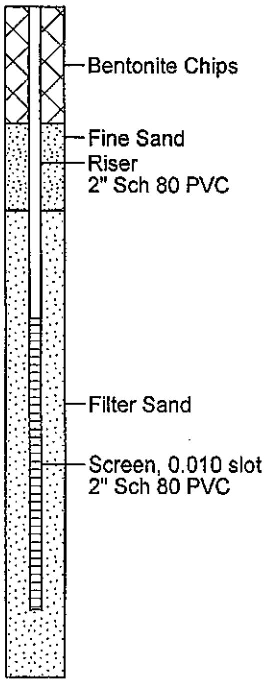
Date Started	: 10/18/2013
Date Well Set	: 10/22/2013
Coring Tools	: NQ Double Wall 10' Barrel
Drilling Tools	: 6" Air Hammer
Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/ Layne

Total Boring Depth	: 158.0 feet
Well Bottom Depth	: 155.7 feet
Surface Elev.	: 600.70 feet above MSL
TOC Elev.	: 603.39 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757070.03
Coordinate E	: 1046676.53
Logged By	: C. Higgins

Depth in Feet	Surf. Elev. 600.7	DESCRIPTION	% RQD	% Recovery
135	466	Tan DOLOMITE, green mottling, white chert nodules - clay and silt infill in horiz frac		
		- 138.5-141 vert frac, tight, filled with green clay and silt - 141-145 few fossils (endocrinus, et. al)		
140	461		97	100
145	456	Tan/green DOLOMITE, few purple vugs, some fossil layers		
		Gray DOLOMITE, some dark gray, few purple vugs, fossil layers		
150	451		95	97
		-150 dark gray clay and fine white sand fill in horiz frac, white chert nodules		
155	446	Tan DOLOMITE, gray hue and dark gray banding, chert nodules, few purple vugs, trace fossils	100	100
		End of boring at 158 feet		
160	441			
165	436			
170	431			
175	426			
180				

Well Diagram: T09S
TOC Elev: 603.39



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GEOLOGIC LOG OF T10S

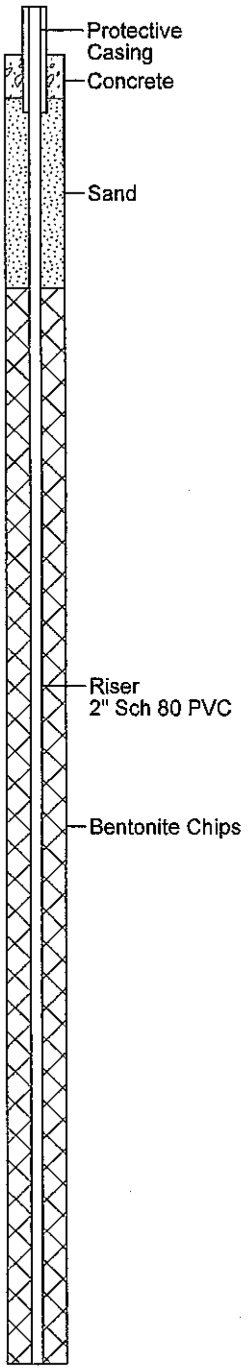
(Page 1 of 4)

Date Started : 10/21/2013
Date Well Set : 10/29/2013
Coring Tools : NQ Double Wall 10' Barrel
Drilling Tools : 6" Air Hammer
Drill Rig : Mobile B61/Gus Pech
Driller Name/Co : D. Mahurin/D. Jones/Layne

Total Boring Depth : 170.0 feet
Well Bottom Depth : 169.0 feet
Surface Elev. : 614.61 feet above MSL
TOC Elev. : 617.10 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1755962.63
Coordinate E : 1047391.39
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 614.61	DESCRIPTION	% RQD	% Recovery
0	615	Brown SILTY CLAY, sand and gravel, moist, concrete pieces		20
5	610	Black SILTY CLAY, soft, organic odor, slightly moist		60
		Green/gray SILTY CLAY, soft, organic odor, slightly moist - brown and gray mottling - 9.5-10.5 gravel/cobble - organics, rust stain		
10	605			100
15	600	Brown SILTY CLAY, moist, wet silt seams		
		Dark green SILTY CLAY, moist, wet silt seams		100
		Green SILTY CLAY, moist, wet silt seams		
		Green/brown SILTY CLAY, moist, wet silt seams		
20	595			
		Gray CLAY, trace medium sand - some mottling, rust		80
		Brown SAND, fine to medium silty sand, beach, slightly moist		
25	590	Brown/gray SILT, layered and cross-bedded, slightly moist		
		Brown, fine to medium SILTY SAND, slightly moist		70
30	585	- coarser sand		
		- coarse sand - gray at 34'		60
35	580	Dark gray CLAYEY SILT, very coarse gravel, moist		
		Dark gray clayey silt and light gray silt banded and cross-bedded		60
		Light gray SILT, moist		
40	575	Gray SILT, moist - occassional band of clay		
45				

Well Diagram: T10S
TOC Elev: 617.10



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GEOLOGIC LOG OF T10S

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Date Started	: 10/21/2013
Date Well Set	: 10/29/2013
Coring Tools	: NQ Double Wall 10' Barrel
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Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/Layne

Total Boring Depth	: 170.0 feet
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Surface Elev.	: 614.61 feet above MSL
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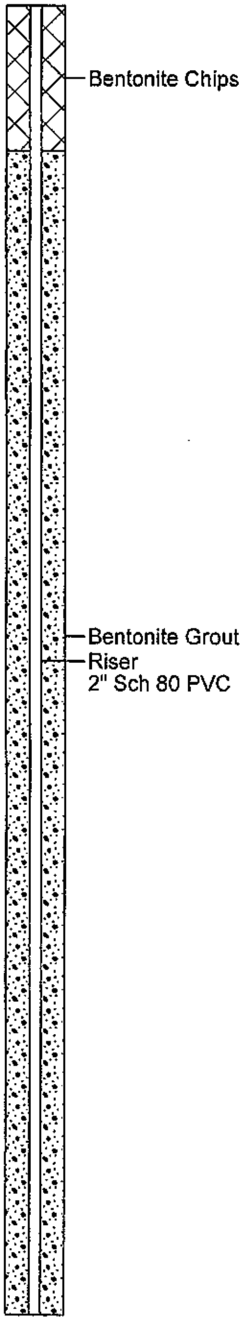
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1755962.63
Coordinate E	: 1047391.39
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 614.61	DESCRIPTION	% RQD	% Recovery
45	570	Gray SILT - sandy seam, wet - gravel		
		Light gray/green SILT, sand and gravel, some very coarse gravel, wet		
50	565	Tan/light brown DOLOMITE, tight horiz and vert frac, many pits & sm vugs		
		White DOLOMITE, many pits, no frac, trace large chert	58	
55	560			
		- chert, horiz frac, rust stain		
60	555		99	100
		- many horiz frac, very narrow, green filled frac, with pyrite		
65	550			
		- vert frac, very narrow, pyrite	97	100
70	545	White DOLOMITE, green hue, trace pink, pits, wavy horiz with green fill, some pits - 60 degree frac, 0.05' wide, clay and dolomite bits infill - 45 deg frac with pyrite		
		- 45 deg frac, 0.02', gree/gray clay filled	93	100
75	540	- 45 deg frac, tight		
80	535		93	100
		Greenish gray DOLOMITE, some tan, some pyrite swirl with stain cloud, trace pits		
		White DOLOMITE, green and pink hue, pyrite cloud, trace wavy, horiz frac, trace pits		
85	530			
		Pink DOLOMITE, horiz frac, green clay and pyrite		
		White DOLOMITE, pink and green hue, long vert frac, tight, pits, trace vugs	100	100
90				

Well Diagram: T10S
TOC Elev: 617.10



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GEOLOGIC LOG OF T10S

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Date Started : 10/21/2013
Date Well Set : 10/29/2013
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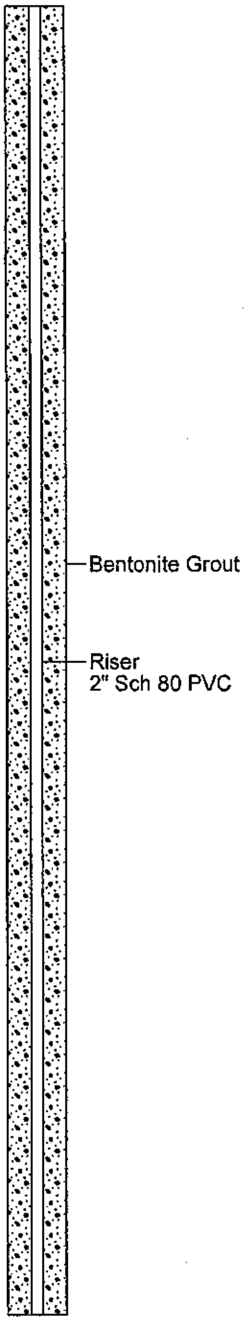
Total Boring Depth : 170.0 feet
Well Bottom Depth : 169.0 feet
Surface Elev. : 614.61 feet above MSL
TOC Elev. : 617.10 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1755962.63
Coordinate E : 1047391.39
Logged By : P. Allenstein

Depth in Feet	Surf. Elev. 614.61	DESCRIPTION	% RQD	% Recovery
90	525			
		Pink DOLOMITE, green hue, wavy horiz frac, narrow to tight, trace pits		
95	520	White DOLOMITE, light pink hue, pitted, some vugs, some horiz frac with green clay fill, 1.5' long vert frac, tight, pyrite	100	100
100	515			
		White DOLOMITE, very light occassional pink hue, pits with small vugs in layers with trace pyrite, wavy horiz frac, tight to narrow with green clay fill		
105	510		93	100
110	505	Gray DOLOMITE, light pink hue, wavy horiz frac, tight to narrow with green clay fill, pitted layers, trace occassional vugs, pyrite		
115	500	- gray fill in fractures - 3" horiz frac, gray clay filled	94	100
120	495	- large vug, 2", little pyrite - 2" horiz frac, gray clay filled		
125	490		99	100
		- 126-128 no pits		
130	485			
			99	100
135				

Well Diagram: T10S
TOC Elev: 617.10



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GEOLOGIC LOG OF T10S

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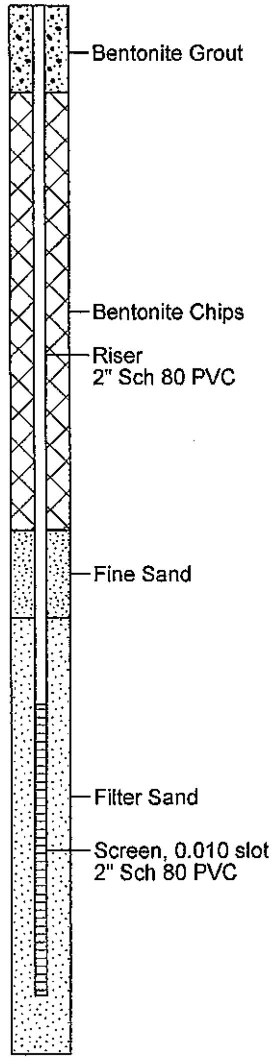
Project No. 18713

Date Started	: 10/21/2013
Date Well Set	: 10/29/2013
Coring Tools	: NQ Double Wall 10' Barrel
Drilling Tools	: 6" Air Hammer
Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/Layne

Total Boring Depth	: 170.0 feet
Well Bottom Depth	: 169.0 feet
Surface Elev.	: 614.61 feet above MSL
TOC Elev.	: 617.10 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1755962.63
Coordinate E	: 1047391.39
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 614.61	DESCRIPTION	% RQD	% Recovery
135	480	Gray DOLOMITE, cherty, fossils, trace green hue, pitted, some vugs, wavy horiz frac, tight to narrow with green clay fill, layers of pits/vugs	99	100
140	475	- 0.1 vug whole core width - horiz frac with calcite and pyrite crystals	95	98
145	470			
150	465	Gray DOLOMITE, some horiz frac, tight to narrow, dark gray clay filled	95	100
155	460	- vert frac, narrow, pyrite White DOLOMITE, trace green hue, pitted layers, small vugs Dark gray DOLOMITE, dark gray filled, tight to narrow horiz frac, pits, trace large chert		
160	455	- pitted and vuggy layer with fossils - trace pits, trace vugs	99	99
165	450			
170	445	End of boring at 170 feet		
175	440			
180				

Well Diagram: T10S
TOC Elev: 617.10



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GEOLOGIC LOG OF T11S

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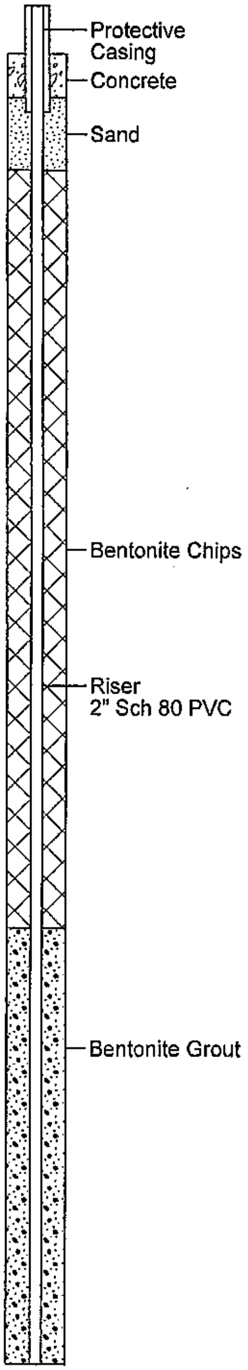
Date Started	: 10/17/2013
Date Well Set	: 10/30/2013
Coring Tools	: NQ Double Wall 10' Barrel
Drilling Tools	: 6" Air Hammer
Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/Layne

Total Boring Depth	: 115.0 feet
Well Bottom Depth	: 111.0 feet
Surface Elev.	: 556.60 feet above MSL
TOC Elev.	: 559.36 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757727.76
Coordinate E	: 1048697.50
Logged By	: C. Higgins

Depth in Feet	Surf. Elev. 556.60	DESCRIPTION	% RQD	% Recovery
0	557	Brown SILTY CLAY, trace fine to coarse sand, wet Tan DOLOMITE, vuggy, weathered, fractured		
5	552	Tan DOLOMITE, trace vugs, green hue, iron stain in horiz frac	0	67
10	547	Tan DOLOMITE, trace green hue, trace pits - vert and horiz frac with clay and fine sand fill		
15	542	- 18.5-19.75 green and red banding - 19.75-20 dark gray laminated shale with clay fill	31	100
20	537	Tan DOLOMITE, green hue/banding, trace chert nodules, few vugs - green clay and fine to medum sand infill of horiz frac - 22-28 vert frac with little displacement, trace fine sand infill, some pits		
25	532		43	100
30	527	Tan DOLOMITE, green hue, trace pits, trace micro fossil layers, some iron stain in vugs and fractures		
35	522	- 33.67-40 horiz frac, green and gray clay and fine sand infill	55	100
40	517	Tan DOLOMITE, green hue, green clay in horiz frac - 40-41.5 vert frac	76	100
45				

Well Diagram: T11S
TOC Elev: 559.36



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GEOLOGIC LOG OF T11S

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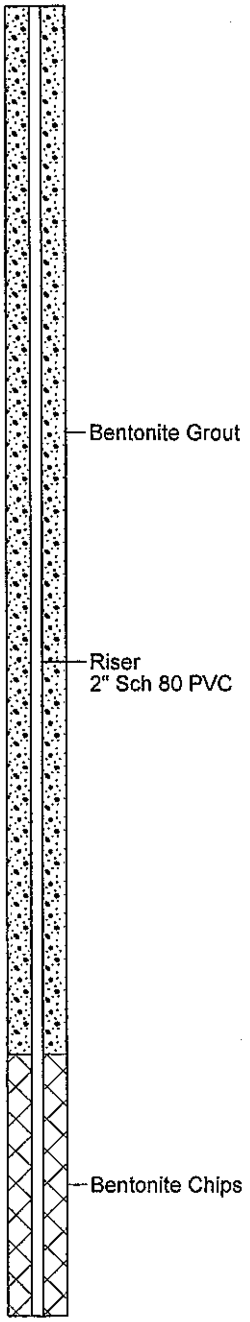
Date Started	: 10/17/2013
Date Well Set	: 10/24/2013
Coring Tools	: NQ Double Wall 10' Barrel
Drilling Tools	: 6" Air Hammer
Drill Rig	: Mobile B61/Gus Pech
Driller Name/Co	: D. Mahurin/D. Jones/Layne

Total Boring Depth	: 115.0 feet
Well Bottom Depth	: 111.0 feet
Surface Elev.	: 556.60 feet above MSL
TOC Elev.	: 559.36 feet above MSL
Groundwater Elev.	: Not measured
Riser Material	: 2" Sch 80 PVC
Screen Material	: 2" Sch 80 PVC, 0.010 slot
Coordinate N	: 1757727.76
Coordinate E	: 1048697.50
Logged By	: C. Higgins

Depth in Feet	Surf. Elev. 556.60	DESCRIPTION	% RQD	% Recovery
45	512	Tan DOLOMITE, green hue, green clay in horiz frac		
			76	100
		- 48-50 few calcite nodules, chert		
50	507	Gray DOLOMITE, green hues, trace micro fossils, green clay and fine sand infill in layers		
55	502		66	100
		- 57-60 green clay and fine sand infill in layers, vuggy		
60	497	Tan DOLOMITE, green hue, trace to few pits, gray clay in horiz frac		
		- 63 pyrite in vugs		
65	492		82	100
70	487	Gray DOLOMITE, trace green hue, white calcite layers, gray clay and fine sand in horiz frac and vert frac		
75	482		50	100
		- 75-77 iron stain, fossils		
80	477	Tan DOLOMITE, green hue, iron stain, pits, chert nodules, wavy horiz frac, vert frac, filled with green clay and fine sand		
85	472		88	100
90				

Well Diagram: T11S
TOC Elev: 559.36



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GEOLOGIC LOG OF T11S

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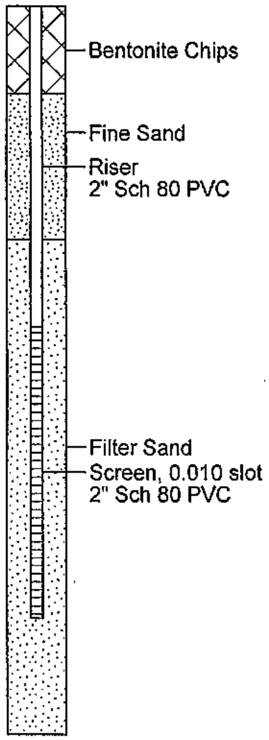
Date Started : 10/17/2013
Date Well Set : 10/24/2013
Coring Tools : NQ Double Wall 10' Barrel
Drilling Tools : 6" Air Hammer
Drill Rig : Mobile B61/Gus Pech
Driller Name/Co : D. Mahurin/D. Jones/Layne

Total Boring Depth : 115.0 feet
Well Bottom Depth : 111.0 feet
Surface Elev. : 556.60 feet above MSL
TOC Elev. : 559.36 feet above MSL
Groundwater Elev. : Not measured
Riser Material : 2" Sch 80 PVC
Screen Material : 2" Sch 80 PVC, 0.010 slot
Coordinate N : 1757727.76
Coordinate E : 1048697.50
Logged By : C. Higgins

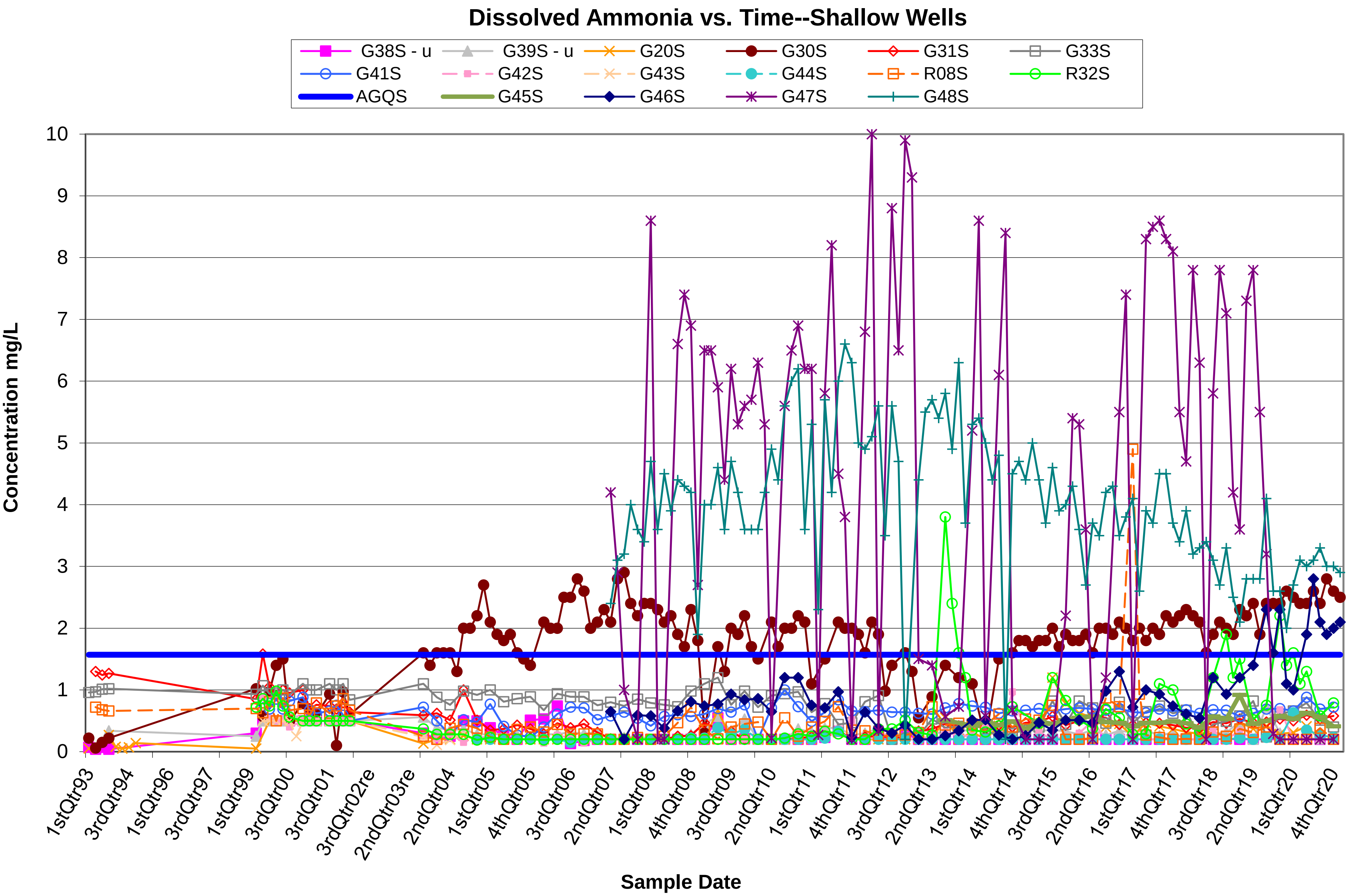
Depth in Feet	Surf. Elev. 556.60	DESCRIPTION	% RQD	% Recovery
90	467	Gray DOLOMITE, green hue, tan/white chert nodules, few vugs - 92-93 iron stain layers		
95	462		95	100
100	457	Gray DOLOMITE, tan and green hue, white chert, marbling, few small vugs, green clay and fine sand in horiz frac		
105	452		97	100
110	447	Gray DOLOMITE, tan and green hue, chert, marbling, few small vugs with trace calcite and pyrite crystals	88	100
115	442	End of boring at 115 feet		
120	437			
125	432			
130	427			
135				

Well Diagram: T11S
TOC Elev: 559.36



Attachment 9-2 – Time vs Concentration Curves

Joliet/Lincoln Stone Quarry



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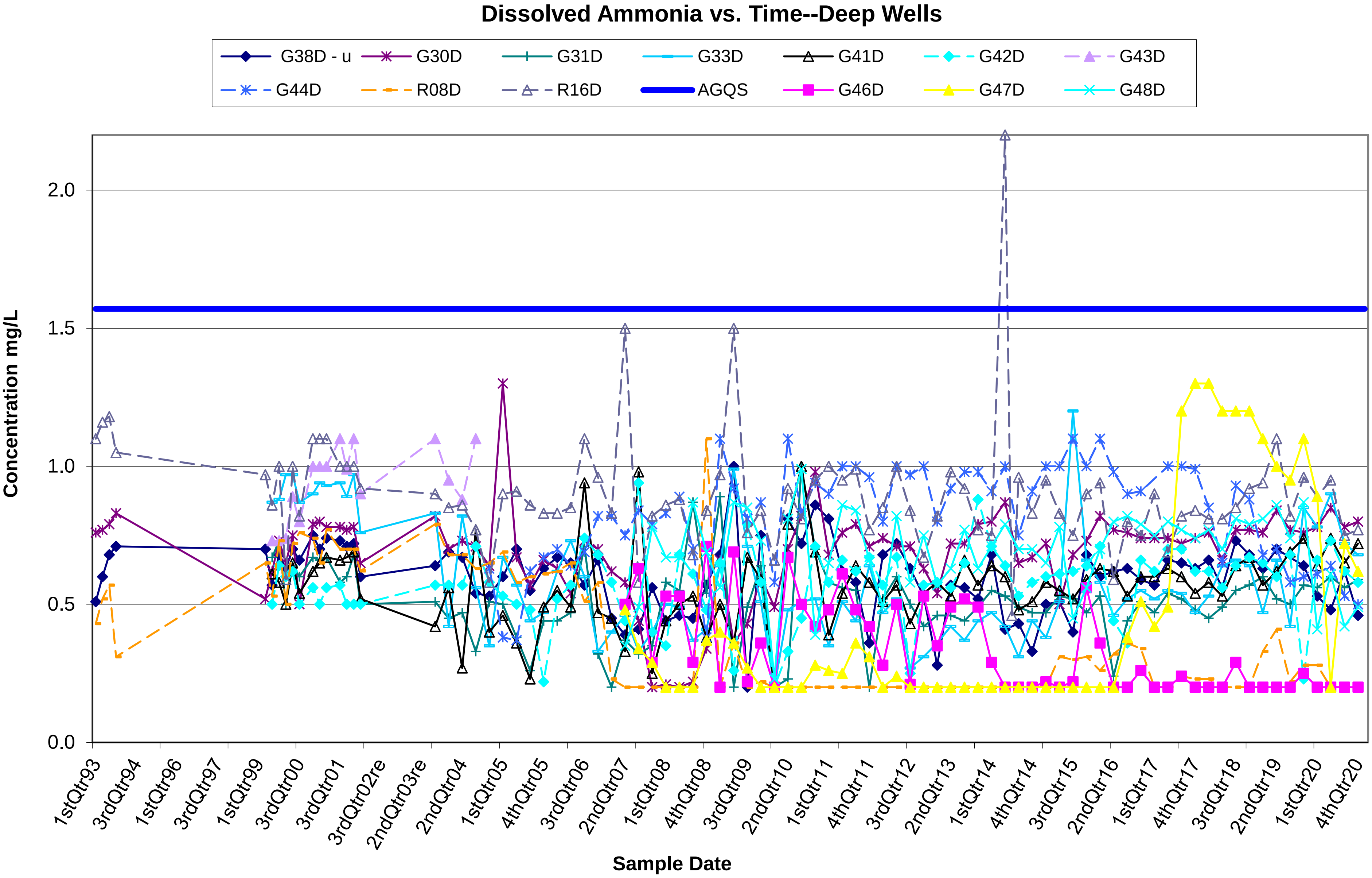
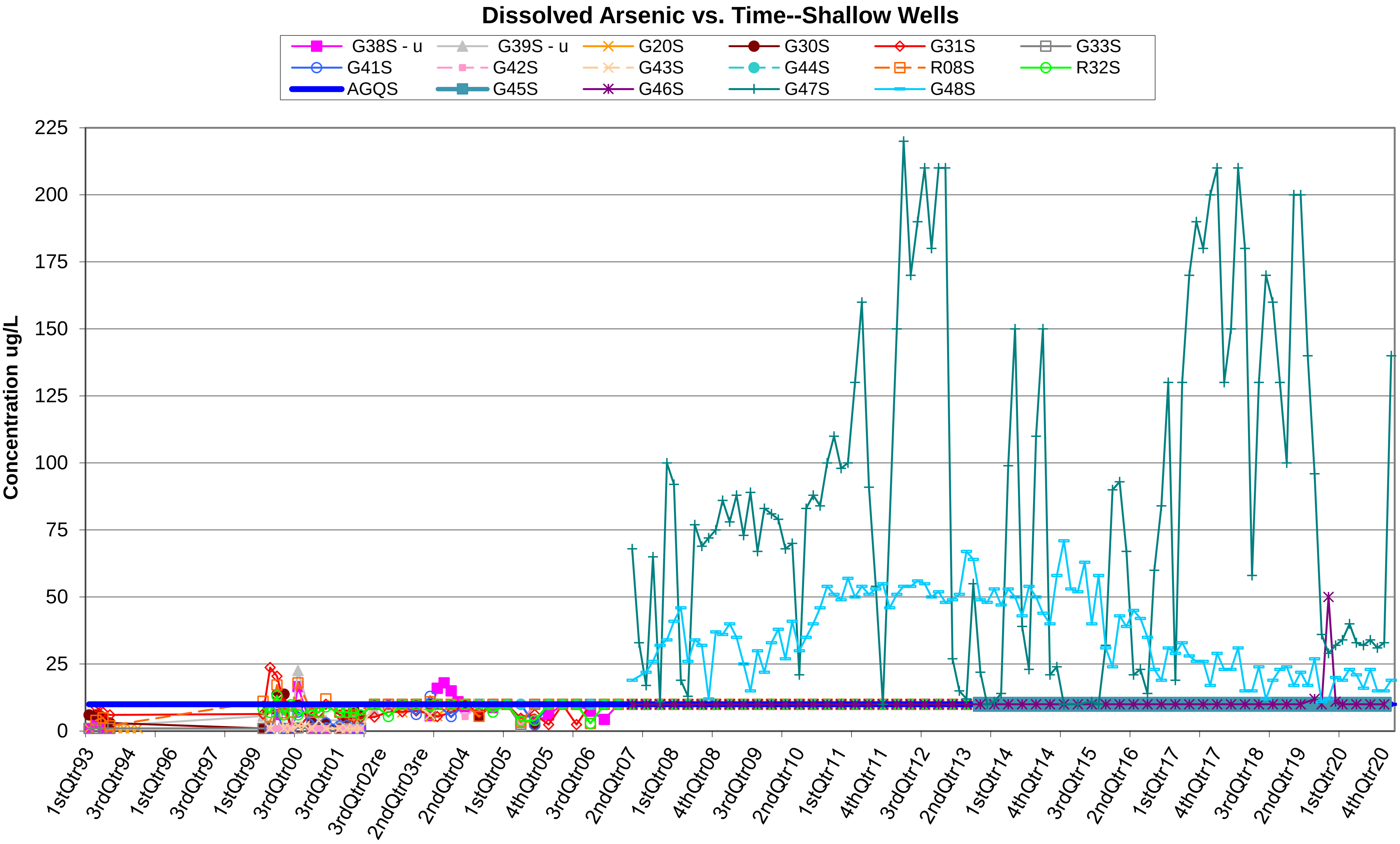


KPRG and Associates, Inc.

Joliet/Lincoln Stone Quarry



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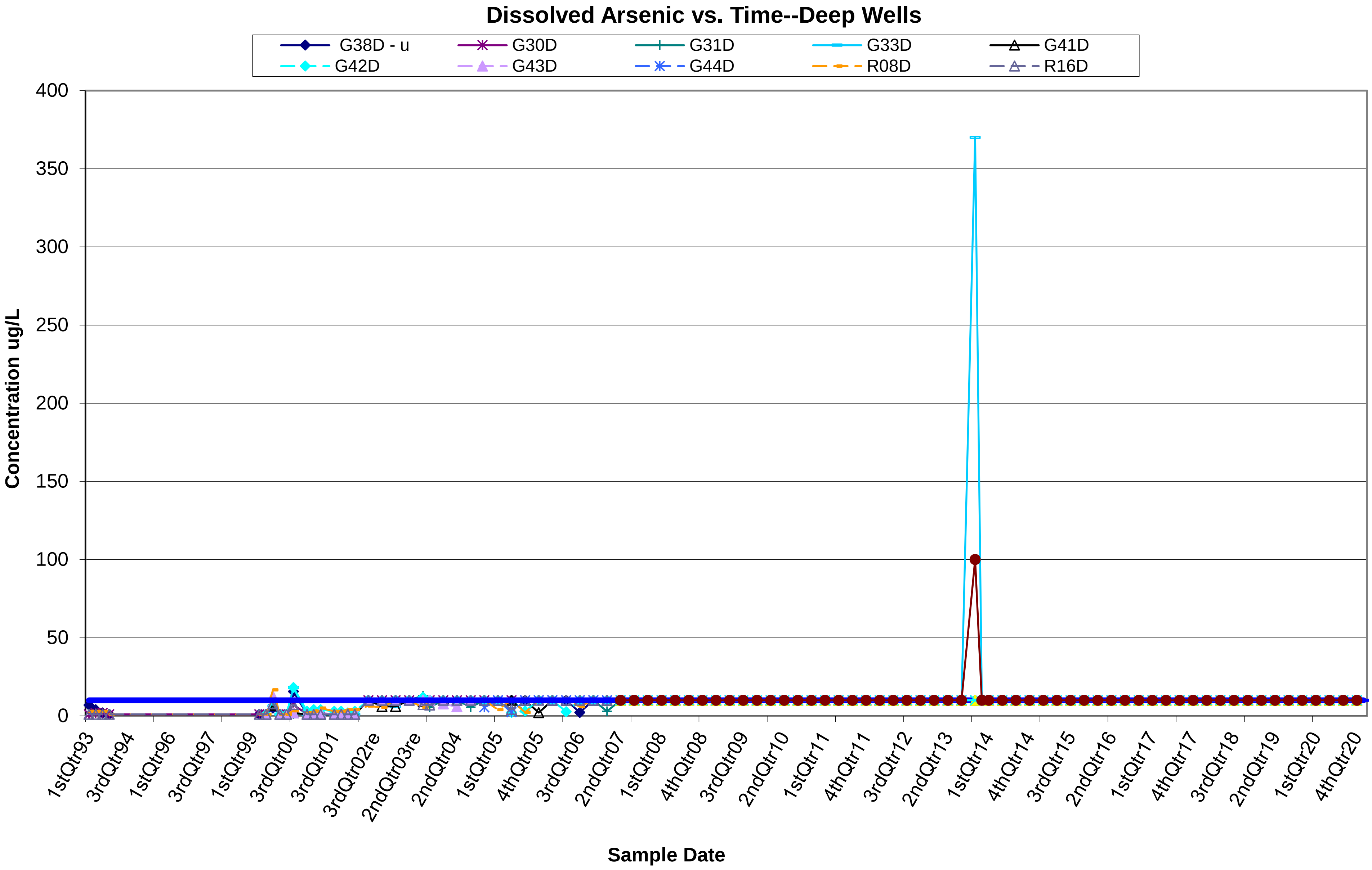

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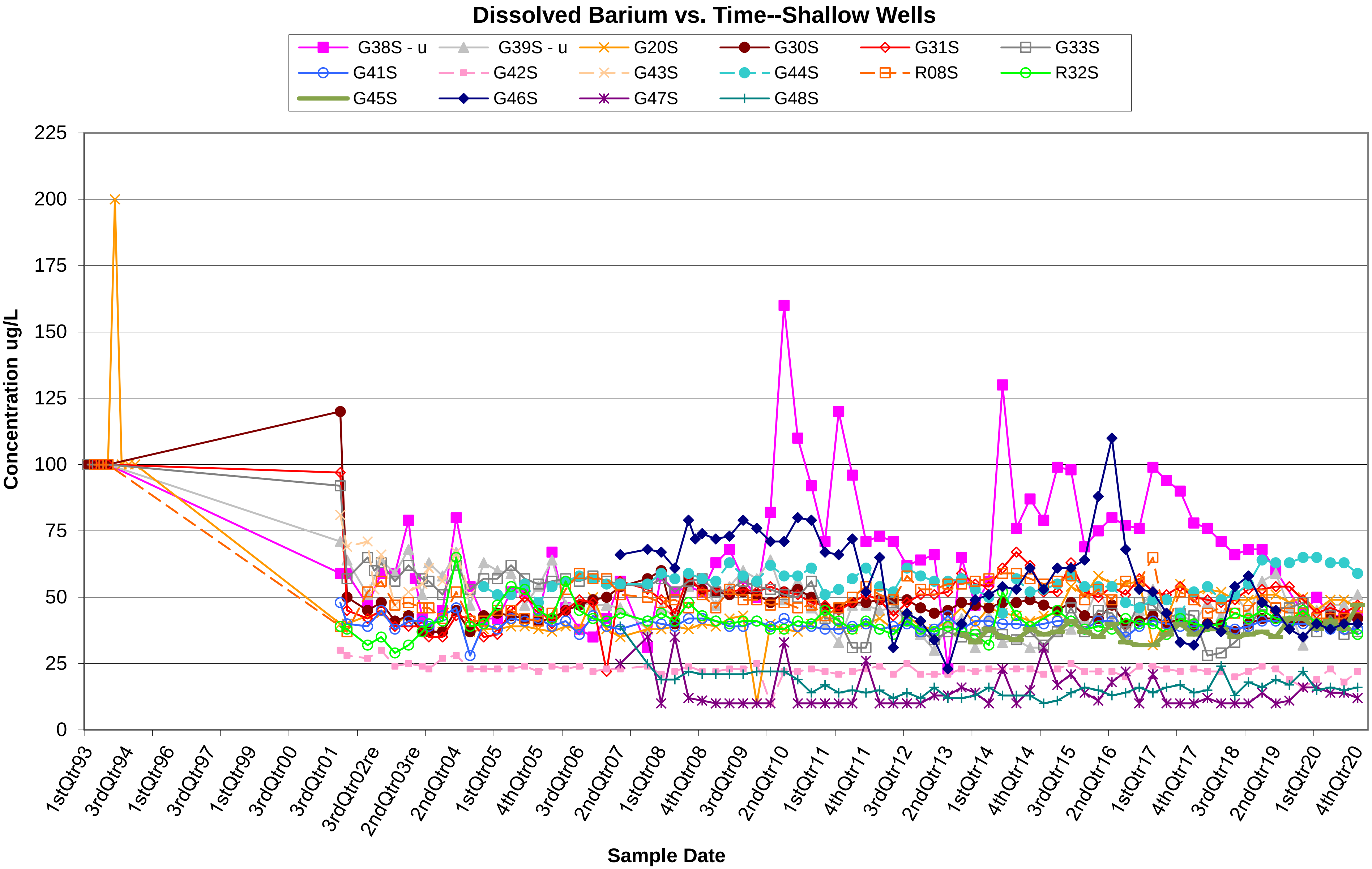

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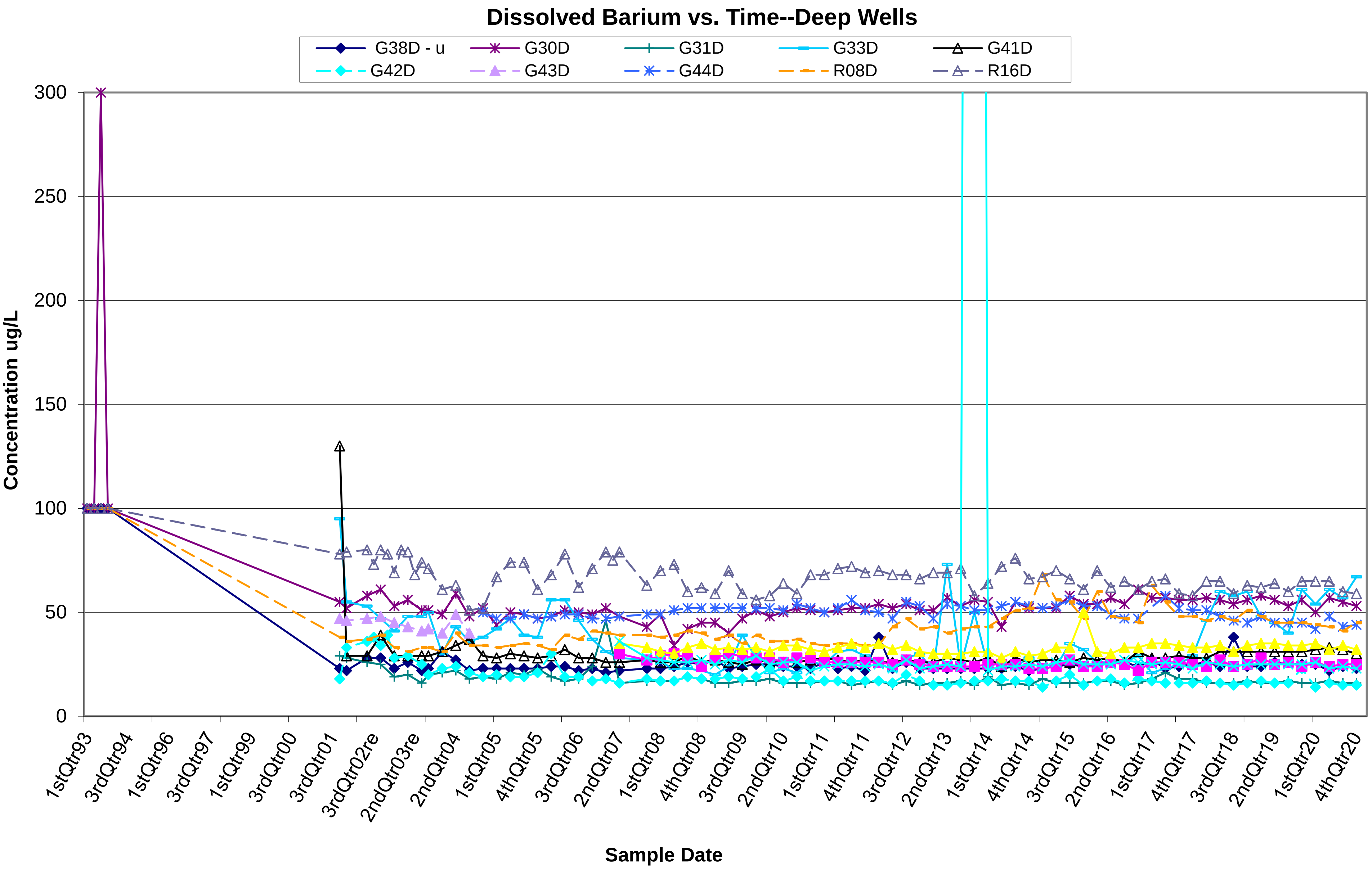
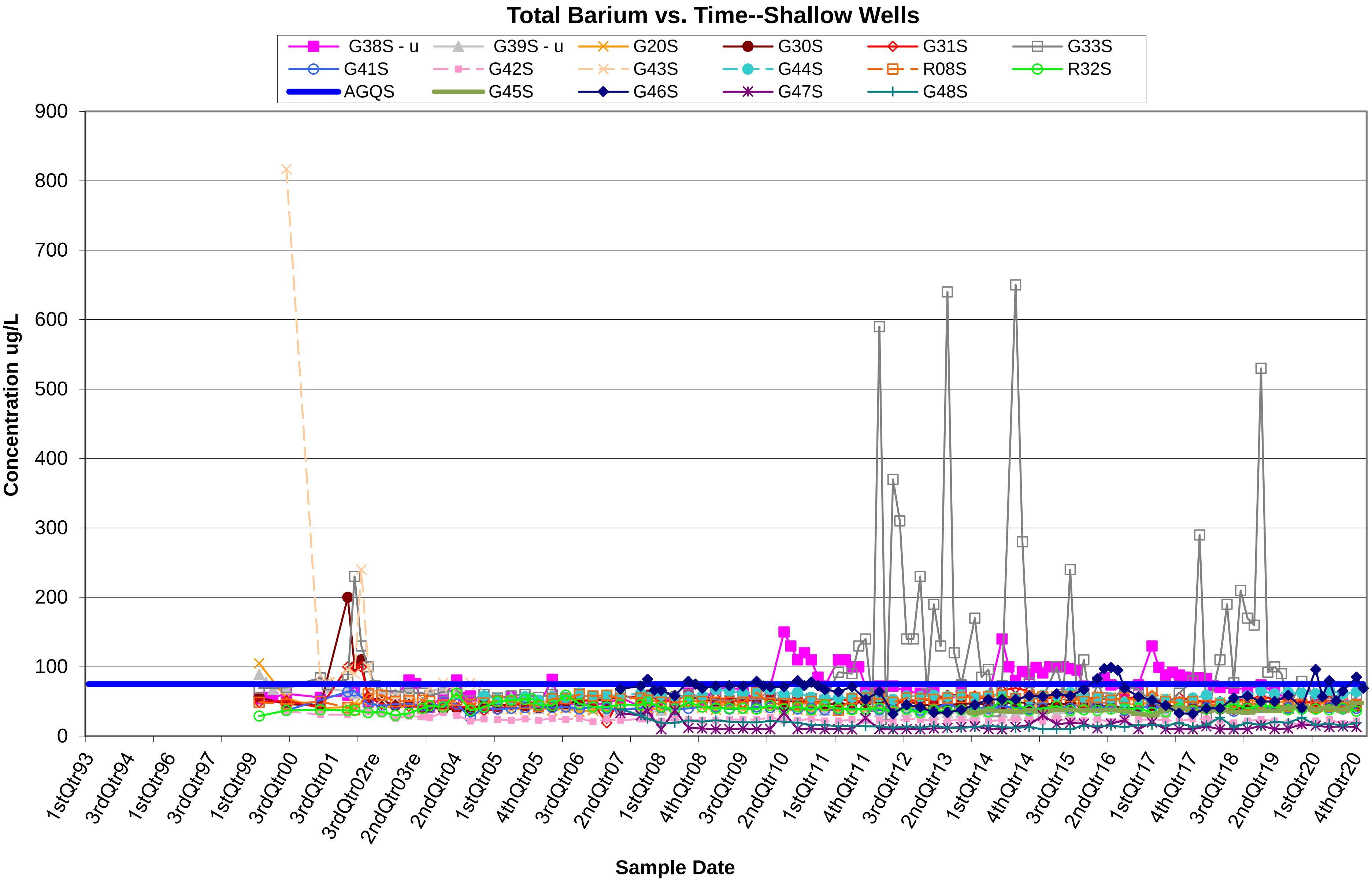

Dissolved Barium vs. Time--Deep Wells
G38D - u
G30D
G31D
G33D
G41D
G42D
G43D
G44D
R08D
R16D
Concentration ug/L
300
250
200
150
100
50
0
1stQtr93
3rdQtr94
1stQtr96
3rdQtr97
1stQtr99
3rdQtr00
3rdQtr01
3rdQtr02re
2ndQtr03re
2ndQtr04
1stQtr05
4thQtr05
3rdQtr06
2ndQtr07
1stQtr08
4thQtr08
3rdQtr09
2ndQtr10
1stQtr11
4thQtr11
3rdQtr12
2ndQtr13
1stQtr14
4thQtr14
3rdQtr15
2ndQtr16
1stQtr17
4thQtr17
3rdQtr18
2ndQtr19
1stQtr20
4thQtr20
Sample Date

Joliet/Lincoln Stone Quarry



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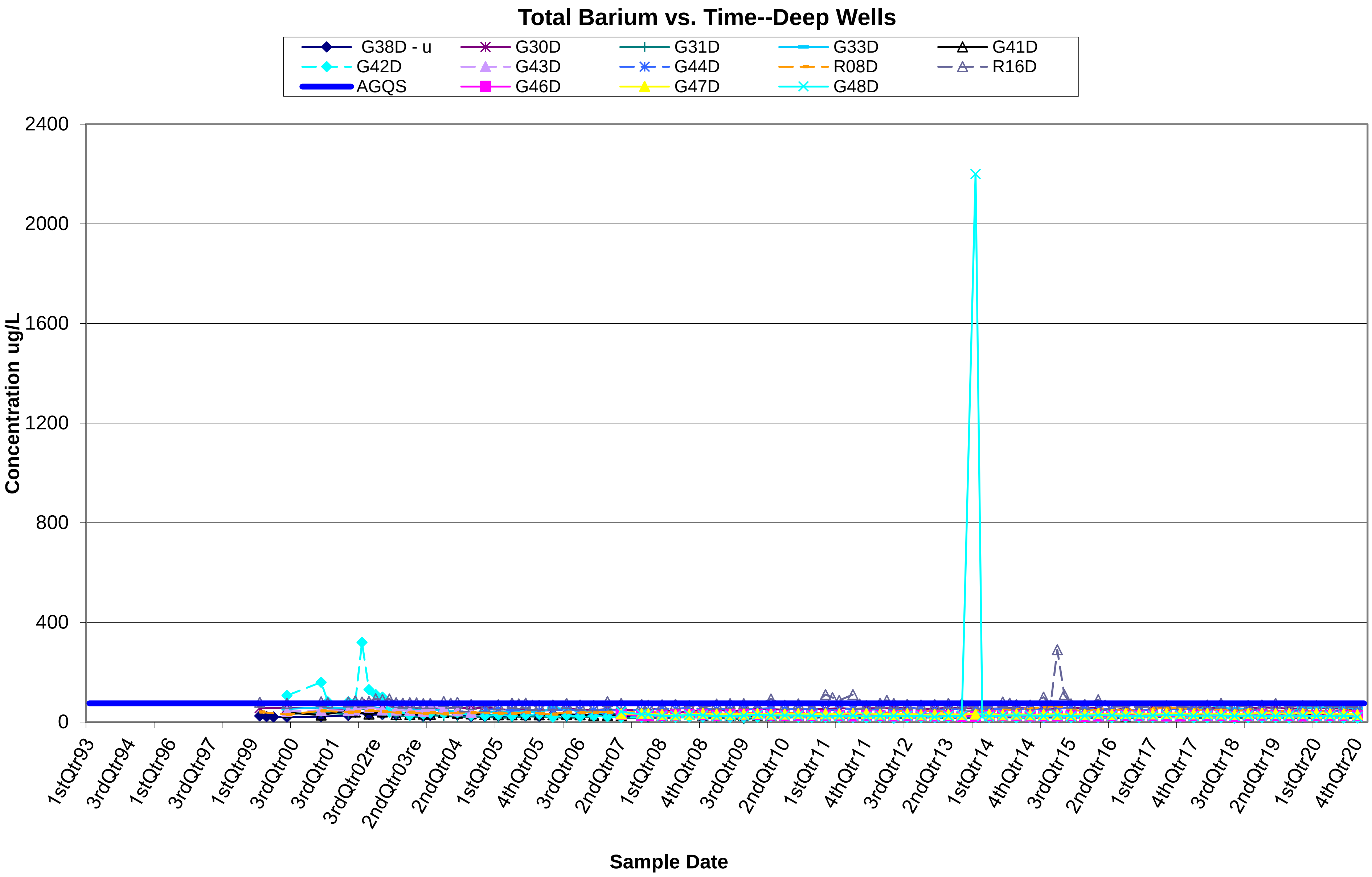
Joliet/Lincoln Stone Quarry



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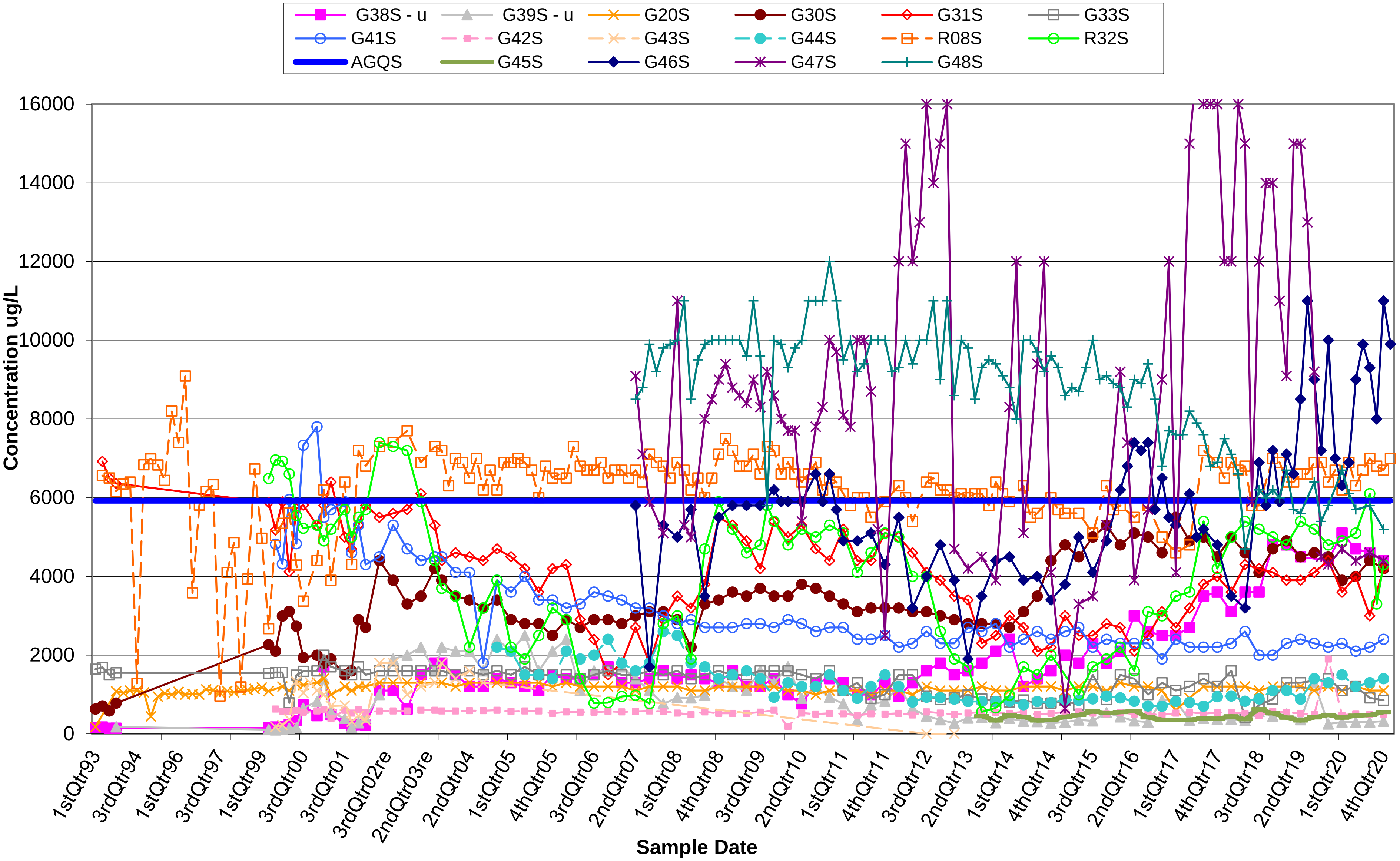
Dissolved Boron vs. Time--Shallow Wells



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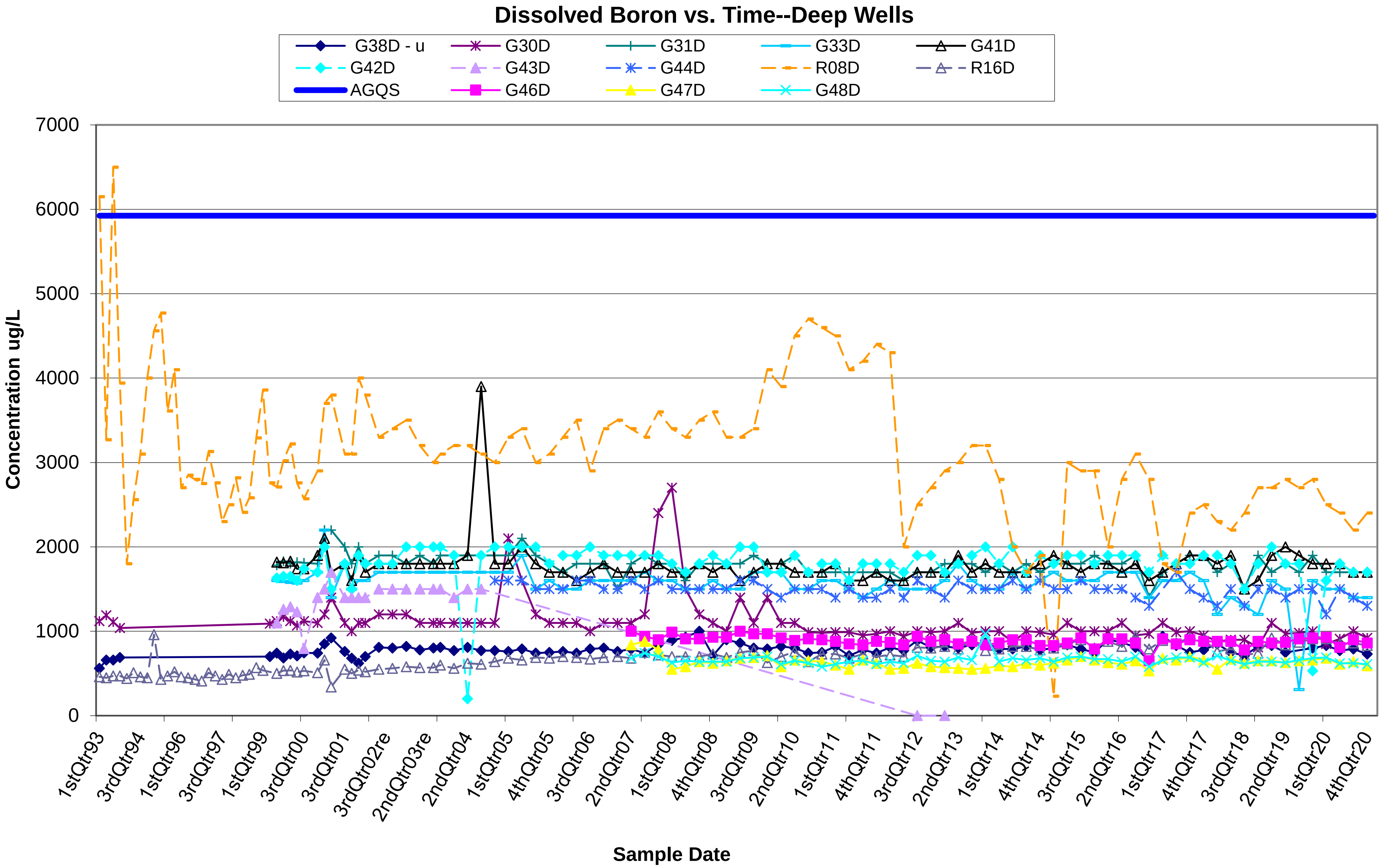
Joliet/Lincoln Stone Quarry



