



**REPORT**

# MCU Assessment of Corrective Measures - Addendum #2

*Northern Indiana Public Service Company LLC*

*Rollin M. Schahfer Generating Station*

*Wheatfield, Indiana*

Submitted to:

**Northern Indiana Public Service Company LLC**

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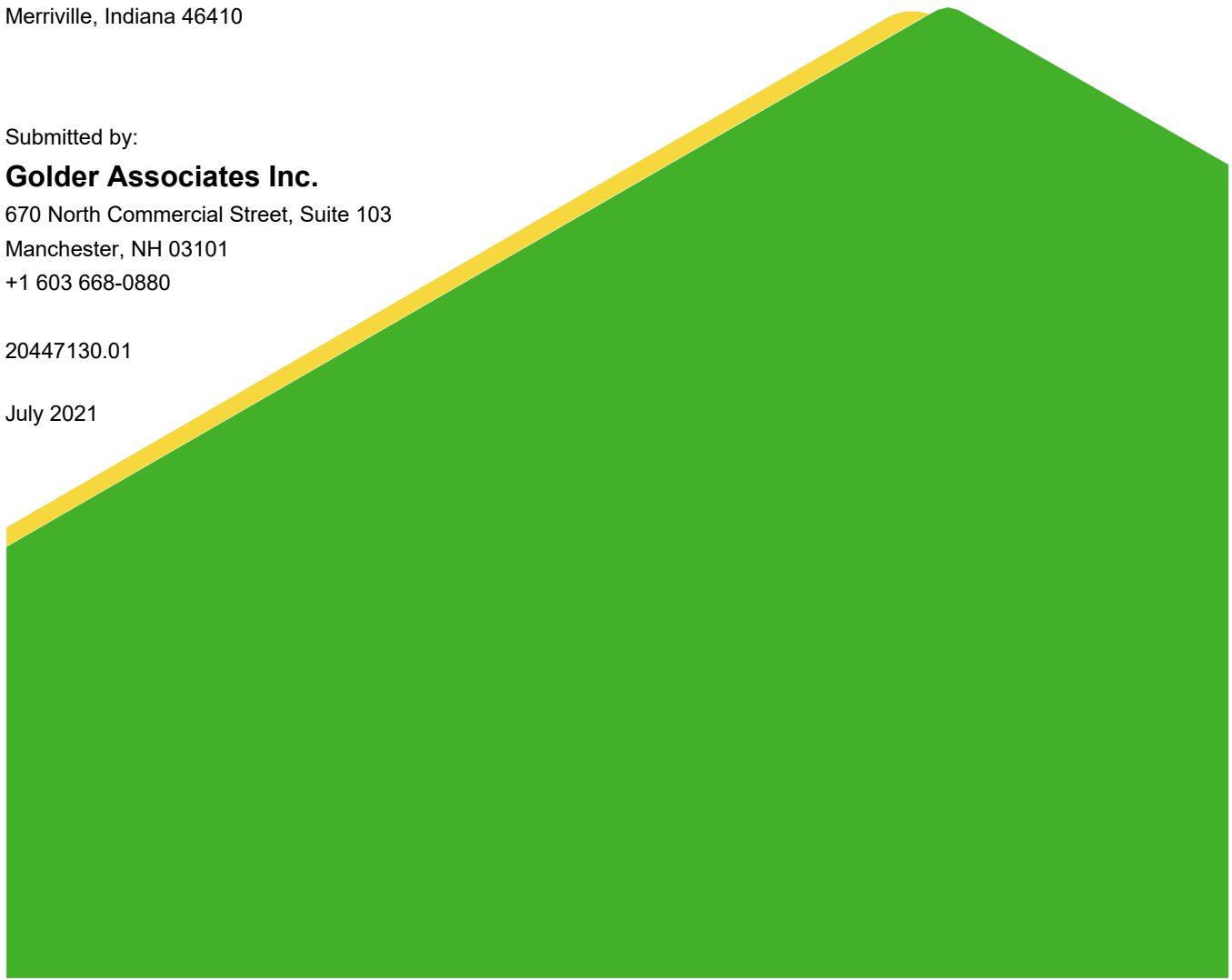
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**Northern Indiana Public Service Company LLC (NIPSCO)  
R. M. Schahfer Generating Station – MSRB, MCWB and DA (collectively the Multi-Cell Unit  
[MCU] or CCR Unit)  
Wheatfield, Indiana**

**Certification of Addendum #2 to the Assessment of Corrective Measures Report  
40 CFR §257.96 & Corresponding Regulations under Indiana Administrative Code**

I have personally reviewed Addendum #2 to the assessment of corrective measures (ACM) report that was prepared by Golder Associates Inc. (Golder) and dated July 2021. The subject of Addendum #2 to the ACM Report is three impoundments, the Material Storage Runoff Basin (MSRB), Metal Cleaning Waste Basin (MCWB), and Drying Area (DA), which are collectively referred to as the Multi-Cell Unit (MCU) or simply the CCR Unit, at the NIPSCO R. M. Schahfer Generating Station. Based on an inquiry of those individuals immediately responsible and on supporting data that I understand to be true, accurate, and complete, I verify the information in this Addendum #2 to the ACM Report is accurate and meets the applicable requirements of the CCR Rule and Indiana Administrative Code. In consideration of the above, I certify to the best of my knowledge, information, and belief, that Addendum #2 to the ACM Report for the regulated CCR management unit referred to as the MCU has been prepared and meets the applicable requirements of 40 CFR §257.96 and corresponding State of Indiana requirements.



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7/29/2021  
Date

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## Acronyms

ACM	Assessment of Corrective Measures
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	Centimeter per second
COC	Constituents of Concern
CSM	Conceptual Site Model
DA	Drying Area
FGD	flue gas desulphurization
ft amsl	feet above mean sea level
ft bgs	feet below ground surface
GMPIM	Groundwater Monitoring Program Implementation Manual
gpm	gallons per minute
GWPS	Groundwater Protection Standards
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
ISS	In situ Stabilization/Solidification
IRWDA	Inactive Retired Waste Disposal Area
MCL	Maximum Contaminant Level
MCWB	Metal Cleaning Waste Basin
mg/L	milligram per liter
MCU	Multi-Cell Unit
MNA	Monitored Natural Attenuation
MSRB	Material Storage Runoff Basin
MW	megawatt
NIPSCO	Northern Indiana Public Service Company
NPDES	National Pollutant Discharge Elimination System
O&M	Operations & Maintenance
POC	Point of Compliance
POTW	Publicly Owned Treatment Works
PRB	Permeable Reactive Barrier
RCG	Remediation Closure Guide
RMSGGS	Rollin. M. Schahfer Generating Station
SSL	Statistically Significant Level
ug/L	microgram per liter
USEPA	United States Environmental Protection Agency
WDA	Waste Disposal Area

## 1.0 INTRODUCTION

On behalf of Northern Indiana Public Service Company LLC (NIPSCO), Golder has prepared this Addendum #2 to supplement the findings of the April 2019 CCR Assessment of Corrective Measures (ACM) Report and replace the November 2020 ACM Addendum for three impoundments, the Material Storage Runoff Basin (MSRB), Metal Cleaning Waste Basin (MCWB), and Drying Area (DA), collectively the Multi-Cell Unit (MCU) or simply the CCR Unit at the NIPSCO Rollin M. Schahfer Generating Station (RMSGs, Site) (ACM Report, Golder 2019 and ACM Addendum #1, Golder 2020).

ACM Addendum #1 was prepared to provide further details of Golder's evaluation of the potential corrective measures for the MCU and specifically focuses on addressing the following requirements under 40 Code of Federal Regulations (CFR) §257.96(c)

*“The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under §257.97 addressing at least the following:*

- 1) *The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies including safety impacts, cross-media impacts, and control of exposure to any residual contamination;*
- 2) *The time required to begin and complete the remedy;*
- 3) *The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).”*

ACM Addendum #2, which supersedes and fully replaces ACM Addendum #1, revises and updates information provided in the predecessor document and incorporates an enhanced final cap design in all corrective measures alternatives. Inclusion of the revised cap design affects the implementability of certain alternatives originally identified in the ACM and Addendum #1, effectively eliminating these alternatives from further consideration in ACM Addendum #2.

Key technical aspects of the cap design revision and update have been proposed to and discussed with the approving state regulatory agency for closure of the CCR Unit, Indiana Department of Environmental Management (IDEM), and the complete Closure Application is currently under IDEM review. Finalization of the ACM as envisioned in Addendum #2 and completion of the Selection of Remedy (SOR) processes is predicated upon IDEM's approval, in particular the source removal and final cap design aspects.

This Addendum #2 and remaining applicable sections of the ACM Report (Golder 2019) should be consulted in combination with one another.

## 2.0 BACKGROUND

NIPSCO owns and operates the RMSGs at 2723 E 1500 N Road, in Wheatfield, Jasper County, Indiana (see Figure 1). RMSGs manages coal combustion residuals (CCR) in surface impoundments subject to applicable requirements of 40 CFR Part 257 as amended (CCR Rule). Pursuant to 40 CFR §257.96(a), the MCU was subject to an ACM, the results of which were presented in the ACM Report (Golder 2019). Figures 2 through 7 show the monitoring well network, geologic cross sections, groundwater elevation contours and shallow/deep boron isoconcentration contour maps for the Site. Regional and Site Hydrogeology are summarized in the ACM

and supported by volume calculations, slug test data and calculations, and vertical gradient calculation included in Appendices A, B, and C, respectively.

NIPSCO plans to close the MCU by removal in accordance with 40 CFR §257.102(c) and an approved IDEM Closure Application. To meet the requirements of 40 CFR §257.97-98, NIPSCO's approach combines CCR source removal/capping followed by groundwater corrective measures and monitoring to demonstrate achievement of applicable groundwater protection standards (GWPS) shown in Table 1.

In the ACM Report (Golder 2019), Golder presented the analytical data for the MCU monitoring wells (see Table 2), identified general groundwater response actions (see Table 3), and presented an initial screening of corrective measure alternatives/process options for groundwater (see Table 4). In addition, Golder identified eight potential groundwater corrective measures for further consideration following the excavation of source material, verification of adequate removal, backfilling, and closure of the MCU. The potential corrective measures and their key components were summarized in Table 5 of the ACM Report (Golder 2019).

After preparation of the ACM Report and ACM Addendum #1, NIPSCO performed additional work with respect to future performance of the initially proposed closure approach and its possible impact on groundwater conditions. Based upon this assessment, NIPSCO determined that an enhanced combination soil/geomembrane cap along with a minor modification of the existing slurry wall, designed to alleviate potential groundwater level build up under the cap, would provide better long-term performance post-closure than either no cap or a soil-only cap. Consequently, NIPSCO proposed this alternative design to IDEM. As referenced above, as of this writing, consideration of the alternative design remains under IDEM review.

Because of NIPSCO's decision and subsequent proposal to IDEM to construct a low permeability cap in conjunction with source removal, it effectively removed groundwater corrective measure Alternative 2 – Capping with Monitored Natural Attenuation (MNA) from future consideration. Furthermore, other alternatives that did not previously include or consider the implications of constructing a low permeability cap immediately following source removal including Alternative 4 – In situ Stabilization/Solidification (ISS) and MNA, Alternative 6 – Capping, Pump-and-Treat and MNA, and Alternative 8 – ISS, Pump-and-Treat, and MNA were likewise removed from future consideration. Also, Alternative 1 – MNA, Alternative 3 – Vertical Barrier/Hydraulic Controls and MNA, Alternative 5 - Pump-and-Treat and MNA, and Alternative 7 – Vertical Barrier/Hydraulic Controls, Pump-and-Treat, and MNA were modified to reflect the inclusion of a low permeability cap. In summary and as identified in the embedded table below, Alternatives 2, 4, 6, and 8 have been removed from future consideration in ACM Addendum #2, leaving four remaining alternatives in original or modified form under consideration.

Alternative	Status	Comments
Alternative 1 - Monitored Natural Attenuation (MNA)	Retained	MNA requires no modifications to the current closure strategy.
Alternative 2 - Capping and MNA	Removed	Capping is already included in the current closure strategy but remains under review by IDEM.
Alternative 3 - Vertical Barrier/Hydraulic Controls and MNA	Retained/Modified	Hydraulic controls can be integrated into the current closure strategy with limited modifications to the cap.

Alternative	Status	Comments
Alternative 4 - In situ Stabilization/Solidification (ISS) and MNA	Removed	ISS cannot be integrated into the current closure strategy without significant modifications and potentially severe damage to the cap.
Alternative 5 - Pump-and-Treat and MNA	Retained/Modified	Pump and treat can be integrated into the current closure strategy with no impact to the cap.
Alternative 6 - Capping, Pump-and-Treat, and MNA	Removed	Capping is already included in the current closure strategy.
Alternative 7 - Vertical Barrier/Hydraulic Control, Pump-and-Treat, and MNA	Retained/Modified	See comments for Alternatives 3 and 5.
Alternative 8 - ISS, Pump-and-Treat, and MNA	Removed	See comments for Alternative 4.

## 3.0 IDENTIFICATION OF POTENTIAL CORRECTIVE MEASURES

### 3.1 Source Material

As discussed in the ACM Report (Golder 2019) and referenced above, NIPSCO plans to close the MCU in accordance with 40 CFR §257.102(c) and an approved IDEM Closure Application. NIPSCO's approach combines CCR source removal/capping and groundwater remediation and monitoring to demonstrate achievement of the IDEM-approved Closure Application requirements and applicable GWPS. The multi-part corrective action approach will be integrated, but will be sequenced, to allow for monitoring of early-stage post-closure results and plume stability. This approach will facilitate optimization of subsequent steps following completion of the initial source removal and capping stages.

The first phase of the integrated corrective action approach is closure by removal/capping of the MCU. Following dewatering activities, the three impoundments will be excavated. In accordance with the Closure Application, excavations are being planned to remove CCR and non-CCR materials to the original design limits (sides and bottom) of the impoundments. Satisfactory excavation will be confirmed by a visual determination that the CCR materials have been removed (Wood 2021).

Following completion of CCR excavation and visual verification of the source removal activities, a final low permeability cap will be installed. As proposed to IDEM, the final cap will consist of the following components presented in descending order from top to bottom (Wood 2021):

- Topsoil (6-inch);
- Cover soil (18-inch);
- Geocomposite drainage layer (GDL);
- 40-mil linear low-density polyethylene (LLDPE) geomembrane; and
- Subgrade fill.

The low permeability cap (e.g., permeability less than or equal to  $1 \times 10^{-7}$  cm/sec) will reduce infiltration of rainwater into the closed CCR unit. In doing so it may further reduce the total volume of impacted groundwater requiring remediation.

During cap construction a hydraulically downgradient section of the slurry wall will be permanently removed down to the average elevation of the groundwater table to address the water buildup/overtopping possibility within the former impoundment. This action should reduce concerns regarding long-term cap performance and maintenance; however, it may result in periodic discharges from within the former impoundment of diluted groundwater that has previously been in contact with CCR.

Closure-by-removal construction activities including, but not limited to, dewatering and excavation of the CCR source material, removal of a portion of the existing slurry wall to the average elevation of the groundwater table, backfill of the closed impoundment, and placement of a low permeability cap are expected to affect the current groundwater flow regime within and in areas proximate to the MCU. Accordingly, NIPSCO will evaluate these impacts on groundwater remedy alternatives as a critical foundational component of the ongoing SOR process. IDEM requires NIPSCO to obtain their approval before closing the MCU; therefore, this stage of additional data collection will begin following IDEM's approval and during NIPSCO's implementation of the Closure Application. In addition to traditional long-term post-closure monitoring during closure implementation and in the early stages of post-closure, NIPSCO will perform remedy-focused groundwater monitoring activities. Beyond the Part 257 Appendix III and IV constituents, monitoring will include parameters specific to the applicability, appropriateness, and performance of MNA, continuing to build upon the results of the MNA Tier I-III evaluation previously completed. In short, NIPSCO will use the monitoring results to evaluate the impacts of source removal and associated closure construction activities and help inform and refine the groundwater remedy selection process as needed.

## 3.2 Groundwater Impacts

Following closure of the MCU by removal/capping, NIPSCO will address impacted groundwater below and downgradient of the MCU.

Because the existing slurry wall surrounding the MCU was installed to contact the underlying bedrock, installation of the low permeability cap will increase the possibility of creating a cell of isolated impacted groundwater beneath the MCU that will not be recharged through migration of un-impacted groundwater or infiltrating rainwater. Due to the history of CCR loading in the MCU, the capacity of the saturated zone within the slurry wall to naturally attenuate these isolated CCR impacts has likely been depleted relative to the aquifer outside the slurry wall. Therefore, there is also a potential for the isolated impacted groundwater within the MCU to be released downgradient if the slurry wall exceeds its operational lifetime or the water level inside the MCU rises and overtops the slurry wall. NIPSCO will also address these potential impacts if monitoring results do not indicate progress towards achievement of GWPS.

In the ACM Report (Golder 2019), Golder identified and preliminarily evaluated the following eight groundwater corrective measure alternatives for further consideration in accordance with the provisions of §257.96(c).

- Alternative 1 - Monitored Natural Attenuation (MNA)
- Alternative 2 - Capping and MNA
- Alternative 3 - Vertical Barrier and MNA

- Alternative 4 - In situ Stabilization/Solidification (ISS) and MNA
- Alternative 5 - Pump-and-Treat and MNA
- Alternative 6 - Capping, Pump-and-Treat, and MNA
- Alternative 7 - Vertical Barrier, Pump-and-Treat, and MNA
- Alternative 8 - ISS, Pump-and-Treat, and MNA

Golder's evaluation of the potential corrective measures and their key components were summarized in Table 5 of the ACM Report (Golder 2019). As noted above, previous Alternatives 2, 4, 6, and 8 have since been removed from future consideration due to a change in closure approach and previous Alternatives 1, 3, 5, and 7 have been modified for the same reason. For this Addendum #2, Golder is providing further supporting evaluation details with respect to each of the four remaining potential groundwater corrective measure alternatives. For clarification and to differentiate the ACM Addendum #2 alternatives from those presented and discussed in predecessor documents, the remaining alternatives are renumbered as follow:

- Alternative A – MNA
- Alternative B – Vertical Barrier/Hydraulic Controls and MNA
- Alternative C – Pump-and-Treat and MNA
- Alternative D – Vertical Barrier/Hydraulic Controls, Pump-and-Treat, and MNA

A summary of the retained groundwater corrective measure alternatives is shown in Table 5. The remedial components of the groundwater corrective measure alternatives following source removal and capping are described further in Section 4.

## 4.0 EVALUATION OF POTENTIAL GROUNDWATER CORRECTIVE MEASURES

### 4.1 Evaluation Criteria

In conformance with the applicable requirements of 40 CFR §257.96 and 40 CFR §257.97, Golder evaluated the effectiveness of each of the four remaining potential groundwater corrective measures originally identified in the ACM Report (Golder 2019) using the following criteria:

- **Performance** - Potential corrective measures were evaluated for their relative performance based on the magnitude of reduction of existing risks, ability to obtain the groundwater protection standard (GWPS) at the point of compliance (POC), the magnitude of residual risks in terms of likelihood of future releases due to remaining CCR following implementation of remedy, and the required type and degree of long-term management including monitoring, operation, and maintenance associated with the corrective measure.
- **Reliability** - Potential corrective measures were evaluated for their relative reliability based on the long-term reliability of engineering and institutional controls, potential need for the replacement of the remedy, extent to which containment practices will reduce further releases, and extent to which the treatment technologies may be used.

- **Ease of Implementation** - Potential corrective measures were evaluated based on their relative ease of implementation based on difficulty associated with construction of the technology, operational reliability of the technology(ies), coordination of regulatory approvals and permits from pertinent agencies, availability of necessary equipment and specialists, and availability capacity and location of needed treatment, storage, and disposal services.
- **Potential Impacts** - Potential corrective measures were evaluated based on their relative potential impacts based on safety impacts, cross-media impacts, and control of exposure. Exposure controls include short-term risks during implementation of a remedy and potential exposure to remaining wastes to the community or environment including potential threats associated with excavation, transportation, re-disposal of CCR, or contaminant.
- **Time Requirements** - Potential corrective measures were evaluated based on the time required to initiate, construct, and complete the remedy.
- **Institutional Requirements** - Potential corrective measures were evaluated based on their institutional requirements including local, state, and federal permit needs.

## 4.2 Evaluation Summaries

Relative to the above evaluation criteria, the following sections present brief summaries of the proposed groundwater corrective measure alternatives following source removal and capping. In addition, the summaries highlight areas where a particular remedy may perform well or poorly relative to other alternatives. A summary of Golder's evaluation of the four retained groundwater corrective measure alternatives is provided in Table 6.

### 4.2.1 Alternative A: Monitored Natural Attenuation

Golder evaluated MNA as a potential groundwater corrective measure for the Site COCs. The MNA Evaluation (Golder 2020) is presented in Appendix D. The results of the evaluation indicate that MNA is a technically feasible and appropriate corrective measure for groundwater at the Site based on the following factors:

- Attenuation is already occurring at the Site at a reasonable rate
- The dissolved plume is stable
- The aquifer has the long-term capacity to attenuate COCs

Based on the results of the Tier I, II, and III MNA evaluations for the Site, Golder concluded that MNA is expected to provide good long-term performance. MNA alone will not substantially affect groundwater concentrations in the short-term, however, it may show some progress within a few months of source material removal during closure of the MCU.

For the MNA evaluation, Golder conducted a point decay evaluation at monitoring wells downgradient of the MCU. Based on the results of the evaluation, maximum concentrations of boron and cobalt observed in downgradient wells over the period of monitoring would take approximately 41 and 39 years, respectively, to attenuate to concentrations below the GWPS (or health-based standard for boron) (Golder 2020).

For the evaluation, Golder also considered the following factors:

- The low groundwater flow velocities observed at the Site



- The distance from the MCU to the property boundary and lack of off-Site migration of groundwater impacts
- The lack of potable water supply wells at the Site in the vicinity of the MCU and the downgradient plume
- Planned institutional controls prohibiting use of groundwater from any impacted area at the Site for drinking water
- Lower observed boron concentrations at monitoring wells further downgradient from the MCU

Based on these other factors, MNA is expected to be protective of human health and reduce environmental degradation until the wells near the MCU achieve the cleanup criteria.

Because there is an existing monitoring well network downgradient of the MCU, implementation of an MNA program is unlikely to require any component construction/installation. In addition, it does not require disturbance of the complex subsurface utility network located hydraulically downgradient of the MCU. Therefore, MNA will be relatively easy to implement following regulatory approval and poses no short-term safety risks. Long-term operation and maintenance (O&M) will include routine groundwater sampling and potentially periodic well redevelopment.

#### **4.2.2 Alternative B: Vertical Barrier/Hydraulic Controls and MNA**

For the Vertical Barrier/Hydraulic Control and MNA Alternative, hydraulic controls within the existing slurry wall would be added to the MNA alternative. The Vertical Barrier/Hydraulic Control and MNA alternative would be implemented to reduce or eliminate downgradient migration of impacted groundwater. This alternative assumes that the existing slurry wall is intact, albeit slightly modified from the original design to address potential water buildup with the former impoundment cell, and that implementation of this alternative involves installation and operation of a pump-and-treat system within the former impoundment areas to prevent over-topping of the modified slurry wall due to groundwater recharge.

The Vertical Barrier/Hydraulic Control and MNA Alternative would have a similar effect as the MNA Alternative on groundwater downgradient of the closed MCU. It would reduce or eliminate the volume of impacted groundwater potentially overtopping the existing or modified slurry wall(s), thus removing a source of contamination, and allowing for more efficient natural attenuation. This remedy would also result in removal of contaminant mass through groundwater extraction and treatment with boron-specific ion exchange resin, which would reduce the potential for future releases of impacted groundwater if the slurry wall fails.

Because there is an existing and functional slurry wall around the MCU, corrective measure implementation would include design, well installation, enclosure construction, and treatment system assembly/construction. Some treatment system components may require lead times prior to delivery; however, most components should be readily available. An amendment to the Site's National Pollutant Discharge Elimination System (NPDES) permit would likely be required to discharge treated water to an on-site stormwater pond, which could delay implementation while awaiting regulatory review.

Resin regeneration requires concentrated sodium hydroxide and hydrochloric acid, which could be released and cause damage to the environment in the event of a containment breach. Likewise, in the event of unidentified contaminant breakthrough, there is the potential for treated water containing unacceptable contaminant levels to be discharged in the treatment system effluent. However, both of these events are unlikely to occur as the reagents will be stored in secondary containment and resin regeneration will be completed automatically on a regular basis to maintain the resin at a high level of removal efficiency.



The hydraulic control system will require a higher level of periodic O&M compared to the MNA Alternative as influent and effluent samples will likely need to be collected monthly and there is significant potential for shut-downs due to the number of different components (filter vessels, ion-exchange columns, slurry dryer, pH adjustment system, etc.) that are needed to keep the system operational. Most or all of these components will also need replacement over the 30-year design lifetime of the system.

### 4.2.3 Alternative C: Pump-and-Treat and MNA

For the Pump-and-Treat and MNA Alternative, a groundwater pump-and-treat system would be designed and installed to capture contaminated groundwater present in the downgradient vicinity of the MCU and/or potentially leaking through/under the CCR slurry wall, to prevent downgradient off-Site migration. The captured groundwater would then be treated to reduce concentrations to an acceptable concentration and discharged to surface water or groundwater.

The Pump-and-Treat and MNA Alternative offers a higher level of short- and long-term protection than capping and ISS as it removes contaminant mass through treatment of extracted water using ion-exchange resin. This will help reduce contaminant concentrations and thereby enhance natural attenuation downgradient of the capture zone. The capture zone is extensive enough that continued operation of the pump-and-treat system will also contain any future groundwater releases if the slurry wall fails.

Some treatment system components may require lead times prior to delivery, but most components should be readily available. An amendment to the Site's NPDES permit would likely be required to discharge treated water to an on-site stormwater pond, which could delay implementation while awaiting regulatory review. Resin regeneration requires concentrated sodium hydroxide and hydrochloric acid, which could be released and cause damage to the environment in the event of a containment breach. Likewise, in the event of unidentified contaminant breakthrough, there is the potential for treated water containing unacceptable contaminant levels to be discharged. However, both of these events are unlikely to occur as the any reagents will be stored in secondary containment and resin regeneration will be completed automatically on a regular basis to maintain the resin at a high level of removal efficiency. The system will require a higher level of periodic O&M compared to capping and ISS as effluent samples will likely need to be collected monthly and there is significant potential for shut-downs due to the number of different components (filter vessels, ion-exchange columns, slurry dryer, pH adjustment system, etc.) that are needed to keep the system operational. Most or all of these components will also need replacement over the 30-year design lifetime of the system.

### 4.2.4 Alternative D: Vertical Barrier/Hydraulic Control, Pump-and-Treat, and MNA

The Vertical Barrier/Hydraulic Control, Pump-and-Treat, and MNA Alternative, which includes a pump-and-treat system pumping from wells both inside and downgradient of the slurry wall, would offer a high level of short- and long-term protection. The downgradient well field would remove impacted groundwater allowing for higher-efficiency natural attenuation downgradient of the capture zone while the well field inside the slurry wall would remove more highly-impacted material and reduce the potential for future releases if the slurry wall fails. This alternative would also result in the highest level of contaminant mass removal.

Construction/implementation of this corrective measure alternative would face similar construction/permitting hurdles as the Vertical Barrier/Hydraulic Control and Pump-and-Treat Alternatives in Sections 4.2.2 and 4.2.3, most significantly lead times on components and discharge permitting. Operation and maintenance for this remedy would also be similar to these alternatives with frequent influent/effluent sampling and component monitoring and maintenance, however, the treatment system could be contained in a single enclosure and have a

single set of components for treating extracted water from both capture areas. Because of the shared treatment system, the O&M level of effort would likely not be significantly higher than that presented in Section 4.2.3 for the Pump-and-Treat Alternative (as opposed to an additive level of effort for the combined remedial alternatives).

## 5.0 SUMMARY AND NEXT STEPS

This Addendum #2 supplements the ACM Report (Golder 2019) and replaces in full ACM Addendum #1 (Golder 2020). It reflects NIPSCO's enhanced closure strategy and ongoing discussions with IDEM in response to comments on the latest Closure Application, providing additional details regarding the remaining four potential groundwater corrective measures originally identified in those reports, and evaluating those corrective measures in accordance with the performance requirements identified in 40 CFR §257.96(c). As noted above, a summary of Golder's evaluation of the four retained groundwater corrective measure alternatives is provided in Table 6.

In addition to updating the ACM to reflect the most recent discussions with IDEM and the revision/submission of the Closure Application for IDEM for review and approval, NIPSCO continues to conduct activities in accordance with the expectations of the ACM and Selection of Remedy (SOR) processes, including the following:

- Preparation of bid documents (specifications and drawings) for closure of the MCU, which provide SOR-related information relative to cost and schedule for alternatives.
- Contractor procurement (including contractor pre-qualification, scheduling of site walks, scope of work question-and-answer, request for alternative approach(es), and establishment of a bid due date) to perform the source removal/capping phase of the corrective measures. This activity informs and refines cost and schedule aspects of the SOR alternatives evaluation process.
- Communications with vendors regarding water treatment technologies, equipment availability, and media costs/handling. This activity also informs and helps refine cost and schedule aspects of the SOR evaluation.

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## Tables

**Table 1: Applicable Groundwater Cleanup Standards  
CCR Unit Schahfer MSRB, MCWB, and DA  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL (mg/L)	GWPS (mg/L)	IDEM RCG (mg/L)
<b>Appendix III Constituents</b>			
Boron	-	NA	4
Calcium	-	NA	-
Chloride	-	NA	-
Fluoride	4	4	0.8
pH	-	NA	-
Sulfate	-	NA	-
Total Dissolved Solids	-	NA	-
<b>Appendix IV Constituents</b>			
Antimony	0.006	0.006	0.006
Arsenic	0.01	0.078	0.01
Barium	2	2	2
Beryllium	0.004	0.004	0.004
Cadmium	0.005	0.005	0.005
Chromium	0.1	0.1	0.1
Cobalt <sup>(1)</sup>	0.006 <sup>(2)</sup>	0.01	0.006
Fluoride	4	4	0.8
Lead <sup>(1)</sup>	0.015 <sup>(2)</sup>	0.0007	0.015
Lithium <sup>(1)</sup>	0.04 <sup>(2)</sup>	0.0082	0.04
Mercury	0.002	0.002	0.002
Molybdenum <sup>(1)</sup>	0.1 <sup>(2)</sup>	0.036	0.1
Radium 226+228	5	5	-
Selenium	0.05	0.05	0.05
Thallium	0.002	0.002	0.002

Prepared by: DFS  
Checked by: KMC  
Reviewed by: MAH

**Notes:**

MCL= Environmental Protection Agency Maximum Contaminant Level

GWPS= Groundwater Protection Standard calculated August 23, 2018.

Revision

mg/L= milligrams per liter

NA= not applicable; GWPS are calculated for Appendix IV constituents only

1) These four constituents do not have an established MCL. Prior to the Phase 1 Part 1 amendment, effective August 29, 2018, the GWPS was calculated based on background concentrations according to the CCR Final Rule.

2) The Phase 1 Part 1 amended health-based standard, effective August 29, 2018 pursuant to 40 CFR §257.95(h)(2)

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW04																					
				2016-07-12	2016-09-08	2016-11-09	2017-01-10		2017-03-01	2017-04-26	2017-06-28	2017-08-22	2017-10-04	2018-03-13	2018-03-14	2018-04-20		2018-10-25	2019-04-23	2019-11-07	2020-05-13				
				N	N	N	FD	N	N	N	N	N	N	N	FD	N	FD	N	N	N	N	N	FD	N	
<b>Appendix III Parameters</b>																									
Boron		4	mg/L	0.48	1.4	2.4 O	1.1	1	1.2	0.74	0.92	1.2	0.54			0.74	0.72	0.78	0.74	1.3	0.66	0.64			
Calcium			mg/L	110	230	300 O	270	240	230	200	200	140				140	140	210	130	190	115	112			
Chloride			mg/L	2.2	27	69 O	13	14	13	5.4	12	13	4.5			3.7 J	4.4	10	3.7	9.5	2	2			
Fluoride	4	4	mg/L	0.92 J+	0.2 J	10 UO	0.19 J	0.17 J	5 U	5 U	0.19 J	0.21 J	0.24 J	0.15 J	5 U	5 U	0.17 J-	0.26	0.16 J+	0.23	0.15	0.15			
pH			SU	7.22	6.83	6.75		6.93	7.01	6.76	6.88	7.21	7.28		6.95		7.2	6.39	7	7.14		7.42			
Sulfate			mg/L	140 J-	460	480 O	460	470	390	470	370	440	250			220	210	530	260	490	136	139			
Total Dissolved Solids			mg/L	420	990	1400 O	1000	1000	890	870	880	920	610			580 J	580	980	600	900	411	419			
<b>Appendix IV Parameters</b>																									
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00027 JO	0.002 U	0.00057 J	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U	0.002 U			0.002 U	0.00065 J	0.00092 J	0.001 U	0.001 U		
Arsenic	0.01	0.01	mg/L	0.0059	0.013	0.0052 O	0.0058	0.0072	0.005 U	0.0099	0.012	0.012			0.004 J	0.0054			0.014	0.0023 J	0.0018 J	0.002	0.002		
Barium	2	2	mg/L	0.041	0.077	0.11 O	0.095	0.079	0.089	0.069	0.084	0.09			0.11	0.077			0.074	0.068	0.066	0.076	0.077		
Beryllium	0.004	0.004	mg/L	0.00027 J	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.00048 J	0.00053 J	0.001 U	0.0002 U	0.0002 U		
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.0002 U	0.0002 U		
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00036 JO	0.00036 J	0.0052 JO	0.002 U	0.002 U	0.002 U	0.002 U			0.0011 J	0.0012 J			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		
Cobalt		0.006	mg/L	0.001 U	0.00031 J	0.00064 JO	0.0061	0.0058	0.0038	0.0049	0.003	0.0023			0.0028	0.0031			0.0026	0.0011	0.00043 J	0.001 U	0.001 U		
Fluoride	4	4	mg/L	0.92 J+	0.2 J	10 UO	0.19 J	0.17 J	5 U	5 U	0.19 J	0.21 J	0.24 J	0.15 J	5 U	5 U	0.17 J-	0.26	0.16 J+	0.23	0.15	0.15			
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		
Lithium		0.04	mg/L	0.0018 J	0.008 U	0.008 UO	0.0021 J	0.0023 J	0.0033 J	0.0033 J	0.0062 J	0.0062 J			0.008 U	0.008 U			0.0023 J	0.0045 J	0.0028 J	0.008 U	0.008 U		
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 UO	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U			0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		
Molybdenum		0.1	mg/L	0.0075 J	0.023	0.073 O	0.037	0.038	0.034	0.016	0.02	0.034			0.0048 J	0.024			0.039	0.024	0.055	0.022	0.022		
Radium 226 + 228	5		pCi/L	5 U	0.583	0.697 O	0.804	0.515 U	0.362 U	0.379 U	0.364 U	0.352 U			1.35 J+	0.778 J+			0.473	0.591		1.7 U	1.62 U		
Radium-226			pCi/L	1 U	0.138 U	0.346 UO	0.301 U	0.242 U	0.121 U	0.117 U	0.119 J+	0.118			0.177	0.0881			0.306	0.311 U		0.78 U	0.613 U		
Radium-228			pCi/L	1 U	0.498 U	0.495 UO	0.677 J+	0.515 U	0.362 U	0.379 U	0.364 U	0.352 U			1.17 J+	0.69 J+			0.462 U	0.405		0.924 U	1.01 U		
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.00064 JO	0.0017 J	0.0021 J	0.005 U	0.005 U	0.005 U	0.005 U			0.001 J	0.001 J			0.005 U	0.0013 J	0.0052	0.001 U	0.001 U		
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		
<b>Field Parameters</b>																									
Dissolved Oxygen			mg/L	0.09	0.58	0.37		1.82	1.47	0.12	0.3	0.52	0.09		0.66		2.3	0.15	7.08	2.55		1.32			
Oxidation Reduction Potential			millivolts	59.6	-24	-6.9		-31.7	14	-57.8	-45	-27	-105.8		-181.8		-81.2	-58.1	19	-60.7		-28.6			
pH			SU	7.22	6.83	6.75		6.93	7.01	6.76	6.88	7.21	7.28		6.95		7.2	6.39	7	7.14		7.42			
Specific Conductivity			uS/cm	595	1345	1681		1109	910	1137	911	1153	813		562		770	1311	549	866		681			
Temperature			deg C	13	17.3	16.3		10.5	8.05	10.2	13.1	15.9	16.1		7.55		3.5	15.5	4.2	13.2		9.8			
Turbidity			NTU	4.04	1.48	2.21		2.28	4.26	4.04	4.88	1.65	0.51		4.92		3.12	1.92	4.48	1.38		3.51			

Notes:  
 IDEM RCG= Indiana Department of Environmental Management  
 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW07																
				2016-07-12	2016-09-08	2016-11-09	2017-01-10	2017-03-01	2017-04-26	2017-06-29	2017-08-23	2017-10-03	2018-03-15	2018-04-23	2018-10-26	2019-05-02	2019-11-08	2020-04-28		
				N	N	N	N	N	N	N	N	N	FD	N	N	N	N	N	FD	N
<b>Appendix III Parameters</b>																				
Boron		4	mg/L	1.2	1	0.91	0.91	1	0.68	0.67	0.68	0.71	0.72		1.2	1.3	0.85	0.85	0.87	0.87
Calcium			mg/L	170	190	200	170	170	190	220	190	220	220		210	230	220	180	209	211
Chloride			mg/L	7.8	6.6	5.3	6	7.6	2.8	3 J	3.2 J	3 J	3.6 J		4.7 J	6.3	6.5	4.8	6.5	6.3
Fluoride	4	4	mg/L	0.72 J+	0.91 J	0.8 J	0.85 J	0.66 J	0.76 J	0.79 J	0.66 J	1.1 J	0.93 J	0.58 J	0.57 J	0.73	0.97	0.88	0.64	0.64
pH			SU	7.03	7.27	7.04	7.15	7.2	7.17	6.57	7.2		7.1	7.28	7.35	5.71	7.2	7.44		7.3
Sulfate			mg/L	310 J-	330	320	320	290	310	360	380	460	450		450	530	500	480	403	399
Total Dissolved Solids			mg/L	770	830	840	750	710	810	970	910	970	1000		900	970	1100	940	840	846
<b>Appendix IV Parameters</b>																				
Antimony	0.006	0.006	mg/L	0.00035 J	0.00039 J	0.00035 J	0.00028 J	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.001 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0013 J	0.0016 J	0.0018 J	0.0028 J	0.005 U	0.0028 J	0.0025 J	0.0016 J			0.005 U		0.0012 J	0.0019 J	0.0011 J	0.001 U	0.001 U
Barium	2	2	mg/L	0.052	0.055	0.056	0.042	0.05	0.05	0.059	0.059			0.056		0.064	0.053	0.043	0.041	0.04
Beryllium	0.004	0.004	mg/L	0.00011 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.0002 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0003 J	0.00022 J			0.001 U		0.00047 J	0.001 U	0.001 U	0.0002 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00047 J	0.00046 J	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.0056	0.0077	0.0055	0.0038	0.0044	0.0063	0.01	0.0095			0.006		0.01	0.0074	0.0049	0.0063	0.0064
Fluoride	4	4	mg/L	0.72 J+	0.91 J	0.8 J	0.85 J	0.66 J	0.76 J	0.79 J	0.66 J	1.1 J	0.93 J	0.58 J	0.57 J	0.73	0.97	0.88	0.64	0.64
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0007 J			0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0034 J	0.008 U	0.008 U	0.0035 J	0.0031 J	0.0041 J	0.0037 J	0.0038 J			0.0024 J		0.0054 J	0.0041 J	0.0033 J	0.008 U	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U			0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.0084 J	0.0098 J	0.0095 J	0.01 U	0.01 U	0.0083 J	0.0081 J	0.007 J			0.0066 J		0.0087 J	0.0097 J	0.0087 J	0.0073	0.0073
Radium 226 + 228	5		pCi/L	1.59	0.696	0.548	0.412 U	0.42 U	0.371 U	0.45	0.588			0.749 J+		0.823 J+	0.37 U		1.62	2.01 U
Radium-226			pCi/L	0.667 J+	0.289	0.374	0.237 U	0.186	0.155	0.232 J+	0.3			0.163		0.483 J+	0.305 U		0.653 U	1.19 U
Radium-228			pCi/L	0.923	0.406	0.462 U	0.412 U	0.42 U	0.371 U	0.262 U	0.413 U			0.585 J+		0.365 U	0.37 U		1.07	0.864
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.003 J	0.003 J	0.005 U	0.008	0.0054	0.005			0.0028 J		0.0016 J	0.0045 J	0.0019 J	0.0017	0.0018
Thallium	0.002	0.002	mg/L	0.00011 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.00024 J	0.001 U	0.001 U	0.001 U	0.001 U
<b>Field Parameters</b>																				
Dissolved Oxygen			mg/L	0.6	1.81	0.59	0.52	0.51	1.96	1.02	0.84			0.48	0.8	3.52	2.64	0.81	0.38	0.34
Oxidation Reduction Potential			millivolts	111.2	64.2	-6.4	71.3	65.3	76.9	291.1	8.5			95.4	-55	-98.7	-233.3	135.1	-131.8	115.2
pH			SU	7.03	7.27	7.04	7.15	7.2	7.17	6.57	7.2			7.1	7.28	7.35	5.71	7.2	7.44	7.3
Specific Conductivity			uS/cm	966	1072	1106	928	832	1121	1151	1157			1273	760	1060	1240	975	828	1223
Temperature			deg C	14.4	19.2	16.7	12.9	10.63	11.8	14.6	16.5			18	10	10	16.95	10.3	15.3	10.5
Turbidity			NTU	4.6	4.51	1.26	3.2	4.76	2.17	2.87	0.9			0.49	1.3	1.75	1.08	2.72	4.58	3.2

Notes:  
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 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
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 deg C = degrees Celsius  
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 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
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 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.