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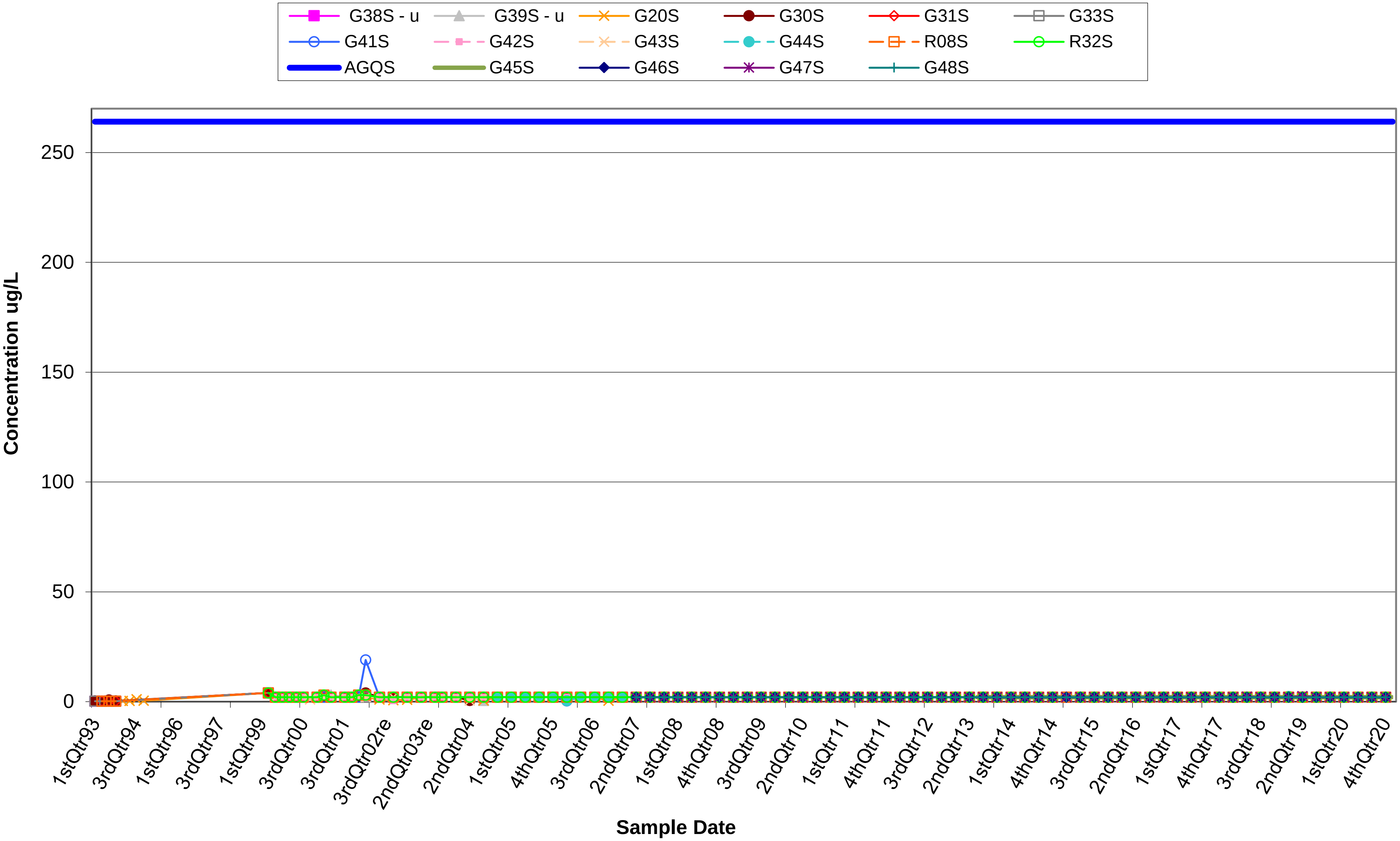

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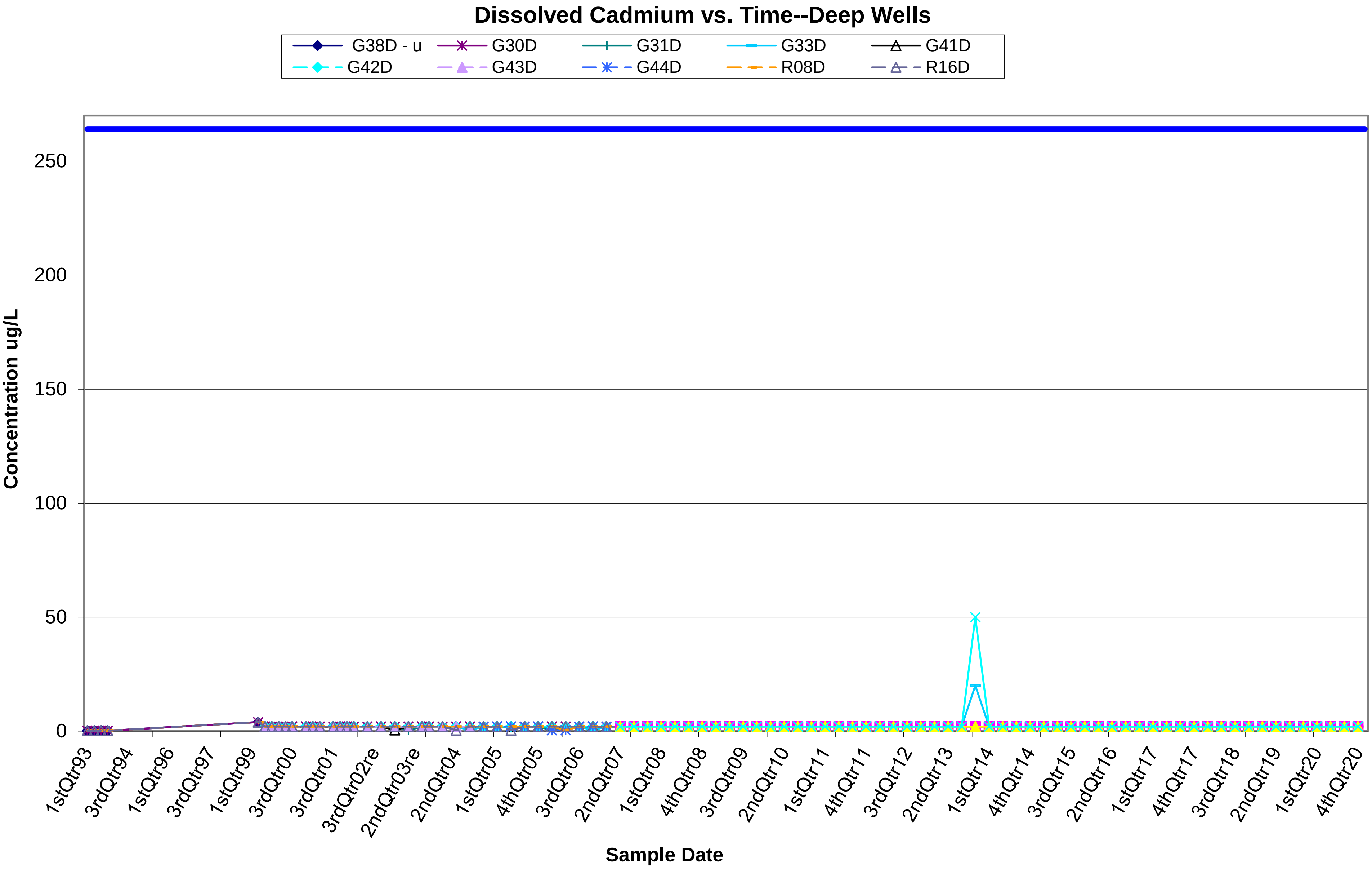
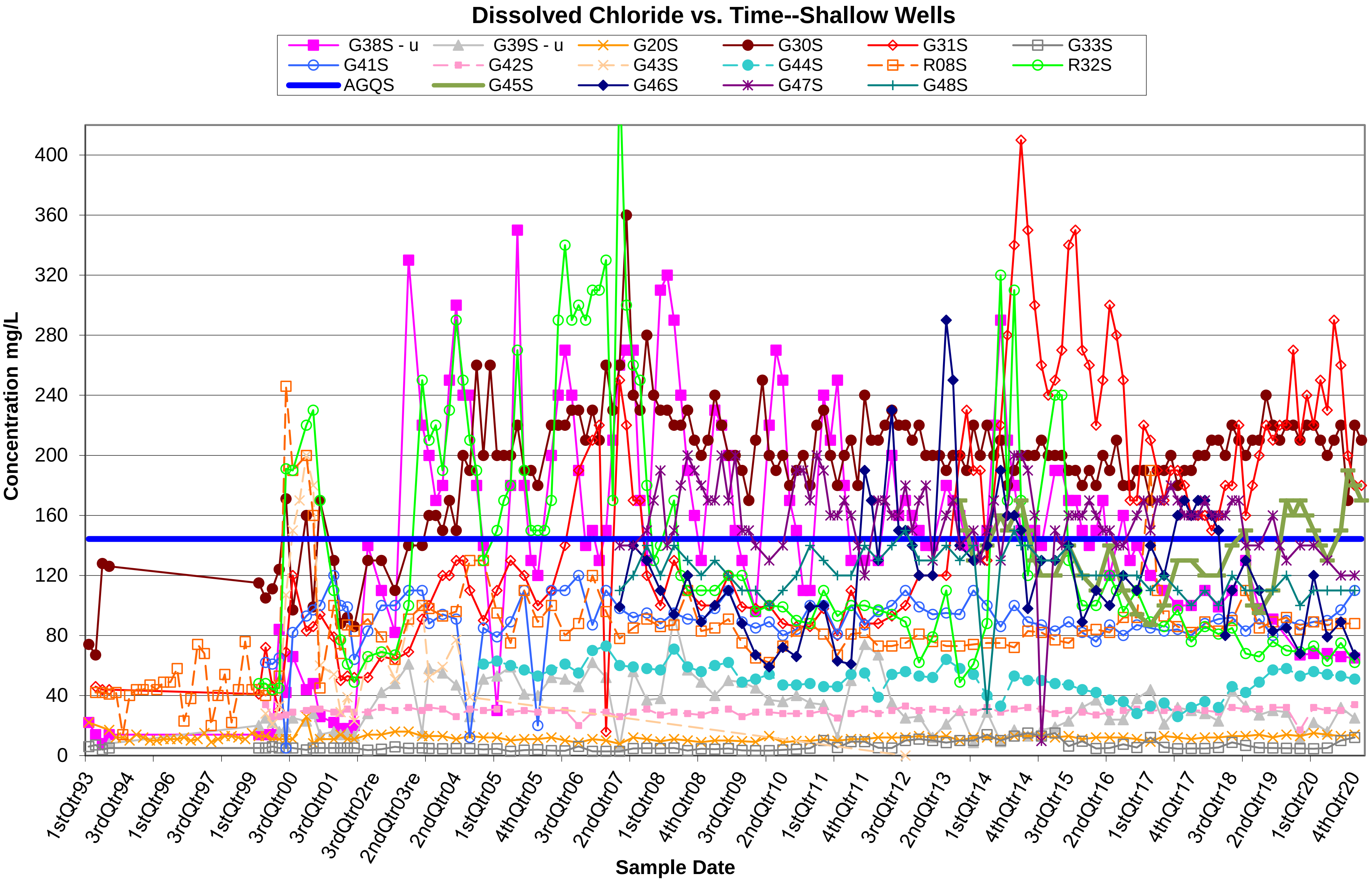
Joliet/Lincoln Stone Quarry



Joliet/Lincoln Stone Quarry



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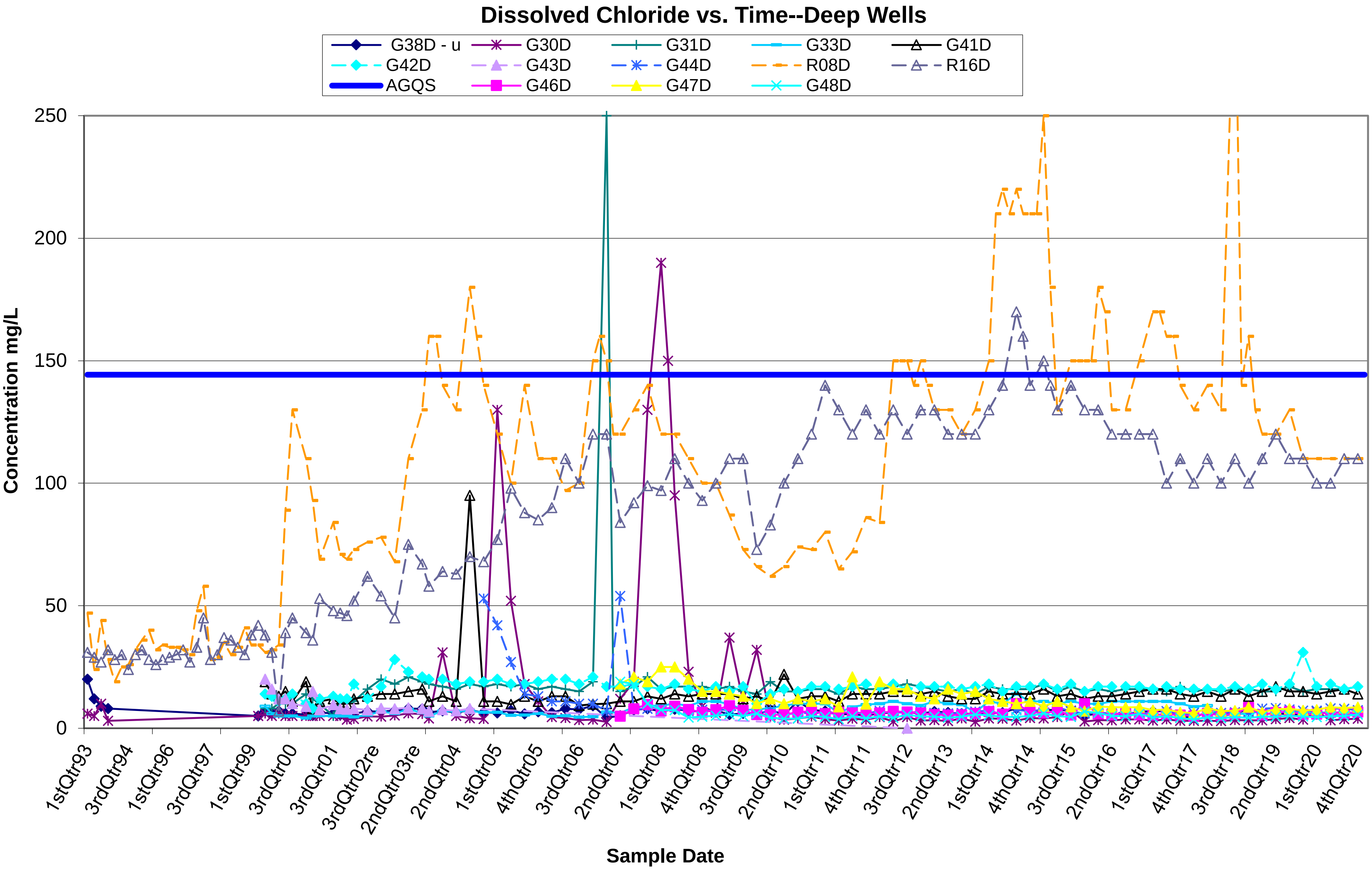

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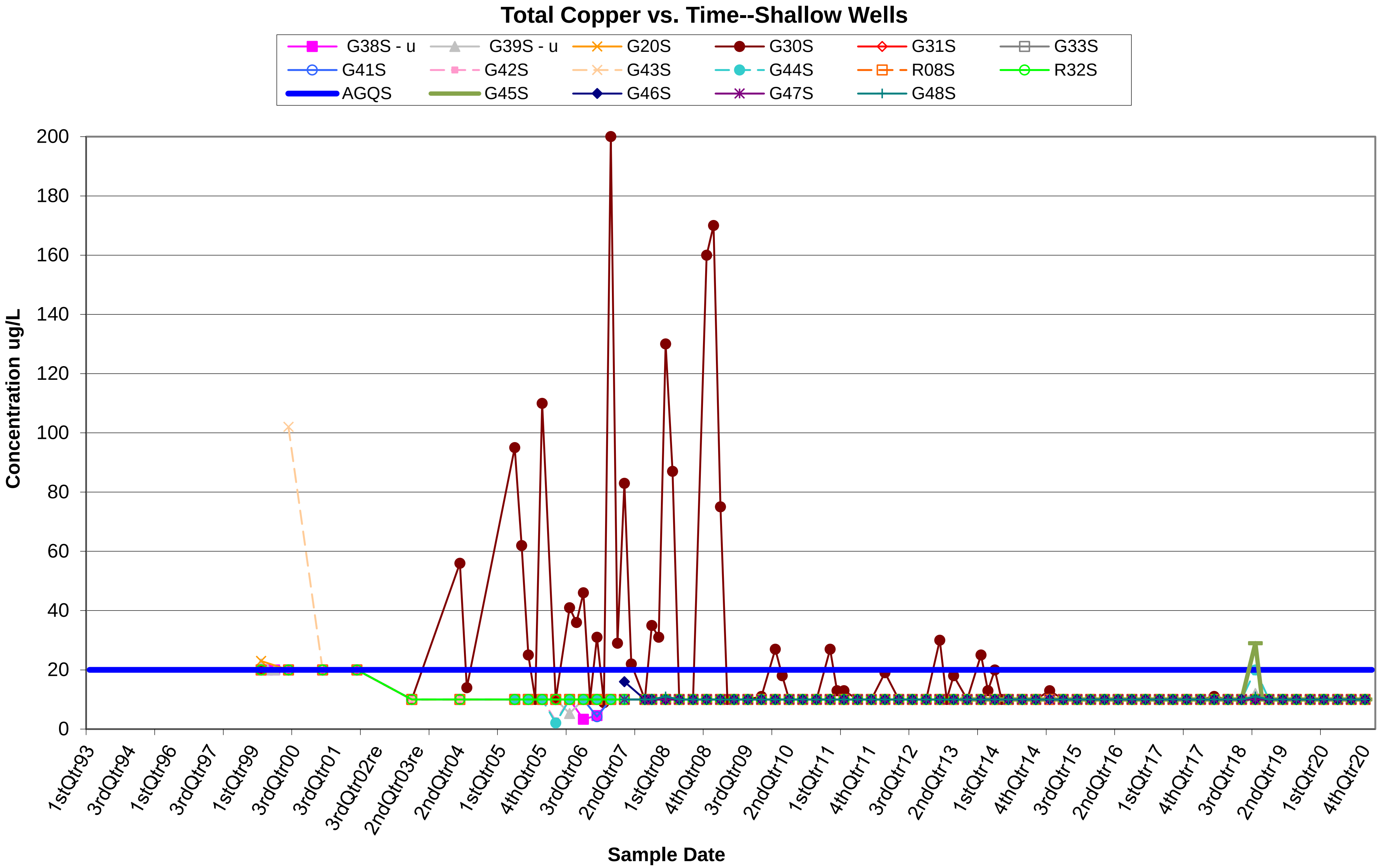

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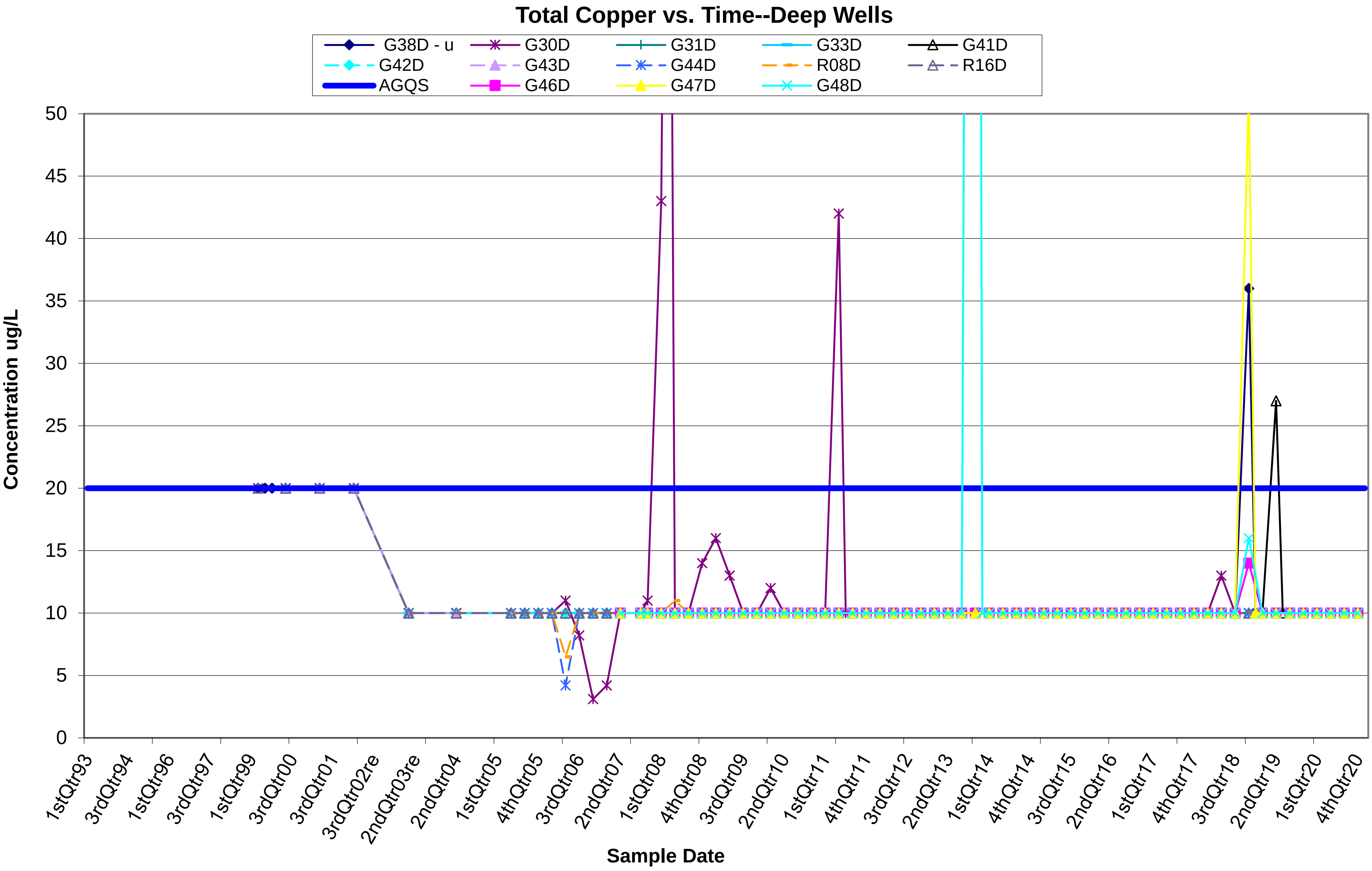

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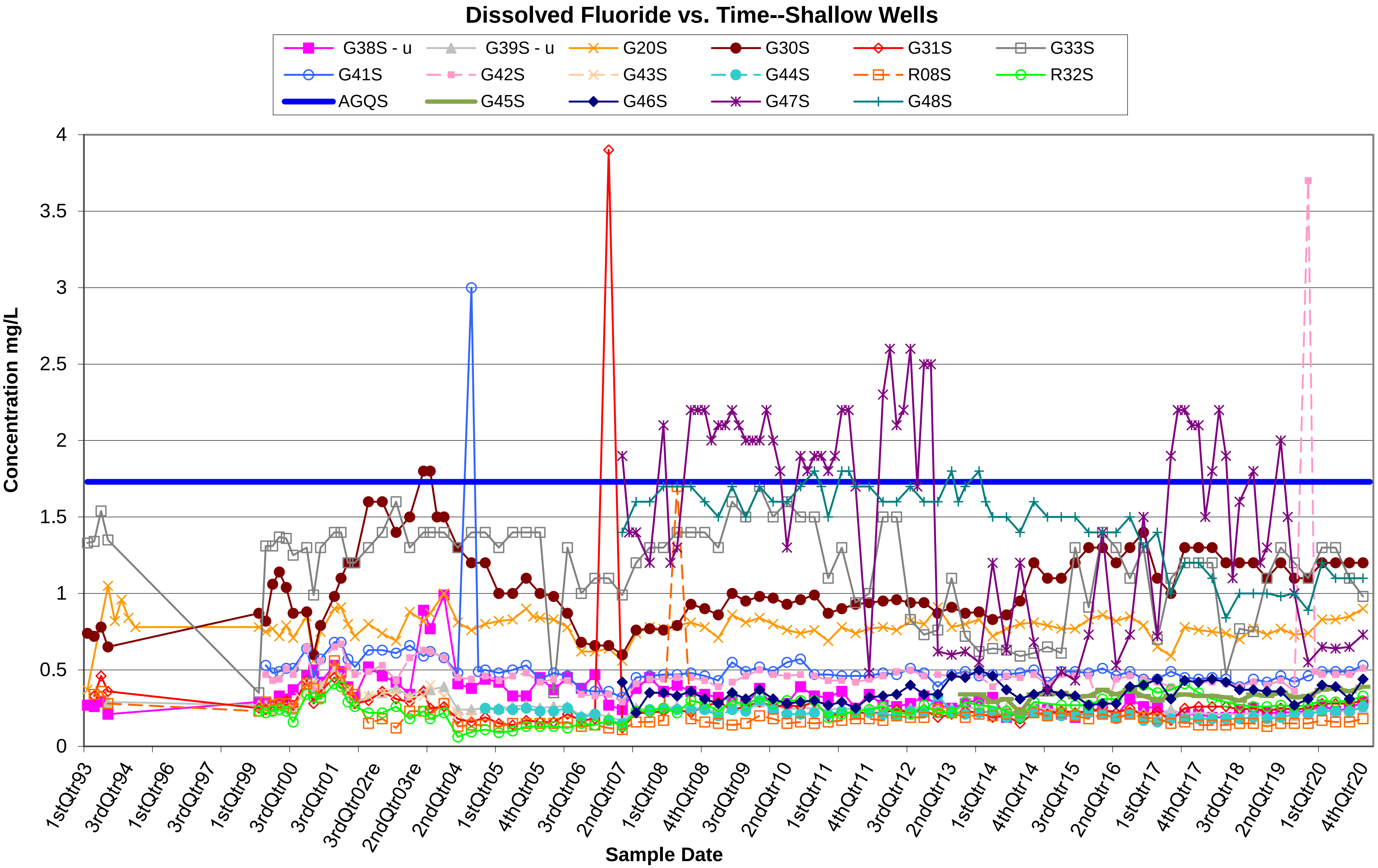
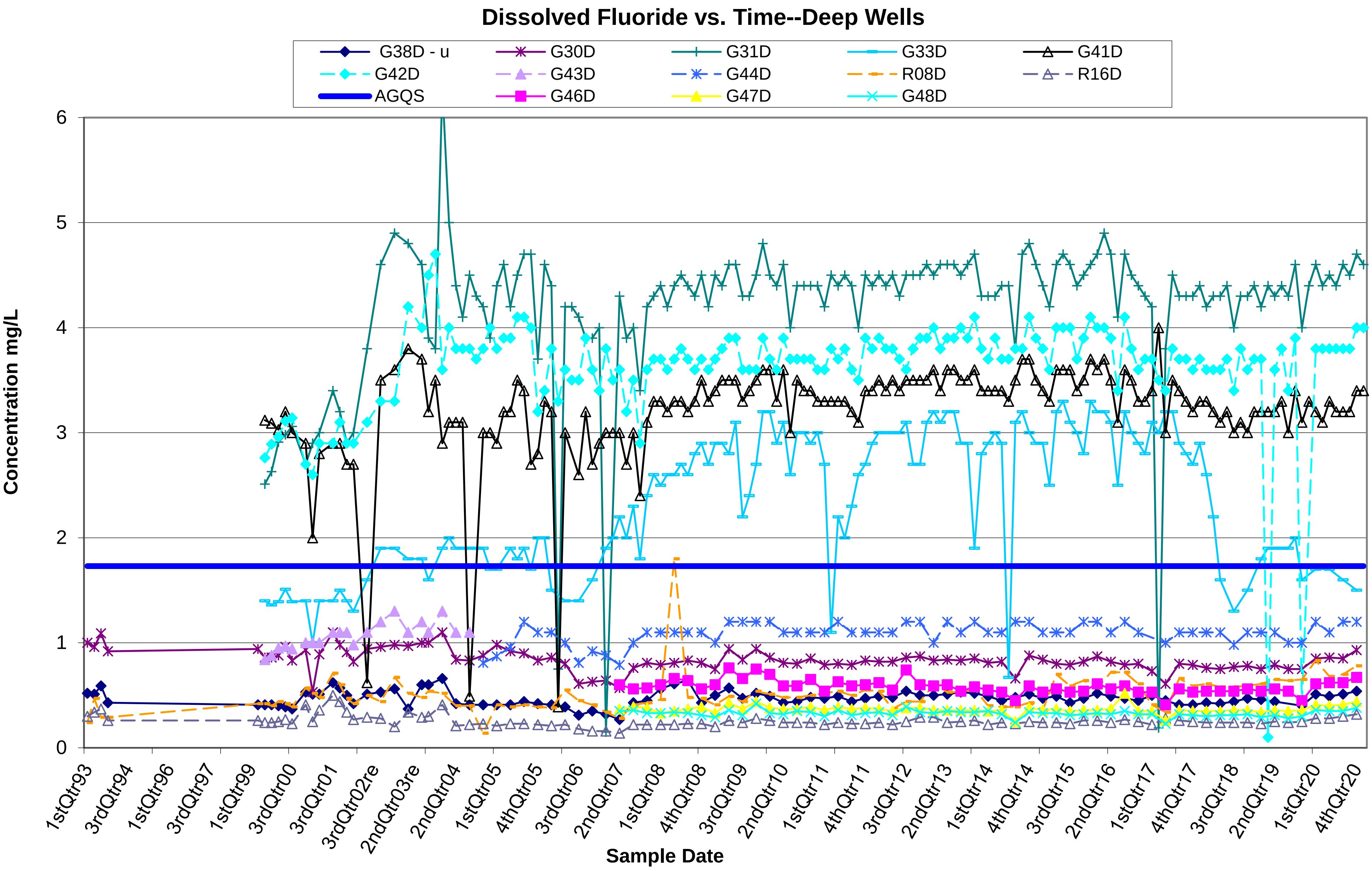


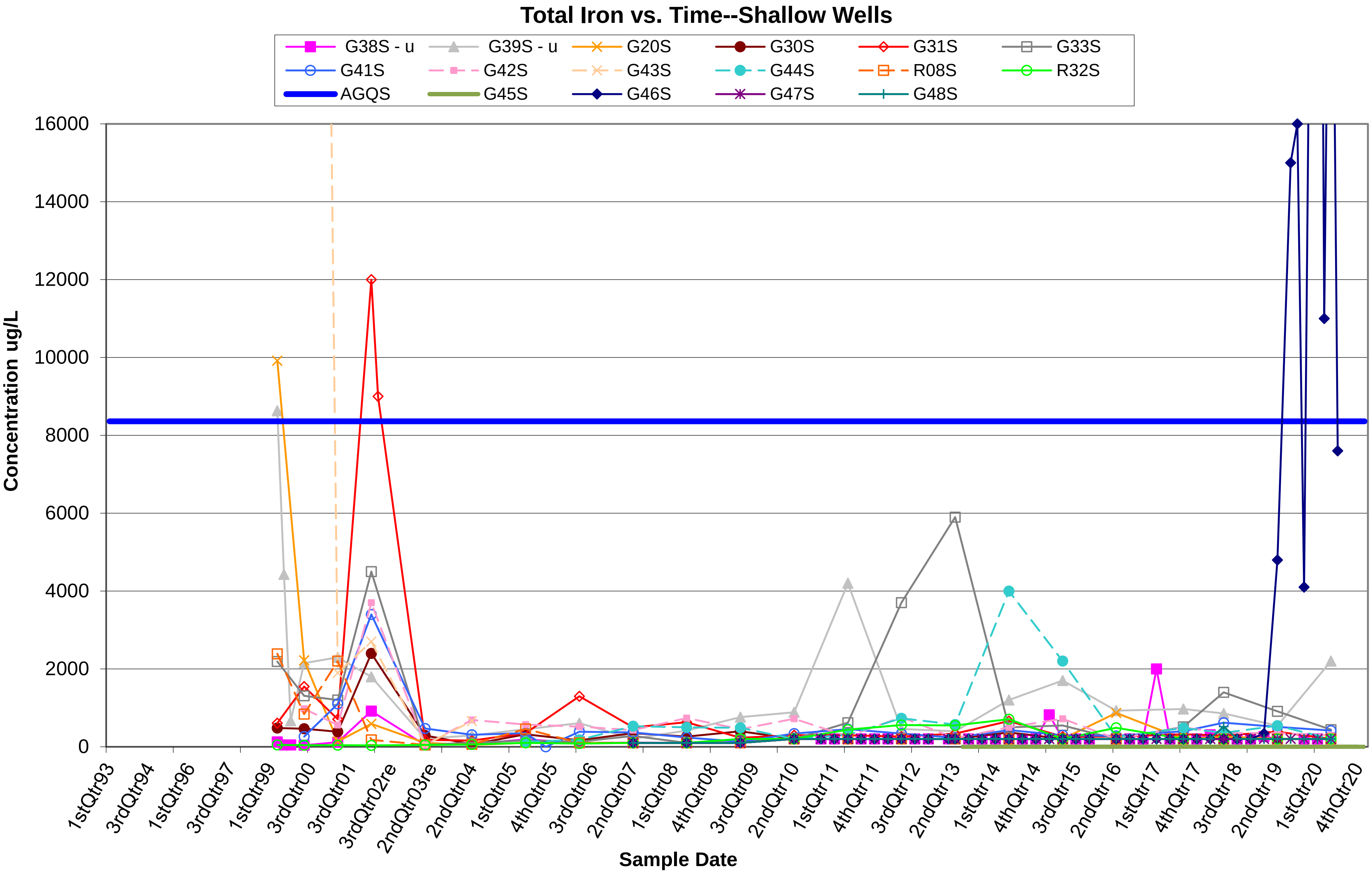
Dissolved Fluoride vs. Time--Shallow Wells

Joliet/Lincoln Stone Quarry



KPRG and Associates, Inc.

Joliet/Lincoln Stone Quarry



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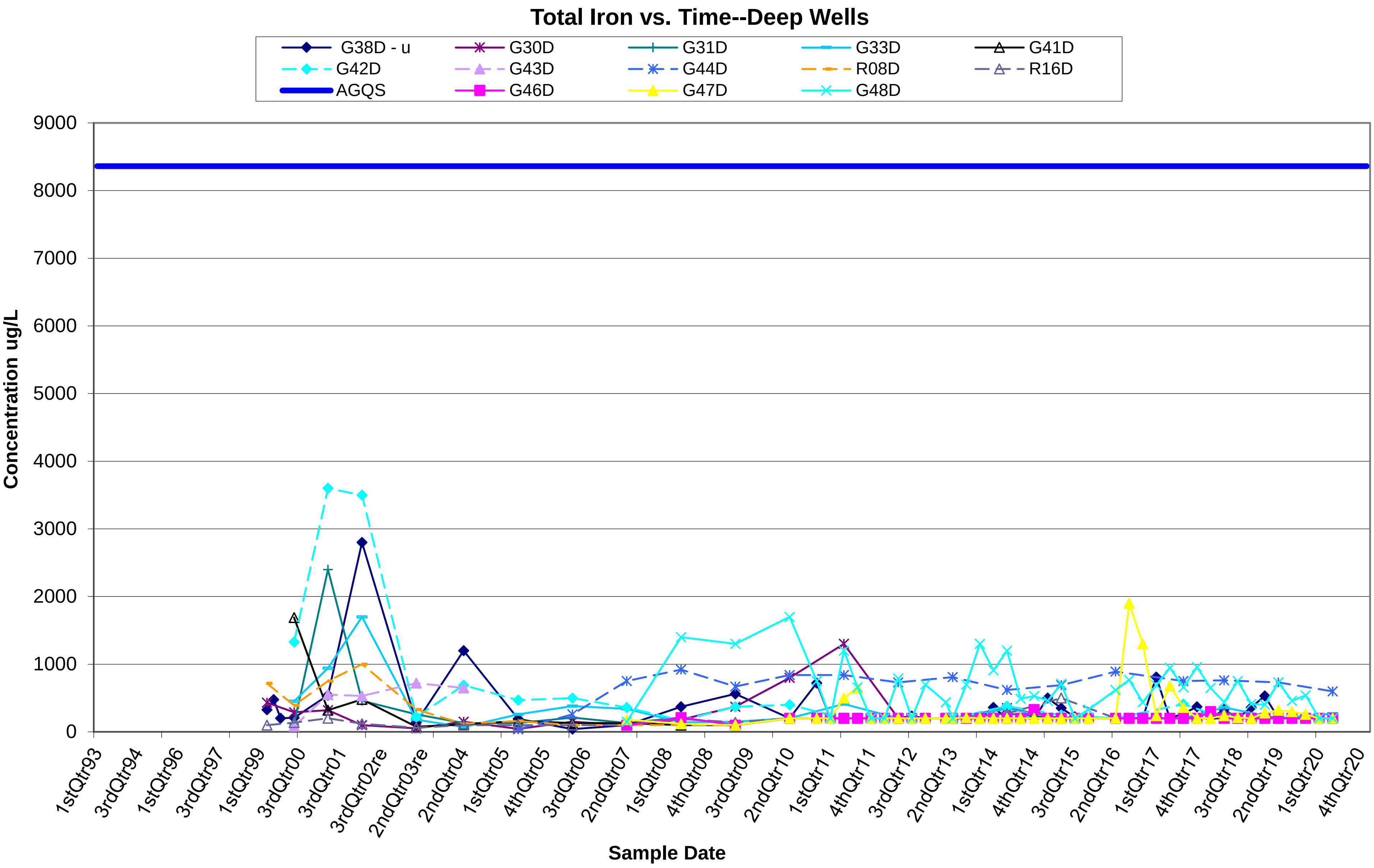

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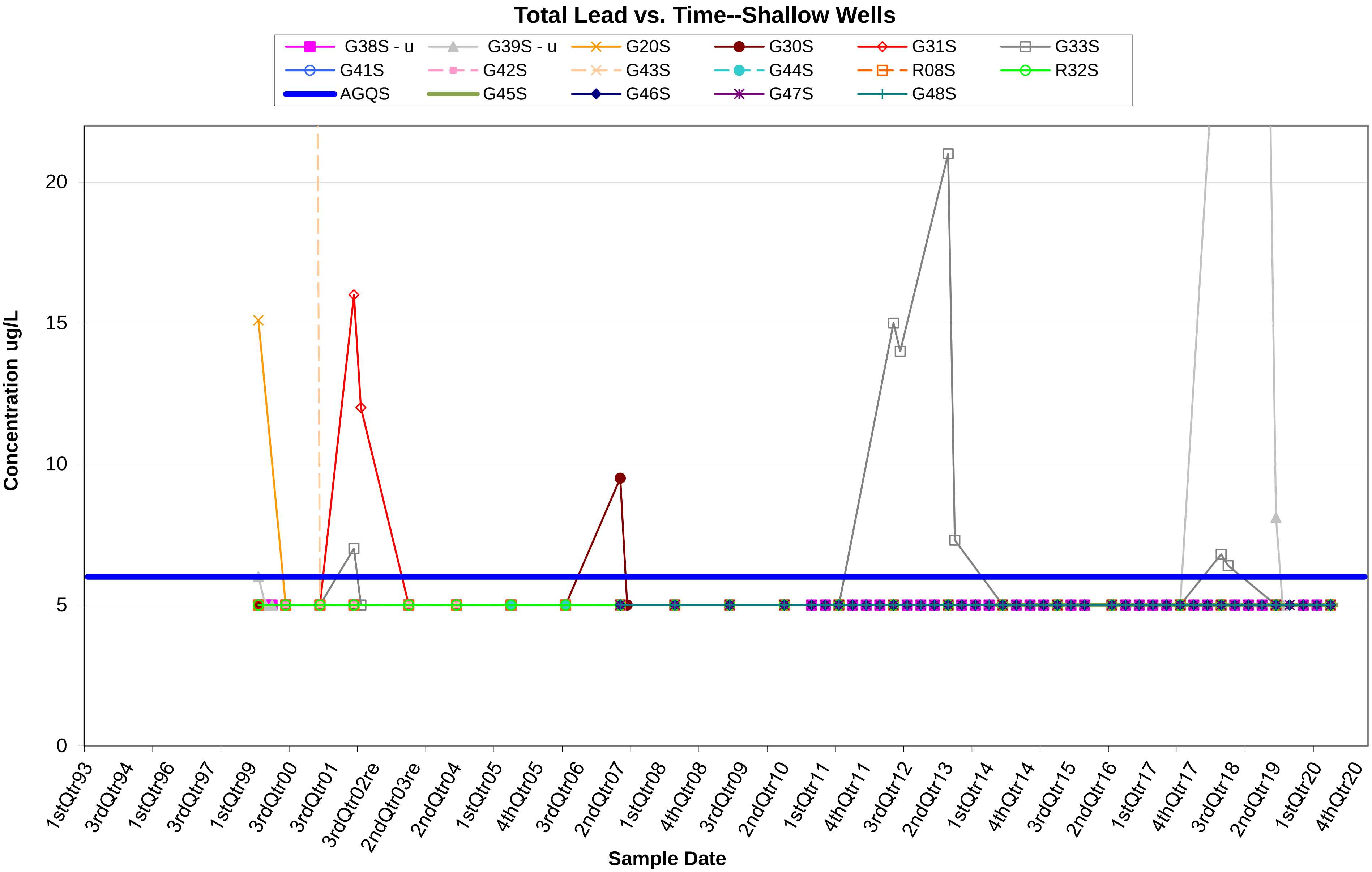

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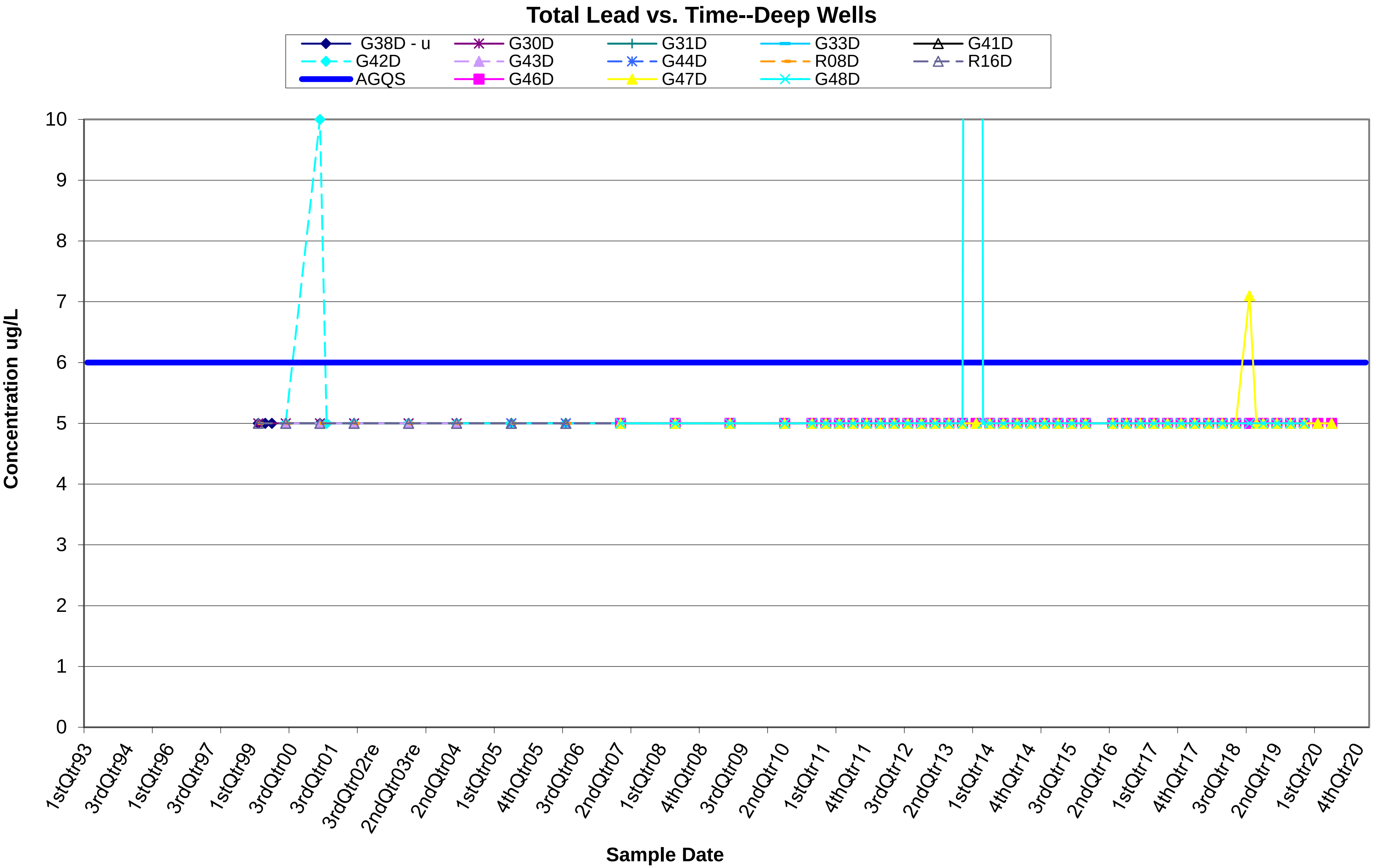
Joliet/Lincoln Stone Quarry



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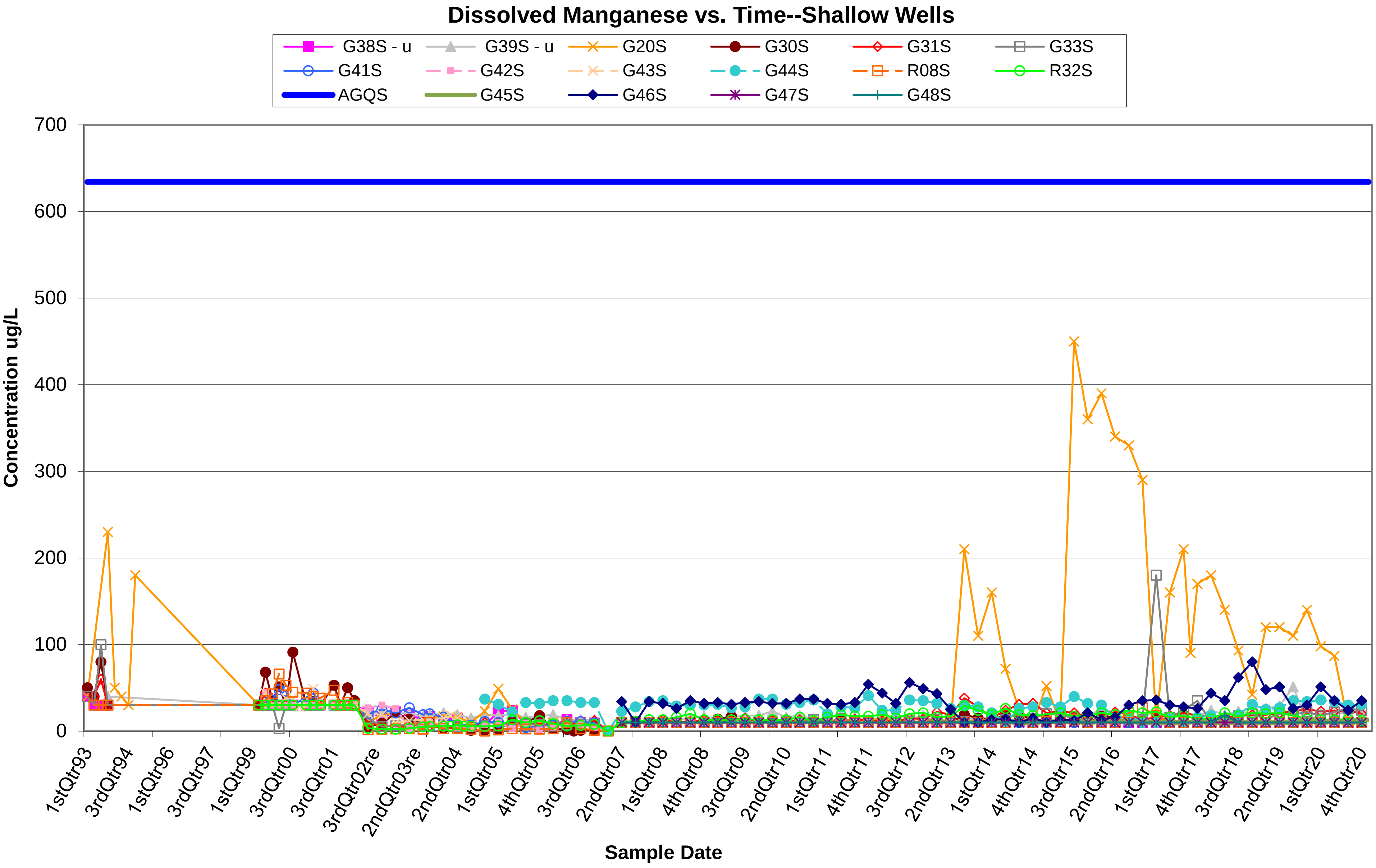

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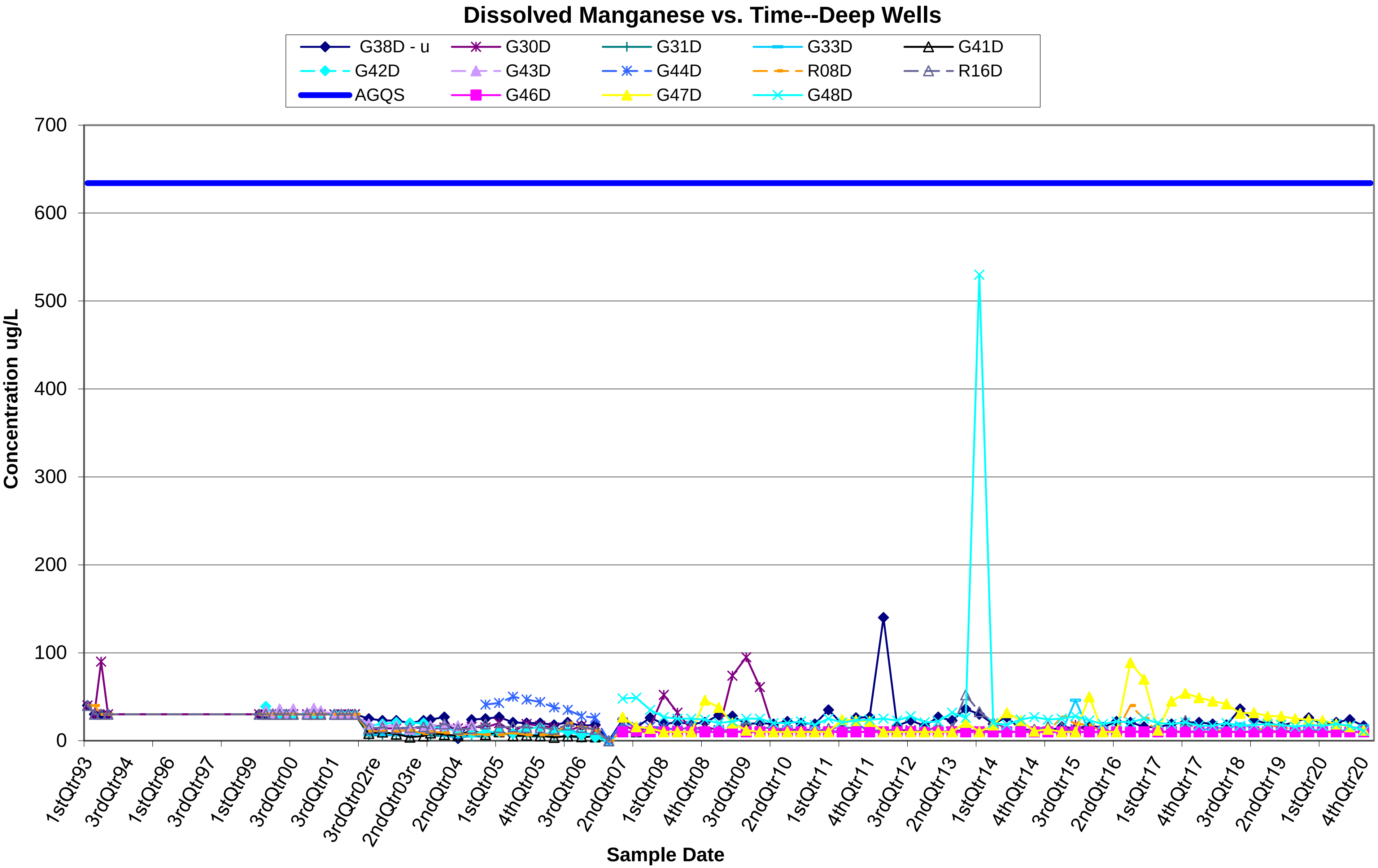

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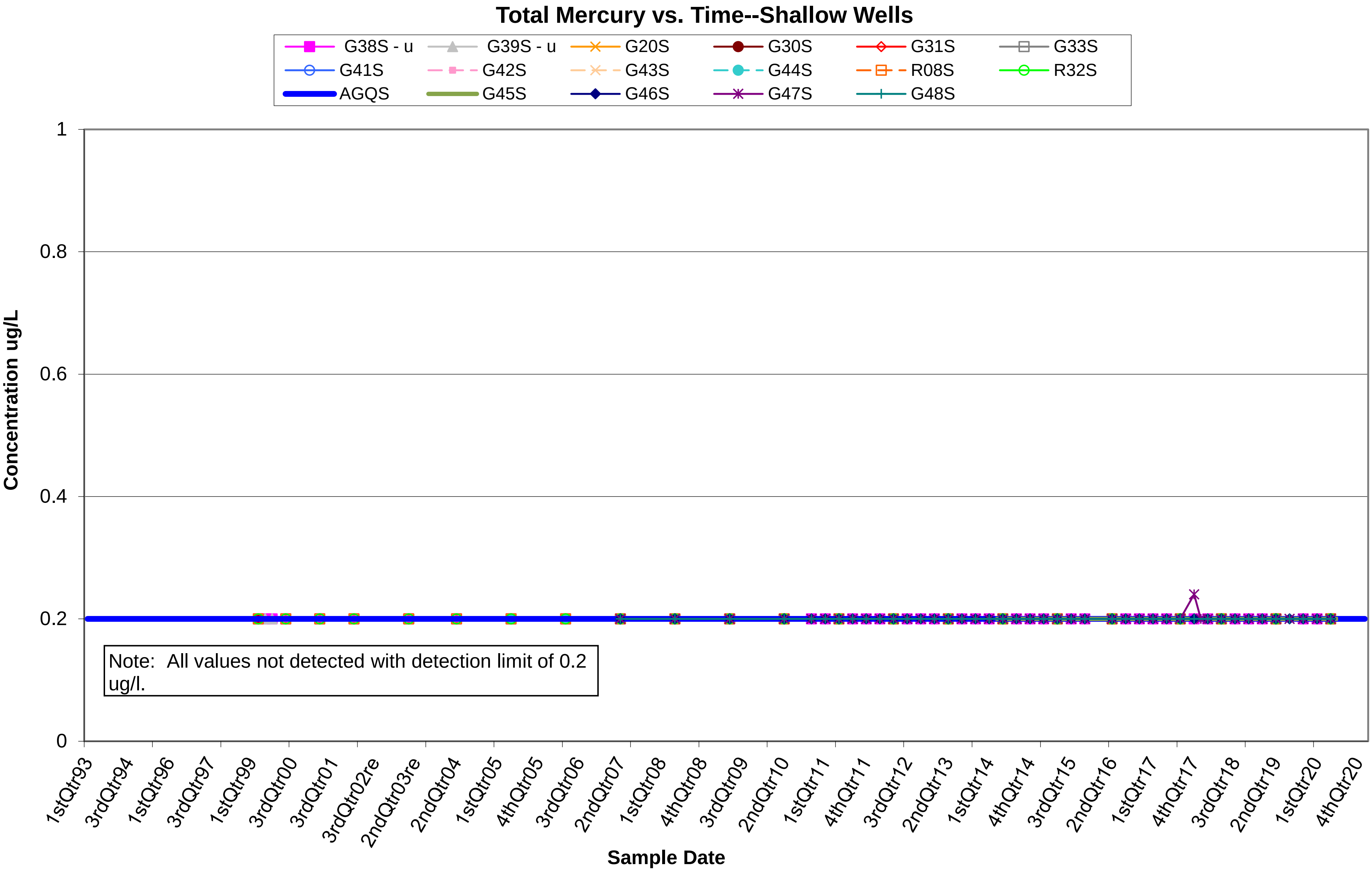
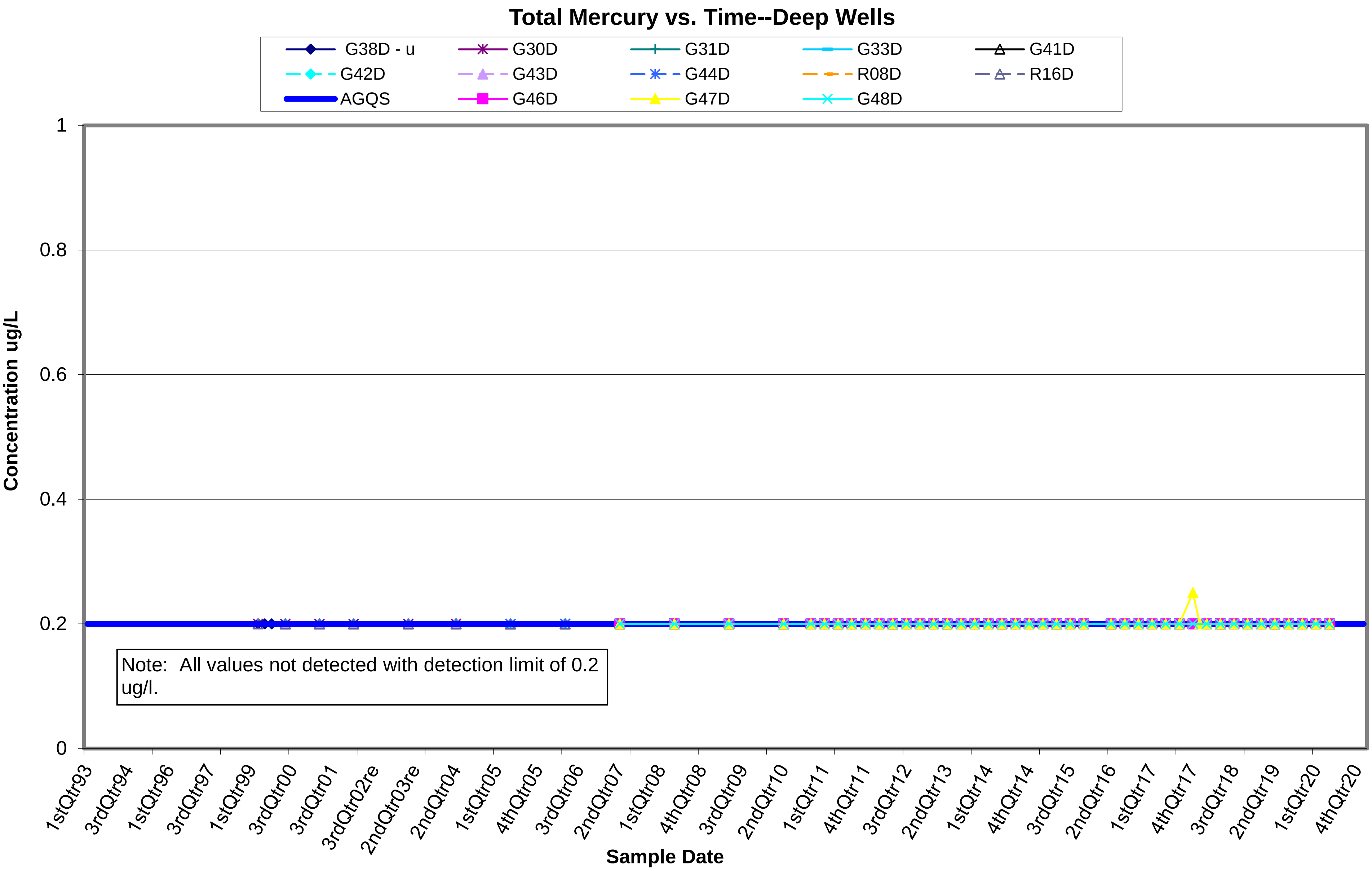


Note: All values not detected with detection limit of 0.2 ug/l.