**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW07B					GAMW08														
				2018-09-06	2018-10-26	2019-05-02	2019-11-12	2020-04-28	2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-04	2018-03-14	2018-04-23	2018-10-26	2019-05-08	2019-11-07	2020-04-24
				N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
<b>Appendix III Parameters</b>																							
Boron		4	mg/L	20	23	18	15	11.1	3.5	3.9	3.2	3.4	3.3	3.2	2.9	2.2	3.7		2.4	1.8	1.4	2.5	3
Calcium			mg/L	370	430	380	400	370	310	310	300	260	270	310	340	270	290		360	230	250	280	309
Chloride			mg/L	10 UO	250	170	150	113	88	71	89	99	110	86	83	39	87		64	56	49	66	67
Fluoride	4	4	mg/L	10 UO	1.5	1.3	1.2	1.2	1 J+	1.2 J	0.73 J	0.87 J	0.94 J	0.92 J	1.3 J	2 J	0.68 J	1.2 J	1.3 J-	1.6	2.2	1.9	1.1 J-
pH			SU	8.29	6.78	7.58	7.13	7.73	6.92	7.03	6.85	7.02	7.09	6.93	7	7.27	6.89	7.41	7.41	6.99	7.37	7.5	7.35
Sulfate			mg/L	10 UO	1600	1500	1400	1260	770 J-	690	680	610	630	770	800	640	670		800	460	540	670	719
Total Dissolved Solids			mg/L	2700	2600	920	2300	2140	1600	1500	1600	1300	1400	1700	2000	1400	1500		1700	1100	1300	1300	1550
<b>Appendix IV Parameters</b>																							
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U	0.00073 J	0.00069 J	0.0014 J	0.00041 J	0.00043 J	0.002 U	0.00059 J	0.00075 J		0.002 U		0.00082 J	0.00076 J	0.00077 J	0.001 U
Arsenic	0.01	0.01	mg/L	0.0028 J	0.0015 J	0.0019 J	0.0017 J	0.0023	0.0018 J	0.0019 J	0.0018 J	0.0027 J	0.0016 J	0.0031 J	0.0027 J	0.0023 J		0.005 U		0.0011 J	0.0015 J	0.0016 J	0.0012
Barium	2	2	mg/L	0.072	0.063	0.053	0.043	0.044	0.068	0.065	0.065	0.05	0.055	0.064	0.074	0.077		0.066	0.069	0.053	0.058	0.066	0.061
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.00017 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.0004 J	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	7.4E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.00037 J	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.00029 J	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.00074 J	0.001 U	0.001 U	0.001 U	0.001 U	0.036	0.034	0.059	0.047	0.05	0.037	0.047	0.02		0.022	0.027	0.011	0.0079	0.011	0.022
Fluoride	4	4	mg/L	10 U	1.5	1.3	1.2	1.2	1 J+	1.2 J	0.73 J	0.87 J	0.94 J	0.92 J	1.3 J	2 J	0.68 J	1.2 J	1.3 J-	1.6	2.2	1.9	1.1 J-
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0043 J	0.0045 J	0.004 J	0.0035 J	0.008 U	0.0098	0.012	0.009	0.0098	0.0093	0.012	0.011	0.012		0.0089	0.009	0.011	0.015	0.0091	0.0087
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.015	0.017	0.025	0.026	0.026	0.034	0.036	0.024	0.02	0.019	0.038	0.049	0.083		0.058	0.058	0.059	0.08	0.068	0.048
Radium 226 + 228	5		pCi/L	2.63	2.6 J+	2.31		1.92 U	1.07	1.08	1.09	0.581	0.777	0.632	1.11	0.762		1.13 J+	0.99	1 J+	0.473		1.25 U
Radium-226			pCi/L	1.16	1.56 J+	1.17		0.884 U	0.501 J+	0.469	0.557	0.375	0.368	0.383	0.613 J+	0.591		0.267	0.437	0.582 J+	0.312 U		0.563 U
Radium-228			pCi/L	1.47	1.04	1.14		1.07	1 U	0.609	0.533	0.43 U	0.423 U	0.365 U	0.499	0.341 U		0.865 J+	0.552	0.423	0.456 U		0.689 U
Selenium	0.05	0.05	mg/L	0.0012 J	0.005 U	0.005 U	0.005 U	0.001 U	0.005 U	0.0065	0.0033 J	0.0014 J	0.0032 J	0.011	0.0088	0.0081		0.024	0.022	0.0021 J	0.016	0.0036 J	0.0062
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.00045 J	0.001 U	0.001 U
<b>Field Parameters</b>																							
Dissolved Oxygen			mg/L	0.13	0.67	0.19	0.2	0.1	1.9	0.38	1.62	1.27	0.96	0.63	1.96	0.93	0.21	0.97	5.09	0.21	0.44	4.2	0.34
Oxidation Reduction Potential			millivolts	-197.6	-230.2	34.9	-196.7	-128.6	159.7	64.6	-8	58.4	49.9	60.4	242.5	61.9	-15.9	110.1	-106.4	27.7	62.2	44.1	52.5
pH			SU	8.29	6.78	7.58	7.13	7.73	6.92	7.03	6.85	7.02	7.09	6.93	7	7.27	6.89	7.41	7.41	6.99	7.37	7.5	7.35
Specific Conductivity			uS/cm	5178	3237	2357	1686	2722	1925	1807	1664	1517	1494	2098	1834	1713	1840	1121	1732	1440	1102	1322	2009
Temperature			deg C	15.03	13.86	12.4	12.9	12.7	15.5	18.78	17.75	12.2	10.06	11.1	15.8	18.5	18.3	9.6	10.2	17.2	11	10.84	10.5
Turbidity			NTU	4.48	3.01	2.86	1.11	3.48	2.3	3.22	0.58	1.26	1.56	1.1	2.41	0.68	4.38	1.11	1.54	1.4	1.81	0.31	2.5

Notes:  
 IDEM RCG= Indiana Department of Environmental Management Remediation Closure Guidance Table A-6 Screening Levels - 2021 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW08B										
				2018-09-07		2018-10-26		2019-05-03		2019-11-07		2020-04-24		
				FD	N	FD	N	N	N	N	N	FD	N	
<b>Appendix III Parameters</b>														
Boron		4	mg/L	18		15		14		13				20.4
Calcium			mg/L	380		370		350		340				355
Chloride			mg/L	240		180		160		180				220
Fluoride	4	4	mg/L	1.6 J		1.5		1.9		1.7				1.5 J-
pH			SU	7.7		7.45		7.57		7.85				7.89
Sulfate			mg/L	1500		1500		1400		1300				1280
Total Dissolved Solids			mg/L	1900 J+		2300		2300		2200				2560
<b>Appendix IV Parameters</b>														
Antimony	0.006	0.006	mg/L	0.002 U		0.002 U		0.002 U		0.002 U				0.001 U
Arsenic	0.01	0.01	mg/L	0.005 U		0.005 U		0.005 U		0.005 U				0.001 U
Barium	2	2	mg/L	0.042		0.03		0.025		0.023				0.028
Beryllium	0.004	0.004	mg/L	0.001 U		0.001 U		0.001 U		0.001 U				0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U		0.001 U		0.001 U		0.001 U				0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U		0.002 U		0.002 U		0.002 U				0.002 U
Cobalt		0.006	mg/L	0.00066 J		0.001 U		0.001 U		0.001 U				0.001 U
Fluoride	4	4	mg/L	1.6 J		1.5		1.9		1.7				1.5 J-
Lead	0.015	0.015	mg/L	0.001 U		0.001 U		0.001 U		0.001 U				0.001 U
Lithium		0.04	mg/L	0.0098		0.0073 J		0.0063 J		0.0058 J				0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U		0.0002 U		0.0002 U		0.0002 U				0.0002 U
Molybdenum		0.1	mg/L	0.037		0.039		0.057		0.044				0.05
Radium 226 + 228	5		pCi/L	1.67 J+		1.02 J+		0.704						1.67 U
Radium-226			pCi/L	1.09 J+		0.596 J+		0.438						0.798 U
Radium-228			pCi/L	0.579		0.454 U		0.518 U						0.867 U
Selenium	0.05	0.05	mg/L	0.0014 J		0.005 U		0.005 U		0.005 U				0.001 U
Thallium	0.002	0.002	mg/L	0.001 U		0.001 U		0.001 U		0.001 U				0.001 U
<b>Field Parameters</b>														
Dissolved Oxygen			mg/L	0.42		0.12		0.13		2.61				0.12
Oxidation Reduction Potential			millivolts	-185.5		-67		7.9		-67				-142.2
pH			SU	7.7		7.45		7.57		7.85				7.89
Specific Conductivity			uS/cm	2538		2375		2190		1896				3391
Temperature			deg C	14.6		14.5		12.8		8.05				13
Turbidity			NTU	3.4		1.63		1.72		2.89				2.91

Notes:  
 IDEM RCG= Indiana Department of Environmental Management  
 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
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 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW09																	
				2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-01	2017-04-26	2017-06-28	2017-08-23	2017-10-03	2018-03-14	2018-04-23	2018-10-25	2019-05-02	2019-11-07	2020-04-24			
				N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	FD	N	N	N
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	5.7	4.7	7.3	5.3	7.7	7.6	5.9	6.1	4.9	7.9	7.3		4.9	6.3	3	3	2.7	3.3
Calcium			mg/L	320	240	210	210	200	200	220	240	270	280	220		220	220	200	200	150	178
Chloride			mg/L	63	55	58	58	75	73	71	67	53	39	64		58	82	46	46	39	54.4
Fluoride	4	4	mg/L	0.15 J+	10 U	10 U	0.22 J	0.13 J	0.14 J	0.16 J	0.13 J	0.18 J	2 JO	0.21 J	5 U	0.26 J-	0.28	0.27	0.27	0.33	0.3 J-
pH			SU	7.27	7.25	7.12	6.68		7.44		7.15	7.25	7.31	7.3	7.28	6.87	6.88		7.1	7.06	7.15
Sulfate			mg/L	910 J-	570	360	500	440	420	460	460	600	740	540		510	510 J-	530	530	380	390
Total Dissolved Solids			mg/L	1500	1100	880	980	1000	990	1000	960	1300	1400	1100		930	1100	970	980	770	772
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0015 J	0.0013 J	0.00076 J	0.0031 J	0.005 U	0.005 U	0.0028 J	0.0029 J	0.002 J	0.0027 J		0.005 U		0.005 U	0.005 U	0.005 U	0.005 U	0.001 U
Barium	2	2	mg/L	0.059	0.043	0.036	0.039	0.035	0.037	0.039	0.042	0.047	0.054		0.041	0.039	0.039	0.041	0.041	0.036	0.032
Beryllium	0.004	0.004	mg/L	0.00012 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00036 J	0.001 U	0.001 U	0.001 U		0.001 UO		0.00092 J	0.00058 J	0.00052 J	0.00049 J
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.00033 J	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.0036	0.002 U	0.00062 J	0.0013 J	0.002 U	0.002 U	0.002 U	0.002 U	0.0011 J	0.0015 J		0.0016 J		0.002 U	0.0012 J	0.0012 J	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.00018 J	0.0002 J	0.0002 J	0.001 U	0.001 U	0.00029 J	0.00025 J	0.001 U	0.001 U		0.001 U		0.00038 J	0.00049 J	0.00055 J	0.00035 J	0.001 U
Fluoride	4	4	mg/L	0.15 J+	10 U	10 U	0.22 J	0.13 J	0.14 J	0.16 J	0.13 J	0.18 J	2 JO	0.21 J	5 U	0.26 J-	0.28	0.27	0.27	0.33	0.3 J-
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0019 J	0.008 U	0.008 U	0.0016 J	0.0011 J	0.0012 J	0.008 U	0.008 U	0.0017 J	0.0018 J		0.008 U		0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.02	0.017	0.029	0.023	0.027	0.027	0.021	0.021	0.028	0.032		0.025	0.035	0.04	0.043	0.043	0.035	0.052
Radium 226 + 228	5		pCi/L	1.5	0.568	0.477 U	0.467 U	0.55	0.469	0.593	0.414	0.707	0.803		1.45 J+	0.096	0.679	0.505	0.427 U		1.47 U
Radium-226			pCi/L	0.506 J+	0.231	0.397 U	0.257	0.134	0.166	0.194	0.205	0.255 J+	0.357		0.188	0.204	0.446	0.33	0.355 U		0.696 U
Radium-228			pCi/L	0.994	0.349 U	0.477 U	0.467 U	0.427 U	0.432 U	0.398	0.36 U	0.452	0.446		1.26 J+	-0.108	0.361 U	0.428 U	0.427 U		0.777 U
Selenium	0.05	0.05	mg/L	0.014	0.0091	0.0049 J	0.011	0.014	0.014	0.019	0.02	0.013	0.027		0.0082	0.011	0.0098	0.012	0.012	0.0077	0.0096
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	3.59	6.69	1.98	6.1		3.41		3.92	5.27	3.24	5.98	6.71	5.43	0.22		5.82	5.54	3.14
Oxidation Reduction Potential			millivolts	-1.4	75.7	27.6	236		90.5		152.6	280.8	58.9	139.5	-116.3	-90.8	-48.8		53.6	-25.7	44
pH			SU	7.27	7.25	7.12	6.68		7.44		7.15	7.25	7.31	7.3	7.28	6.87	6.88		7.1	7.06	7.15
Specific Conductivity			uS/cm	1671	736	1110	822		1041		1209	702	1542	1331	600	1156	1274		888	685	774
Temperature			deg C	14.4	18.4	16.9	11.9		10.75		11.9	14.7	17.2	18.2	10.2	10.6	17.9		11.4	15.9	10.3
Turbidity			NTU	1.59	3.92	1.15	1.34		3.12		1.88	1.91	0.91	0.39	0.82	2.44	2.41		3.41	1.55	2.37

Notes:  
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 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
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 "J-" = Indicates the result is estimated and may be biased low.  
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 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW09B																		
				2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-01	2017-04-26	2017-06-28	2017-08-23	2017-10-03	2018-03-14	2018-04-23	2018-09-06	2018-10-26	2019-05-08	2019-11-07	2020-04-27			
				FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
<b>Appendix III Parameters</b>																						
Boron		4	mg/L	24	25	25	16	11	11	11	12	16	16	16		14	12	12	14	14	8	6.1
Calcium			mg/L	260	280	270	190	200	170	170	180	180	180	160		160	150	180	150	150	150	148
Chloride			mg/L	210	180	190	130	110	120	130	150	170	160	140		150	180	150	140	140	110	117
Fluoride	4	4	mg/L	0.54 J+	0.55 J+	0.67 J	0.68 J	0.1 J	1.3 J	1.2 J	1.4 J	1.2 J	0.37 J	1.5 J	1.4 J	1.6 J	1.8 J	1.6	1.6	1.6	1.5	1.3
pH			SU		7.08	7.15	6.96	7.36	7.44	7.29	7.36		7.46	7.36	7.56	7.43	7.32	7.46		7.49	7.56	7.65
Sulfate			mg/L	970 J-	1000 J-	960	740	670 J+	550	570	640	630	650	550		430	570	580	510	520	440	387
Total Dissolved Solids			mg/L	2100	2000	2100	1700	1300	1200	1200	1500	1500	1500	1300		990	1300	1200	1200	1200	990	906
<b>Appendix IV Parameters</b>																						
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0024 J	0.0026 J	0.002 J	0.0014 J	0.0027 J	0.005 U	0.004 J	0.004 J	0.0031 J	0.0031 J		0.0054	0.0064	0.0044 J	0.004 J	0.0052	0.0057	0.0042 J	0.0049
Barium	2	2	mg/L	0.069	0.071	0.076	0.062	0.048	0.04	0.046	0.055	0.062	0.058		0.045	0.04	0.049	0.047	0.042	0.041	0.029	0.034
Beryllium	0.004	0.004	mg/L	0.00012 J	9.1E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.00027 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.001 U	0.00069 J	0.00028 J	0.00045 J	0.001 U	0.00028 J	0.00045 J	0.00041 J	0.00041 J		0.001 U		0.00058 J	0.00028 J	0.00022 J	0.00025 J	0.001 U	0.001 U
Fluoride	4	4	mg/L	0.54 J+	0.55 J+	0.67 J	0.68 J	0.1 J	1.3 J	1.2 J	1.4 J	1.2 J	0.37 J	1.5 J	1.4 J	1.6 J	1.8 J	1.6	1.6	1.6	1.5	1.3
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.00017 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0055 J	0.0065 J	0.008 U	0.008 U	0.0049 J	0.0045 J	0.0056 J	0.0054 J	0.0047 J	0.0042 J		0.0031 J		0.0037 J	0.0052 J	0.0053 J	0.0055 J	0.0033 J	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.01 U	0.0079 J	0.0075 J	0.0097 J	0.013	0.015	0.015	0.013	0.0094 J	0.01		0.014	0.012	0.01	0.011	0.012	0.012	0.0096 J	0.013
Radium 226 + 228	5		pCi/L	1.12	1.86	1.65	1.14	0.453	1.09	0.774	1.85	1.01	1.27		1.18 J+	0.868	1.04	1.24 J+	1.03	1.01		1.28 U
Radium-226			pCi/L	0.809 J+	0.947 J+	0.907	0.579	0.476	0.585	0.316	0.781 J+	0.585	0.709		0.482	0.301	0.653	0.69 J+	0.586	0.449		0.596 U
Radium-228			pCi/L	1 U	0.913	0.743	0.559	0.41 U	0.508	0.458	1.07	0.422	0.563		0.699 J+	0.567	0.386	0.546	0.491 U	0.564		0.838
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U	0.0014 J	0.001 J	0.0015 J	0.0016 J		0.005 U		0.002 J	0.0019 J	0.005 U	0.005 U	0.0011 J	0.001 U
Thallium	0.002	0.002	mg/L	0.0003 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.0002 J	0.001 U	0.001 U
<b>Field Parameters</b>																						
Dissolved Oxygen			mg/L		0.44	1.06	0.43	0.38	0.44	0.61	0.71		0.57	0.45	0.1	0.04	0.61	0.28		0.04	0.35	0.17
Oxidation Reduction Potential			millivolts		-57.7	67.3	-76.4	-100.1	-80.6	-102.6	68.2		19.7	-46.8	-121.6	-130.5	-100.5	-101.1		-16.8	-131.8	-106
pH			SU		7.08	7.15	6.96	7.36	7.44	7.29	7.36		7.46	7.36	7.56	7.43	7.32	7.46		7.49	7.56	7.65
Specific Conductivity			uS/cm		2356	2435	2088	1559	1352	1592	1561		1922	1722	1053	1301	1556	1693		1165	9.24	1419
Temperature			deg C		14.1	14.7	15.1	13.6	13.45	14.5	14.8		15.5	16	14	14.4	16.1	16		14.2	14.4	13.3
Turbidity			NTU		3.48	4.29	2.17	0.99	2.58	1.88	1.69		2.54	1.96	4.18	4.11	2.96	1.39		4.7	3.36	4.8

Notes:  
 IDEM RCG= Indiana Department of Environmental Management  
 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.



**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW15															
				2016-07-13	2016-09-08		2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-03	2018-03-15	2018-04-24	2018-10-26	2019-05-06	2019-11-08	2020-04-27
				N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	
<b>Appendix III Parameters</b>																			
Boron		4	mg/L	0.75	0.45 J	1 J	1.1	0.6	0.44	0.45	0.87	0.91	0.66		0.72	0.76	0.71	0.73	0.68
Calcium			mg/L	100	130	120	100	82	81	95	160	150	77		170	120	140	100	128
Chloride			mg/L	28	31	31	27	28	27	27	27	25	19		24	21	22	28	25.2
Fluoride	4	4	mg/L	1.2 J+	0.85 J	0.85 J	0.74 J	0.8 J	0.77 J	0.74 J	0.82 J	0.82 J	0.93 J	0.67 J	0.76 J	0.69	0.52	0.73	0.6
pH			SU	6.88		6.98	6.83	6.96	6.99	6.76	6.61	6.96	6.88	6.95	6.89	5.2	7.1	7.34	7.34
Sulfate			mg/L	160 J-	260	260	150	140	140	160	300	330	260		410	240	380	260	227
Total Dissolved Solids			mg/L	570	660	630	520	400	400	420	780	750	660		790	5900 O	740	640	572
<b>Appendix IV Parameters</b>																			
Antimony	0.006	0.006	mg/L	0.002 U	0.00041 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.056	0.072	0.069	0.078	0.076	0.054	0.062	0.059	0.066		0.058		0.091	0.081	0.075	0.061
Barium	2	2	mg/L	0.044	0.053	0.053	0.039	0.032	0.031	0.034	0.054	0.058		0.047		0.046	0.047	0.037	0.039
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.00027 J	0.00028 J	0.00029 J	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.0019	0.0022	0.0022	0.0021	0.0019	0.0018	0.0022	0.0029	0.0027		0.0025		0.0023	0.0035	0.0017	0.0018
Fluoride	4	4	mg/L	1.2 J+	0.85 J	0.85 J	0.74 J	0.8 J	0.77 J	0.74 J	0.82 J	0.82 J	0.93 J	0.67 J	0.76 J	0.69	0.52	0.73	0.6
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0053 J	0.008 U	0.008 U	0.008 U	0.004 J	0.0024 J	0.0041 J	0.0058 J	0.005 J		0.0023 J		0.0054 J	0.0053 J	0.0027 J	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.02	0.027	0.026	0.023	0.022	0.022	0.026	0.017	0.019		0.029		0.016	0.017	0.029	0.031
Radium 226 + 228	5		pCi/L	5 U	0.479	0.513	0.646 U	0.555 J+	0.339 U	0.463 U	0.335	0.342 U		0.657 J+		0.858 J+	0.476 U		1.72 U
Radium-226			pCi/L	1 U	0.202	0.145	0.337 U	0.38	0.127 U	0.1	0.0965 J+	0.104		0.0817		0.527 J+	0.28 U		1.02 U
Radium-228			pCi/L	1 U	0.397 U	0.382 U	0.646 U	0.401 U	0.339 U	0.463 U	0.278 U	0.342 U		0.576 J+		0.407 U	0.476 U		0.695 U
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U		0.005 U	0.005 U	0.005 U	0.001 U
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
<b>Field Parameters</b>																			
Dissolved Oxygen			mg/L	0.48		0.48	0.14	0.25	0.16	0.19	1	0.32	0.29	0.06	0.02	1.97	0.15	0.12	0.09
Oxidation Reduction Potential			millivolts	-79.2		-60.1	-111	-114.3	-104.1	-104.4	-46.9	-43.7	-13.8	-56.8	-99.1	-254.7	-27.5	-100	-103.9
pH			SU	6.88		6.98	6.83	6.96	6.99	6.76	6.61	6.96	6.88	6.95	6.89	5.2	7.1	7.34	7.34
Specific Conductivity			uS/cm	779		909	733	594	584	674	9.32	1004	901	581	933	855	730	598	950
Temperature			deg C	15.3		20.3	19.9	14.6	12.1	11.6	14.6	16.6	18.1	10.8	10.6	17.1	8.3	15.8	11.5
Turbidity			NTU	4.48		2.96	3.41	3.98	4.4	4.92	4.2	3.1	4.11	3.98	4.29	3.1	4.9	6.9	4.51

Notes:  
 IDEM RCG= Indiana Department of Environmental Management Remediation Closure Guidance Table A-6 Screening Levels - 2021 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW15B																	
				2016-07-13	2016-09-08	2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-03	2018-03-15	2018-04-24	2018-09-06	2018-10-26	2019-05-08	2019-11-08	2020-04-27		
				N	N	N	N	N	N	N	N	N	N	N	FD	N	N	FD	N	N	
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	1.1	1.7	2	3.7	3.3	3.6	3.1	2.1	2.1		4.4		4.1	4.9	10		6.2	7.9
Calcium			mg/L	160	160	160	180	160	170	190	170	73		230		200	210	280		280	273
Chloride			mg/L	52	58	62	81	64	65	71	64	64		87		89	93	110		80	104
Fluoride	4	4	mg/L	0.65 J+	0.62 J	0.46 J	0.74 J	0.77 J	0.75 J	0.72 J	0.61 J	0.5 J	0.69 J	0.79 J		0.6 J	0.6	0.84 J+		0.89	0.84
pH			SU	7.81	7.49	7.04	7.52	7.48	7.11	7.26	7.37	7.42	7.45	7.36		7.8	6.74	7.43		7.57	7.56
Sulfate			mg/L	380 J-	390	340	500	390	460	530	540	500		790		720	770	1300		940	912
Total Dissolved Solids			mg/L	830	800	840	1000	890	980	1200	1100	1100		1400		1400	1400	2100		1600	1720
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.001 U	
Arsenic	0.01	0.01	mg/L	0.003 J	0.0011 J	0.0014 J	0.0022 J	0.0011 J	0.00098 J	0.00084 J	0.00081 J		0.005 U		0.005 U	0.005 U	0.00088 J		0.005 U	0.001 U	
Barium	2	2	mg/L	0.054	0.053	0.056	0.056	0.051	0.052	0.064	0.069		0.068		0.07	0.064	0.081		0.054	0.054	
Beryllium	0.004	0.004	mg/L	7.8E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.0002 U	
Chromium	0.1	0.1	mg/L	0.00062 J	0.002 U	0.002 U	0.00033 J	0.00034 J	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	
Cobalt		0.006	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.00016 J	0.001 U	0.001 U	0.001 U		0.00029 J		0.00037 J	0.001 U	0.001 U		0.001 U	0.001 U	
Fluoride	4	4	mg/L	0.65 J+	0.62 J	0.46 J	0.74 J	0.77 J	0.75 J	0.72 J	0.61 J	0.5 J	0.69 J	0.79 J		0.6 J	0.6	0.84 J+		0.89	0.84
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.00023 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	
Lithium		0.04	mg/L	0.0069 J	0.008 U	0.008 U	0.0077 J	0.0053 J	0.0082	0.0082	0.0077 J		0.007 J		0.008	0.0096	0.012		0.0085	0.0086	
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	
Molybdenum		0.1	mg/L	0.011	0.013	0.01	0.012	0.015	0.014	0.014	0.012		0.011		0.01	0.011	0.012		0.01	0.012	
Radium 226 + 228	5		pCi/L	1.26	0.594	0.61	1.14 J+	0.876	0.687	0.789	0.872		1.69 J+		1.31	1.51 J+	1.61			1.63 U	
Radium-226			pCi/L	0.607 J+	0.442	0.361 U	0.785	0.441	0.442	0.537 J+	0.547		0.752		0.711	0.837 J+	1.07			0.656 U	
Radium-228			pCi/L	1 U	0.389 U	0.498 U	0.502 U	0.435	0.378 U	0.329 U	0.363 U		0.94 J+		0.603	0.676	0.544			0.975 U	
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U		0.0017 J	0.005 U	0.005 U		0.005 U	0.001 U	
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.0003 J		0.001 U	0.001 U	
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	0.22	0.91	0.56	0.22	0.46	0.3	0.43	0.64	0.23	0.08	0.04		0.29	2.06	0.23		0.16	0.16
Oxidation Reduction Potential			millivolts	-129.7	-21.6	-94.6	-132.6	-81.7	-79.6	-21.3	-36.5	-42.6	-64	-102.4		-91.2	-256.1	46.3		-189.2	-98.1
pH			SU	7.81	7.49	7.04	7.52	7.48	7.11	7.26	7.37	7.42	7.45	7.36		7.8	6.74	7.43		7.57	7.56
Specific Conductivity			uS/cm	834	1049	1060	1237	940	1096	1099	1110	1294	1255	1612		2757	1889	1798		1384	2359
Temperature			deg C	12.71	15.9	16.1	13.9	13.6	13	13.8	14.2	14.5	13.3	13		14.13	13.6	8.1		13.8	13.9
Turbidity			NTU	4.72	1.56	1.48	3.8	2.23	3.65	3.16	1.78	0.4	4.59	4.88		3.59	1.35	3.56		1.49	4.3

Notes:  
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 Revision  
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 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
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 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
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 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW16																	
				2016-07-13	2016-09-08	2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-15	2018-04-24	2018-10-29	2019-05-03	2019-11-08	2020-04-23			
				N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	FD	N	N
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	1.1	1.8	1.6	1.2	0.89	1.3	1	1.4	1.1		1.4	1.4	1.4	1.6		1.9	1.1	
Calcium			mg/L	230	180	170	120	160	210	220	240	57		220	160	160	210		210	302	
Chloride			mg/L	53	37	30	28	24	25	28	31	42		58	36	36	28		59	21.9	
Fluoride	4	4	mg/L	1.4 J+	1.6 J	1.3 J	1.5	1.3 J	1.3 J	1.2 J	1.3 J	1.5 J	1 J	1.2 J	1.1	1.1	0.99		1.1	0.88	
pH			SU	7.92	7.18	7.48	7.5	7.58	7.17	7.36	7.06	7.62	7.41	7.67		7.28	7.46		7.8	7.79	
Sulfate			mg/L	530 J-	400	320	47 O	300	500	480	630	520		530	340	350	570		530	757	
Total Dissolved Solids			mg/L	1100	810	790	570	670	930	1000	1100	980		1100	740	730	1100		1100	1290	
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00028 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.001 U	
Arsenic	0.01	0.01	mg/L	0.011	0.0077	0.012	0.0084	0.0079	0.006	0.008	0.0096		0.002 J	0.0065	0.01	0.0098	0.005		0.0082	0.009	
Barium	2	2	mg/L	0.049	0.042	0.035	0.024	0.029	0.043	0.044	0.054		0.057	0.045	0.035	0.035	0.034		0.034	0.046	
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.0002 U	
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.0002 U	
Chromium	0.1	0.1	mg/L	0.00062 J	0.002 U	0.002 U	0.0031	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	
Cobalt		0.006	mg/L	0.001 U	0.00068 J	0.00051 J	0.00046 J	0.00055 J	0.00092 J	0.00094 J	0.0011		0.0013		0.00059 J	0.00061 J	0.00066 J		0.00061 J	0.0012	
Fluoride	4	4	mg/L	1.4 J+	1.6 J	1.3 J	1.5	1.3 J	1.3 J	1.2 J	1.3 J	1.5 J	1 J	1.2 J	1.1	1.1	0.99		1.1	0.88	
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	
Lithium		0.04	mg/L	0.00043 J	0.008 U	0.008 U	0.00023 J	0.008 U	0.008 U	0.008 U	0.008 U		0.008 U		0.008 U	0.008 U	0.008 U		0.008 U	0.008 U	
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	
Molybdenum		0.1	mg/L	0.024	0.036	0.045	0.044	0.03	0.027	0.023	0.024		0.027	0.031	0.033	0.033	0.027		0.028	0.022	
Radium 226 + 228	5		pCi/L	1.68	0.543	0.527 U	0.629 U	0.648	0.392 U	0.339 U	0.429		0.862 J+	0.29	0.862 J+	1.32 J+	0.685 U			1.69 U	
Radium-226			pCi/L	0.537 J+	0.249	0.363 U	0.256 U	0.129 U	0.094	0.106 J+	0.246		0.1	0.0822	0.214 J+	0.278 J+	0.277 U			0.644 U	
Radium-228			pCi/L	1.14	0.395 U	0.527 U	0.629 U	0.528	0.392 U	0.339 U	0.322 U		0.762 J+	0.208	0.648 J+	1.04 J+	0.685 U			1.05 U	
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.0005 J	0.0005 J	0.005 U	0.0012 J	0.005 U	0.005 U		0.0015 J		0.005 U	0.005 U	0.005 U		0.0015 J	0.001 U	
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	0.16	0.27	0.48	0.31	0.36	0.14	0.5	0.14	0.06	0.22	0.22		1.27	0.29		4.02	0.19	
Oxidation Reduction Potential			millivolts	-18.06	711.6	-124.8	-78.8	-136.9	-73.6	-114.2	9.6	-158.4	-55.9	-106.5		-216.8	8		-2	-124.3	
pH			SU	7.92	7.18	7.48	7.5	7.58	7.17	7.36	7.06	7.62	7.41	7.67		7.28	7.46		7.8	7.79	
Specific Conductivity			uS/cm	1331	1112	927	751	821	1257	1123	1406	1254	1029	1239		1046	1001		1014	1680	
Temperature			deg C	15.02	18.8	18.15	12.1	9.72	10.6	15.41	18	17.8	8.71	9.2		17.81	10.5		17.52	10.3	
Turbidity			NTU	3.89	2.16	1.93	3.16	4.14	3.25	4.33	2.45	4.95	4.62	12.81		3.64	4.65		3.98	8.11	

Notes:  
 IDEM RCG= Indiana Department of Environmental Management  
 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW16B																	
				2016-07-13	2016-09-08	2016-11-09		2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-15	2018-04-24	2018-09-07	2018-10-29	2019-05-06	2019-11-08		2020-04-24
				N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	1.8	1.6	1.4	1.4	1.4	1.4	1.1	3.4	6.5	2.9		4.1	7.6	9.7	12	11	10	8.2
Calcium			mg/L	230	190	180	180	210	210	270	220	260	100		250	310	350	350	300	280	230
Chloride			mg/L	63	56	57	55	57	47	71	71	120	78		140	160	150	190	220	210	122
Fluoride	4	4	mg/L	1.1 J+	1.1 J	0.84 J	0.73 J	0.99 J	0.87 J	0.83 J	0.76 J	0.78 J	1 J	0.8 J	0.76 J	0.73 J	0.64	0.76	1	1	0.78 J-
pH			SU	7.76	7.47		7.41	7.57	7.55	7.3	7.51	7.28	7.54	7.6	7.65	7.97	7.02	7.49		7.85	7.73
Sulfate			mg/L	580 J-	480	500	440	50 O	470	730	720	640	580		690	760	890	940	1500	1500	884
Total Dissolved Solids			mg/L	1100	1000	1000	1000	1000	1000	1300	1200	1400	1200		1400	20 UO	1600	1800	2400	2400	1860
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00057 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.00095 J		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0068	0.0064	0.011	0.011	0.012	0.0095	0.012	0.0096	0.0081		0.0099	0.0097	0.011	0.0088	0.0071	0.0079	0.0076	0.008
Barium	2	2	mg/L	0.072	0.04	0.036	0.035	0.038	0.039	0.055	0.043	0.046		0.053	0.058	0.068	0.071	0.079	0.055	0.054	0.043
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.00022 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00029 J	0.002 U	0.00026 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.00016 J	0.00019 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.0003 J		0.00054 J	0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	4	4	mg/L	1.1 J+	1.1 J	0.84 J	0.73 J	0.99 J	0.87 J	0.83 J	0.76 J	0.78 J	1 J	0.8 J	0.76 J	0.73 J	0.64	0.76	1	1	0.78 J-
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0055 J	0.008 U	0.0032 J	0.0022 J	0.0058 J	0.0035 J	0.0072 J	0.006 J	0.0061 J		0.007 J		0.0059 J	0.0059 J	0.007 J	0.0054 J	0.0055 J	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.013	0.012	0.012	0.012	0.012	0.013	0.023	0.016	0.013		0.016	0.015	0.012	0.011	0.014	0.02	0.019	0.017
Radium 226 + 228	5		pCi/L	1.31	1.05	0.866	0.794	0.998 J+	0.577	1.23	0.795	1.21		1.11 J+	0.99	1.17 J+	1.64 J+	0.984			1.5 U
Radium-226			pCi/L	0.651 J+	0.458	0.427	0.412 U	0.507	0.348	0.635	0.54 J+	0.559	0.443	0.535	0.724 J+	0.719 J+	0.753				0.673 U
Radium-228			pCi/L	0.66	0.59	0.467 U	0.435 U	0.491 J+	0.399 U	0.597	0.287 U	0.647		0.671 J+	0.455	0.522 U	0.919 J+	0.459 U			0.855
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.00061 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	1.23	1.63		0.39	0.3	0.21	0.12	0.32	0.16	0.15	0.28	0.25	1.02	4.23	0.33		3.41	0.14
Oxidation Reduction Potential			millivolts	-122.6	-89		-126.3	-148.5	-132.2	-130.2	-123.1	-32.7	-135.8	-75.5	-117.8	-101.5	-166.8	21.2		-99.5	-129.6
pH			SU	7.76	7.47		7.41	7.57	7.55	7.3	7.51	7.28	7.54	7.6	7.65	7.97	7.02	7.49		7.85	7.73
Specific Conductivity			uS/cm	1147	1297		1158	1230	1192	1645	1333	1665	1461	1142	1653	3104	2098	1692		2340	2595
Temperature			deg C	13.04	14.44		15.27	14.3	13.37	12.3	13.48	14.3	15	12.6	12.3	15	17.7	11.2		14.65	13
Turbidity			NTU	4.1	3.99		1.8	2.76	4.21	4.58	3.27	2.48	3.9	4.08	4.2	4.99	3.49	3.72		2.81	6.61

Notes:  
 IDEM RCG= Indiana Department of Environmental Management Remediation Closure Guidance Table A-6 Screening Levels - 2021 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.



**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW17																			
				2016-07-14	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-14		2018-04-23		2018-10-29	2019-05-09	2019-11-08	2020-04-24			
				N	N	N	N	N	N	N	N	N	N	N	FD	N	FD	N	N	N	N	N	
<b>Appendix III Parameters</b>																							
Boron		4	mg/L	12	12	11	11	11	8.9	7.6	12	12					5.8	5.8	16	7.7	4.9	7.6	
Calcium			mg/L	150	160	170	180	200	180	120	150	64					110	110	200	130	120	198	
Chloride			mg/L	110	100	130	150	140	81	170	130	160					40	38	150	90	92	106	
Fluoride	4	4	mg/L	1.8 J+	2.2 J	2 J	1.9 J	1.6 J	1.6 J	0.79 J	1.9 J	2.4 J	5 U	1.7 J	1.9 J	1.9 J-	1.7	1.6	1.7	1.6	1.7	1.2 J-	
pH			SU	7.56	7.27	7.21	7.33	7.54	7.23	7.4	7.16	7.22		7.62		7.82	6.85	7.53	7.75	7.34			
Sulfate			mg/L	330 J-	330	360	390	390	390	520	250	350					240	220	430	300	290	459	
Total Dissolved Solids			mg/L	940	920	940	1000	1100	950	1400	890	1000					630	620	1100	800	860	1120	
<b>Appendix IV Parameters</b>																							
Antimony	0.006	0.006	mg/L	0.00034 J	0.00032 J	0.00032 J	0.002 U	0.00028 J	0.002 U	0.002 U	0.002 U			0.002 U	0.002 U			0.002 U	0.002 U	0.002 U	0.001 U		
Arsenic	0.01	0.01	mg/L	0.0054	0.0056	0.0042 J	0.0069	0.0055	0.0054	0.0035 J	0.0028 J			0.005 U	0.0027 J			0.004 J	0.0021 J	0.0028 J	0.0023		
Barium	2	2	mg/L	0.047	0.056	0.054	0.05	0.054	0.048	0.044	0.06			0.041	0.058		0.029	0.073	0.041	0.052	0.067		
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.00076 J	0.001 U	0.0002 U		
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.0002 U		
Chromium	0.1	0.1	mg/L	0.0015 J	0.002 U	0.0011 J	0.0011 J	0.0012 J	0.0012 J	0.002 U	0.002 U			0.0017 J	0.0014 J			0.002 U	0.002 U	0.002 U	0.002 U		
Cobalt		0.006	mg/L	6.3E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.001 U		
Fluoride	4	4	mg/L	1.8 J+	2.2 J	2 J	1.9 J	1.6 J	1.6 J	0.79 J	1.9 J	2.4 J	5 U	1.7 J	1.9 J	1.9 J-	1.7	1.6	1.7	1.6	1.7	1.2 J-	
Lead	0.015	0.015	mg/L	0.00018 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U	0.001 U		
Lithium		0.04	mg/L	0.0047 J	0.008 U	0.0036 J	0.0047 J	0.0024 J	0.0045 J	0.0058 J	0.0076 J			0.008 U	0.0035 J			0.0066 J	0.0035 J	0.0052 J	0.008 U		
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U			0.0002 U	0.0002 U	0.0002 U	0.0002 U		
Molybdenum		0.1	mg/L	0.015	0.012	0.011	0.01 U	0.01	0.011	0.018	0.024			0.024	0.024		0.02	0.017	0.017	0.012	0.03		
Radium 226 + 228	5		pCi/L	0.569	0.451 U	0.447 U	0.553 U	0.428	0.477	0.403 U	0.71			0.816 J+	0.384 U		0.205	1.1 J+	0.518 U		1.58 U		
Radium-226			pCi/L	1 U	0.331	0.415 U	0.246 U	0.222	0.23	0.191 J+	0.215			0.202	0.112		0.0399	0.315 J+	0.26 U		0.783 U		
Radium-228			pCi/L	1 U	0.451 U	0.447 U	0.553 U	0.402 U	0.406 U	0.403 U	0.495			0.614 J+	0.384 U		0.166	0.783 J+	0.518 U		0.797 U		
Selenium	0.05	0.05	mg/L	0.019	0.03	0.018	0.023	0.028	0.026	0.0081	0.0032 J			0.0074	0.021		0.015	0.022	0.004 J	0.011	0.0011		
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U			0.001 U	0.00063 J	0.001 U	0.001 U		
<b>Field Parameters</b>																							
Dissolved Oxygen			mg/L	5.78	1.7	1.8	1.01	2.35	7.33	3.18	4.33	3.3					4.99		9	1.78	5.75	6.47	3.15
Oxidation Reduction Potential			millivolts	45.8	825.9	6.1	82.3	6.6	67.9	23.3	8	57.9					-90.2		-90.2	-237	53.1	35	25.2
pH			SU	7.56	7.27	7.21	7.33	7.54	7.23	7.4	7.16	7.22		7.62		7.82	6.85	7.53	7.75	7.34			
Specific Conductivity			uS/cm	1059	1287	1141	1272	1541	1290	902	1151	1357		832		675	1513	894	798	1017			
Temperature			deg C	17.23	20.6	18.63	13.6	10.95	11.8	17.71	24.4	22.3		10.9		11.4	20	12.1	17.23	9.31			
Turbidity			NTU	1.56	1.09	0.58	2.58	0.44	2.21	1.02	1.5	2.51		0.54		1.19	0.45	0.44	0.86	0.73			

Notes:  
 IDEM RCG= Indiana Department of Environmental Management  
 Remediation Closure Guidance Table A-6 Screening Levels - 2021  
 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW17B															
				2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-04	2018-03-14	2018-04-23	2018-09-06	2018-10-29	2019-05-09	2019-11-08	2020-04-24
				N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
<b>Appendix III Parameters</b>																			
Boron		4	mg/L	18	19	19	21	22	20	16	13	11		13	10	12	12	9.4	8.7
Calcium			mg/L	230	250	240	250	270	250	240	160	57		180	150	150	180	150	141
Chloride			mg/L	180	170	180	190	200	200	71	99	130		140	120	110	130	110	111
Fluoride	4	4	mg/L	0.9 J+	0.98 J	0.68 J	0.58 J	0.6 J	0.6 J	2.1 J	1.3 J	1.1 J	0.55 J	0.58 J	0.84 J	0.71	0.62	0.67	0.68 J-
pH			SU	7.43	7.37	7.1	7.24	7.44	7.02	7.25	7.19	7.38	7.48	7.39	7.63	7.4	7.15	7.66	7.22
Sulfate			mg/L	710 J-	680	710	740	710	680	300	380	420		520	350	350	270	350	314
Total Dissolved Solids			mg/L	1500	1400	1400	1500	1700	1500	660	1000	960		1100	940	950	980	990	835
<b>Appendix IV Parameters</b>																			
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0024 J	0.0021 J	0.0024 J	0.0035 J	0.0023 J	0.0022 J	0.0023 J	0.0026 J		0.0011 J		0.0017 J	0.0023 J	0.0022 J	0.0019 J	0.0015
Barium	2	2	mg/L	0.078	0.079	0.086	0.092	0.1	0.089	0.065	0.06		0.085	0.069	0.066	0.073	0.11	0.074	0.065
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.00033 J	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.0003 J	0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	4	4	mg/L	0.9 J+	0.98 J	0.68 J	0.58 J	0.6 J	0.6 J	2.1 J	1.3 J	1.1 J	0.55 J	0.58 J	0.84 J	0.71	0.62	0.67	0.68 J-
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0017 J	0.008 U	0.008 U	0.0019 J	0.00046 J	0.0021 J	0.0019 J	0.008 U		0.008 U		0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.024	0.021	0.013	0.011	0.012	0.011	0.017	0.021		0.017	0.016	0.01	0.011	0.0073 J	0.01	0.014
Radium 226 + 228	5		pCi/L	1.79	1.84	2.53	2.58	1.25	1.94	1.03	2.4		1.64 J+	1.21	1.47	2.48 J+	1.71		1.74
Radium-226			pCi/L	0.882 J+	0.864	1.28	1.4	1.01	1.09	0.639 J+	0.867		0.799	0.518	0.945	1.15 J+	0.964		0.671 U
Radium-228			pCi/L	0.913	0.98	1.25	1.17	0.423 U	0.846	0.395	1.53		0.845 J+	0.696	0.524	1.33 J+	0.748		1.12
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.00053 J	0.00051 J	0.005 U	0.005 U	0.005 U		0.005 U		0.0011 J	0.005 U	0.005 U	0.005 U	0.001 U
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.00022 J	0.001 U	0.001 U
<b>Field Parameters</b>																			
Dissolved Oxygen			mg/L	0.33	0.24	0.67	0.36	0.13	0.13	0.18	0.14	0.09	0.16	0.11	0.2	0.88	0.23	4.2	0.2
Oxidation Reduction Potential			millivolts	-115	654	-100.8	-119.6	-91.8	102.3	-98.6	-51.1	-129.4	-95.2	-131.9	-91.9	-244.5	11.8	-3.6	-94.1
pH			SU	7.43	7.37	7.1	7.24	7.44	7.02	7.25	7.19	7.38	7.48	7.39	7.63	7.4	7.15	7.66	7.22
Specific Conductivity			uS/cm	1525	1734	1568	171.9	2251	1950	1488	1244	1337	1235	1463	2077	1380	1060	890	920
Temperature			deg C	15.29	16.16	15.77	15	14.8	14.4	15.62	16.5	16.6	15.2	15.2	16.55	16.1	13.6	15.05	13.12
Turbidity			NTU	4.09	2.48	0.62	0.92	0.58	2.11	2.35	1.86	3.45	3.76	3.88	3.55	4.86	3.61	2.68	4.58

Notes:  
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 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
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 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW18																	
				2016-07-13	2016-09-08	2016-11-09		2017-01-10	2017-03-01	2017-04-26	2017-07-12		2017-08-23	2017-10-03		2018-03-14	2018-04-23	2018-10-25	2019-04-29	2019-11-07	2020-04-23
				N	N	FD	N	N	N	N	FD	N	N	FD	N	N	N	N	N	N	
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	1.8	3.5	1.9	1.8	1.3	1	0.77	1.2	1.2	1.5	1.9	1.9		1.2	1.7	0.95	1.7	1.2
Calcium			mg/L	320	610 O	370	360	330	280	210	280	290	300	380 J	64 J		320	230	320	360	294
Chloride			mg/L	17	39	17	17	9.3	5	4.3	10	10	11	23	23		7.3	22	12	27	16.7
Fluoride	4	4	mg/L	0.047 J+	0.036 J	10 U	10 U	5 U	5 U	2 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	0.057	0.074	0.15	0.17
pH			SU	6.95	6.83		6.7	6.88	7.11	6.6		6.96	7.02		6.91	7.2	7.21	6.54	6.71	7.18	6.96
Sulfate			mg/L	760 J-	1400	850	830	640	540	370	600	610	690	960	950		670	550	780	920	679
Total Dissolved Solids			mg/L	1300	2200	1500	1500	1200	1000	730	1100	1100	1300	1600	1500		2400	1100	1400	1500	1130
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00096 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0014 J	0.0023 J	0.0014 J	0.00091 J	0.0014 J	0.005 U	0.0015 J	0.0021 J	0.0021 J	0.0011 J			0.005 U		0.005 U	0.00079 J	0.005 U	0.001 U
Barium	2	2	mg/L	0.038	0.047	0.041	0.039	0.037	0.024	0.021	0.051	0.052	0.055			0.048	0.035	0.037	0.039	0.05	0.033
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	8.1E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00067 J	0.00046 J	0.0005 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.00023 J	0.00047 J	0.0002 J	0.00024 J	0.001 U	0.00023 J	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.00028 J	0.001 U	0.001 U
Fluoride	4	4	mg/L	0.047 J+	0.036 J	10 U	10 U	5 U	5 U	2 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	0.057	0.074	0.15	0.17
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.00051 J	0.00025 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.00067 J		0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.00096 J	0.008 U	0.008 U	0.008 U	0.00042 J	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U			0.008 U		0.008 U	0.008 U	0.008 U	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U			0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.11	0.18 O	0.14 O	0.13 O	0.094	0.1	0.1	0.1	0.11	0.1			0.097	0.085	0.057	0.062	0.076	0.071
Radium 226 + 228	5		pCi/L	5 U	0.803	0.474	0.449	0.581 U	0.398 U	0.384 U	0.493	0.337 U	0.629			0.373 U	0.259	0.477	0.365 U		1.74 U
Radium-226			pCi/L	1 U	0.348	0.334 U	0.33 U	0.325	0.13	0.131 U	0.166 J+	0.179 J+	0.332			0.111	0.0715	0.291	0.325 U		0.789 U
Radium-228			pCi/L	1 U	0.49 U	0.455 U	0.413 U	0.581 U	0.398 U	0.384 U	0.381 U	0.337 U	0.369 U			0.373 U	0.187	0.357 U	0.365 U		0.947 U
Selenium	0.05	0.05	mg/L	0.01	0.018	0.0065	0.0052	0.0099	0.011	0.0053	0.012	0.012	0.006			0.009	0.0084	0.015	0.015	0.012	0.018
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	4.83	4.77		5.93	7.52	8.86	7.79		6.04	4.52		5.32	6.5	8.49	3.78	7.01	2.95	5.6
Oxidation Reduction Potential			millivolts	98.9	76.8		28.7	106.8	97.9	209.2		203.2	24.7		121.9	-129.6	-51.6	-36.6	129.2	-41.1	241.3
pH			SU	6.95	6.83		6.7	6.88	7.11	6.6		6.96	7.02		6.91	7.2	7.21	6.54	6.71	7.18	6.96
Specific Conductivity			uS/cm	1474	2362		1740	1255	986	970		1299	1414		1760	905	1170	1230	1060	1338	995
Temperature			deg C	16.3	20.1		16.6	9.65	8.47	11.2		17.9	19.8		19.3	8.1	8.9	17.4	8.8	14.2	9.18
Turbidity			NTU	3.32	1.63		2.38	3.05	4.44	2.48		1.71	1.03		4.16	4.59	0.71	1.29	4.55	2.04	1.33

Notes:  
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 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW18B					GAMW46									
				2018-09-10	2018-10-25	2019-04-29	2019-11-07	2020-04-23	2018-06-13	2019-03-01	2019-04-17	2019-06-06	2019-07-18	2019-08-26	2019-10-04	2019-11-19	2020-04-21	
				N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N
<b>Appendix III Parameters</b>																		
Boron		4	mg/L	13	12	13	14	11	10.9	0.055 JO	0.1 U	0.033 J	0.1 U	0.032 J	0.053 J	0.043 J	0.049 J	0.1 U
Calcium			mg/L	260	200	220	240	180	299	56 O	14	28	25 J-	25	25	23	27	24.5
Chloride			mg/L	150	140	140	170	140	117	8.4 O	2.4	1.9		1.8	1.6	1.6	1.6	1.6
Fluoride	4	4	mg/L	0.77 J	0.74	0.73	0.88	0.99	0.91	0.052 JO	0.068	0.063		0.065	0.06	0.079 J+	0.062	0.062
pH			SU	7.73		6.86	7.15	7.68	7.21	7.93	8.17	8.23	7.52	8.15	7.9	7.81	7.77	8.64
Sulfate			mg/L	1100	1000	1100	1100	840	1220	55 O	34	30		28	29	30	27	24.7
Total Dissolved Solids			mg/L	2100	2000	2000	2100	1500	2060	260 O	160	150		130	150	140 J+	140	101
<b>Appendix IV Parameters</b>																		
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U	0.002 UO	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0018 J	0.0026 J	0.0028 J	0.0037 J	0.0041 J	0.0029	0.0014 JO	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.00086 J	0.005 U	0.001 U
Barium	2	2	mg/L	0.048	0.035	0.039	0.039	0.024	0.041	0.027 O	0.0028 J	0.0059	0.0065	0.0054	0.0054	0.0049 J	0.0059	0.0053
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 UO	0.005 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00054 J	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 UO	0.002 U	0.002 U	0.002 U	0.002 U	0.0014 J	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.00027 J	0.00026 J	0.00028 J	0.00024 J	0.00024 J	0.001 U	0.0002 JO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	4	4	mg/L	0.77 J	0.74	0.73	0.88	0.99	0.91	0.052 JO	0.068	0.063		0.065	0.06	0.079 J+	0.062	0.062
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.025	0.015	0.016	0.023	0.015	0.026	0.008 UO	0.04 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 UO	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.024	0.014	0.015	0.026	0.011	0.039	0.0031 JO	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.0015 J	0.01 U	0.001 U
Radium 226 + 228	5		pCi/L	1.7	1.28	1.46			1.7 U	0.384 UO	0.486 U	0.33 U		0.427 U	0.505 U	0.566		1.7 U
Radium-226			pCi/L	0.773 J+	0.717	0.748	0.41		0.882 U	0.244 UO	0.103 U	0.0708 U		0.214 U	0.0925 UJ	0.179 J+		0.745 U
Radium-228			pCi/L	0.928	0.562	0.708	0.941		0.821 U	0.384 UO	0.486 U	0.33 U		0.427 U	0.505 UJ	0.481 U		0.95 U
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U	0.001 JO	0.025 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00059 J	0.001 U	0.001 U
<b>Field Parameters</b>																		
Dissolved Oxygen			mg/L	0.24		0.29	0.92	0.36	0.18	0.12	1.85	4.18	6.44	6.58	4.03	2.44	3.36	3.42
Oxidation Reduction Potential			millivolts	-140.7		-103.4	109.2	-144.8	-77.7	-171.4	1.9	7.7	157.6	25.5	40.6	9.16	-141.1	125.6
pH			SU	7.73		6.86	7.15	7.68	7.21	7.93	8.17	8.23	7.52	8.15	7.9	7.81	7.77	8.64
Specific Conductivity			uS/cm	3311		2147	1902	1475	1897	367	155	161	179	153	153	152	132	208
Temperature			deg C	15.39		14.9	11.8	13.7	12.1	11.4	8	9.1	11.1	13.2	14.2	14.8	11.7	8.3
Turbidity			NTU	2.78		3.58	3.21	3.14	2.35	3.96	1.91	1.33	0.51	0.82	0.69	0.89	0.66	2.18

Notes:  
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 Revision  
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 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
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 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.



**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW46B								GAMW52								
				2018-06-13	2019-03-04	2019-04-17	2019-06-07	2019-07-18	2019-08-26	2019-10-04	2019-11-19	2020-04-21	2018-09-10	2018-10-31	2019-05-09	2019-11-14	2020-04-30			
				N	N	N	N	N	N	N	N	N	N	FD	N	N	FD	N	N	
<b>Appendix III Parameters</b>																				
Boron		4	mg/L	0.05 JO	0.05 J	0.037 J	0.047 J	0.03 J	0.05 J	0.047 J	0.046 J	0.1 U	0.34		0.17	0.077 J		0.13	0.1 U	
Calcium			mg/L	25 O	58	58	56	52	58	49	56	53.8	75		59	52		72	48.3	
Chloride			mg/L	3 O	7.9	7.9		7.2	8	7.1	6.9	5.5	34		9.1	5.5		37	8.2	
Fluoride	4	4	mg/L	0.048 JO	0.066	0.076		0.072	0.069	0.073 J+	0.072	0.084	0.36 J		0.3	0.25 J+		0.3	0.29	
pH			SU	8.2	7.11	7.99	7.58	8.18	7.62	7.44	7.47	8.08	7.5		7.06	7.17		7.59	7.98	
Sulfate			mg/L	29 O	64	64		64	68	65	64	58.8	86		39	24		67	21.6	
Total Dissolved Solids			mg/L	150 O	260	290		240	220 J	250	240	209	400		250	240		350	205	
<b>Appendix IV Parameters</b>																				
Antimony	0.006	0.006	mg/L	0.002 UO	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U	0.002 U		0.002 U	0.002 U		0.002 U	0.001 U	
Arsenic	0.01	0.01	mg/L	0.0015 JO	0.0012 J	0.00076 J	0.005 U	0.00091 J	0.00095 J	0.0013 J	0.001 J	0.001 U	0.005 U		0.005 U	0.005 U		0.005 U	0.001 U	
Barium	2	2	mg/L	0.0086 O	0.027	0.026	0.025	0.023	0.024	0.021	0.025	0.025	0.039		0.019	0.015		0.02	0.013	
Beryllium	0.004	0.004	mg/L	0.001 UO	0.0011	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0011	0.0002 U	0.001 U		0.001 U	0.001 U		0.001 U	0.0002 U	
Cadmium	0.005	0.005	mg/L	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 U		0.00024 J	0.001 U		0.001 U	0.0002 U	
Chromium	0.1	0.1	mg/L	0.0021 O	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U		0.002 U	0.002 U	
Cobalt		0.006	mg/L	0.00034 JO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00058 J		0.00031 J	0.001 U		0.001 U	0.001 U	
Fluoride	4	4	mg/L	0.048 JO	0.066	0.076		0.072	0.069	0.073 J+	0.072	0.084	0.36 J		0.3	0.25 J+		0.3	0.29	
Lead	0.015	0.015	mg/L	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U	
Lithium		0.04	mg/L	0.008 UO	0.0017 J	0.008 U	0.008 U	0.002 J	0.008 U	0.008 U	0.003 J	0.008 U	0.0017 J		0.008 U	0.008 U		0.0025 J	0.008 U	
Mercury	0.002	0.002	mg/L	0.0002 UO	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U		0.0002 U	0.0002 U	
Molybdenum		0.1	mg/L	0.0018 JO	0.0024 J	0.0022 J	0.0025 J	0.0028 J	0.0028 J	0.0025 J	0.003 J	0.0021	0.005 J		0.0035 J	0.0016 J		0.0017 J	0.0012	
Radium 226 + 228	5		pCi/L	0.392 UO	0.402 U	0.308 U		0.427 U	0.609 U	0.408 U		1.68 U	0.796		1 J+	0.53 U			1.64 U	
Radium-226			pCi/L	0.223 UO	0.286	0.108		0.232 U	0.105 UJ	0.192 J+		0.881 U	0.46 J+		0.299 J+	0.436			0.738 U	
Radium-228			pCi/L	0.392 UO	0.402 U	0.308 U		0.427 U	0.609 UJ	0.408 U		1.25	0.392 U		0.706 J+	0.53 U			0.904 U	
Selenium	0.05	0.05	mg/L	0.0017 JO	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U	0.0014 J		0.0017 J	0.0014 J		0.0011 J	0.001 U	
Thallium	0.002	0.002	mg/L	0.001 UO	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00068 J	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U	
<b>Field Parameters</b>																				
Dissolved Oxygen			mg/L	3.59	0.08	1.9	0.3	1.4	1.25	0.31	0.3	0.17	0.48		0.21	6.42		2.2	6.9	
Oxidation Reduction Potential			millivolts	-29.4	111.9	-111.1	-133.1	-93.9	-119.9	33.7	-229.6	-137.1	-30.3		85.1	108.2		-43.2	165.6	
pH			SU	8.2	7.11	7.99	7.58	8.18	7.62	7.44	7.47	8.08	7.5		7.06	7.17		7.59	7.98	
Specific Conductivity			uS/cm	211	268	294	282	274	284	260	242	405	0.896		448	308		320	389	
Temperature			deg C	11.3	9.6	10.8	11	11.9	12.3	12.3	11.3	10	19.97		17.6	14.2		15.3	10.9	
Turbidity			NTU	3.45	3.26	4.3	3.25	3.11	1.15	4.16	2.84	4.02	0.45		0.83	0.42		0.74	1.57	

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 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
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 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW52B					GAMW53					GAMW53B					
				2018-09-11	2018-10-31	2019-05-09	2019-11-14	2020-04-30	2018-09-11	2018-10-30	2019-04-30	2019-11-14	2020-05-01	2018-09-11	2018-10-30	2019-04-30	2019-11-14	2020-05-01	
				N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	N
<b>Appendix III Parameters</b>																			
Boron		4	mg/L	0.75	0.8	1	1.3	0.77	0.19	0.25	0.056 J	0.13	0.1 U	2.5		3.1	2.2	0.73	3.3
Calcium			mg/L	160	160	110	130	129	45	53	17	25	32	180		190	150	140	180
Chloride			mg/L	530	470	380	370	496	4.9	4.6	1.9	3.6	4.3	90		85	81	74	107
Fluoride	4	4	mg/L	10 U	0.18	0.21 J+	0.23	0.26	0.17 J	0.17	0.05 U	0.05 U	0.05 U	0.52 J		0.46	0.51	0.7	0.46
pH			SU	8.3	7.1	7.42	7.34	7.6	6	6.47	5.93	6.21	6.42	7.3		7.35	7.41	7.52	7.48
Sulfate			mg/L	210	190	220	290	216	51	56	37	36	32.6	430		510	340	320	488
Total Dissolved Solids			mg/L	1500	1300	1100	1100	1260	240	250	130	160	161	1100		1100	900	770	1060
<b>Appendix IV Parameters</b>																			
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U	0.002 U	0.002 U	0.002 U	0.00061 J	0.001 U	0.002 U		0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0013 J	0.0016 J	0.00083 J	0.0012 J	0.0011	0.013	0.015	0.00097 J	0.0018 J	0.0015	0.00079 J		0.00083 J	0.001 J	0.0016 J	0.0028
Barium	2	2	mg/L	0.32	0.31	0.25	0.28	0.29	0.027	0.028	0.019	0.026	0.023	0.052		0.054	0.044	0.072	0.099
Beryllium	0.004	0.004	mg/L	0.001 U	0.00042 J	0.001 U	0.001 U	0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 U		0.001 U	0.00059 J	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.00029 J	0.001 U	0.001 U	0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 U		0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0019 J	0.0018 J	0.0012 J	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.001 U	0.00032 J	0.001 U	0.001 U	0.001 U	0.00084 J	0.00099 J	0.0005 J	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	4	4	mg/L	10 U	0.18	0.21 J+	0.23	0.26	0.17 J	0.17	0.05 U	0.05 U	0.05 U	0.52 J		0.46	0.51	0.7	0.46
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0014	0.00089 J	0.00057 J	0.00063 J	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.0041 J	0.0031 J	0.0033 J	0.0071 J	0.0086	0.008 U	0.008 U	0.008 U	0.0021 J	0.008 U	0.0042 J		0.0052 J	0.005 J	0.0066 J	0.011
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.014	0.015	0.0095 J	0.0086 J	0.016	0.012	0.015	0.0051 J	0.011	0.0068	0.0083 J		0.0075 J	0.0098 J	0.02	0.016
Radium 226 + 228	5		pCi/L	3.52	5.55 J+	2.63		2.44	0.547 U	1.45 J+	0.344 U		1.9 U	1.69		0.48 J+	1.26		1.73
Radium-226			pCi/L	2.11	2.76 J+	1.2		1.76	0.257	0.795 J+	0.316 U		1.08 U	0.789		0.238 J+	0.544		0.845
Radium-228			pCi/L	1.41	2.79 J+	1.44		0.885 U	0.547 U	0.658 J+	0.344 U		0.822 U	0.897		0.347 U	0.719		0.886 J+
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U	0.005 U		0.005 U	0.005 U	0.005 U	0.001 U
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.00049 J	0.001 U	0.001 U
<b>Field Parameters</b>																			
Dissolved Oxygen			mg/L	0.44	0.1	0.15	0.19	0.09	0.53	0.86	3.11	0.84	1.39	0.26		0.8	0.36	0.09	0.12
Oxidation Reduction Potential			millivolts	-214.9	-103.5	6.31	-102.9	-104.2	-24.6	-199.5	43.7	-54.8	168	-183.2		-168	27.7	-75.3	-118.9
pH			SU	8.3	7.1	7.42	7.34	7.6	6	6.47	5.93	6.21	6.42	7.3		7.35	7.41	7.52	7.48
Specific Conductivity			uS/cm	1934	2005	1652	1353	2424	307	400	125	155	260	1354		1620	1160	870	1634
Temperature			deg C	17.26	16.6	15.3	16.1	15.3	21.3	20.1	11.4	17.5	13.3	20.89		20.4	18.7	19.7	20.2
Turbidity			NTU	1.6	0.88	2.35	1.01	4.92	9.93	5.17	4.76	4.8	4.8	2.43		3	3.45	2.5	7.86

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 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected  
 above the method detection limit (MDL) for the  
 sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected  
 above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an  
 outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW54					GAMW54B					GAMW55				GAMW55R			
				2018-09-10	2018-10-31	2019-04-30	2019-11-14	2020-05-04	2018-09-10	2018-10-31	2019-05-01	2019-11-15	2020-05-04	2018-09-10	2018-10-29	2019-11-15	2020-05-05				
				N	N	N	N	N	N	FD	N	N	N	FD	N	FD	N	FD	N	N	N
<b>Appendix III Parameters</b>																					
Boron		4	mg/L	0.84	0.77	0.39	0.37	0.42	5.6		6.5	5.9	6		2.7	1.9	1.9	1.8	1.8	1.1	0.96
Calcium			mg/L	93	88	93	81	131	210		220	200	240		214	260	250	270	260	180	169
Chloride			mg/L	15	10	10	4	12.3	100		95	110	120		68.3	58	59	69	70	61	46.3
Fluoride	4	4	mg/L	0.18 J	0.17	0.14	0.28	0.18	0.41 J		0.52	0.59	0.58		0.54	0.51 J	0.52 J	0.47	0.47	0.62	0.52
pH			SU	6.24	7.92	6.82	7.08	6.74	6.95		8.71	7.27	7.2		7.43		6.77		7.04	7.31	7.51
Sulfate			mg/L	190	150	190	76	284	750		730	710	720		470	590	600	630	620	480	345
Total Dissolved Solids			mg/L	500	400	470	350	618	1600		1400	1500	1400		1000	1200	1300	1300	1300	950	846
<b>Appendix IV Parameters</b>																					
Antimony	0.006	0.006	mg/L	0.0011 J	0.00074 J	0.00078 J	0.001 J	0.001 U	0.002 U		0.002 U	0.002 U	0.002 U		0.001 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U
Arsenic	0.01	0.01	mg/L	0.0024 J	0.0028 J	0.0022 J	0.0045 J	0.0045	0.0025 J		0.0032 J	0.0045 J	0.005		0.0042	0.00083 J	0.005 U	0.005 U	0.005 U	0.005 U	0.001 U
Barium	2	2	mg/L	0.043	0.039	0.031	0.031	0.052	0.098		0.093	0.08	0.084		0.06	0.099	0.097	0.068	0.069	0.035	0.046
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 U		0.001 U	0.001 U	0.001 U		0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.001 U		0.001 U	0.001 U	0.001 U		0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt		0.006	mg/L	0.00053 J	0.00052 J	0.00062 J	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.0065	0.0058	0.0044	0.0044	0.001 U	0.001 U
Fluoride	4	4	mg/L	0.18 J	0.17	0.14	0.28	0.18	0.41 J		0.52	0.59	0.58		0.54	0.51 J	0.52 J	0.47	0.47	0.62	0.52
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium		0.04	mg/L	0.008 U	0.008 U	0.008 U	0.0023 J	0.008 U	0.0048 J		0.0036 J	0.0048 J	0.0074 J		0.008 U	0.0021 J	0.0017 J	0.008 U	0.008 U	0.0035 J	0.008 U
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum		0.1	mg/L	0.043	0.044	0.023	0.03	0.014	0.018		0.019	0.0085 J	0.012		0.018	0.03	0.028	0.026	0.026	0.024	0.02
Radium 226 + 228	5		pCi/L	0.5	1.08 J+	0.393 U		1.51 U	2.03		2.7 J+	1.82			1.41 U	1.4	0.802	0.922 J+	1.24 J+		1.58 U
Radium-226			pCi/L	0.385 J+	0.237 J+	0.337 U		0.73 U	1.18 J+		1.35 J+	0.956			0.654 U	0.574 J+	0.474 J+	0.363 J+	0.447 J+		0.387 U
Radium-228			pCi/L	0.385 U	0.843 J+	0.393 U		0.783 U	0.849		1.35 J+	0.865			0.754 U	0.824	0.403 U	0.559 J+	0.796 J+		1.34
Selenium	0.05	0.05	mg/L	0.0017 J	0.0012 J	0.0043 J	0.0035 J	0.0043	0.005 U		0.005 U	0.005 U	0.005 U		0.001 U	0.0037 J	0.0031 J	0.0027 J	0.0027 J	0.0046 J	0.0045
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.00021 J	0.001 U	0.00023 J	0.00022 J	0.00022 J	0.001 U
<b>Field Parameters</b>																					
Dissolved Oxygen			mg/L	0.61	1.41	0.72	0.26	0.65	0.42		2.12	0.42	0.31		0.1		1.73		0.33	0.72	1.95
Oxidation Reduction Potential			millivolts	107.8	-294.7	48.4	-69.5	24.5	-123.4		-315.7	-23.1	-43.3		117.5		21.6		-69.4	-28.9	148.6
pH			SU	6.24	7.92	6.82	7.08	6.74	6.95		8.71	7.27	7.2		7.43		6.77		7.04	7.31	7.51
Specific Conductivity			uS/cm	675	630	493	374	960	1816		1983	1636	1310		0.63		1493		1574	1017	1270
Temperature			deg C	21.2	18.53	10.5	15.3	11.4	17.6		17.29	15.5	15.8		15.6		21.1		19.4	16.7	12.8
Turbidity			NTU	2.03	1	3.24	2.31	4.9	4.2		1.64	4.49	1.67		4.31		1.74		0.66	2.26	2.4

Notes:  
 IDEM RCG= Indiana Department of Environmental Management Remediation Closure Guidance Table A-6 Screening Levels - 2021 Revision  
 MCL= Maximum Contaminant Level  
 mg/L = milligrams per liter  
 SU = standard units  
 pCi/L = picoCuries per liter  
 uS/cm = microSiemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J-" = Indicates the result is estimated and may be biased low.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "O" = Indicates the result was identified as an outlier and removed from the data set.

**Table 2: Analytical Results for MCU Monitoring Wells  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

Analyte	MCL	IDEM RCG	Unit	GAMW55B								GAMW56					GAMW56B																						
				2018-09-11		2018-10-29		2019-05-01		2019-11-15		2020-05-05		2018-09-11		2018-10-26		2019-04-29		2019-11-15		2020-05-05		2018-09-11		2018-10-29		2019-04-29		2019-11-15		2020-05-05							
				FD	N	N	N	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N						
<b>Appendix III Parameters</b>																																							
Boron		4	mg/L	7.1	7.4	8.2	9.1	11	0.21 J	10.9 J	0.26	0.28	0.21	0.2		0.22	1.2	1.2	2.3	3.2	2.1																		
Calcium			mg/L	250	250	260	210	210	116 J	219 J	130	110	91	120		115	140	140	150	150	141																		
Chloride			mg/L	220	220	190	170	150	119	119	3.1	2.4	3.2	2.1		2.8	50	36	55	64	50.8																		
Fluoride	4	4	mg/L	0.29 J	10 U	0.25	0.31	0.31	0.33	0.32	1.2 J	0.99	0.53	0.71		0.66	0.41 J	0.33	0.4	0.44	0.55																		
pH			SU		7.07	7.19	7.31	7.46		7.45	6.82	7.17	6.83	7.06		7.05	6.95	6.91	7.08	7.21	7.52																		
Sulfate			mg/L	820	820	910	790	750	676	674	57	63	54	56		56.3	170	130	260	360	280																		
Total Dissolved Solids			mg/L	1800	1900	1800	1700	1400	1400	1420	470	480	420	440		456	740	690	830	860	753																		
<b>Appendix IV Parameters</b>																																							
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.001 U	0.001 U	0.002 U	0.002 U	0.002 U	0.002 U		0.001 U	0.002 U	0.002 U	0.002	0.002 U	0.001 U																		
Arsenic	0.01	0.01	mg/L	0.0014 J	0.0011 J	0.005 U	0.005 U	0.005 U	0.0079 J	0.001 UJ	0.019	0.022	0.011	0.0097		0.0076	0.005 U	0.005 U	0.005	0.005 U	0.001 U																		
Barium	2	2	mg/L	0.14	0.14	0.12	0.074	0.067	0.045 J	0.067 J	0.068	0.049	0.044	0.04		0.047	0.076	0.072	0.082	0.076	0.071																		
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U		0.0002 U	0.001 U	0.001 U	0.001	0.001 U	0.0002 U																		
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 U	0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U		0.0002 U	0.001 U	0.001 U	0.001	0.001 U	0.0002 U																		
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U																		
Cobalt		0.006	mg/L	0.00034 J	0.00028 J	0.001 U	0.001 U	0.001 U	0.0087 J	0.001 UJ	0.0017	0.0053	0.0084	0.0081		0.0092	0.001 U	0.001 U	0.001	0.001 U	0.001 U																		
Fluoride	4	4	mg/L	0.29 J	10 U	0.25	0.31	0.31	0.33	0.32	1.2 J	0.99	0.53	0.71		0.66	0.41 J	0.33	0.4	0.44	0.55																		
Lead	0.015	0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U																		
Lithium		0.04	mg/L	0.0064 J	0.0064 J	0.0054 J	0.0055 J	0.0078 J	0.008 U	0.013	0.0034 J	0.0039 J	0.0023 J	0.0053 J		0.008 U	0.0051 J	0.0035 J	0.0044	0.0062 J	0.0082																		
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U																		
Molybdenum		0.1	mg/L	0.0057 J	0.0055 J	0.0055 J	0.0046 J	0.005 J	0.009 J	0.0053 J	0.013	0.0094 J	0.0072 J	0.0079 J		0.0093	0.004 J	0.003 J	0.0031	0.0064 J	0.0086																		
Radium 226 + 228	5		pCi/L	3.35	3.18	3.66 J+	2.08		3.06	3.02	0.728	0.698 J+				1.24 U	1.26	1.28 J+		2.11																			
Radium-226			pCi/L	1.72	1.75	1.86 J+	1.15		1.23	1.06	0.504	0.357 J+	0.334 U			0.509 U	0.763	0.578 J+	0.506	0.966																			
Radium-228			pCi/L	1.63	1.43	1.79 J+	0.926		1.83	1.96	0.371 U	0.429 U	0.373 U			0.735 U	0.493	0.698 J+	0.571	1.23 U																			
Selenium	0.05	0.05	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002	0.001 U	0.005 U	0.005 U	0.005 U	0.005 U		0.0022	0.005 U	0.005 U	0.005	0.005 U	0.001 U																		
Thallium	0.002	0.002	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U																		
<b>Field Parameters</b>																																							
Dissolved Oxygen			mg/L		0.37	0.17	0.11	0.17		0.1	0.99	0.28	1.3	0.34		0.21	0.29	0.26	0.79	0.18	0.09																		
Oxidation Reduction Potential			millivolts		-129.5	-115.9	-57.5	-137.9		-101.9	-97.4	-95.4	64	-86.6		-42.1	-102.8	-44.4	31.8	-105.7	-105.5																		
pH			SU		7.07	7.19	7.31	7.46		7.45	6.82	7.17	6.83	7.06		7.05	6.95	6.91	7.08	7.21	7.52																		
Specific Conductivity			uS/cm		2109	2201	1967	1491		2018	749	835	460	466		782	928	1036	856	741	1179																		
Temperature			deg C		19.2	18.5	18.1	17.9		17.1	17	15.7	8.7	14		9.6	13.9	13.8	11.6	12.9	11.8																		
Turbidity			NTU		4.38	1.74	4.77	3.92		4.11	2.91	2.99	2.31	2.01		2.4	2.96	1.45	4.77	1.4	4.56																		

Notes:  
IDEM RCG= Indiana Department of Environmental Management  
Remediation Closure Guidance Table A-6 Screening Levels - 2021  
Revision

MCL= Maximum Contaminant Level  
mg/L = milligrams per liter  
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"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
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"O" = Indicates the result was identified as an outlier and removed from the data set.

Prepared by: KMC  
Checked by:  
Reviewed by:



**Table 3: General Groundwater Response Actions  
CCR Unit Schahfer MSRB, MCWB, and DA  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

General Response Action	Comments	Corrective Measure Area	
		Below CCR Unit	Downgradient of CCR Unit
Limited Action	Access Restrictions Institutional Controls Use Restrictions Environmental Monitoring Monitored Natural Attenuation	X	X
Containment	Physical	X	
Removal	Extraction	X	X
Treatment	In-Situ Ex-Situ	X	X
On-Site Disposal	Surface Water Discharge Groundwater Discharge POTW Discharge	X	X
Off-Site Disposal	Permitted Disposal Facility	X	X

Notes

X- General Response Action selected for further screening at the indicated Corrective Measure Area

Prepared by: DFS  
Checked by: KMC  
Reviewed by: MAH

**Table 4: Initial Screening of Corrective Measure Alternatives / Process Options for Groundwater  
CCR Unit Schahfer MSRB, MCWB, and DA  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

General Response Action	Remedial Technology	Process Option	Description	Screening Comments	Retained for Further Evaluation	
					Below CCR Unit	Downgradient of CCR Unit
Limited Action	Institutional Controls	Permitting and Notices	Administrative controls to restrict groundwater use.	Potentially implementable.	Yes	Yes
		Access Restrictions	Physical restrictions or structures that prevent access by unauthorized persons.	Potentially implementable.	Yes	Yes
	Monitoring	Groundwater Monitoring	Periodic sampling and analyses of groundwater as a means of detecting unacceptable changes in constituent concentrations.	Potentially implementable.	Yes	Yes
	Use Restriction	Deed Restrictions	Administrative controls to provide future land use restrictions.	Potentially implementable.	Yes	Yes
	Monitored Natural Attenuation	Monitored Natural Attenuation	Long-term monitoring of natural attenuation, including advection/dispersion/adsorption and biotic and abiotic degradation/transformation, of the inorganic constituents dissolved in groundwater; advection/dispersion/adsorption of inorganics.	Potentially implementable.	Yes	Yes
Containment	Physical Containment	Capping	Low-permeable cap covering the source area.	Potentially implementable, minimizes stormwater infiltration reducing the potential for plume migration.	Yes	NA
		Vertical Barriers	Vertical barriers including slurry walls and sheet piling placed around the area of contamination to contain groundwater.	Potentially implementable, reduces potential for plume migration.	Yes	NA
Removal	Extraction	Extraction Wells	Use of extraction wells to extract contaminated groundwater and control groundwater movement within capture zone.	Potentially implementable, results in physical removal of dissolved constituents of concern and reduces potential for plume migration.	Yes	Yes
		Extraction Trench	Removal of groundwater by pumping from extraction trenches.	Potentially implementable, results in physical removal of dissolved constituents of concern and reduces potential for plume migration.	Yes	Yes
In Situ Treatment	Stabilization/Solidification	Solidification	Blending soil with grout to contain and immobilize contaminated groundwater.	Potentially implementable for the corrective measure area below the CCR Unit. Reduces potential for plume migration.	Yes	No
	Permeable Reactive Barrier	Vertical Reactive Barrier	Construction of vertical reactive barrier (e.g., carbon wall) to treat groundwater as it flows through the treatment zone.	Not effective on all Site COCs, limited effectiveness on Sites with high groundwater velocity.	No	No
In Situ Treatment	Chemical Addition/Treatment	Chemical Precipitation	Increasing inorganic precipitation through chemical injection, either by changing site geochemical conditions (i.e., pH, Eh, or ionic strength) or the addition of a co-precipitate that reacts with or acts as an adsorbent for the COC.	Not effective on all Site COCs.	No	No
		Chemical Reduction	Injection of a reducing agent such as nanoscale or microscale zero valent iron into groundwater. Reduction reactions chemically convert constituents to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	Not effective on all Site COCs.	No	No
	Biological Treatment	Bioremediation	Use of microorganisms to oxidize/reduce metal contaminants directly or by the production of chemical oxidizing/reducing agents.	Not effective on all Site COCs.	No	No

**Table 4: Initial Screening of Corrective Measure Alternatives / Process Options for Groundwater  
CCR Unit Schahfer MSRB, MCWB, and DA  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

General Response Action	Remedial Technology	Process Option	Description	Screening Comments	Retained for Further Evaluation	
					Below CCR Unit	Downgradient of CCR Unit
Ex Situ Treatment	On-Site Treatment Facility	On-Site, Various Physical/chemical Process Options	Extracted groundwater is pumped to the on-Site treatment facility (physical/chemical treatment).	Potentially implementable to treat extracted contaminated groundwater. Treatment processes that could remediate the Site COCs include chemical/physical precipitation, activated carbon, and reverse osmosis.	Yes	Yes
Disposal	On-Site Discharge	On-Site Discharge to Surface Water	Treated groundwater discharged to local water body pursuant to updated NPDES permit.	Potentially implementable. Treated landfill leachate is currently discharged to a local water body pursuant to a NPDES permit.	Yes	Yes
		On-Site Discharge to Groundwater	Treated groundwater discharged to groundwater within the Station Area.	Potentially implementable.	Yes	Yes
		POTW Discharge	Discharge of treated groundwater to POTW under a discharge authorization.	No access to POTW.	No	No
	Off-Site Treatment	Off-Site Disposal/Treatment of Collected Groundwater	Transport and treatment of extracted groundwater at off-Site treatment facility.	Not retained due to higher safety concerns and much higher disposal costs.	No	No

Notes

COC- constituent of concern  
 NPDES- National Pollutant Discharge Elimination System  
 POTW- publicly owned treatment works  
 NA- not applicable

Prepared by: DFS  
 Checked by: KMC  
 Reviewed by: MAH

**Table 5: Summary of Groundwater Corrective Measure Alternatives For Multi-Cell Unit (MSRB, MCWB, and DA) NIPSCO Rollin M. Schahfer Generating Station Wheatfield, Indiana**

Alternative		Key Components
A	Monitored natural attenuation	Permitting Implementation of deed restrictions Environmental monitoring
B	Vertical barrier/hydraulic controls and monitored natural attenuation	Permitting Implementation of deed restrictions Installation of hydraulic controls within existing vertical barrier wall <i>Ex situ</i> treatment of pumped groundwater by an on-Site treatment facility Disposal of treated groundwater to on-Site surface water or groundwater NPDES permit or installation of injection wells and UIC permit Long-term maintenance Environmental monitoring
C	Pump-and-treat and monitored natural attenuation	Permitting Implementation of deed restrictions Installation of monitoring wells or extraction trench immediately downgradient of the slurry wall <i>Ex situ</i> treatment of pumped groundwater by an on-Site treatment facility Disposal of treated groundwater to on-Site surface water or groundwater NPDES permit or of injection wells and UIC permit Long-term maintenance Environmental monitoring
D	Vertical barrier/hydraulic controls, pump-and-treat, and monitored natural attenuation	Permitting Implementation of deed restrictions Installation of hydraulic controls within existing vertical barrier wall Installation of monitoring wells or extraction trench outside the vertical barrier wall <i>Ex situ</i> treatment of pumped groundwater by an on-Site treatment facility Disposal of treated groundwater to on-Site surface water or groundwater NPDES permit or of injection wells and UIC permit Long-term maintenance Environmental monitoring

Prepared by: JBG  
 Checked by: CMJ  
 Reviewed by: JBG

**Table 6: Evaluation of Groundwater Corrective Measure Alternatives  
For Multi-Cell Unit (MSRB, MCWB, and DA)  
NIPSCO Rollin M. Schahfer Generating Station  
Wheatfield, Indiana**

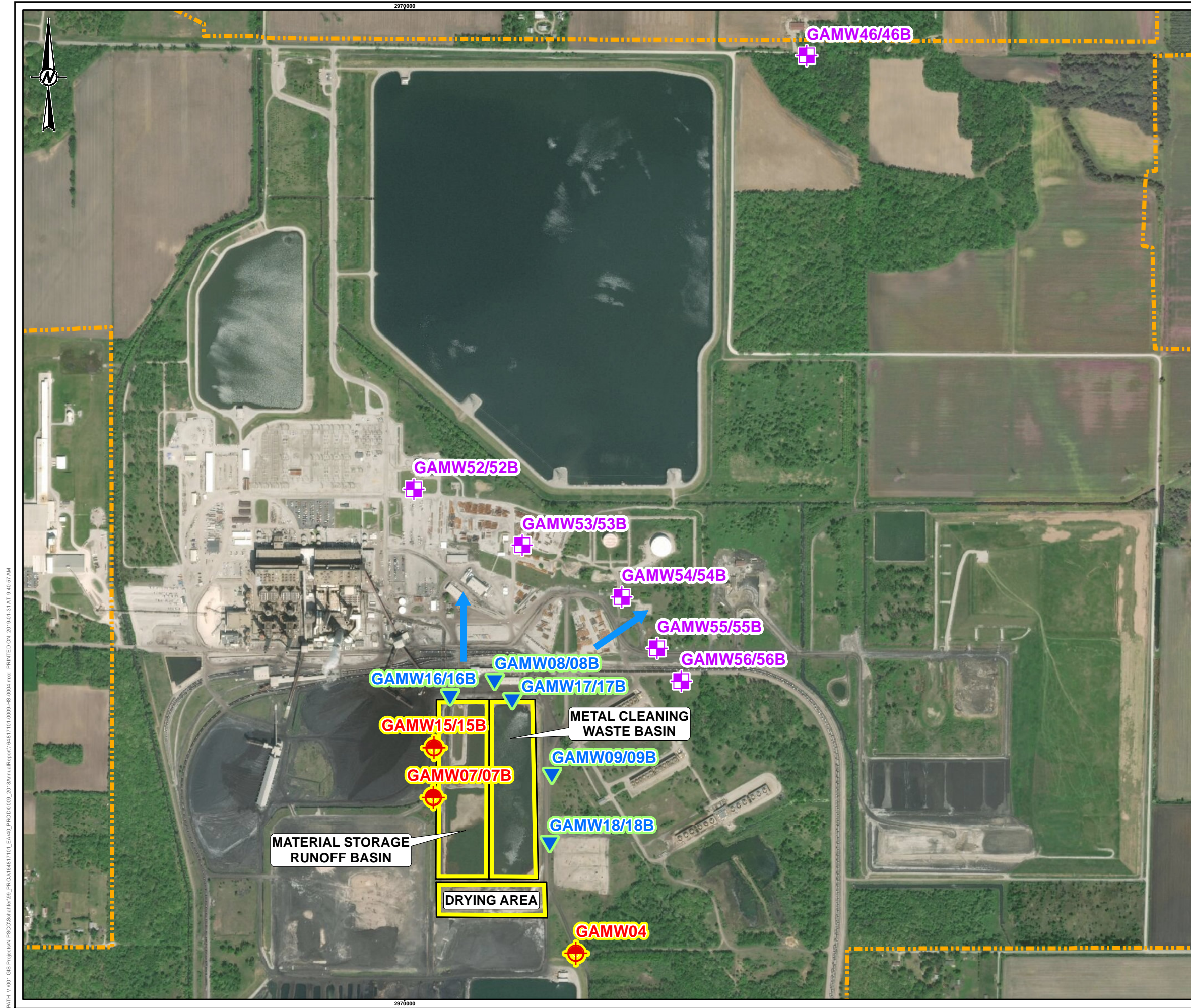
Evaluation Criteria	Corrective Measure Alternatives			
	Alternative A	Alternative B	Alternative C	Alternative D
	Monitored natural attenuation	Vertical barrier/hydraulic controls and monitored natural attenuation	Pump-and-treat and monitored natural attenuation	Vertical barrier/hydraulic controls, pump-and-treat, and monitored natural attenuation
<b>Performance</b>	Initial review of site conditions indicates plume stability and confirmation of attenuation and immobilization, therefore, monitored natural attenuation could be effective in reducing the COC concentrations and mobility.  Relative short-term effectiveness varies depending on success of excavation to remove the source material and the low-permeability cap to reduce the mobility of residual COCs and potential for plume migration. Minimally effective short-term.	Hydraulic controls within an existing vertical barrier (slurry wall) are an effective means of containing the source area.  Relatively effective both short-term and long-term.	Groundwater extraction of contaminated groundwater could be potentially effective in reducing volume and mobility of dissolved COCs in groundwater.  Relatively effective both short-term and long-term.	Hydraulic controls within an existing vertical barrier (slurry wall) are an effective means of containing the source area and groundwater extraction of contaminated groundwater downgradient of the barrier could be potentially effective in reducing volume and mobility of dissolved COCs in groundwater.  Relatively effective both short-term and long-term.
<b>Reliability</b>	Moderate to High. No O&M required, but long-term changes to geochemistry may impact attenuation.	Moderate. Some O&M required and potential treatment replacement.	Moderate, some O&M required and potential treatment replacement.	Moderate, some O&M required and potential treatment replacement.
<b>Ease of Implementation</b>	Already occurring.	Technology is common; some installation challenges expected based on existing slurry walls and proposed cap.	Technology is common, some installation and drilling challenges expected.	Technology is common; some installation challenges expected based on existing slurry walls and proposed cap.
<b>Potential Impacts</b>	Minimal potential for impacts to surface water and off-site groundwater.	Hydraulic controls within an existing vertical barrier control cross media impacts outside of the wall. Some safety concerns related to drilling wells and operating treatment plant (e.g., regenerating resin).	Groundwater collection and treatment will reduce long-term downgradient cross media impacts. Some safety concerns related to drilling wells and operating treatment plant (e.g., regenerating resin).	Hydraulic controls within an existing vertical barrier and groundwater collection and treatment have very good control of cross media impacts. Some safety concerns related to drilling wells and operating treatment plant (e.g., regenerating resin).
<b>Time Requirements</b>	Relatively long, no active remediation.	Moderate, should be shorter than MNA alone.	Moderate, should be shorter than MNA alone.	Moderate, should be shorter than MNA or pump-and-treat alone.
<b>Institutional Requirements</b>	Low permitting requirements	May require NPDES permit modifications or UIC permit, overall low permitting requirements	May require NPDES permit modifications or UIC permit, overall low permitting requirements	May require NPDES permit modifications or UIC permit, overall low permitting requirements
<b>Relative Costs</b>	Low Capital, Low O&M and Replacement	Moderate Capital, Moderate O&M and Replacement	Moderate Capital, Moderate O&M and Replacement	Moderate Capital, High O&M and Replacement

Prepared by: JBG  
Checked by: CMJ  
Reviewed by: JBG

# Figures







- LEGEND**
- Assessment Monitoring Well
  - Background Monitoring Well
  - Downgradient Monitoring Well
  - Generalized Groundwater Flow Direction
  - CCR Units
  - Approximate Property Line



**NOTE(S)**  
 1. THIS FIGURE DEPICTS THE GENERALIZED GROUNDWATER FLOW DIRECTION WITHIN THE UPPER PORTION OF THE SURFICIAL AQUIFER.

**REFERENCE(S)**  
 1. SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY

**CLIENT**  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

**PROJECT**  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 R.M. SCHAHFER GENERATING STATION  
 WHEATFIELD, INDIANA

**TITLE**  
**MONITORING WELL LOCATIONS**  
**DRYING AREA, MSRB, AND MCWB**

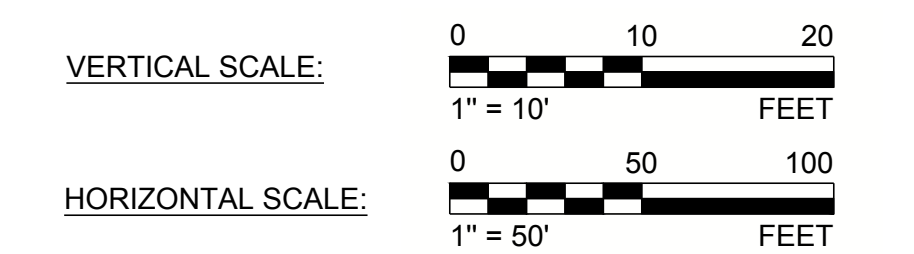
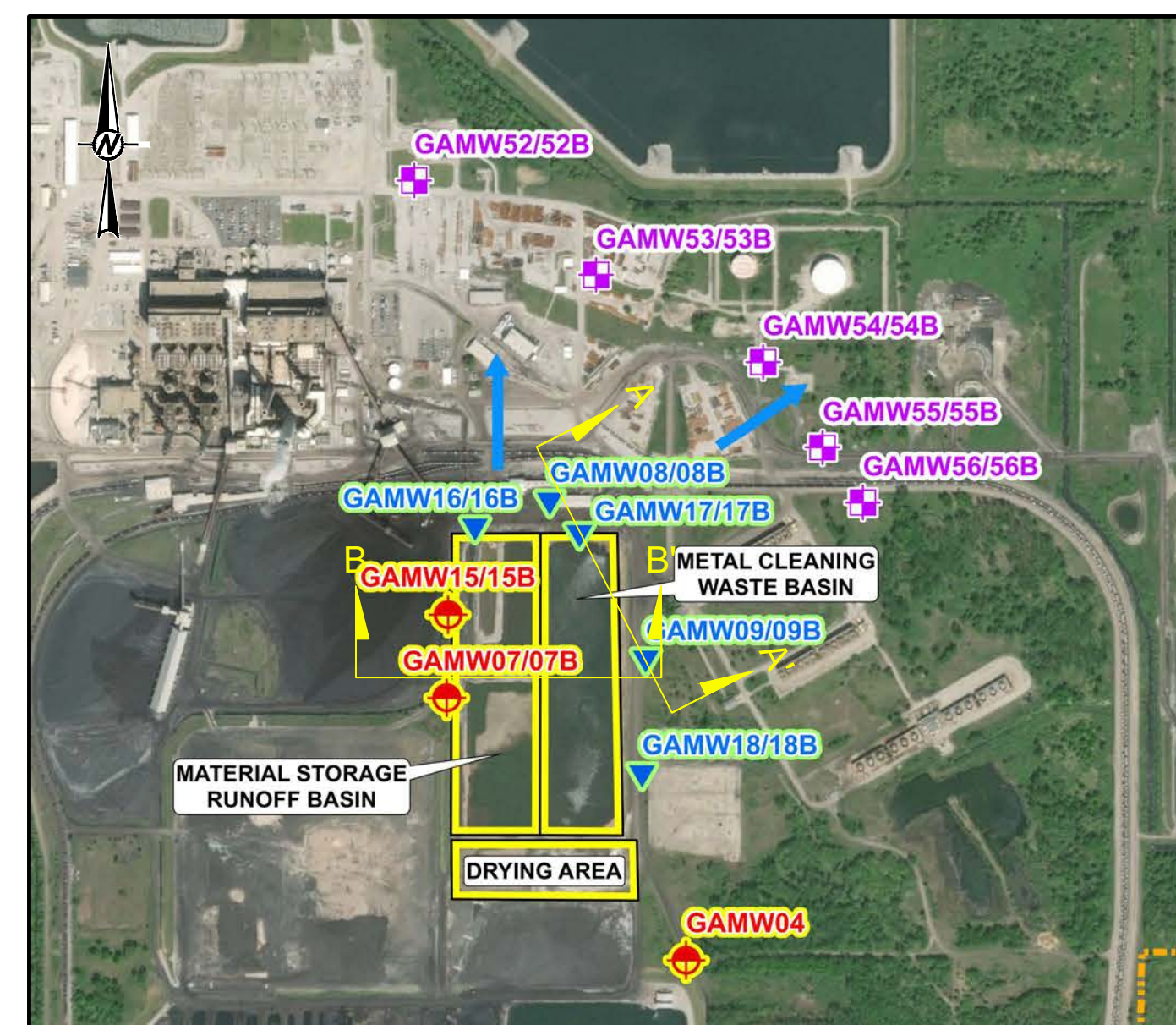
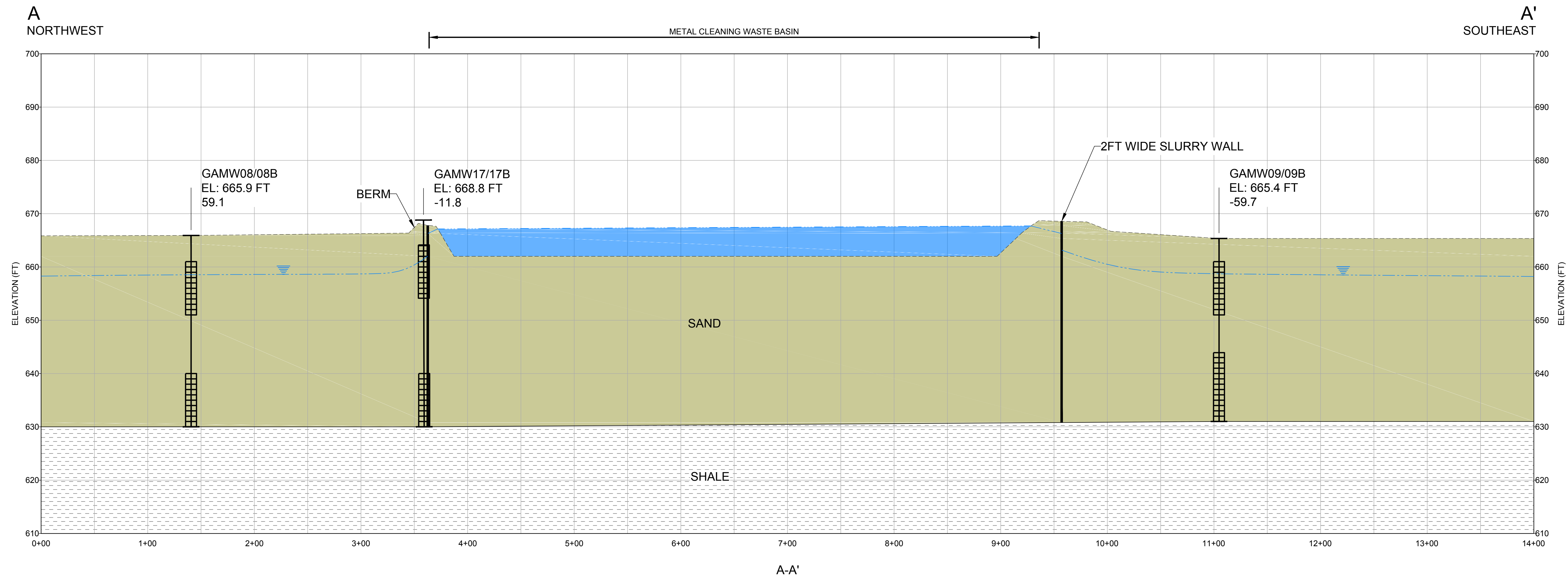
CONSULTANT	YYYY-MM-DD	1/31/2019
	DESIGNED	DFS
	PREPARED	SHL
	REVIEWED	MAH
	APPROVED	MAH

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1in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



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**LEGEND**

	= WELL I.D.
	= GROUND SURFACE ELEVATION
	= OFFSET DISTANCE
	= CENTERLINE
	= GROUNDWATER ELEVATION
	= WELL SCREEN
	= END OF BORING LOCATION
	= IMPOUNDMENT WATER
	= SAND
	= SHALE

**NOTE(S)**  
 1. GEOLOGIC CONTACTS ILLUSTRATED BETWEEN AND BELOW BORINGS ARE INFERRED AND SHOULD NOT BE INTERPRETED AS EXACT INDICATORS OF GEOLOGIC CONDITIONS AT, BETWEEN, OR BELOW BORINGS.