Total Mercury vs. Time--Deep Wells
G38D - u
G30D
G31D
G33D
G41D
G42D
G43D
G44D
R08D
R16D
AGQS
G46D
G47D
G48D
Concentration ug/L
1
0.8
0.6
0.4
0.2
0
Note: All values not detected with detection limit of 0.2 ug/l.
1stQtr93
3rdQtr94
1stQtr96
3rdQtr97
1stQtr99
3rdQtr00
3rdQtr01
3rdQtr02re
2ndQtr03re
2ndQtr04
1stQtr05
4thQtr05
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4thQtr14
3rdQtr15
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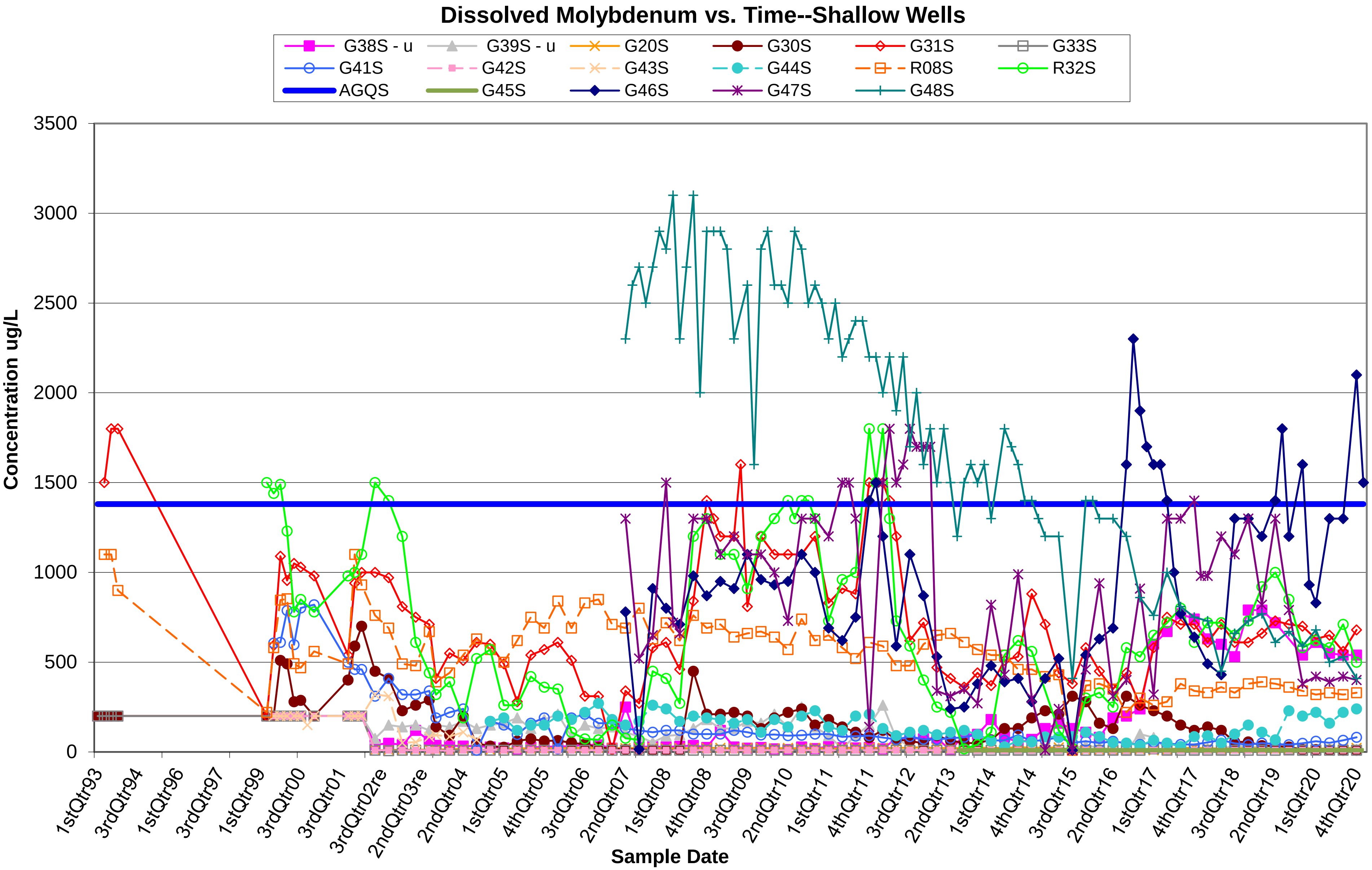
1stQtr17
4thQtr17
3rdQtr18
2ndQtr19
1stQtr20
4thQtr20
Sample Date


Dissolved Molybdenum vs. Time--Shallow Wells
G38S - u
G39S - u
G20S
G30S
G31S
G33S
G41S
G42S
G43S
G44S
R08S
R32S
AGQS
G45S
G46S
G47S
G48S
Concentration ug/L
3500
3000
2500
2000
1500
1000
500
0
1stQtr93
3rdQtr94
1stQtr96
3rdQtr97
1stQtr99
3rdQtr00
3rdQtr01
3rdQtr02re
2ndQtr03re
2ndQtr04
1stQtr05
4thQtr05
3rdQtr06
2ndQtr07
1stQtr08
4thQtr08
3rdQtr09
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4thQtr14
3rdQtr15
2ndQtr16
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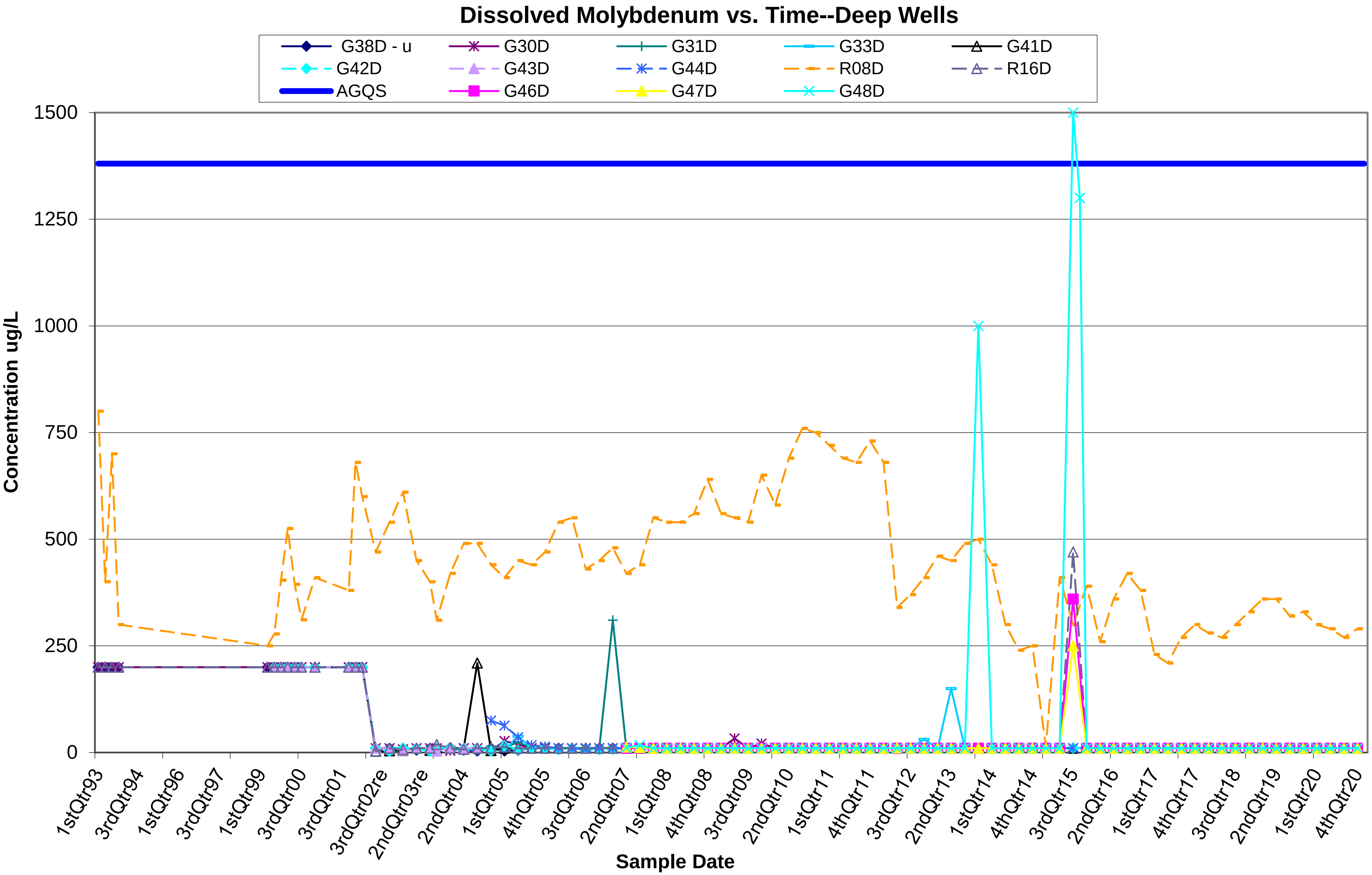
4thQtr20
Sample Date

Joliet/Lincoln Stone Quarry



KPRG and Associates, Inc.

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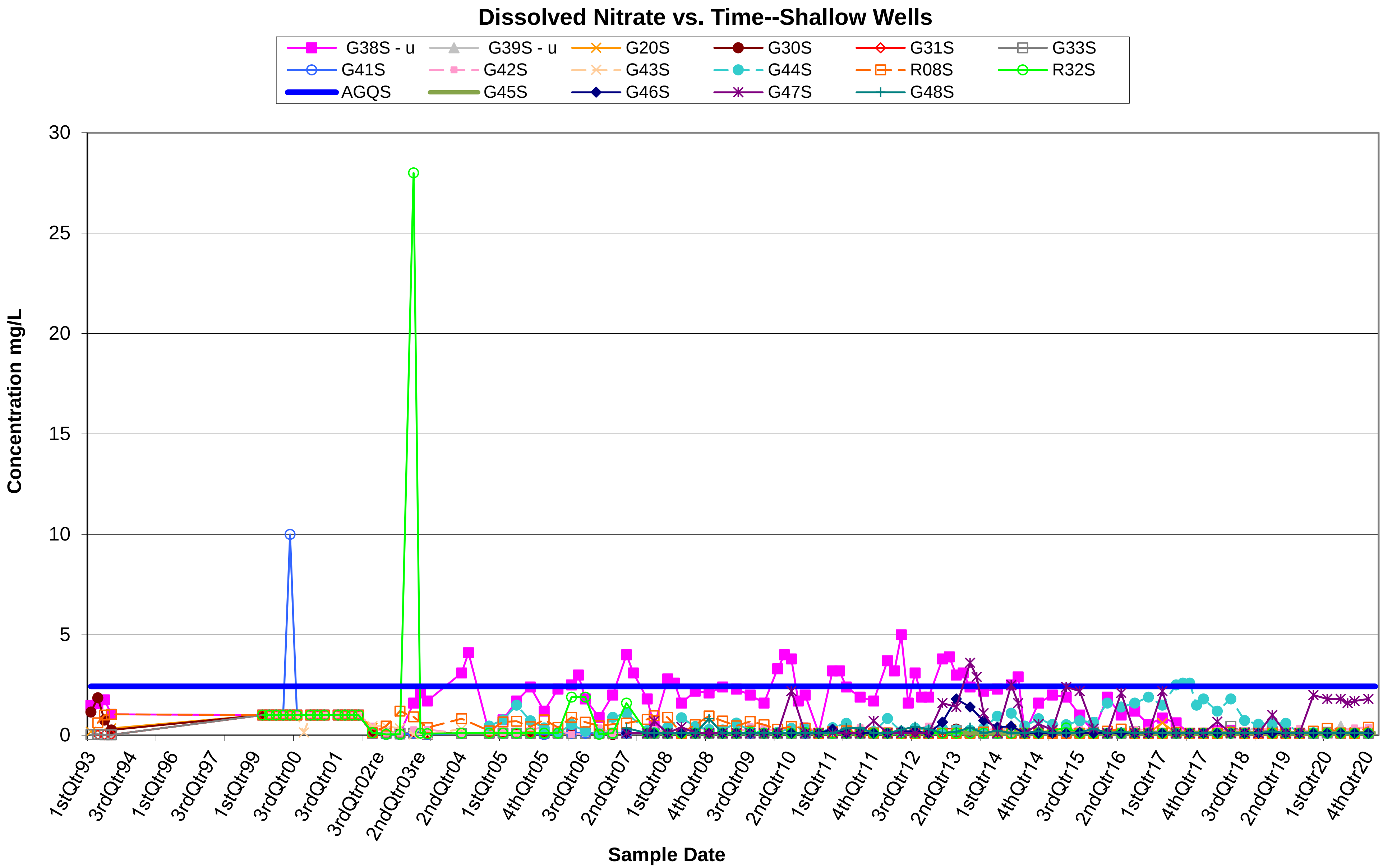

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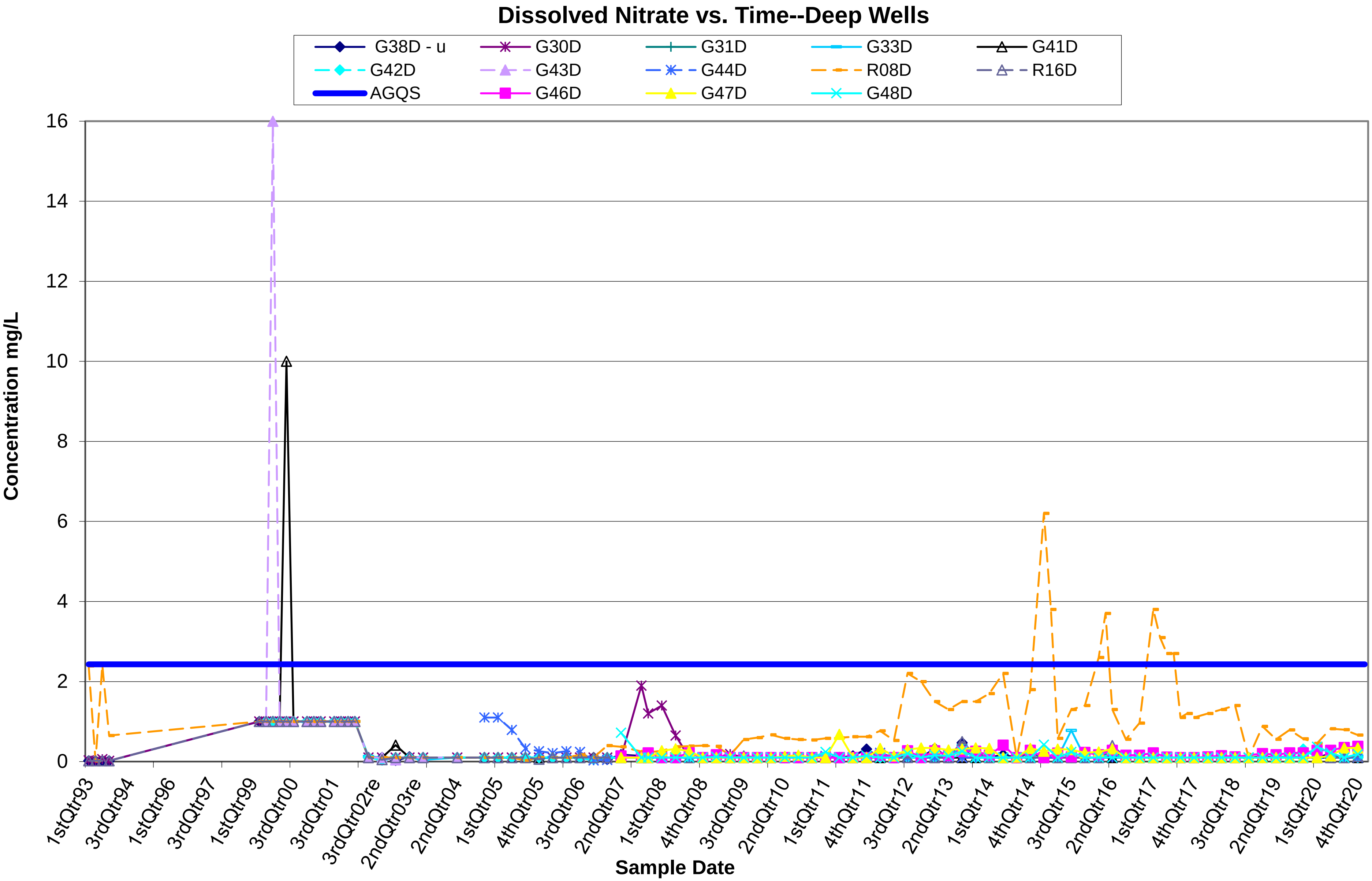

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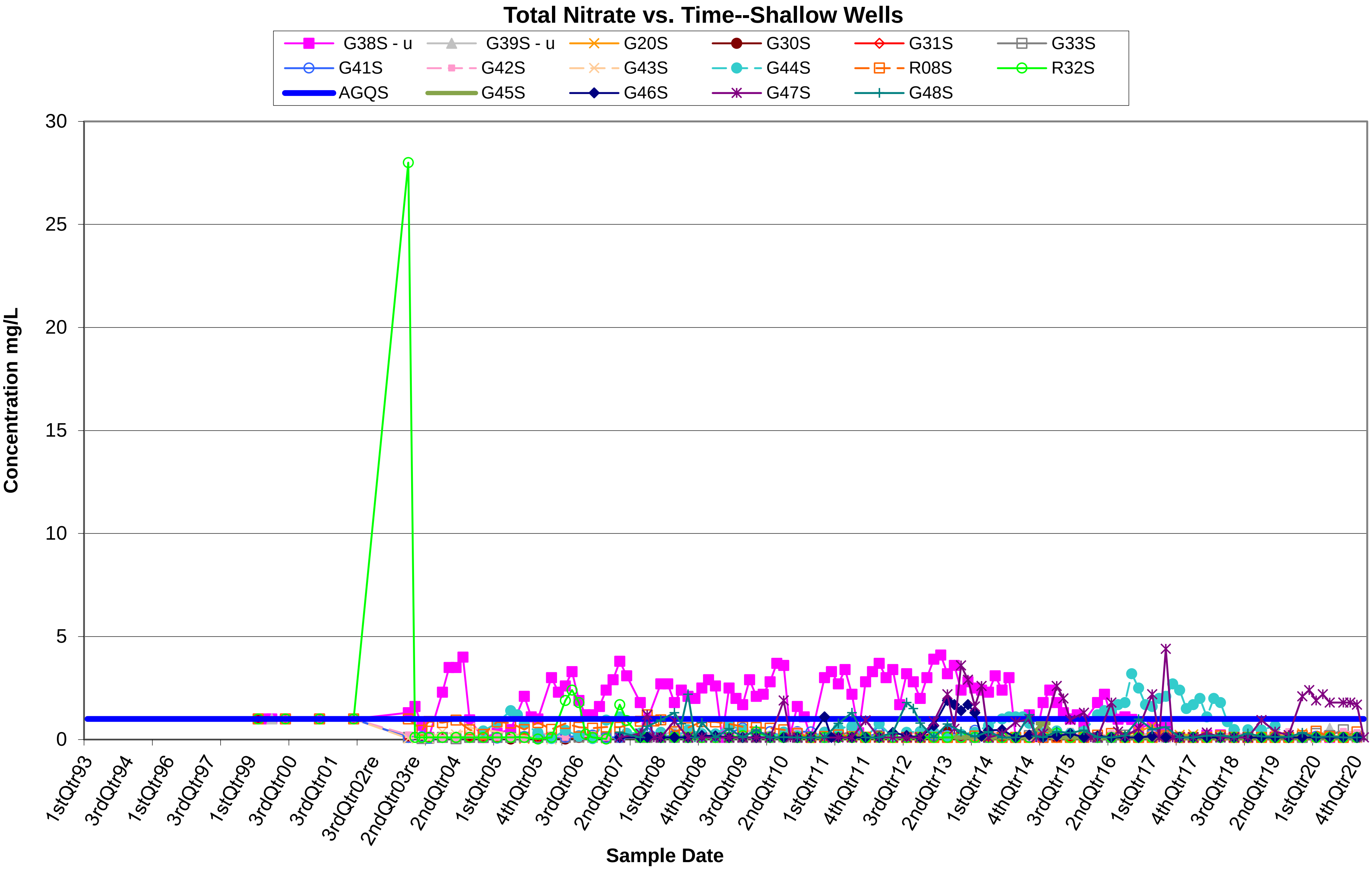

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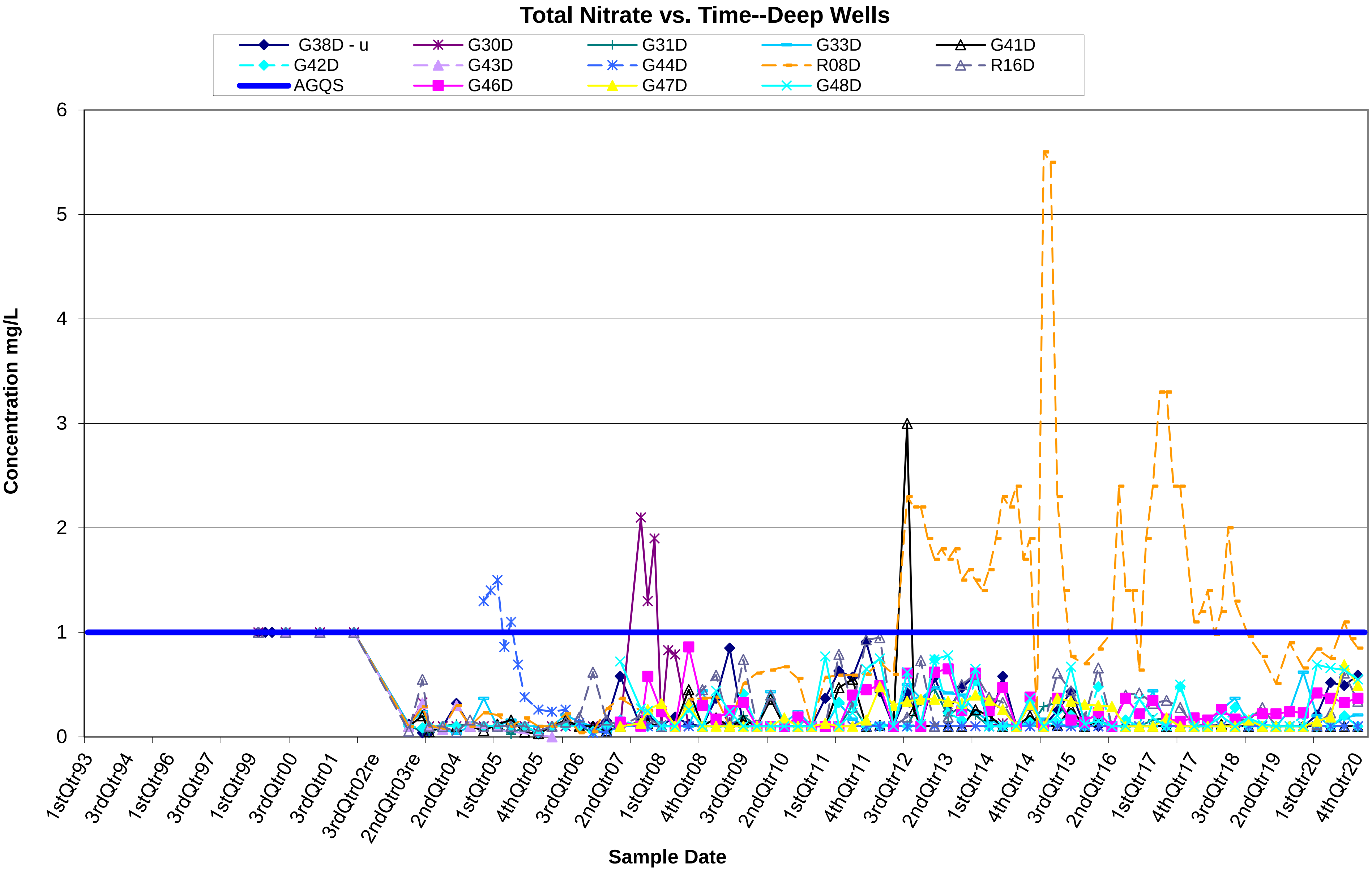

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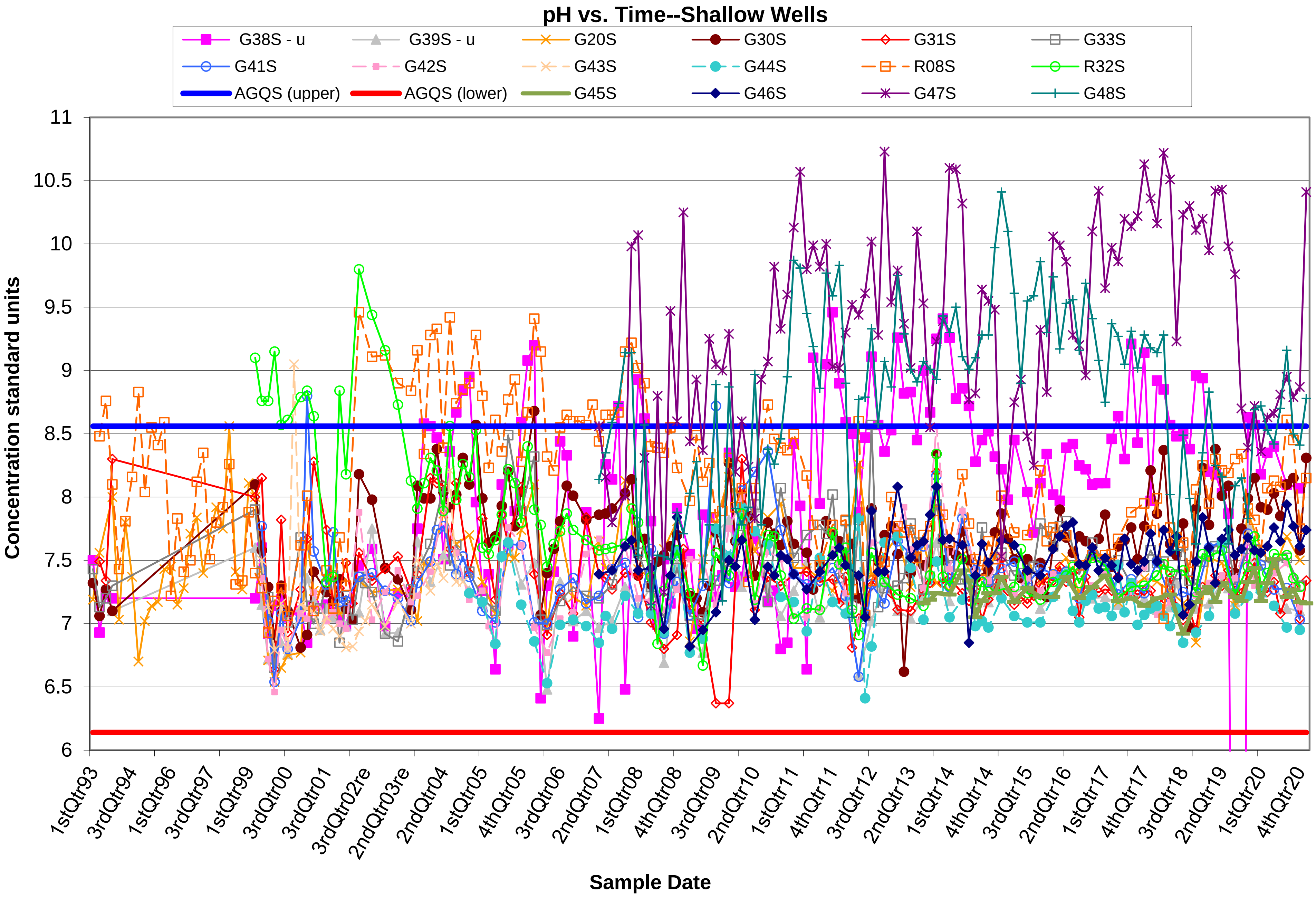

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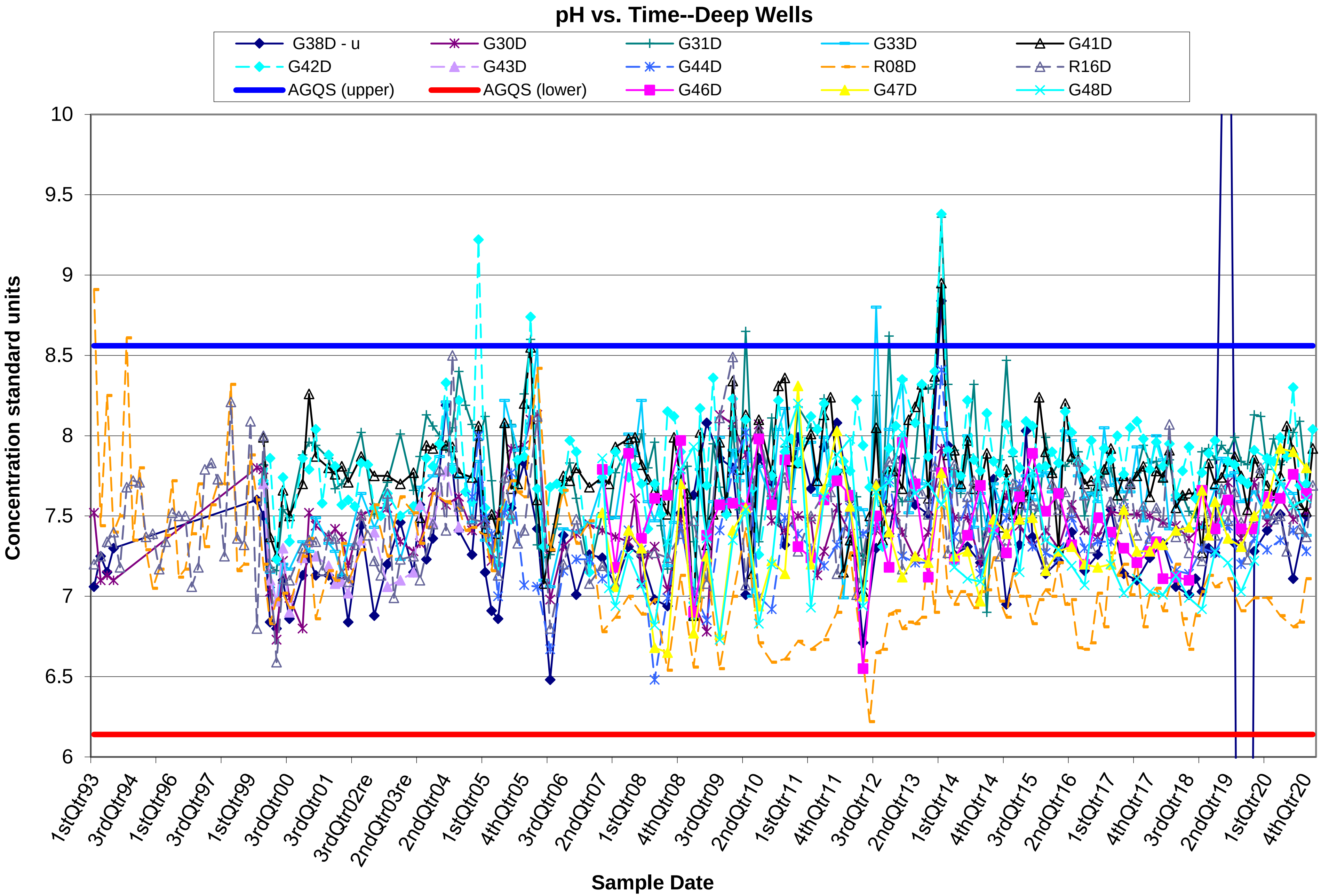

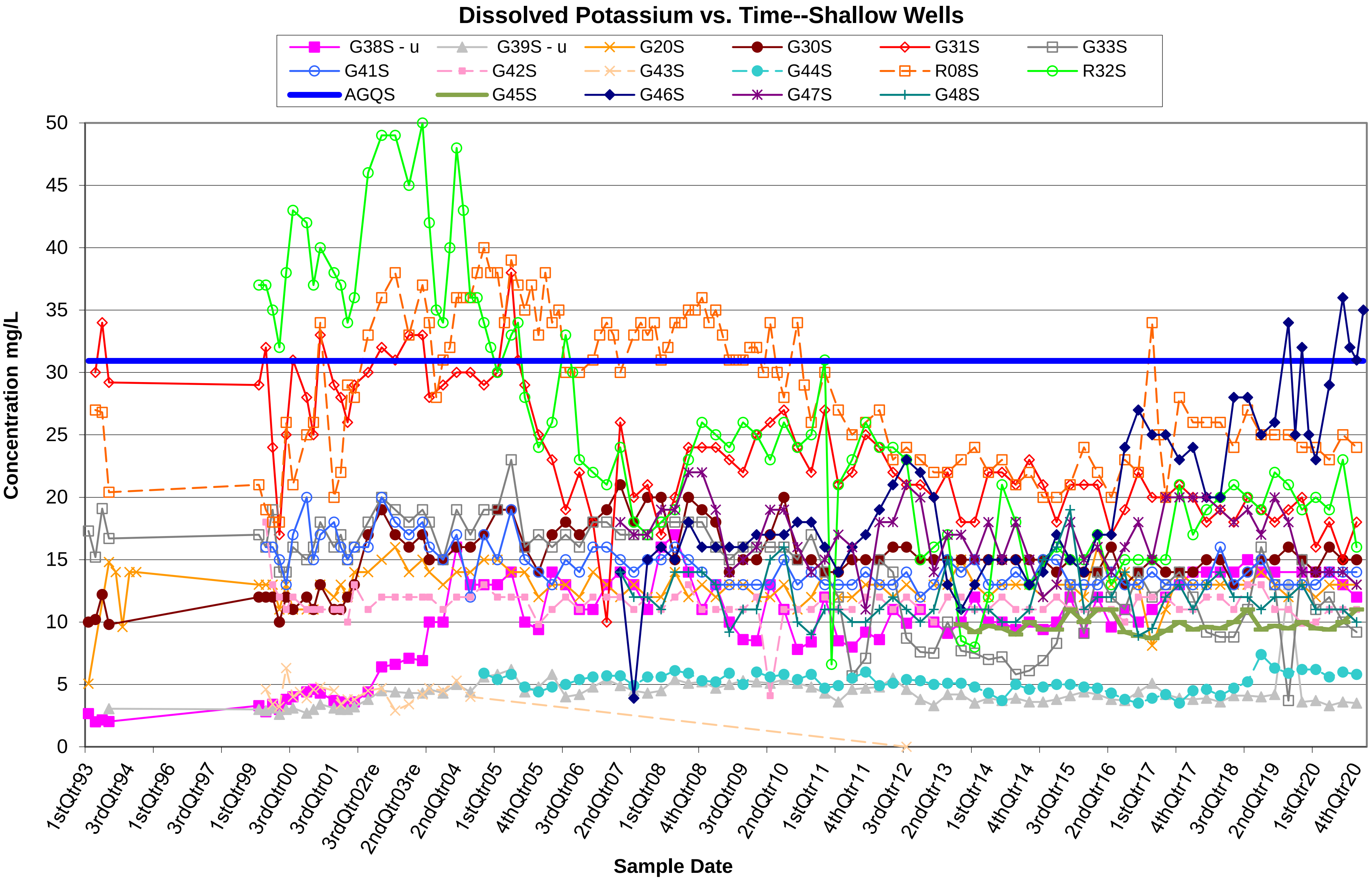
Dissolved Potassium vs. Time--Shallow Wells
G38S - u
G39S - u
G20S
G30S
G31S
G33S
G41S
G42S
G43S
G44S
R08S
R32S
AGQS
G45S
G46S
G47S
G48S
Concentration mg/L
0
5
10
15
20
25
30
35
40
45
50
Sample Date
1stQtr93
3rdQtr94
1stQtr96
3rdQtr97
1stQtr99
3rdQtr00
3rdQtr01
3rdQtr02re
2ndQtr03re
2ndQtr04
1stQtr05
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3rdQtr06
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1stQtr08
4thQtr08
3rdQtr09
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1stQtr11
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3rdQtr12
2ndQtr13
1stQtr14
4thQtr14
3rdQtr15
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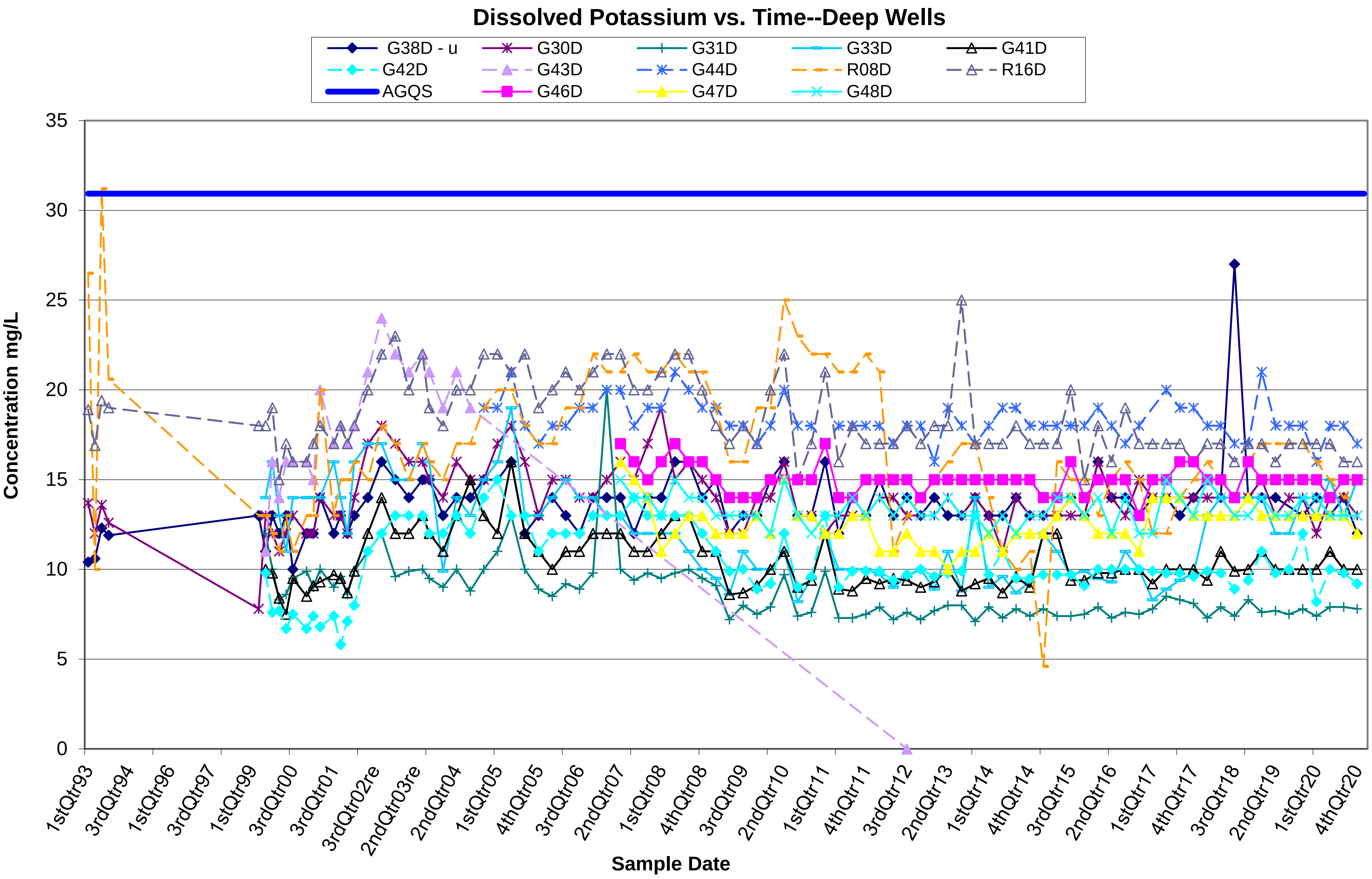

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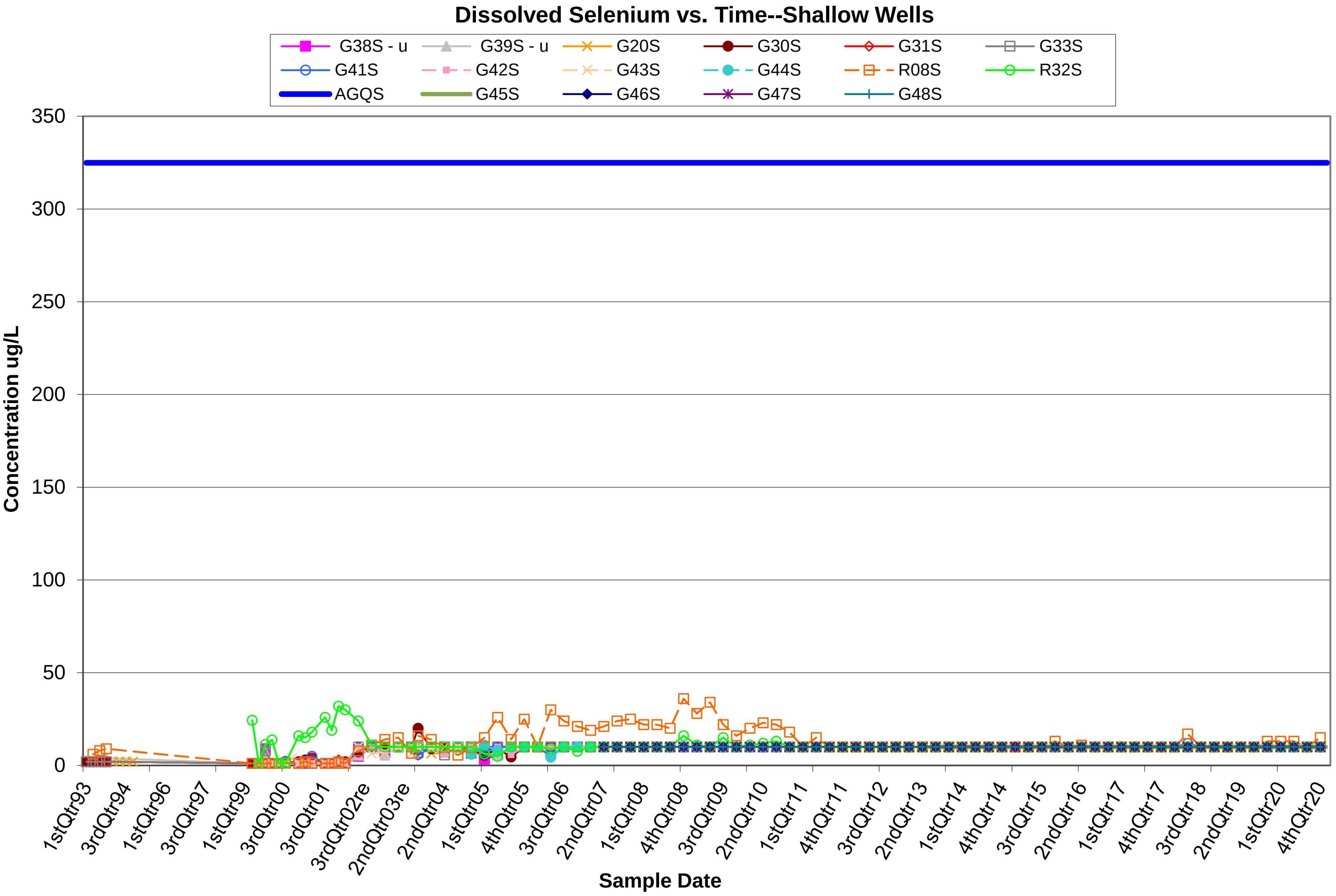

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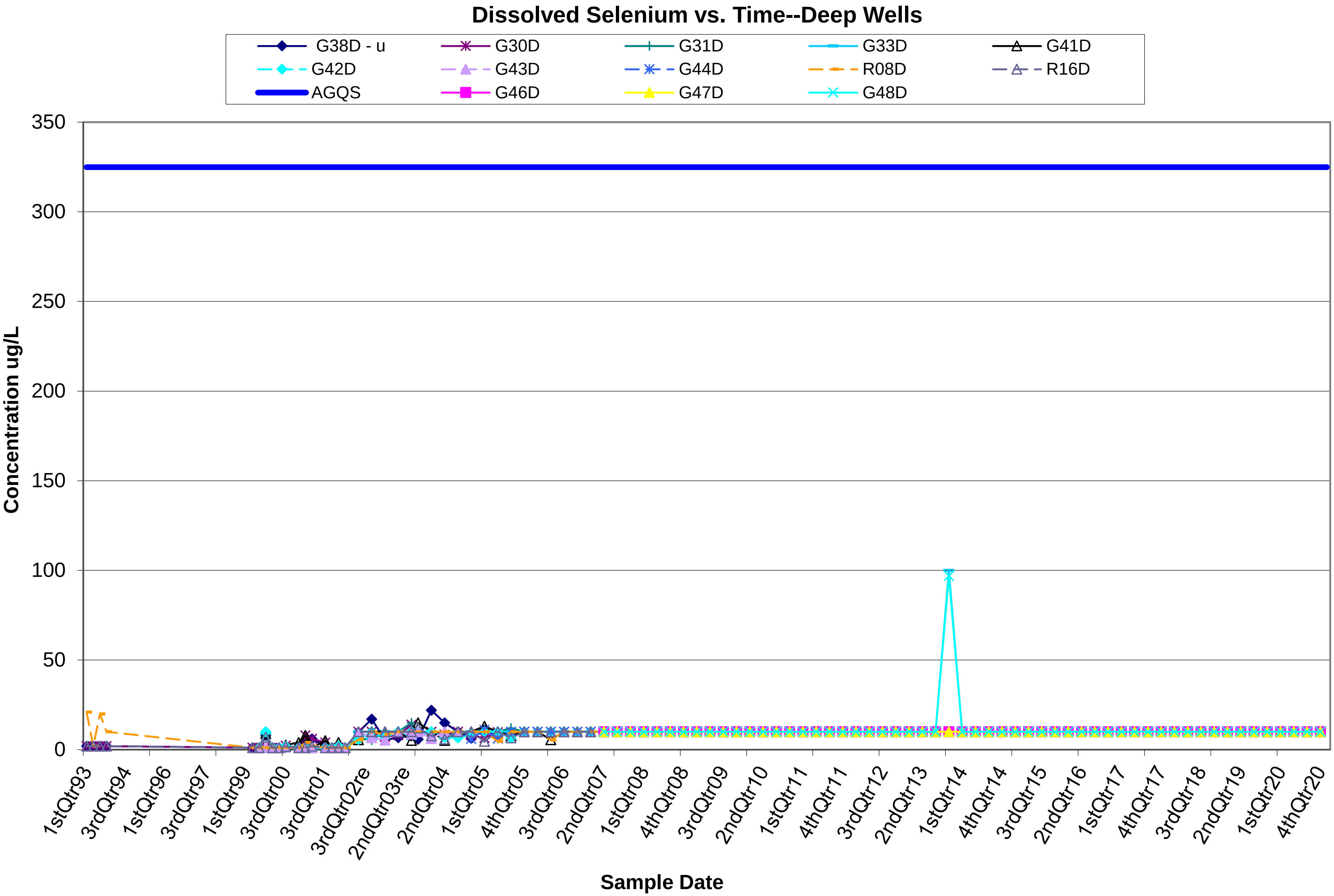

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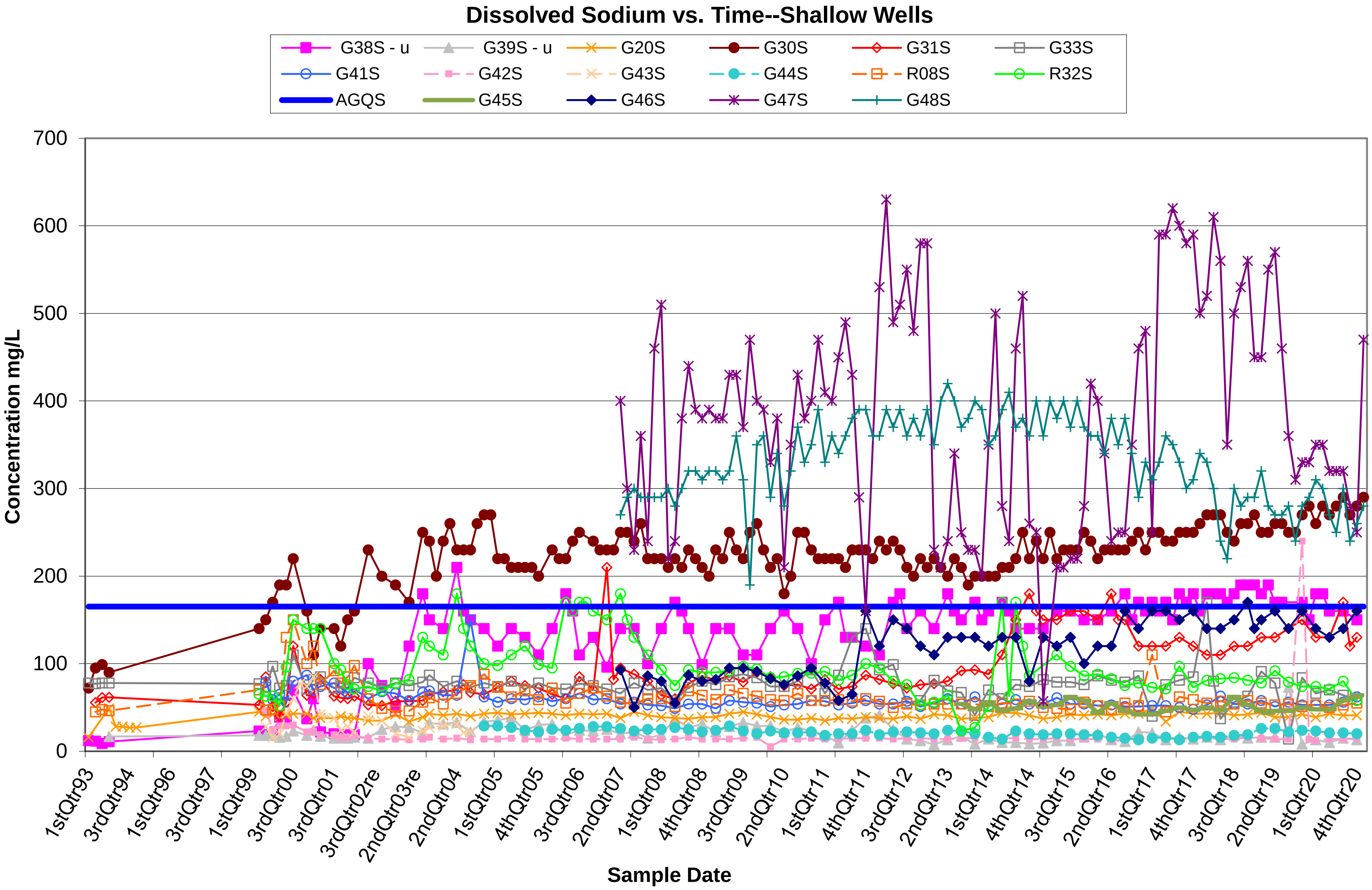