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 ROLLIN M. SCHAHFER GENERATING STATION  
 WHEATFIELD, INDIANA

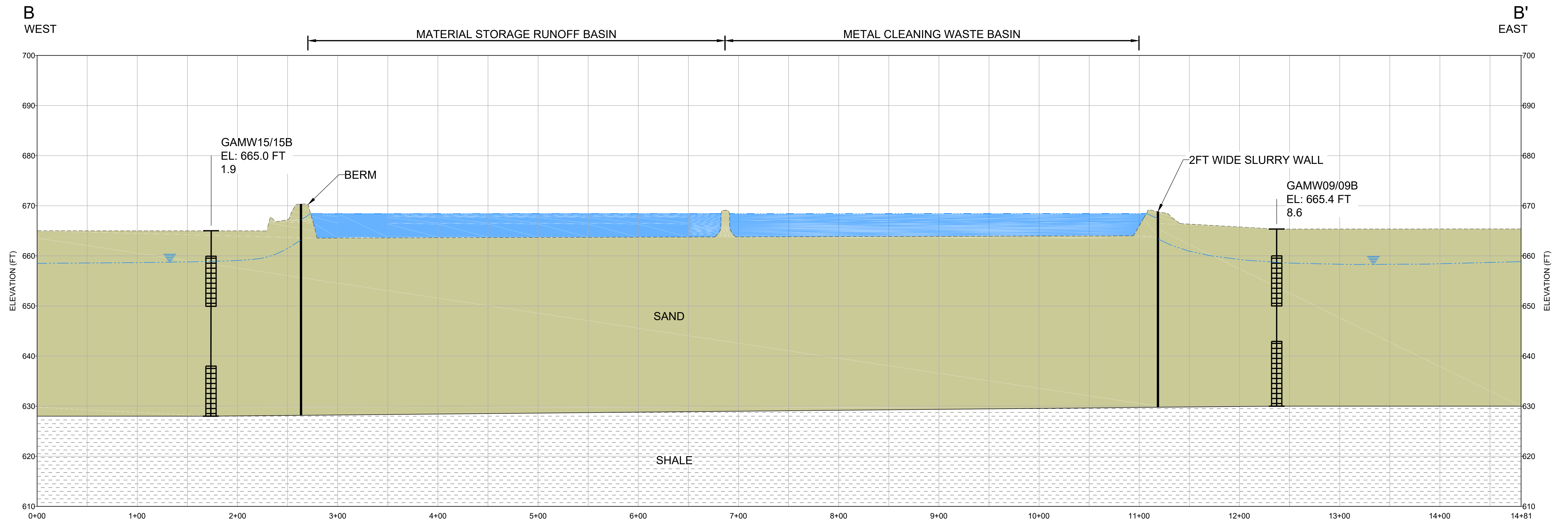
CONSULTANT	YYYY-MM-DD	2019-02-28
	DESIGNED	RWC
	PREPARED	RWC
	REVIEWED	JBG
	APPROVED	MAH

TITLE	PROJECT NO.	CONTROL	REV.	FIGURE
<b>GEOLOGIC INTERPRETATION CROSS SECTION A-A'</b>	1648171	03	0	3

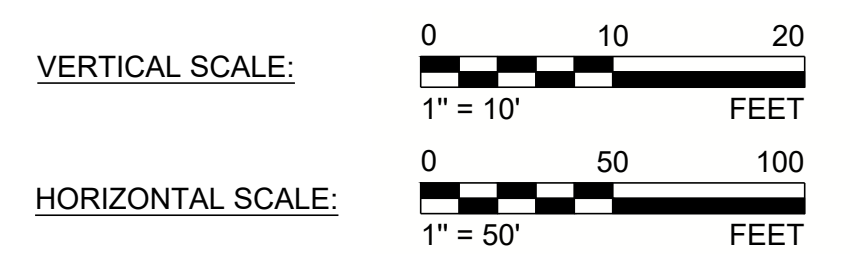
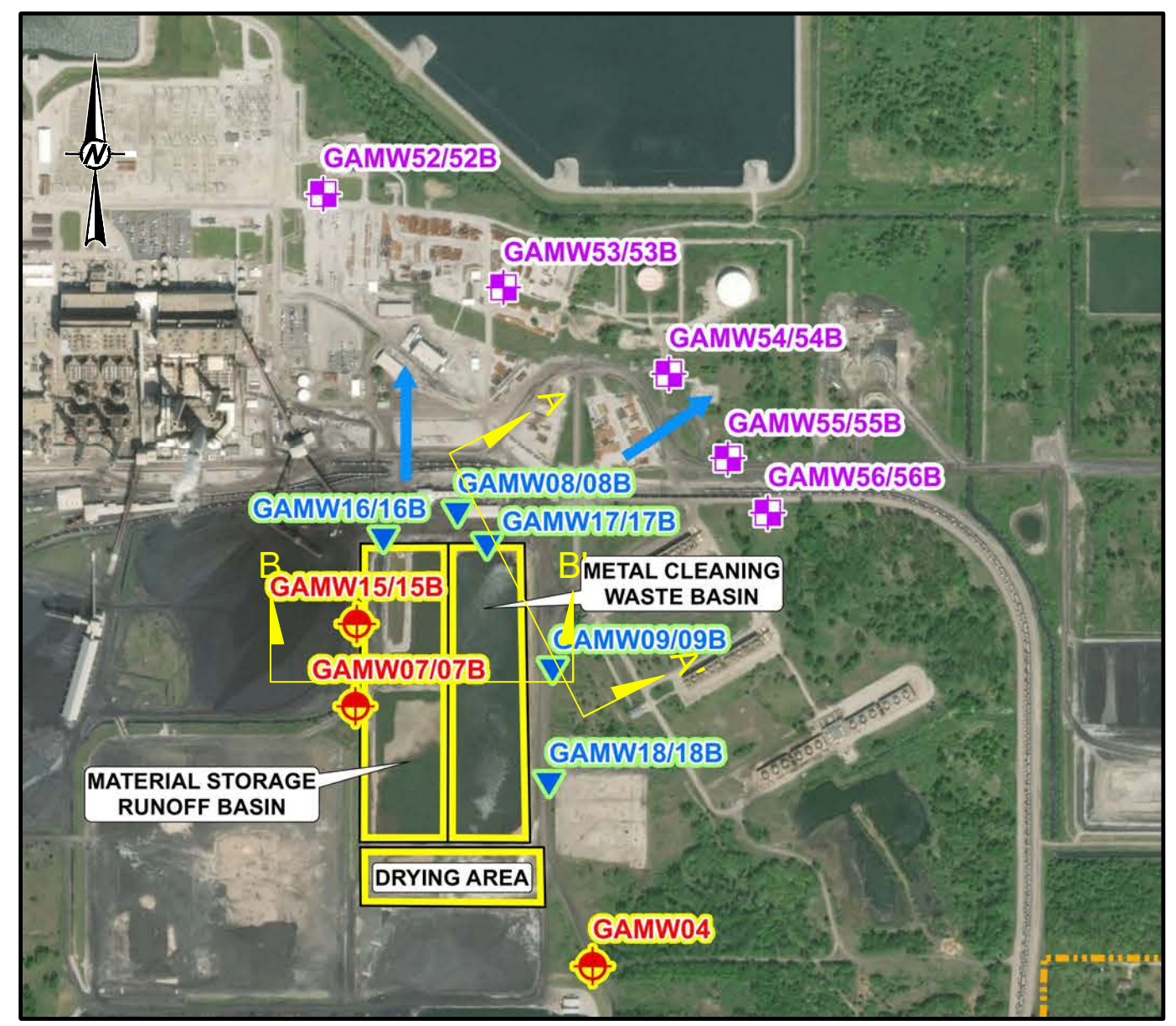
1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANS D



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B-B'



**LEGEND**

	= WELL I.D.
	= GROUND SURFACE ELEVATION
	= OFFSET DISTANCE
	= CENTERLINE
	= GROUNDWATER ELEVATION
	= WELL SCREEN
	= END OF BORING LOCATION
	= IMPOUNDMENT WATER
	= SAND
	= SHALE

**NOTE(S)**  
 1. GEOLOGIC CONTACTS ILLUSTRATED BETWEEN AND BELOW BORINGS ARE INFERRED AND SHOULD NOT BE INTERPRETED AS EXACT INDICATORS OF GEOLOGIC CONDITIONS AT, BETWEEN, OR BELOW BORINGS.

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 ROLLIN M. SCHAHFER GENERATING STATION  
 WHEATFIELD, INDIANA

CONSULTANT	YYYY-MM-DD	2019-02-28
	DESIGNED	RWC
	PREPARED	RWC
	REVIEWED	JBG
	APPROVED	MAH

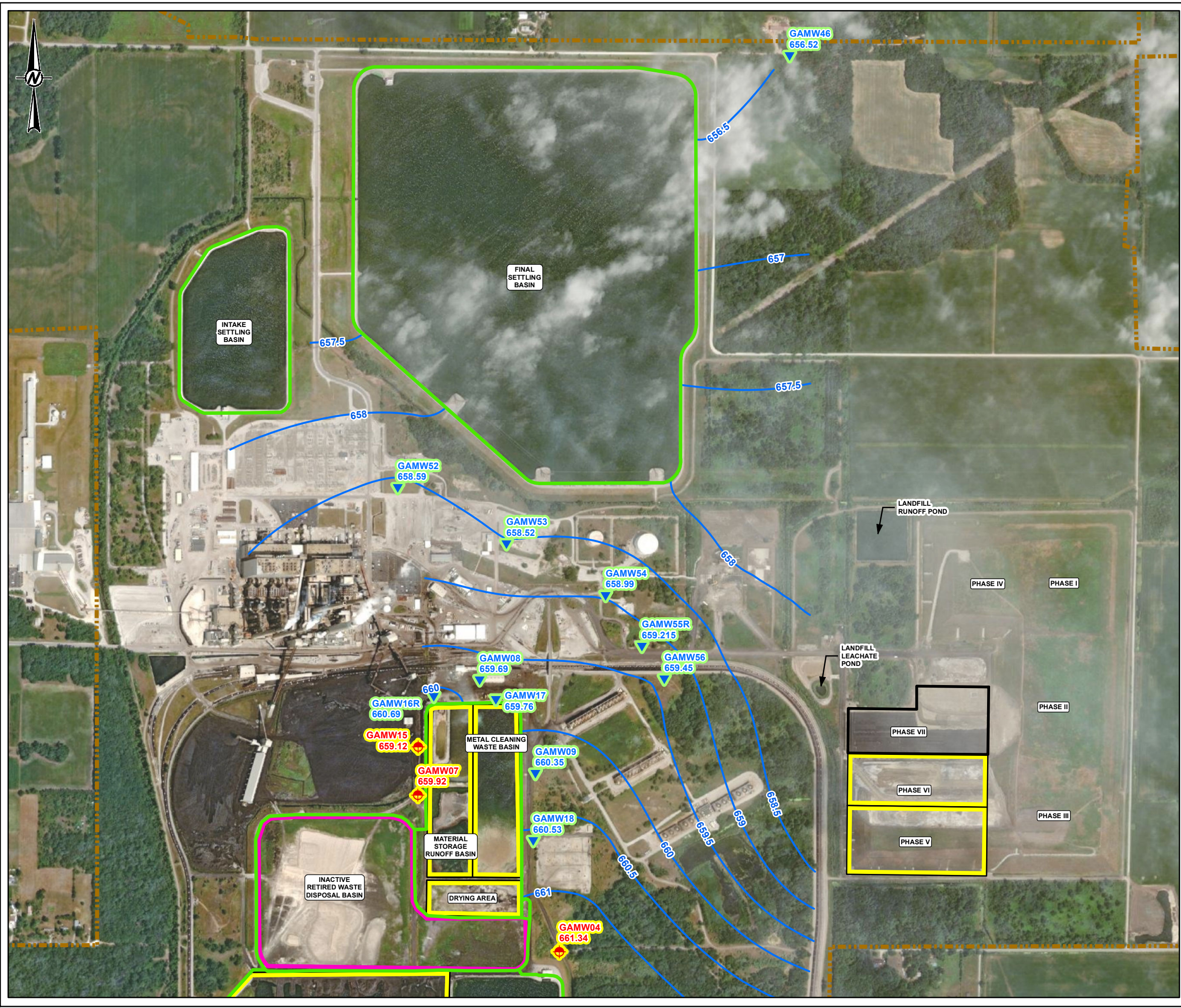


TITLE  
**GEOLOGIC INTERPRETATION  
 CROSS SECTION B-B'**

PROJECT NO.	CONTROL	REV.	FIGURE
1648171	03	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM A3S-D





**LEGEND**

- Background Monitoring Well
- Downgradient Monitoring Well
- Non-CCR Well
- Surface Water Location
- April 2021 Groundwater Elevation Contour (0.5 ft interval)
- Slurry Wall
- Approximate Property Line
- CCR Units
- Inactive Retired Waste Disposal Basin
- Phase VII



**FIGURE NARRATIVE**  
 THIS FIGURE DEPICTS THE GROUNDWATER ELEVATION, AS MEASURED IN 77 MONITORING WELLS SCREENED WITHIN THE UPPER PORTION OF THE SURFICIAL AQUIFER, AND IS INTENDED TO REPRESENT THE APPROXIMATE ELEVATION OF THE GROUNDWATER POTENTIOMETRIC SURFACE. THE POSTED DATA WERE CALCULATED FROM DEPTH TO WATER MEASUREMENTS MADE BY GOLDER ON APRIL 8-9, 2021.

THE DIRECTION OF HORIZONTAL GROUNDWATER FLOW AT AND NEAR THE POTENTIOMETRIC SURFACE CAN BE GENERALLY INTERPRETED AS BEING PERPENDICULAR TO THE GROUNDWATER ELEVATION CONTOURS. GOLDER INFERRED THE ELEVATION CONTOURS BASED ON THE DATA ILLUSTRATED.

THE ACTUAL ELEVATION OF THE POTENTIOMETRIC SURFACE IS LIKELY MORE HETEROGENEOUS THAN SHOWN AND ACTUAL CONDITIONS WILL VARY. OTHER INTERPRETATIONS ARE POSSIBLE. THE DEPTH TO GROUNDWATER IS KNOWN TO VARY WITH TIME.

- NOTE(S)**
1. NS INDICATES LOCATION WAS NOT SAMPLED.
  2. \* INDICATES NOT USED IN CONTOURING

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT  
 R.M. SCHAHFER GENERATING STATION  
 WHEATFIELD, INDIANA

TITLE  
**MONITORING WELL LOCATIONS AND GROUNDWATER ELEVATION CONTOURS (APRIL 2021)**

CONSULTANT	YYYY-MM-DD	2021-07-26
GOLDER MEMBER OF WSP	DESIGNED	DFS
	PREPARED	TBH
	REVIEWED	JBG
	APPROVED	MAH

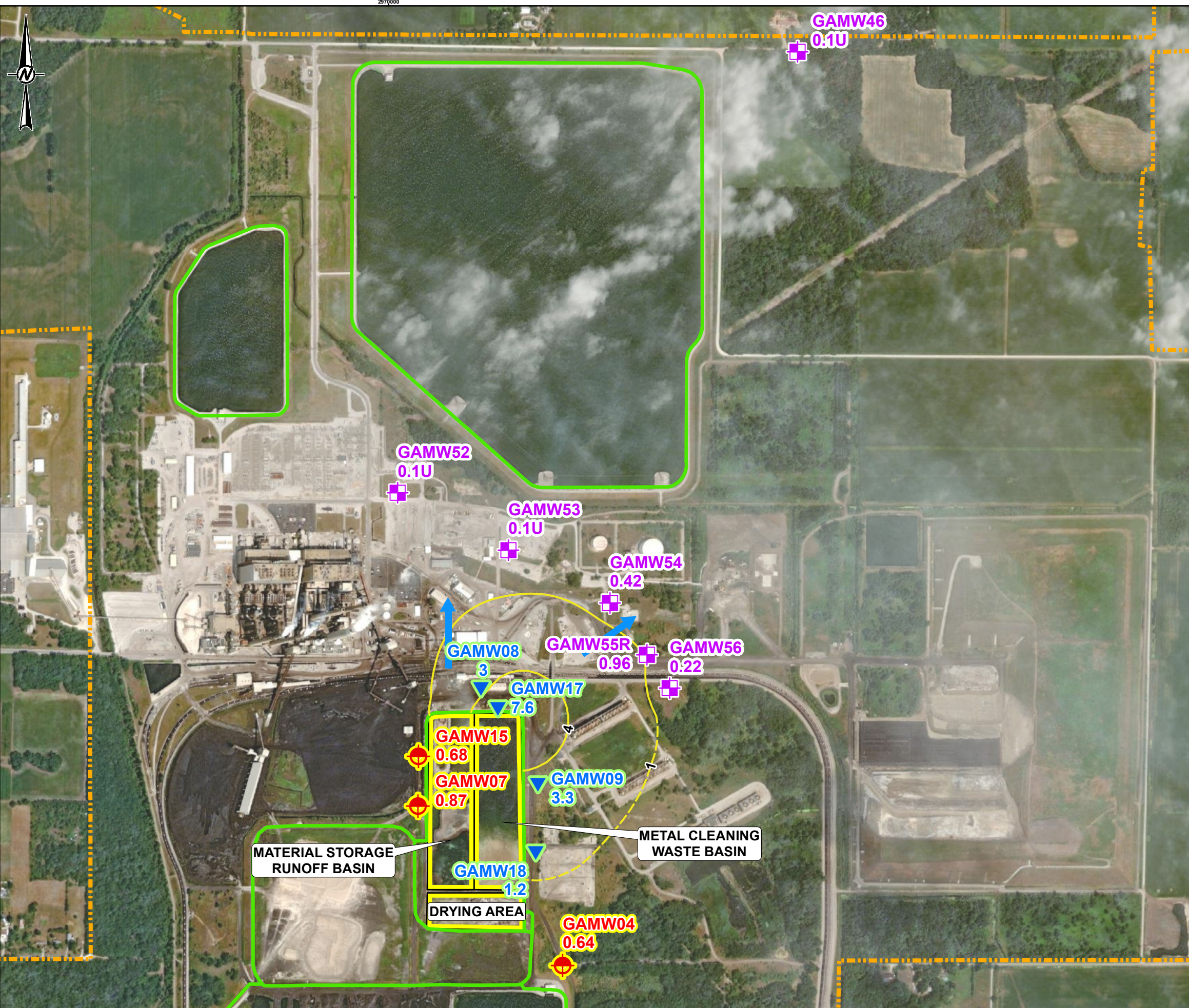
PROJECT NO. 19121567	CONTROL A	REV. 0	FIGURE 5
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

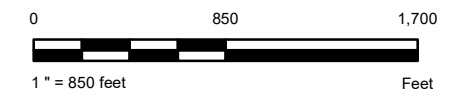


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LEGEND

- 0.17 April - May 2020 Boron Concentration (mg/L)
- Assessment Monitoring Well
- Background Monitoring Well
- Downgradient Monitoring Well
- April - May 2020 Shallow Boron Contour (mg/L)
- Inferred April - May 2020 Shallow Boron Contour (mg/L)
- Generalized Groundwater Flow Direction
- Slurry Wall
- CCR Units
- Approximate Property Line



**FIGURE NARRATIVE**  
 THIS FIGURE SHOWS THE INTERPRETED BORON ISOCONCENTRATION CONTOURS BASED ON GROUNDWATER ANALYTICAL DATA FROM THE APRIL AND MAY 2020 SAMPLING EVENT FOR SHALLOW WELLS SCREENED IN THE SURFICIAL AQUIFER. THE ISOCONCENTRATION CONTOURS ARE INTENDED TO DEPICT THE INFERRED DISTRIBUTION OF BORON IN GROUNDWATER ON THE BASIS OF THE DATA ILLUSTRATED. THE DISTRIBUTION IS LIKELY MORE HETEROGENEOUS THAN SHOWN, AND THE ACTUAL CONDITIONS WILL VARY. OTHER INTERPRETATIONS ARE POSSIBLE. BORON DISTRIBUTION IN GROUNDWATER IS KNOWN TO VARY WITH TIME.

**NOTE(S)**  
 1. THIS FIGURE DEPICTS THE GENERALIZED GROUNDWATER FLOW DIRECTION WITHIN THE UPPER PORTION OF THE SURFICIAL AQUIFER.  
 2. ALL VALUES SHOWN ARE IN MILLIGRAMS PER LITER (MG/L)

**REFERENCE(S)**  
 1. SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT  
 R.M. SCHAFFER GENERATING STATION  
 WHEATFIELD, INDIANA

TITLE  
**ASSESSMENT OF CORRECTIVE MEASURES  
 BORON ISOCONCENTRATION CONTOUR MAP  
 APRIL - MAY 2020 (SHALLOW)**

CONSULTANT	YYYY-MM-DD	7/23/2021
DESIGNED		KC
PREPARED		TBH
REVIEWED		JBG
APPROVED		MAH

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1in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANS I B







**APPENDIX A**

**Volume Calculations**

**Volume of impacted material below the CCR Unit**

Assumptions:

Entire remaining volume of water within the slurry walls after excavation is impacting.

Area is estimated by the combined area of the three impoundments (Figure 6).

Depth is estimated by the approximate saturated thickness outside the slurry walls (Figure 3).

Area	36.2 acre	(A)	(Wood 2019)
Saturated depth	32 feet	(D)	(Golder 2017)

Estimated volume of impacted material was calculated using the following formula:

$$\text{Volume} = A * D = V_1 \qquad 1 \text{ acre} = 43560 \text{ ft}^2$$

$V_1$	1158 acre-ft
$V_1$	5.0E+07 ft <sup>3</sup>

**Volume of impacted material downgradient of the CCR Unit**

Assumptions:

The volume is estimated by the volume with boron concentrations greater than 4 mg/L.

Plume areas are calculated based on the 4 mg/L contours displayed on Figure 6 and Figure 7.

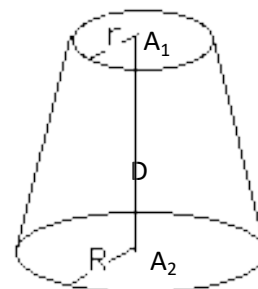
Shallow plume area	21.75 acre		
	9.474E+05 ft <sup>2</sup>	(A1)	
Deep plume area	87.40 acre		
	3.807E+06 ft <sup>2</sup>	(A2)	
Saturated depth	32 feet	(D)	(Golder 2017)
Assumed effective porosity	0.3	(n)	(Golder 2017)

The plume area were approximated as circles, and the volume of impacted material was estimated as a frustrum using the following formula:

$$\text{Volume} = \pi * D / 3 * (R^2 + Rr + r^2) = V_2$$

$$r = (A_1 / \pi)^{1/2}, R = (A_2 / \pi)^{1/2}$$

r	549.2	ft
R	1101	ft
$V_2$	7.10E+07	ft <sup>3</sup>
$V_2$	1629	acre-ft



Estimated volume of impacted groundwater was calculated using the following formula:

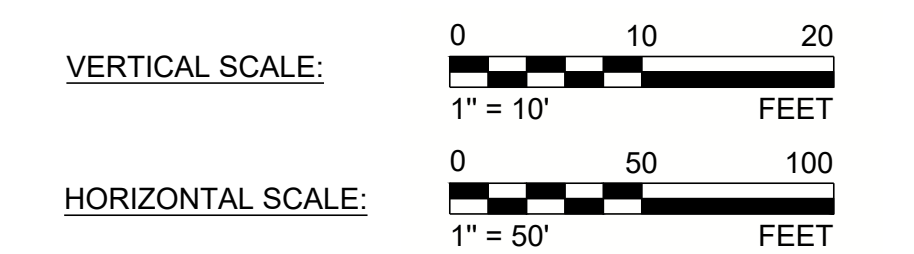
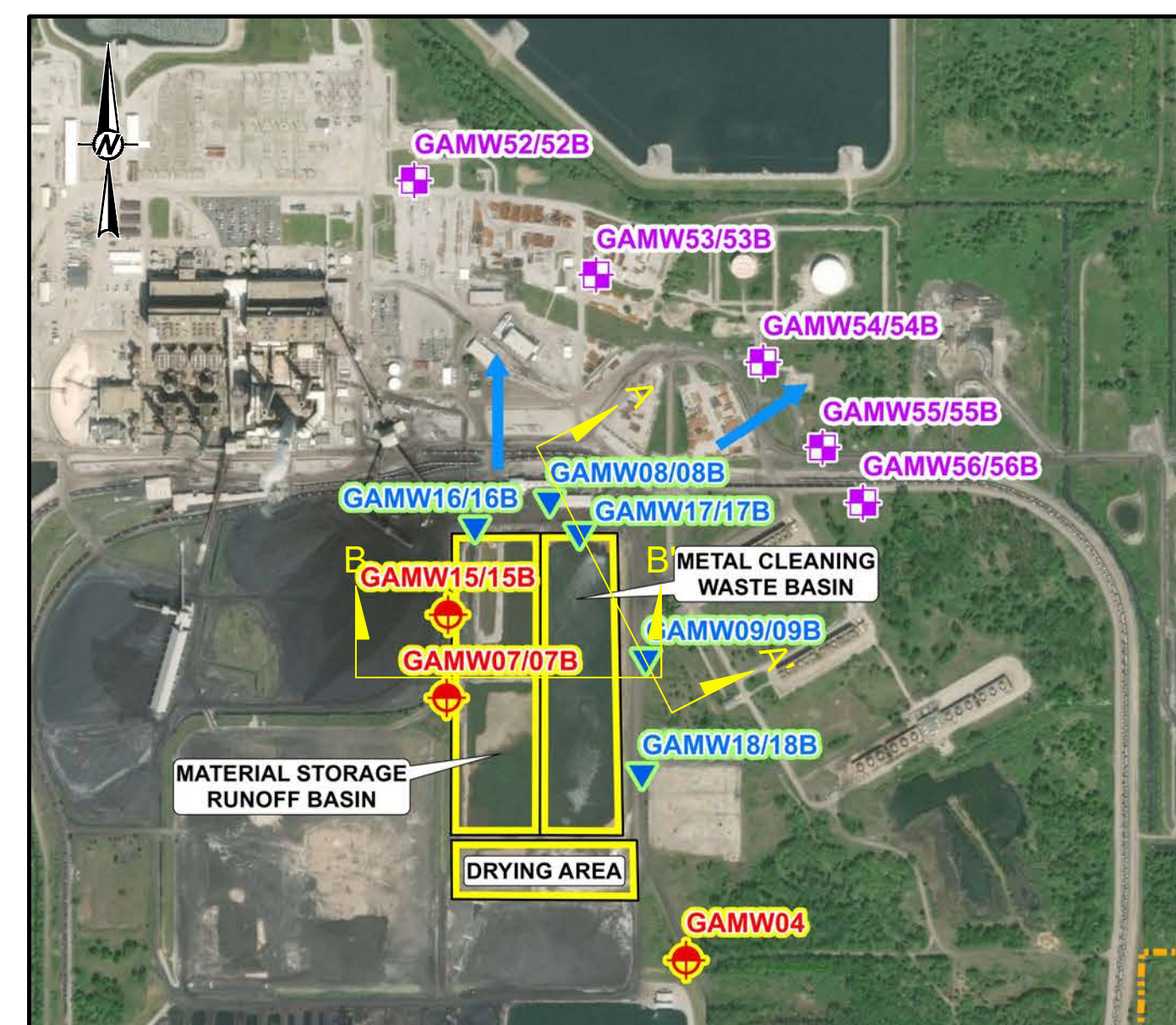
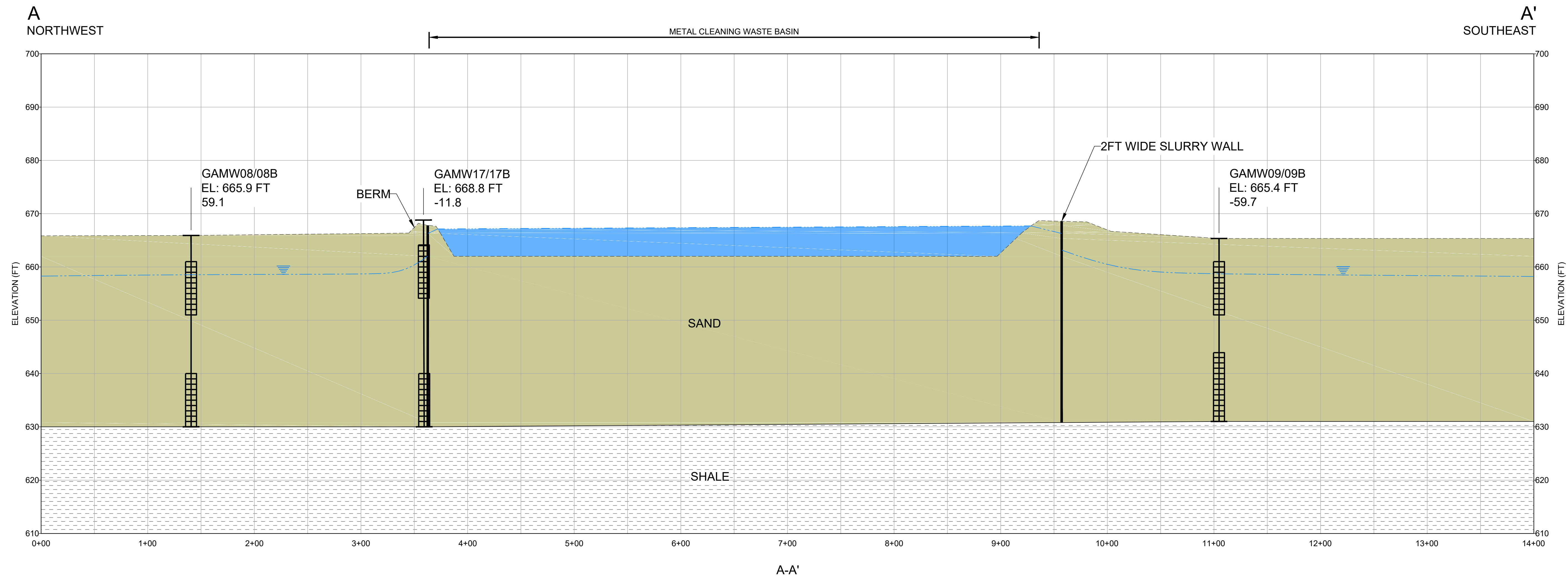
$$\text{Volume} = V_2 * n = V_{\text{water}}$$

$V_{\text{water}}$	2.13E+07 ft <sup>3</sup>
$V_{\text{water}}$	1.59E+08 gallons

Prepared by: DFS  
Checked by: BPC  
Reviewed by: JBG

Golder Associates, Groundwater Monitoring Program Implementation Manual, October 2017  
Wood, 2019. Multi-Cell Unit Surface Impoundments (CCR Final Rule) Draft Closure Application. March 8, 2019.

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**LEGEND**

	= WELL I.D.
	= GROUND SURFACE ELEVATION
	= OFFSET DISTANCE
	= CENTERLINE
	= GROUNDWATER ELEVATION
	= WELL SCREEN
	= END OF BORING LOCATION
	= IMPOUNDMENT WATER
	= SAND
	= SHALE

**NOTE(S)**  
 1. GEOLOGIC CONTACTS ILLUSTRATED BETWEEN AND BELOW BORINGS ARE INFERRED AND SHOULD NOT BE INTERPRETED AS EXACT INDICATORS OF GEOLOGIC CONDITIONS AT, BETWEEN, OR BELOW BORINGS.

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 ROLLIN M. SCHAHFER GENERATING STATION  
 WHEATFIELD, INDIANA

CONSULTANT	YYYY-MM-DD	2019-02-28
	DESIGNED	RWC
	PREPARED	RWC
	REVIEWED	
	APPROVED	

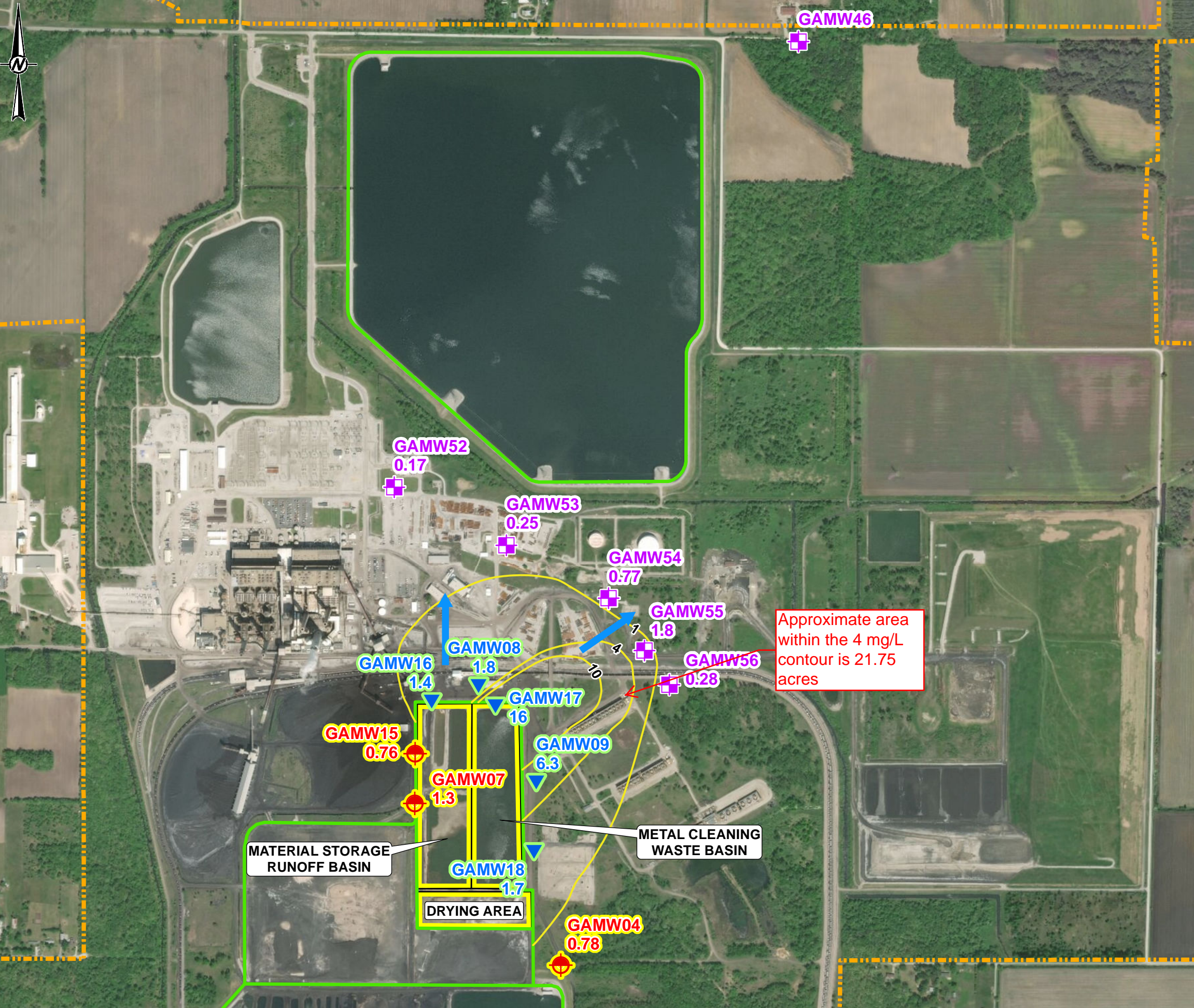


TITLE  
**GEOLOGIC INTERPRETATION  
 CROSS SECTION A-A'**

PROJECT NO.	CONTROL	REV.	FIGURE
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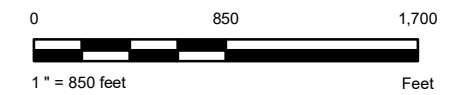
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**LEGEND**

- 0.17 October 2018 Boron Concentration (mg/L)
- Assessment Monitoring Well
- Background Monitoring Well
- Downgradient Monitoring Well
- October 2018 Shallow Boron Contour (mg/L)
- Generalized Groundwater Flow Direction
- Slurry Wall
- CCR Units
- Approximate Property Line



**FIGURE NARRATIVE**  
 THIS FIGURE SHOWS THE INTERPRETED BORON ISOCONCENTRATION CONTOURS BASED ON GROUNDWATER ANALYTICAL DATA FROM THE OCTOBER 2018 SAMPLING EVENT FOR SHALLOW WELLS SCREENED IN THE SURFICIAL AQUIFER. THE ISOCONCENTRATION CONTOURS ARE INTENDED TO DEPICT THE INFERRED DISTRIBUTION OF BORON IN GROUNDWATER ON THE BASIS OF THE DATA ILLUSTRATED. THE DISTRIBUTION IS LIKELY MORE HETEROGENEOUS THAN SHOWN, AND THE ACTUAL CONDITIONS WILL VARY. OTHER INTERPRETATIONS ARE POSSIBLE. BORON DISTRIBUTION IN GROUNDWATER IS KNOWN TO VARY WITH TIME.

**NOTE(S)**  
 1. THIS FIGURE DEPICTS THE GENERALIZED GROUNDWATER FLOW DIRECTION WITHIN THE UPPER PORTION OF THE SURFICIAL AQUIFER.  
 2. ALL VALUES SHOWN ARE IN MILLIGRAMS PER LITER (MG/L)

**REFERENCE(S)**  
 1. SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

**CLIENT**  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

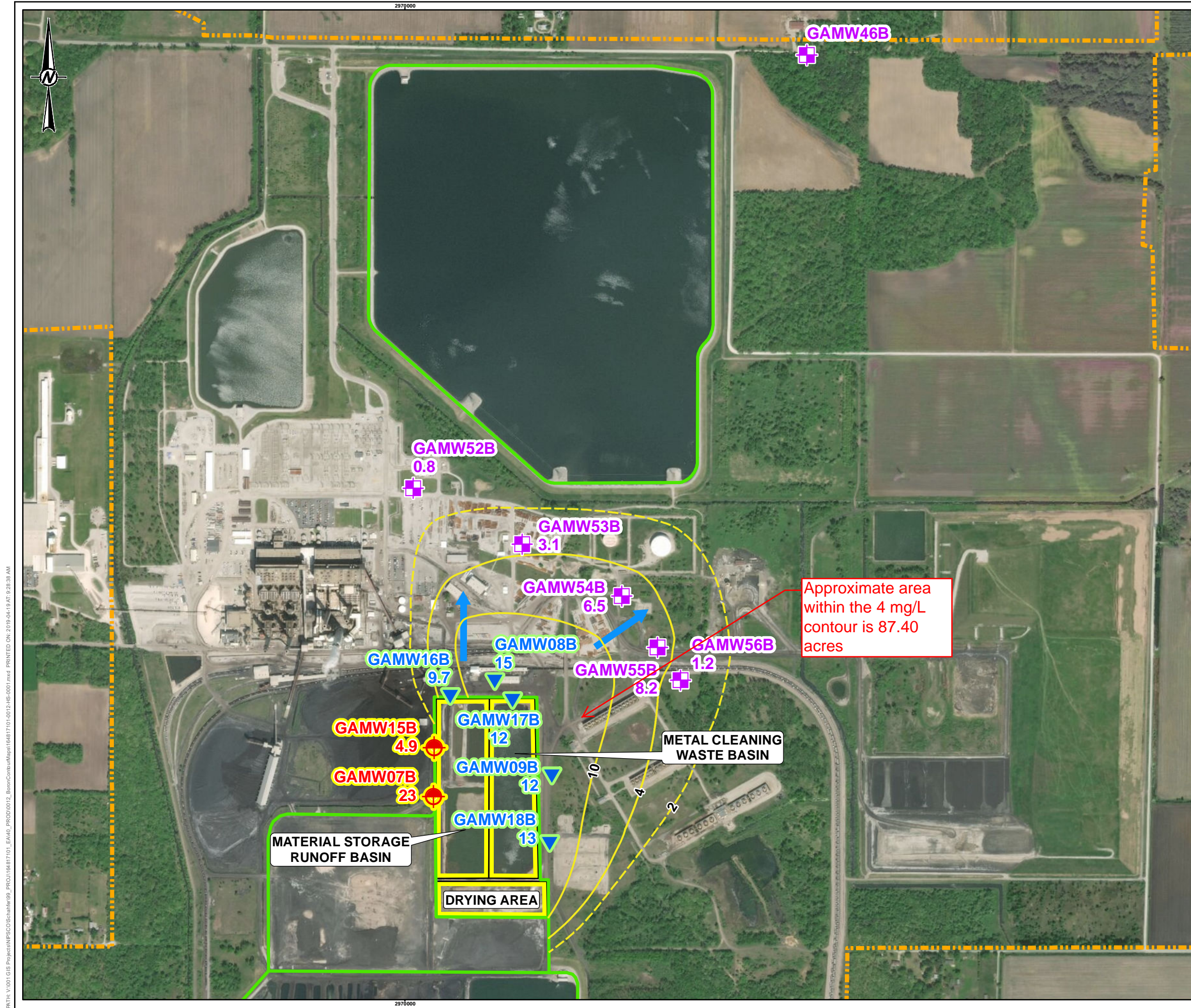
**PROJECT**  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 R.M. SCHAFER GENERATING STATION  
 WHEATFIELD, INDIANA

**TITLE**  
 ASSESSMENT OF CORRECTIVE MEASURES  
 BORON ISOCONCENTRATION CONTOUR MAP  
 OCTOBER 2018 (SHALLOW)

<b>CONSULTANT</b>	YYYY-MM-DD	4/18/2019
<b>DESIGNED</b>	DFS	
<b>PREPARED</b>	SHL	
<b>REVIEWED</b>	MAH	
<b>APPROVED</b>	MAH	

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 IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B





**LEGEND**

- 3.1 October 2018 Boron Concentration (mg/L)
- Assessment Monitoring Well
- Background Monitoring Well
- Downgradient Monitoring Well
- October 2018 Deep Boron Contour (mg/L)
- Inferred October 2018 Deep Boron Contour (mg/L)
- Generalized Groundwater Flow Direction
- Slurry Wall
- CCR Units
- Approximate Property Line

0 850 1,700  
1" = 850 feet Feet

**FIGURE NARRATIVE**  
 THIS FIGURE SHOWS THE INTERPRETED BORON ISOCONCENTRATION CONTOURS BASED ON GROUNDWATER ANALYTICAL DATA FROM THE OCTOBER 2018 SAMPLING EVENT FOR DEEP WELLS SCREENED IN THE SURFICIAL AQUIFER. THE ISOCONCENTRATION CONTOURS ARE INTENDED TO DEPICT THE INFERRED DISTRIBUTION OF BORON IN GROUNDWATER ON THE BASIS OF THE DATA ILLUSTRATED. THE DISTRIBUTION IS LIKELY MORE HETEROGENEOUS THAN SHOWN, AND THE ACTUAL CONDITIONS WILL VARY. OTHER INTERPRETATIONS ARE POSSIBLE. BORON DISTRIBUTION IN GROUNDWATER IS KNOWN TO VARY WITH TIME.

THE IMPACTS DETECTED IN GAMW-07B AND GAMW-15B ARE NOT CONTOURED IN THIS MAP. GOLDER'S INTERPRETATION IS THAT THESE CONCENTRATIONS ARE DUE TO UPGRADIENT IMPACT.

**NOTE(S)**  
 1. THIS FIGURE DEPICTS THE GENERALIZED GROUNDWATER FLOW DIRECTION WITHIN THE UPPER PORTION OF THE SURFICIAL AQUIFER.  
 2. ALL VALUES SHOWN ARE IN MILLIGRAMS PER LITER (MG/L)

**REFERENCE(S)**  
 1. SERVICE LAYER CREDITS: SOURCES: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

CLIENT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT  
 NORTHERN INDIANA PUBLIC SERVICE COMPANY  
 R.M. SCHAFER GENERATING STATION  
 WHEATFIELD, INDIANA

TITLE  
**ASSESSMENT OF CORRECTIVE MEASURES  
 BORON ISOCONCENTRATION CONTOUR MAP  
 OCTOBER 2018 (DEEP)**

CONSULTANT	YYYY-MM-DD	4/19/2019
DESIGNED	DFS	
PREPARED	SHL	
REVIEWED	DFS	
APPROVED	MAH	

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 IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



**APPENDIX B**

# Slug Test Data and Calculations

**Appendix B  
HYDRAULIC CONDUCTIVITY TESTING RESULTS**

Well	Date	Screened Interval	Type	Test Duration	Test Number	Hvorslev Method		Bouwer and Rice Method		van der Kamp Method		Hvorslev/Bouwer and Rice Arithmetic Mean	
						cm/sec	ft/day	cm/sec	ft/day	cm/sec	ft/day	cm/sec	ft/day
GAMW03	7/7/2016	5-15	Transducer (Rising)	<2 min	1	7.44E-03	2.11E+01	4.99E-03	1.42E+01	n/a	n/a	6.22E-03	1.77E+01
					2	7.45E-03	2.11E+01	5.22E-03	1.48E+01	n/a	n/a	6.34E-03	1.80E+01
GAMW13	7/7/2016	5-15	Transducer (Rising)	<2 min	1	5.75E-02	1.63E+02	3.91E-02	1.11E+02	n/a	n/a	4.83E-02	1.37E+02
					2	6.50E-02	1.84E+02	4.81E-02	1.36E+02	n/a	n/a	5.66E-02	1.60E+02
GAMW15	7/7/2016	5-15	Transducer (Rising)	<2 min	1	2.59E-02	7.34E+01	1.63E-02	4.63E+01	n/a	n/a	2.11E-02	5.99E+01
					2	1.11E-02	3.15E+01	1.08E-02	3.05E+01	n/a	n/a	1.10E-02	3.10E+01
GAMW19	7/7/2016	6-16	Transducer (Rising)	<2 min	1	3.70E-02	1.05E+02	2.25E-02	6.38E+01	n/a	n/a	2.98E-02	8.44E+01
					2	1.01E-01	2.87E+02	6.85E-02	1.94E+02	n/a	n/a	8.48E-02	2.41E+02
<b>Average Shallow (515 ftbgs)</b>						<b>3.90E-02</b>	<b>1.11E+02</b>	<b>2.69E-02</b>	<b>7.63E+01</b>	<b>n/a</b>	<b>n/a</b>	<b>3.30E-02</b>	<b>9.35E+01</b>
GAMW03B	7/8/2016	27-37	Transducer (Falling)	<2 min	1	6.78E-03	1.92E+01	5.81E-03	1.65E+01	n/a	n/a	6.30E-03	1.79E+01
					2	4.30E-03	1.22E+01	4.79E-03	1.36E+01	n/a	n/a	4.55E-03	1.29E+01
			Transducer (Rising)	<2 min	1	5.65E-03	1.60E+01	6.42E-03	1.82E+01	n/a	n/a	6.04E-03	1.71E+01
					2	1.47E-02	4.16E+01	1.25E-02	3.55E+01	1.49E-02	4.22E+01	1.36E-02	3.86E+01
GAMW13B	7/7/2016	25-35	Transducer (Falling)	<2 min	1	8.48E-03	2.40E+01	9.27E-03	2.63E+01	n/a	n/a	8.88E-03	2.52E+01
					2	8.09E-03	2.29E+01	9.27E-03	2.63E+01	n/a	n/a	8.68E-03	2.46E+01
			Transducer (Rising)	<2 min	1	1.11E-02	3.15E+01	1.16E-02	3.30E+01	2.73E-02	7.74E+01	1.14E-02	3.23E+01
					2	1.06E-02	3.00E+01	1.08E-02	3.06E+01	1.06E-02	3.01E+01	1.07E-02	3.03E+01
GAMW15B	7/7/2016	27.7-37.7	Transducer (Falling)	<2 min	1	4.50E-03	1.28E+01	3.45E-03	9.79E+00	n/a	n/a	3.98E-03	1.13E+01
					2	1.03E-02	2.91E+01	8.75E-03	2.48E+01	9.53E-03	2.70E+01	9.53E-03	2.70E+01
			Transducer (Rising)	<2 min	1	1.17E-02	3.32E+01	1.06E-02	3.02E+01	1.24E-02	3.50E+01	1.12E-02	3.17E+01
					2	1.06E-02	3.02E+01	9.79E-03	2.77E+01	1.69E-02	4.80E+01	1.02E-02	2.90E+01
GAMW19B	7/7/2016	23-33	Transducer (Falling)	<2 min	1	1.37E-02	3.88E+01	1.44E-02	4.09E+01	n/a	n/a	1.41E-02	3.99E+01
					2	6.82E-03	1.93E+01	6.31E-03	1.79E+01	n/a	n/a	6.57E-03	1.86E+01
			Transducer (Rising)	<2 min	1	1.84E-02	5.21E+01	1.83E-02	5.18E+01	1.29E-02	3.67E+01	1.84E-02	5.20E+01
					2	1.21E-02	3.43E+01	1.03E-02	2.91E+01	1.21E-02	3.43E+01	1.12E-02	3.17E+01
<b>Average Deep (2535 ftbgs)</b>						<b>9.86E-03</b>	<b>2.80E+01</b>	<b>9.52E-03</b>	<b>2.70E+01</b>	<b>1.46E-02</b>	<b>4.13E+01</b>	<b>9.69E-03</b>	<b>2.75E+01</b>

**Notes:**

ft/day = feet per day  
 cm/sec = centimeters per second  
 n/a = not analyzed

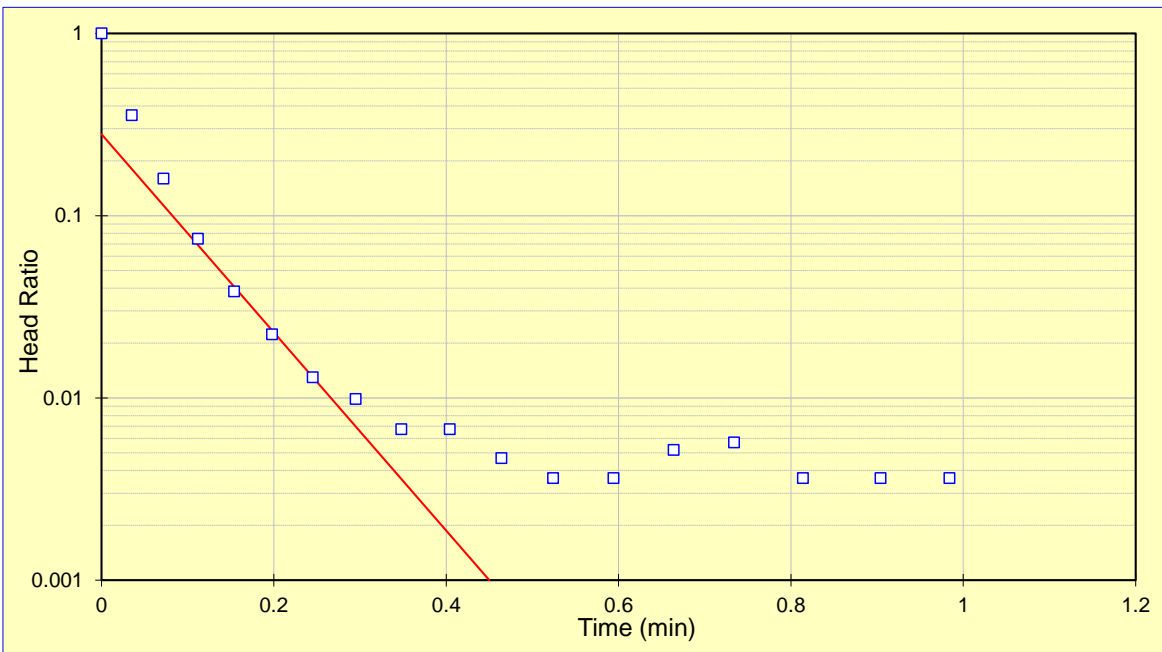
Prepared by: DFS  
 Checked by: KMC  
 Reviewed by: MAH