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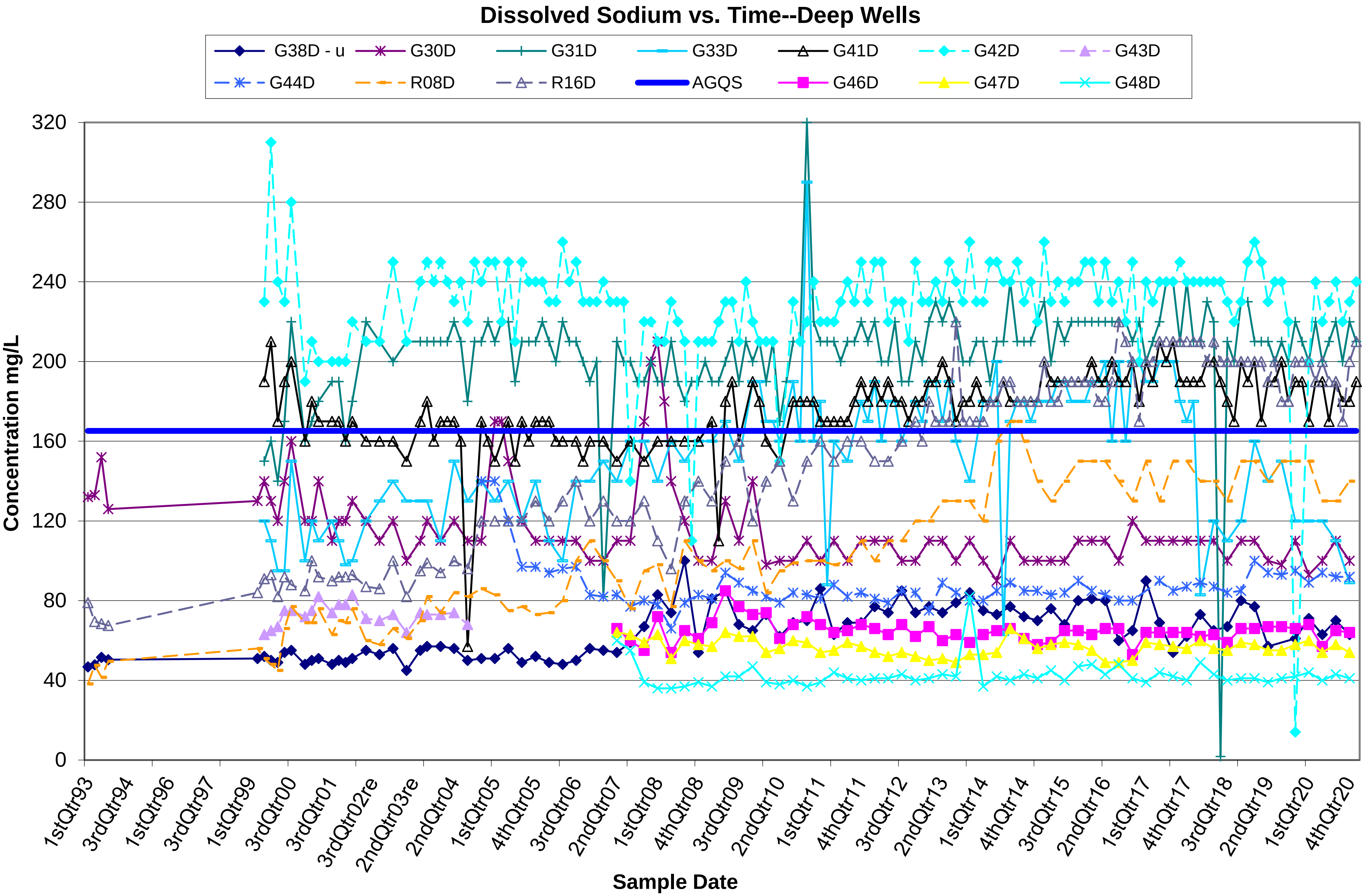

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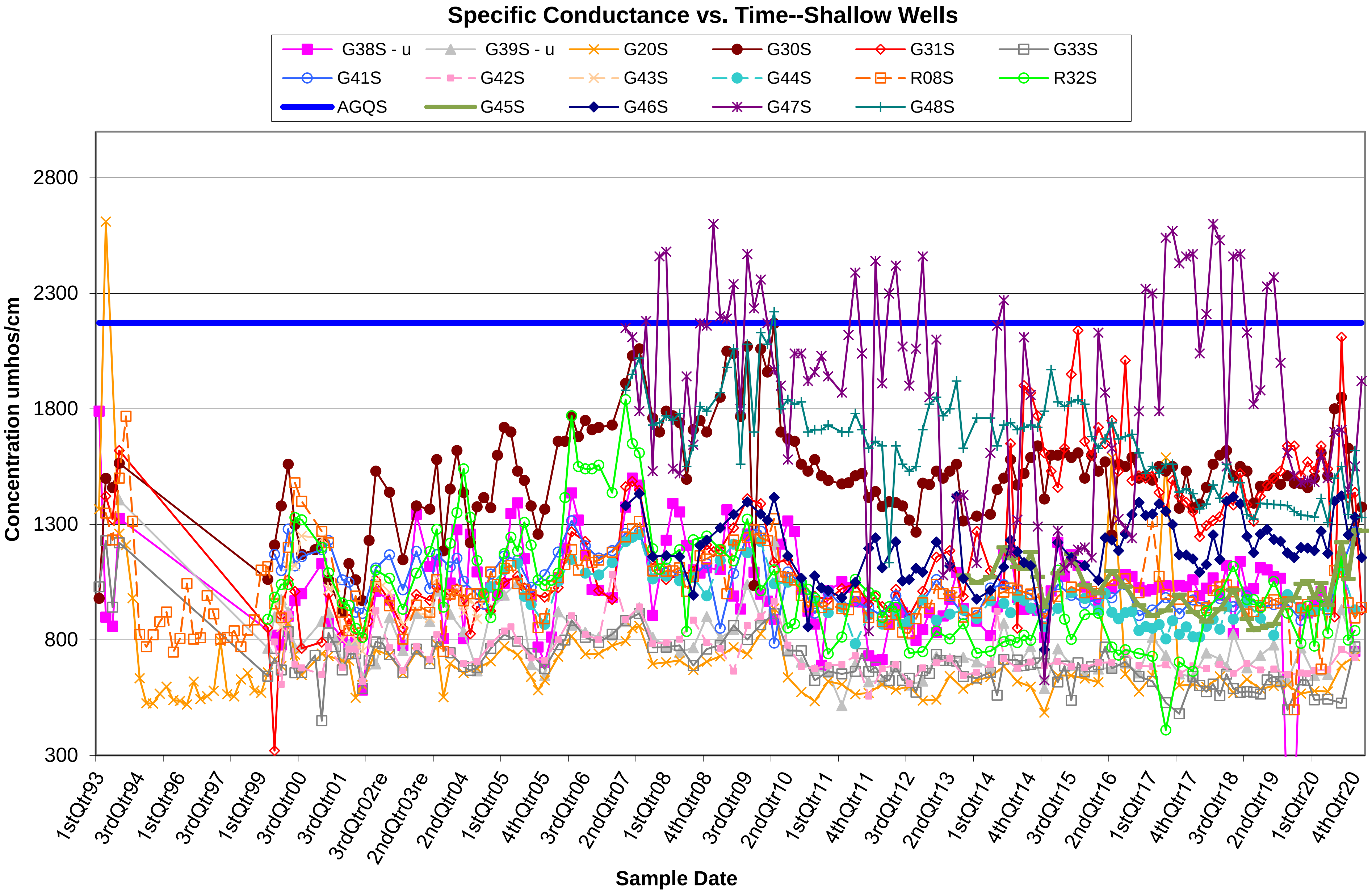

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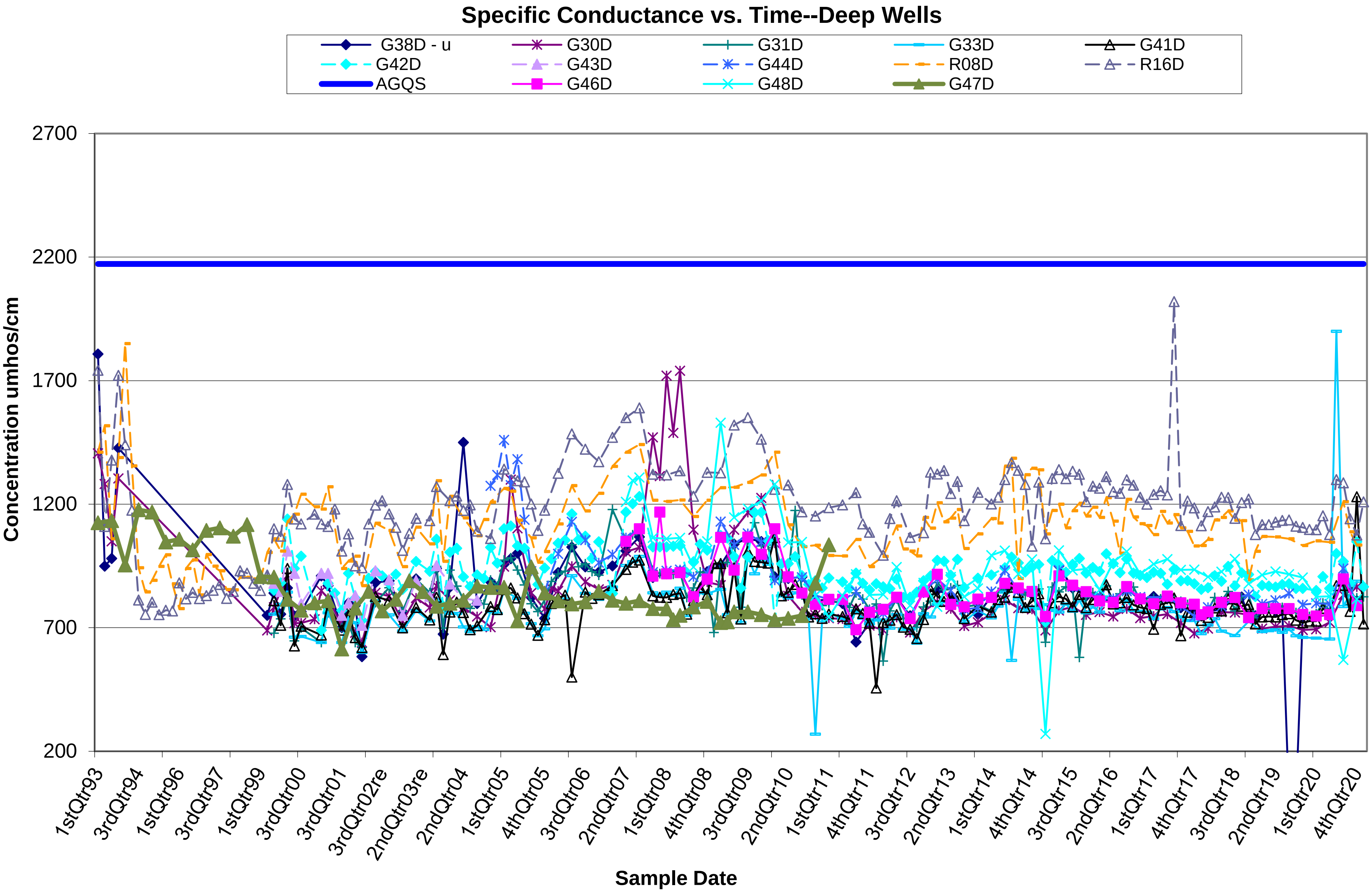

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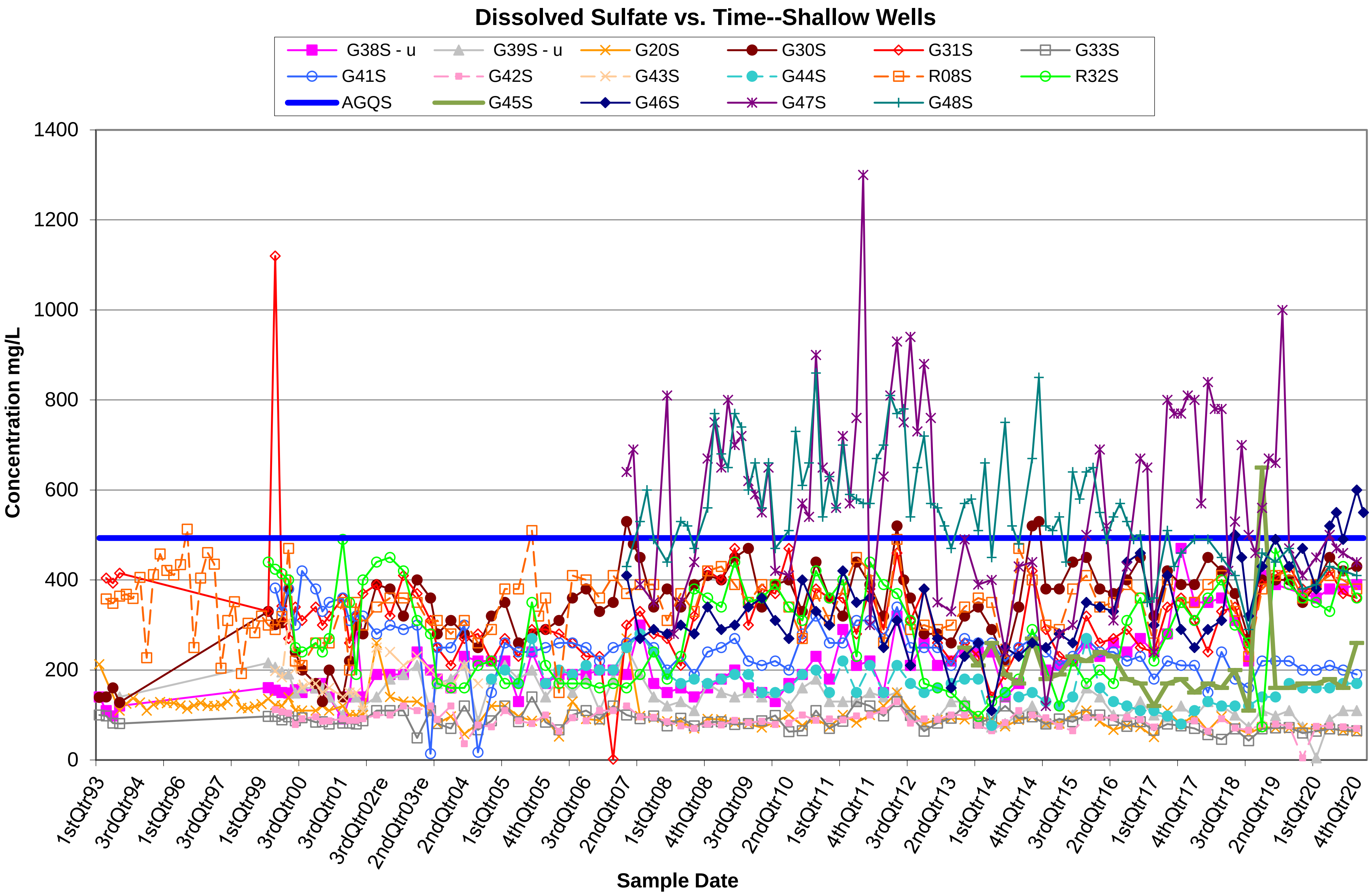

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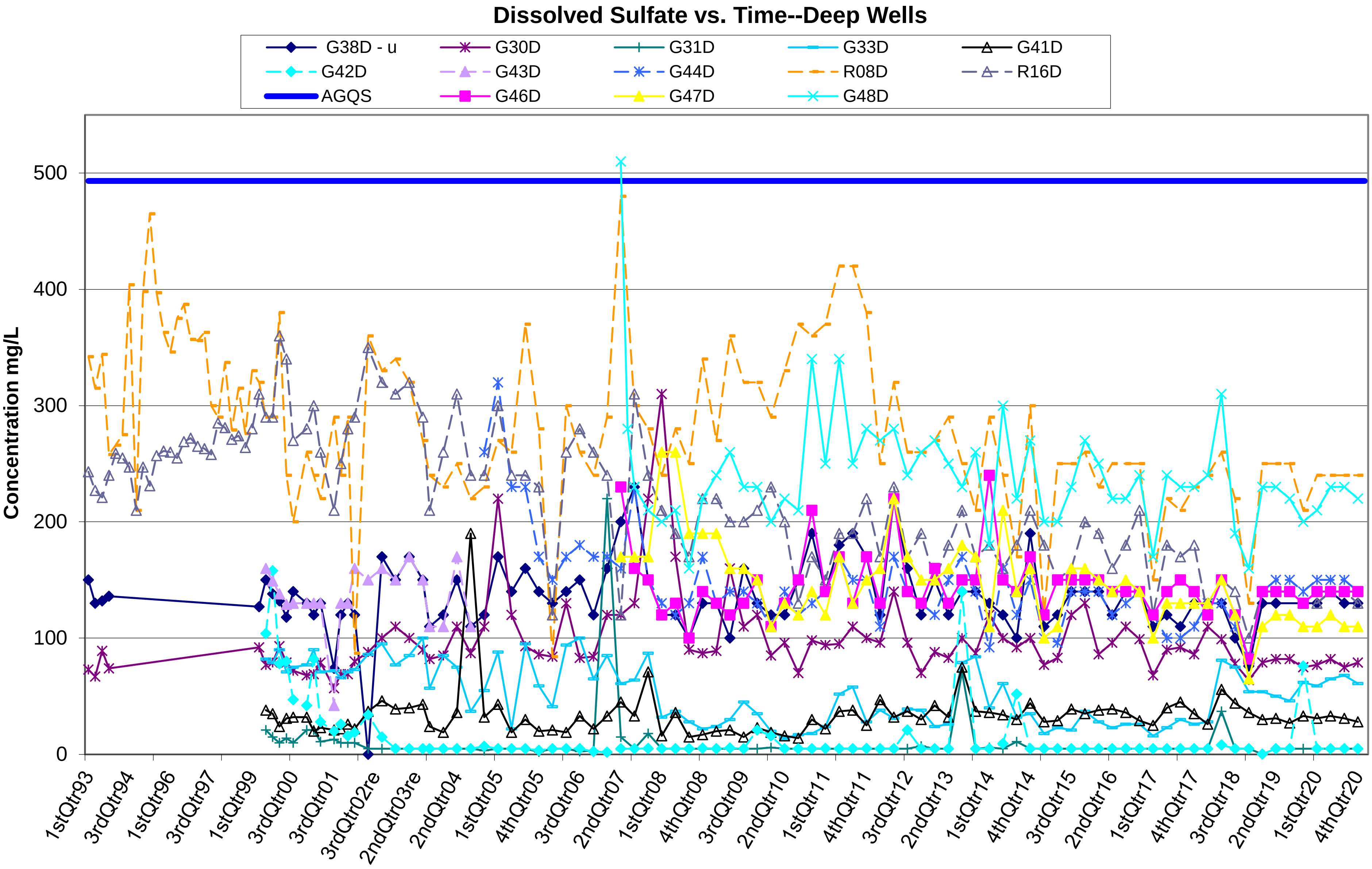

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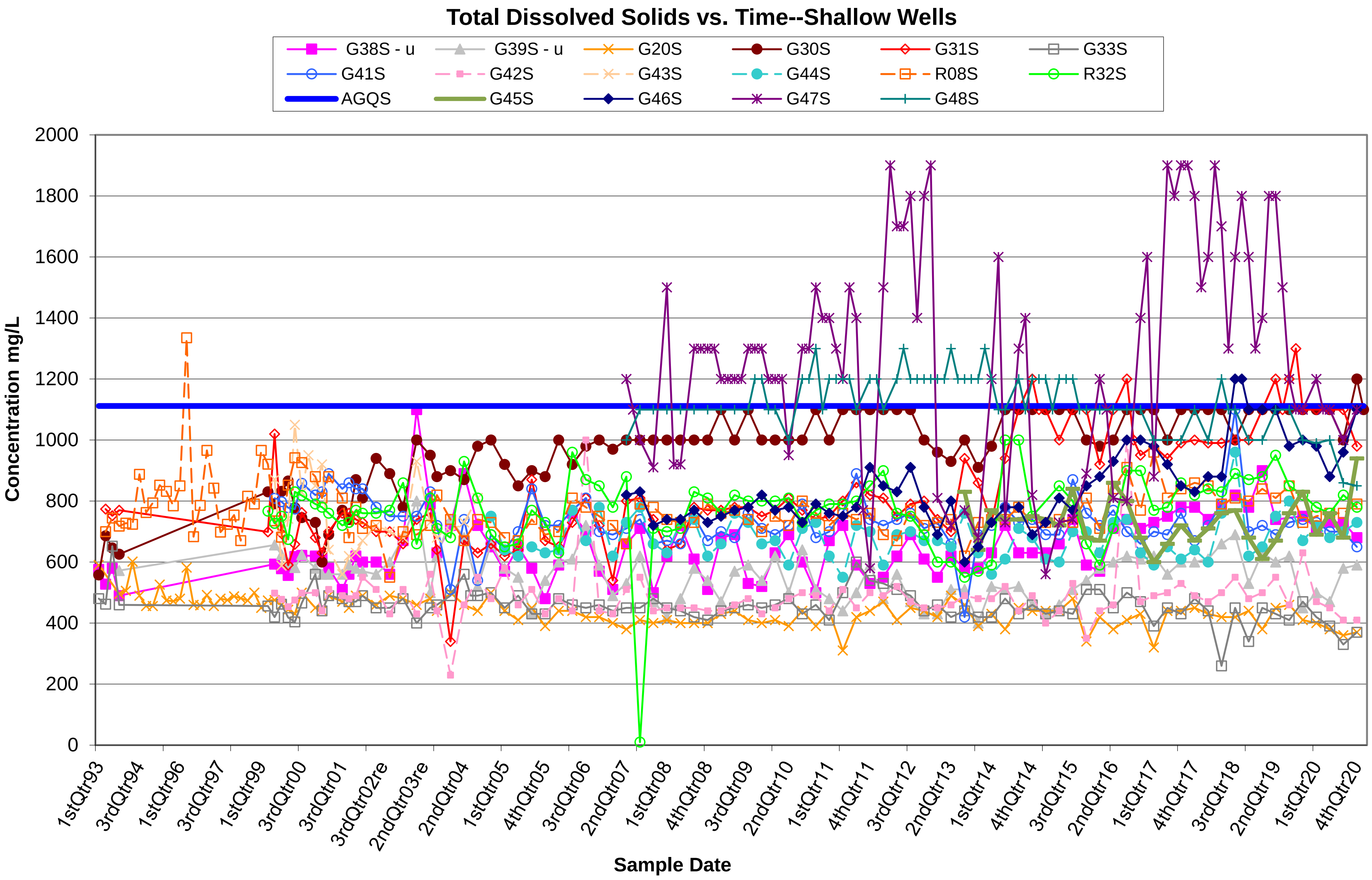

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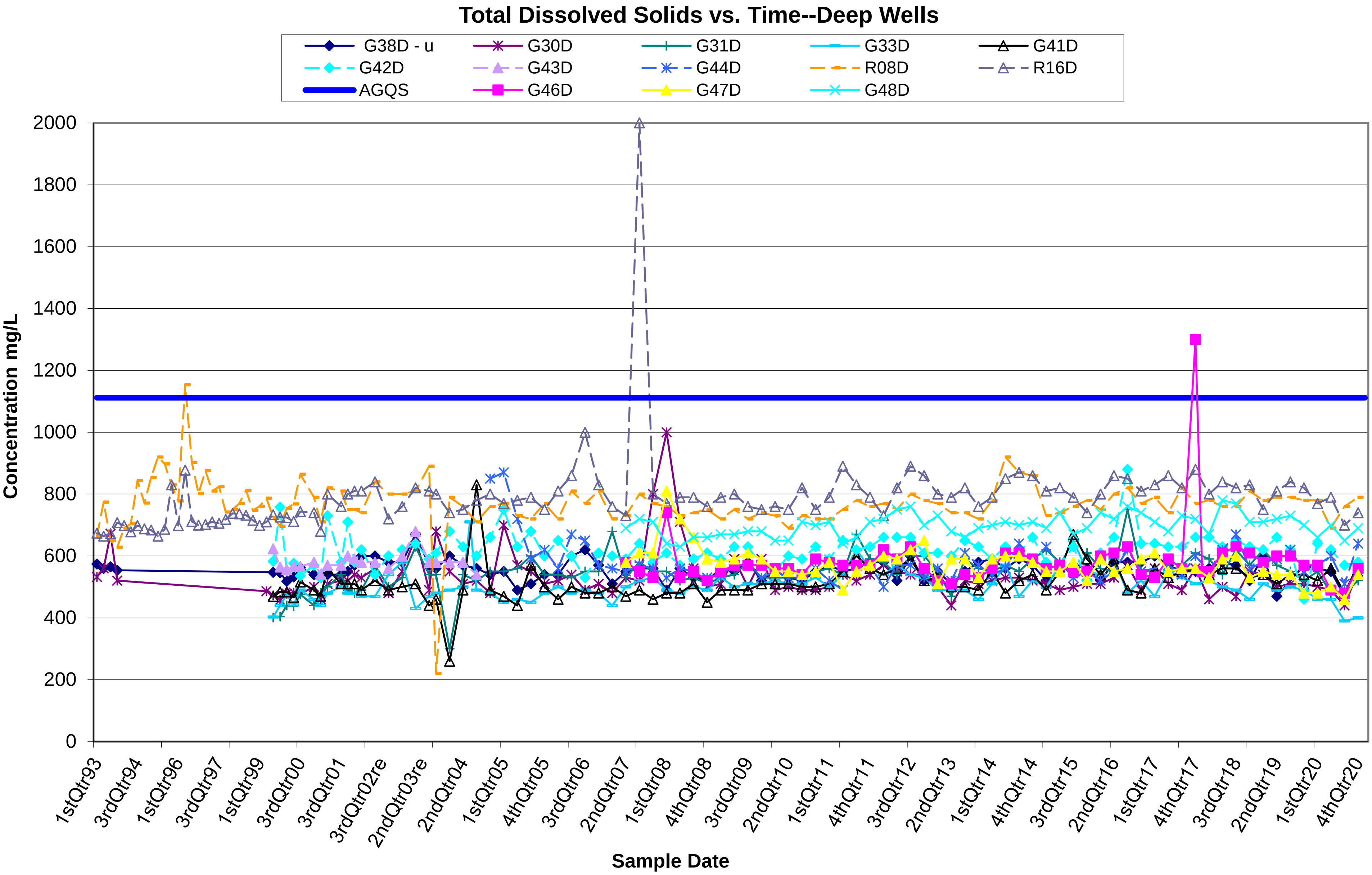

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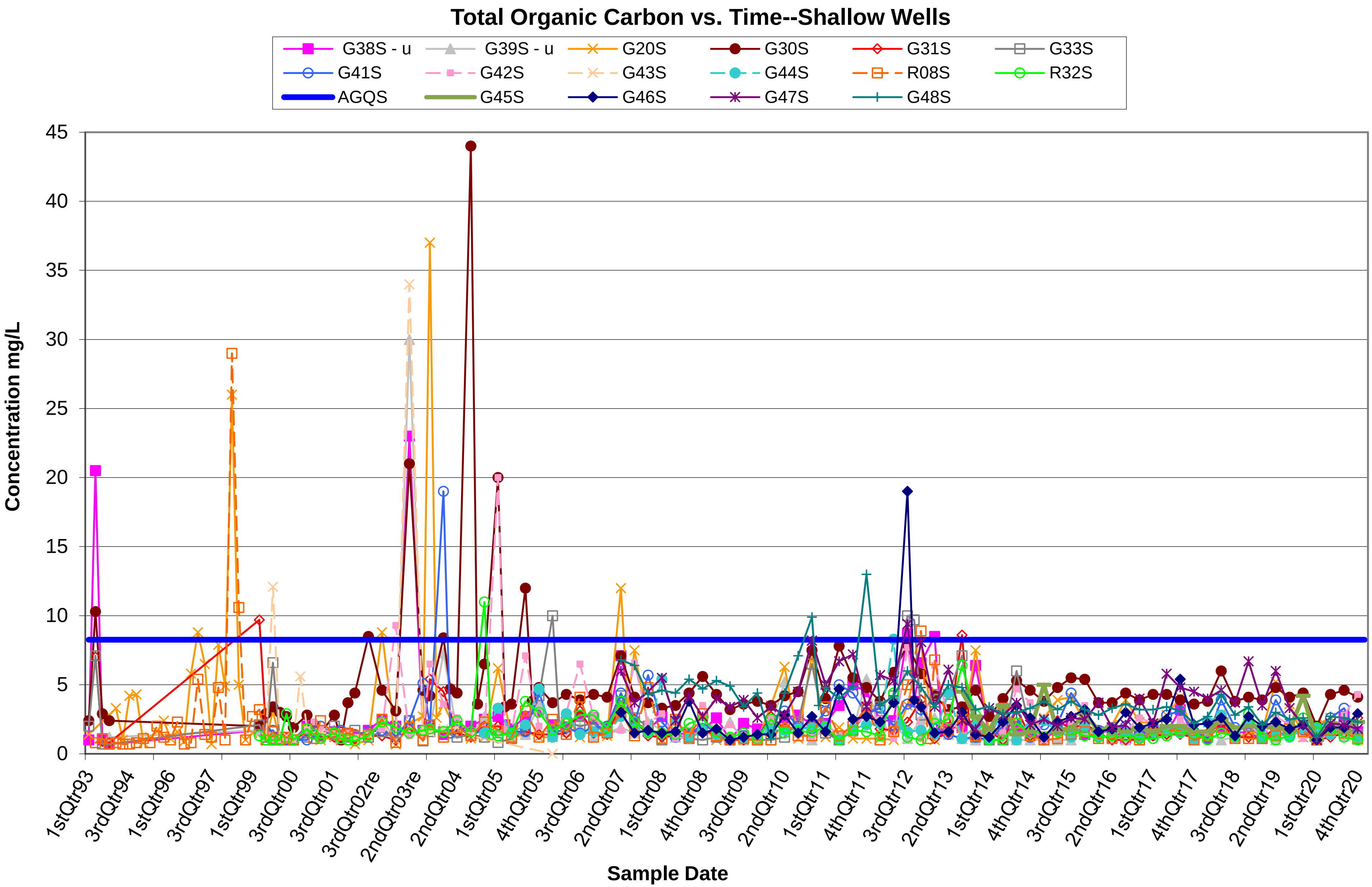

KPRG and Associates, Inc.

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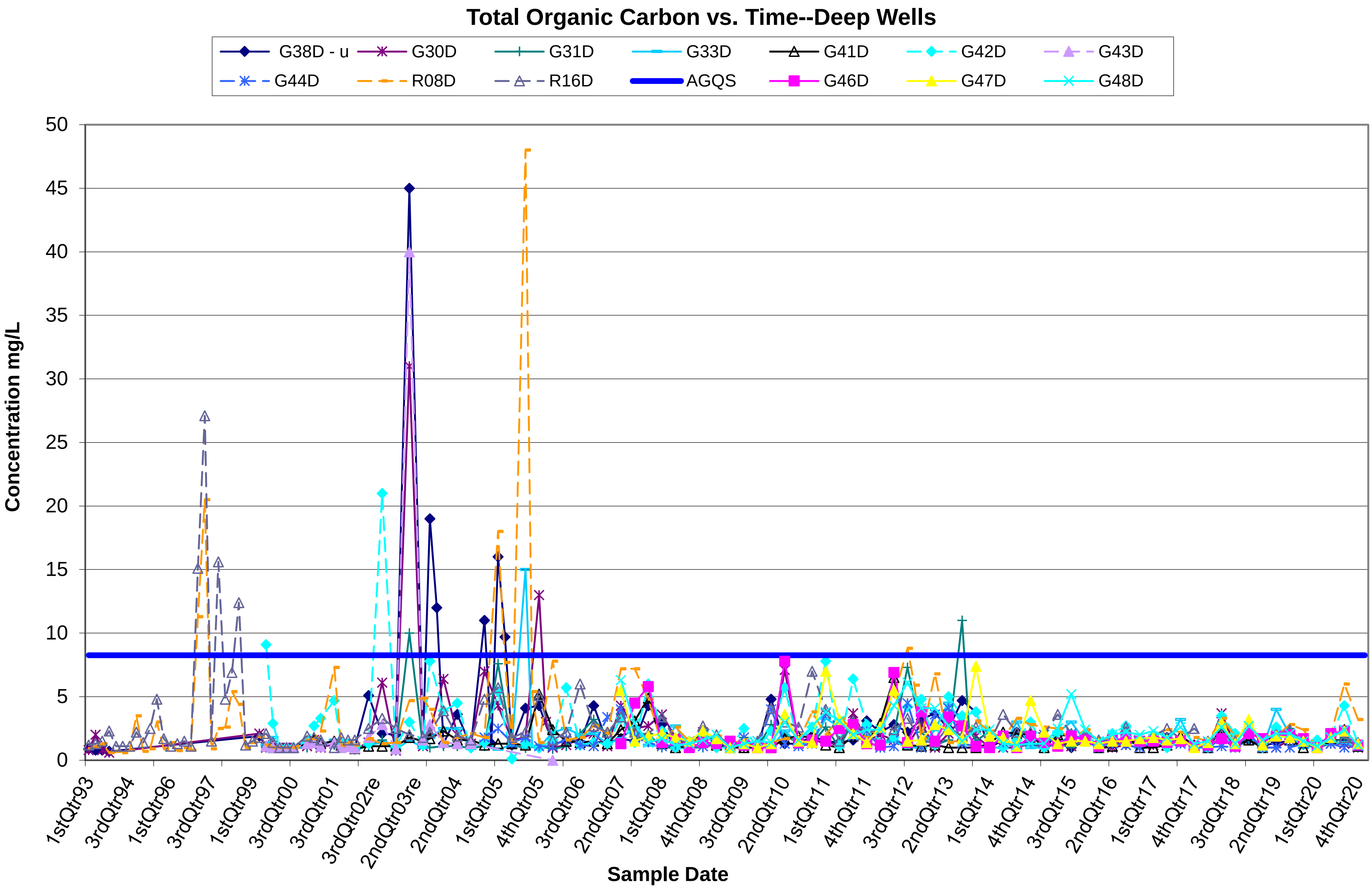
TOC Sh

Joliet/Lincoln Stone Quarry



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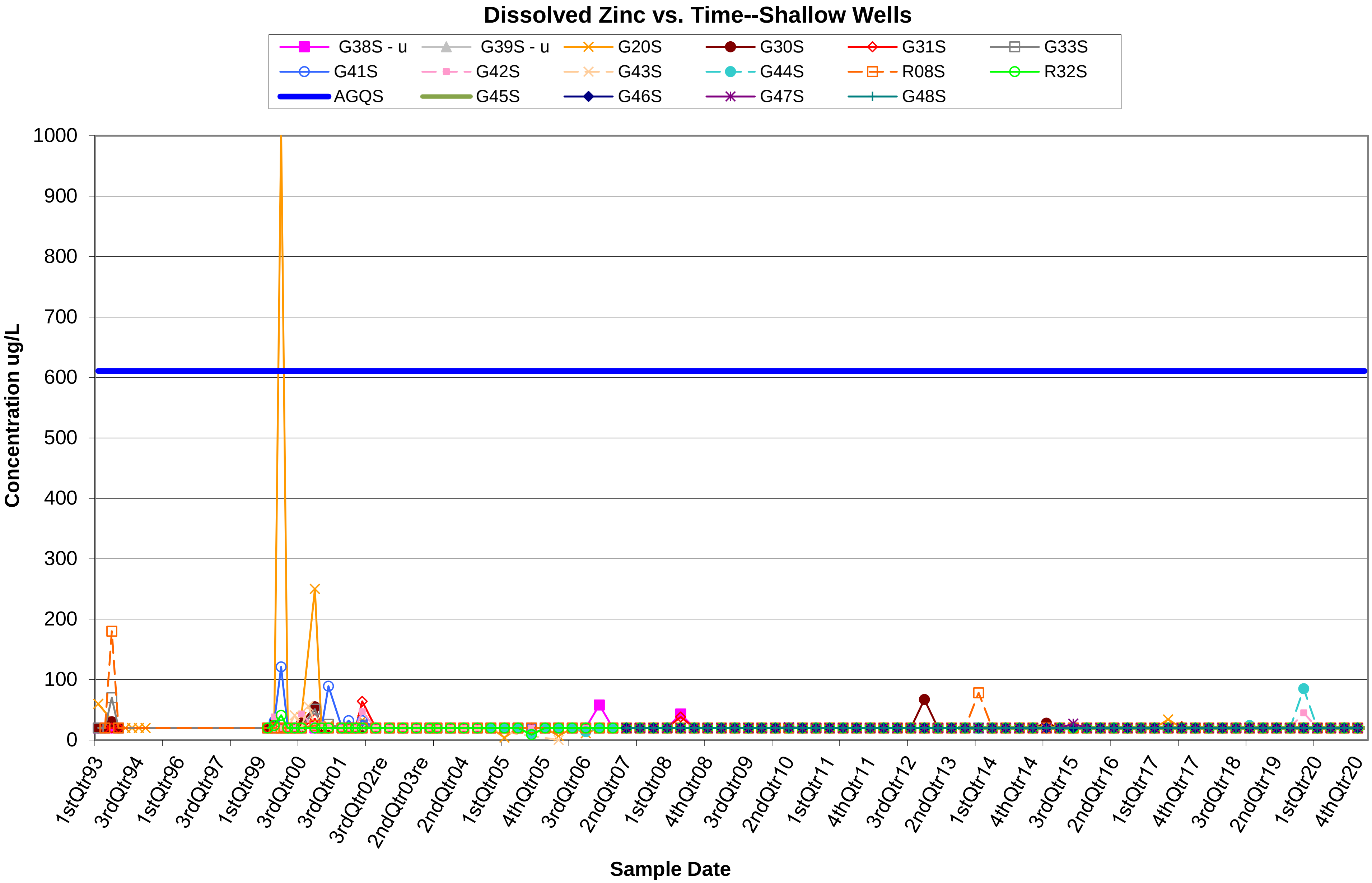

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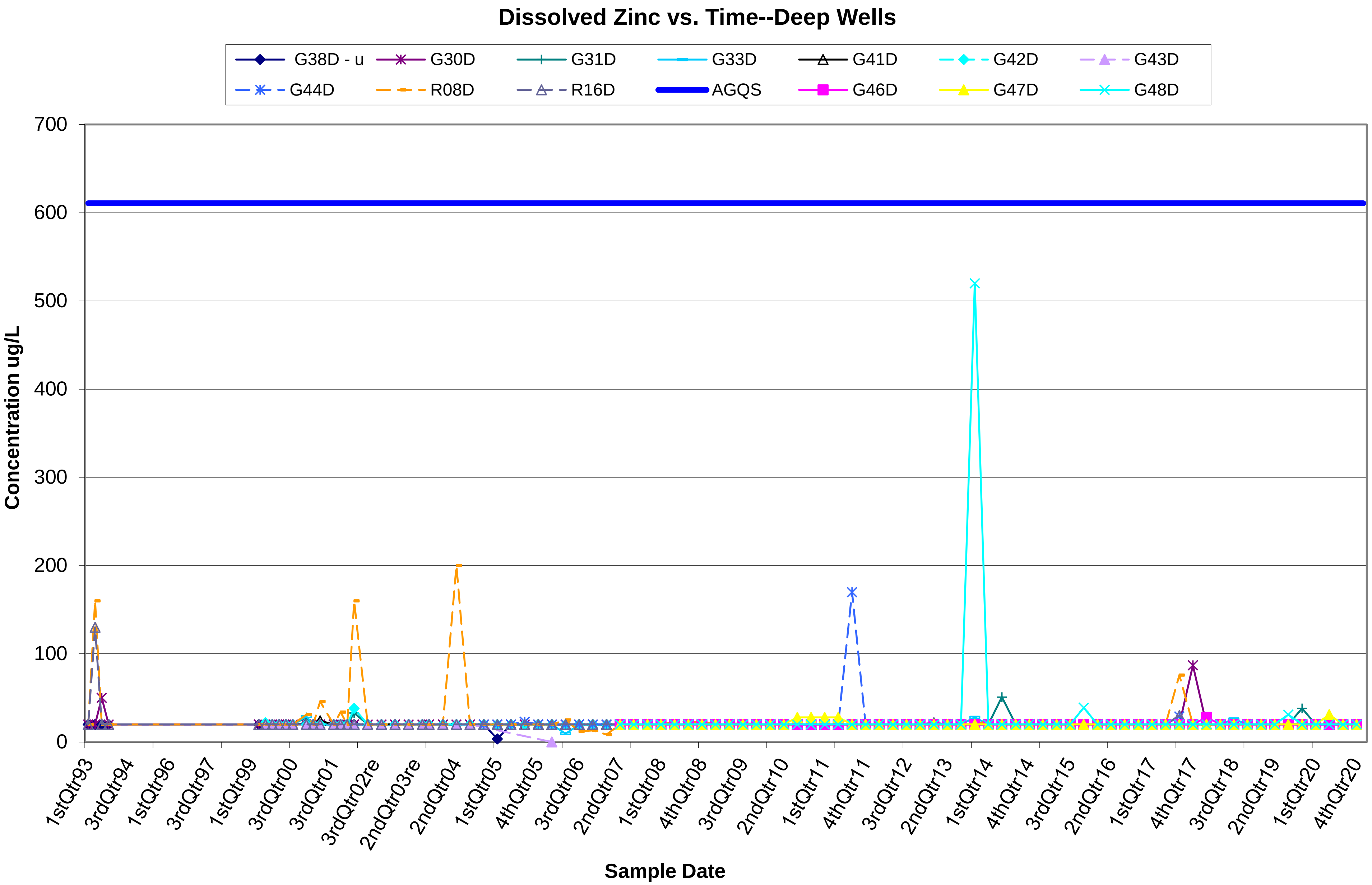

KPRG and Associates, Inc.

Attachment 9-3 – IL PE Stamp

CERTIFICATION
35 Ill. Adm. Code 845.630

In accordance with Section 35 Ill. Adm. Code 845.630(g), I hereby certify based on review of the information contained within the Initial Operating Permit Application for Joliet #9 Station dated October 29, 2021, the groundwater monitoring system has been designed and constructed to satisfy the requirements of 35 Ill. Adm. Code 845.630. For this site the minimum number of wells required is deemed sufficient based on the following: 1) The number of wells, placement and screened intervals are based on a hydrogeologic assessment performed for the site; 2) hydrogeologic considerations included aquifer characteristics affecting flow velocity and physical transport processes; 3) available historical groundwater flow data indicate consistent flow conditions over time; 4) Illinois Environmental Protection Agency (IEPA) approved the overall hydrogeologic assessment as part of a larger study.

Certified by: ______________________

Date: 10/29/21

Joshua Davenport, P.E.
Professional Engineer Registration No.: 062-061945
KPRG and Associates, Inc.

JOSHUA D. DAVENPORT
062-061945

Attachment 9-4 – CCR Compliance Statistical Approach

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

ILLINOIS STATE CCR RULE COMPLIANCE STATISTICAL APPROACH FOR GROUNDWATER DATA EVALUATION

Midwest Generation, LLC
Joliet #9 Generating Station
Lincoln Stone Quarry
Patterson Rd.
Joliet, Illinois 60436

PREPARED BY: KPRG and Associates, Inc.
14665 West Lisbon Road, Suite 1A
Brookfield, WI 53005

August 2, 2021

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<u>FIGURE</u>

<u>TABLE</u>

1.0 INTRODUCTION

On April 21, 2021, the Illinois Pollution Control Board (IPCB) and Illinois Environmental Protection Agency (Illinois EPA) enacted a final rule regulating coal combustion residuals (CCR) as part of Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule). The State CCR Rule specifically requires that the owner or operator of a CCR unit must develop an Operating Permit that will specify a sampling and analysis program that includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain of custody (COC) control, and quality assurance and quality control. As a result, each regulated facility must develop a program that meets the State CCR Rule. At the Joliet #9 generating station, the Lincoln Stone Quarry (LSQ) requires monitoring under the State CCR Rule. The monitoring well network around the LSQ consists of ten monitoring wells. These wells are R08S, G20S, G30S, R32S, G44S, G45S, G46S, G47S, G48S and T03S). Wells T03S (side-gradient) and G45S are considered background monitoring wells and the remaining wells are considered downgradient wells. The locations of these wells are shown on Figure 1.

Section 845.640(f) of the State CCR Rule requires the development of the statistical approach that will be used for assessing the data and determining whether a statistically significant increase over background concentrations in groundwater has occurred at identified downgradient monitoring points. Potential statistical methods that can be applied to the data are listed in Section 845.640(f) and performance standards are provided in 845.640(g).

This narrative of the statistical approach that will be used for the LSQ groundwater monitoring data is intended to fulfill certification requirements under Section 845.640(f)(2). The professional engineer's certification of this statistical approach is provided in Section 4.0 of this document.

2.0 STATISTICAL METHOD SELECTION and BACKGROUND DATA EVALUATION

Section 845.640(f)(1) identifies five statistical data evaluation methods that can be used for assessing site groundwater data. Relative to the subject site, the prediction interval procedure identified in 845.640(f)(1)(C) will be used. This approach is robust and conforms to varying data distributions and facilitates various non-detect frequencies. U.S. EPA identifies this method as preferred over establishment of tolerance intervals (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009 [Unified Guidance]).

Total recoverable metals groundwater data has been collected for this site since 2015 as part of Federal CCR Rule requirements. Under the Federal CCR Rule, the initial eight rounds of quarterly data generated were used to develop a representative background concentration with which to develop applicable prediction limits for subsequent statistical downgradient monitoring well data comparisons. Since additional data has been generated since the initial eight rounds of groundwater monitoring under the Federal CCR Rule, the full, currently available data set through the second quarter 2021 will be evaluated for potential use in developing a representative background dataset. If appending this additional data to the original eight rounds of background sampling is determined to be not statistically appropriate, then the background calculations will be reverted to using the initial eight rounds of background data for subsequent calculations. The established, representative background concentration for the upgradient well locations will be used to develop prediction limits for the regulated unit for each constituent listed in Section 845.600(a) and (b) as provided in Table 1.

Statistical evaluations will be performed with the assistance of the Sanitas^{TM} software package.

2.1 Outlier Testing

The background dataset will be first checked for potential outliers for each constituent. Potential causes of outliers can be, but are not limited to:

- Changes in sampling technique;
- Changes in analytical methods;
- Data transcription errors;
- Unnatural localized event such as a spill; or
- Natural but extreme variations in constituent concentration.

The Unified Guidance does not recommend removing an outlier from the data set unless it can be shown that the outlier is not caused by extreme natural variation. If the outlier can be traced to other than natural causes, the data set will be adjusted appropriately.

2.2 Spatial Variability

If more than one background well is being used for the monitored unit, an evaluation of spatial variability will be performed to determine whether the mean concentration of a constituent varies statistically between the background points. This is generally accomplished by performing an Analysis of Variance (ANOVA). If statistically significant spatial variation is determined to be present, the background points will not be combined between the wells. If the spatial variability is determined to be natural, an intrawell data evaluation approach may be considered for both upgradient and downgradient wells.

2.3 Temporal Variability

Temporal variability in groundwater data from a specific monitoring point occurs when a consistent fluctuation of constituent concentrations occurs over time. The most common example is seasonal variation. If such a variation is noted in the data, the dataset should be corrected to account for the trend; however, any such corrections must be applied judiciously and would be completed in accordance with the Unified Guidance recommended procedures.

2.4 Trend Testing

As discussed above, it is intended to expand the initial background dataset collected under the Federal CCR Rule which consisted of eight rounds of quarterly sampling, with any additional data collected for a specific well since that time to facilitate a larger background data set upon which to develop subsequent interwell, and if necessary intrawell, prediction limits. The expanded background dataset for each upgradient well, for each constituent listed in Table 1, will undergo trend analysis to determine if there may be a potential statistically significant trend in the data. Linear regression will be the primary trend analysis tool, however, other methods such Sen’s Slope Estimator may also be used. If a statistically significant trend is identified in the larger combined background dataset, the new data cannot be added to the initial background dataset, and only the original eight rounds of data can be used for that well in background development and associated subsequent calculations.

2.5 Test of Normality

The main underlying assumption in parametric data evaluations, such as establishing prediction limits, is that the underlying data distribution is normal. A quick approximation can be made by calculating the Coefficient of Variance (CV) which is the quotient of the standard deviation divided by the sample mean. In general, if this quotient is greater than 1, the underlying data distribution is probably not normal. The new Unified Guidance is more conservative and suggests that if this quotient is greater than 0.5, the dataset may not be normal and a more robust distribution evaluation should be performed. Therefore, for any CV value greater than 0.5 for a specific dataset, normality will be evaluated using the Shapiro-Wilk Test with an alpha (α) value of 0.05 (or 95%).

If the dataset does not pass this initial test, the data will undergo a log transformation and the test will be repeated for the natural log values of the dataset. If it is determined that this dataset is log-normal, statistical evaluations will be completed on those values and the result converted back to the standard value. If the underlying distribution is also determined not to be log-normal, the Unified Guidance provides for a number of other data transformations that can be performed to evaluate whether those underlying distributions may be normal at which point the entire dataset would be transformed for subsequent calculations.

If a normal underlying distribution can not be determined, non-parametric statistical evaluations will need to be considered which do not rely on a specific underlying distribution.

2.6 Non-Detects

It is not uncommon in environmental datasets to have parameters being detected at low concentrations during one sampling event and being not detected in other sampling events. Having a consistent approach to the handling of non-detect values is an important part of the statistical evaluation process. The handling of non-detect values will be accomplished as follows:

- 100 Percent Non-Detects – Assumed that the constituent is not present and no statistical evaluations will be performed. The upper prediction limit will be set at the Reporting Limit (RL) established by the analytical laboratory.
- 50 Percent or Greater Non-Detects – A non-parametric evaluation will be performed where the confidence interval will be constructed using the highest detected concentration as the upper prediction limit.
- 15 to 50 Percent Non-Detects – Aitchison's Adjustment will be used with subsequent parametric or non-parametric evaluations, as appropriate, based on underlying distributions.
- 0 to 15 Percent Non-Detects - The non-detect values will be replaced with RL/2 and the dataset will be evaluated for distribution normality with subsequent parametric or non-parametric evaluations, as appropriate, based on underlying distributions.

2.7 Prediction Limit Calculation for Normally Distributed Data

For datasets where the distribution or underlying transformed distribution is normal, a parametric statistical approach will be used for establishing the prediction limit at the required 95% statistical confidence. In accordance with Unified Guidance, the following equation will be used:

$$95\%\ Prediction\ Limit\ = \bar{x} + t_{1-0.05/m,n-1} s\sqrt{1+\frac{1}{n}}$$

Where:

$\bar{x}$ = the sample mean of the detected or adjusted results
S = sample standard deviation of the detected or adjusted results
$t_{1-0.05/m,n-1}$ = the students t-coefficient for degrees of freedom (n-1) and confidence level (1-0.05/m)
n = the number of samples
m = the number of future samples

The number of future sampling events (*m*) will be set at 2 which will account for one sampling event and a confirmation resampling. This will assist in limiting the potential number of false positives. An acceptable site-wide false positive (SWFP) rate of 10% or less is acceptable under the Unified Guidance.

2.8 Prediction Limit Calculation for Non-Normally Distributed Data

If the dataset distribution or underlying distribution is determined not to be normal, a non-parametric approach will need to be used for the establishment of the prediction limit. The non-parametric evaluation will use the highest detected concentration as the upper prediction limit for the specific constituent.

3.0 GROUNDWATER MONITORING

The State CCR Rule does not distinguish between detection monitoring or assessment monitoring as was defined under the Federal CCR Rule. To meet the requirements set forth in Section 845.650(b), a minimum of eight rounds of groundwater data need to be collected for establishing background. As noted above, if more than eight rounds of data are available, then the larger dataset will be evaluated to determine whether the background dataset can be expanded to provide a more robust statistical assessment. At that point, statistical evaluation of the background dataset will be performed to establish the upper prediction limits for each Section 845.600(a) and (b) constituent. It is noted that in the case of pH, a lower prediction limit will also be established since this parameter has an established upper and lower value range for compliance.

Site specific Groundwater Protection Standards (GWPSs) will be developed in accordance with Section 845.600(a)(2) as follows:

- If the constituent has an established State standard listed in Section 845.600(a)(1) and the standard is greater than the calculated background upper prediction limit, then the standard will serve as the GWPS. If the background upper prediction limit is greater than the standard, the upper prediction limit will serve as the GWPS.

- If the constituent does not have an established standard (i.e., calcium and turbidity) then the calculated upper prediction limit will serve as the GWPS.

Once the proposed GWPSs are determined and approved by Illinois EPA, subsequent downgradient well concentrations will be compared against the upper prediction limit (and lower prediction limit in the case of pH), and the GWPSs. If an exceedance of the GWPS is identified during a quarterly sampling event, an immediate resampling of the specific well(s) will be completed for those specific parameters. If the exceedance is confirmed by the resampling, the Illinois EPA will be notified of the exceedance(s) and the notification will be placed in the facilities operating record in accordance with 845.800(d)(16). It is noted that there are some constituents that historically may have had no detections (i.e., 100% non-detects). In this case, in accordance with the Unified Guidance, if there is a detection of such a constituent, then the Double Quantification Rule will be applied. Under this rule, a confirmed exceedance is registered if any well-constituent pair in the 100% non-detect group exhibits quantified measurements (i.e., at or above the Reporting Limit in two consecutive sample and resample events.

If an exceedance of the GWPS is recorded and reported to Illinois EPA, an Alternate Source Demonstration (ASD) may be completed within 60-days of the confirmed exceedance in accordance with Section 845.650(e) and submitted to the Illinois EPA as well as placing the ASD on the facility's publically accessible CCR website. Illinois EPA will review and approve or disapprove the ASD.

If it is decided not to complete an ASD or if Illinois EPA does not concur with and approve the ASD, a characterization of the nature and extent of the potential release must be completed in accordance with Section 845.650(d)(1) as well as meeting the requirements of Sections 845.660, 845.670 and 845.680.

4.0 CERTIFICATION

In accordance with Section 845.640(f)(2) of the State CCR Rule, I hereby certify based on a review of the information contained within this Illinois State CCR Rule Compliance Statistical Approach for Groundwater Data Evaluation dated August 2, 2021, the statistical procedures developed and selected for evaluation of groundwater data associated with the Midwest Generation Joliet #9 Station/Lincoln Stone Quarry CCR Units are adequate and appropriate for evaluating the groundwater data.

Certified by: ______________________

Date: 8/2/21

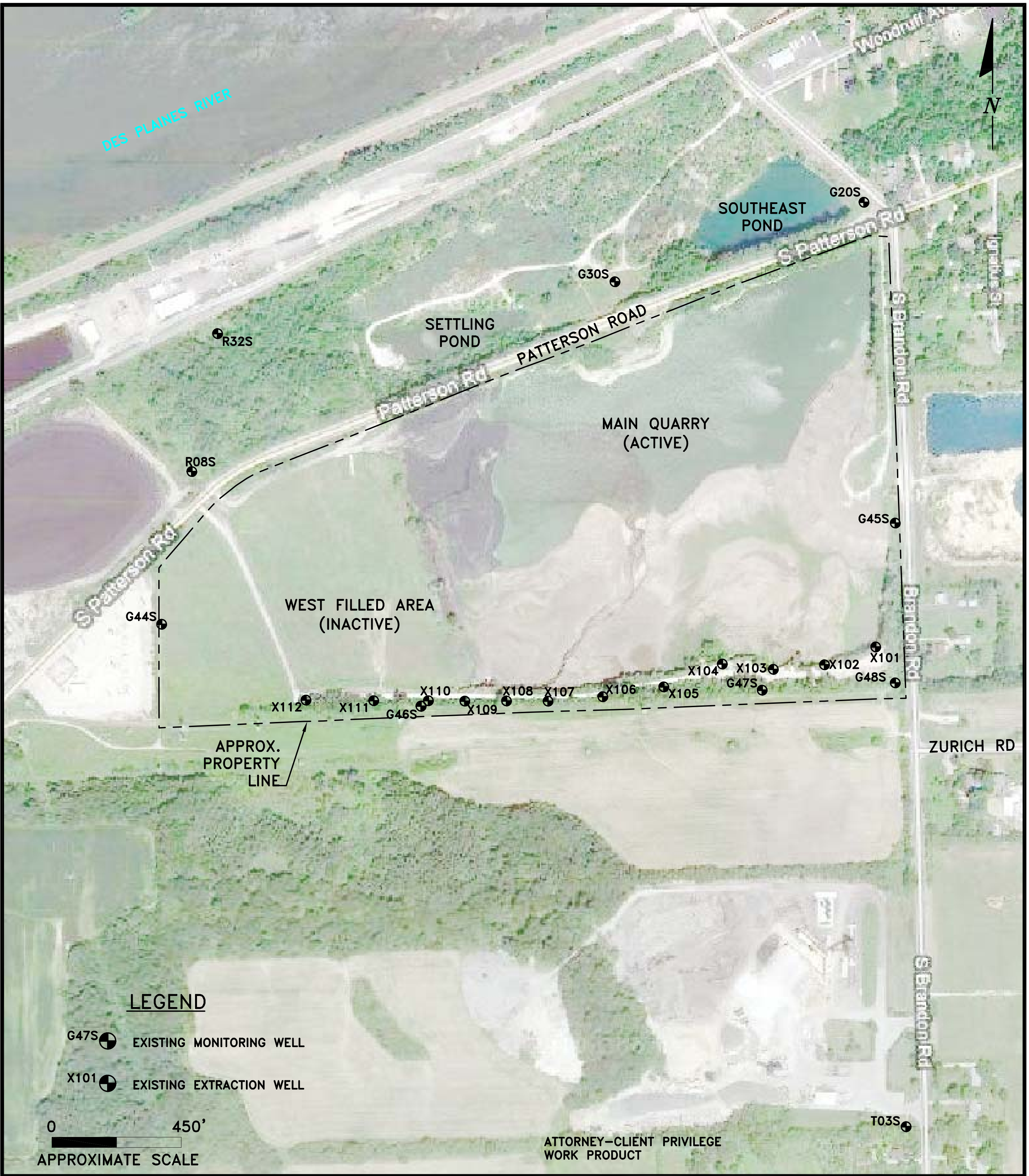
JOSHUA D. DAVENPORT
062-061945

Joshua Davenport, P.E.

Professional Engineer Registration No. 062-061945

KPRG and Associates, Inc.

FIGURE



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CCR MONITORING WELL SITE MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450'

Date: February 11, 2016

KPRG Project No. 12313

FIGURE 1

W:\c\projects\midwest generation\lincoln quarry gw monitoring\permit well map 4-4-14.dwg

TABLE

Table 1. Section 845.600 Groundwater Monitoring Parameter List

Parameter	Section 845.600 Standards
Antimony	0.006
Arsenic	0.01
Barium	2
Beryllium	0.004
Boron	2.0
Cadmium	0.005
Chloride	200
Chromium	0.1
Cobalt	0.006
Combined Radium 226 + 228 (pCi/L)	5.0
Fluoride	4.0
Lead	0.0075
Lithium	0.04
Mercury	0.002
Molybdenum	0.10
pH (standard units)	6.5-9.0
Selenium	0.05
Sulfate	400
Thallium	0.002
Total Dissolved Solids	1200
Calcium	NE
Turbidity	NE

All vaues in mg/l unless otherwise specified.
NE- Not Established

Attachment 9-5 – Statistical Evaluation Summary

ATTACHMENT 9-5

BACKGROUND STATISTICAL EVALUATION SUMMARY
STATE RULE CCR GROUNDWATER MONITORING
JOLIET #9 GENERATING STATION

The newly enacted Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule) requires development of proposed Groundwater Protection Standards (GWPSs) for inclusion within the Operating Permit for the regulated surface impoundments at the facility. Upon Illinois Environmental Protection Agency (EPA) review, concurrence and approval of these site-specific proposed GWPSs, subsequent quarterly downgradient groundwater monitoring data will be compared against these standards to determine whether standard quarterly monitoring is to continue or whether additional evaluations need to occur to in accordance with Section 845.650(d), 845.650(e), 845.660 and 845.670. The overall statistical approach to be used for the development of the proposed GWPSs is provided in Attachment 9-4 of this Operating Permit.

The proposed site-specific GWPSs for the Joliet #9 Generating Station are summarized in Table 9-7 in Section 9 of this Operating Permit. The background Prediction Limit values presented in that table were developed, where possible, by combining or “pooling” as many background data points as possible from the two background monitoring wells. This includes evaluating whether the initial eight rounds of data generated as part of Federal CCR Rule compliance that was completed between 2015 and 2017 can be combined with subsequent available data from ongoing groundwater monitoring since that time at a specific upgradient monitoring well location, and whether datasets from individual upgradient monitoring points can also be combined or “pooled”. The turbidity data was collected this calendar year (2021) since this was a new state requirement that was not part of the Federal CCR Rule. The following general decision process was followed to determine whether background data from within a well and/or between upgradient wells can be pooled for background calculations:

- If the combined dataset (original eight rounds of data plus any subsequent data generated since the initial background sampling) at a specific well location (intrawell evaluation) for a specific parameter does not show a statistically significant trend, the data for that specific parameter at that well location can be pooled. If a statistically significant trend in the data is noted to exist, only the original eight rounds of background sampling can be used for subsequent calculations. If there is more than one background monitoring well, and one of the combined datasets for a specific parameter shows a statistically significant trend but the other does not, then the specific parameter data for the well that did not indicate a trend can potentially be used for subsequent evaluations.

- If there is more than one background monitoring well, then datasets for individual parameters between the wells (interwell evaluation) must pass an analysis of variance to determine whether there may be a statistically significant variation between the two datasets. If no statistically significant variance is noted between the two background monitoring points, and the individual parameter data passes the intrawell trend evaluation noted above, then the datasets for that parameter can be pooled between the wells to establish a larger background dataset. If there is a statistically significant variation noted between the two background monitoring points, then the specific parameter datasets from those wells cannot be combined.

- If it is determined that datasets from background monitoring points cannot be combined, then a decision needs to be made as to which monitoring point will be used for a specific parameter for background calculations. At this point some professional judgement needs to be used by considering the number of data points within each dataset, any potential statistical outliers, any statistical seasonality/temporal variance, the distribution and/or underlying distribution of that data, number of detects versus non-detects, etc.

With the above decision process in mind, the various statistical evaluations performed are summarized below. The evaluations were performed with the assistance of the Sanitas® statistical software package.

Outlier Testing

Outlier tests were performed for all monitoring wells in the proposed State CCR monitoring well network for all data available since the start of Federal CCR monitoring. Wells G45S and T03S are the designated background wells. The following statistically significant outliers (dates in parentheses) were noted in these background wells:

- Barium – T03S (11/19/15 and 7/7/17)
- Combined Radium – G45S (11/21/17)
- Fluoride – G45S (7/7/17)
- Turbidity – T03S (3/15/21 and 4/22/21)

Since the outliers cannot be attributed to either lab error, transcription error or field sampling error, the outlier values were not removed from the datasets at this time but may be considered during subsequent data evaluations. A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion.

Seasonality/Temporal Variability Testing

Seasonality/temporal variability tests were performed for all monitoring wells in the proposed State CCR monitoring well network for all data available since the start of Federal CCR monitoring. Wells T03S and G45S are the designated background monitoring wells. No statistically significant seasonal/temporal variations were noted in these wells for any of the parameters. A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion. The turbidity database to date is insufficient to evaluate potential seasonal/temporal variability at this time.

Trend Analysis

To determine whether data generated since the initial eight rounds of background groundwater sampling since the enactment of the Federal Rule can potentially be pooled at a specific background monitoring well location (T03S and G45S), trend analysis for each constituent at each upgradient well location was performed. The results are summarized as flows:

- T03S – Statistically significant trends were noted for barium, boron, fluoride, lithium and molybdenum.
- G45S – Statistically significant trends was noted for arsenic.

A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion.

Spatial Variability Testing

To determine whether the background data sets from background wells can be pooled to establish a representative statistical background, spatial variability testing was performed on the datasets using a parametric analysis of variance (ANOVA). This analysis was done for each of the monitoring parameters. The following observations are made:

- Upgradient wells T03S and G45S all parameter values pooled – No statistically significant variance between the full datasets for pH, lead and turbidity.

It is noted that antimony, beryllium, cadmium, chromium, mercury, selenium and thallium had no detections at any of the two background well locations during any sampling event, therefore, although an analysis of variance cannot be formally completed, these data sets can be pooled since there is no variation in the reporting limits.

Statistical run summaries which include the specific statistical method used for each parameter for each of the dataset comparisons are provided at the end of this discussion.

Test of Normality

The Shapiro-Wilk Normality Test with an alpha (α) value of 0.05 (or 95%) was used to evaluate the distribution of the background datasets for each constituent at each background well location and the distribution of pooled datasets. A Test of Ladders was also run to evaluate other potential underlying transformational distributions in the case that the non-transformed dataset was found not to be normally distributed. The statistical runs are provided for the various combinations of upgradient wells by parameter at the end of this discussion.

Prediction Limits

Based on the various statistical evaluations discussed above, the following background data sets were used for background prediction limit calculations:

- Background wells G45S and T03S all parameter values pooled for antimony, beryllium, cadmium, chromium, pH, lead, mercury, selenium, thallium and turbidity. Relative to lead pH and turbidity, there were no statistically significant trends within the wells for the combined data observations and there was no statistically significant variance noted between the datasets. Relative to the other parameters, all values at both background well locations were non-detects with no differences in detection limits.
- Background well G45S all parameter values were pooled for barium, boron, calcium, chloride, cobalt, fluoride, lithium, molybdenum, sulfate and total dissolved solids (TDS). For each of these combine parameter datasets, there were no individual statistically significant trends within the well. Fluoride was noted to have an outlier value at well G45S (0.05 mg/l), however there was a statistically significant data trend noted in the other background well (T03S) for fluoride precluding that expanded fluoride dataset to be pooled. Since the noted fluoride outlier concentration was still substantially below the Section 845.600 standard of 4.0 mg/l, and as stated above there is no known laboratory or field sampling error basis on which to remove this data point, it was decided to include the full available fluoride dataset for G45S in the statistical background calculation.
- Background well T03S all parameter values were used for arsenic and combined radium. None of these parameters indicated statistically significant trends within this well and none of these parameters were noted as statistical outliers at this well location. Combined radium was noted as having an outlier concentration within the G45S background dataset.

The calculated prediction limits under the various background dataset selection scenarios are summarized in Table 9-7 in Section 9 of this permit application. A prediction limit statistical run summary which includes the specific statistical method used for each parameter for each well scenario noted above are provided at the end of this discussion.

Outlier Analysis - Joliet #9 - UG Wells G45S and T03S

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 8/12/2021, 2:29 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Arsenic (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.008961	0.001186	normal	ShapiroWilk
Arsenic (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.00145	0.0005649	normal	ShapiroWilk
Barium (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.0385	0.005136	normal	ShapiroWilk
Barium (mg/L)	**T03S (bg)**	**Yes**	**0.11,0.063**	**12/15/202...**	**Dixon`s**	**0.05**	**18**	**0.0875**	**0.009256**	**normal**	**ShapiroWilk**
Beryllium (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Boron (mg/L)	G45S (bg)	No	n/a	n/a	NP (nrm)	NaN	18	0.5044	0.144	unknown	ShapiroWilk
Boron (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	1.464	0.6131	normal	ShapiroWilk
Cadmium (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Calcium (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	101.6	12.86	ln(x)	ShapiroWilk
Calcium (mg/L)	T03S (bg)	No	n/a	n/a	NP (nrm)	NaN	18	106.8	11.05	unknown	ShapiroWilk
Chloride (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	133.2	34.65	ln(x)	ShapiroWilk
Chloride (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	98.61	25.97	ln(x)	ShapiroWilk
Chromium (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Chromium (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Cobalt (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	18	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	T03S (bg)	No	n/a	n/a	NP (nrm)	NaN	18	0.001156	0.0001756	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**G45S (bg)**	**Yes**	**8.45**	**11/21/2017**	**NP (nrm)**	**NaN**	**16**	**2.526**	**1.648**	**unknown**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	16	1.334	0.1996	normal	ShapiroWilk
Fluoride (mg/L)	**G45S (bg)**	**Yes**	**0.05**	**7/7/2017**	**Dixon`s**	**0.05**	**18**	**0.3217**	**0.07006**	**normal**	**ShapiroWilk**
Fluoride (mg/L)	T03S (bg)	No	n/a	n/a	NP (nrm)	NaN	18	0.225	0.05943	unknown	ShapiroWilk
Lead (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	18	0.0005	0	unknown	ShapiroWilk
Lead (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	18	0.0006	0.0004243	unknown	ShapiroWilk
Lithium (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.03189	0.003628	normal	ShapiroWilk
Lithium (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.02194	0.004304	normal	ShapiroWilk
Mercury (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	11	0.0002	0	unknown	ShapiroWilk
Mercury (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	11	0.0002	0	unknown	ShapiroWilk
Molybdenum (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.009194	0.001668	ln(x)	ShapiroWilk
Molybdenum (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	0.157	0.1007	normal	ShapiroWilk
Selenium (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	18	0.0025	0	unknown	ShapiroWilk
Selenium (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	18	0.0025	0	unknown	ShapiroWilk
Sulfate (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	181.1	59.4	ln(x)	ShapiroWilk
Sulfate (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	212.8	38.32	normal	ShapiroWilk
Thallium (mg/L)	G45S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	T03S (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Total Dissolved Solids (mg/L)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	18	745	107.4	normal	ShapiroWilk
Total Dissolved Solids (mg/L)	T03S (bg)	No	n/a	n/a	EPA 1989	0.05	18	834.4	79.72	normal	ShapiroWilk

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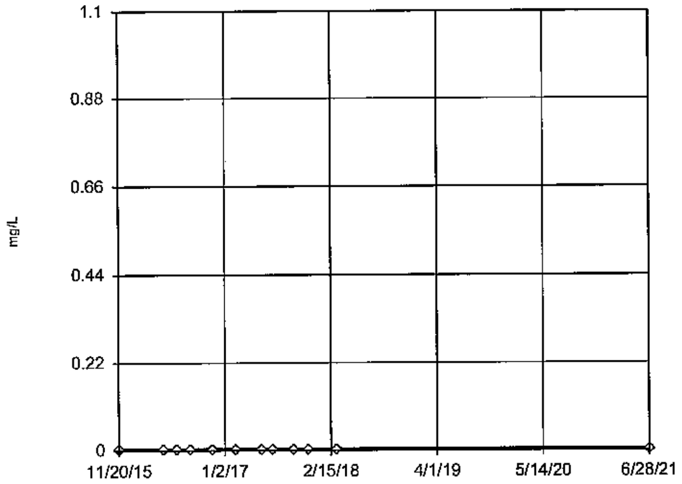
Tukey's Outlier Screening

G45S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Antimony Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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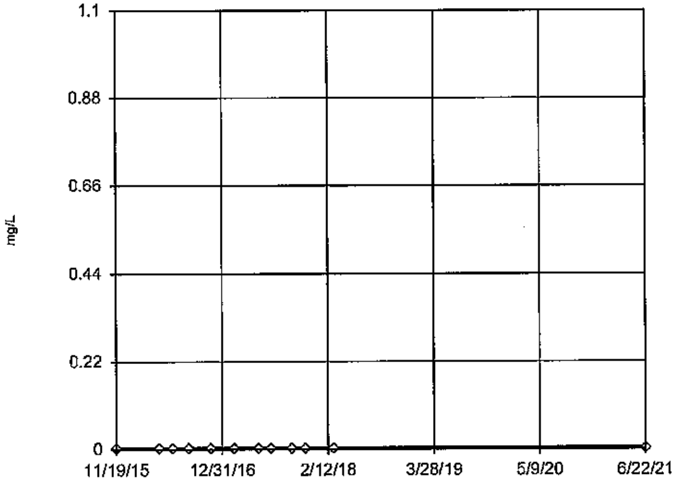
Tukey's Outlier Screening

T03S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Antimony Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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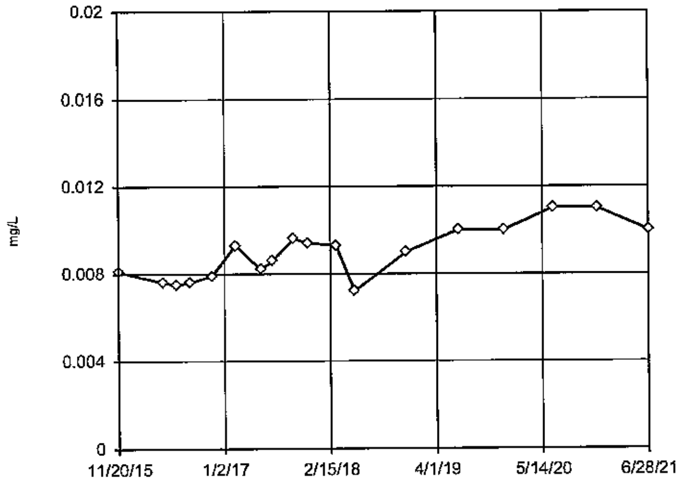
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.008981, std. dev.
0.001186, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9429
Critical = 0.914
The distribution was found
to be normally distrib-
uted.

Constituent: Arsenic Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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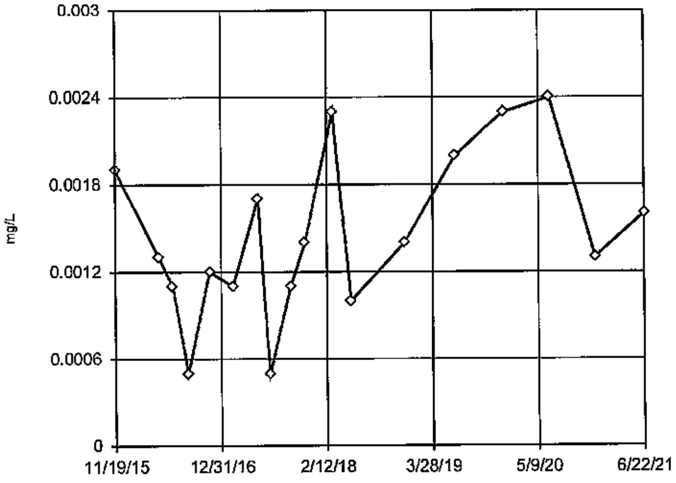
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

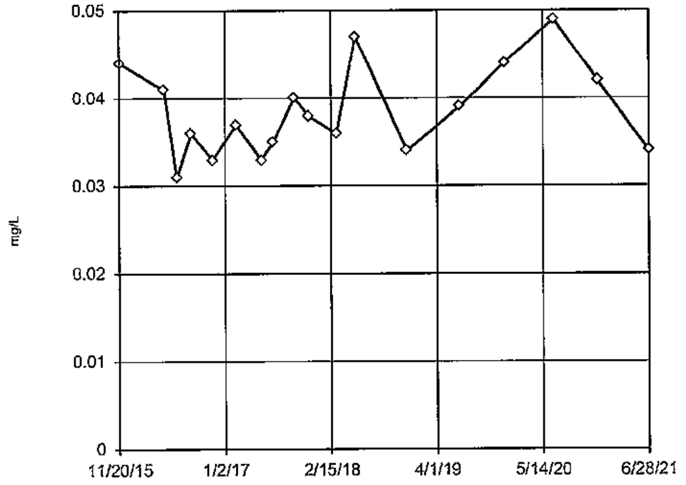
Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.00145, std. dev.
0.0005649, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9474
Critical = 0.914
The distribution was found
to be normally distrib-
uted.

Constituent: Arsenic Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

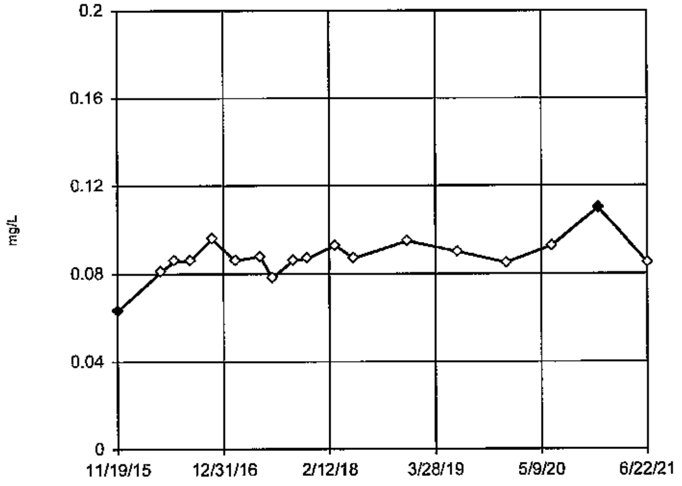
Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.0385, std. dev.
0.005136, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9526
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Barium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Dixon's Outlier Test

T03S (bg)



n = 18

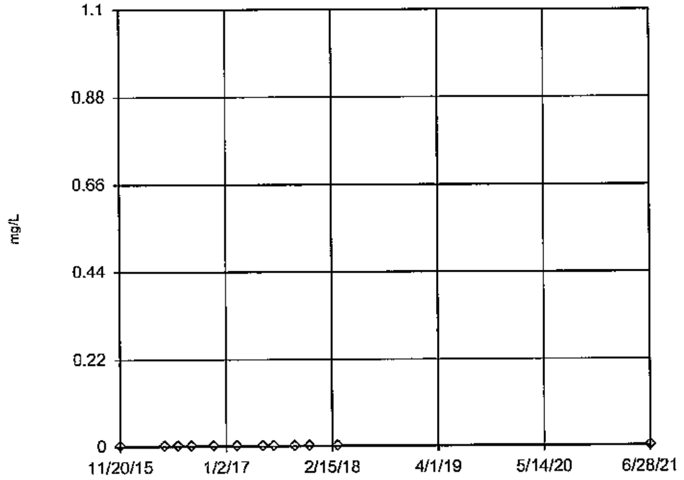
Statistical outliers are
drawn as solid.
Testing for 1 high and
1 low outliers.
Mean = 0.0875.
Std. Dev. = 0.009256.
0.11: c = 0.5172
tabl = 0.475.
0.063: c = 0.5625
tabl = 0.475.
Alpha = 0.05.

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9402
Critical = 0.906
The distribution, after
removal of suspect values, was found to be normally distributed.

Constituent: Barium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Tukey's Outlier Screening

G45S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

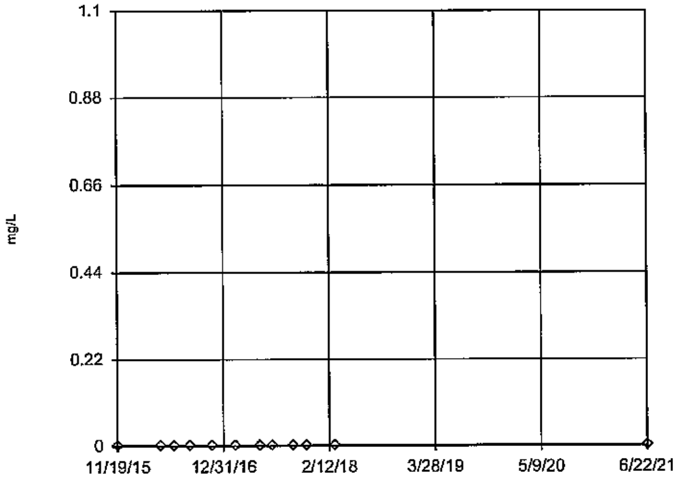
Data were cube root transformed to achieve best
W statistic (graph shown
in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Beryllium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Tukey's Outlier Screening

T03S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were cube root transformed to achieve best
W statistic (graph shown
in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Beryllium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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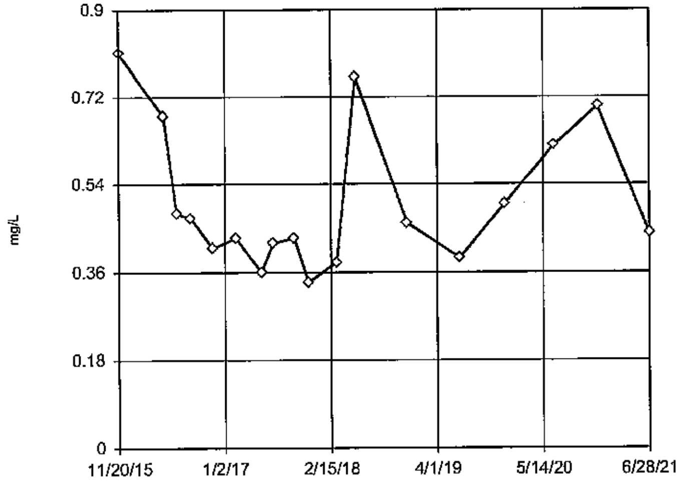
Tukey's Outlier Screening

G45S (bg)



n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

High cutoff = 2.78, low
cutoff = 0.0934, based
on IQR multiplier of 3.

Constituent: Boron Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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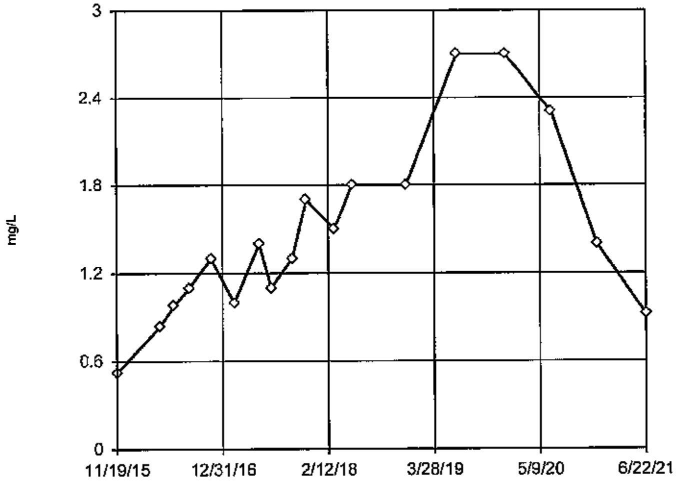
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 1.464, std. dev.
0.6131, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9222
Critical = 0.914
The distribution was found
to be normally distrib-
uted.

Constituent: Boron Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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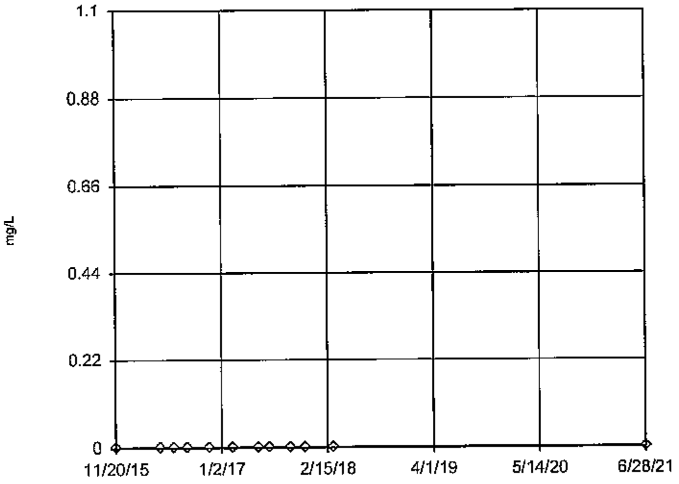
Tukey's Outlier Screening

G45S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Cadmium Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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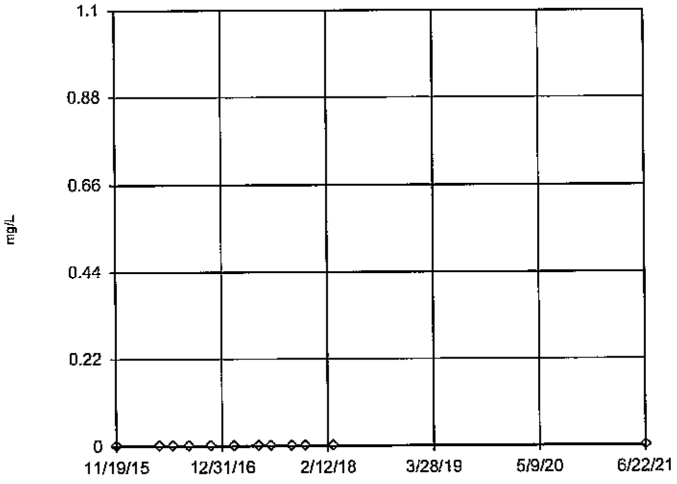
Tukey's Outlier Screening

T03S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Cadmium Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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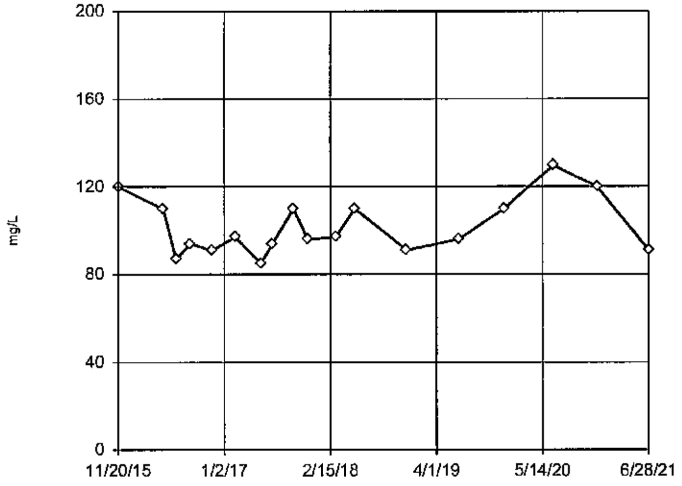
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 101.6, std. dev.
12.86, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9165
Critical = 0.914 (after
natural log transforma-
tion)
The distribution was found
to be log-normal.

Constituent: Calcium   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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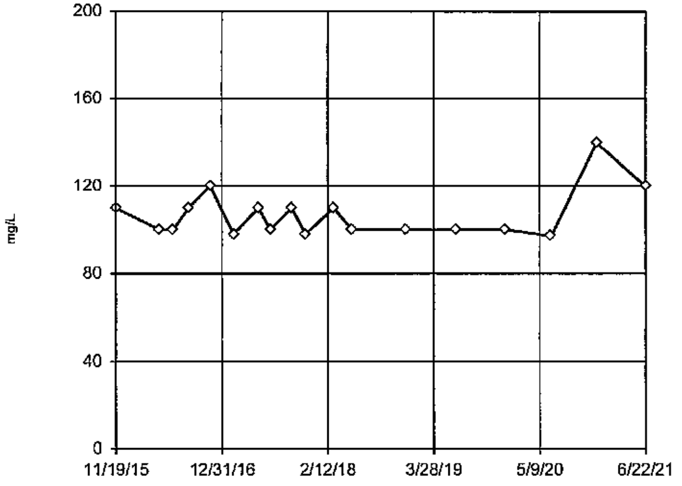
Tukey's Outlier Screening

T03S (bg)



n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

High cutoff = 146.4, low
cutoff = 75.13, based
on IQR multiplier of 3.

Constituent: Calcium   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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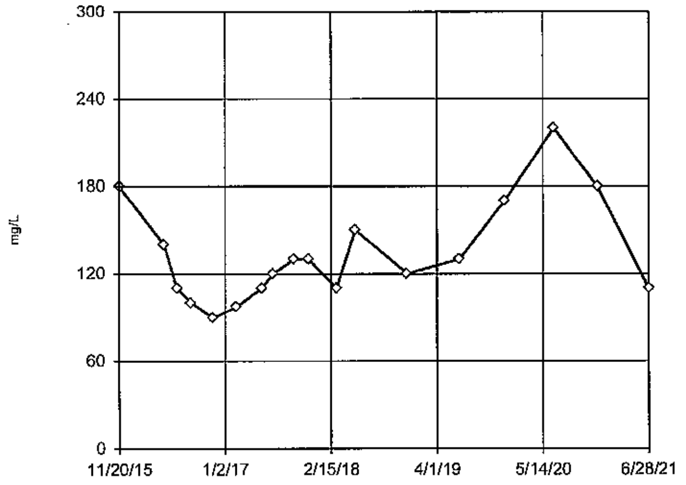
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 133.2, std. dev.
34.65, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9474
Critical = 0.914 (after
natural log transforma-
tion)
The distribution was found
to be log-normal.

Constituent: Chloride   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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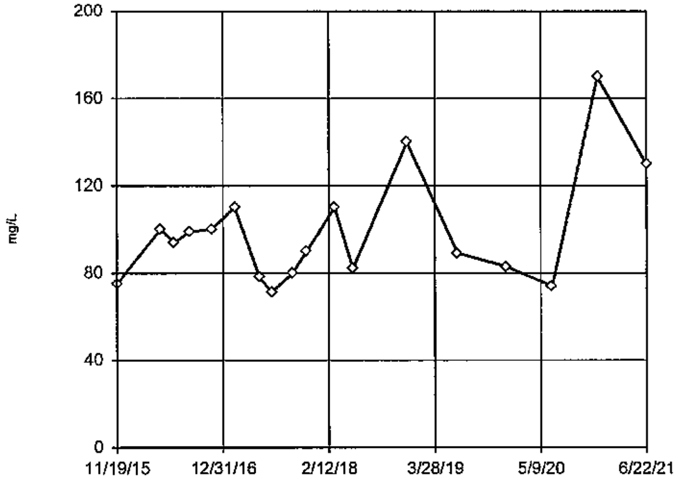
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 98.61, std. dev.
25.87, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9257
Critical = 0.914 (after
natural log transforma-
tion)
The distribution was found
to be log-normal.

Constituent: Chloride   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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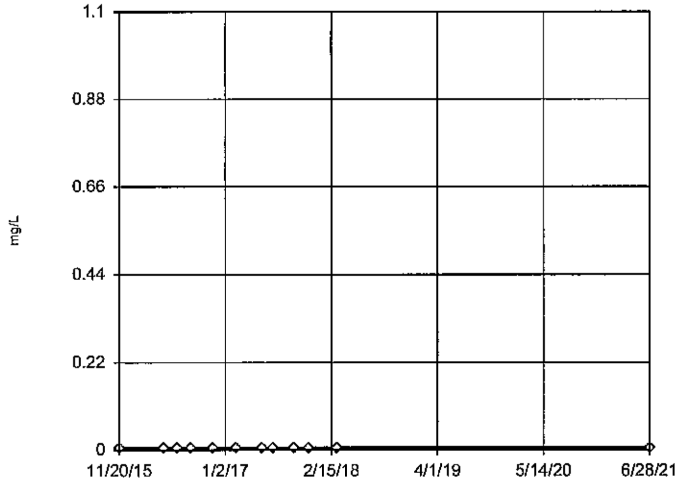
Tukey's Outlier Screening

G45S (bg)



n = 12

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Chromium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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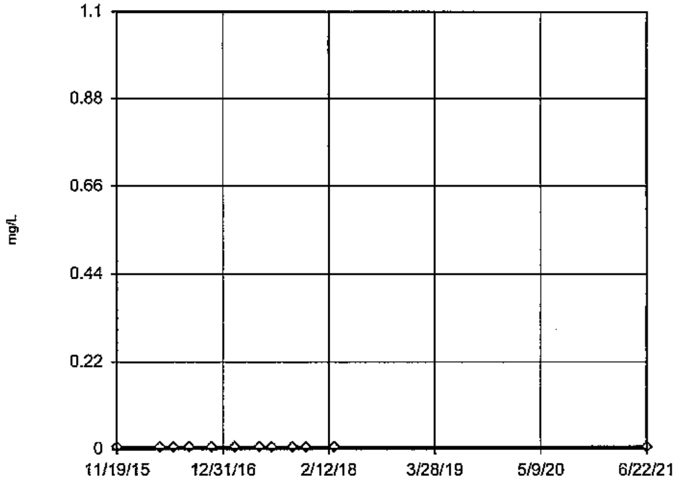
Tukey's Outlier Screening

T03S (bg)



n = 12

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Chromium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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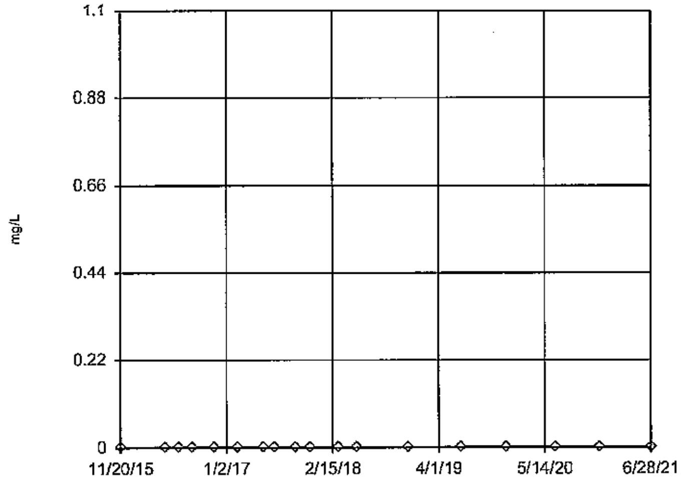
Tukey's Outlier Screening

G45S (bg)



n = 18

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cobalt Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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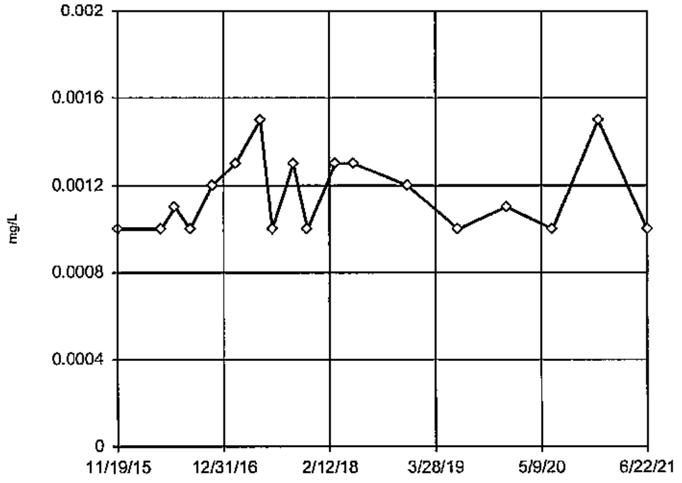
Tukey's Outlier Screening

T03S (bg)



n = 18

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.002856, low cutoff = 0.0004552, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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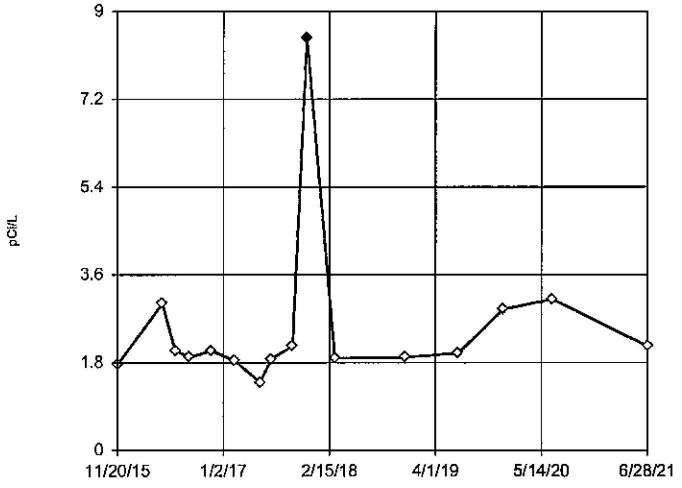
Tukey's Outlier Screening

G45S (bg)



n = 16

Outlier is drawn as solid. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.711, low cutoff = 0.6209, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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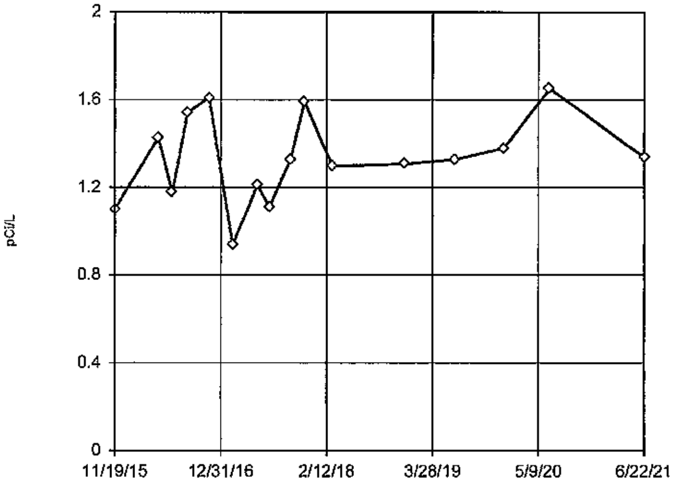
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified or unable to establish suspect values.
Mean 1.334, std. dev. 0.1996, critical Tn 2.443

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9665
Critical = 0.908
The distribution was found to be normally distributed.

Constituent: Combined Radium 226 + 228   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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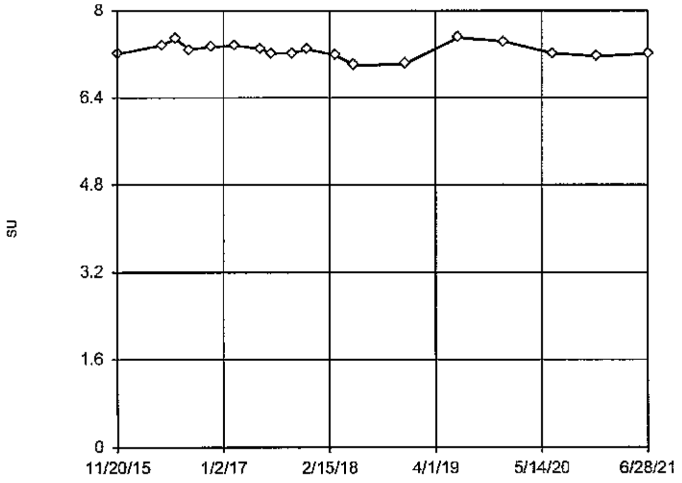
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified or unable to establish suspect values.
Mean 7.268, std. dev. 0.1413, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.957
Critical = 0.914
The distribution was found to be normally distributed.

Constituent: Field pH   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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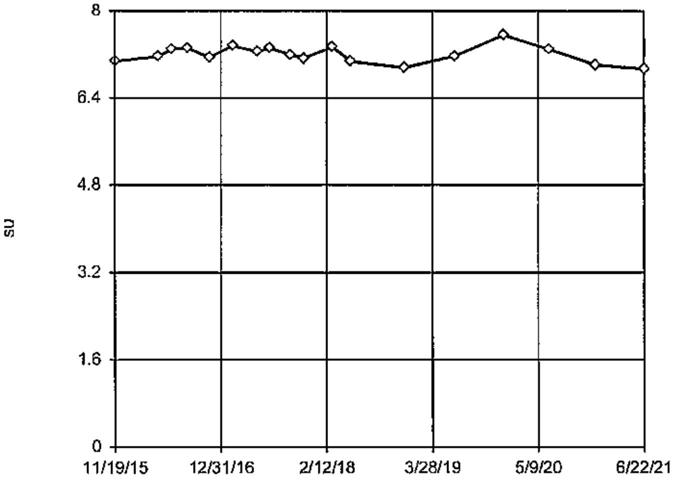
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified or unable to establish suspect values.
Mean 7.199, std. dev. 0.1605, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.966
Critical = 0.914
The distribution was found to be normally distributed.

Constituent: Field pH   Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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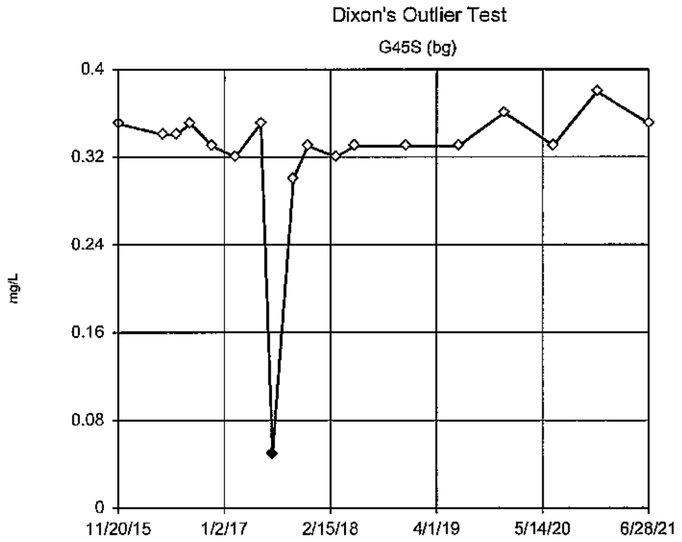

n = 18

Statistical outlier is
drawn as solid.
Testing for 1 low outlier.
Mean = 0.3217.
Std. Dev. = 0.07006.
<0.1: c = 0.9
tabl = 0.475.
Alpha = 0.05.

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9443
Critical = 0.91
The distribution, after removal of suspect value, was found to be normally distributed.

Constituent: Fluoride   Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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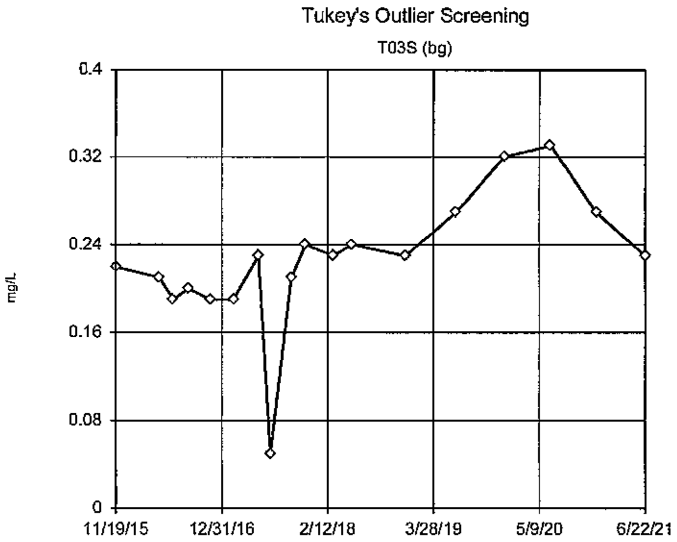

n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3832,
low cutoff = -0.2087,
based on IQR multiplier
of 3.

Constituent: Fluoride   Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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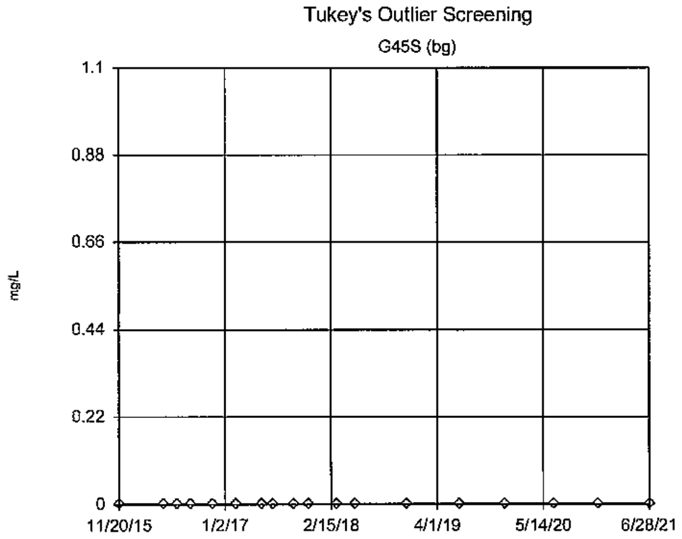

n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alphe level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead   Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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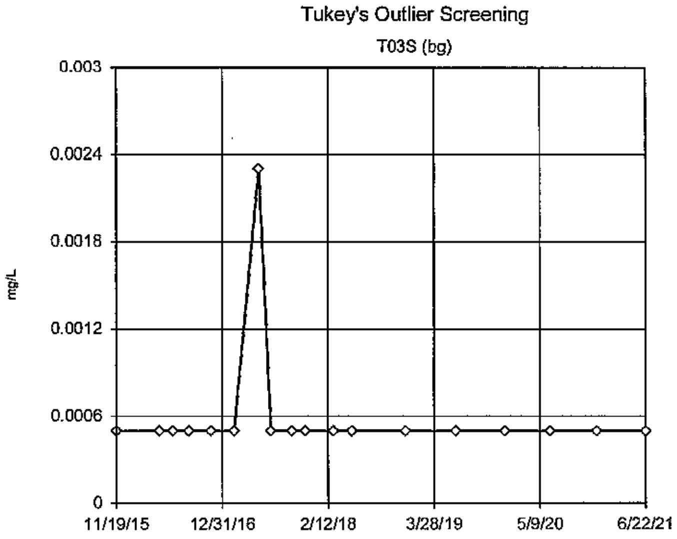


n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

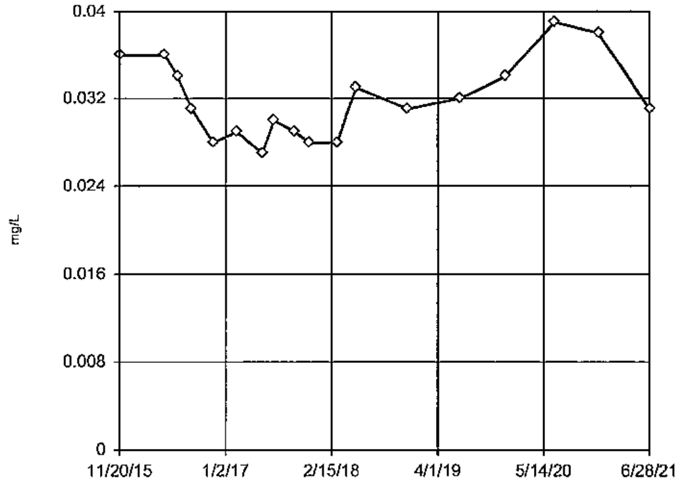
Data were x^5 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead   Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

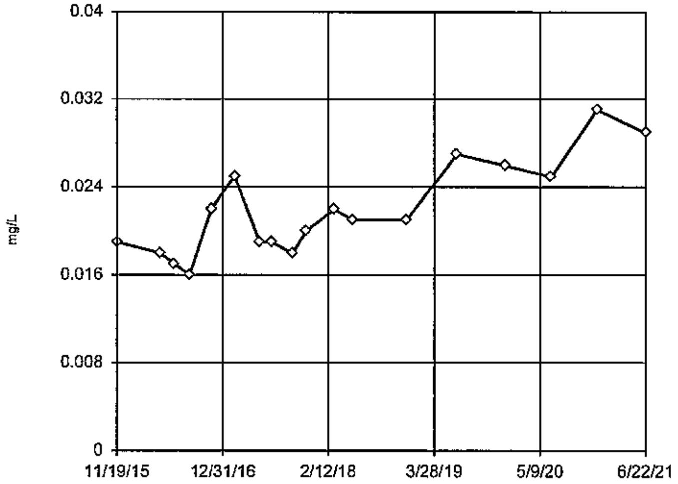
Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.03189, std. dev.
0.003628, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.936
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Lithium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

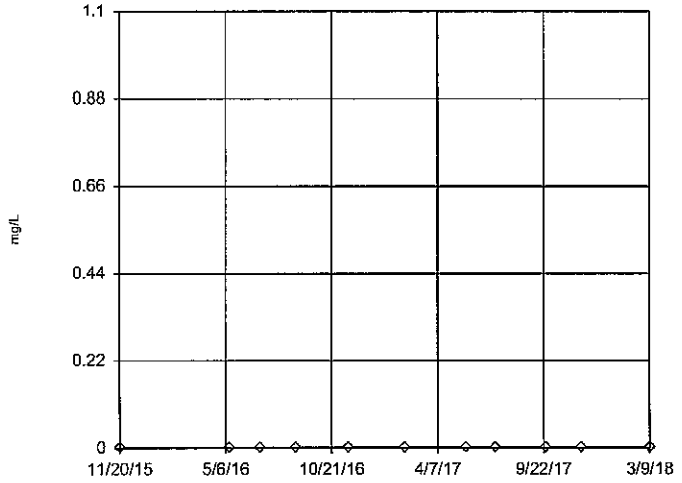
Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.02194, std. dev.
0.004304, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9363
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Lithium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Tukey's Outlier Screening

G45S (bg)



n = 11

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

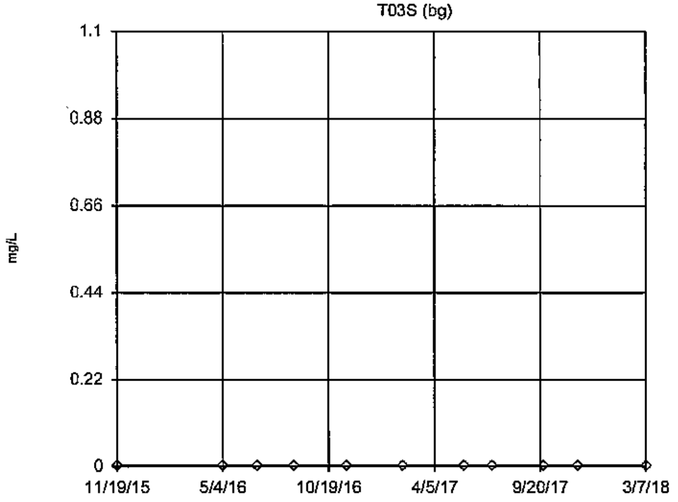
Data were cube root transformed to achieve best
W statistic (graph shown
in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Mercury Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Tukey's Outlier Screening

T03S (bg)



n = 11

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were cube root transformed to achieve best
W statistic (graph shown
in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Mercury Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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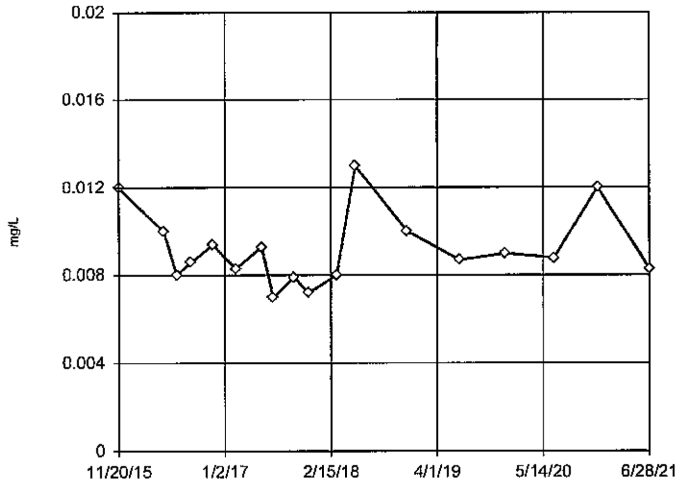
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.009194, std. dev.
0.001668, critical Tn
2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9334
Critical = 0.914 (after
natural log transforma-
tion)
The distribution was found
to be log-normal.

Constituent: Molybdenum Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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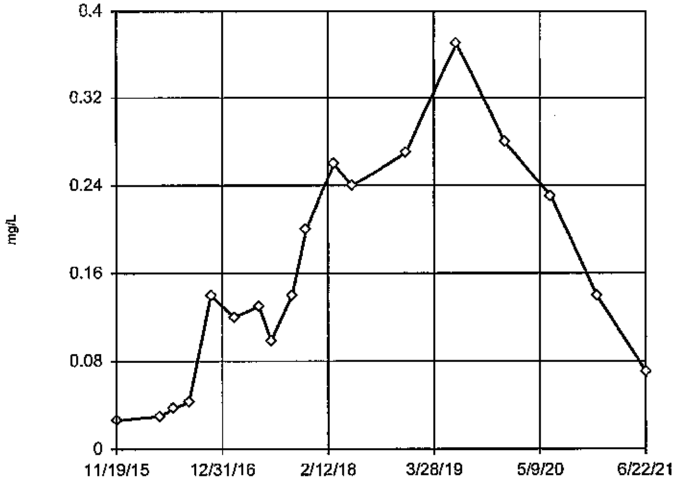
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 0.157, std. dev.
0.1007, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9403
Critical = 0.914
The distribution was found
to be normally distrib-
uted.

Constituent: Molybdenum Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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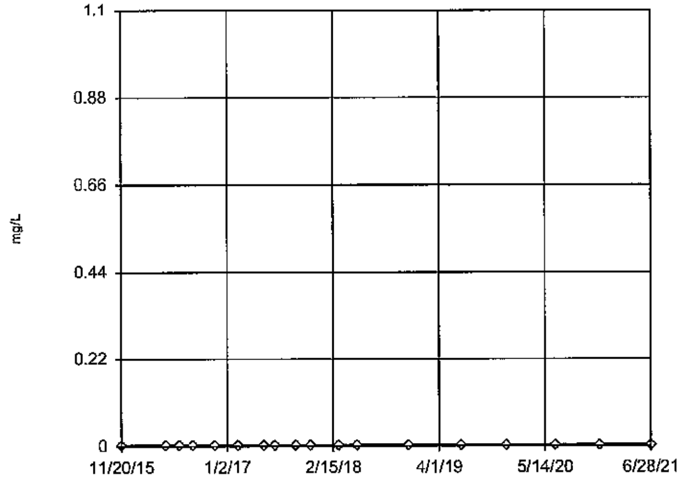
Tukey's Outlier Screening

G45S (bg)



n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Selenium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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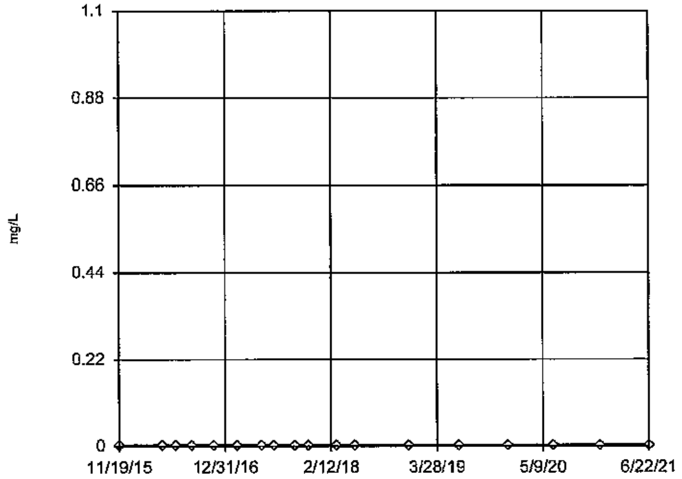
Tukey's Outlier Screening

T03S (bg)



n = 18

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Selenium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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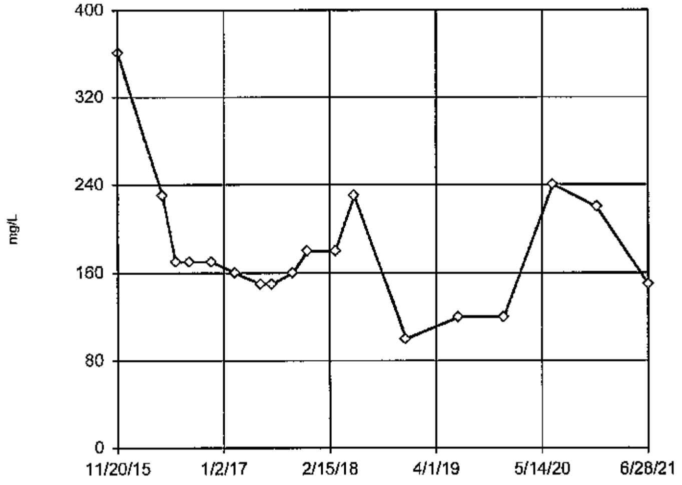
EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 181.1, std. dev.
59.4, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9533
Critical = 0.914 (after
natural log transformation)
The distribution was found
to be log-normal.