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 7.44E-03 \text{ cm/sec}</math>  <math>K = 2.11E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.45$	
$h_1/h_0 = 0.28$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/25/2016



**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

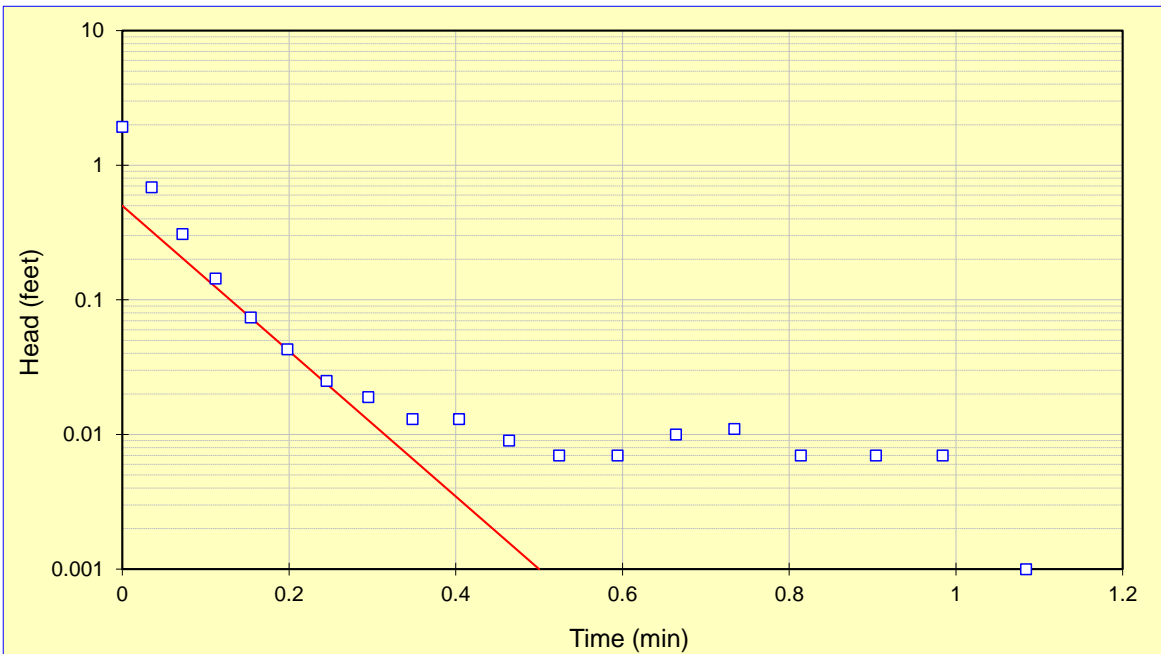
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>4.99E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.42E+01 ft/day</td> </tr> </table>	K=	4.99E-03 cm/sec	K=	1.42E+01 ft/day
K=		4.99E-03 cm/sec			
K=		1.42E+01 ft/day			
$r_w = 0.34$					
$L_e = 10$					
$\ln(R_e/r_w) = 2.28$					
$y_0 = 0.50$					
$y_t = 0.001$					
$t = 0.5$					



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

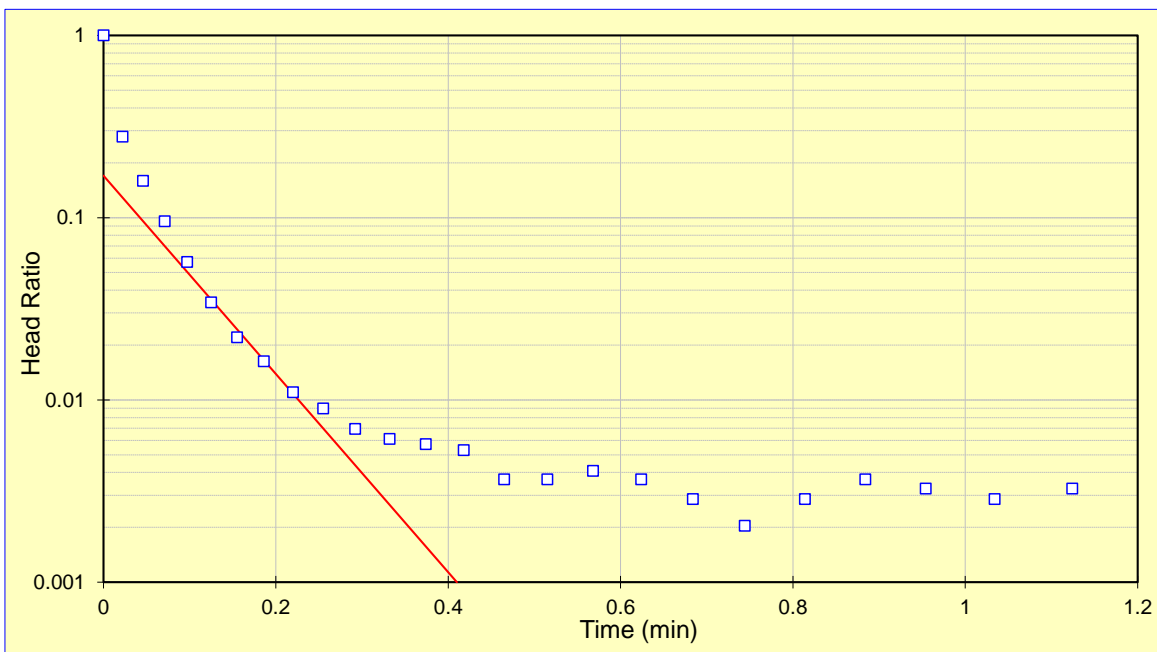
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 7.45E-03 cm/sec</b>  <b>K= 2.11E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.41$	
$h_1/h_0 = 0.17$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

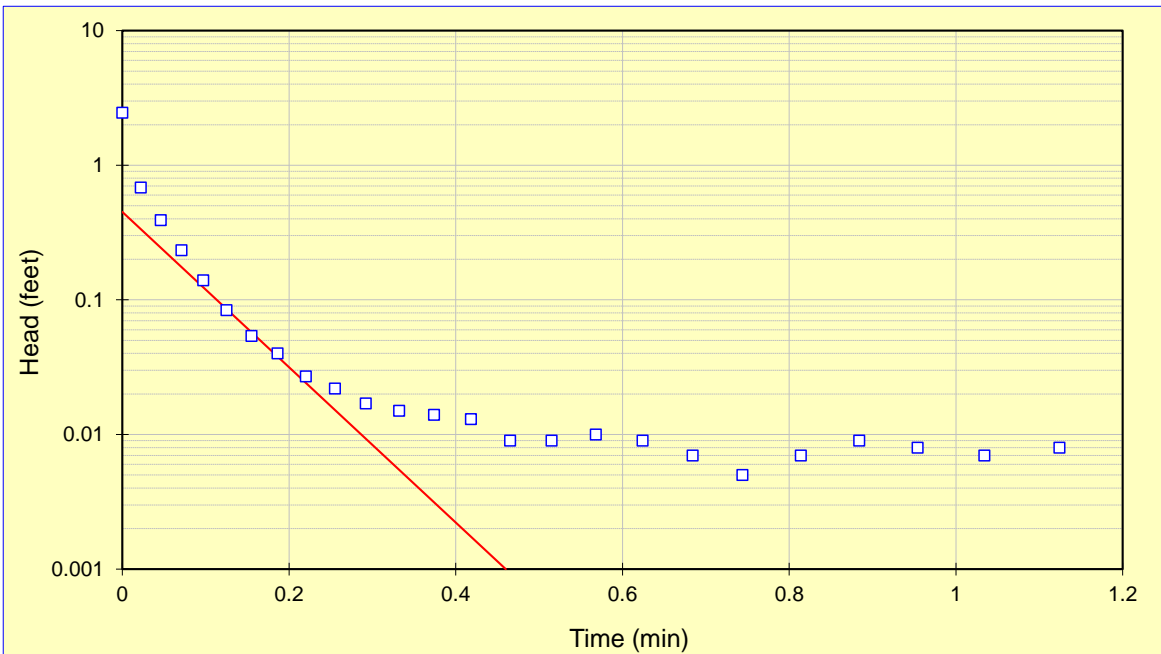
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>5.22E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.48E+01 ft/day</td> </tr> </table>	K=	5.22E-03 cm/sec	K=	1.48E+01 ft/day
K=		5.22E-03 cm/sec			
K=		1.48E+01 ft/day			
$r_w = 0.34$					
$L_e = 10$					
$\ln(R_e/r_w) = 2.23$					
$y_0 = 0.45$					
$y_t = 0.001$					
$t = 0.5$					



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

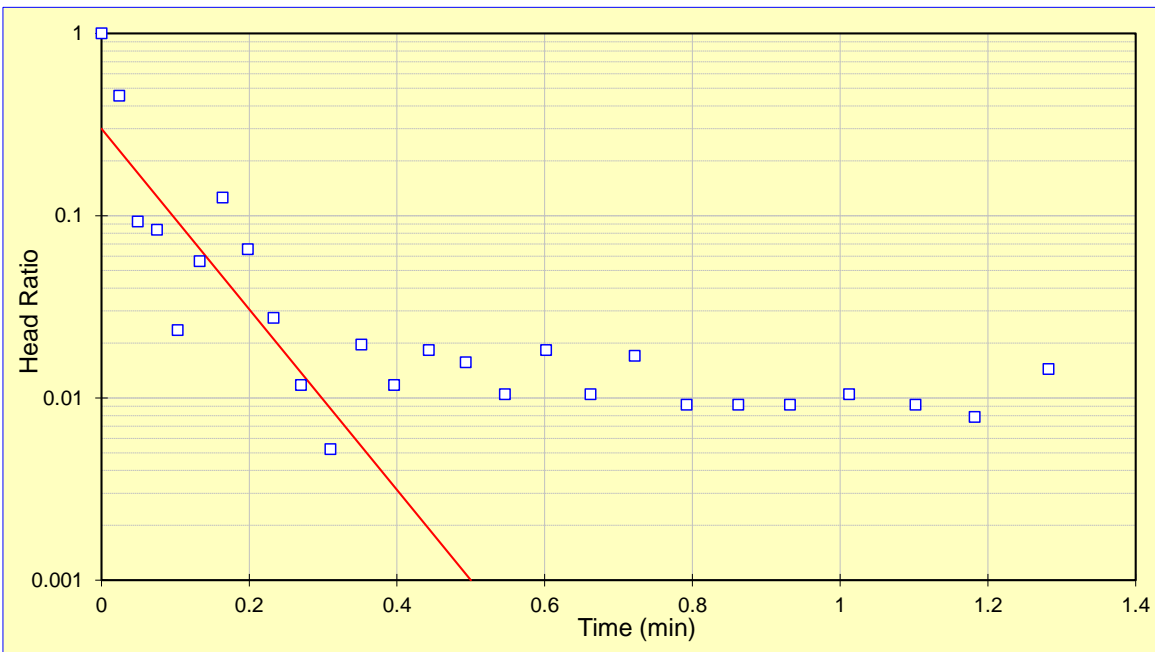
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-03B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 6.78E-03 \text{ cm/sec}</math>  <math>K = 1.92E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.5$	
$h_1/h_0 = 0.30$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-03B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

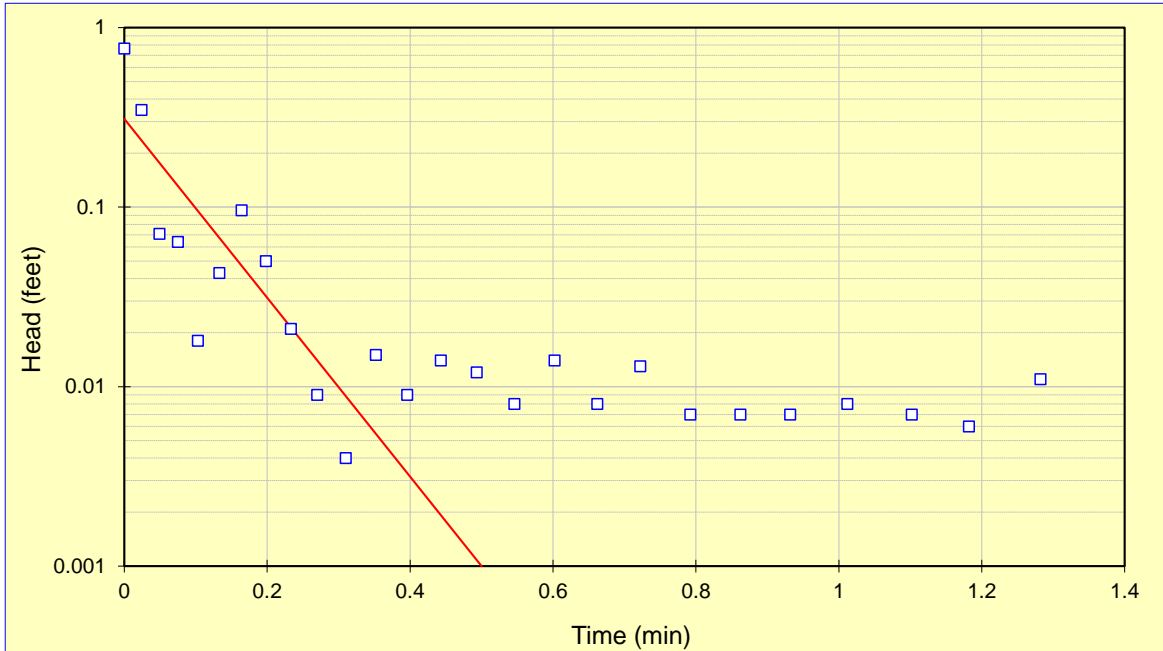
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 5.81E-03</math> cm/sec  <math>K = 1.65E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.87$	
$y_0 = 0.31$	
$y_t = 0.001$	
$t = 0.5$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

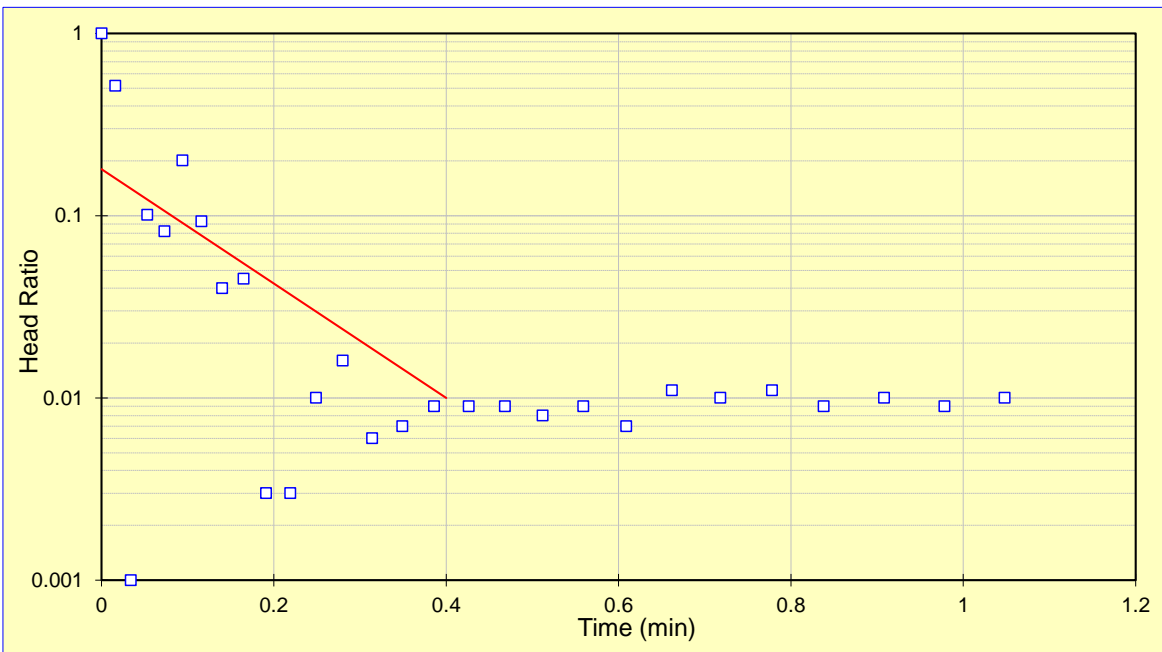


**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-03B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>4.30E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.22E+01 ft/day</td> </tr> </table>	K=	4.30E-03 cm/sec	K=	1.22E+01 ft/day
K=		4.30E-03 cm/sec			
K=		1.22E+01 ft/day			
$R_e = 0.34$					
$L_e = 10$					
$t_1 = 0$					
$t_2 = 0.4$					
$h_1/h_0 = 0.18$					
$h_2/h_0 = 0.01$					



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-03B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

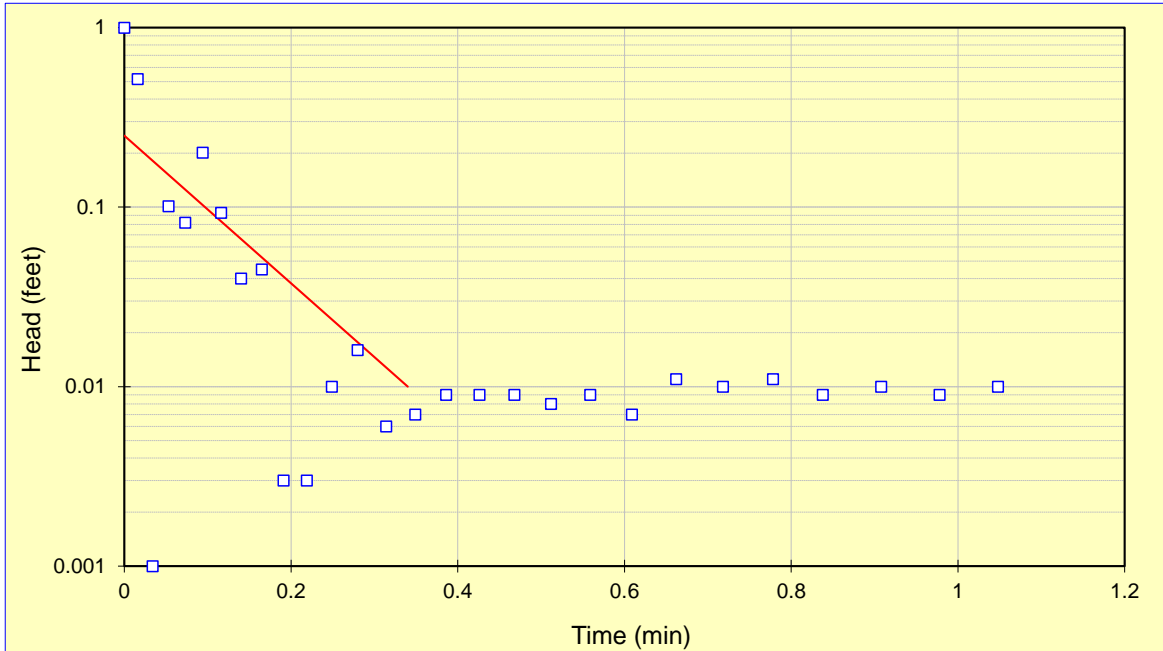
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>4.79E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.36E+01 ft/day</td> </tr> </table>	K=	4.79E-03 cm/sec	K=	1.36E+01 ft/day
K=		4.79E-03 cm/sec			
K=		1.36E+01 ft/day			
$r_w = 0.34$					
$L_e = 10$					
$\ln(R_e/r_w) = 2.87$					
$y_0 = 0.25$					
$y_t = 0.010$					
$t = 0.3$					



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

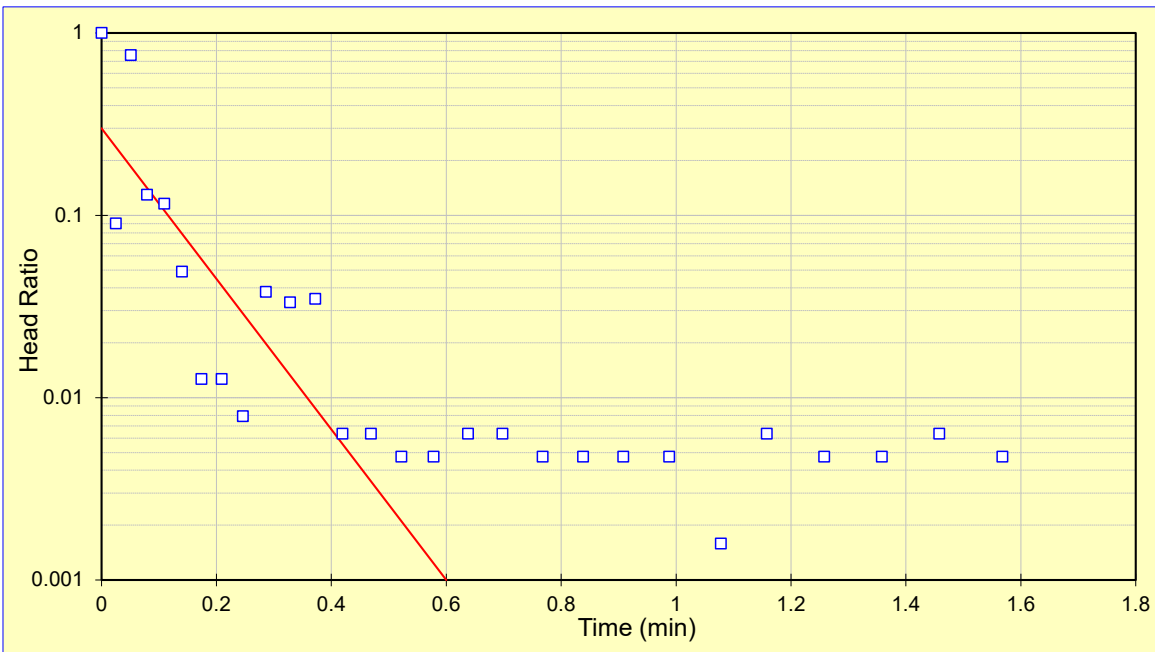
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 5.65E-03 \text{ cm/sec}</math>  <math>K = 1.60E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.6$	
$h_1/h_0 = 0.30$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

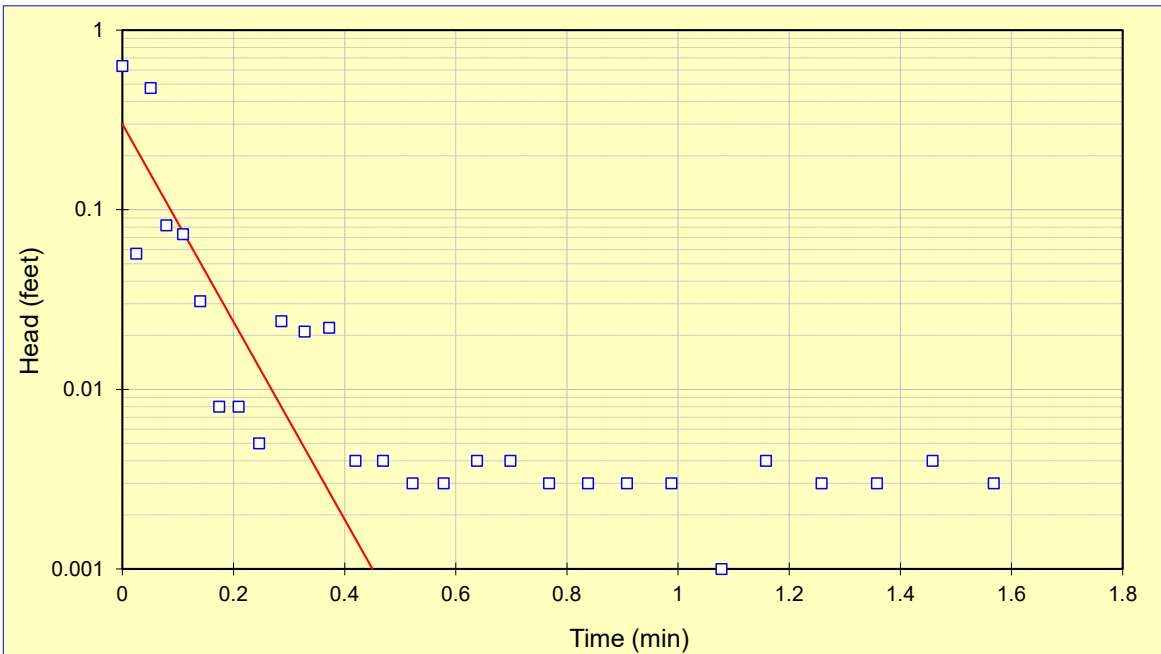
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 6.42E-03</math> cm/sec  <math>K = 1.82E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.87$	
$y_0 = 0.30$	
$y_t = 0.001$	
$t = 0.5$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-03B (TEST 2)**

$$T = b + a \ln T$$

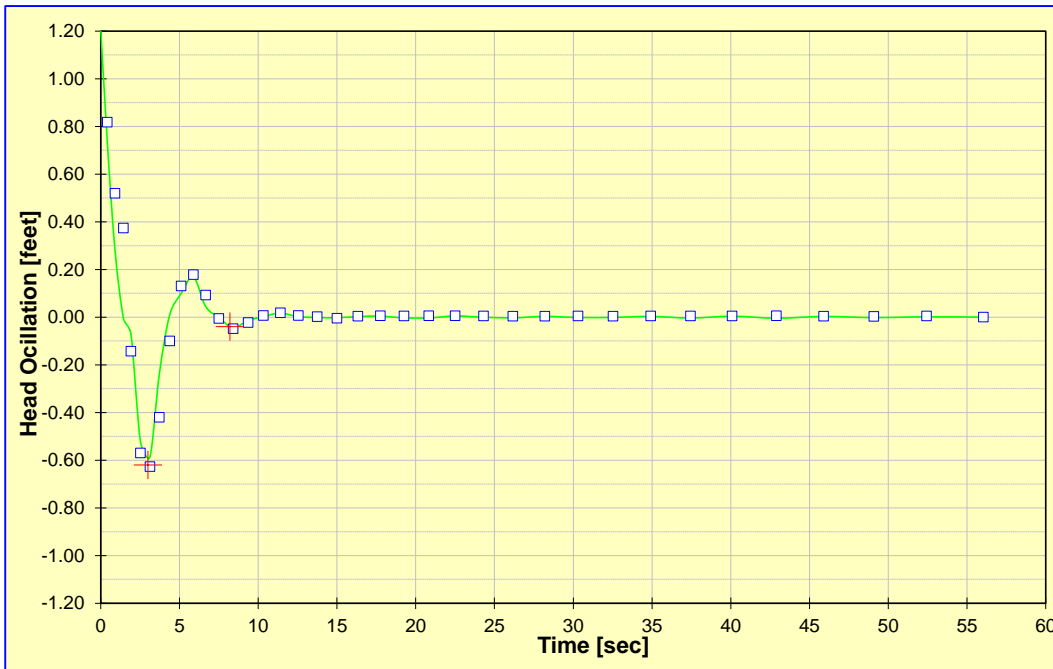
where:  $b = -a \ln [0.79 r_s^2 S (g/L)^{1/2}]$   
 $a = r_c^2 (g/L^{1/2}) / 8d$   
 $d = \gamma / (g/L)^{1/2}$   
 $L = g / (\omega^2 + \gamma^2)$

**INPUT PARAMETERS**

$r_c =$	<b>0.08</b>	ft	$(g/L)^{1/2} =$	<b>1.31826</b>	ft <sup>2</sup>
$r_s =$	<b>0.08</b>	ft	$d =$	<b>0.3998</b>	ft <sup>-1</sup>
$L_c =$	<b>19.62</b>	ft	$a =$	<b>0.00286</b>	ft <sup>3</sup>
$L_s =$	<b>10.00</b>	ft	$t_1 =$	<b>3.00</b>	sec
$\omega =$	<b>1.2083</b>	ft <sup>-1</sup>	$t_2 =$	<b>8.20</b>	sec
$\gamma =$	<b>0.5271</b>	ft <sup>-1</sup>	$h(t_1) =$	<b>0.62</b>	ft
$L =$	<b>18.52</b>	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	<b>0.04</b>	ft
$g =$	<b>32.19</b>	ft/sec <sup>2</sup>	$S =$	<b>1.00E-02</b>	dim

**RESULTS**

$b = T_0 =$	<b>2.73E-02</b>	ft <sup>2</sup> /sec	$\alpha < 0.1?$	<b>YES</b>
$T =$	<b>1.53E-02</b>	ft <sup>2</sup> /sec	$d < 0.7?$	<b>YES</b>
$T =$	<b>1.32E+03</b>	ft <sup>2</sup> /day	$L_1 =$	<b>18.52</b>
$K =$	<b>4.22E+01</b>	ft/day	$L_2 =$	<b>24.62</b>
$K =$	<b>1.49E-02</b>	cm/sec	$L_1 : L_2$ Diff < 20% ?	<b>NO</b>



Project Name: **NIPSCO RMSGS**  
 Project No.: **164-8171**  
 Test Date: **07/08/16**

Analysis By: **DFS**  
 Checked By: **JRS**  
 Analysis Date: **8/8/2016**

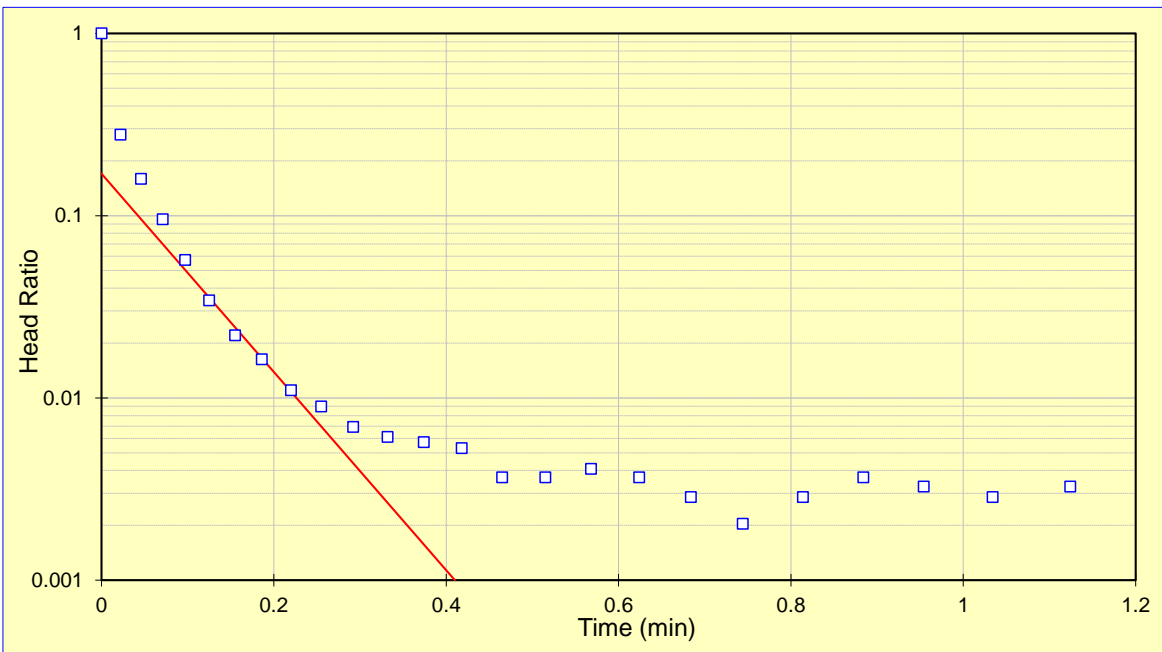


**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 7.45E-03 \text{ cm/sec}</math>  <math>K = 2.11E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.41$	
$h_1/h_0 = 0.17$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-03 (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

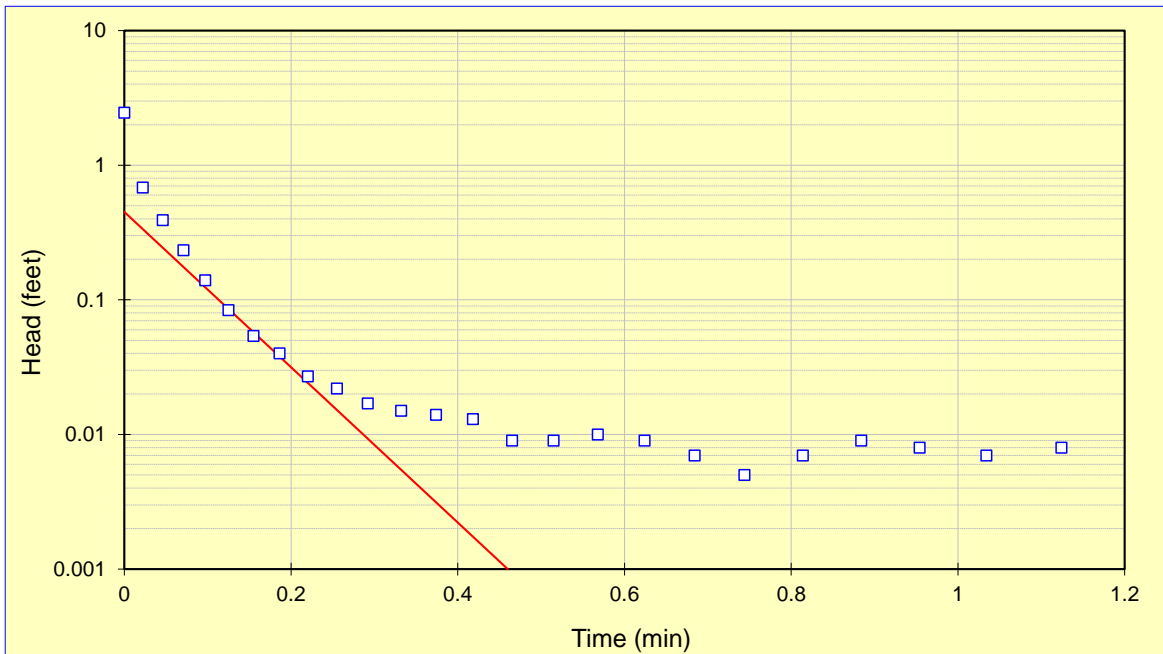
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>5.22E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.48E+01 ft/day</td> </tr> </table>	K=	5.22E-03 cm/sec	K=	1.48E+01 ft/day
K=		5.22E-03 cm/sec			
K=		1.48E+01 ft/day			
$r_w = 0.34$					
$L_e = 10$					
$\ln(R_e/r_w) = 2.23$					
$y_0 = 0.45$					
$y_t = 0.001$					
$t = 0.5$					



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

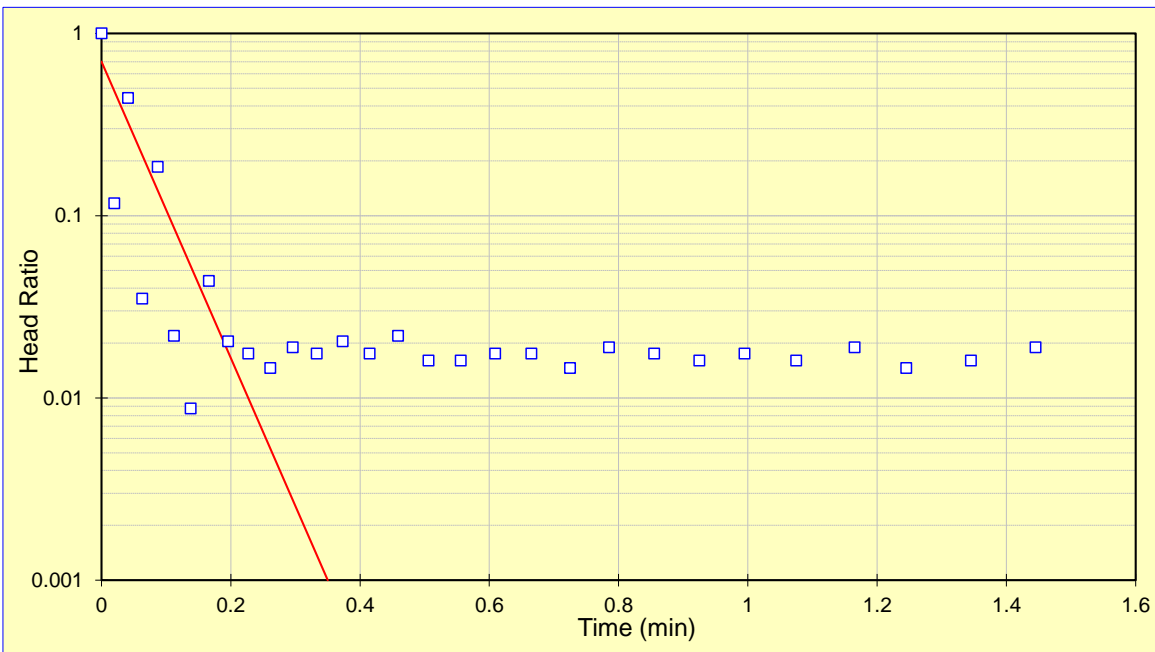
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.11E-02 cm/sec</b>  <b>K= 3.15E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.35$	
$h_1/h_0 = 0.70$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

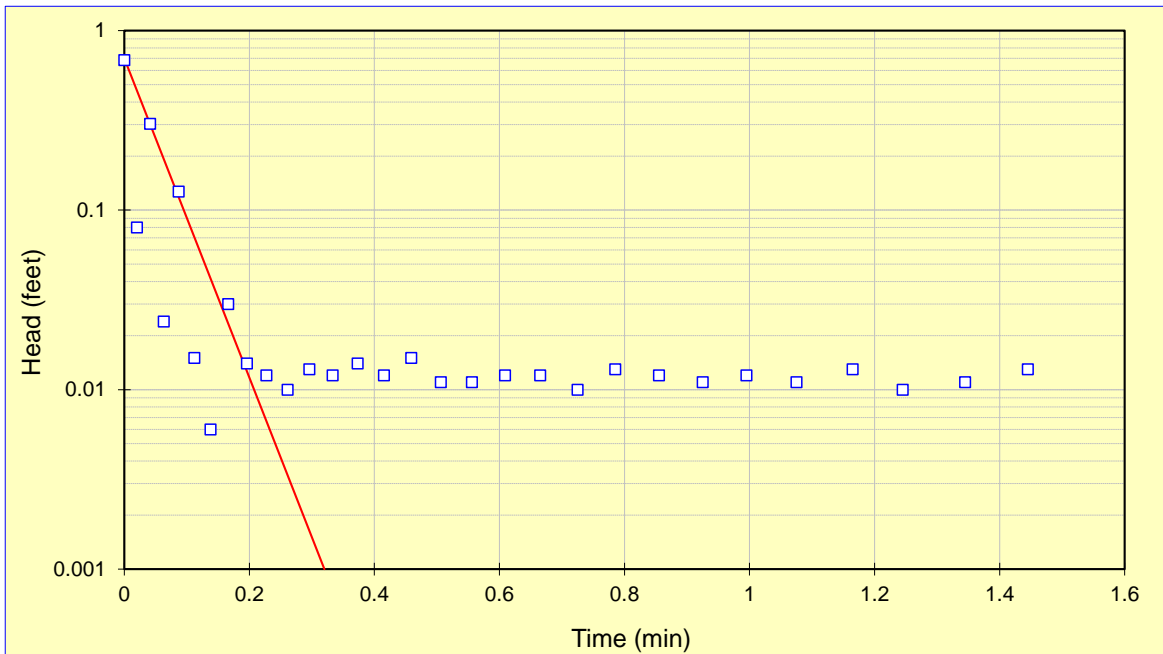
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 1.16E-02</math> cm/sec  <math>K = 3.30E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.22$	
$y_0 = 0.70$	
$y_t = 0.001$	
$t = 0.3$	



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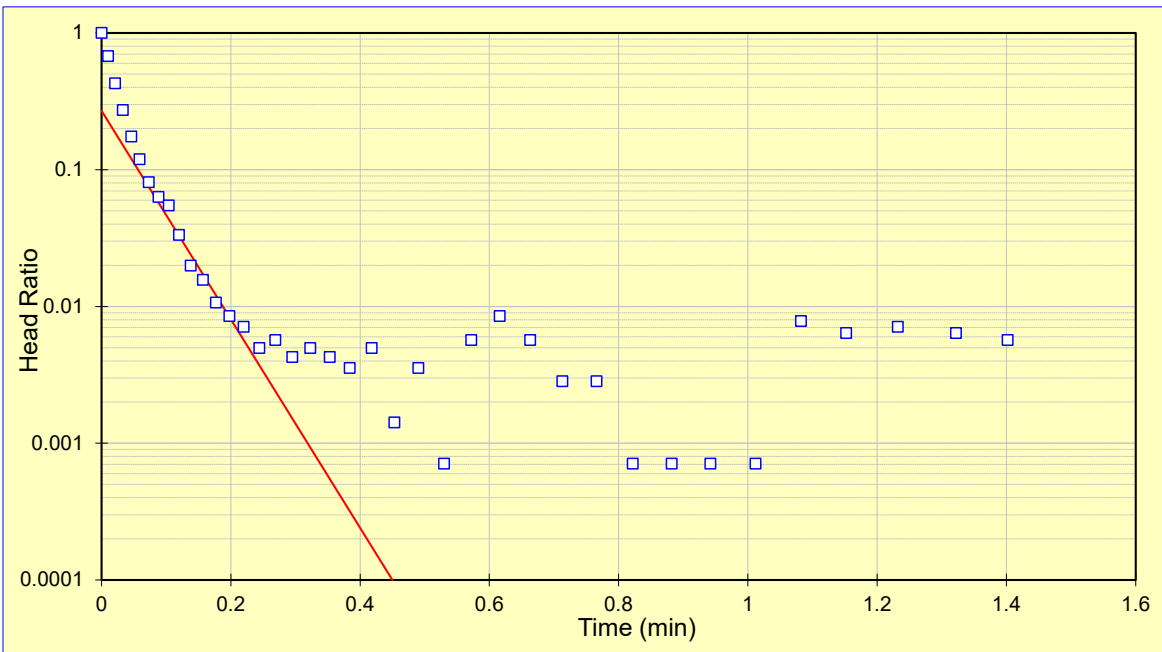
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13 (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 6.50E-02</math> cm/sec  <math>K = 1.84E+02</math> ft/day                 </div>
$R_e = 0.34$	
$L_e = 9.037$	
$t_1 = 0$	
$t_2 = 0.45$	
$h_1/h_0 = 0.27$	
$h_2/h_0 = 0.00$	



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 Checked By: JRS  
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**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13 (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

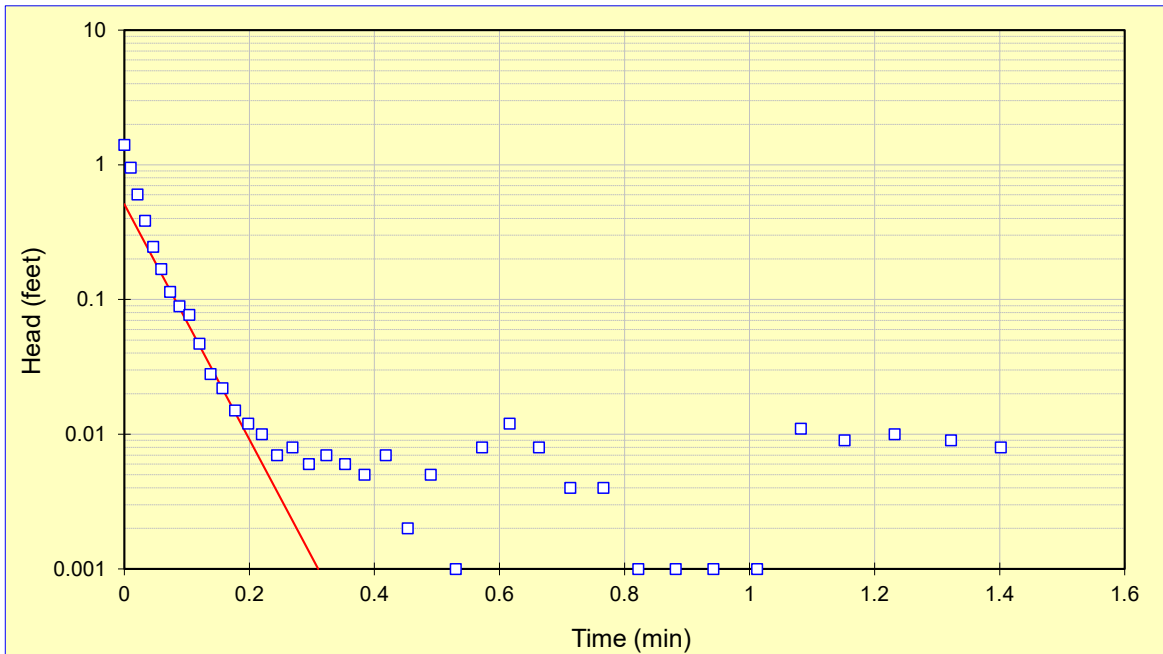
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	$K = 4.81E-02$ cm/sec $K = 1.36E+02$ ft/day
$r_w = 0.34$	
$L_e = 9.037$	
$\ln(R_e/r_w) = 2.11$	
$y_0 = 0.51$	
$y_t = 0.001$	
$t = 0.3$	



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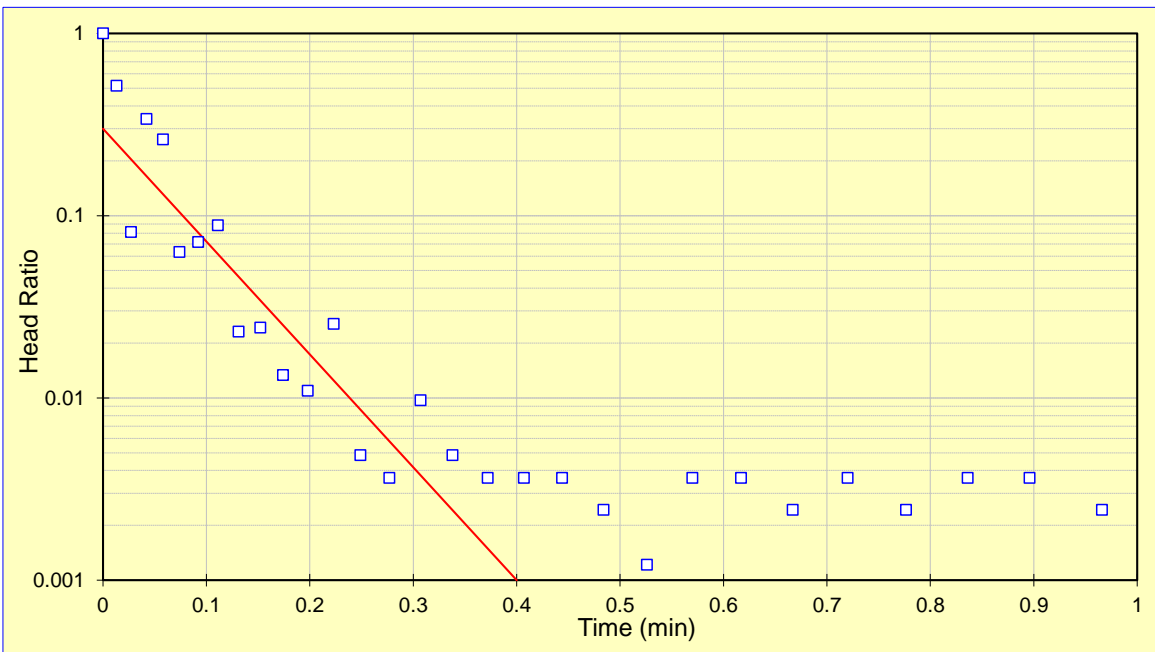
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 8.48E-03 \text{ cm/sec}</math>  <math>K = 2.40E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.4$	
$h_1/h_0 = 0.30$	
$h_2/h_0 = 0.00$	



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 Checked By: JRS  
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**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

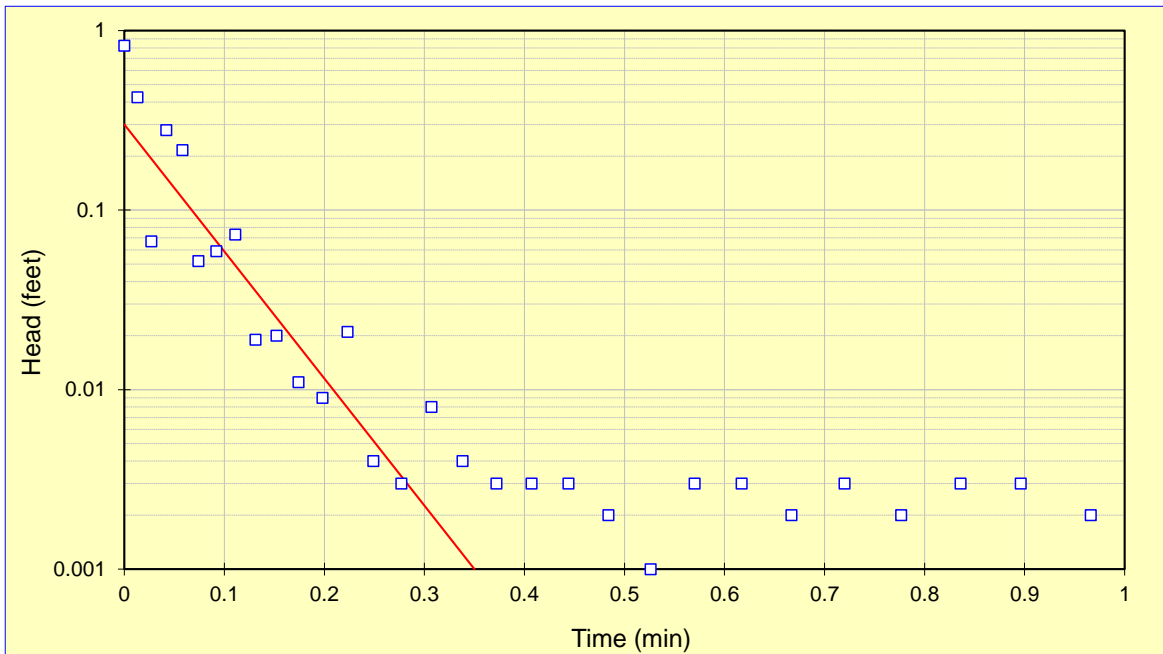
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>9.27E-03 cm/sec</td> </tr> <tr> <td>K=</td> <td>2.63E+01 ft/day</td> </tr> </table>	K=	9.27E-03 cm/sec	K=	2.63E+01 ft/day
K=		9.27E-03 cm/sec			
K=		2.63E+01 ft/day			
$r_w = 0.34$					
$L_e = 10$					
$\ln(R_e/r_w) = 3.22$					
$y_0 = 0.30$					
$y_t = 0.001$					
$t = 0.4$					



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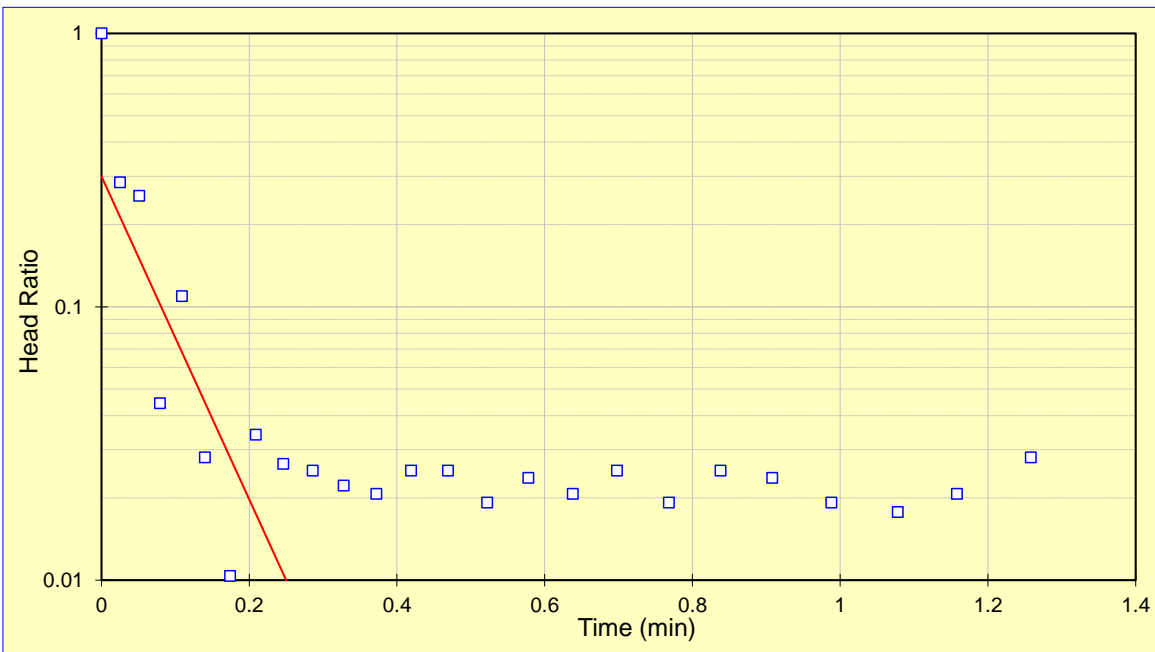
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-13B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 8.09E-03 \text{ cm/sec}</math>  <math>K = 2.29E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.25$	
$h_1/h_0 = 0.30$	
$h_2/h_0 = 0.01$	



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 Checked By: JRS  
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**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-13B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

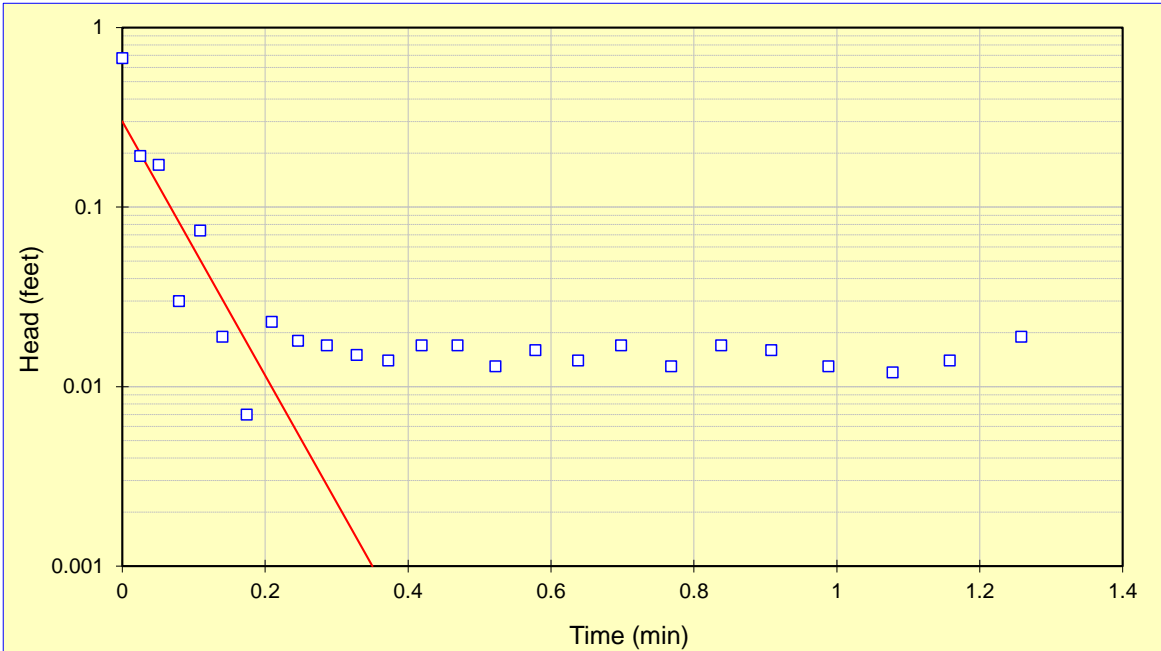
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 9.27E-03</math> cm/sec  <math>K = 2.63E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.22$	
$y_0 = 0.30$	
$y_t = 0.001$	
$t = 0.4$	



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 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016



**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-13B (TEST 1)**

$$T = b + a \ln T$$

*where:*

$$b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$$

$$a = r_c^2 (g/L^{1/2}) / 8d$$

$$d = \gamma / (g/L)^{1/2}$$

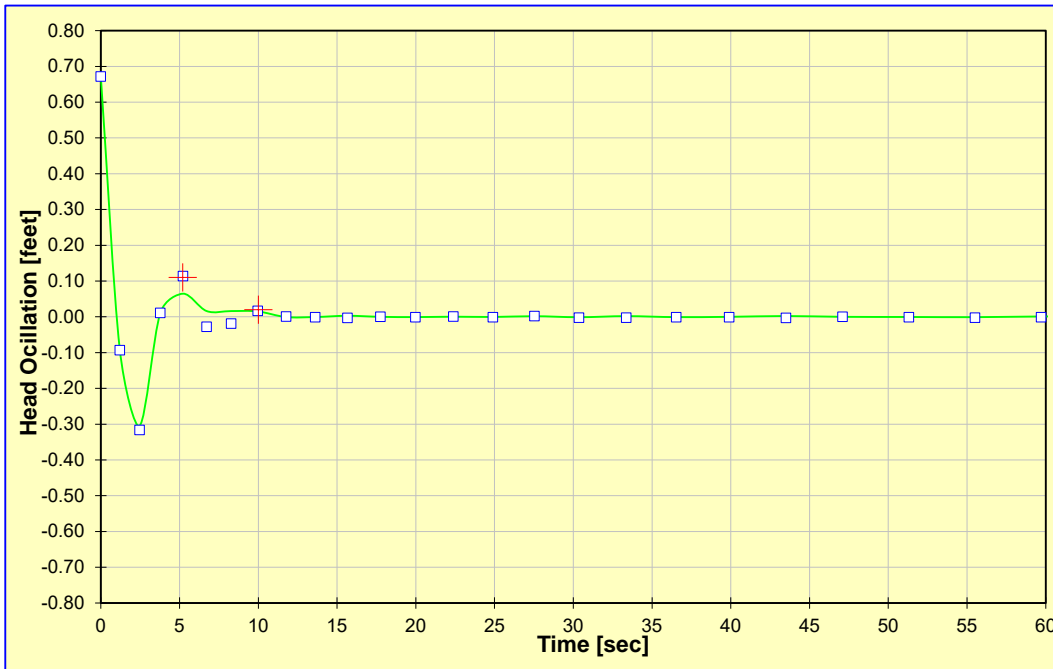
$$L = g / (\omega^2 + \gamma^2)$$

**INPUT PARAMETERS**

$r_c =$	0.08	ft	$(g/L)^{1/2} =$	1.35632	ft <sup>2</sup>
$r_s =$	0.08	ft	$d =$	0.2619	ft <sup>-1</sup>
$L_c =$	19.45	ft	$a =$	0.00450	ft <sup>3</sup>
$L_s =$	9.98	ft	$t_1 =$	5.20	sec
$w =$	1.3090	ft <sup>-1</sup>	$t_2 =$	10.00	sec
$g =$	0.3552	ft <sup>-1</sup>	$h(t_1) =$	0.11	ft
$L =$	17.50	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	0.02	ft
$g =$	32.19	ft/sec <sup>2</sup>	$S =$	1.00E-02	dim

**RESULTS**

$b = T_0 =$	4.27E-02 ft <sup>2</sup> /sec	$a < 0.1?$	YES
$T =$	2.64E-02 ft <sup>2</sup> /sec	$d < 0.7?$	YES
$T =$	2.28E+03 ft <sup>2</sup> /day	$L_1 =$	17.50
$K =$	7.74E+01 ft/day	$L_2 =$	24.44
$K =$	2.73E-02 cm/sec	$L_1 : L_2$ Diff < 20% ?	NO



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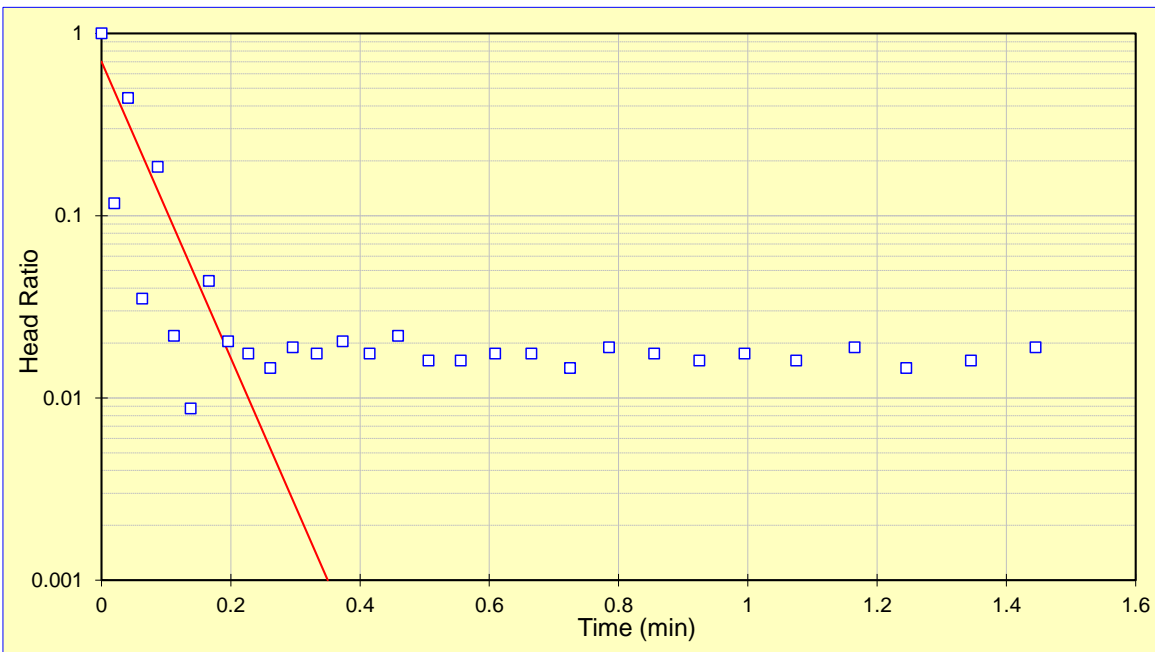
Analysis By: DFS  
Checked By: JRS  
Analysis Date: 7/31/2017

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 1.11E-02 \text{ cm/sec}</math>  <math>K = 3.15E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.35$	
$h_1/h_0 = 0.70$	
$h_2/h_0 = 0.00$	



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 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

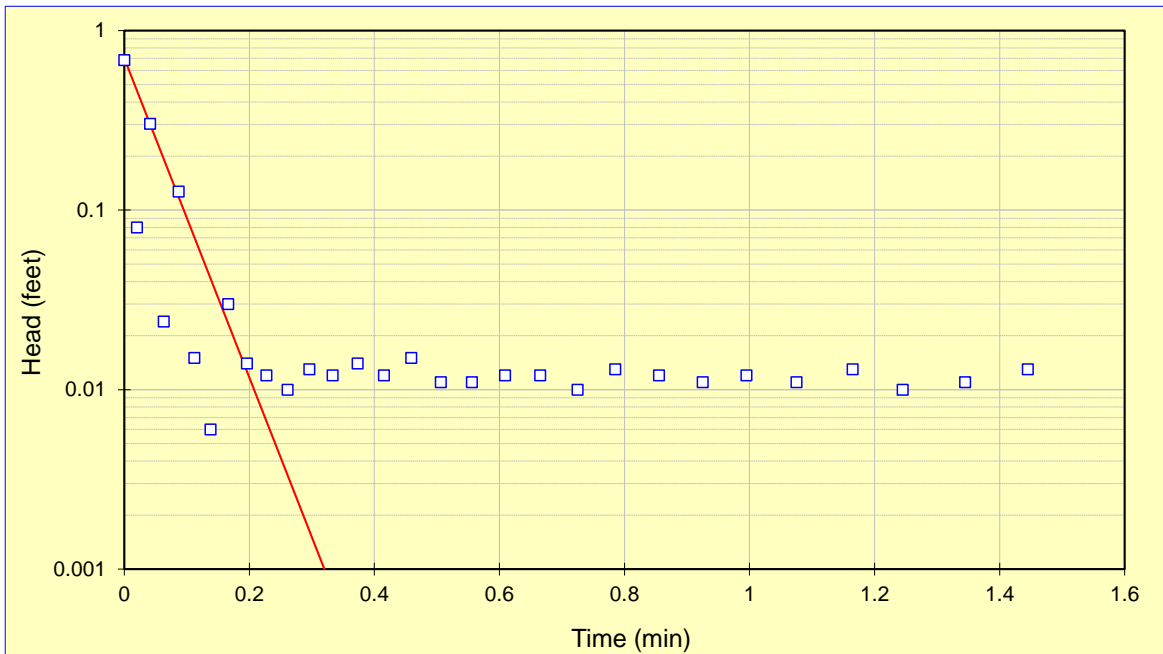
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 1.16E-02</math> cm/sec  <math>K = 3.30E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.22$	
$y_0 = 0.70$	
$y_t = 0.001$	
$t = 0.3$	



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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

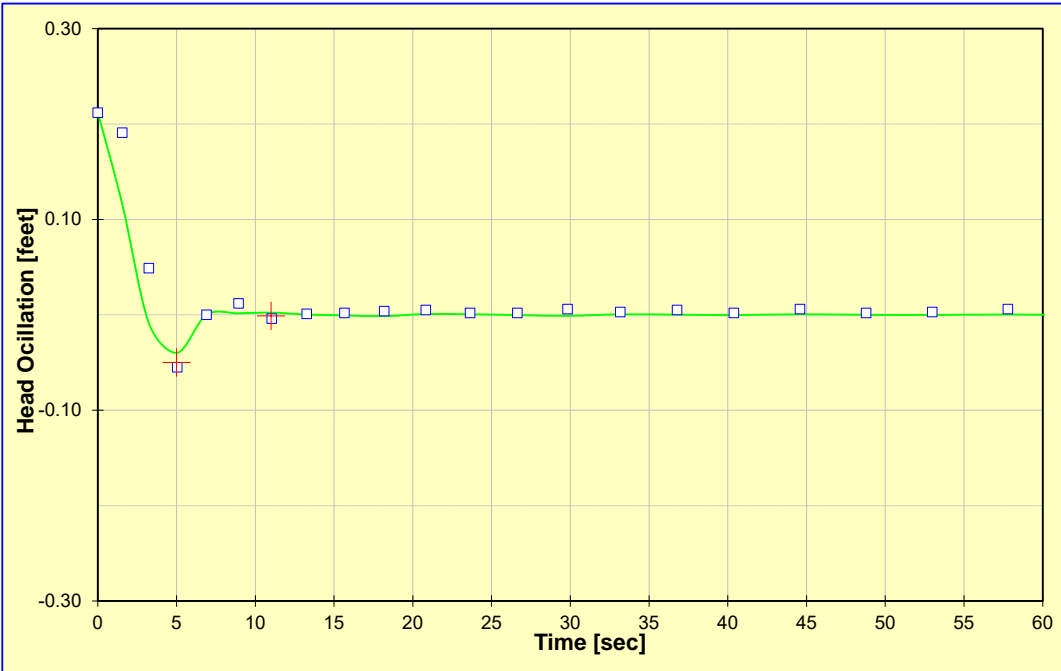
**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-13B (TEST 2)**

$T = b + a \ln T$	<p><i>where:</i></p> $b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$ $a = r_c^2 (g/L^{1/2}) / 8d$ $d = \gamma / (g/L)^{1/2}$ $L = g / (\omega^2 + \gamma^2)$
-------------------	---

INPUT PARAMETERS					
$r_c =$	0.08	ft	$(g/L)^{1/2} =$	1.23358	ft <sup>2</sup>
$r_s =$	0.08	ft	$d =$	0.5285	ft <sup>-1</sup>
$L_c =$	19.14	ft	$a =$	0.00203	ft <sup>3</sup>
$L_s =$	9.98	ft	$t_1 =$	5.00	sec
$w =$	1.0472	ft <sup>-1</sup>	$t_2 =$	11.00	sec
$g =$	0.6520	ft <sup>-1</sup>	$h(t_1) =$	0.05	ft
$L =$	21.15	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	0.00	ft
$g =$	32.19	ft/sec <sup>2</sup>	$S =$	1.00E-02	dim

RESULTS				
$b = T_0 =$	1.95E-02	ft <sup>2</sup> /sec	$a < 0.1?$	YES
$T =$	1.02E-02	ft <sup>2</sup> /sec	$d < 0.7?$	YES
$T =$	8.77E+02	ft <sup>2</sup> /day	$L_1 =$	21.15
$K =$	3.01E+01	ft/day	$L_2 =$	24.13
$K =$	1.06E-02	cm/sec	$L_1 : L_2$ Diff < 20% ?	YES



Project Name: NIPSCO RMSGS  
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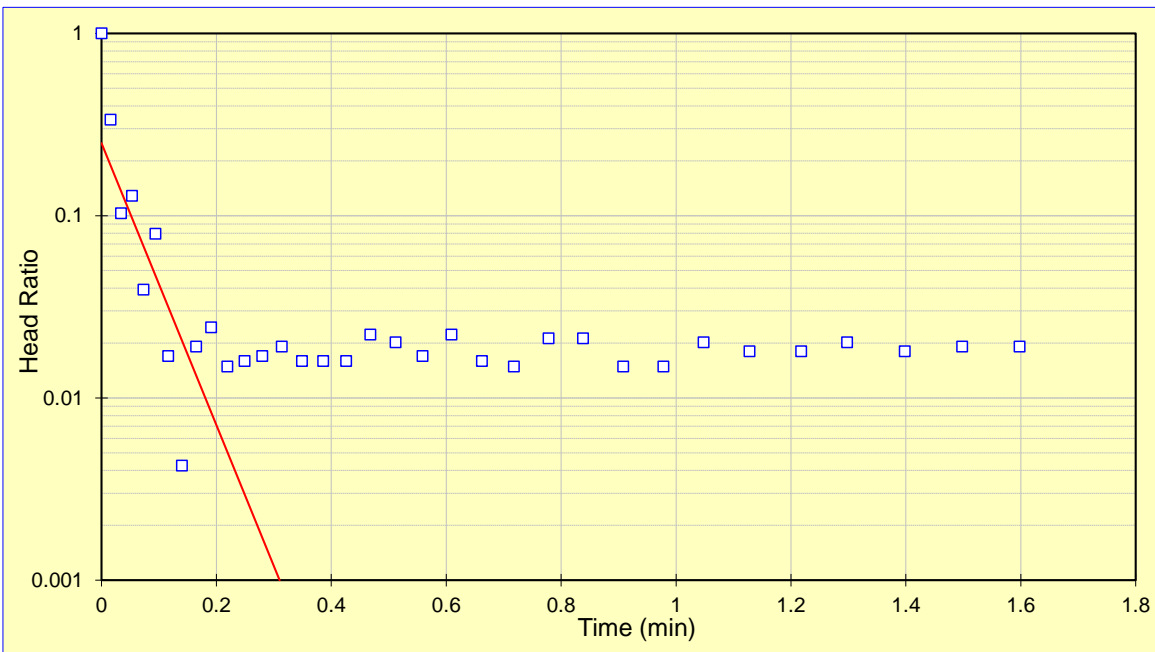
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/31/2017

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     K= 1.06E-02 cm/sec                      K= 3.00E+01 ft/day                 </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.31$	
$h_1/h_0 = 0.25$	
$h_2/h_0 = 0.00$	



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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016



**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-13B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

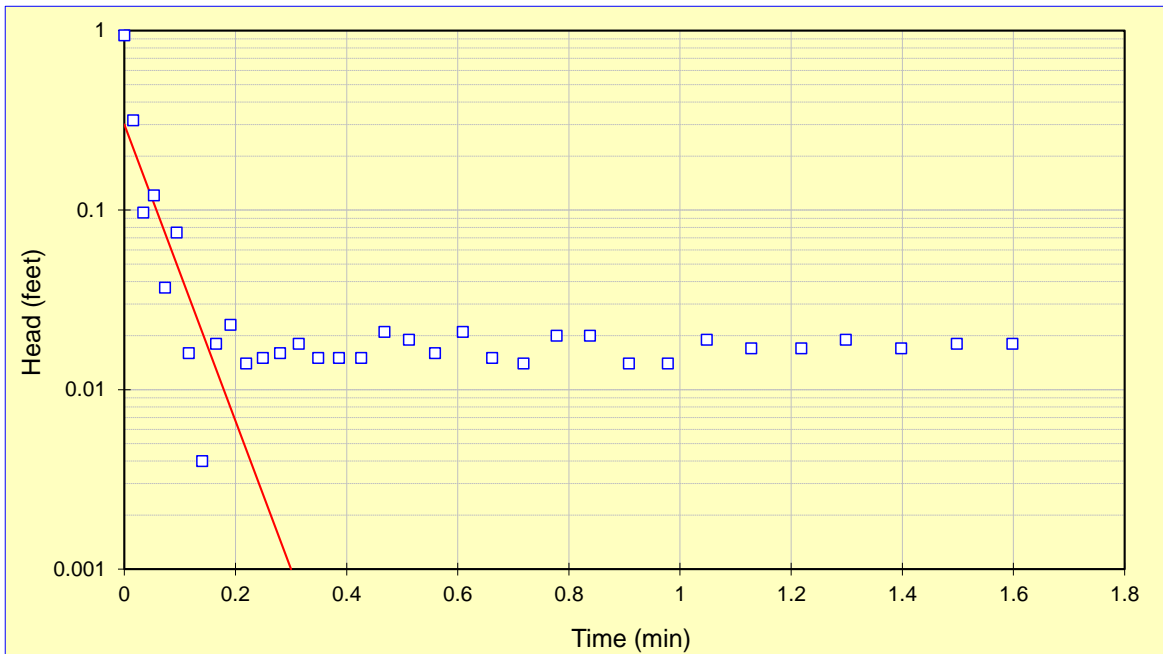
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	$K = 1.08E-02 \text{ cm/sec}$ $K = 3.06E+01 \text{ ft/day}$
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.22$	
$y_0 = 0.30$	
$y_t = 0.001$	
$t = 0.3$	



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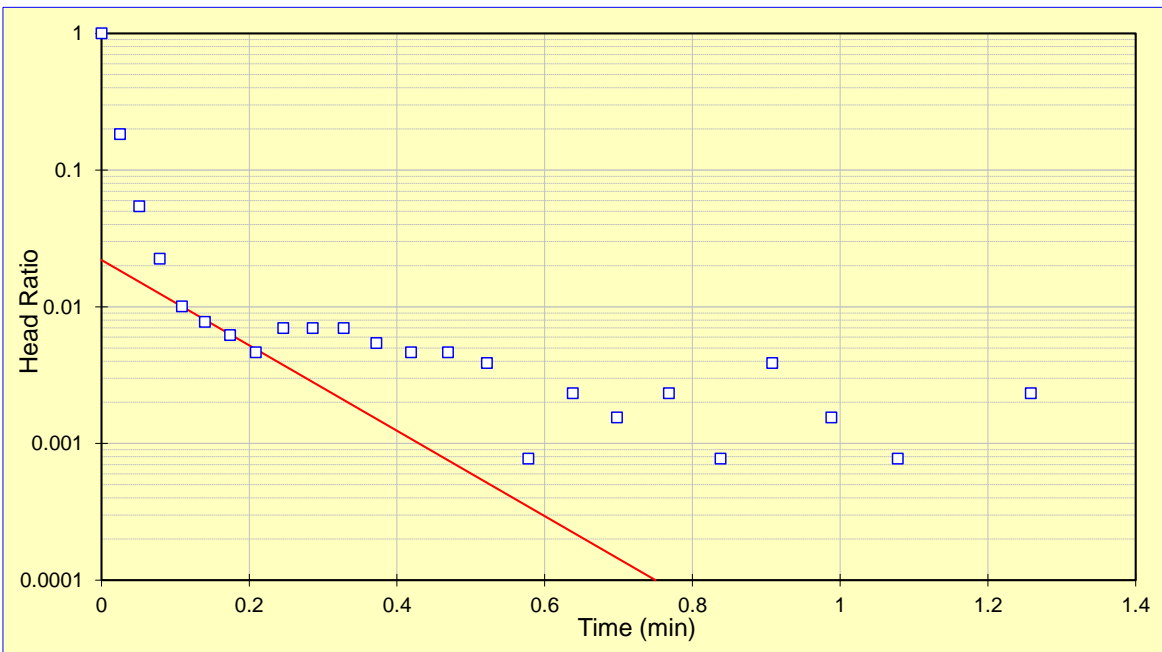
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15 (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 2.59E-02 cm/sec</b>  <b>K= 7.34E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 9.417$	
$t_1 = 0$	
$t_2 = 0.75$	
$h_1/h_0 = 0.02$	
$h_2/h_0 = 0.00$	



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 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15 (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

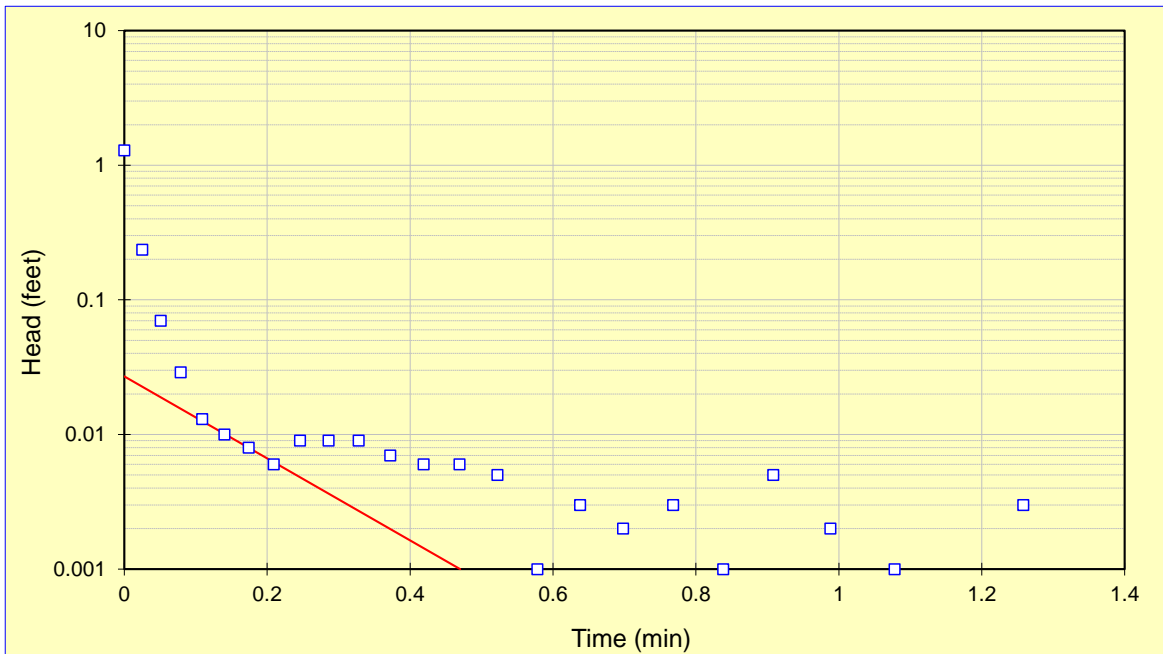
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.20$	<table border="1"> <tr> <td>K=</td> <td>1.63E-02 cm/sec</td> </tr> <tr> <td>K=</td> <td>4.63E+01 ft/day</td> </tr> </table>	K=	1.63E-02 cm/sec	K=	4.63E+01 ft/day
K=		1.63E-02 cm/sec			
K=		4.63E+01 ft/day			
$r_w = 0.34$					
$L_e = 9.417$					
$\ln(R_e/r_w) = 2.14$					
$y_0 = 0.03$					
$y_t = 0.001$					
$t = 0.5$					



Project Name: NIPSCO Schahfer  
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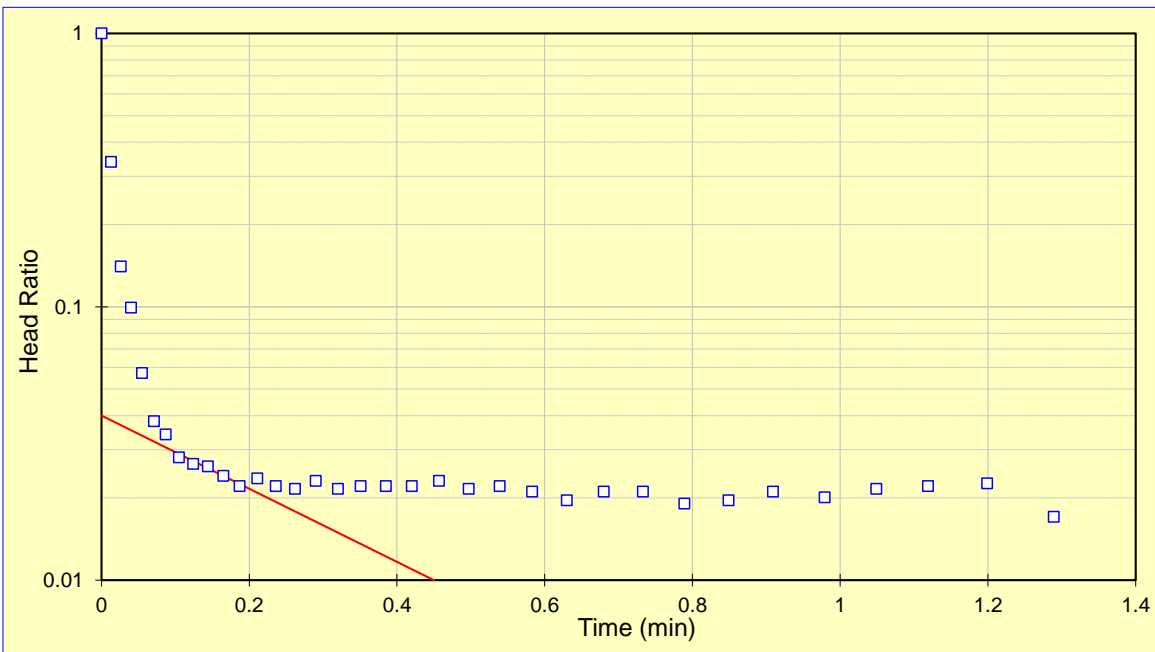
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15 (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.11E-02 cm/sec</b>  <b>K= 3.16E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 9.348$	
$t_1 = 0$	
$t_2 = 0.45$	
$h_1/h_0 = 0.04$	
$h_2/h_0 = 0.01$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15 (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

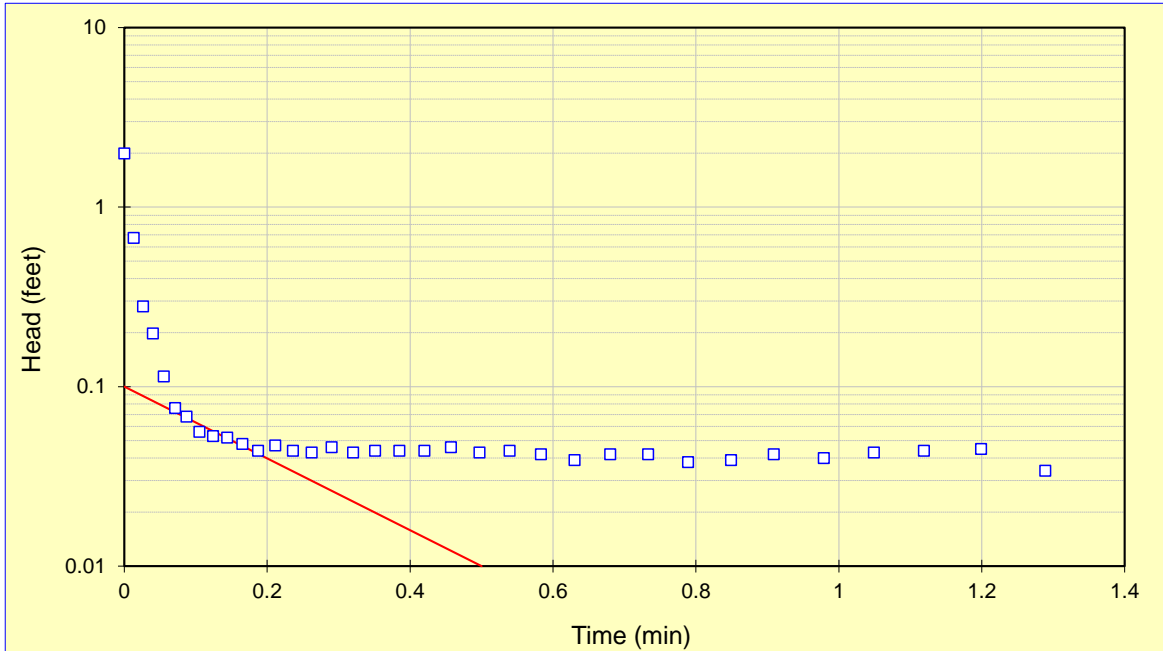
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 1.08E-02</math> cm/sec  <math>K = 3.05E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 9.348$	
$\ln(R_e/r_w) = 2.13$	
$y_0 = 0.10$	
$y_t = 0.010$	
$t = 0.5$	



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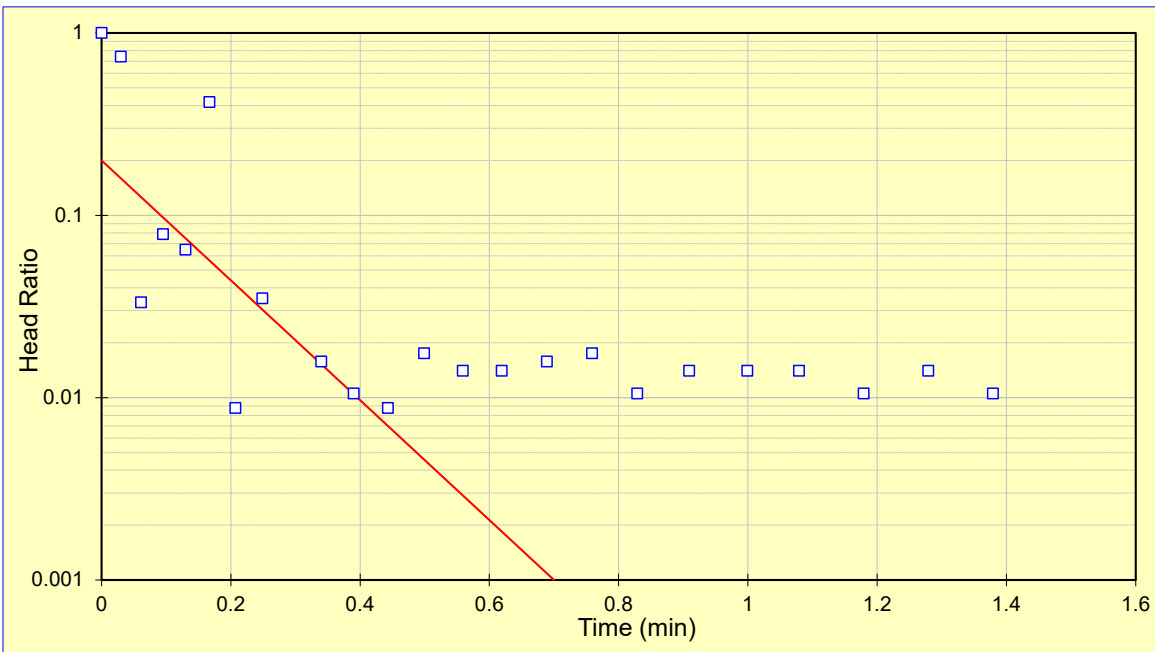
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-15B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 4.50E-03 \text{ cm/sec}</math>  <math>K = 1.28E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.7$	
$h_1/h_0 = 0.20$	
$h_2/h_0 = 0.00$	



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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016



**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-15B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

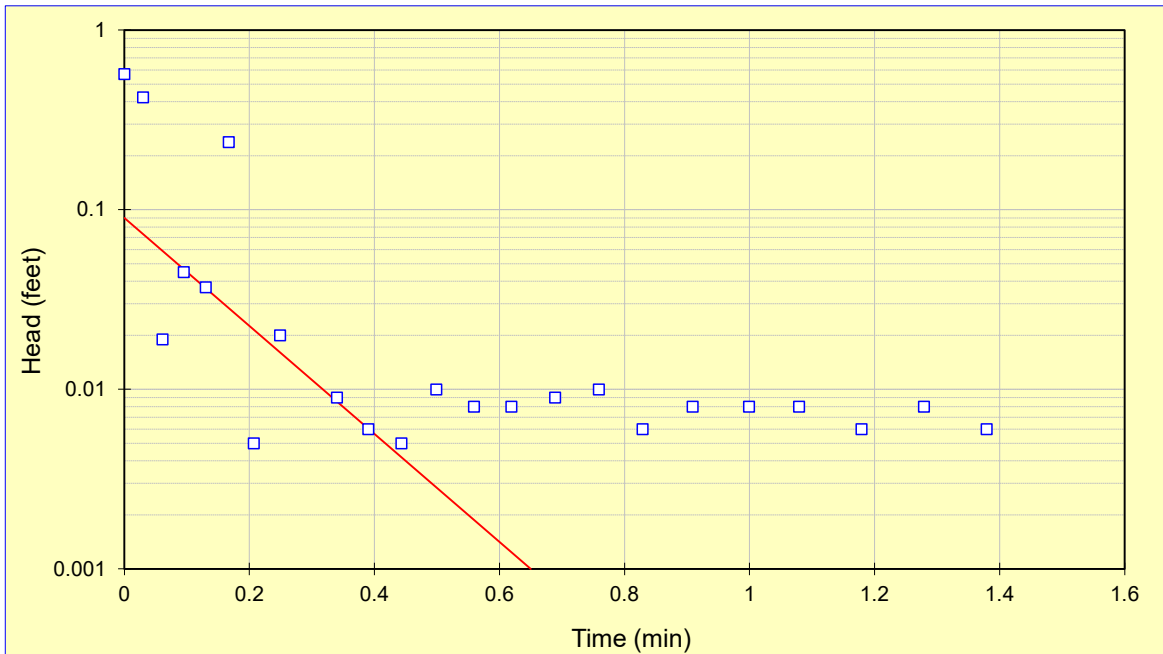
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 3.45E-03</math> cm/sec  <math>K = 9.79E+00</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.83$	
$y_0 = 0.09$	
$y_t = 0.001$	
$t = 0.7$	



Project Name: NIPSCO Schahfer  
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 Checked By: JRS  
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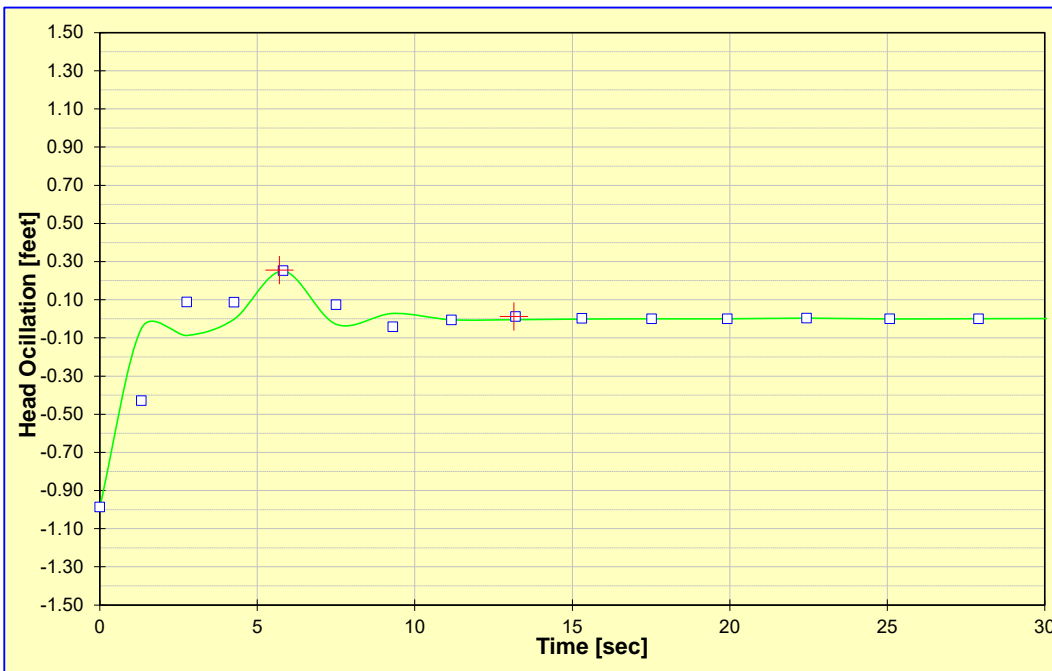
**van der KAMP FALLING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-15B (TEST 2)**

$T = b + a \ln T$	<p><i>where:</i></p> $b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$ $a = r_c^2 (g/L^{1/2}) / 8d$ $d = \gamma / (g/L)^{1/2}$ $L = g / (\omega^2 + \gamma^2)$
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INPUT PARAMETERS					
$r_c =$	<b>0.08</b>	ft	$(g/L)^{1/2} =$	<b>0.93787</b>	ft <sup>2</sup>
$r_s =$	<b>0.08</b>	ft	$d =$	<b>0.4374</b>	ft <sup>-1</sup>
$L_c =$	<b>19.23</b>	ft	$a =$	<b>0.00186</b>	ft <sup>3</sup>
$L_s =$	<b>10.00</b>	ft	$t_1 =$	<b>5.70</b>	sec
$w =$	<b>0.8434</b>	ft <sup>-1</sup>	$t_2 =$	<b>13.15</b>	sec
$g =$	<b>0.4102</b>	ft <sup>-1</sup>	$h(t_1) =$	<b>0.26</b>	ft
$L =$	<b>36.60</b>	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	<b>0.01</b>	ft
$g =$	<b>32.19</b>	ft/sec <sup>2</sup>	$S =$	<b>1.00E-02</b>	dim

RESULTS					
$b = T_0 =$	<b>1.84E-02</b>	ft <sup>2</sup> /sec	$a < 0.1?$	<b>YES</b>	
$T =$	<b>9.76E-03</b>	ft <sup>2</sup> /sec	$d < 0.7?$	<b>YES</b>	
$T =$	<b>8.44E+02</b>	ft <sup>2</sup> /day	$L_1 =$	<b>36.60</b>	
$K =$	<b>2.70E+01</b>	ft/day	$L_2 =$	<b>24.23</b>	
$K =$	<b>9.53E-03</b>	cm/sec	$L_1 : L_2 \text{ Diff} < 20\% ?$	<b>NO</b>	



Project Name: **NIPSCO RMSGS**  
 Project No.: **164-8171**  
 Test Date: **07/08/16**

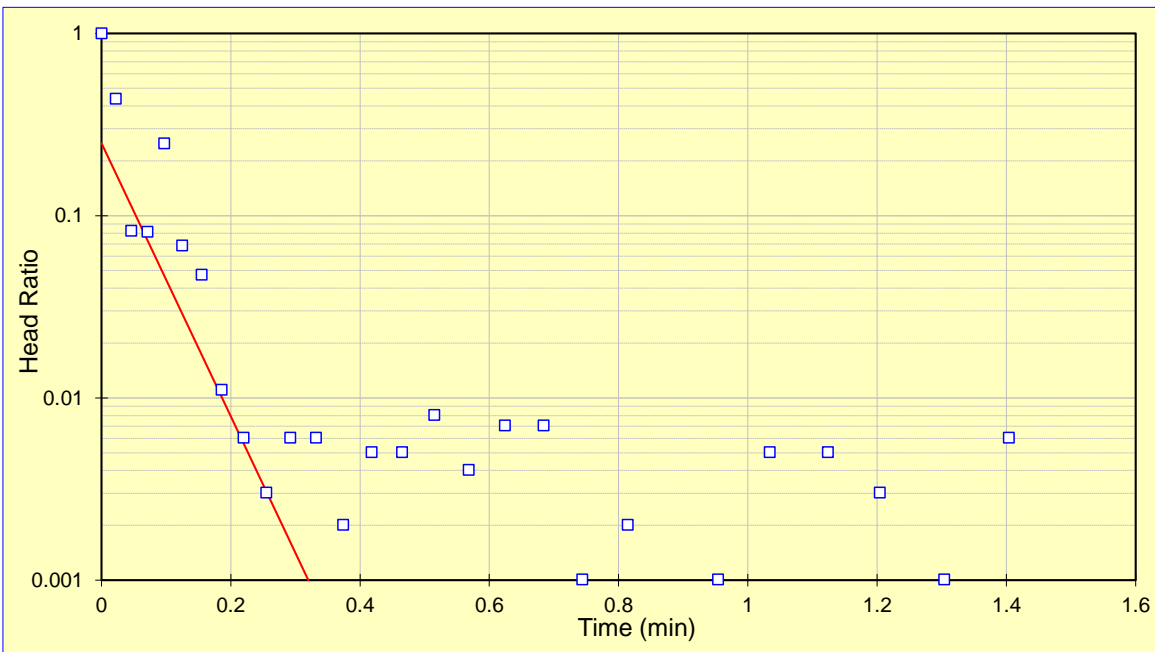
Analysis By: **DFS**  
 Checked By: **JRS**  
 Analysis Date: **7/31/2017**