Constituent: Sulfate Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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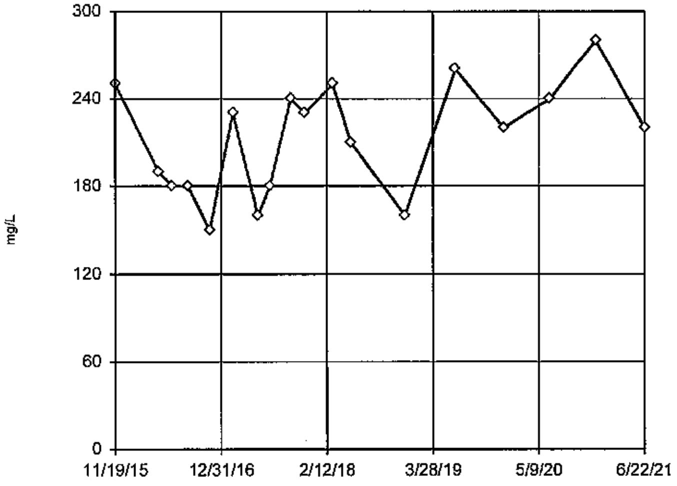
EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)



n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 212.8, std. dev.
38.32, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9533
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Sulfate Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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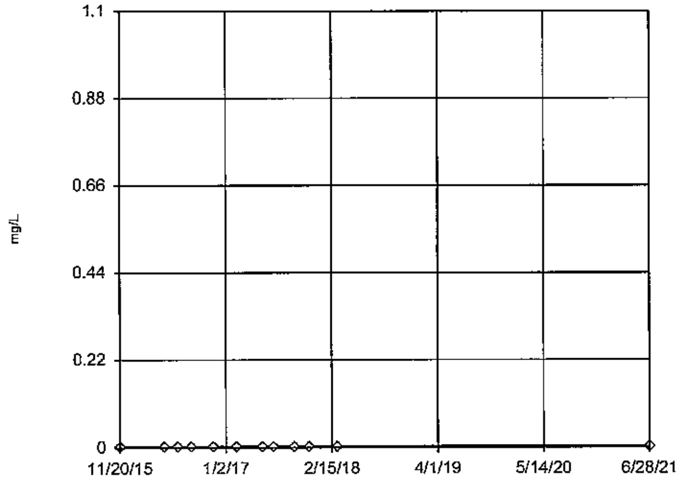
Tukey's Outlier Screening

G45S (bg)



n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Thallium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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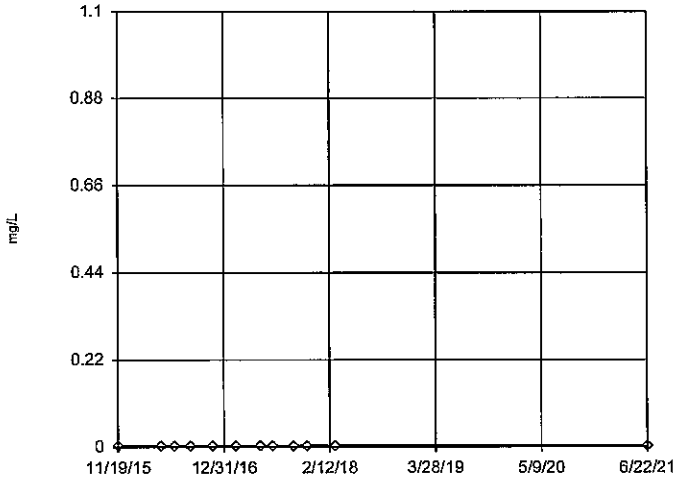
Tukey's Outlier Screening

T03S (bg)



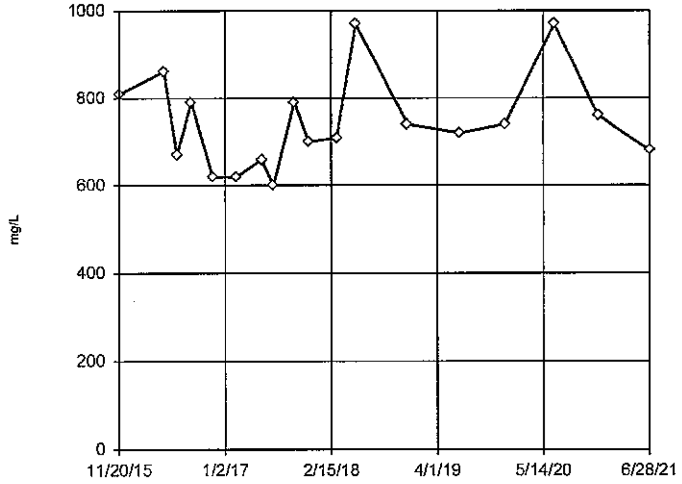
n = 12

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.1 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Thallium Analysis Run 8/9/2021 2:25 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29


EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)

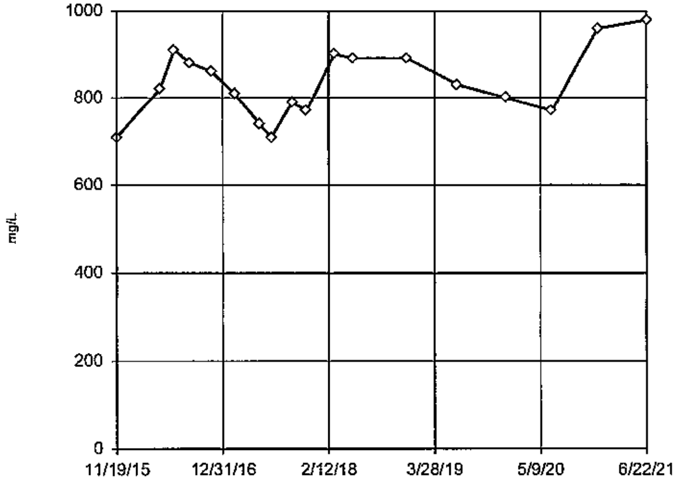
n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 745, std. dev. 107.4,
critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9219
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29


EPA Screening (suspected outliers for Dixon's Test)

T03S (bg)

n = 18

Dixon's will not be run.
No suspect values identified
or unable to establish
suspect values.
Mean 834.4, std. dev.
79.72, critical Tn 2.504

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9677
Critical = 0.914
The distribution was found
to be normally distributed.

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 2:25 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

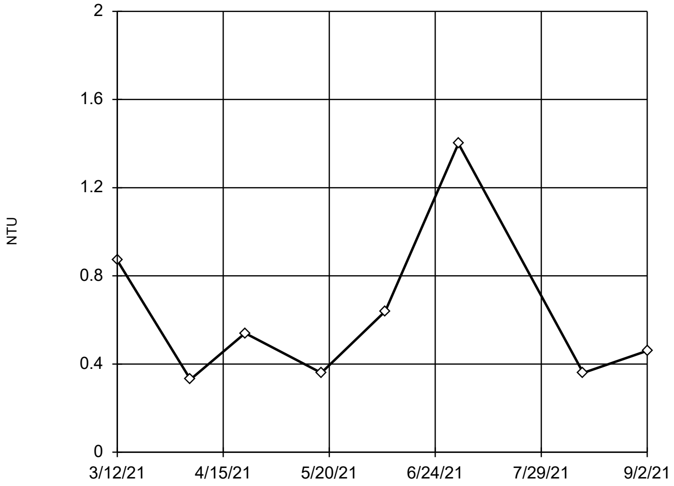
Outlier Analysis - Joliet 9 - UG Wells Turbidity

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 10/8/2021, 11:50 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Turbidity (NTU)	G45S (bg)	No	n/a	n/a	EPA 1989	0.05	8	0.62	0.363	ln(x)	ShapiroWilk
Turbidity (NTU)	**T03S (bg)**	**Yes**	**2.42,94**	**3/15/2021...**	**Dixon`s**	**0.05**	**8**	**12.39**	**32.98**	**normal**	**ShapiroWilk**

EPA Screening (suspected outliers for Dixon's Test)

G45S (bg)



n = 8

Dixon's will not be run.
No suspect values identified or unable to establish suspect values.
Mean 0.62, std. dev. 0.363, critical Tn 2.032

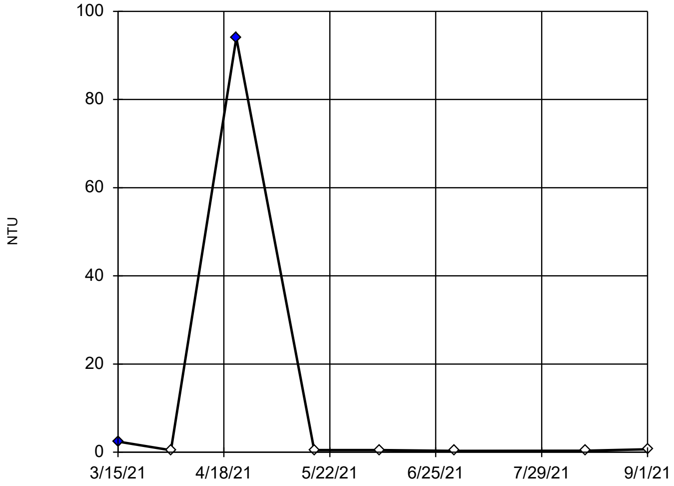
Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.9071
Critical = 0.851 (after natural log transformation)
The distribution was found to be log-normal.

Constituent: Turbidity Analysis Run 10/8/2021 11:49 AM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Dixon's Outlier Test

T03S (bg)



n = 8

Statistical outliers are drawn as solid.
Testing for 2 high outliers.
Mean = 12.39.
Std. Dev. = 32.98.
2.42: c = 0.8413
tabl = 0.554.
Alpha = 0.05.

Normality test used:
Shapiro Wilk@alpha = 0.1
Calculated = 0.915
Critical = 0.826
The distribution, after removal of suspect values, was found to be normally distributed.

Constituent: Turbidity Analysis Run 10/8/2021 11:49 AM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Seasonality - Joliet #9 - UG CCR Wells

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 8/9/2021, 2:40 PM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Antimony (mg/L)	G45S (bg)	No	0	0	0	12	0.05
Antimony (mg/L)	T03S (bg)	No	0	0	0	12	0.05
Arsenic (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Arsenic (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Barium (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Barium (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Beryllium (mg/L)	G45S (bg)	No	0	0	0	12	0.05
Beryllium (mg/L)	T03S (bg)	No	0	0	0	12	0.05
Boron (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Boron (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Cadmium (mg/L)	G45S (bg)	No	0	0	0	12	0.05
Cadmium (mg/L)	T03S (bg)	No	0	0	0	12	0.05
Calcium (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Calcium (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Chloride (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Chloride (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Chromium (mg/L)	G45S (bg)	No	0	0	0	12	0.05
Chromium (mg/L)	T03S (bg)	No	0	0	0	12	0.05
Cobalt (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Cobalt (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Combined Radium 226 + 228 (pCi/L)	G45S (bg)	No	0	0	0	16	0.05
Combined Radium 226 + 228 (pCi/L)	T03S (bg)	No	0	0	0	16	0.05
Field pH (SU)	G45S (bg)	No	0	0	0	18	0.05
Field pH (SU)	T03S (bg)	No	0	0	0	18	0.05
Fluoride (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Fluoride (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Lead (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Lead (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Lithium (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Lithium (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Mercury (mg/L)	G45S (bg)	No	0	0	0	11	0.05
Mercury (mg/L)	T03S (bg)	No	0	0	0	11	0.05
Molybdenum (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Molybdenum (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Selenium (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Selenium (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Sulfate (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Sulfate (mg/L)	T03S (bg)	No	0	0	0	18	0.05
Thallium (mg/L)	G45S (bg)	No	0	0	0	12	0.05
Thallium (mg/L)	T03S (bg)	No	0	0	0	12	0.05
Total Dissolved Solids (mg/L)	G45S (bg)	No	0	0	0	18	0.05
Total Dissolved Solids (mg/L)	T03S (bg)	No	0	0	0	18	0.05

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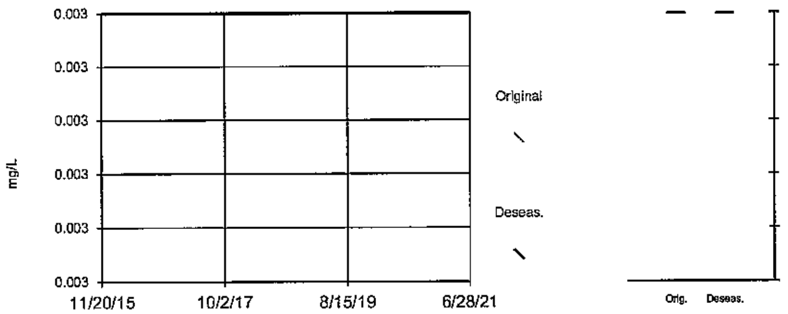
Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Antimony Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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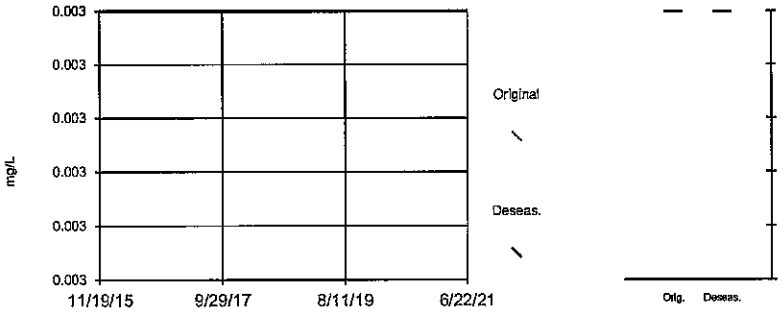
Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Antimony Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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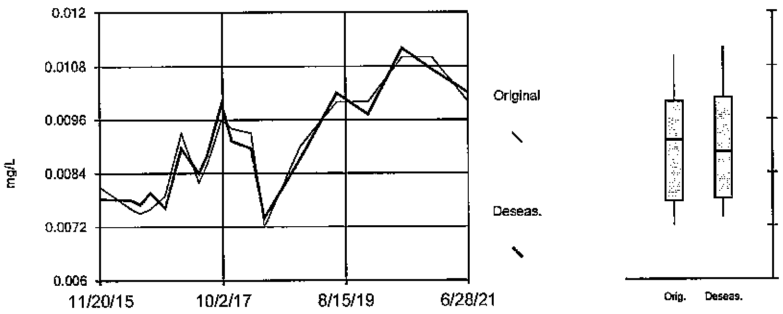
Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Arsenic Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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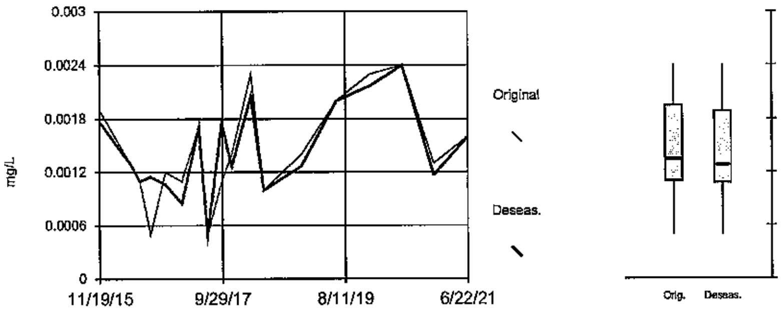
Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Arsenic Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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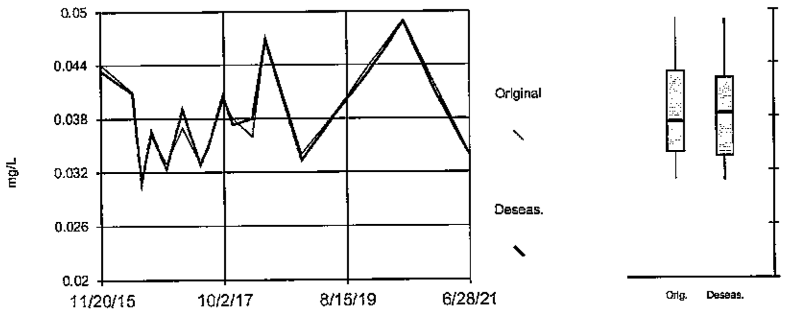
Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Barium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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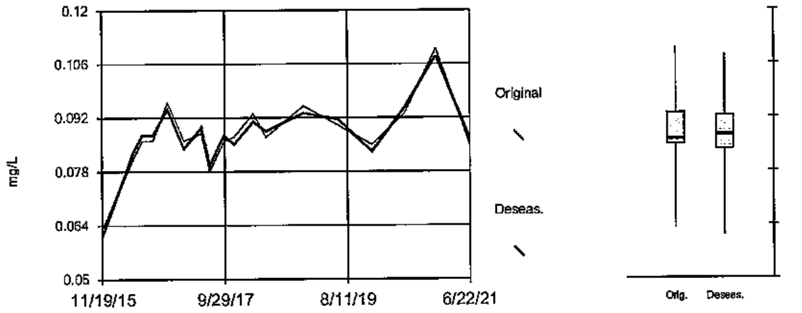
Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Barium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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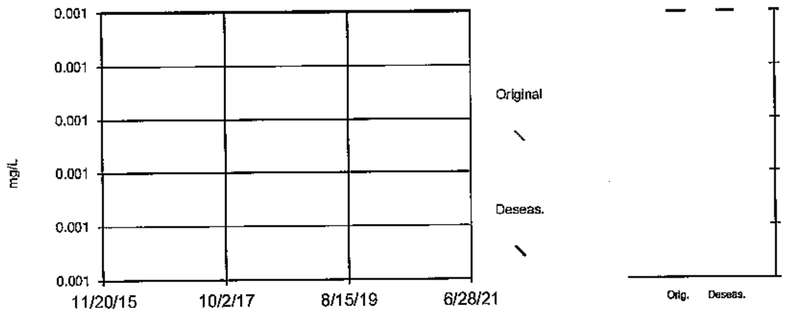
Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Beryllium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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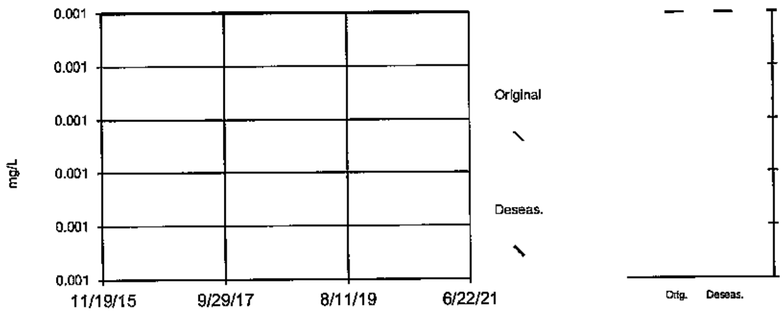
Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Beryllium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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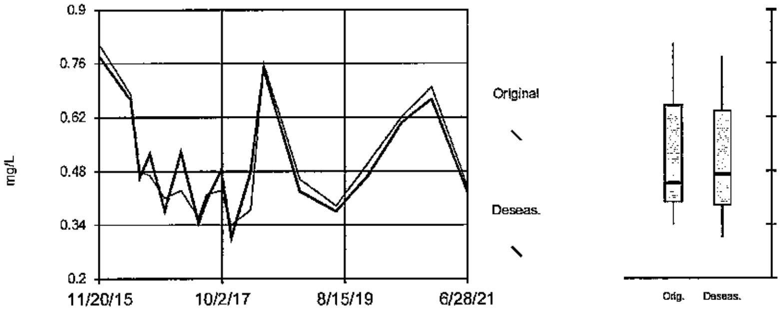
Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

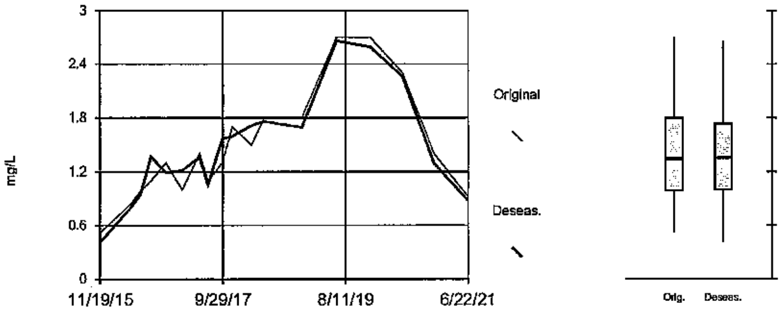


Constituent: Boron Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

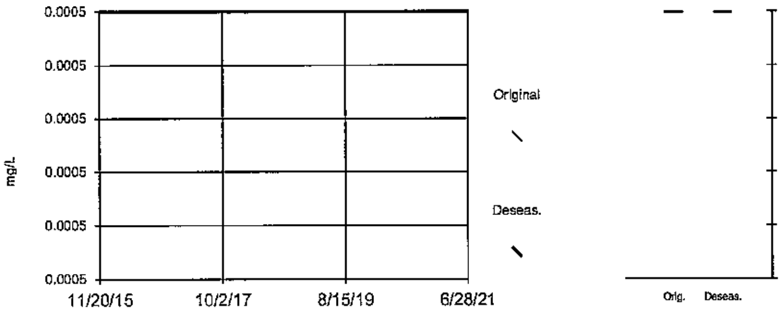


Constituent: Boron Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

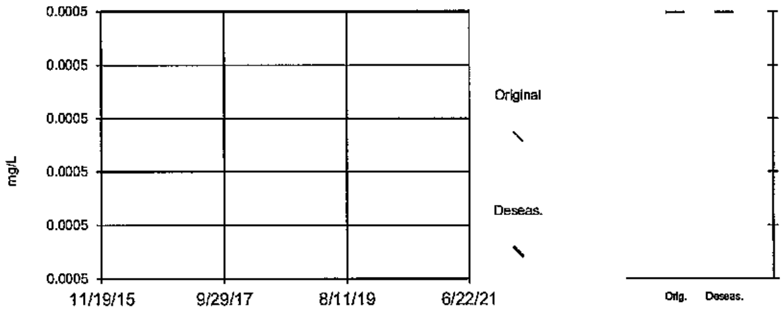


Constituent: Cadmium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

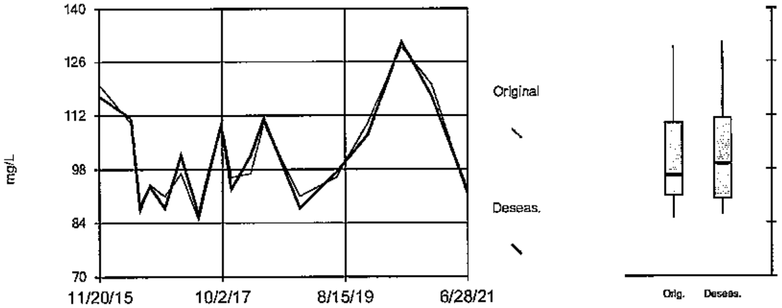


Constituent: Cadmium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

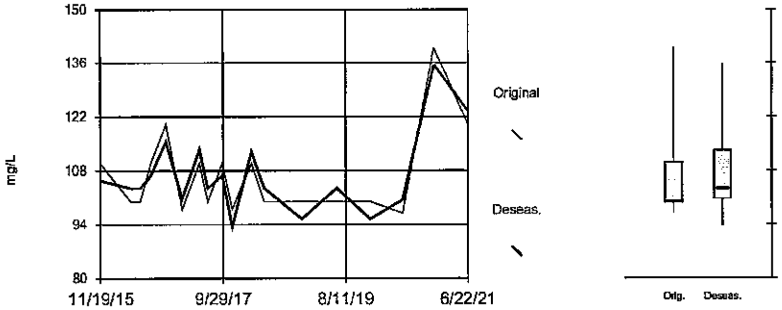


Constituent: Calcium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

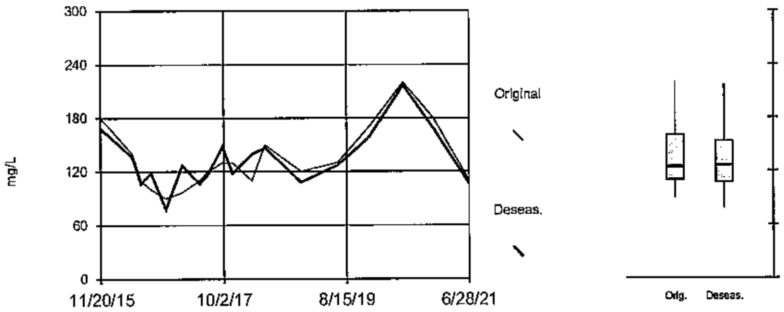


Constituent: Calcium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

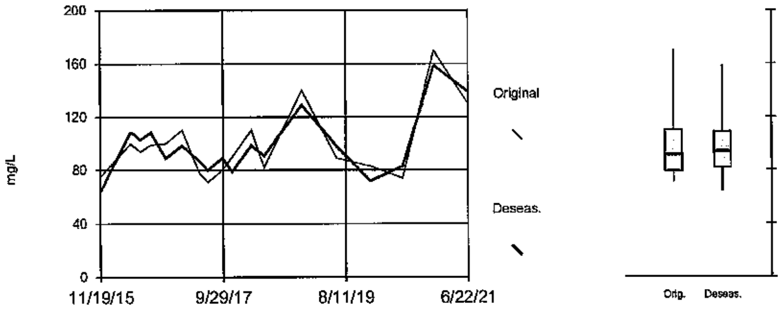


Constituent: Chloride Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

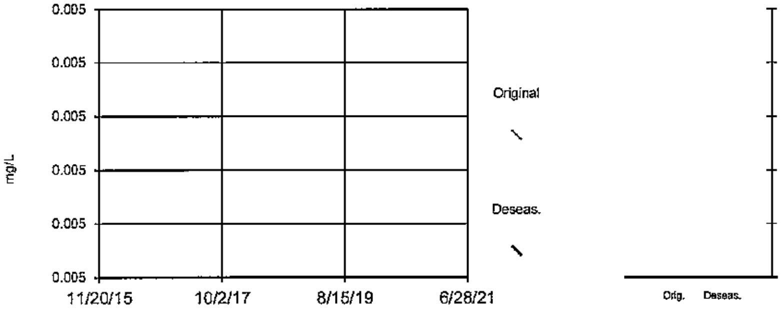


Constituent: Chloride Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

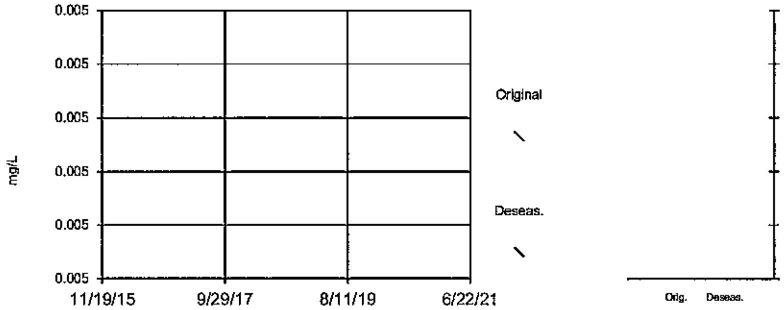


Constituent: Chromium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

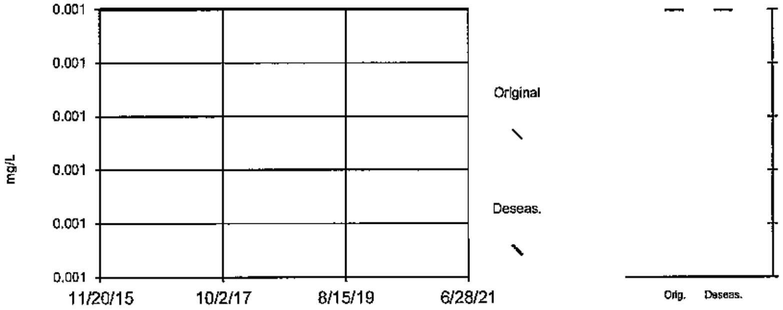


Constituent: Chromium Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

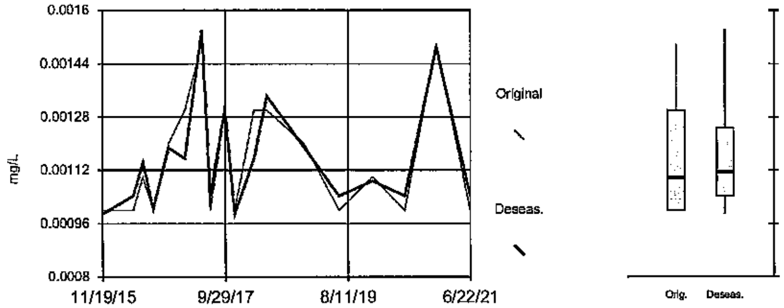


Constituent: Cobalt Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

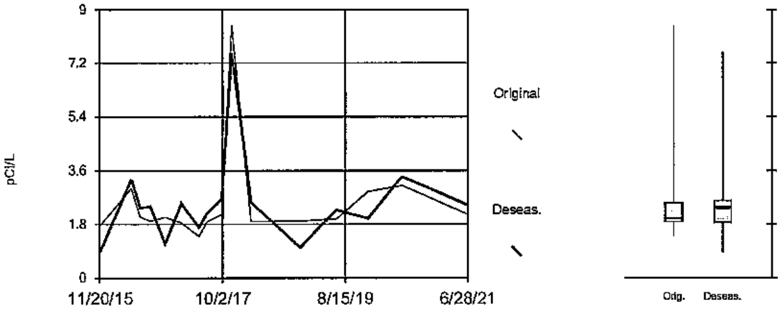


Constituent: Cobalt Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

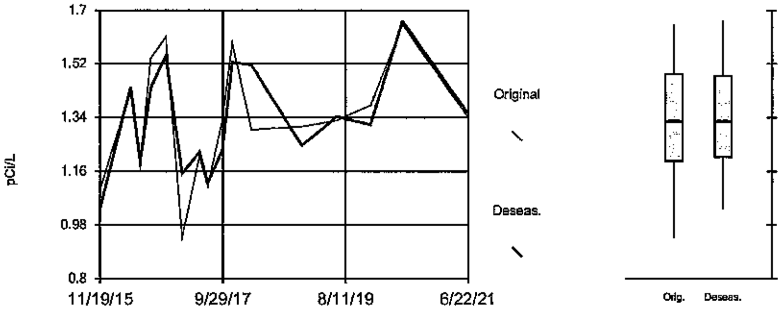


Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

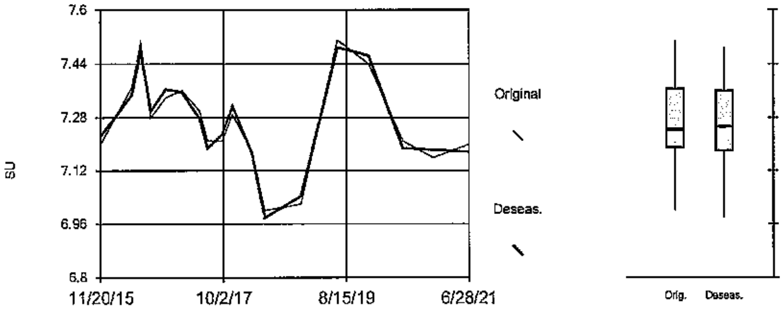


Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

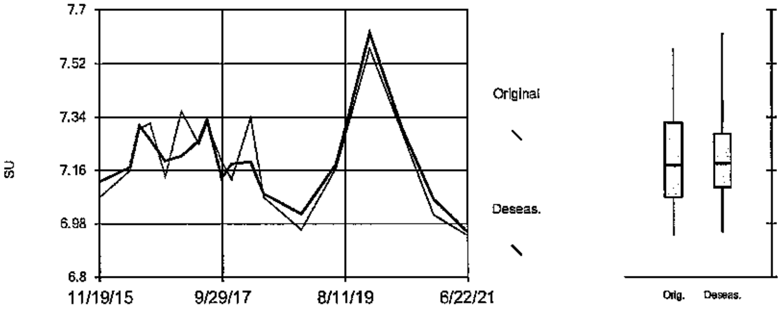


Constituent: Field pH Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

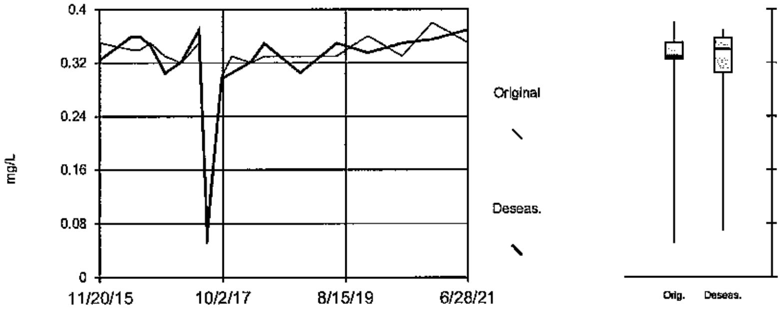


Constituent: Field pH Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

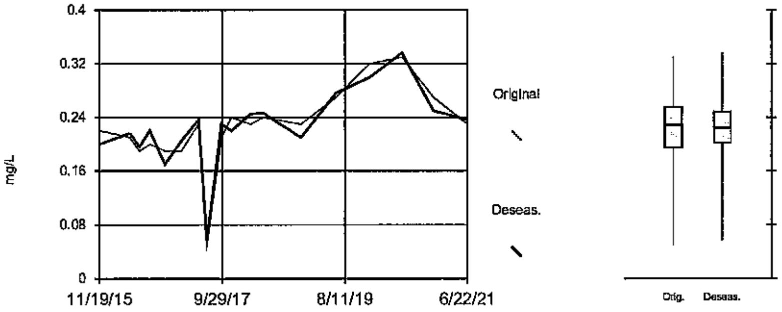


Constituent: Fluoride Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

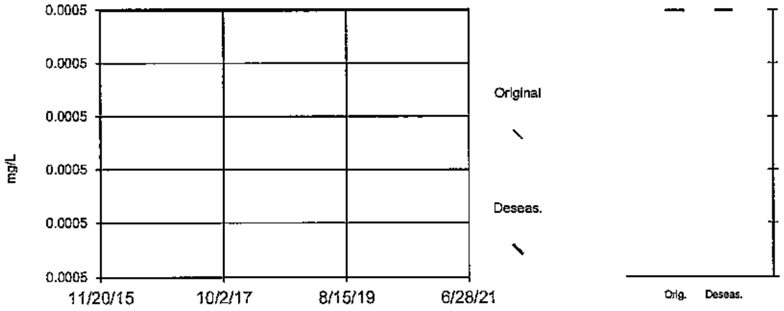


Constituent: Fluoride Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

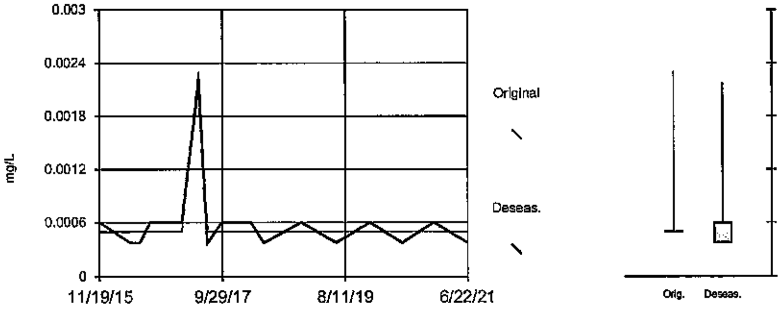


Constituent: Lead Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

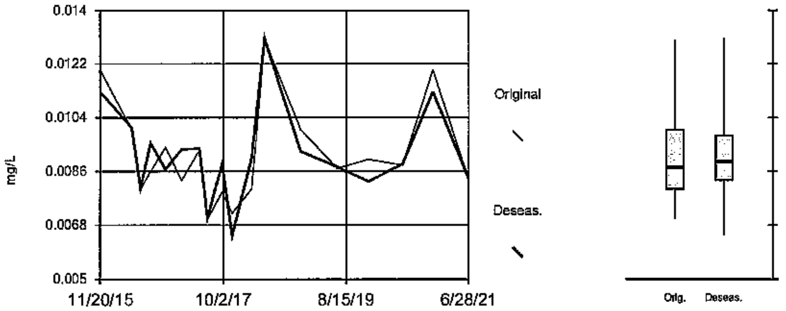


Constituent: Lead Analysis Run 8/9/2021 2:38 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

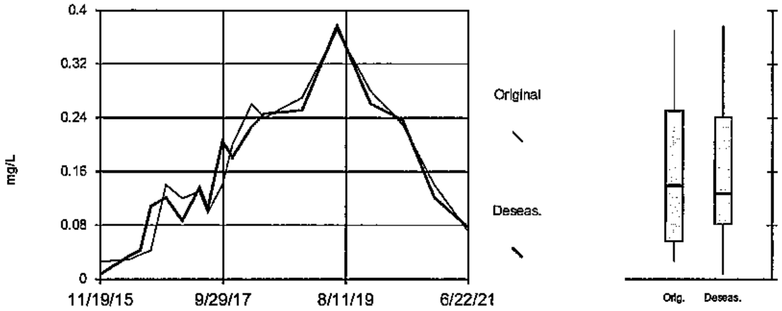


Constituent: Molybdenum Analysis Run 8/9/2021 2:39 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

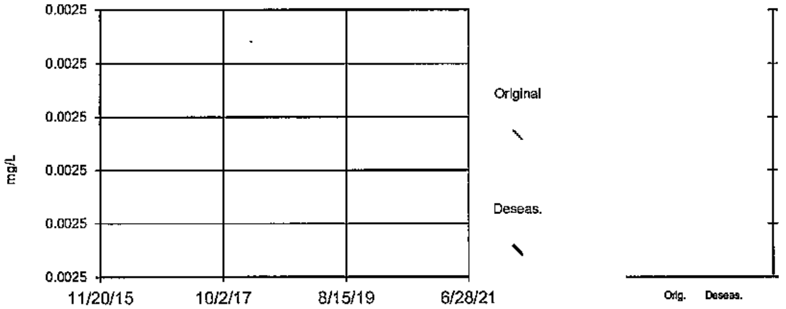


Constituent: Molybdenum Analysis Run 8/9/2021 2:39 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

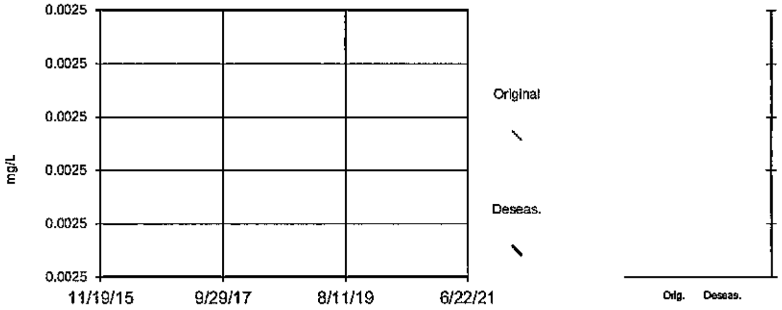


Constituent: Selenium Analysis Run 8/9/2021 2:39 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

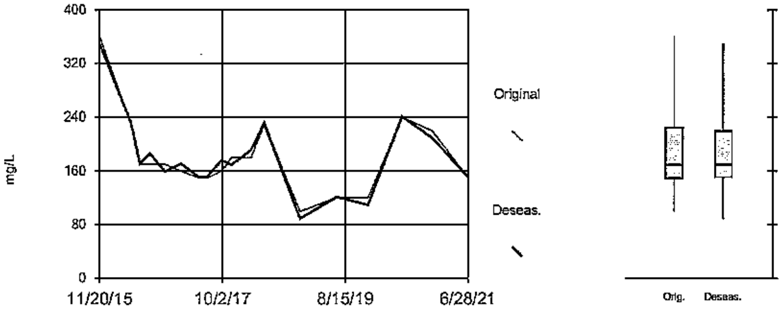


Constituent: Selenium Analysis Run 8/9/2021 2:39 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



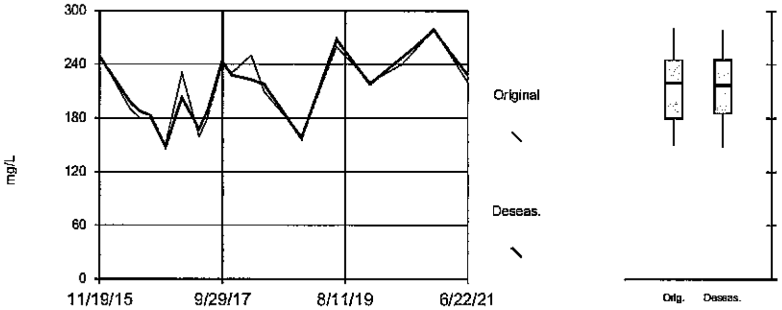
Constituent: Sulfate Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



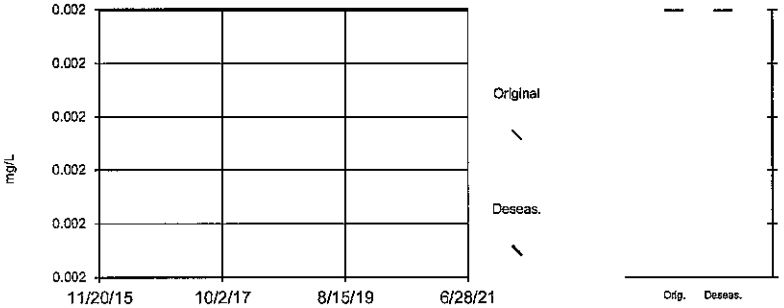
Constituent: Sulfate Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



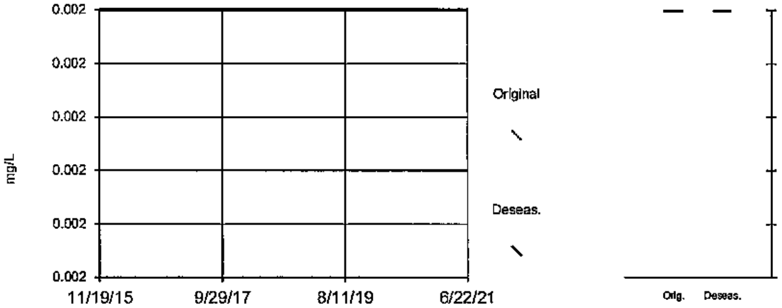
Constituent: Thallium Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

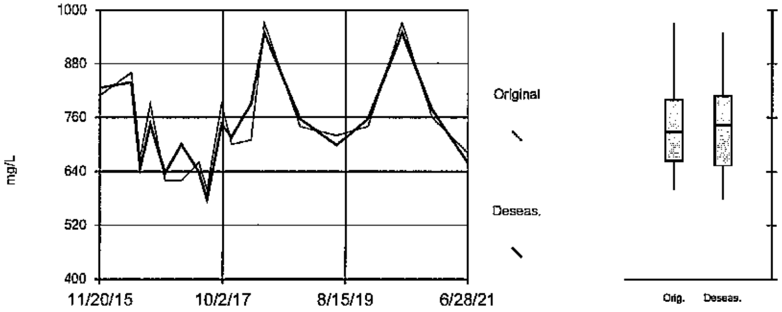


Constituent: Thallium Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Seasonality: G45S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).

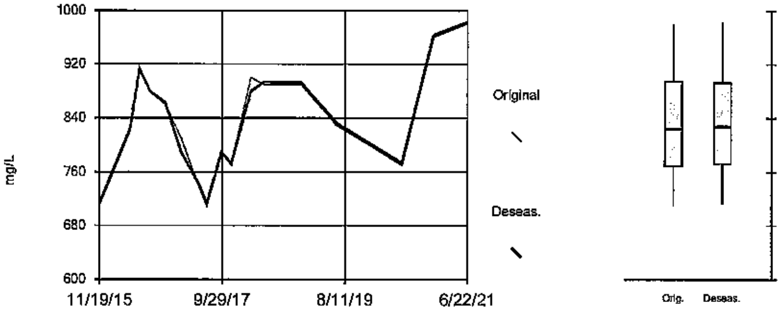


Constituent: Total Dissolved Solids   Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Seasonality: T03S (bg)

Data set is of insufficient size to test for seasonality (non-parametric ANOVA requires a minimum of three observations per group, i.e. season).



Constituent: Total Dissolved Solids   Analysis Run 8/9/2021 2:39 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Trend Test Joliet #9 UG Wells

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29 Printed 8/9/2021, 2:47 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony (mg/L)	G45S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Antimony (mg/L)	T03S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Arsenic (mg/L)	**G45S (bg)**	**0.000...**	**5.446**	**2.235**	**Yes**	**18**	**0**	**Yes**	**no**	**0.02**	**Param.**
Arsenic (mg/L)	T03S (bg)	0.000...	1.929	2.235	No	18	11.11	Yes	no	0.02	Param.
Barium (mg/L)	G45S (bg)	0.000...	1.203	2.235	No	18	0	Yes	no	0.02	Param.
Barium (mg/L)	**T03S (bg)**	**0.002987**	**2.556**	**2.235**	**Yes**	**18**	**0**	**Yes**	**no**	**0.02**	**Param.**
Beryllium (mg/L)	G45S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Beryllium (mg/L)	T03S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Boron (mg/L)	G45S (bg)	0.003884	0.098	2.235	No	18	5.556	Yes	natura...	0.02	Param.
Boron (mg/L)	**T03S (bg)**	**0.2068**	**2.723**	**2.235**	**Yes**	**18**	**0**	**Yes**	**no**	**0.02**	**Param.**
Cadmium (mg/L)	G45S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Cadmium (mg/L)	T03S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Calcium (mg/L)	G45S (bg)	2.031	1.091	2.235	No	18	0	Yes	no	0.02	Param.
Calcium (mg/L)	T03S (bg)	1.952	1.233	2.235	No	18	0	Yes	no	0.02	Param.
Chloride (mg/L)	G45S (bg)	8.491	1.791	2.235	No	18	0	Yes	no	0.02	Param.
Chloride (mg/L)	T03S (bg)	6.822	1.951	2.235	No	18	0	Yes	no	0.02	Param.
Chromium (mg/L)	G45S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Chromium (mg/L)	T03S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Cobalt (mg/L)	G45S (bg)	0	0	63	No	18	100	n/a	n/a	0.02	NP (NDs)
Cobalt (mg/L)	T03S (bg)	0.000...	0.341	2.235	No	18	44.44	Yes	no	0.02	Param.
Combined Radium 226 + 228 (pCi/L)	G45S (bg)	0.06457	32	53	No	16	0	n/a	n/a	0.02	NP (Nor...
Combined Radium 226 + 228 (pCi/L)	T03S (bg)	0.03416	1.078	2.264	No	16	0	Yes	no	0.02	Param.
Field pH (SU)	G45S (bg)	-0.01842	-0.8901	2.235	No	18	0	Yes	no	0.02	Param.
Field pH (SU)	T03S (bg)	-0.01944	-0.8257	2.235	No	18	0	Yes	no	0.02	Param.
Fluoride (mg/L)	G45S (bg)	0	10	63	No	18	5.556	n/a	n/a	0.02	NP (Nor...
Fluoride (mg/L)	**T03S (bg)**	**0.01913**	**79**	**63**	**Yes**	**18**	**5.556**	**n/a**	**n/a**	**0.02**	**NP (Nor...**
Lead (mg/L)	G45S (bg)	0	0	63	No	18	100	n/a	n/a	0.02	NP (NDs)
Lead (mg/L)	T03S (bg)	0	-5	-63	No	18	94.44	n/a	n/a	0.02	NP (NDs)
Lithium (mg/L)	G45S (bg)	0.000...	1.233	2.235	No	18	0	Yes	no	0.02	Param.
Lithium (mg/L)	**T03S (bg)**	**0.002177**	**6.3**	**2.235**	**Yes**	**18**	**5.556**	**Yes**	**no**	**0.02**	**Param.**
Mercury (mg/L)	G45S (bg)	0	0	31	No	11	100	n/a	n/a	0.02	NP (NDs)
Mercury (mg/L)	T03S (bg)	0	0	31	No	11	100	n/a	n/a	0.02	NP (NDs)
Molybdenum (mg/L)	G45S (bg)	0.000...	0.2117	2.235	No	18	0	Yes	no	0.02	Param.
Molybdenum (mg/L)	**T03S (bg)**	**0.03093**	**2.388**	**2.235**	**Yes**	**18**	**0**	**Yes**	**no**	**0.02**	**Param.**
Selenium (mg/L)	G45S (bg)	0	0	63	No	18	100	n/a	n/a	0.02	NP (NDs)
Selenium (mg/L)	T03S (bg)	0	0	63	No	18	100	n/a	n/a	0.02	NP (NDs)
Sulfate (mg/L)	G45S (bg)	-9.969	-1.166	2.235	No	18	0	Yes	no	0.02	Param.
Sulfate (mg/L)	T03S (bg)	10.09	1.957	2.235	No	18	0	Yes	no	0.02	Param.
Thallium (mg/L)	G45S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Thallium (mg/L)	T03S (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Total Dissolved Solids (mg/L)	G45S (bg)	10.49	0.66	2.235	No	18	0	Yes	no	0.02	Param.
Total Dissolved Solids (mg/L)	T03S (bg)	20.44	1.894	2.235	No	18	0	Yes	no	0.02	Param.

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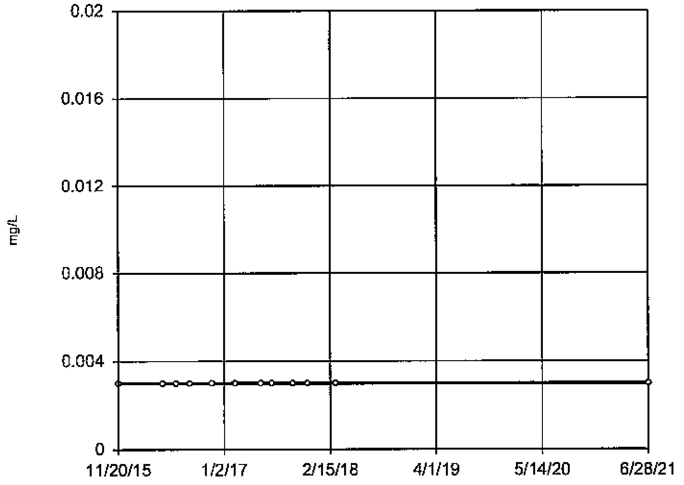
Hollow symbols indicate censored values.

Sen's Slope Estimator

G45S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Antimony Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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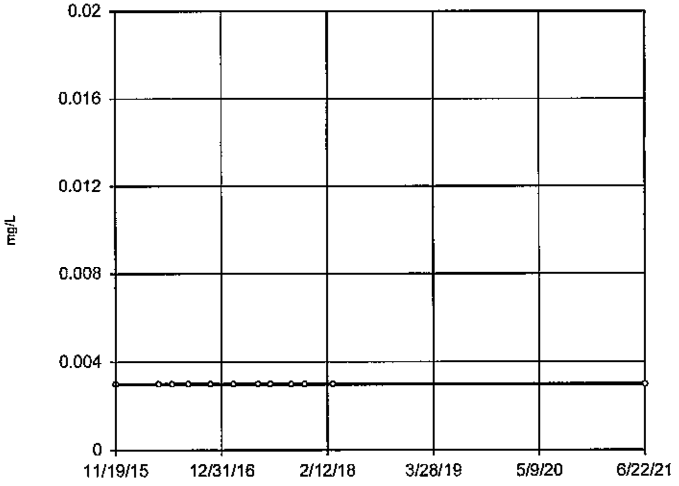
Hollow symbols indicate censored values.

Sen's Slope Estimator

T03S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Antimony Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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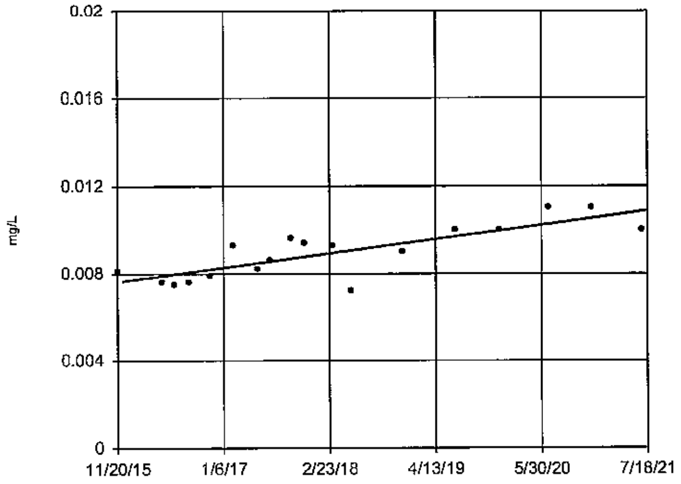
Linear Regression

G45S (bg)



n = 18

Slope = 0.0005729
units/year.

alpha = 0.02
t = 5.446
critical = 2.235

Significant increasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9304, critical
= 0.858.

Constituent: Arsenic Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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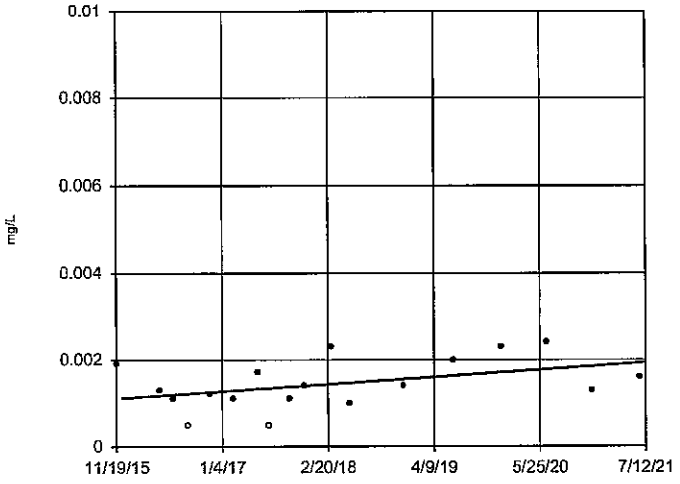
Hollow symbols indicate censored values.

Linear Regression

T03S (bg)



n = 18
11.11% NDs

Slope = 0.0001471
units/year.

alpha = 0.02
t = 1.929
critical = 2.235

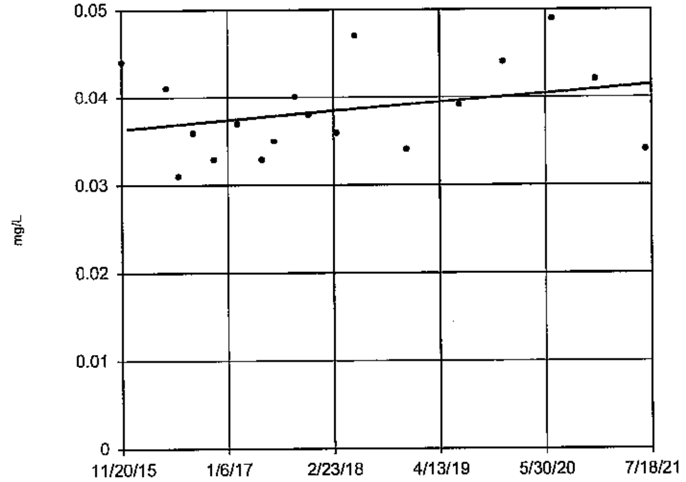
No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9655, critical
= 0.858.

Constituent: Arsenic Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Linear Regression

G45S (bg)



n = 18

Slope = 0.0008875
units/year.

alpha = 0.02
t = 1.203
critical = 2.235

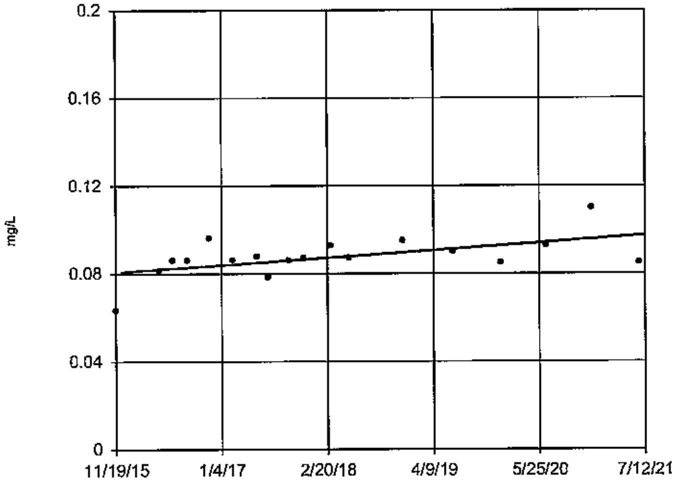
No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9441, critical
= 0.858.