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-15B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.03E-02 cm/sec</b>  <b>K= 2.91E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.32$	
$h_1/h_0 = 0.25$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-15B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

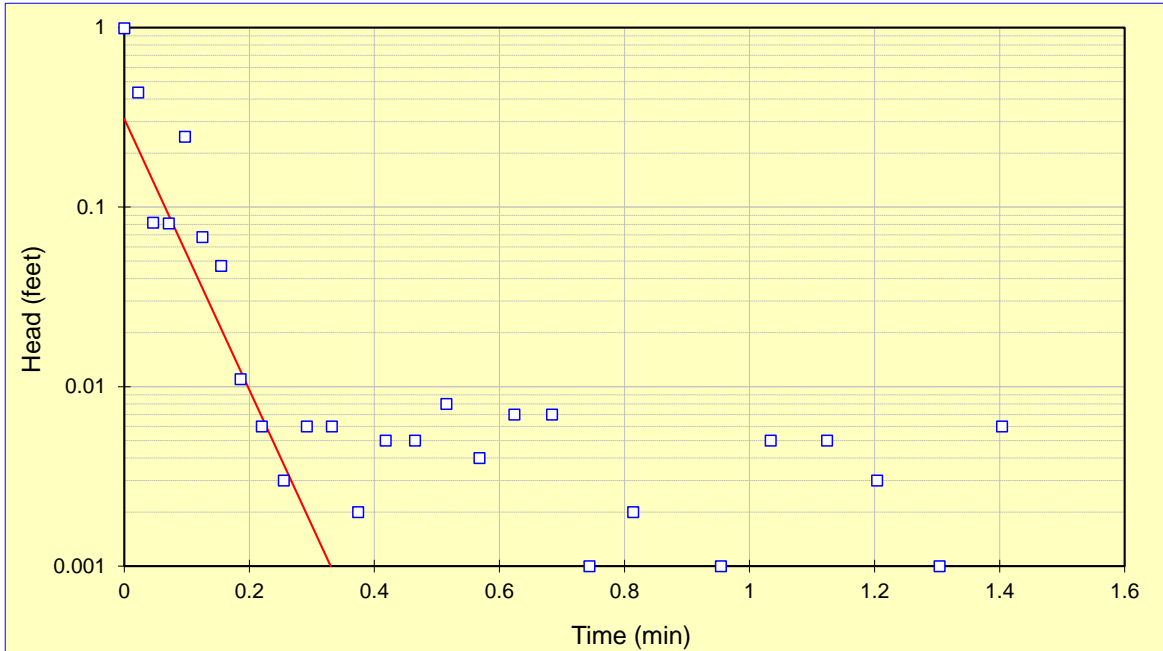
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 8.75E-03 cm/sec</b>  <b>K= 2.48E+01 ft/day</b> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.85$	
$y_0 = 0.31$	
$y_t = 0.001$	
$t = 0.3$	



Project Name: NIPSCO Schahfer  
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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

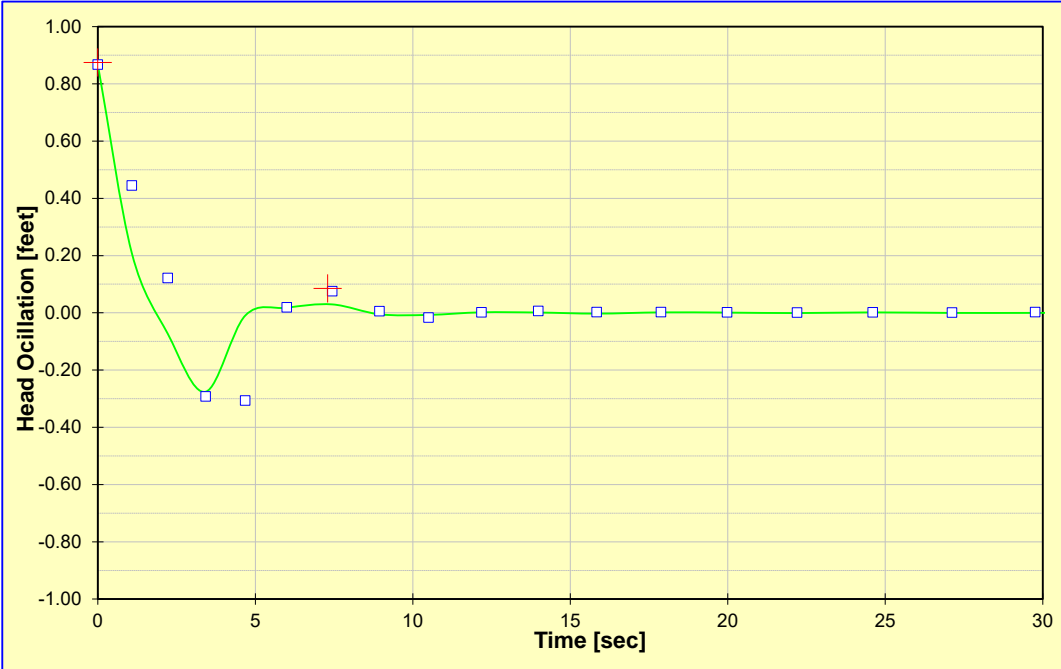
**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-15B (TEST 1)**

$T = b + a \ln T$	<p><i>where:</i></p> $b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$ $a = r_c^2 (g/L^{1/2}) / 8d$ $d = \gamma / (g/L)^{1/2}$ $L = g / (\omega^2 + \gamma^2)$
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INPUT PARAMETERS					
$r_c =$	<b>0.08</b>	ft	$(g/L)^{1/2} =$	<b>0.91806</b>	ft <sup>2</sup>
$r_s =$	<b>0.08</b>	ft	$d =$	<b>0.3479</b>	ft <sup>-1</sup>
$L_c =$	<b>19.23</b>	ft	$a =$	<b>0.00229</b>	ft <sup>3</sup>
$L_s =$	<b>10.00</b>	ft	$t_1 =$	<b>0.00</b>	sec
$w =$	<b>0.8607</b>	ft <sup>-1</sup>	$t_2 =$	<b>7.30</b>	sec
$g =$	<b>0.3194</b>	ft <sup>-1</sup>	$h(t_1) =$	<b>0.88</b>	ft
$L =$	<b>38.19</b>	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	<b>0.09</b>	ft
$g =$	<b>32.19</b>	ft/sec <sup>2</sup>	$S =$	<b>1.00E-02</b>	dim

RESULTS					
$b = T_0 =$	<b>2.27E-02</b>	ft <sup>2</sup> /sec	$a < 0.1?$	<b>YES</b>	
$T =$	<b>1.27E-02</b>	ft <sup>2</sup> /sec	$d < 0.7?$	<b>YES</b>	
$T =$	<b>1.09E+03</b>	ft <sup>2</sup> /day	$L_1 =$	<b>38.19</b>	
$K =$	<b>3.50E+01</b>	ft/day	$L_2 =$	<b>24.23</b>	
$K =$	<b>1.24E-02</b>	cm/sec	$L_1 : L_2 \text{ Diff} < 20\% ?$	<b>NO</b>	



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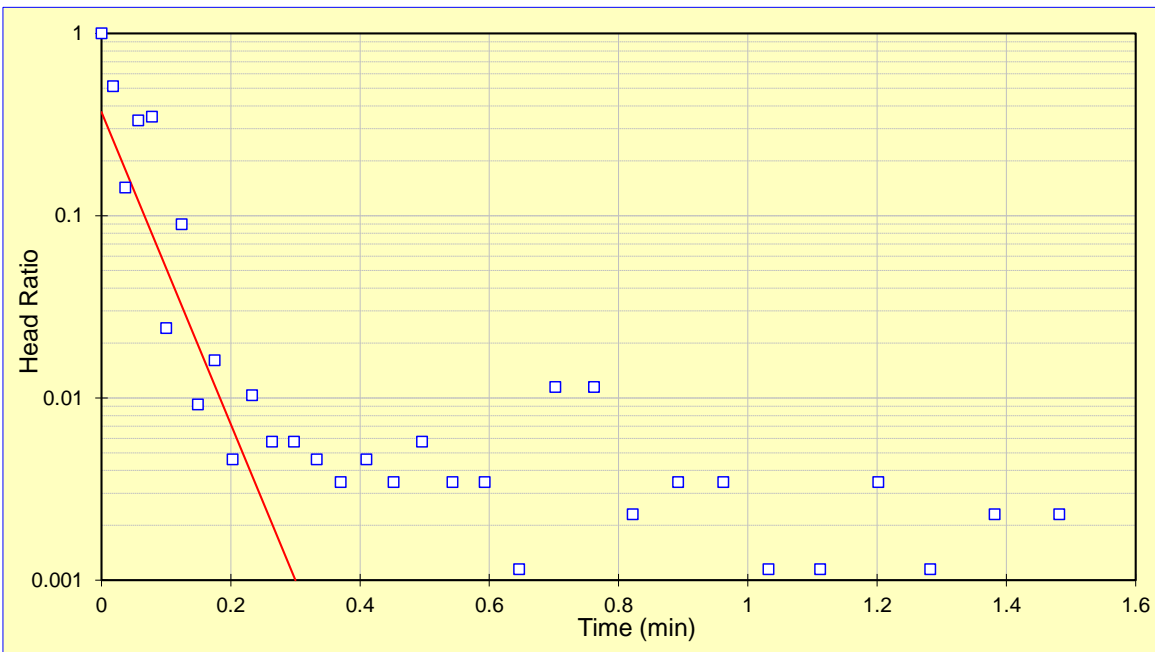
Analysis By: **DFS**  
 Checked By: **JRS**  
 Analysis Date: **7/31/2017**

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.17E-02 cm/sec</b>  <b>K= 3.32E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.3$	
$h_1/h_0 = 0.37$	
$h_2/h_0 = 0.00$	



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 Checked By: JRS  
 Analysis Date: 7/27/2016



**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

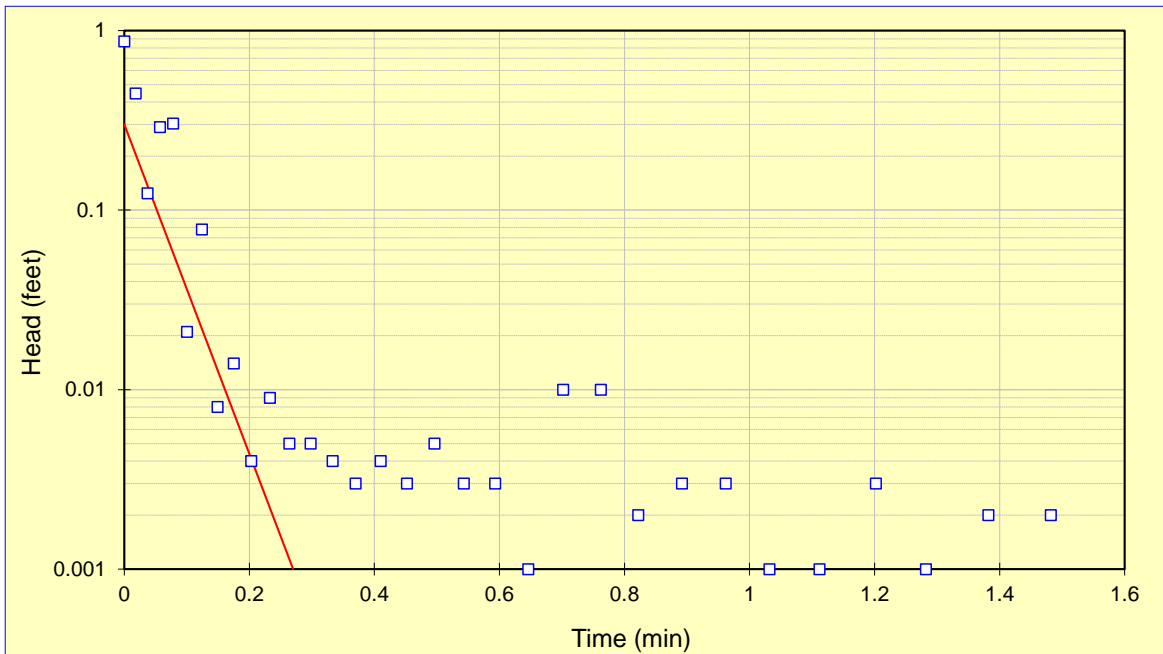
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 1.06E-02</math> cm/sec  <math>K = 3.02E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.85$	
$y_0 = 0.30$	
$y_t = 0.001$	
$t = 0.3$	



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 Test Date: 07/08/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-15B (TEST 2)**

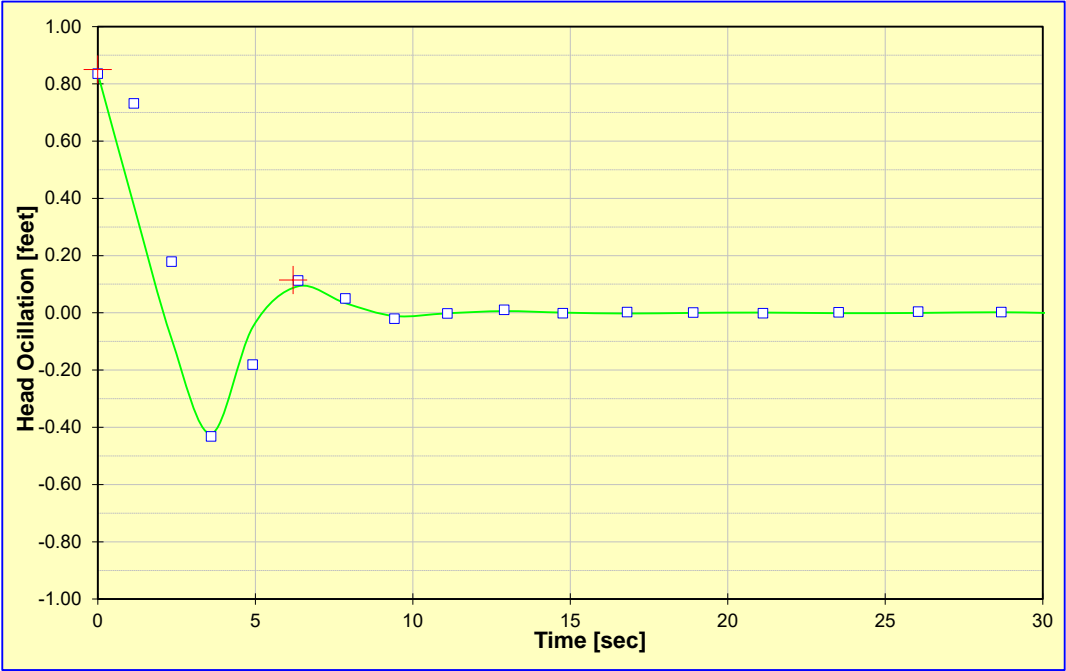
$$T = b + a \ln T$$

where:  $b = -a \ln [0.79 r_s^2 S (g/L)^{1/2}]$   
 $a = r_c^2 (g/L^{1/2}) / 8d$   
 $d = \gamma / (g/L)^{1/2}$   
 $L = g / (\omega^2 + \gamma^2)$

INPUT PARAMETERS					
$r_c =$	0.08	ft	$(g/L)^{1/2} =$	1.06353	ft <sup>2</sup>
$r_s =$	0.08	ft	$d =$	0.3034	ft <sup>-1</sup>
$L_c =$	19.22	ft	$a =$	0.00304	ft <sup>3</sup>
$L_s =$	10.00	ft	$t_1 =$	0.00	sec
$w =$	1.0134	ft <sup>-1</sup>	$t_2 =$	6.20	sec
$g =$	0.3226	ft <sup>-1</sup>	$h(t_1) =$	0.85	ft
$L =$	28.46	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	0.12	ft
$g =$	32.19	ft/sec <sup>2</sup>	$S =$	1.00E-02	dim

RESULTS				
$b = T_0 =$	2.97E-02	ft <sup>2</sup> /sec	$a < 0.1?$	YES
$T =$	1.73E-02	ft <sup>2</sup> /sec	$d < 0.7?$	YES
$T =$	1.50E+03	ft <sup>2</sup> /day	$L_1 =$	28.46
$K =$	4.80E+01	ft/day	$L_2 =$	24.22
$K =$	1.69E-02	cm/sec	$L_1 : L_2$ Diff < 20% ?	YES



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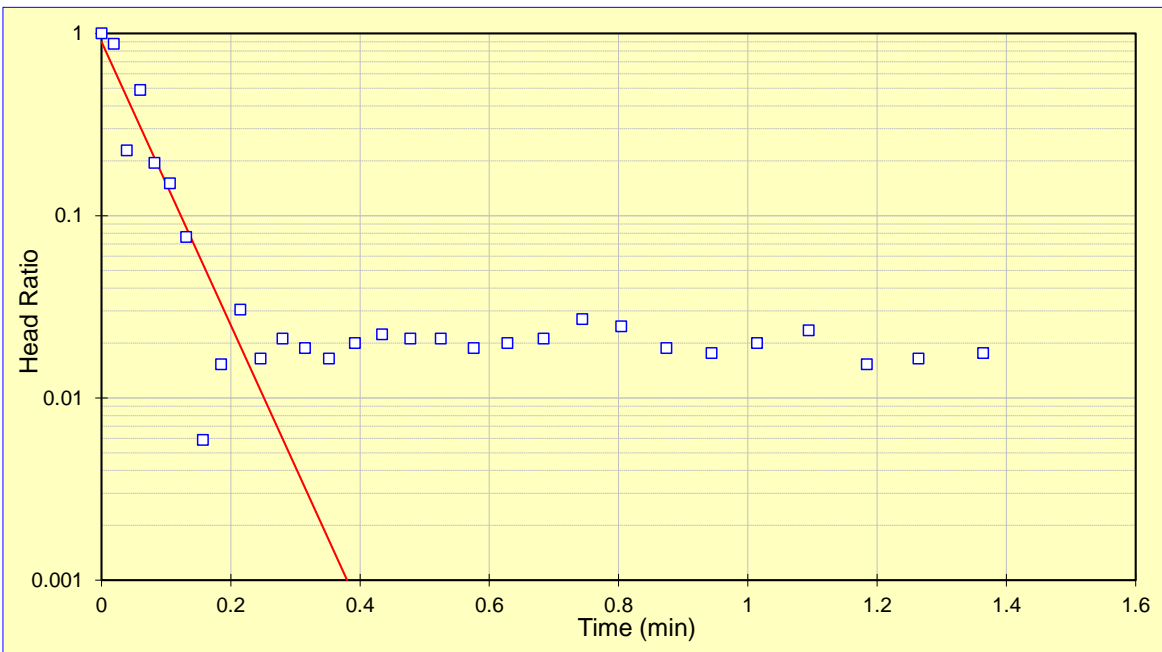
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/31/2017

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     K= 1.06E-02 cm/sec                      K= 3.02E+01 ft/day                 </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.38$	
$h_1/h_0 = 0.90$	
$h_2/h_0 = 0.00$	



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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-15B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

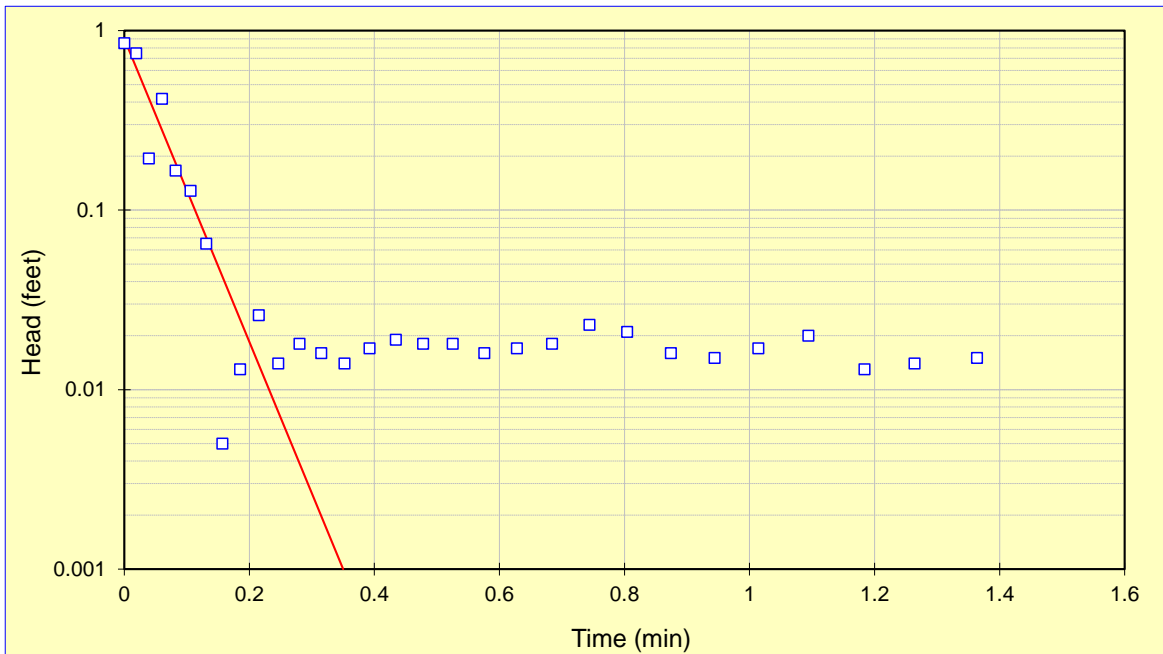
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	$K = 9.79E-03 \text{ cm/sec}$ $K = 2.77E+01 \text{ ft/day}$
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 2.85$	
$y_0 = 0.90$	
$y_t = 0.001$	
$t = 0.4$	



Project Name: NIPSCO Schahfer  
 Project No.: 164-8171  
 Test Date: 07/08/16

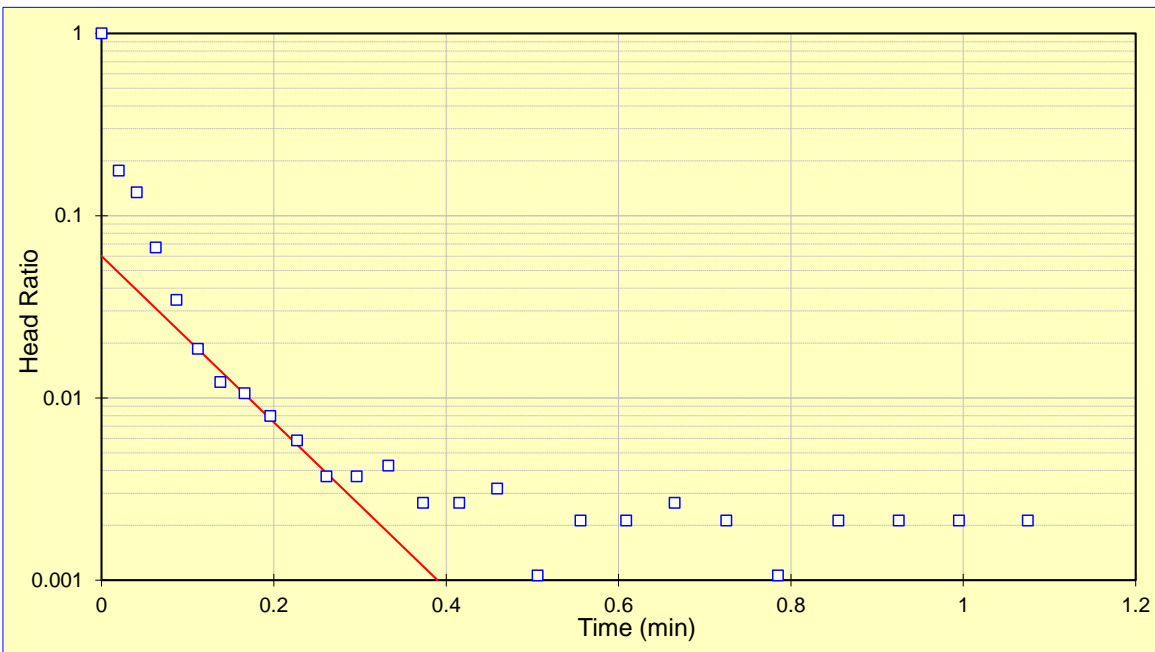
Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19 (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 3.70E-02 cm/sec</b>  <b>K= 1.05E+02 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 9.705$	
$t_1 = 0$	
$t_2 = 0.39$	
$h_1/h_0 = 0.06$	
$h_2/h_0 = 0.00$	



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 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19 (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

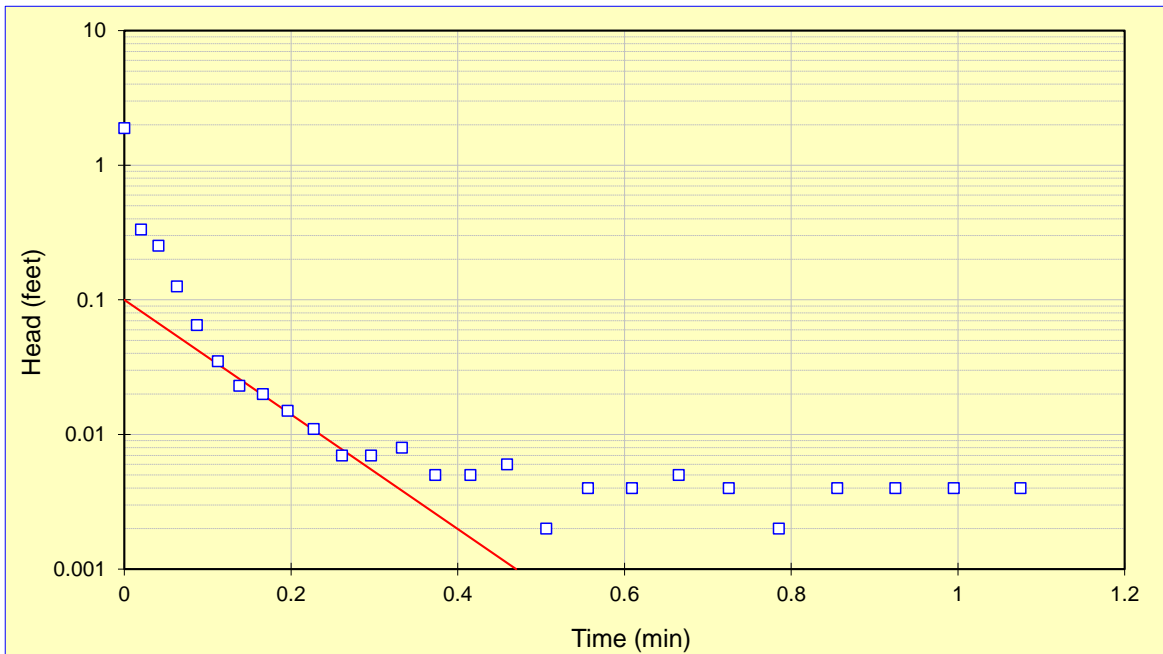
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 2.25E-02</math> cm/sec  <math>K = 6.38E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 9.705$	
$\ln(R_e/r_w) = 2.18$	
$y_0 = 0.10$	
$y_t = 0.001$	
$t = 0.5$	



Project Name: NIPSCO Schahfer  
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 Checked By: JRS  
 Analysis Date: 7/27/2016

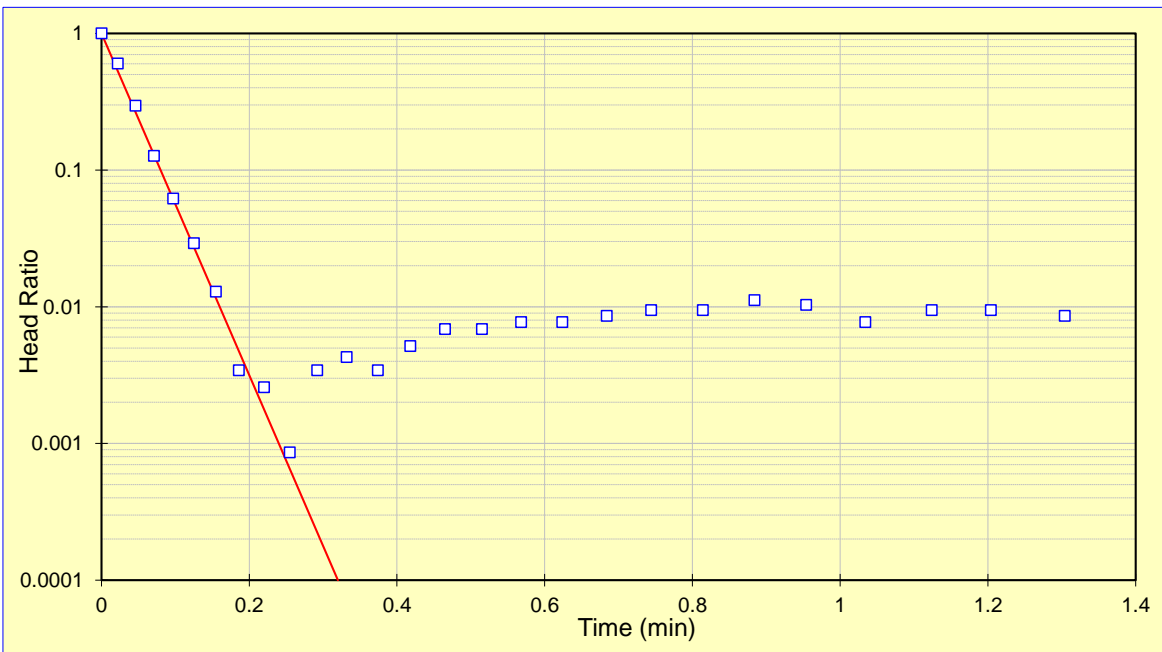


**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19 (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.20$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.01E-01 cm/sec</b>  <b>K= 2.87E+02 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 9.735$	
$t_1 = 0$	
$t_2 = 0.32$	
$h_1/h_0 = 1.00$	
$h_2/h_0 = 0.00$	



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Analysis By: DFS  
 Checked By: JRS  
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**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19 (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

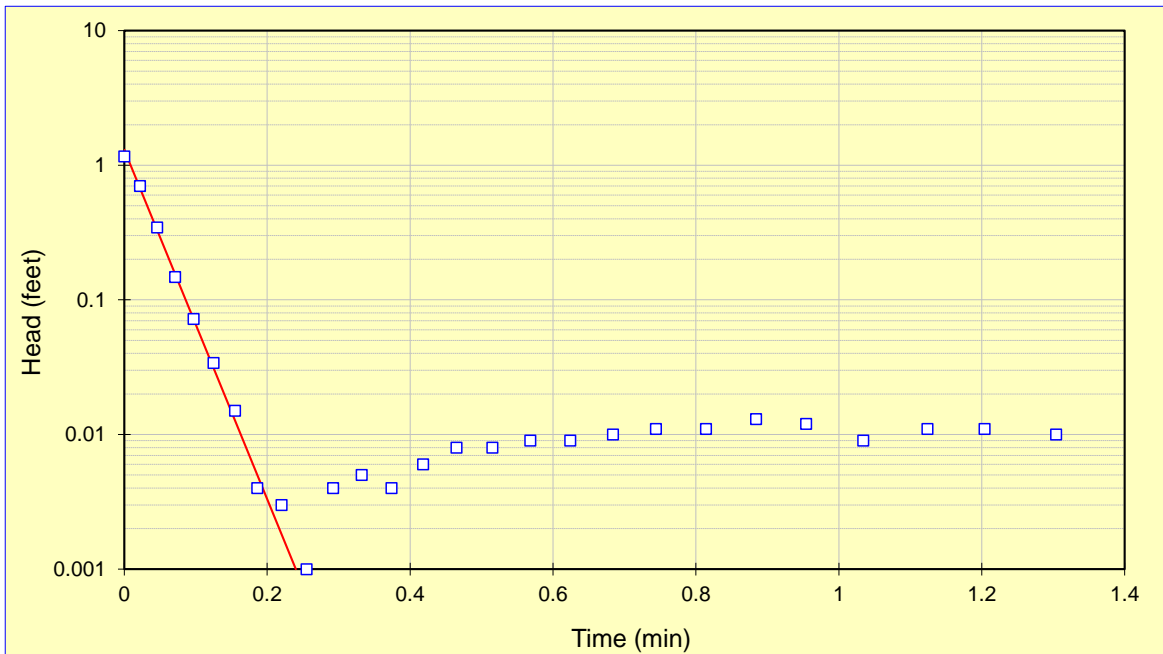
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS				
$r_c = 0.20$	<table border="1"> <tr> <td>K=</td> <td>6.85E-02 cm/sec</td> </tr> <tr> <td>K=</td> <td>1.94E+02 ft/day</td> </tr> </table>	K=	6.85E-02 cm/sec	K=	1.94E+02 ft/day
K=		6.85E-02 cm/sec			
K=		1.94E+02 ft/day			
$r_w = 0.34$					
$L_e = 9.735$					
$\ln(R_e/r_w) = 2.18$					
$y_0 = 1.30$					
$y_t = 0.001$					
$t = 0.2$					



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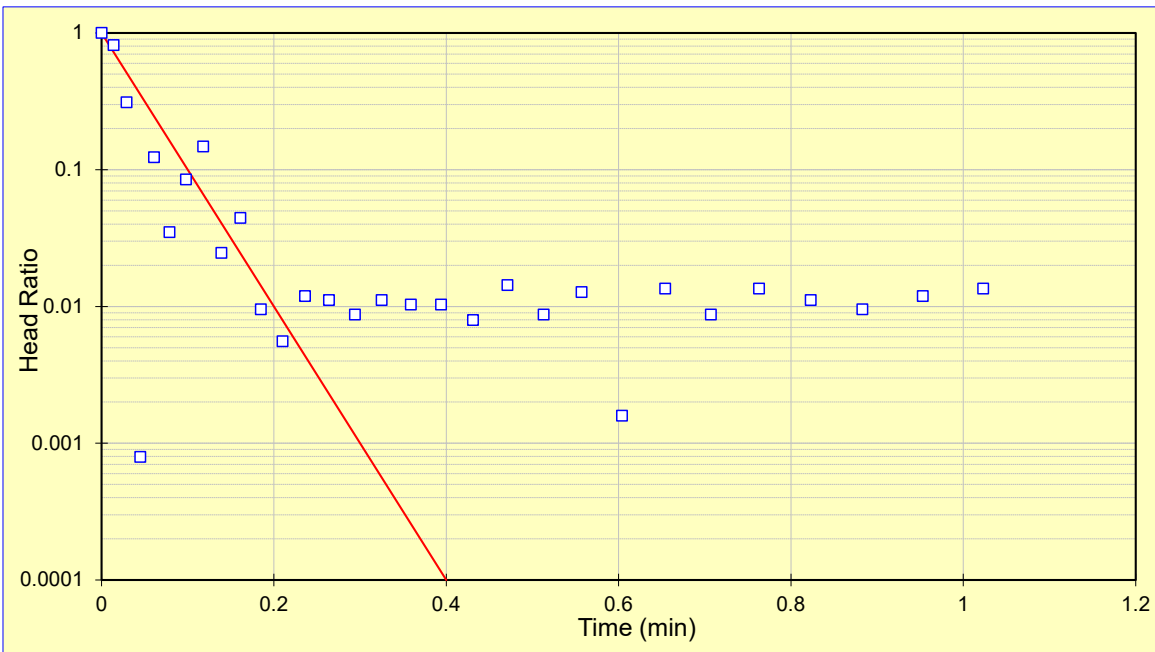
Analysis By: DFS  
Checked By: JRS  
Analysis Date: 7/27/2016

**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-19B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 1.37E-02</math> cm/sec  <math>K = 3.88E+01</math> ft/day                 </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.4$	
$h_1/h_0 = 1.00$	
$h_2/h_0 = 0.00$	



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 Checked By: JRS  
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**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-19B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

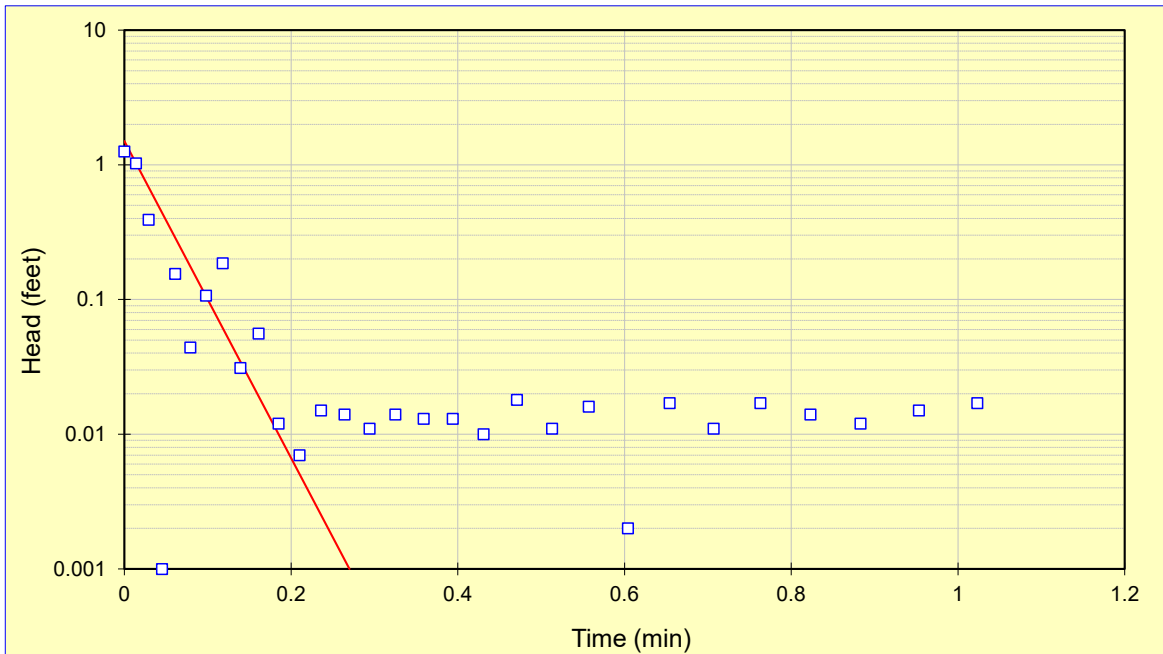
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 1.44E-02</math> cm/sec <math>K = 4.09E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.02$	
$y_0 = 1.50$	
$y_t = 0.001$	
$t = 0.3$	



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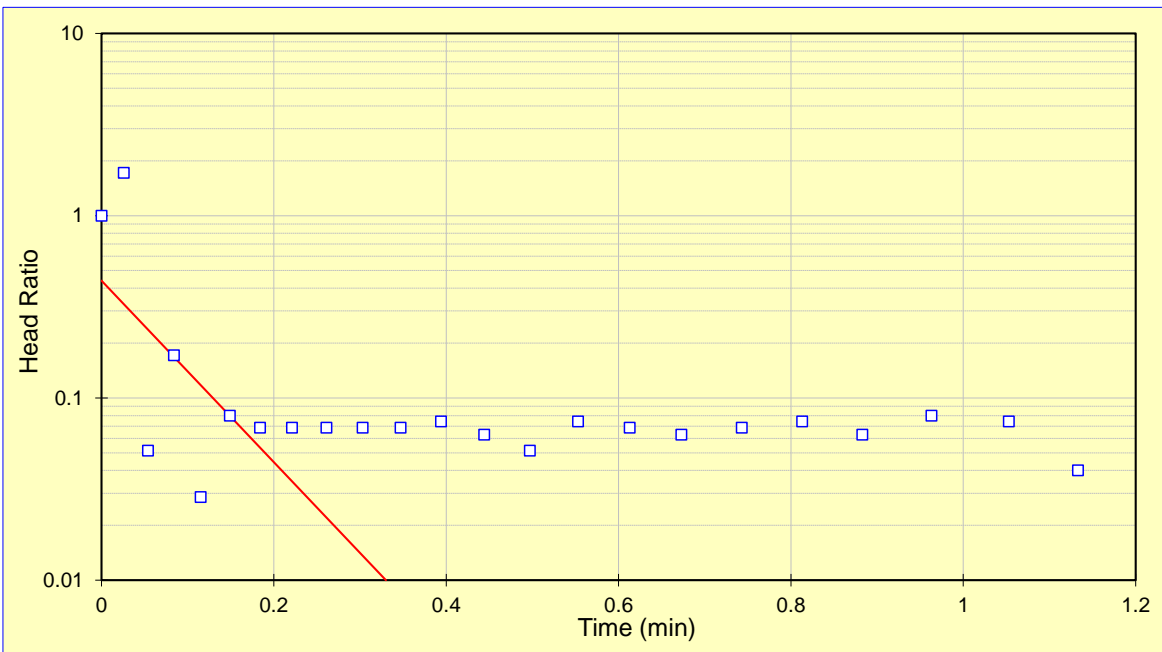


**HVORSLEV SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-19B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>K = 6.82E-03 \text{ cm/sec}</math>  <math>K = 1.93E+01 \text{ ft/day}</math> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.33$	
$h_1/h_0 = 0.44$	
$h_2/h_0 = 0.01$	



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 Test Date: 07/07/16

Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
FALLING HEAD TEST GAMW-19B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

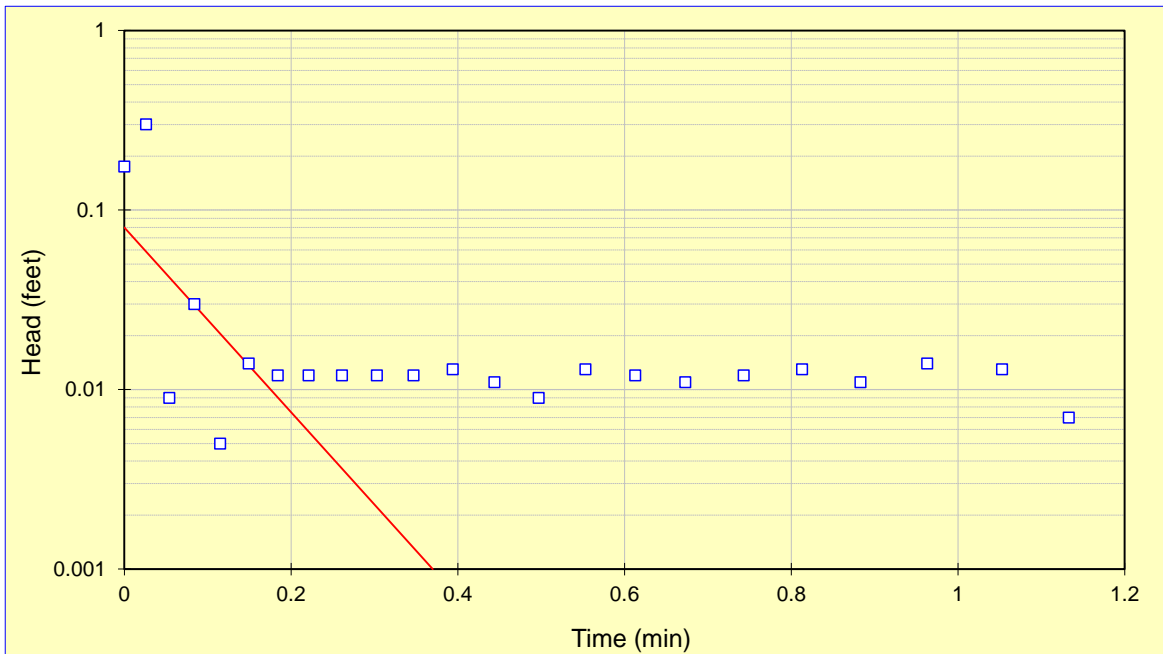
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><math>K = 6.31E-03</math> cm/sec  <math>K = 1.79E+01</math> ft/day</p> </div>
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.02$	
$y_0 = 0.08$	
$y_t = 0.001$	
$t = 0.4$	



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 Checked By: JRS  
 Analysis Date: 7/27/2016

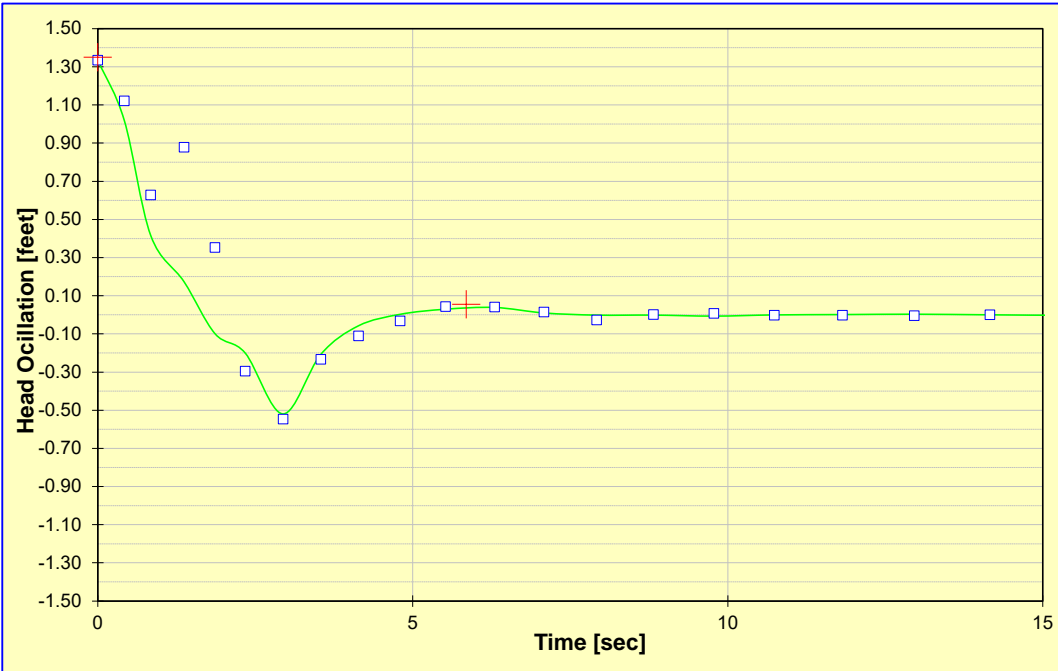
**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-19B (TEST 1)**

$T = b + a \ln T$	<p><i>where:</i></p> $b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$ $a = r_c^2 (g/L^{1/2}) / 8d$ $d = \gamma / (g/L)^{1/2}$ $L = g / (\omega^2 + \gamma^2)$
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INPUT PARAMETERS					
$r_c =$	<b>0.08</b>	ft	$(g/L)^{1/2} =$	<b>1.20536</b>	ft <sup>2</sup>
$r_s =$	<b>0.08</b>	ft	$d =$	<b>0.4539</b>	ft <sup>-1</sup>
$L_c =$	<b>17.92</b>	ft	$a =$	<b>0.00231</b>	ft <sup>3</sup>
$L_s =$	<b>10.00</b>	ft	$t_1 =$	<b>0.00</b>	sec
$w =$	<b>1.0740</b>	ft <sup>-1</sup>	$t_2 =$	<b>5.85</b>	sec
$g =$	<b>0.5471</b>	ft <sup>-1</sup>	$h(t_1) =$	<b>1.35</b>	ft
$L =$	<b>22.16</b>	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	<b>0.06</b>	ft
$g =$	<b>32.19</b>	ft/sec <sup>2</sup>	$S =$	<b>1.00E-02</b>	dim

RESULTS					
$b = T_0 =$	<b>2.22E-02</b>	ft <sup>2</sup> /sec	$a < 0.1?$	<b>YES</b>	
$T =$	<b>1.20E-02</b>	ft <sup>2</sup> /sec	$d < 0.7?$	<b>YES</b>	
$T =$	<b>1.04E+03</b>	ft <sup>2</sup> /day	$L_1 =$	<b>22.16</b>	
$K =$	<b>3.67E+01</b>	ft/day	$L_2 =$	<b>22.92</b>	
$K =$	<b>1.29E-02</b>	cm/sec	$L_1 : L_2 \text{ Diff} < 20\% ?$	<b>YES</b>	



Project Name: **NIPSCO RMSGS**  
 Project No.: **164-8171**  
 Test Date: **07/07/16**