Constituent: Barium Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Linear Regression

T03S (bg)



n = 18

Slope = 0.002987
units/year.

alpha = 0.02
t = 2.556
critical = 2.235

Significant increasing trend.

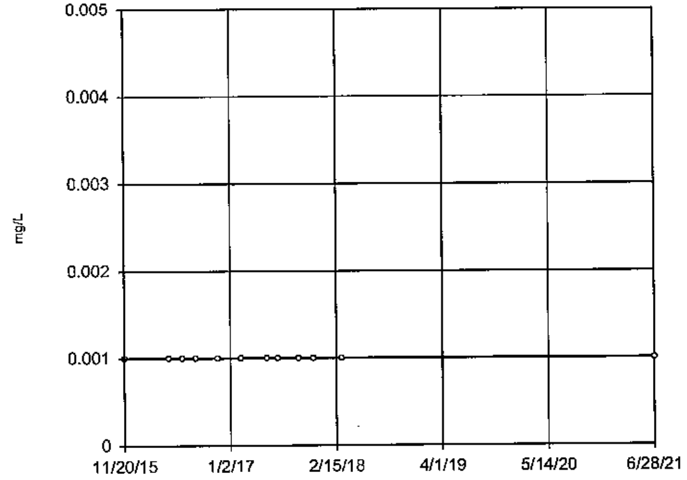
Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9529, critical
= 0.858.

Constituent: Barium Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Hollow symbols indicate censored values.

Sen's Slope Estimator

G45S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

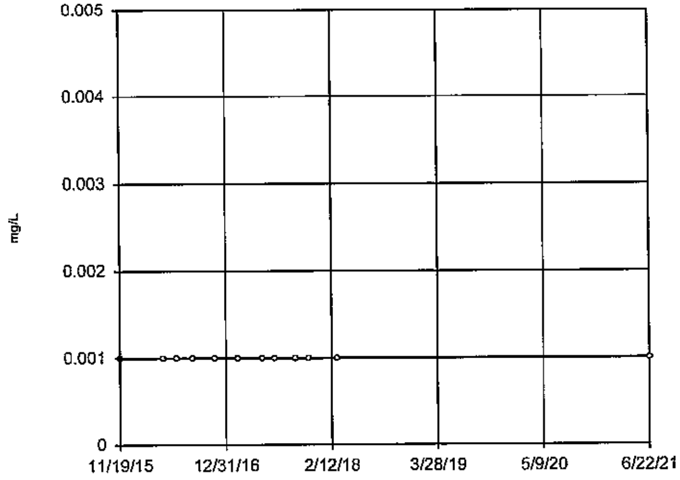
Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Beryllium Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Hollow symbols indicate censored values.

Sen's Slope Estimator

T03S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Beryllium Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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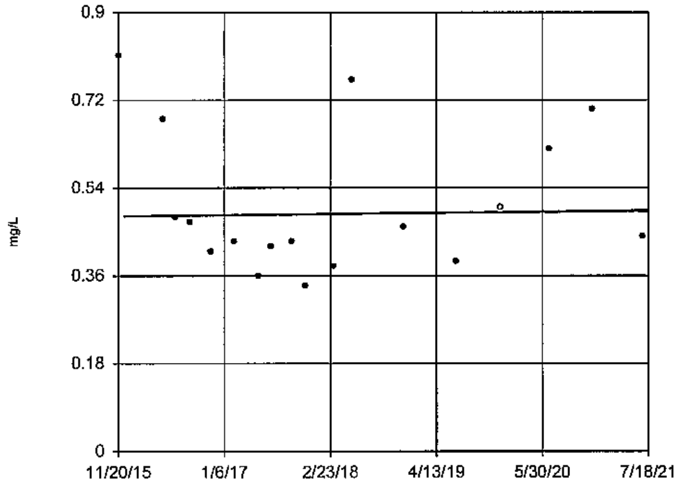
Hollow symbols indicate censored values.



Linear Regression

G45S (bg)

n = 18
5.556% NDs

Slope = 0.003884
natural log units/year.

alpha = 0.02
t = 0.098
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9046 after natural
log transformation,
critical = 0.858.

Constituent: Boron   Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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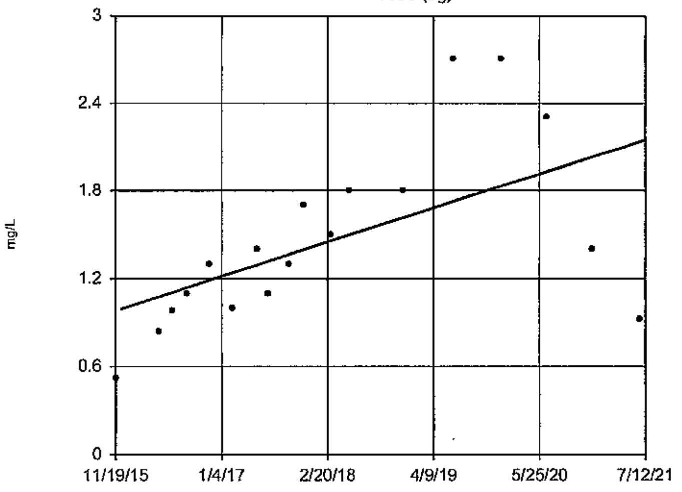

Linear Regression

T03S (bg)

n = 18

Slope = 0.2068
units/year.

alpha = 0.02
t = 2.723
critical = 2.235

Significant increasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9587, critical
= 0.858.

Constituent: Boron   Analysis Run 8/9/2021 2:44 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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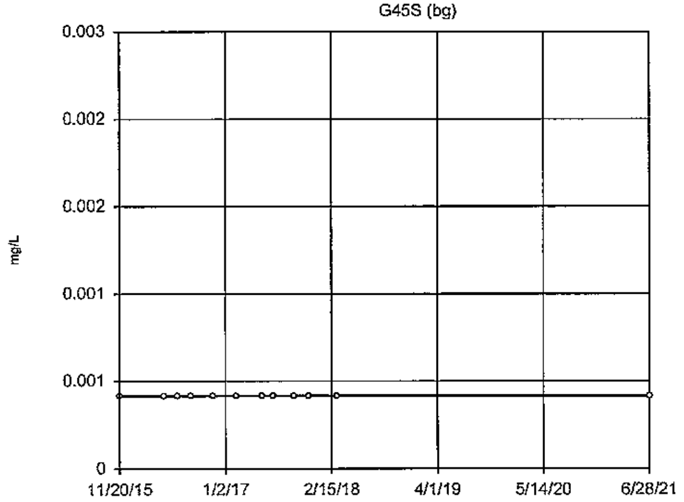
Hollow symbols indicate censored values.



Sen's Slope Estimator

G45S (bg)

n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
censored data
exceeded 75%.

Constituent: Cadmium   Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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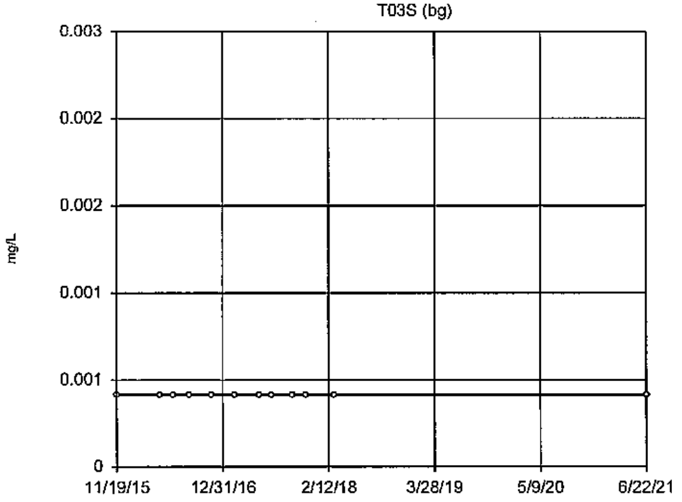
Hollow symbols indicate censored values.



Sen's Slope Estimator

T03S (bg)

n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
censored data
exceeded 75%.

Constituent: Cadmium   Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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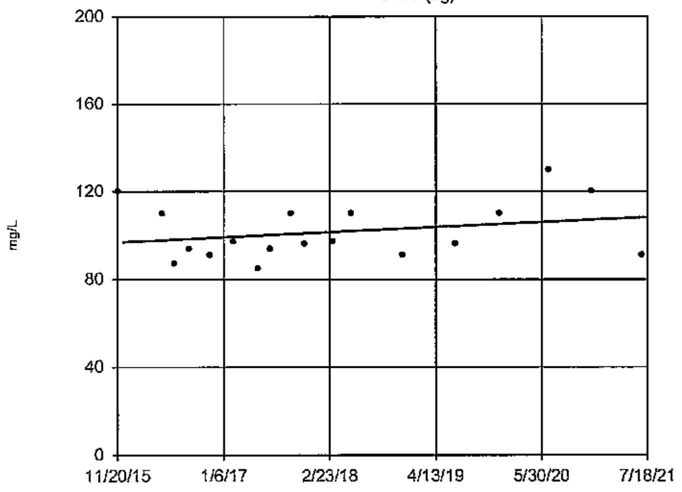

Linear Regression

G45S (bg)

n = 18

Slope = 2.031
units/year.

alpha = 0.02
t = 1.091
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.927, critical =
0.858.

Constituent: Calcium   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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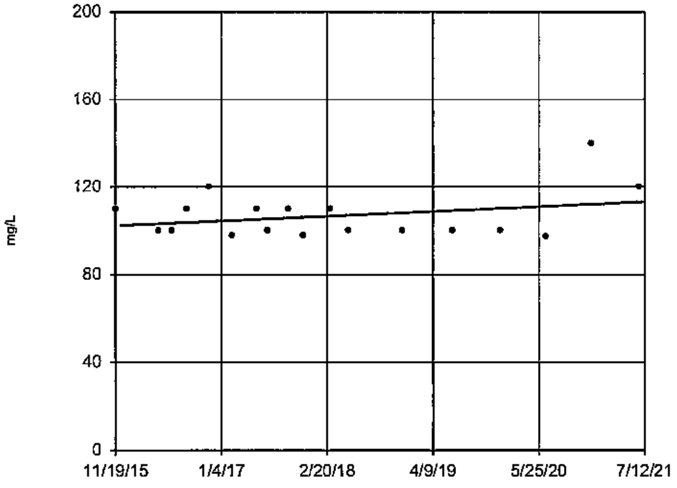

Linear Regression

T03S (bg)

n = 18

Slope = 1.952
units/year.

alpha = 0.02
t = 1.233
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9077, critical
= 0.858.

Constituent: Calcium   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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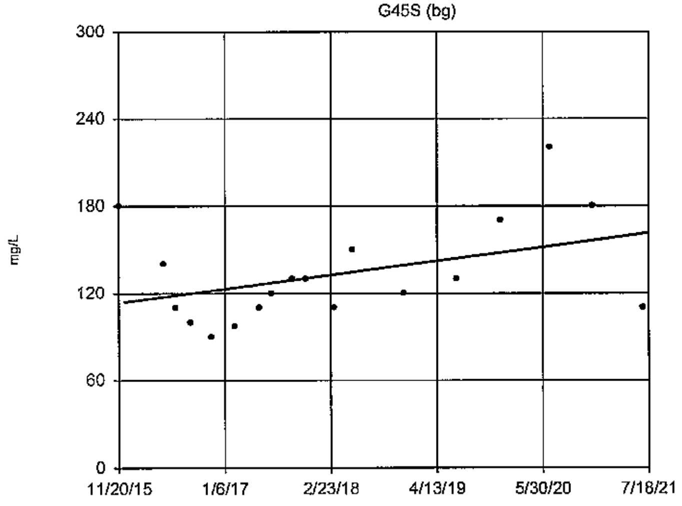

Linear Regression

G45S (bg)

n = 18

Slope = 8.491
units/year.

alpha = 0.02
t = 1.791
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9188, critical
= 0.858.

Constituent: Chloride   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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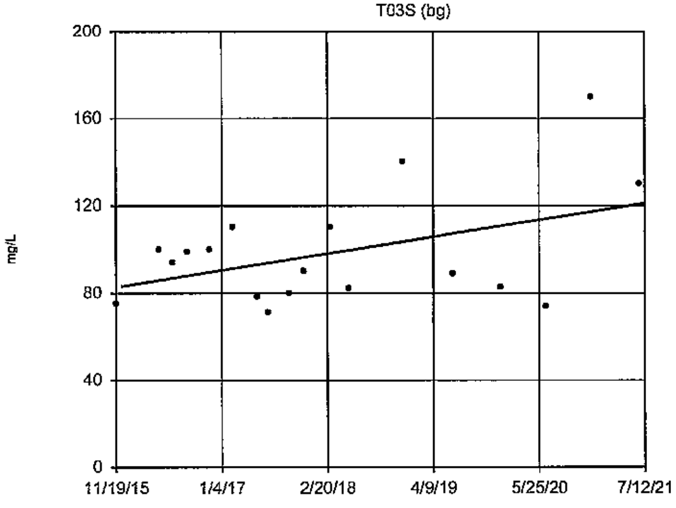

Linear Regression

T03S (bg)

n = 18

Slope = 6.822
units/year.

alpha = 0.02
t = 1.951
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.962, critical =
0.858.

Constituent: Chloride   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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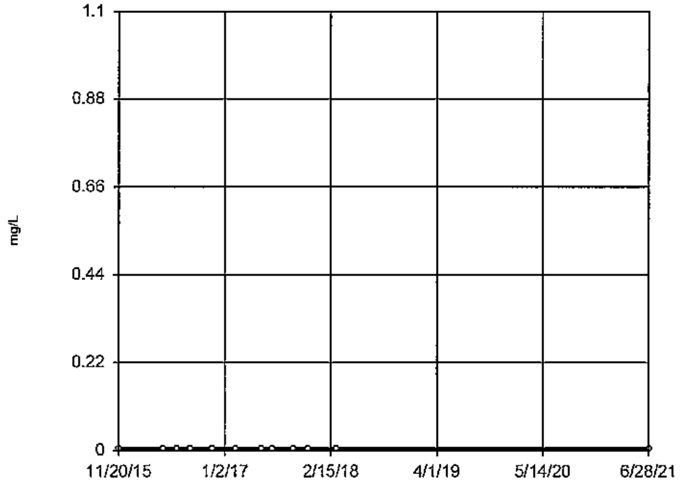
Hollow symbols indicate censored values.

Sen's Slope Estimator

G45S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Chromium Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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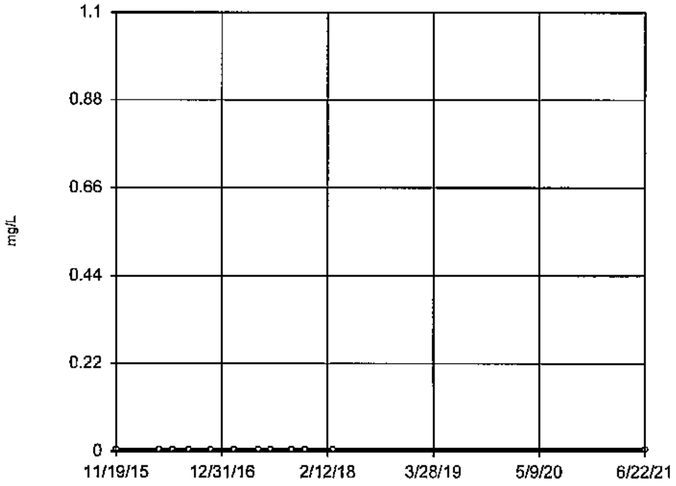
Hollow symbols indicate censored values.

Sen's Slope Estimator

T03S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Chromium Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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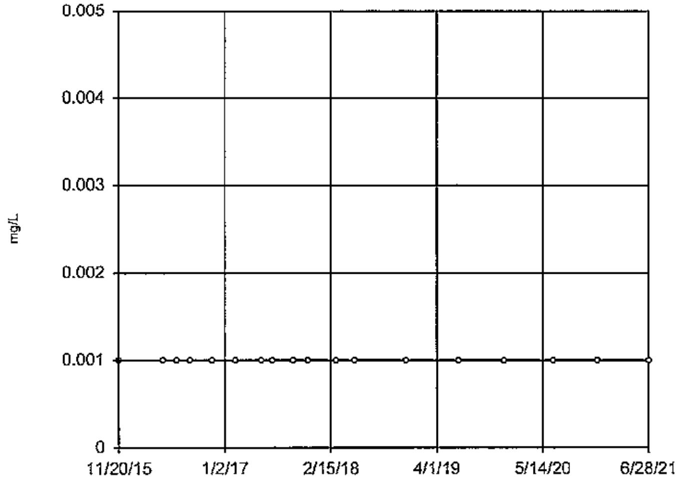
Hollow symbols indicate censored values.

Sen's Slope Estimator

G45S (bg)



n = 18

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Cobalt Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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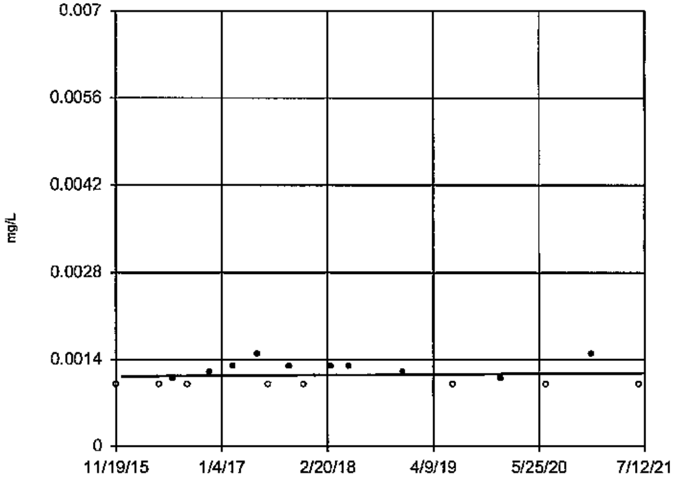
Hollow symbols indicate censored values.

Linear Regression

T03S (bg)



n = 18
44.44% NDs

Slope = 0.000008942
units/year.

alpha = 0.02
t = 0.341
critical = 2.235

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.8689, critical = 0.858.

Constituent: Cobalt Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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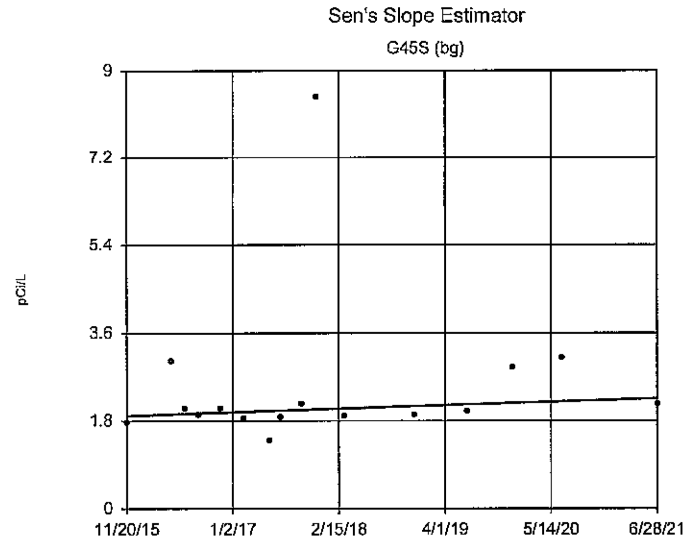

n = 16

Slope = 0.06457
units per year.

Mann-Kendall
statistic = 32
critical = 53

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
the Shapiro Wilk
normality test
showed the residuals
to be non-normal
at the 0.01 alpha
level, calculated
= 0.7001, critical
= 0.844.

Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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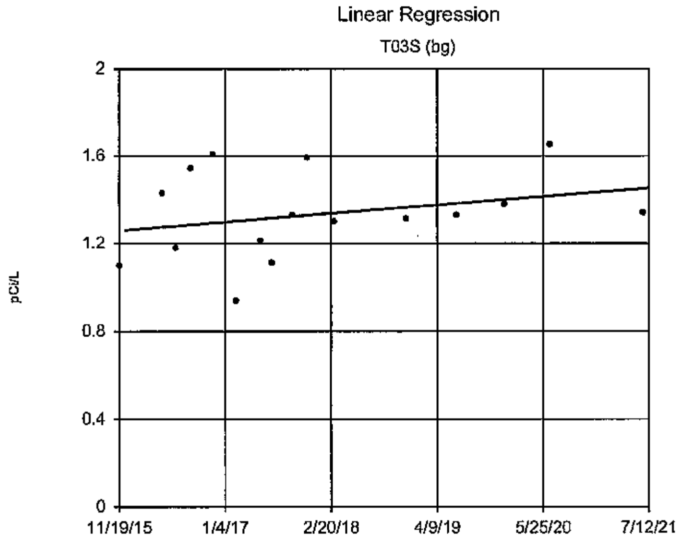


n = 16

Slope = 0.03416
units/year.

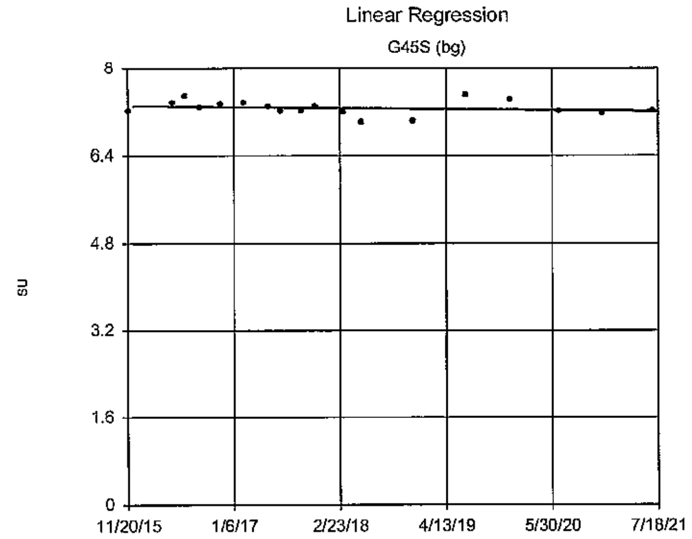
alpha = 0.02
t = 1.078
critical = 2.264

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9362, critical
= 0.844.

Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 18

Slope = -0.01842
units/year.

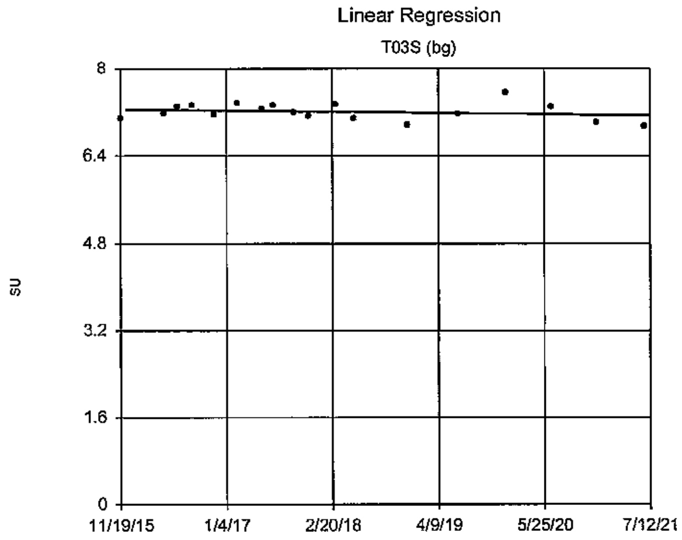
alpha = 0.02
t = -0.8901
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9608, critical
= 0.858.

Constituent: Field pH Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 18

Slope = -0.01944
units/year.

alpha = 0.02
t = -0.8257
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9395, critical
= 0.858.

Constituent: Field pH Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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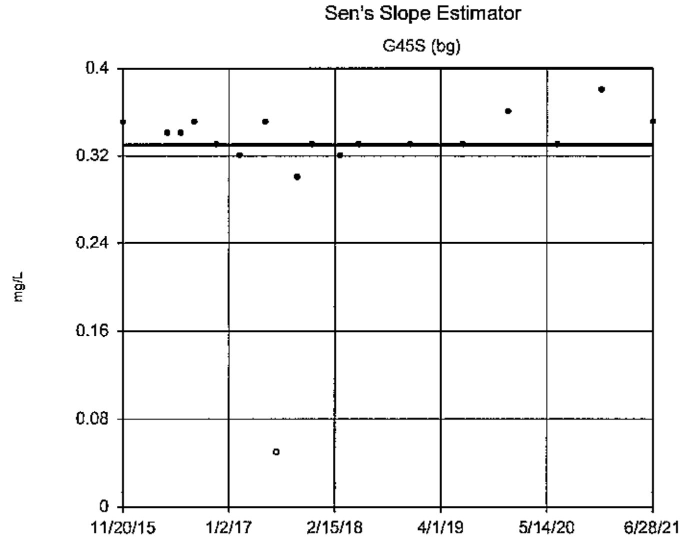
Hollow symbols indicate censored values.



n = 18

Slope = 0
units per year.

Mann-Kendall
statistic = 10
critical = 63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because the Shapiro Wilk normality test showed the residuals to be non-normal at the 0.01 alpha level, calculated = 0.3929, critical = 0.858.

Constituent: Fluoride   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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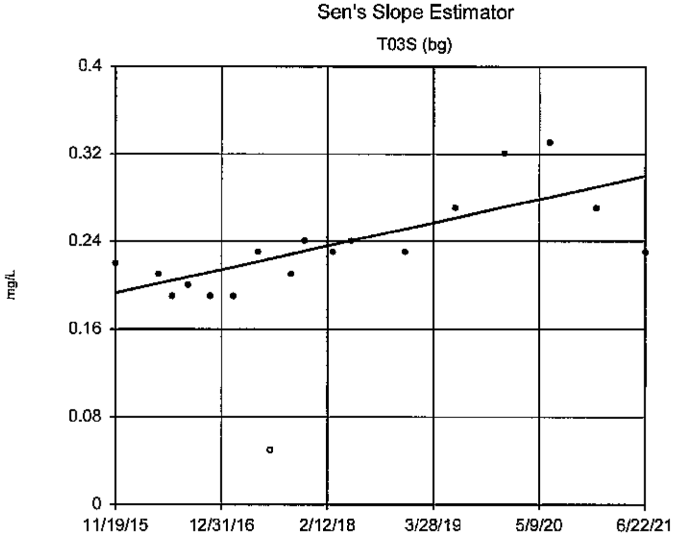
Hollow symbols indicate censored values.



n = 18

Slope = 0.01913
units per year.

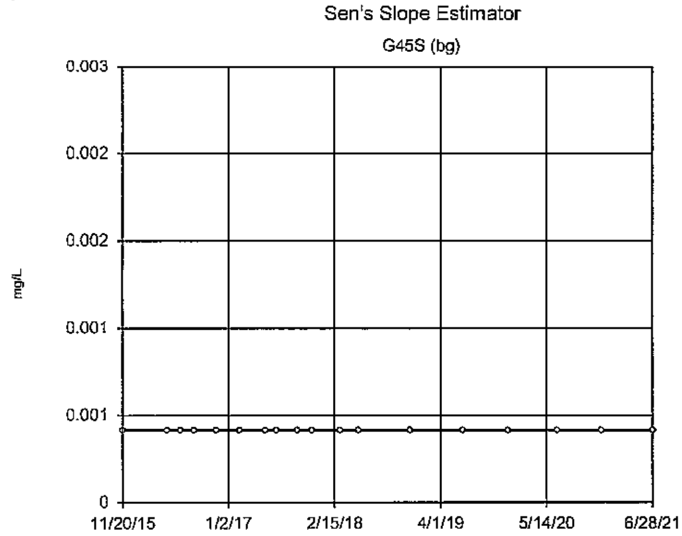
Mann-Kendall
statistic = 79
critical = 63

Increasing trend significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because the Shapiro Wilk normality test showed the residuals to be non-normal at the 0.01 alpha level, calculated = 0.5359, critical = 0.858.

Constituent: Fluoride   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 18

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Lead   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

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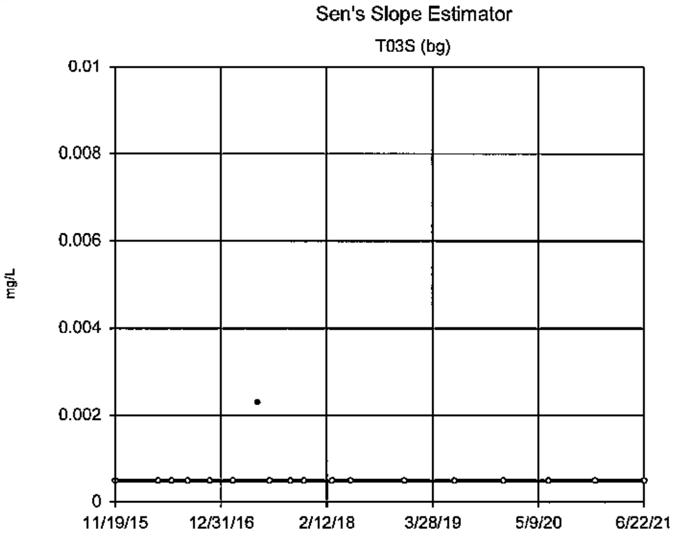
Hollow symbols indicate censored values.



n = 18

Slope = 0
units per year.

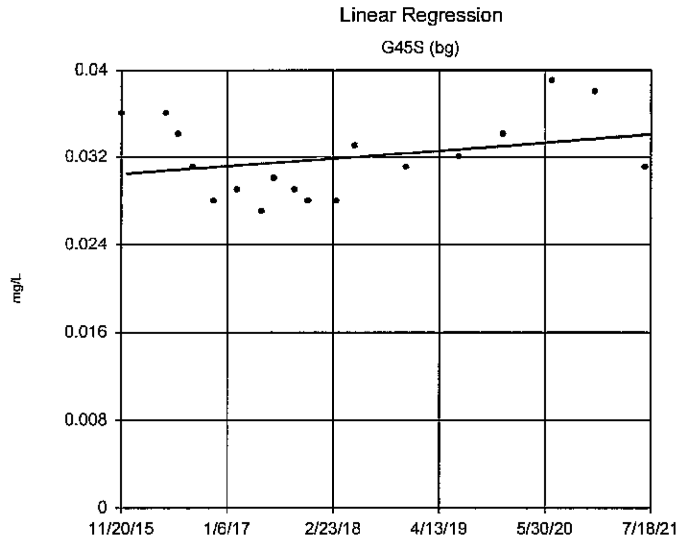
Mann-Kendall
statistic = -5
critical = -63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Lead   Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 18

Slope = 0.0006413 units/year.

alpha = 0.02
t = 1.233
critical = 2.235

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.8964, critical = 0.858.

Constituent: Lithium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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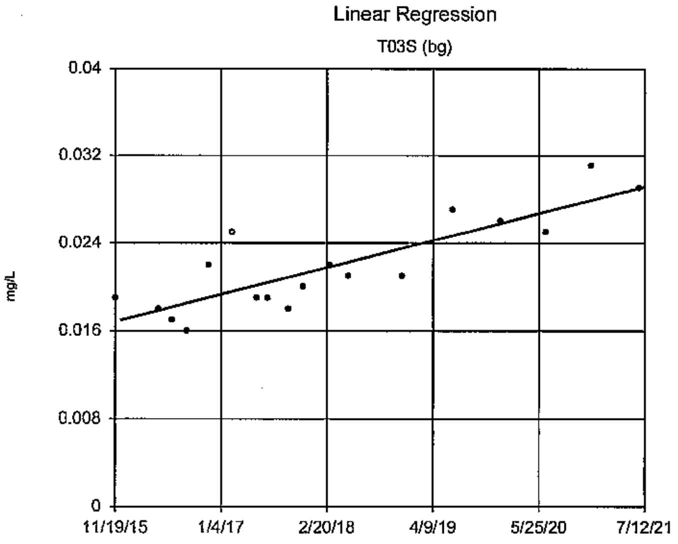
Hollow symbols indicate censored values.



n = 18
5.556% NDs

Slope = 0.002177 units/year.

alpha = 0.02
t = 6.3
critical = 2.235

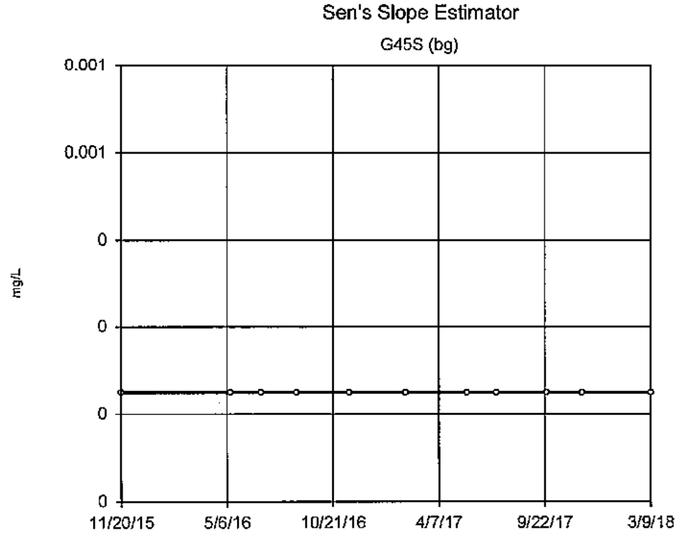
Significant increasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9137, critical = 0.858.

Constituent: Lithium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 11

Slope = 0 units per year.

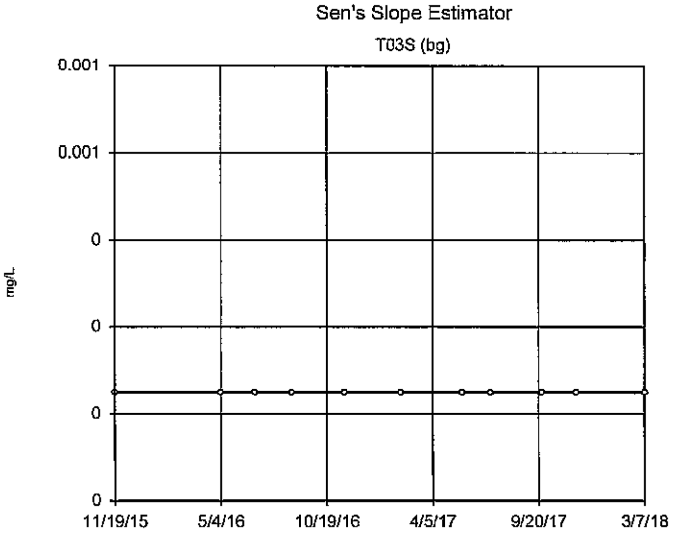
Mann-Kendall statistic = 0
critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Mercury Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 11

Slope = 0 units per year.

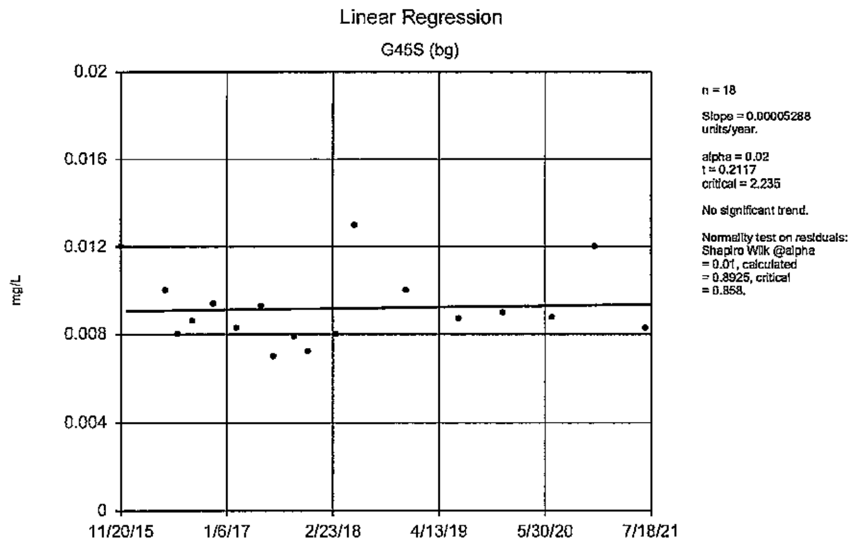
Mann-Kendall statistic = 0
critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Mercury Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 18

Slope = 0.00005288 units/year.

alpha = 0.02
t = 0.2117
critical = 2.235

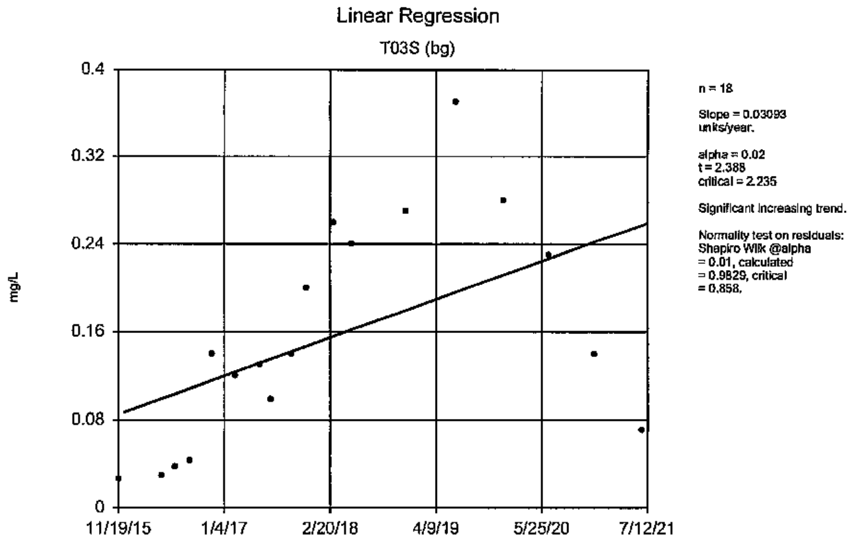
No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.8925, critical = 0.858.

Constituent: Molybdenum Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 18

Slope = 0.03093 units/year.

alpha = 0.02
t = 2.388
critical = 2.235

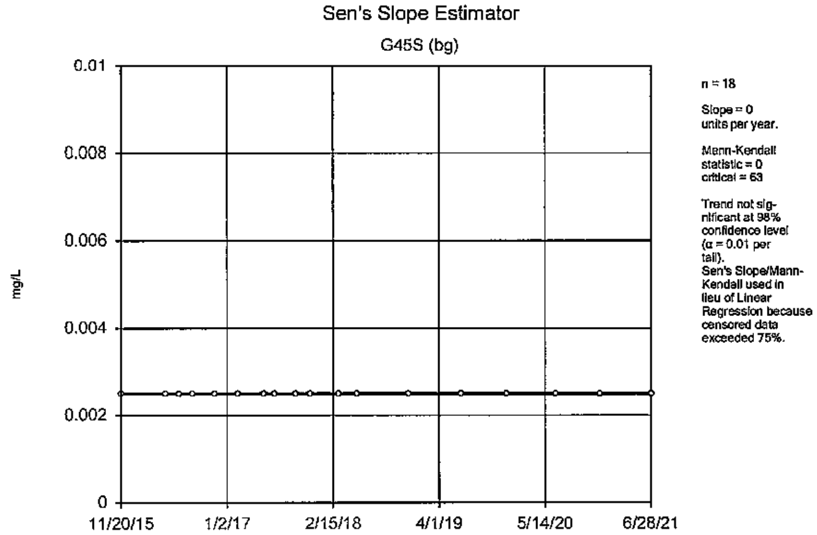
Significant increasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9829, critical = 0.858.

Constituent: Molybdenum Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 18

Slope = 0 units per year.

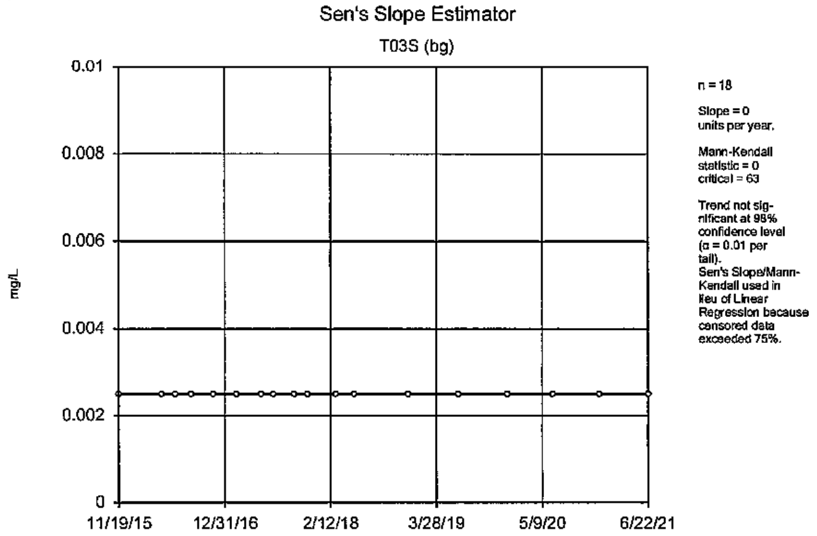
Mann-Kendall statistic = 0 critical = 63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Selenium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 18

Slope = 0 units per year.

Mann-Kendall statistic = 0 critical = 63

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

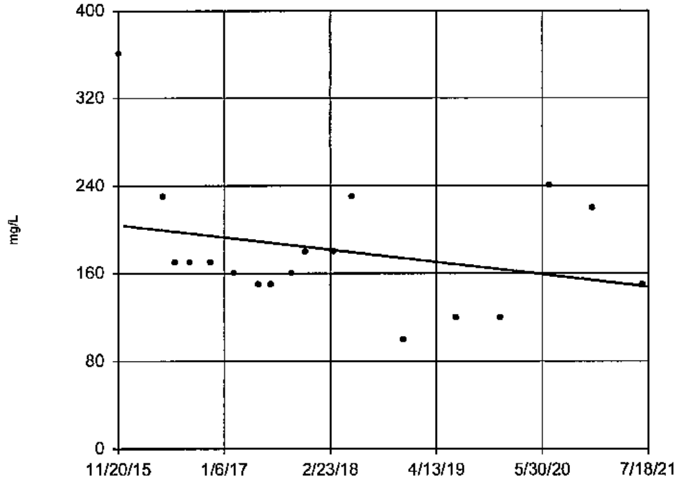
Constituent: Selenium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Linear Regression

G45S (bg)



n = 18

Slope = -9.969
units/year.

alpha = 0.02
t = -1.166
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8675, critical
= 0.858.

Constituent: Sulfate Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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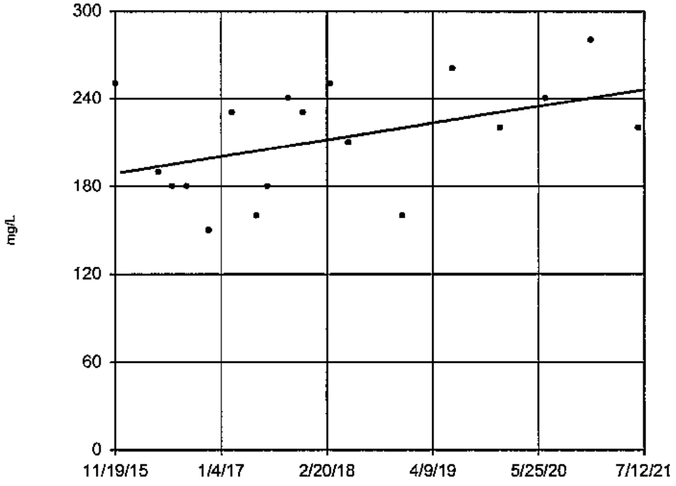
Linear Regression

T03S (bg)



n = 18

Slope = 10.09
units/year.

alpha = 0.02
t = 1.957
critical = 2.235

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9657, critical
= 0.858.

Constituent: Sulfate Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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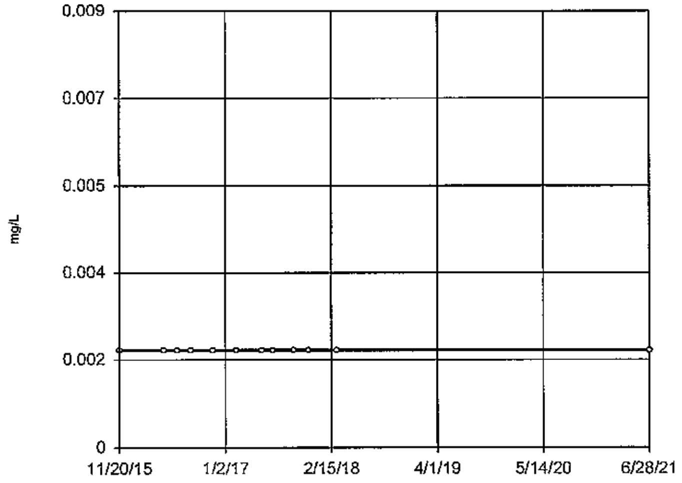
Hollow symbols indicate censored values.

Sen's Slope Estimator

G45S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
censored data
exceeded 75%.

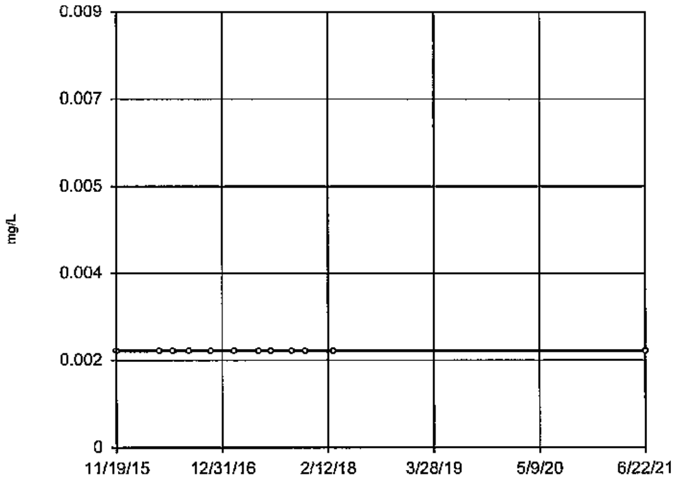
Constituent: Thallium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

T03S (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

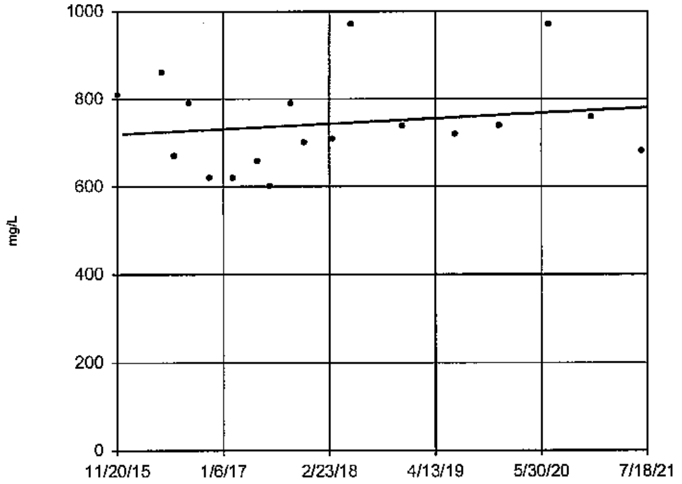
Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
censored data
exceeded 75%.

Constituent: Thallium Analysis Run 8/9/2021 2:45 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Linear Regression

G45S (bg)



n = 18

Slope = 10.49
units/year.

alpha = 0.02
t = 0.66
critical = 2.235

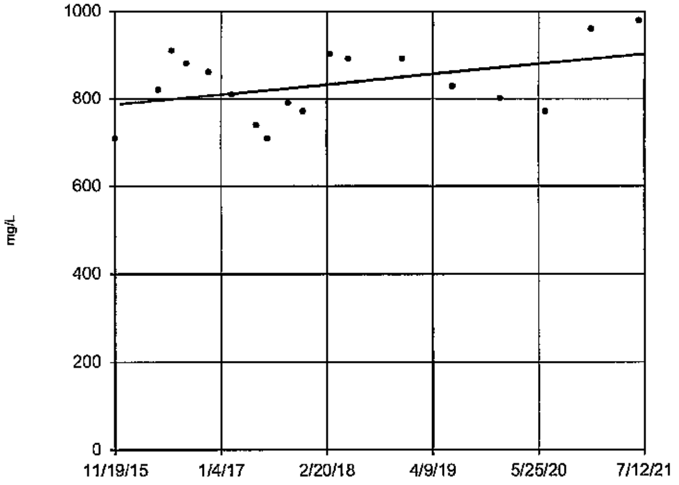
No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9152, critical
= 0.858.

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Linear Regression

T03S (bg)



n = 18

Slope = 20.44
units/year.

alpha = 0.02
t = 1.894
critical = 2.235

No significant trend.

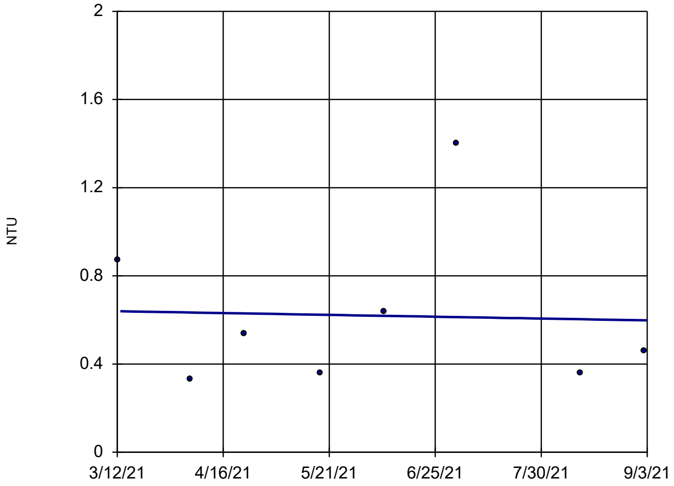
Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9216, critical
= 0.858.

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 2:45 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Linear Regression

G45S (bg)



n = 8

Slope = -0.08649
units/year.

alpha = 0.02
t = -0.09738
critical = 2.612

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.813, critical =
0.749.

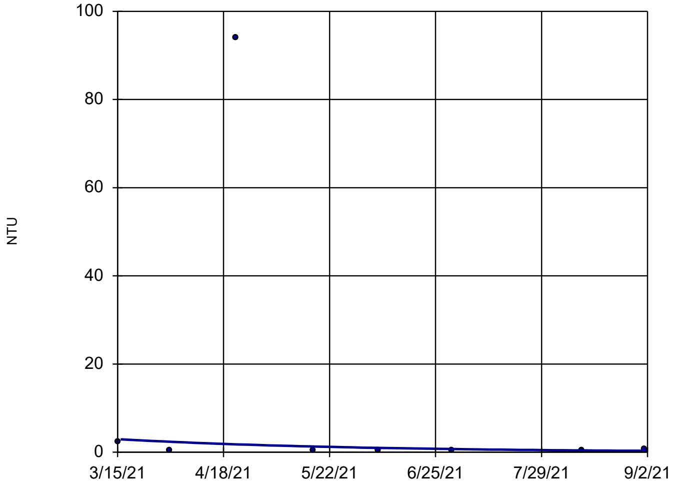
Constituent: Turbidity Analysis Run 10/8/2021 11:52 AM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Linear Regression

T03S (bg)



n = 8

Slope = -4.804
natural log units/year.

alpha = 0.02
t = -1.117
critical = 2.612

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.7908 after natural
log transformation,
critical = 0.749.

Constituent: Turbidity Analysis Run 10/8/2021 11:52 AM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Trend Test Joliet #9 UG WellsTurbidity

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 10/8/2021, 11:53 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Turbidity (NTU)	G45S (bg)	-0.08649	-0.09738	2.612	No	8	0	Yes	no	0.02	Param.
Turbidity (NTU)	T03S (bg)	-4.804	-1.117	2.612	No	8	0	Yes	natura...	0.02	Param.

Joliet #9 ANOVA UG Wells All Values

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 8/9/2021, 2:49 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Arsenic (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Barium (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Boron (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Calcium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Cobalt (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Combined Radium 226 + 228 (pCi/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Field pH (SU)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Fluoride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Lead (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Lithium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Molybdenum (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.

Parametric ANOVA

Constituent: Arsenic Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 592.4

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.9646, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.2153, tabulated = 4.134.

Parametric ANOVA

Constituent: Barium   Analysis Run 8/9/2021 2:49 PM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 425.4

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.9657, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.06556, tabulated = 4.134.

Parametric ANOVA

Constituent: Boron   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 75.07

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.9672, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 2.445, tabulated = 4.134.

Non-Parametric ANOVA

Constituent: Calcium Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 3.948

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 8 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 3.848
Adjusted Kruskal-Wallis statistic (H') = 3.948

Non-Parametric ANOVA

Constituent: Chloride Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 11.33

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 8 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 11.25
Adjusted Kruskal-Wallis statistic (H') = 11.33

Non-Parametric ANOVA

Constituent: Cobalt   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 13.04

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 5 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 8.108
Adjusted Kruskal-Wallis statistic (H') = 13.04

Non-Parametric ANOVA

Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 21.5

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 3 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 21.49
Adjusted Kruskal-Wallis statistic (H') = 21.5

Parametric ANOVA

Constituent: Field pH   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 1.721

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9749, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.348, tabulated = 4.134.

Non-Parametric ANOVA

Constituent: Fluoride   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 18.87

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 10 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 18.65
Adjusted Kruskal-Wallis statistic (H') = 18.87

Non-Parametric ANOVA

Constituent: Lead   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 1

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.08108
Adjusted Kruskal-Wallis statistic (H') = 1

Parametric ANOVA

Constituent: Lithium   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 56.17

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9351, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.4952, tabulated = 4.134.

Non-Parametric ANOVA

Constituent: Molybdenum   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 26.3

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 5 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 26.27
Adjusted Kruskal-Wallis statistic (H') = 26.3

Parametric ANOVA

Constituent: Sulfate   Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 4.453

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.956, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.9277, tabulated = 4.134.

Parametric ANOVA

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 2:49 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

For observations made between 11/19/2015 and 6/28/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 8.045

Tabulated F statistic = 4.134 with 1 and 34 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	72003	1	72003	8.045
Error Within Groups	304294	34	8950	
Total	376297	35		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9494, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.706, tabulated = 4.134.

Non-Parametric ANOVA

Constituent: Turbidity   Analysis Run 10/8/2021 11:54 AM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

For observations made between 3/12/2021 and 9/2/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.04425

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.04412
Adjusted Kruskal-Wallis statistic (H') = 0.04425

ANOVA Joliet #9 UG Wells - Turbidity

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 10/8/2021, 11:54 AM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Turbidity (NTU)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)

Shapiro-Wilk Normality Test

Constituent: Antimony Analysis Run 8/9/2021 3:02 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
T03S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Arsenic Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.9429	0.897	Yes
	square root	0.9448	0.897	Yes
	square	0.9348	0.897	Yes
	cube root	0.9451	0.897	Yes
	cube	0.921	0.897	Yes
	natural log	0.9453	0.897	Yes
	x^4	0.9019	0.897	Yes
	x^5	0.878	0.897	No
	x^6	0.8503	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9474	0.897	Yes
	square root	0.9415	0.897	Yes
	square	0.8931	0.897	No
	cube root	0.9319	0.897	Yes
	cube	0.8166	0.897	No
	natural log	0.9006	0.897	Yes
	x^4	0.7505	0.897	No
	x^5	0.6986	0.897	No
	x^6	0.6582	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.8046	0.935	No
	square root	0.8183	0.935	No
	square	0.8048	0.935	No
	cube root	0.825	0.935	No
	cube	0.8059	0.935	No
	natural log	0.8373	0.935	No
	x^4	0.7893	0.935	No
	x^5	0.7579	0.935	No
	x^6	0.7189	0.935	No

Shapiro-Wilk Normality Test

Constituent: Barium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.9528	0.897	Yes
	square root	0.9604	0.897	Yes
	square	0.9333	0.897	Yes
	cube root	0.9626	0.897	Yes
	cube	0.9088	0.897	Yes
	natural log	0.9665	0.897	Yes
	x^4	0.8801	0.897	No
	x^5	0.8485	0.897	No
	x^6	0.815	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.8897	0.897	No
	square root	0.8798	0.897	No
	square	0.8899	0.897	No
	cube root	0.875	0.897	No
	cube	0.8667	0.897	No
	natural log	0.8635	0.897	No
	x^4	0.8258	0.897	No
	x^5	0.7745	0.897	No
	x^6	0.719	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.8261	0.935	No
	square root	0.8267	0.935	No
	square	0.8256	0.935	No
	cube root	0.8271	0.935	No
	cube	0.8211	0.935	No
	natural log	0.828	0.935	No
	x^4	0.8051	0.935	No
	x^5	0.7726	0.935	No
	x^6	0.7239	0.935	No

Shapiro-Wilk Normality Test

Constituent: Beryllium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
T03S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Boron Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.8567	0.897	No
	square root	0.8817	0.897	No
	square	0.8047	0.897	No
	cube root	0.8897	0.897	No
	cube	0.7543	0.897	No
	natural log	0.9048	0.897	Yes
	x^4	0.7083	0.897	No
	x^5	0.6671	0.897	No
	x^6	0.6303	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9222	0.897	Yes
	square root	0.9612	0.897	Yes
	square	0.8093	0.897	No
	cube root	0.9684	0.897	Yes
	cube	0.7014	0.897	No
	natural log	0.9713	0.897	Yes
	x^4	0.6182	0.897	No
	x^5	0.5584	0.897	No
	x^6	0.5159	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.8415	0.935	No
	square root	0.8968	0.935	No
	square	0.6881	0.935	No
	cube root	0.9093	0.935	No
	cube	0.5503	0.935	No
	natural log	0.9249	0.935	No
	x^4	0.4566	0.935	No
	x^5	0.3971	0.935	No
	x^6	0.3588	0.935	No

Shapiro-Wilk Normality Test

Constituent: Cadmium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
T03S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	-1	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Calcium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.9001	0.897	Yes
	square root	0.9088	0.897	Yes
	square	0.88	0.897	No
	cube root	0.9115	0.897	Yes
	cube	0.8565	0.897	No
	natural log	0.9165	0.897	Yes
	x^4	0.8299	0.897	No
	x^5	0.8009	0.897	No
	x^6	0.7699	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.7677	0.897	No
	square root	0.7823	0.897	No
	square	0.735	0.897	No
	cube root	0.7868	0.897	No
	cube	0.6983	0.897	No
	natural log	0.7955	0.897	No
	x^4	0.6588	0.897	No
	x^5	0.6179	0.897	No
	x^6	0.5771	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9187	0.935	No
	square root	0.9317	0.935	No
	square	0.8865	0.935	No
	cube root	0.9355	0.935	Yes
	cube	0.8467	0.935	No
	natural log	0.9425	0.935	Yes
	x^4	0.8008	0.935	No
	x^5	0.7504	0.935	No
	x^6	0.6978	0.935	No

Shapiro-Wilk Normality Test

Constituent: Chloride Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.898	0.897	Yes
	square root	0.9255	0.897	Yes
	square	0.8298	0.897	No
	cube root	0.9335	0.897	Yes
	cube	0.7517	0.897	No
	natural log	0.9474	0.897	Yes
	x^4	0.6724	0.897	No
	x^5	0.5985	0.897	No
	x^6	0.5335	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.8597	0.897	No
	square root	0.8958	0.897	No
	square	0.7744	0.897	No
	cube root	0.9065	0.897	Yes
	cube	0.6829	0.897	No
	natural log	0.9257	0.897	Yes
	x^4	0.5969	0.897	No
	x^5	0.5233	0.897	No
	x^6	0.4638	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9079	0.935	No
	square root	0.9401	0.935	Yes
	square	0.819	0.935	No
	cube root	0.9485	0.935	Yes
	cube	0.7133	0.935	No
	natural log	0.9618	0.935	Yes
	x^4	0.6088	0.935	No
	x^5	0.5167	0.935	No
	x^6	0.4408	0.935	No

Shapiro-Wilk Normality Test

Constituent: Chromium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
T03S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Cobalt Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	-1	0.897	No
	square root	0	0.897	No
	square	-1	0.897	No
	cube root	0	0.897	No
	cube	-1	0.897	No
	natural log	0	0.897	No
	x^4	-1	0.897	No
	x^5	-1	0.897	No
	x^6	-1	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.8169	0.897	No
	square root	0.8202	0.897	No
	square	0.8059	0.897	No
	cube root	0.821	0.897	No
	cube	0.789	0.897	No
	natural log	0.8222	0.897	No
	x^4	0.7668	0.897	No
	x^5	0.7402	0.897	No
	x^6	0.7105	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.597	0.935	No
	square root	0.601	0.935	No
	square	0.5864	0.935	No
	cube root	0.6021	0.935	No
	cube	0.5724	0.935	No
	natural log	0.6041	0.935	No
	x^4	0.5549	0.935	No
	x^5	0.5345	0.935	No
	x^6	0.512	0.935	No

Shapiro-Wilk Normality Test

Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 16, alpha = 0.05)				
	no	0.511	0.887	No
	square root	0.6109	0.887	No
	square	0.3754	0.887	No
	cube root	0.6471	0.887	No
	cube	0.3128	0.887	No
	natural log	0.7197	0.887	No
	x^4	0.2877	0.887	No
	x^5	0.2782	0.887	No
	x^6	0.2747	0.887	No
T03S (bg) (n = 16, alpha = 0.05)				
	no	0.9665	0.887	Yes
	square root	0.9641	0.887	Yes
	square	0.9607	0.887	Yes
	cube root	0.9625	0.887	Yes
	cube	0.9439	0.887	Yes
	natural log	0.9579	0.887	Yes
	x^4	0.9198	0.887	Yes
	x^5	0.8917	0.887	Yes
	x^6	0.8621	0.887	No
Pooled Background (bg) (n = 32, alpha = 0.05)				
	no	0.5338	0.93	No
	square root	0.7014	0.93	No
	square	0.3089	0.93	No
	cube root	0.7569	0.93	No
	cube	0.2233	0.93	No
	natural log	0.855	0.93	No
	x^4	0.1951	0.93	No
	x^5	0.1858	0.93	No
	x^6	0.1827	0.93	No

Shapiro-Wilk Normality Test

Constituent: Field pH Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.957	0.897	Yes
	square root	0.9568	0.897	Yes
	square	0.9571	0.897	Yes
	cube root	0.9567	0.897	Yes
	cube	0.957	0.897	Yes
	natural log	0.9566	0.897	Yes
	x^4	0.9566	0.897	Yes
	x^5	0.9559	0.897	Yes
	x^6	0.9549	0.897	Yes
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.966	0.897	Yes
	square root	0.9669	0.897	Yes
	square	0.9637	0.897	Yes
	cube root	0.9672	0.897	Yes
	cube	0.9611	0.897	Yes
	natural log	0.9678	0.897	Yes
	x^4	0.958	0.897	Yes
	x^5	0.9545	0.897	Yes
	x^6	0.9506	0.897	Yes
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9765	0.935	Yes
	square root	0.9766	0.935	Yes
	square	0.976	0.935	Yes
	cube root	0.9766	0.935	Yes
	cube	0.9752	0.935	Yes
	natural log	0.9766	0.935	Yes
	x^4	0.9741	0.935	Yes
	x^5	0.9726	0.935	Yes
	x^6	0.9708	0.935	Yes

Shapiro-Wilk Normality Test

Constituent: Fluoride Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.486	0.897	No
	square root	0.4131	0.897	No
	square	0.6472	0.897	No
	cube root	0.3917	0.897	No
	cube	0.782	0.897	No
	natural log	0.3544	0.897	No
	x^4	0.8681	0.897	No
	x^5	0.9115	0.897	Yes
	x^6	0.9249	0.897	Yes
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.8645	0.897	No
	square root	0.7698	0.897	No
	square	0.9048	0.897	Yes
	cube root	0.7289	0.897	No
	cube	0.8395	0.897	No
	natural log	0.6408	0.897	No
	x^4	0.7587	0.897	No
	x^5	0.6875	0.897	No
	x^6	0.6288	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.8634	0.935	No
	square root	0.7876	0.935	No
	square	0.9107	0.935	No
	cube root	0.7525	0.935	No
	cube	0.9059	0.935	No
	natural log	0.6711	0.935	No
	x^4	0.8941	0.935	No
	x^5	0.8823	0.935	No
	x^6	0.8697	0.935	No

Shapiro-Wilk Normality Test

Constituent: Lead   Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	-1	0.897	No
	square root	0	0.897	No
	square	-1	0.897	No
	cube root	0	0.897	No
	cube	-1	0.897	No
	natural log	0	0.897	No
	x^4	-1	0.897	No
	x^5	-1	0.897	No
	x^6	-1	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.2528	0.897	No
	square root	0.2528	0.897	No
	square	0.2528	0.897	No
	cube root	0.2528	0.897	No
	cube	0.2528	0.897	No
	natural log	0.2528	0.897	No
	x^4	0.2528	0.897	No
	x^5	0.2528	0.897	No
	x^6	0.2528	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.1702	0.935	No
	square root	0.1702	0.935	No
	square	0.1702	0.935	No
	cube root	0.1702	0.935	No
	cube	0.1702	0.935	No
	natural log	0.1702	0.935	No
	x^4	0.1702	0.935	No
	x^5	0.1702	0.935	No
	x^6	0.1702	0.935	No

Shapiro-Wilk Normality Test

Constituent: Lithium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.936	0.897	Yes
	square root	0.9417	0.897	Yes
	square	0.9221	0.897	Yes
	cube root	0.9433	0.897	Yes
	cube	0.9047	0.897	Yes
	natural log	0.9463	0.897	Yes
	x^4	0.8845	0.897	No
	x^5	0.8619	0.897	No
	x^6	0.8376	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9363	0.897	Yes
	square root	0.9491	0.897	Yes
	square	0.9037	0.897	Yes
	cube root	0.9527	0.897	Yes
	cube	0.8637	0.897	No
	natural log	0.959	0.897	Yes
	x^4	0.819	0.897	No
	x^5	0.7723	0.897	No
	x^6	0.7259	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9534	0.935	Yes
	square root	0.9488	0.935	Yes
	square	0.9476	0.935	Yes
	cube root	0.9462	0.935	Yes
	cube	0.9227	0.935	No
	natural log	0.9396	0.935	Yes
	x^4	0.8827	0.935	No
	x^5	0.8333	0.935	No
	x^6	0.7805	0.935	No

Shapiro-Wilk Normality Test

Constituent: Mercury Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 11, alpha = 0.05)				
	no	-1	0.85	No
	square root	-1	0.85	No
	square	-1	0.85	No
	cube root	0	0.85	No
	cube	-1	0.85	No
	natural log	-1	0.85	No
	x^4	-1	0.85	No
	x^5	-1	0.85	No
	x^6	-1	0.85	No
T03S (bg) (n = 11, alpha = 0.05)				
	no	-1	0.85	No
	square root	-1	0.85	No
	square	-1	0.85	No
	cube root	0	0.85	No
	cube	-1	0.85	No
	natural log	-1	0.85	No
	x^4	-1	0.85	No
	x^5	-1	0.85	No
	x^6	-1	0.85	No
Pooled Background (bg) (n = 22, alpha = 0.05)				
	no	-1	0.911	No
	square root	-1	0.911	No
	square	-1	0.911	No
	cube root	0	0.911	No
	cube	-1	0.911	No
	natural log	0	0.911	No
	x^4	-1	0.911	No
	x^5	-1	0.911	No
	x^6	-1	0.911	No

Shapiro-Wilk Normality Test

Constituent: Molybdenum Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.8933	0.897	No
	square root	0.9147	0.897	Yes
	square	0.8446	0.897	No
	cube root	0.9213	0.897	Yes
	cube	0.7927	0.897	No
	natural log	0.9334	0.897	Yes
	x^4	0.7415	0.897	No
	x^5	0.6939	0.897	No
	x^6	0.6511	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9403	0.897	Yes
	square root	0.9496	0.897	Yes
	square	0.8352	0.897	No
	cube root	0.9422	0.897	Yes
	cube	0.7059	0.897	No
	natural log	0.9115	0.897	Yes
	x^4	0.5907	0.897	No
	x^5	0.4984	0.897	No
	x^6	0.4292	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.7558	0.935	No
	square root	0.8011	0.935	No
	square	0.6318	0.935	No
	cube root	0.8102	0.935	No
	cube	0.5175	0.935	No
	natural log	0.8187	0.935	No
	x^4	0.4246	0.935	No
	x^5	0.3531	0.935	No
	x^6	0.3004	0.935	No

Shapiro-Wilk Normality Test

Constituent: Selenium   Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	-1	0.897	No
	square root	0	0.897	No
	square	-1	0.897	No
	cube root	-1	0.897	No
	cube	-1	0.897	No
	natural log	0	0.897	No
	x^4	-1	0.897	No
	x^5	-1	0.897	No
	x^6	-1	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	-1	0.897	No
	square root	0	0.897	No
	square	-1	0.897	No
	cube root	-1	0.897	No
	cube	-1	0.897	No
	natural log	0	0.897	No
	x^4	-1	0.897	No
	x^5	-1	0.897	No
	x^6	-1	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	-1	0.935	No
	square root	0	0.935	No
	square	-1	0.935	No
	cube root	-1	0.935	No
	cube	-1	0.935	No
	natural log	0	0.935	No
	x^4	-1	0.935	No
	x^5	-1	0.935	No
	x^6	-1	0.935	No

Shapiro-Wilk Normality Test

Constituent: Sulfate Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.861	0.897	No
	square root	0.9174	0.897	Yes
	square	0.7145	0.897	No
	cube root	0.9318	0.897	Yes
	cube	0.5709	0.897	No
	natural log	0.9533	0.897	Yes
	x^4	0.4606	0.897	No
	x^5	0.3857	0.897	No
	x^6	0.3373	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9533	0.897	Yes
	square root	0.9485	0.897	Yes
	square	0.9556	0.897	Yes
	cube root	0.9464	0.897	Yes
	cube	0.9477	0.897	Yes
	natural log	0.9415	0.897	Yes
	x^4	0.9299	0.897	Yes
	x^5	0.9033	0.897	Yes
	x^6	0.8695	0.897	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9499	0.935	Yes
	square root	0.9696	0.935	Yes
	square	0.8639	0.935	No
	cube root	0.9724	0.935	Yes
	cube	0.7354	0.935	No
	natural log	0.9723	0.935	Yes
	x^4	0.5974	0.935	No
	x^5	0.4771	0.935	No
	x^6	0.3852	0.935	No

Shapiro-Wilk Normality Test

Constituent: Thallium Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
T03S (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 3:03 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Well	Transformation	Calculated	Critical	Normal
G45S (bg) (n = 18, alpha = 0.05)				
	no	0.9219	0.897	Yes
	square root	0.9374	0.897	Yes
	square	0.8843	0.897	No
	cube root	0.942	0.897	Yes
	cube	0.8402	0.897	No
	natural log	0.9502	0.897	Yes
	x^4	0.7925	0.897	No
	x^5	0.7443	0.897	No
	x^6	0.6979	0.897	No
T03S (bg) (n = 18, alpha = 0.05)				
	no	0.9677	0.897	Yes
	square root	0.9681	0.897	Yes
	square	0.9639	0.897	Yes
	cube root	0.968	0.897	Yes
	cube	0.9562	0.897	Yes
	natural log	0.9674	0.897	Yes
	x^4	0.9447	0.897	Yes
	x^5	0.9299	0.897	Yes
	x^6	0.9122	0.897	Yes
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9658	0.935	Yes
	square root	0.9684	0.935	Yes
	square	0.9542	0.935	Yes
	cube root	0.9688	0.935	Yes
	cube	0.9354	0.935	Yes
	natural log	0.9687	0.935	Yes
	x^4	0.911	0.935	No
	x^5	0.8826	0.935	No
	x^6	0.852	0.935	No

Shapiro-Wilk Normality Test

Constituent: Turbidity   Analysis Run 10/8/2021 11:51 AM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

```
Well                  Transformation        Calculated            Critical              Normal
G45S (bg) (n = 8, alpha = 0.05)
                      no                    0.8058                0.818                 No
                      square root           0.8631                0.818                 Yes
                      square                0.6821                0.818                 No
                      cube root             0.8795                0.818                 Yes
                      cube                  0.5827                0.818                 No
                      natural log           0.9071                0.818                 Yes
                      x^4                   0.5174                0.818                 No
                      x^5                   0.4778                0.818                 No
                      x^6                   0.4542                0.818                 No
T03S (bg) (n = 8, alpha = 0.05)
                      no                    0.4327                0.818                 No
                      square root           0.4917                0.818                 No
                      square                0.419                 0.818                 No
                      cube root             0.5363                0.818                 No
                      cube                  0.4186                0.818                 No
                      natural log           0.6699                0.818                 No
                      x^4                   0.4186                0.818                 No
                      x^5                   0.4186                0.818                 No
                      x^6                   0.4186                0.818                 No
Pooled Background (bg) (n = 16, alpha = 0.05)
                      no                    0.2879                0.887                 No
                      square root           0.3593                0.887                 No
                      square                0.273                 0.887                 No
                      cube root             0.4178                0.887                 No
                      cube                  0.2727                0.887                 No
                      natural log           0.6067                0.887                 No
                      x^4                   0.2727                0.887                 No
                      x^5                   0.2727                0.887                 No
                      x^6                   0.2727                0.887                 No
```

Interwell Joliet #9 Interwell PL UG G45S and T03S All Values

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29 Printed 8/9/2021, 3:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Antimony (mg/L)	n/a	0.003	n/a	n/a	8 future	n/a	24	100	n/a	0.002646	NP (NDs) 1 of 2
Beryllium (mg/L)	n/a	0.001	n/a	n/a	8 future	n/a	24	100	n/a	0.002646	NP (NDs) 1 of 2
Cadmium (mg/L)	n/a	0.0005	n/a	n/a	8 future	n/a	24	100	n/a	0.002646	NP (NDs) 1 of 2
Chromium (mg/L)	n/a	0.005	n/a	n/a	8 future	n/a	24	100	n/a	0.002646	NP (NDs) 1 of 2
Field pH (SU)	n/a	7.618	6.847	n/a	8 future	n/a	36	0	No	0.000...	Param 1 of 2
Lead (mg/L)	n/a	0.0023	n/a	n/a	8 future	n/a	36	97.22	n/a	0.001311	NP (NDs) 1 of 2
Mercury (mg/L)	n/a	0.0002	n/a	n/a	8 future	n/a	22	100	n/a	0.003067	NP (NDs) 1 of 2
Selenium (mg/L)	n/a	0.0025	n/a	n/a	8 future	n/a	36	100	n/a	0.001311	NP (NDs) 1 of 2
Thallium (mg/L)	n/a	0.002	n/a	n/a	8 future	n/a	24	100	n/a	0.002646	NP (NDs) 1 of 2

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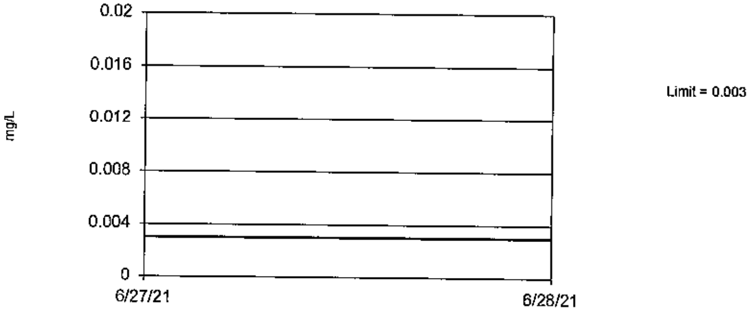
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 24) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.08129. Individual comparison alpha = 0.002646 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Antimony Analysis Run 8/9/2021 3:55 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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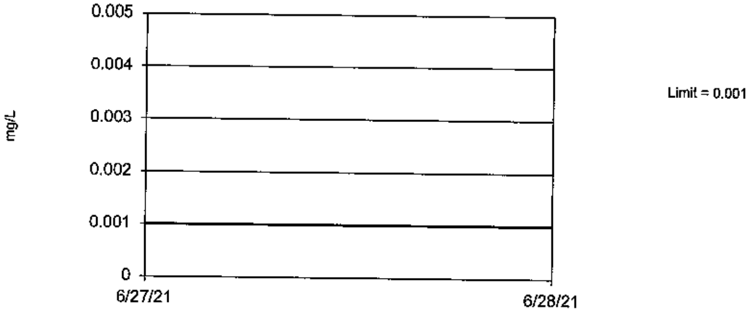
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 24) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.08129. Individual comparison alpha = 0.002646 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Beryllium Analysis Run 8/9/2021 3:55 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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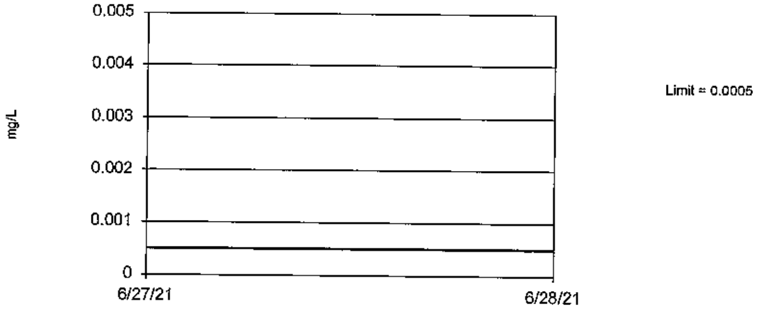
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 24) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.08129. Individual comparison alpha = 0.002646 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Cadmium Analysis Run 8/9/2021 3:55 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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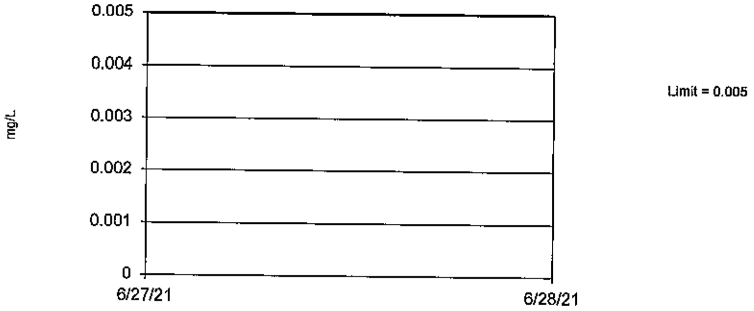
Prediction Limit

Interwell Non-parametric

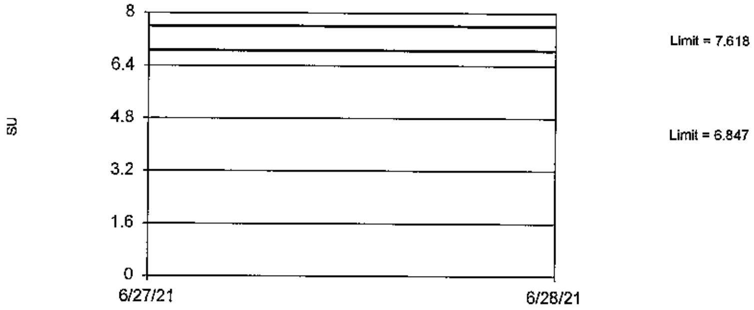


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 24) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.08129. Individual comparison alpha = 0.002646 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Chromium Analysis Run 8/9/2021 3:55 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Parametric



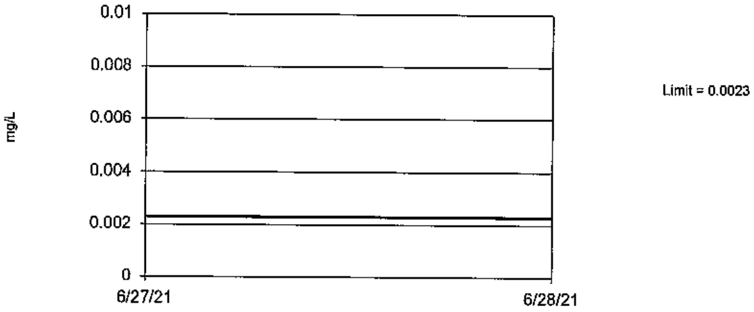
Background Data Summary: Mean=7.233, Std. Dev.=0.1528, n=36. Seasonality was not detected with 95% confidence. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9765, critical = 0.935. Kappa = 2.522 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.00007482. Assumes 8 future values.

Constituent: Field pH Analysis Run 8/9/2021 3:55 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Non-parametric



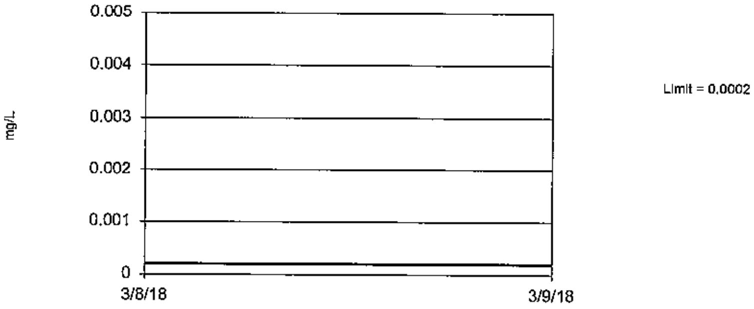
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 36 background values. 97.22% NDs. Annual per-constituent alpha = 0.04111. Individual comparison alpha = 0.001311 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Lead Analysis Run 8/9/2021 3:55 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Non-parametric



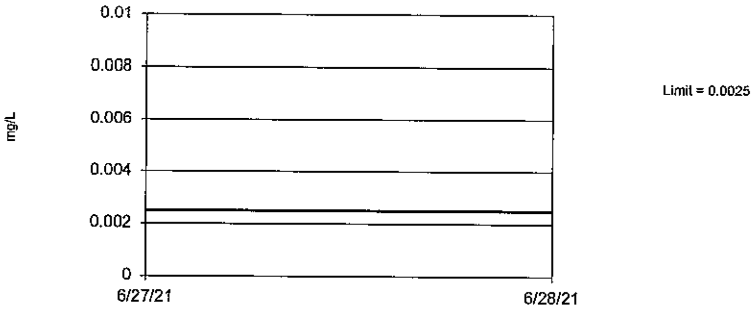
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 22) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.09361. Individual comparison alpha = 0.003067 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Mercury Analysis Run 8/9/2021 3:55 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

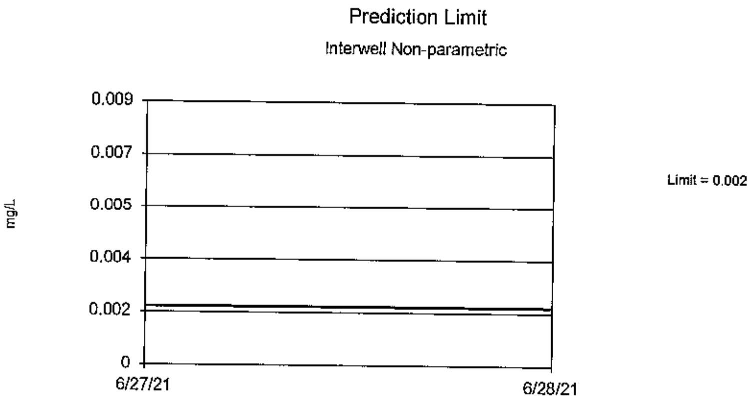
Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 36) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.04111. Individual comparison alpha = 0.001311 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

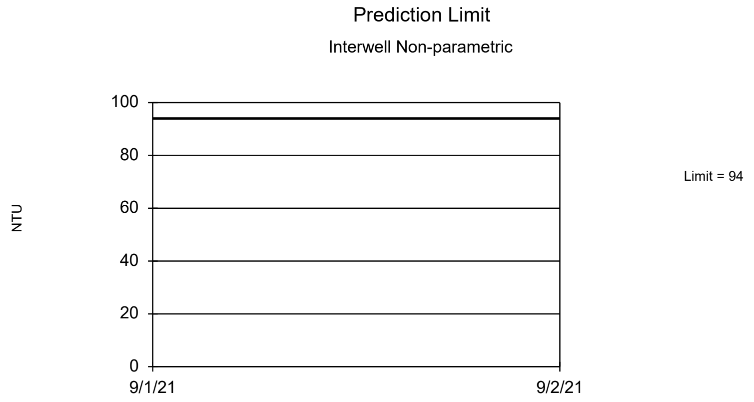
Constituent: Selenium Analysis Run 8/9/2021 3:55 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 24) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.08129. Individual comparison alpha = 0.002646 (1 of 2). Assumes 8 future values. Seasonality was not detected with 95% confidence.

Constituent: Thallium Analysis Run 8/9/2021 3:55 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 16 background values. Annual per-constituent alpha = 0.1454. Individual comparison alpha = 0.004899 (1 of 2). Assumes 8 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Turbidity   Analysis Run 10/8/2021 11:54 AM

Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29

Interwell Prediction Limit Joliet #9 Comb G45S-T03S Turbidity

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29 Printed 10/8/2021, 11:56 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Turbidity (NTU)	n/a	94	n/a	n/a	8 future	n/a	16	0	n/a	0.004899	NP (normality) 1 of 2

Interwell Joliet #9 Interwell PL UG G45S All Values

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29 Printed 8/9/2021, 3:50 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Barium (mg/L)	n/a	0.05321	n/a	n/a	8 future	n/a	18	0	No	0.000...	Param 1 of 2
Boron (mg/L)	n/a	1.039	n/a	n/a	8 future	n/a	18	5.556	ln(x)	0.000...	Param 1 of 2
Calcium (mg/L)	n/a	138.4	n/a	n/a	8 future	n/a	18	0	No	0.000...	Param 1 of 2
Chloride (mg/L)	n/a	232.4	n/a	n/a	8 future	n/a	18	0	No	0.000...	Param 1 of 2
Cobalt (mg/L)	n/a	0.001	n/a	n/a	8 future	n/a	18	100	n/a	0.004188	NP (NDs) 1 of 2
Fluoride (mg/L)	n/a	0.3889	n/a	n/a	8 future	n/a	18	5.556	x^5	0.000...	Param 1 of 2
Lithium (mg/L)	n/a	0.04228	n/a	n/a	8 future	n/a	18	0	No	0.000...	Param 1 of 2
Molybdenum (mg/L)	n/a	0.01432	n/a	n/a	8 future	n/a	18	0	sqrt(x)	0.000...	Param 1 of 2
Sulfate (mg/L)	n/a	369.6	n/a	n/a	8 future	n/a	18	0	sqrt(x)	0.000...	Param 1 of 2
Total Dissolved Solids (mg/L)	n/a	1053	n/a	n/a	8 future	n/a	18	0	No	0.000...	Param 1 of 2

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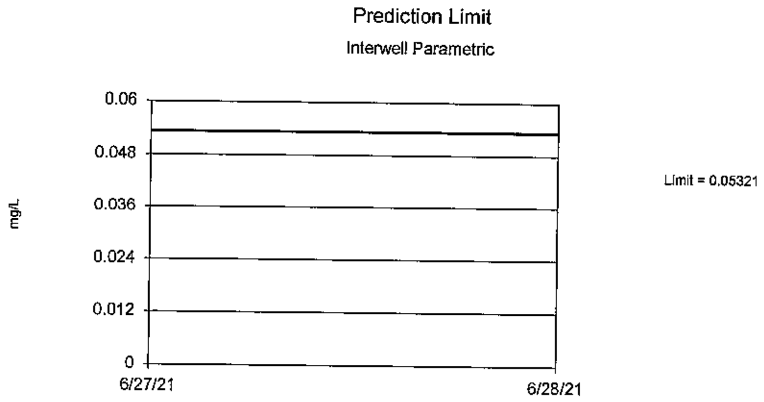

Background Data Summary: Mean=0.0385, Std. Dev.=0.005136, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9528, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Barium Analysis Run 8/9/2021 3:50 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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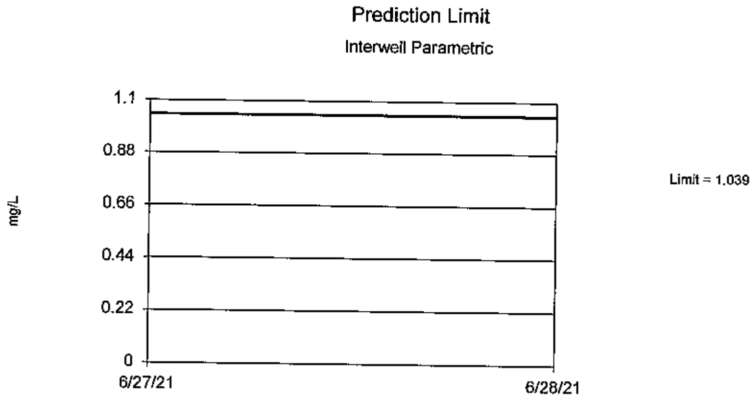
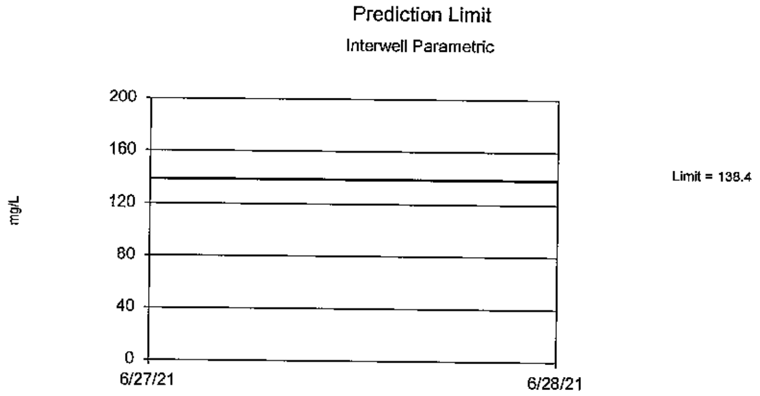


Background Data Summary (based on natural log transformation): Mean=-0.719, Std. Dev.=0.2643, n=18, 5.556% NDs. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9048, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Boron Analysis Run 8/9/2021 3:50 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

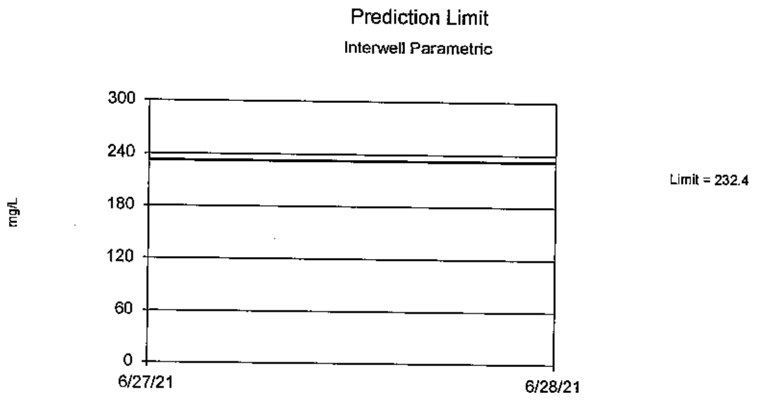
Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



Background Data Summary: Mean=101.6, Std. Dev.=12.86, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9001, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Calcium Analysis Run 8/9/2021 3:50 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

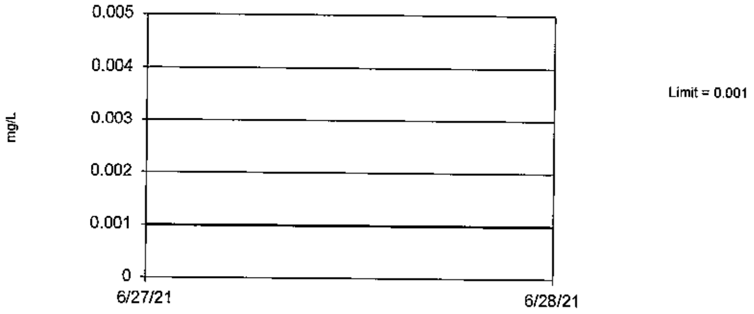


Background Data Summary: Mean=133.2, Std. Dev.=34.65, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.898, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Chloride Analysis Run 8/9/2021 3:50 PM
Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Non-parametric



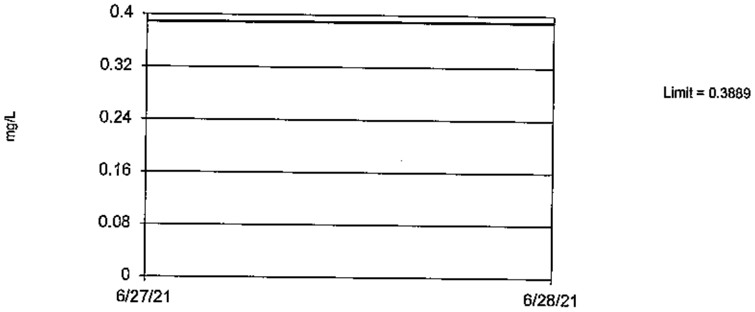
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 18) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.1257. Individual comparison alpha = 0.004188 (1 of 2). Assumes 8 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Cobalt Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Parametric



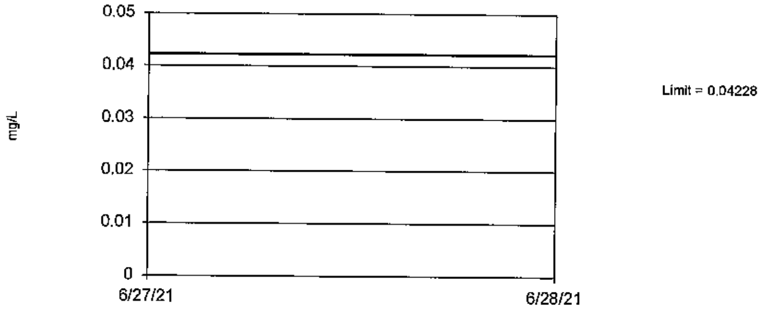
Background Data Summary (based on x^5 transformation): Mean=0.00426, Std. Dev.=0.001619, n=18, 5.556% NDs. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9115, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Fluoride Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Parametric



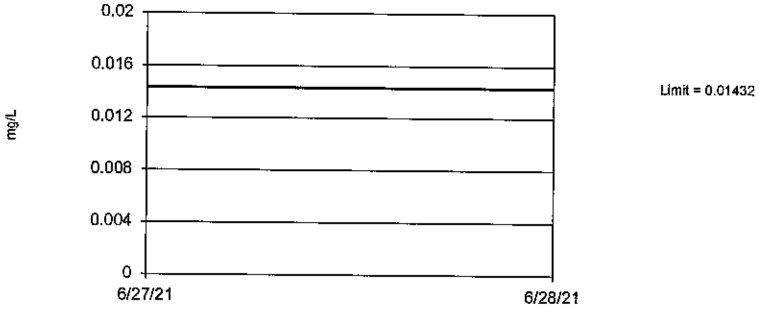
Background Data Summary: Mean=0.03189, Std. Dev.=0.003628, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.936, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Lithium Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Prediction Limit

Interwell Parametric



Background Data Summary (based on square root transformation): Mean=0.09554, Std. Dev.=0.008422, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9147, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Molybdenum Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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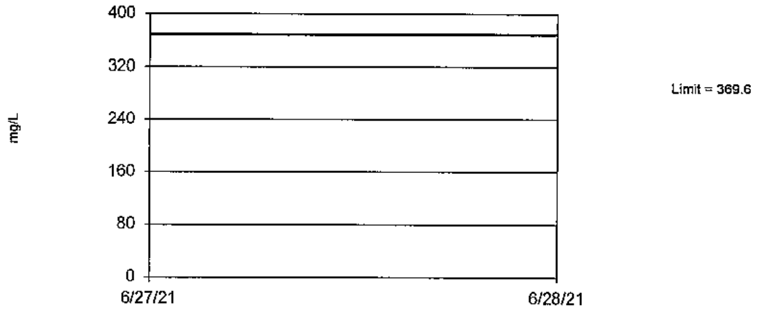
Prediction Limit

Interwell Parametric



Background Data Summary (based on square root transformation): Mean=13.31, Std. Dev.=2.067, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9174, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Sulfate Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

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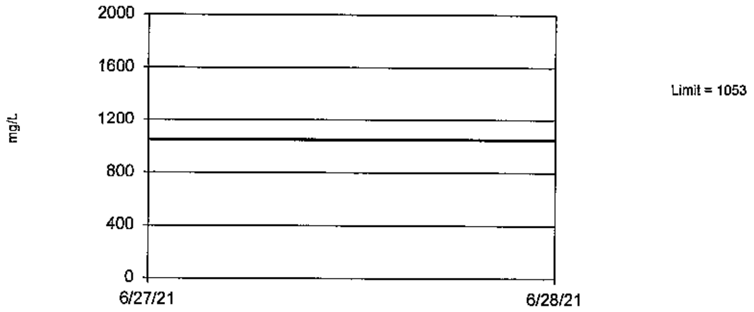
Prediction Limit

Interwell Parametric



Background Data Summary: Mean=745, Std. Dev.=107.4, n=18. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9219, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Total Dissolved Solids Analysis Run 8/9/2021 3:50 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Interwell Joliet #9 Interwell PL UG T03S All Values

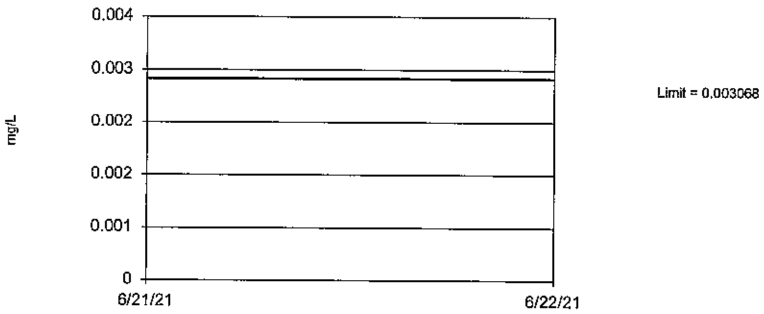
Joliet 9,29 Generating Station   Client: NRG   Data: Joliet 9 - Joliet 29   Printed 8/9/2021, 3:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Arsenic (mg/L)	n/a	0.003068	n/a	n/a	8 future	n/a	18	11.11	No	0.000...	Param 1 of 2
Combined Radium 226 + 228 (pCi/L)	n/a	1.922	n/a	n/a	8 future	n/a	16	0	No	0.000...	Param 1 of 2

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.00145, Std. Dev.=0.0005649, n=18, 11.11% NDs. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9474, critical = 0.897. Kappa = 2.864 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

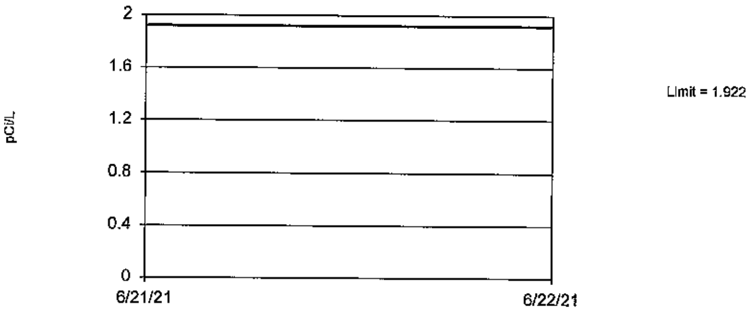
Constituent: Arsenic Analysis Run 8/9/2021 3:48 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=1.334, Std. Dev.=0.1996, n=16. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9665, critical = 0.887. Kappa = 2.946 (c=22, w=8, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001496. Assumes 8 future values.

Constituent: Combined Radium 226 + 228 Analysis Run 8/9/2021 3:48 PM

Joliet 9,29 Generating Station Client: NRG Data: Joliet 9 - Joliet 29

ATTACHMENT 10
P.E. CERTIFICATION

Attachment 10 – No Attachment

ATTACHMENT 11
OWNER CERTIFICATION

Attachment 11 – Owner Certification

I, William Naglosky, as an authorized representative of Midwest Generation, certify that the public notification and public meeting requirements were completed in accordance with 35 Ill. Adm. Code 845.240.

Signature: William Naglosky

Title: Plant Manager.

Midwest Generation, LLC
Joliet 9 Generating Station
Lincoln Stone Quarry Closure Alternatives Assessment
Public Meeting General Summary

INTRODUCTION

In accordance with Title 35 of the Illinois Administrative Code ("35 IAC") Section 845.240, Midwest Generation, LLC (MWG) posted the public meeting notice on the Closure Plans for Joliet 9 Generating Station's Lincoln Stone Quarry on its publicly available website and provided a copy of such notice to the Illinois Environmental Protection Agency (Illinois EPA or Agency) to email to its listserv for this facility. The bilingual public meeting notice was also mailed to all residents within at least 1 mile of the facility on November 6, 2021, which totaled 4,401 residential mailing addresses. The notice was also posted in 35 public locations within 10 miles of the facility boundary.

The public meetings for Joliet 9 Generating Station's Lincoln Stone Quarry were held on December 8, 2021 from 6:00 p.m. to 8:00 p.m. and on December 9, 2021 from 10:00 a.m. to 12:00 p.m. The meetings were held virtually, and participants were invited to attend via Zoom or telephone. Twenty-six members of the public attended the December 8th meeting, and twenty-four members of the public attended the December 9th meeting (the remaining attendees were MWG affiliate employees and consultants). Attendees who wished to sign up for a copy of the meeting summary and/or be added to Illinois EPA's listserv for the facility were asked to sign up via a link to a Google form that was provided within the chat function of the Zoom meeting and posted on MWG's website, midwestgenerationllc.com. Seventeen attendees requested a copy of the meeting summary, fourteen of whom requested transmittal of their email address to the Agency to be added to the Agency's listserv for the facility. It was announced that the link would be available on MWG's public website for two weeks. After an introduction and approximate 45-minute presentation on the proposed closure construction plan, the public was given approximately 1 hour during each meeting to ask questions and provide comments.

This document serves as a summary of the issues and questions raised during the meeting.

MWG proposes to close Lincoln Stone Quarry in place by installing an alternate final cover system (ClosureTurf).

SUMMARY OF ISSUES AND QUESTIONS RAISED DURING THE MEETING

Meeting – General

Several attendees commented on the virtual format of the meeting. MWG had initially intended and even made plans to hold the public meeting in-person. But as the date of the public meeting got closer, case rates in the region were troubling, so it was decided the safest and most prudent thing to do was to hold the meetings virtually. A copy of the presentation is posted on MWG's public website, midwestgenerationllc.com.

Closure Method

Two members of the public commented their agreement with closing the Lincoln Stone Quarry in place with an approved final cover system. The President of the Will County Environmental Network, a group that has been involved in environmental matters in the vicinity of Lincoln Stone Quarry for over 40 years, stated, in part, at the December 8th meeting:

> "The Network believes that covering and maintaining the system design would be the best solution for the closure of this facility. We would be opposed to the removal of the ash for several reasons."

However, others, including members of other environmental groups, oppose MWG's proposal.

Groundwater

Several attendees had questions relating to groundwater impacts from the Lincoln Stone Quarry. Groundwater quality and flow conditions for the facility are monitored on a quarterly basis through an Illinois EPA approved groundwater monitoring well network established pursuant to the Lincoln Stone Quarry's landfill permit issued by the Illinois EPA. The monitoring network consists of both detection wells and assessment wells, which cover all four sides of the facility, including wells that are outside of the Lincoln Stone Quarry property boundary. No private wells have been impacted by the Lincoln Stone Quarry.

In the 2000's, the groundwater flow direction was reversed by dewatering operations at a nearby active quarrying operation to the south. The reversal of groundwater flow caused elevated concentrations of boron, molybdenum, arsenic, and sulfate to migrate from the south/southeastern corner of the Main Quarry. To mitigate the migration, MWG installed a groundwater extraction system along the southern edge of the Lincoln Stone Quarry. The extraction system has been operating since February 2012. The objective of the extraction system is to establish a sufficient hydraulic trough (*i.e.*, a groundwater low point) to capture water moving toward the south and to re-establish an inward hydraulic gradient from the south property boundary to the north. In addition to the extraction system, Illinois EPA approved a groundwater management zone in the area south of the Lincoln Stone Quarry.

Several attendees asked about the groundwater monitoring program. The complete list of analyzed constituents can be found in 35 IAC Section 845.600(a)(1). Groundwater samples are collected by third parties and are sent to a state-certified environmental analytical laboratory for analysis. The results from each groundwater sampling event are posted on MWG's public website – midwestgenerationllc.com.

Groundwater monitoring after closure in place is required for thirty years after completion of closure or the results meet the requirements specified under Section 845.780(c)(2), whichever is later.

Groundwater modeling

Multiple attendees questioned or commented upon the groundwater modeling. The model allows for a mathematical representation of the groundwater flow system. Actual groundwater level data collected from site monitoring wells over many years is used within the model to replicate the flow conditions within the aquifer that currently exist. Once the computer model can sufficiently replicate actual existing field conditions, various proposed engineering scenarios being considered and developed can then be overlain in the model to assess future short- and long-term effects of a proposed engineering option on changes in groundwater quality and flow conditions.

The initial groundwater model was generated as part of the landfill operating permit renewal which was formally approved by Illinois EPA on August 14, 2015 (Landfill Permit No. 1994-241-LFM, Modification No. 21). The model is very large, has 10 layers, and contains approximately 1.7 million cells horizontally and vertically. To account for the fractured flow system, a cell size of 12.5 feet was established in the vicinity of the Lincoln Stone Quarry, which is extremely small. The model is described in detail in The Revised Groundwater Impact Assessment – Lincoln Stone Quarry Landfill, Addendum to IEPA Application Logs 2004-052 and 2009-211 dated March 13, 2013.

The purpose of groundwater modeling for the proposed construction permit application was to provide feedback to the engineering team to show the effectiveness of each closure scenario. The modeling was done for the overall concepts – complete removal of ash, placement of cap/closure in place, closure in place with hydraulic containment, and closure in place with hydraulic controls. The modeling showed that, even with a slow dewatering over the course of a year, the dewatering required for a closure by removal would dewater (or drawdown) nearby residential wells substantially. Results of the modeling show that while there will be improvement in groundwater quality, there will be residual groundwater impacts downgradient of the Lincoln Stone Quarry for some time, regardless of the closure method chosen. Management of these impacts will require implementation of institutional controls as part of any engineering alternative considered, which may include such items as establishment and monitoring of a Groundwater Management Zone (GMZ) along with a deed restriction precluding installation of water wells within that area and use of the groundwater.

The full groundwater modeling report will be included with the construction permit application that will be submitted to Illinois EPA by February 1, 2022. The permit application will be posted to MWG's website within 14 days of submittal to the Illinois EPA.

Other Closure Concerns

Several attendees asked about the composition of the bottom of the Lincoln Stone Quarry and leachate management. The Lincoln Stone Quarry is an old dolomite quarry; the base and sidewalls are Silurian dolomite which is the type of bedrock found in the surrounding area. Leachate that would be collected and generated in a closure in place scenario would be treated as required by the Illinois EPA prior to being discharged to the Des Plaines river via the existing NPDES permitted outfall. The water must meet permit limits before discharge.

Questions were raised about using rail and barge to transport ash and the rail and conveyor system located at Joliet 9 Station. When the Joliet Stations burned coal, coal was delivered via rail to the Joliet 9 Station. It would be offloaded at Joliet 9 and then transported to Joliet 29 via a conveyor system on a suspension bridge over the Des Plaines River. The system was designed to transfer coal in one direction, from Joliet 9 Station to Joliet 29 Station. It was not designed to transfer CCR (a different material than coal) nor to move material from Joliet 29 to Joliet 9. While the rail line at Joliet 9 is still in place and available for pass through rail operations, the coal dumping and conveyor systems are no longer operational. To use the rail system at Joliet 9 for transport of CCR, new loading and unloading equipment, as well as a new conveyor system, would need to be installed, requiring extensive environmental permitting. Necessary permits include NPDES, stormwater, and air construction permits. A barge loading system is not currently present at Joliet

9, so like the rail system, a new system would need to be installed and would also require extensive environmental permitting.

Several attendees asked about the wet cap closure scenario. A wet cap involves installing a physical barrier, like an engineered sand, that fully caps the containments below the natural water table, so water would be above the physical barrier and be the top surface. A wet closure is an effective and protective means of closure; however, it is not currently permissible under the State or Federal CCR rules.

Multiple questions were asked about the final development of the space once a final cap was installed. Once the impoundment has completed post closure care, the area will be considered passive open space.

Several questions were raised about truck traffic arising from transporting CCR off site. High volumes of truck traffic would occur if a closure by removal option is selected. The trucking route would depend on the final disposal location but is expected to travel through some portions of residential neighborhoods since there are only 3 ways to access the Lincoln Stone Quarry, from the north and south via Brandon Road and from the east via Patterson Road. Removing the ash by extensive truck traffic would increase the risk of vehicle accidents and would result in a significant amount of greenhouse gas emissions. Under the preferred closure scenario, there would be minimal trucking (orders of magnitude less than closure by removal), because MWG would only need to truck the final cap materials into facility.

Questions were raised regarding beneficial use of the ash within Lincoln Stone Quarry. The process of evaluating the market for beneficial use of ash is done by MWG's commercial marketing team. MWG routinely evaluates the market for sources that would accept ash for beneficial use and at this time, MWG has not identified a source. With regard to the closure of Lincoln Stone Quarry, beneficial reuse of ash would have the same effect as closure by removal, requiring significant dewatering and truck traffic.

A question was asked about hydraulic controls presented in the Closure Alternatives Analysis. Hydraulic controls may be able to control the groundwater flow around the Lincoln Stone Quarry. However, due to the geology of the Lincoln Stone Quarry, it is unknown if hydraulic controls could be installed or technically effective.

Residential Well testing

Several attendees inquired about residential well testing, referring to a public meeting held in August 2019 for Lincoln Stone Quarry. At that meeting, MWG offered to sample residential wells and of a total of nine residents sought testing. As MWG was in the planning process for well sampling, the Covid-19 pandemic began and for safety of the residents and sampling team, MWG delayed execution of sampling.

Additionally, at the time of the 2019 meeting, MWG was unaware that the City of Joliet had restricted the use of groundwater for potable use in a large portion of the neighborhood northeast of Lincoln Stone Quarry due to sulfate contamination from a different industrial source. MWG will follow up with the residents who requested well water testing at the 2019 meeting and are not connected to the public water supply. MWG does not plan to offer testing to any additional residents.

MWG and prior operators of Lincoln Stone Quarry has been monitoring the groundwater flow direction and quality around the Lincoln Stone Quarry for decades pursuant to the Lincoln Stone Quarry's landfill permit issued by the Illinois EPA. Groundwater from Lincoln Stone Quarry is not moving toward the northeast and is not impacting residential well water quality.

Financial Assurance

Questions were asked about what financial systems are in place to ensure long-term monitoring is completed after closure. Owners of CCR surface impoundments are required to provide financial assurance to ensure the completion of closure, completion of post-closure care, and, when applicable, remediation of releases from CCR surface impoundments. Pursuant to its landfill permit, to the best of its knowledge, MWG has had financial assurance for closure of Lincoln Stone Quarry dating back to the 1980s. Pursuant to the Illinois CCR rule, MWG has provided financial assurance in the form of a performance bond to Illinois EPA.

ClosureTurf

MWG has not completed any CCR surface impoundment closures under Part 845. ClosureTurf has been approved for use for CCR surface impoundments or landfills at more than 100 sites in the US, including a closure at the Meridosia Power Plant in Illinois. Geosyntec Consultants has been involved in multiple projects that have successfully used ClosureTurf. The design and engineering of the ClosureTurf cap is expected to last for over 1,000 years, based upon accelerated testing to determine how long materials will last in the real world. The Illinois CCR Rule also requires routine inspections of final cover system and any repairs needed would be made.

Closure Costs

Questions were asked about closure costs. Costs were not determinative in selecting closure by removal. The Bipartisan Infrastructure Investment Bill signed into law in November 2021 was not a consideration in any of the closure scenarios evaluated because the law is geared for public infrastructure, not private.

Future Use

Several members of the public commented upon or questioned the future use of Lincoln Stone Quarry, specifically around making the space accessible for public access. MWG is currently not able to suggest or predict future uses other than passive open space.

SUMMARY OF REVISIONS, CHANGES, AND CONSIDERATIONS

Public engagement is an important part of the permitting process. Midwest Generation valued the opportunity to hear and consider the comments of community members and others who participated in the public meetings. At this time, we are proceeding with our proposal for closing Lincoln Stone Quarry in place by installing an alternate final cover system (ClosureTurf) as presented at the public meetings. Taking public comments into consideration, and with additional deliberations after the public meetings, our full analysis continues to indicate that our proposed plan – which remains subject to regulatory review and approval – prioritizes the environment and community well-being.

Timestamp	Email Address	Name	The Illinois Environmental Protection Agency is creating a listserv for the facility. Would you like us to transmit your email address to the Agency to be added to the listserv?
12/8/2021 16:21:13	tomnugentfarm@gmail.com	Patti nugent	Yes
12/8/2021 18:05:49	sandrad.foo@gmail.com	Sandy Costa	Yes
12/8/2021 18:06:59	matt@vondra.us	Matt Vondra	Yes
12/8/2021 18:12:30	sandyfromcare@aol.com	Sandy Burcenski	Yes
12/8/2021 20:10:52	cyndi1superski@gmail.com	Cynthia Superczynski	Yes
12/9/2021 9:53:38	kathy.hulina@gmail.com	Kathy Hulina	Yes
12/9/2021 10:13:21	jgintzler@hotmail.com	Janice Gintzler	Yes
12/9/2021 10:55:56	chadwen@kentlaw.iit.edu	Cassandra Hadwen	Yes
12/9/2021 11:35:11	elise@elisekendrot.com	Elise Kendrot	Yes
12/10/2021 10:10:19	uofialumni@comcast.net	Bruce A Renwick	Yes
12/11/2021 12:41:25	bmerrigold@gmail.com	MaryBurnitz	Yes
12/14/2021 13:43:23	jduffey@northstar.com	John Duffey	Yes
12/15/2021 20:04:15	greg.claus@mail.house.gov	Greg Claus	Yes
12/17/2021 12:38:23	kcourtney@elpc.org	Kiana Courtney	Yes