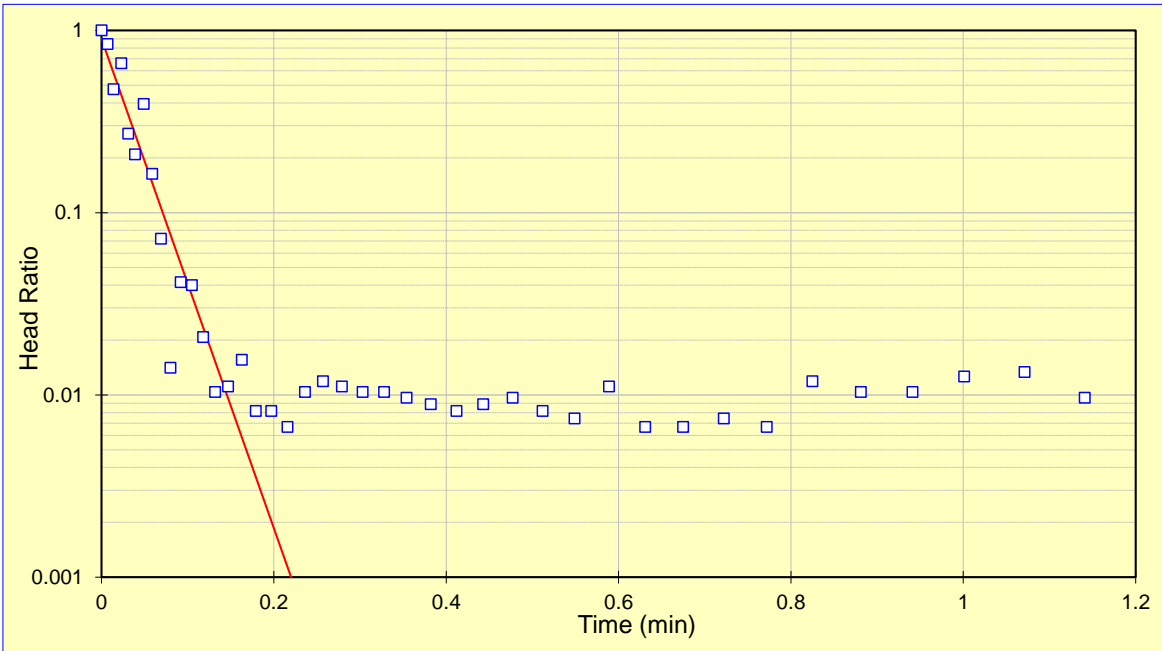
Analysis By: **DFS**  
 Checked By: **JRS**  
 Analysis Date: **7/31/2017**

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19B (TEST 1)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>K= 1.84E-02 cm/sec</b>  <b>K= 5.21E+01 ft/day</b> </div>
$R_e = 0.34$	
$L_e = 10$	
$t_1 = 0$	
$t_2 = 0.22$	
$h_1/h_0 = 0.90$	
$h_2/h_0 = 0.00$	



Project Name: NIPSCO Schahfer  
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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19B (TEST 1)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

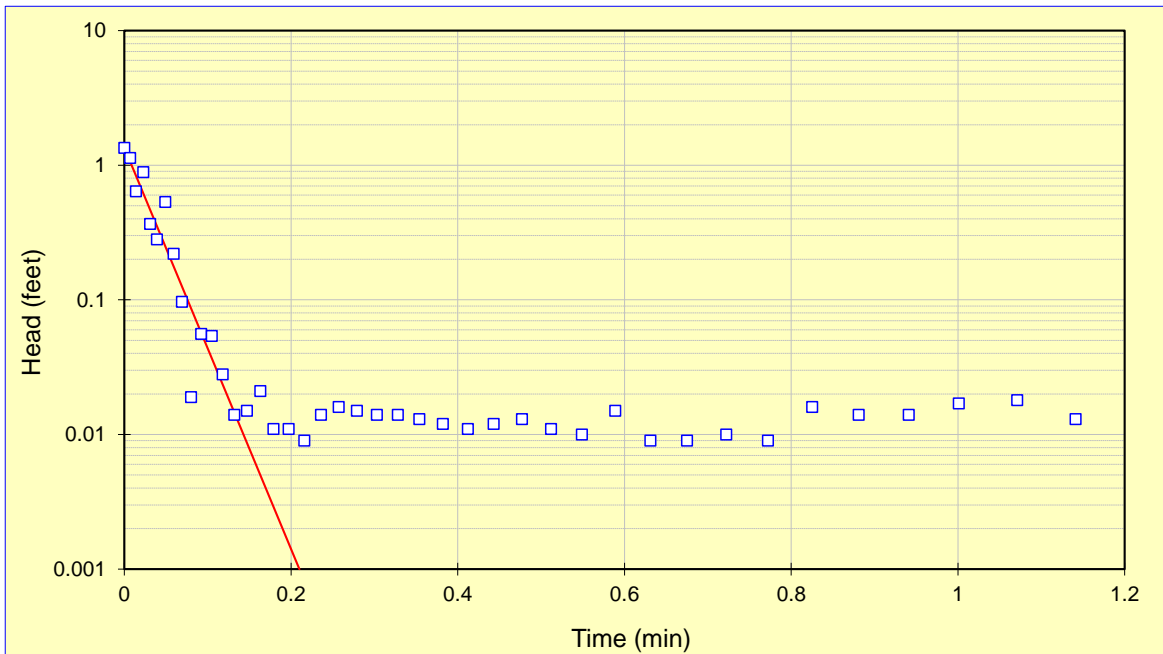
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	$K = 1.83E-02 \text{ cm/sec}$ $K = 5.18E+01 \text{ ft/day}$
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.02$	
$y_0 = 1.35$	
$y_t = 0.001$	
$t = 0.2$	



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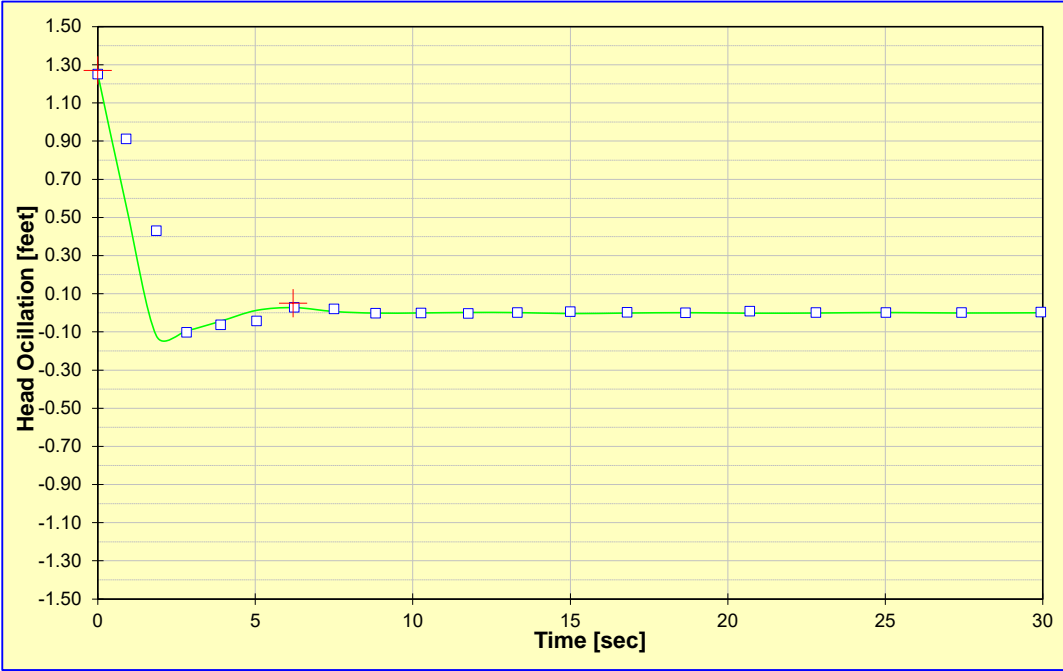
**van der KAMP RISING HEAD SLUG TEST ANALYSIS  
UNDERDAMPED SLUG TEST GAMW-19B (TEST 2)**

$T = b + a \ln T$	<p><i>where:</i></p> $b = -a \ln \left[ 0.79 r_s^2 S (g/L)^{1/2} \right]$ $a = r_c^2 (g/L^{1/2}) / 8d$ $d = \gamma / (g/L)^{1/2}$ $L = g / (\omega^2 + \gamma^2)$
-------------------	---

INPUT PARAMETERS					
$r_c =$	<b>0.08</b>	ft	$(g/L)^{1/2} =$	<b>1.13983</b>	ft <sup>2</sup>
$r_s =$	<b>0.08</b>	ft	$d =$	<b>0.4577</b>	ft <sup>-1</sup>
$L_c =$	<b>17.95</b>	ft	$a =$	<b>0.00216</b>	ft <sup>3</sup>
$L_s =$	<b>10.00</b>	ft	$t_1 =$	<b>0.00</b>	sec
$w =$	<b>1.0134</b>	ft <sup>-1</sup>	$t_2 =$	<b>6.20</b>	sec
$g =$	<b>0.5217</b>	ft <sup>-1</sup>	$h(t_1) =$	<b>1.27</b>	ft
$L =$	<b>24.78</b>	ft <sup>3</sup> /sec <sup>2</sup>	$h(t_2) =$	<b>0.05</b>	ft
$g =$	<b>32.19</b>	ft/sec <sup>2</sup>	$S =$	<b>1.00E-02</b>	dim

RESULTS				
$b = T_0 =$	<b>2.09E-02</b>	ft <sup>2</sup> /sec	$a < 0.1?$	<b>YES</b>
$T =$	<b>1.12E-02</b>	ft <sup>2</sup> /sec	$d < 0.7?$	<b>YES</b>
$T =$	<b>9.69E+02</b>	ft <sup>2</sup> /day	$L_1 =$	<b>24.78</b>
$K =$	<b>3.43E+01</b>	ft/day	$L_2 =$	<b>22.95</b>
$K =$	<b>1.21E-02</b>	cm/sec	$L_1 : L_2$ Diff < 20% ?	<b>YES</b>



Project Name: **NIPSCO RMSGS**  
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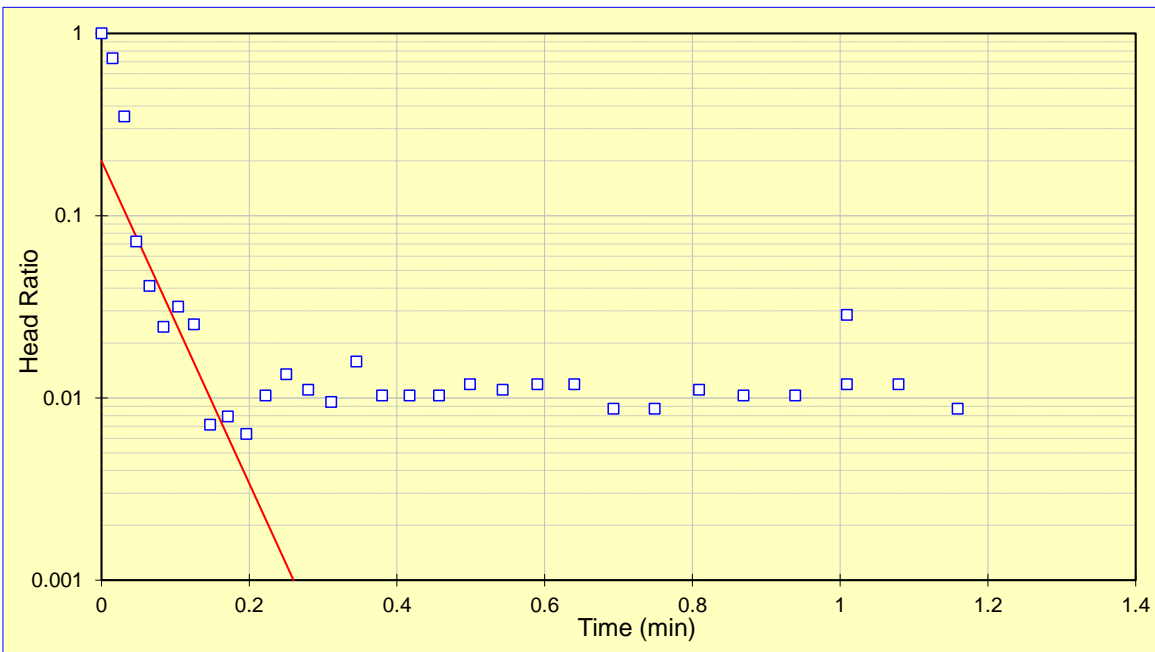
Analysis By: **DFS**  
 Checked By: **JRS**  
 Analysis Date: **7/31/2017**

**HVORSLEV SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19B (TEST 2)**

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[ \frac{\ln \left( \frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] 30.48$$

where:  $r_c$  = casing radius (feet)  
 $R_e$  = equivalent radius (feet)  
 $L_e$  = length of screened interval (feet)  
 $t$  = time (minutes)  
 $h_t$  = head at time  $t$  (feet)

INPUT PARAMETERS	RESULTS				
$r_c = 0.08$	<table border="1"> <tr> <td>K=</td> <td>1.21E-02 cm/sec</td> </tr> <tr> <td>K=</td> <td>3.43E+01 ft/day</td> </tr> </table>	K=	1.21E-02 cm/sec	K=	3.43E+01 ft/day
K=		1.21E-02 cm/sec			
K=		3.43E+01 ft/day			
$R_e = 0.34$					
$L_e = 10$					
$t_1 = 0$					
$t_2 = 0.26$					
$h_1/h_0 = 0.20$					
$h_2/h_0 = 0.00$					



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Analysis By: DFS  
 Checked By: JRS  
 Analysis Date: 7/27/2016

**BOUWER AND RICE SLUG TEST ANALYSIS  
RISING HEAD TEST GAMW-19B (TEST 2)**

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

$r_c$  = casing radius (feet);

$R_e$  = effective radius (feet);

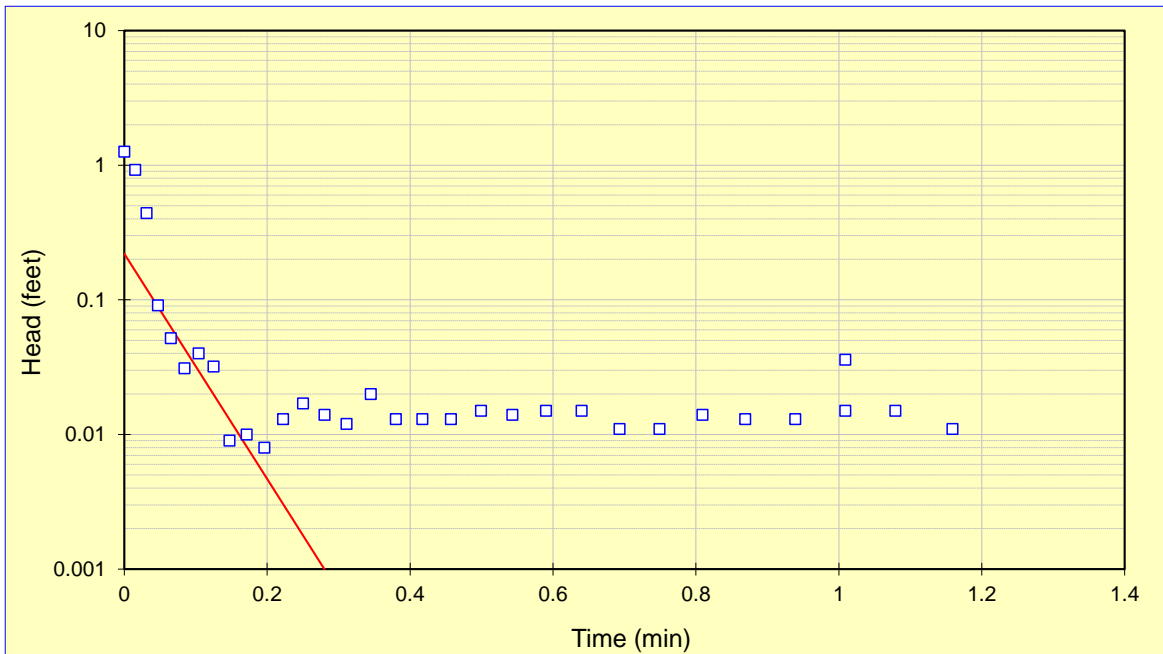
$L_e$  = length of screened interval (feet);

$r_w$  = radial distance to undisturbed aquifer (feet)

$y_0$  = initial drawdown (feet)

$y_t$  = drawdown (feet) at time t (minutes)

INPUT PARAMETERS	RESULTS
$r_c = 0.08$	$K = 1.03E-02$ cm/sec $K = 2.91E+01$ ft/day
$r_w = 0.34$	
$L_e = 10$	
$\ln(R_e/r_w) = 3.02$	
$y_0 = 0.22$	
$y_t = 0.001$	
$t = 0.3$	



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 Checked By: JRS  
 Analysis Date: 7/27/2016

**APPENDIX C**

# Vertical Gradient Calculation

Appendix C  
VERTICAL GRADIENT FLOW CALCULATIONS

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				June 13, 2016				July 11, 2016				September 6, 2016				November 7, 2016			
			Top (ft-bgs)	Bottom (ft-bgs)	Center (ft bgs)	Center (ft msl)	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction
GAMW07	666.55	669.89	5	15	10	656.55	10.17	659.72	NA	NA	10.48	659.41	NA	NA	8.57	661.32	NA	NA	7.88	662.01	-1.08E-01	Down
GAMW07B	666.83	669.39	30	40	35	631.83	-	-	-	-	-	-	-	-	-	-	-	-	10.04	659.35	-	-
GAMW08	665.95	669.66	5	15	10	655.95	8.91	660.75	NA	NA	-	-	NA	NA	9.86	659.80	NA	NA	10.40	659.26	-3.95E-02	Down
GAMW08B	665.92	668.47	26	36	31	634.92	-	-	-	-	-	-	-	-	-	-	-	-	10.04	658.43	-	-
GAMW09	665.1	668.99	5	15	10	655.51	9.02	659.97	-	-	10.09	658.90	-	-	8.41	660.58	-	-	8.92	660.07	-	-
GAMW09B	665.35	668.29	24.5	34.5	29.5	635.87	8.75	659.54	-2.19E-02	Down	9.81	658.48	-2.14E-02	Down	8.15	660.14	-2.24E-02	Down	8.68	659.61	-2.34E-02	Down
GAMW15	665.01	668.25	5	15	10	654.54	8.59	659.66	-	-	8.82	659.43	0.00E+00	Up	7.32	660.93	1.97E-03	Up	6.76	661.49	0.00E+00	Up
GAMW15B	665.14	668.05	27.7	37.7	32.7	634.19	8.40	659.65	-4.91E-04	Down	8.62	659.43	-	-	7.08	660.97	-	-	6.56	661.49	-	-
GAMW16	665.2	668.37	5	15	10	655.17	9.21	659.16	-	-	9.61	658.76	4.44E-04	Up	8.08	660.29	4.44E-04	Up	8.24	660.13	4.39E-02	Up
GAMW16B	665.16	667.76	27.75	37.75	32.75	632.63	8.90	658.86	-1.33E-02	Down	8.99	658.77	-	-	7.46	660.30	-	-	6.64	661.12	-	-
GAMW17	668.81	671.93	5	15	10	658.93	13.13	658.80	-	-	9.72	662.21	-	-	12.05	659.88	-	-	12.60	659.33	-	-
GAMW17B	668.86	670.6	28	38	33	635.26	11.79	658.81	4.22E-04	Up	12.31	658.29	-1.66E-01	Down	10.73	659.87	-4.22E-04	Down	11.28	659.32	-4.22E-04	Down
GAMW18	666.04	669.07	5	15	10	656.04	8.75	660.32	-	-	9.96	659.11	-	-	8.44	660.63	-	-	8.86	660.21	-8.86E-02	Down
GAMW18B	665.94	668.47	25	35	30	635.94	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	10.04	658.43	-	-
GAMW46	661.99	664.80	5	15	10	651.99	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.04	657.76	-	-
GAMW46B	661.98	664.79	22	32	27	634.98	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.05	657.74	-1.18E-03	Down
GAMW52	664.07	666.79	5	15	10	654.07	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.04	659.75	4.64E-03	Up
GAMW52B	664.50	666.90	27	37	32	632.50	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.05	659.85	-	-
GAMW53	664.68	667.24	5	15	10	654.68	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	6.05	661.19	1.42E-03	Up
GAMW53B	664.62	667.29	26	36	31	633.62	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	6.07	661.22	-	-
GAMW54	663.87	666.37	5	15	10	653.87	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	6.05	660.32	4.74E-03	Up
GAMW54B	663.98	666.47	22	32	27	636.98	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	6.07	660.40	-	-
GAMW55	665.06	667.64	5	15	10	655.06	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	10.04	657.60	-1.56E-02	Down
GAMW55B	665.18	667.53	25	35	30	635.18	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	10.24	657.29	-	-
GAMW56	665.43	667.91	5	15	10	655.43	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.04	660.87	-4.98E-03	Down
GAMW56B	665.33	667.82	25	35	30	635.33	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA	7.05	660.77	-	-

Notes:  
ft-bgs = Feet below ground surface  
ft-msl = Feet above mean sea level  
ft-btoc = Feet below top of casing  
ft/ft = Feet/Feet  
NA= not applicable



Appendix C  
VERTICAL GRADIENT FLOW CALCULATIONS

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				January 4, 2017				February 27, 2017				April 24, 2017				June 26, 2017			
			Top (ft-bgs)	Bottom (ft-bgs)	Center (ft bgs)	Center (ft msl)	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction
GAMW07	666.55	669.89	5	15	10	656.55	10.09	659.80	-1.62E-03	Down	8.82	661.07	-6.67E-02	Down	8.56	661.33	NA	NA	9.52	660.37	NA	NA
GAMW07B	666.83	669.39	30	40	35	631.83	9.63	659.76			9.97	659.42			-	-			-	-		
GAMW08	665.95	669.66	5	15	10	655.95	10.82	658.84	5.41E-15	Up	10.62	659.04	-2.57E-02	Down	9.71*	659.95	NA	NA	10.15	659.51	NA	NA
GAMW08B	665.92	668.47	26	36	31	634.92	9.63	658.84			9.97	658.50			-	-			-	-		
GAMW09	665.1	668.99	5	15	10	655.51	8.95	660.04			8.50	660.49	-2.09E-02	Down	7.59	661.40	-1.93E-02	Down	8.30	660.69	-2.14E-02	Down
GAMW09B	665.35	668.29	24.5	34.5	29.5	635.87	8.66	659.63			8.21	660.08			7.27	661.02			8.02	660.27		
GAMW15	665.01	668.25	5	15	10	654.54	8.63	659.62	0.00E+00	Up	7.35	660.90	4.91E-04	Up	7.00	661.25	1.47E-03	Up	8.00	660.25	0.00E+00	Up
GAMW15B	665.14	668.05	27.7	37.7	32.7	634.19	8.43	659.62			7.14	660.91			6.77	661.28			7.80	660.25		
GAMW16	665.2	668.37	5	15	10	655.17	9.18	659.19	4.44E-04	Up	8.66	659.71	2.22E-03	Up	7.87	660.50	8.87E-04	Up	8.72	659.65	1.33E-03	Up
GAMW16B	665.16	667.76	27.75	37.75	32.75	632.63	8.56	659.20			8.00	659.76			7.24	660.52			8.08	659.68		
GAMW17	668.81	671.93	5	15	10	658.93	NA	-	NA	NA	12.67	659.26	0.00E+00	Up	11.75	660.18	8.45E-04	Up	12.30	659.63	1.65E-02	Up
GAMW17B	668.86	670.6	28	38	33	635.26	11.62	658.98			11.34	659.26			10.40	660.20			10.58	660.02		
GAMW18	666.04	669.07	5	15	10	656.04	8.96	660.11	-6.32E-02	Down	8.55	660.52	-1.00E-01	Down	7.45	661.62	NA	NA	8.55	660.52	NA	NA
GAMW18B	665.94	668.47	25	35	30	635.94	9.63	658.84			9.97	658.50			-	-			-	-		
GAMW46	661.99	664.80	5	15	10	651.99	6.75	658.05	-5.88E-04	Down	7.05	657.75	5.88E-04	Up	-	-	NA	NA	-	-	NA	NA
GAMW46B	661.98	664.79	22	32	27	634.98	6.75	658.04			7.03	657.76			-	-			-	-		
GAMW52	664.07	666.79	5	15	10	654.07	6.75	660.04	5.10E-03	Up	7.05	659.74	6.03E-03	Up	-	-	NA	NA	-	-	NA	NA
GAMW52B	664.50	666.90	27	37	32	632.50	6.75	660.15			7.03	659.87			-	-			-	-		
GAMW53	664.68	667.24	5	15	10	654.68	5.85	661.39	2.37E-03	Up	6.07	661.17	2.37E-03	Up	-	-	NA	NA	-	-	NA	NA
GAMW53B	664.62	667.29	26	36	31	633.62	5.85	661.44			6.07	661.22			-	-			-	-		
GAMW54	663.87	666.37	5	15	10	653.87	5.85	660.52	5.92E-03	Up	6.07	660.30	5.92E-03	Up	-	-	NA	NA	-	-	NA	NA
GAMW54B	663.98	666.47	22	32	27	636.98	5.85	660.62			6.07	660.40			-	-			-	-		
GAMW55	665.06	667.64	5	15	10	655.06	9.63	658.01	-1.56E-02	Down	9.97	657.67	-1.51E-02	Down	-	-	NA	NA	-	-	NA	NA
GAMW55B	665.18	667.53	25	35	30	635.18	9.83	657.70			10.16	657.37			-	-			-	-		
GAMW56	665.43	667.91	5	15	10	655.43	6.75	661.16	-4.48E-03	Down	7.05	660.86	-3.48E-03	Down	-	-	NA	NA	-	-	NA	NA
GAMW56B	665.33	667.82	25	35	30	635.33	6.75	661.07			7.03	660.79			-	-			-	-		

Notes:  
ft-bgs = Feet below ground surface  
ft-msl = Feet above mean sea level  
ft-btoc = Feet below top of casing  
ft/ft = Feet/Feet  
NA= not applicable

Appendix C  
VERTICAL GRADIENT FLOW CALCULATIONS

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				August 21, 2017				October 2, 2017				February 26, 2018				March 12, 2018			
			Top (ft-bgs)	Bottom (ft-bgs)	Center (ft bgs)	Center (ft msl)	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction
GAMW07	666.55	669.89	5	15	10	656.55	9.08	660.81	NA	NA	10.16	659.73	NA	NA	-	-	NA	NA	8.8	661.09	NA	NA
GAMW07B	666.83	669.39	30	40	35	631.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW08	665.95	669.66	5	15	10	655.95	10.15	659.51	NA	NA	NA	-	NA	NA	-	-	NA	NA	8.38	661.28	NA	NA
GAMW08B	665.92	668.47	26	36	31	634.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW09	665.1	668.99	5	15	10	655.51	8.11	660.88	-	-	10.06	658.93	-	-	-	-	NA	NA	6.23	662.76	-2.14E-02	Down
GAMW09B	665.35	668.29	24.5	34.5	29.5	635.87	7.85	660.44	-	-	9.81	658.48	-2.29E-02	Down	-	-	-	-	5.95	662.34	-	-
GAMW15	665.01	668.25	5	15	10	654.54	7.56	660.69	-	-	9.02	659.23	-	-	-	-	NA	NA	7.38	660.87	9.83E-04	Up
GAMW15B	665.14	668.05	27.7	37.7	32.7	634.19	7.33	660.72	1.47E-03	Up	8.77	659.28	2.46E-03	Up	-	-	-	-	7.16	660.89	-	-
GAMW16	665.2	668.37	5	15	10	655.17	8.45	659.92	-	-	10.56	657.81	-	-	-	-	NA	NA	7.38	660.99	4.44E-03	Up
GAMW16B	665.16	667.76	27.75	37.75	32.75	632.63	7.84	659.92	0.00E+00	Up	9.94	657.82	4.44E-04	Up	-	-	-	-	6.67	661.09	-	-
GAMW17	668.81	671.93	5	15	10	658.93	12.24	659.69	-	-	NA	-	-	-	-	-	NA	NA	10.45	661.48	4.80E-15	Up
GAMW17B	668.86	670.6	28	38	33	635.26	10.95	659.65	-1.69E-03	Down	13.33	657.27	-	-	-	-	-	-	9.12	661.48	-	-
GAMW18	666.04	669.07	5	15	10	656.04	8.23	660.84	-	-	10.03	659.04	-	-	-	-	NA	NA	6.3	662.77	-	-
GAMW18B	665.94	668.47	25	35	30	635.94	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW46	661.99	664.80	5	15	10	651.99	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW46B	661.98	664.79	22	32	27	634.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW52	664.07	666.79	5	15	10	654.07	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW52B	664.50	666.90	27	37	32	632.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW53	664.68	667.24	5	15	10	654.68	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW53B	664.62	667.29	26	36	31	633.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW54	663.87	666.37	5	15	10	653.87	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW54B	663.98	666.47	22	32	27	636.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW55	665.06	667.64	5	15	10	655.06	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW55B	665.18	667.53	25	35	30	635.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMW56	665.43	667.91	5	15	10	655.43	-	-	NA	NA	-	-	NA	NA	-	-	-	-	-	-	NA	NA
GAMW56B	665.33	667.82	25	35	30	635.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:  
 ft-bgs = Feet below ground surface  
 ft-msl = Feet above mean sea level  
 ft-btoc = Feet below top of casing  
 ft/ft = Feet/Feet  
 NA= not applicable

Appendix C  
VERTICAL GRADIENT FLOW CALCULATIONS

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				April 18, 2018				June 12, 2018				August 27-28, 2018				October 22-24, 2018			
			Top (ft-bgs)	Bottom (ft-bgs)	Center (ft bgs)	Center (ft msl)	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction
GAMW07	666.55	669.89	5	15	10	656.55	8.9	660.99	1.78E-01	Up	9.15	660.74	1.75E-01	Up	9.95	659.94	2.83E-03	Up	10.62	659.27	8.09E-04	Up
GAMW07B	666.83	669.39	30	40	35	631.83	4	665.39			4.32	665.07			9.38	660.01			10.1	659.29		
GAMW08	665.95	669.66	5	15	10	655.95	9.58	660.08	2.09E-01	Up	9.55	660.11	1.92E-01	Up	10.22	659.44	4.28E-03	Up	10.6	659.06	2.85E-03	Up
GAMW08B	665.92	668.47	26	36	31	634.92	4	664.47			4.32	664.15			8.94	659.53			9.35	659.12		
GAMW09	665.1	668.99	5	15	10	655.51	7.42	661.57	-2.04E-02	Down	7.5	661.49	-2.19E-02	Down	8.36	660.63	-2.04E-02	Down	8.65	660.34	-2.04E-02	Down
GAMW09B	665.35	668.29	24.5	34.5	29.5	635.87	7.12	661.17			7.23	661.06			8.06	660.23			8.35	659.94		
GAMW15	665.01	668.25	5	15	10	654.54	7.62	660.63	9.83E-04	Up	7.9	660.35	5.06E-02	Up	8.56	659.69	1.97E-03	Up	9.15	659.1	1.47E-03	Up
GAMW15B	665.14	668.05	27.7	37.7	32.7	634.19	7.4	660.65			6.67	661.38			8.32	659.73			8.92	659.13		
GAMW16	665.2	668.37	5	15	10	655.17	8.15	660.22	3.99E-03	Up	8.28	660.09	3.11E-03	Up	8.94	659.43	1.77E-03	Up	9.3	659.07	3.11E-03	Up
GAMW16B	665.16	667.76	27.75	37.75	32.75	632.63	7.45	660.31			7.6	660.16			8.29	659.47			8.62	659.14		
GAMW17	668.81	671.93	5	15	10	658.93	11.75	660.18	4.80E-15	Up	11.65	660.28	0.00E+00	Up	12.28	659.65	-2.11E-03	Down	12.7	659.23	-2.11E-03	Down
GAMW17B	668.86	670.6	28	38	33	635.26	10.42	660.18			10.32	660.28			11	659.6			11.42	659.18		
GAMW18	666.04	669.07	5	15	10	656.04	7.17	661.9	1.28E-01	Up	7.72	661.35	1.39E-01	Up	8.86	660.21	0.00E+00	Up	9.5	659.57	2.89E-02	Up
GAMW18B	665.94	668.47	25	35	30	635.94	4	664.47			4.32	664.15			8.26	660.21			8.32	660.15		
GAMW46	661.99	664.80	5	15	10	651.99	-	-	NA	NA	7.55	657.25	-5.88E-04	Down	9.24	655.56	-5.88E-04	Down	8.75	655.75	-7.23E-02	Down
GAMW46B	661.98	664.79	22	32	27	634.98	-	-			7.55	657.24			9.24	655.55			9.80	654.52		
GAMW52	664.07	666.79	5	15	10	654.07	-	-	NA	NA	-	-	NA	NA	8.50	658.29	4.64E-04	Up	8.80	657.99	4.64E-04	Up
GAMW52B	664.50	666.90	27	37	32	632.50	-	-			-	-			8.60	658.30			8.90	658.00		
GAMW53	664.68	667.24	5	15	10	654.68	-	-	NA	NA	7.13	660.11	7.12E-03	Up	8.80	658.44	4.27E-03	Up	9.10	658.14	4.75E-03	Up
GAMW53B	664.62	667.29	26	36	31	633.62	-	-			7.03	660.26			8.76	658.53			9.05	658.24		
GAMW54	663.87	666.37	5	15	10	653.87	7.20	-7.20	5.92E-03	Up	7.93	658.44	9.47E-03	Up	7.58	658.79	-4.14E-03	Down	7.90	658.47	-2.96E-03	Down
GAMW54B	663.98	666.47	22	32	27	636.98	7.10	-7.10			7.87	658.60			7.75	658.72			8.05	658.42		
GAMW55	665.06	667.64	5	15	10	655.06	-	-	NA	NA	8.64	659.00	2.52E-03	Up	8.88	658.96	-2.52E-03	Down	8.92	658.72	-2.01E-03	Down
GAMW55B	665.18	667.53	25	35	30	635.18	-	-			8.48	659.05			8.62	658.91			8.85	658.68		
GAMW56	665.43	667.91	5	15	10	655.43	-	-	NA	NA	7.55	660.36	-4.48E-03	Down	8.92	658.99	4.98E-04	Up	9.05	658.86	4.98E-04	Up
GAMW56B	665.33	667.82	25	35	30	635.33	-	-			7.55	660.27			8.82	659.00			8.95	658.87		

Notes:  
ft-bgs = Feet below ground surface  
ft-msl = Feet above mean sea level  
ft-btoc = Feet below top of casing  
ft/ft = Feet/Feet  
NA= not applicable

Appendix C  
VERTICAL GRADIENT FLOW CALCULATIONS

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				February 25, 2019				Average Vertical Gradient (ft/ft)	Flow Direction
			Top (ft-bgs)	Bottom (ft-bgs)	Center (ft bgs)	Center (ft msl)	Depth To Water (ft-btoc)	Groundwater Elevation (ft-msl)	Vertical Gradient (ft/ft)	Flow Direction		
GAMW07	666.55	669.89	5	15	10	656.55	8.85	661.04	4.85E-03	Up	0.0232	Up
GAMW07B	666.83	669.39	30	40	35	631.83	8.23	661.16				
GAMW08	665.95	669.66	5	15	10	655.95	9.46	660.2	6.66E-03	Up	0.0437	Up
GAMW08B	665.92	668.47	26	36	31	634.92	8.13	660.34				
GAMW09	665.1	668.99	5	15	10	655.51	6.78	662.21	-2.04E-02	Down	-0.0214	Down
GAMW09B	665.35	668.29	24.5	34.5	29.5	635.87	6.48	661.81				
GAMW15	665.01	668.25	5	15	10	654.54	7.78	660.47	3.44E-03	Up	0.0042	Up
GAMW15B	665.14	668.05	27.7	37.7	32.7	634.19	7.51	660.54				
GAMW16	665.2	668.37	5	15	10	655.17	8.28	660.09	6.21E-03	Up	0.0037	Up
GAMW16B	665.16	667.76	27.75	37.75	32.75	632.63	7.53	660.23				
GAMW17	668.81	671.93	5	15	10	658.93	11.46	660.47	-1.27E-03	Down	-0.0111	Down
GAMW17B	668.86	670.6	28	38	33	635.26	10.16	660.44				
GAMW18	666.04	669.07	5	15	10	656.04	6.69	662.38	1.19E-02	Up	0.0070	Up
GAMW18B	665.94	668.47	25	35	30	635.94	5.85	662.62				
GAMW46	661.99	664.80	5	15	10	651.99	7.05	657.75	5.88E-04	Up	-0.0106	Down
GAMW46B	661.98	664.79	22	32	27	634.98	7.03	657.76				
GAMW52	664.07	666.79	5	15	10	654.07	8.10	658.69	4.64E-04	Up	0.0029	Up
GAMW52B	664.50	666.90	27	37	32	632.50	8.20	658.70				
GAMW53	664.68	667.24	5	15	10	654.68	8.45	658.79	7.12E-03	Up	0.0042	Up
GAMW53B	664.62	667.29	26	36	31	633.62	8.35	658.94				
GAMW54	663.87	666.37	5	15	10	653.87	6.90	659.47	-5.92E-03	Down	0.0024	Up
GAMW54B	663.98	666.47	22	32	27	636.98	7.10	659.37				
GAMW55	665.06	667.64	5	15	10	655.06	8.03	659.61	5.03E-03	Up	-0.0062	Down
GAMW55B	665.18	667.53	25	35	30	635.18	7.82	659.71				
GAMW56	665.43	667.91	5	15	10	655.43	7.91	660.00	-5.66E-15	Down	-0.0023	Down
GAMW56B	665.33	667.82	25	35	30	635.33	7.82	660.00				

Notes:  
ft-bgs = Feet below ground surface  
ft-msl = Feet above mean sea level  
ft-btoc = Feet below top of casing  
ft/ft = Feet/Feet  
NA= not applicable

Prepared by: ERW  
Checked by: TK  
Reviewed by: MAH

**APPENDIX D**

# Monitored Natural Attenuation Evaluation





**REPORT**

# MONITORED NATURAL ATTENUATION EVALUATION

*Northern Indiana Public Service Company LLC  
Rollin M Schahfer Generating Station  
Wheatfield, IN*

Submitted to:

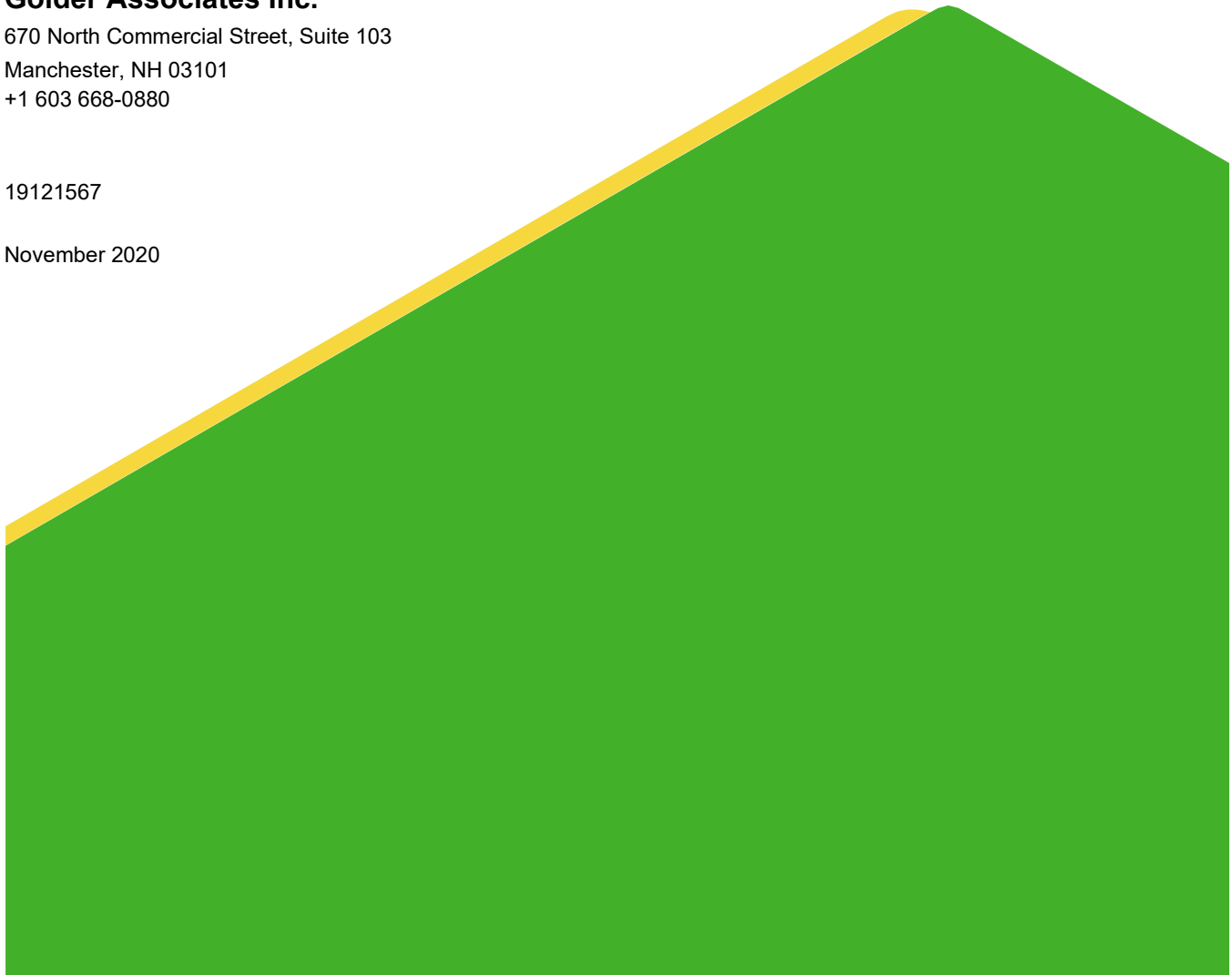
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## **APPENDICES**

### **APPENDIX A**

Groundwater and Porewater Monitoring Data

### **APPENDIX B**

Groundwater Flow Model Technical Memorandum

## Acronyms

ACM	Assessment of Corrective Measures
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
DO	Dissolved Oxygen
Eh	Reduction Potential
ft bgs	feet below ground surface
g	Gram
GMPIM	Groundwater Monitoring Program Implementation Manual
GWPS	Groundwater Protection Standards
IAP	Ion Activity Product
IDEM	Indiana Department of Environmental Management
ITRC	Interstate Technology Regulatory Council
kg	kilogram
Ksp	Solubility Product
MCL	Maximum Contaminant Level
MCWB	Metal Cleaning Waste Basin
mg	milligram
mg/L	milligram per liter
MNA	Monitored Natural Attenuation
mV	millivolt
MSRB	Material Storage Runoff Basin
NIPSCO LLC	Northern Indiana Public Service Company LLC
ORP	Oxidation-Reduction Potential
RMSGs	R. M. Schahfer Generating Station
SCM	surface complexation model
SEP	Sequential Extraction Potential
SI	Saturation Index
SSL	Statistically Significant Level
SU	Standard Unit
TAL	Target Analyte List
TDS	Total Dissolved Solids
USEPA	United States Environmental Protection Agency
XRD	X-ray diffraction



## 1.0 OVERVIEW

Groundwater and solid materials were evaluated to determine the feasibility of Monitored Natural Attenuation (MNA) as part of the assessment of corrective measures process for the Coal Combustion Residuals (CCR) surface impoundments (i.e., Material Storage Runoff Basin (MSRB), Metal Cleaning Waste Basin (MCWB), and the Drying Area (together, the CCR Unit) at the Northern Indiana Public Service Company LLC (NIPSCO LLC) Rollin M. Schahfer Generating Station (RMSGGS, or Site). The structure of this feasibility evaluation closely follows the United States Environmental Protection Agency (USEPA) guidance on using MNA as a remedial strategy (USEPA 2007a and 2007b) and considers best practices from the Interstate Technology Regulatory Council (ITRC) document: “A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater” (ITRC 2010).

RMSGGS manages CCR in the surface impoundments subject to applicable requirements of 40 Code of Federal Regulations (CFR) Part 257 as amended (CCR Rule). In April 2019, pursuant to 40 CFR §257.96(a), an assessment of corrective measures (ACM) was completed for the CCR Unit. This evaluation identified MNA as a potential remedial alternative for cobalt due to a detection at a Statistically Significant Level (SSL) in groundwater. Additionally, arsenic, boron, lithium, and molybdenum were evaluated as part of this assessment due to the potential for future SSLs, should they ever occur. The results of the evaluation will be used to assess the performance and reliability of MNA as a potential remedial alternative as required by 40 CFR §257.97. Golder determined the overall feasibility of MNA for the CCR Unit by evaluating the following tiers (USEPA 2007a,b):

- 1) Demonstrate active constituent removal from groundwater and dissolved plume stability (Tier I)
- 2) Determine the mechanisms and rates of the operative attenuation processes (Tier II)
- 3) Determine the long-term capacity for attenuation and the stability of immobilized constituents (Tier III)

Following completion of this multi-tier evaluation, the fourth and final tier of an MNA program, which involves the design of a performance monitoring program and the development of a contingency plan, will be developed.

## 2.0 APPROACH

Golder evaluated the feasibility, mechanisms, rates, and stability of MNA as a remedy for groundwater impacts from the CCR Unit. In order to perform the evaluation, Golder collected samples of groundwater and overburden soil between July 24, 2018 and March 3, 2020 for geochemical analysis. The supplemental MNA assessment included the following activities:

- Groundwater:
  - Characterization to identify temporal and geographical trends, where present, and to estimate site-wide attenuation rates using temporal and spatial trends in groundwater quality data.
  - Geochemical modeling to identify the major chemical species and evaluate saturation indices of minerals relevant to attenuation of arsenic, boron, cobalt, lithium, and molybdenum.
  - Determination of the capacity of different mechanisms to attenuate arsenic, boron, cobalt, lithium, and molybdenum, including adsorption, precipitation and co-precipitation, and physical attenuation (dilution/dispersion).
  - Geochemical modeling to assess the stability and reversibility of attenuation due to adsorption.

- Overburden soil:
  - Mineralogical analysis of overburden soils to identify and quantify the major mineral components.
  - Chemical analysis of overburden soils to quantify the total metal content and identify the environmentally-available fraction of metals.

The results generated by this supplemental assessment were used by Golder to complete the Tier I, Tier II, and Tier III evaluation (USEPA 2007a,b). In addition, groundwater data collected during previous sampling events were used. The results of the Tier I, Tier II, and Tier III are described in the subsequent sections to establish a basis for the likely success of MNA at the RMSGS site.

## 2.1 Groundwater and Porewater Sampling

### 2.1.1 Sample Collection

Golder personnel collected groundwater and porewater samples in accordance with the Golder RMSGS Groundwater Monitoring Program Implementation Manual (GMPIM, Golder 2017) from the background, downgradient, Assessment, and property boundary monitoring wells presented in Table 1, and from piezometers located within the CCR Unit. Piezometer GAPEZ-06 is located interior of the slurry wall on the western edge of the MSRB and is screened within the CCR materials. Piezometers DAPZ-02A and DAPZ-02B (abandoned in April 2020) were installed interior of the slurry wall on the eastern edge of the Drying Area and were screened in native materials (i.e., below the extent of CCR) from approximately five to 20 feet below ground surface (ft bgs) and 33 to 38 ft bgs, respectively. The monitoring well and former piezometer locations are shown in Figure 1.

**Table 1: Overview of the Wells Used in the Monitored Natural Attenuation Assessment**

Background Wells	Downgradient Wells	Assessment Wells	Property Boundary Wells
GAMW-04, GAMW-07, GAMW-07B, GAMW-15, GAMW-15B	GAMW-08, GAMW-08B, GAMW-09, GAMW-09B, GAMW-16, GAMW-16B, GAMW-17, GAMW-17B, GAMW-18, GAMW-18B	GAMW-52, GAMW-52B, GAMW-53, GAMW-53B, GAMW-54, GAMW-54B, GAMW-55/55R, GAMW-55B, GAMW-56, GAMW-56B	GAMW-46, GAMW-46B

### 2.1.2 Groundwater and Porewater Analysis

The geochemical characterization of porewater and groundwater samples included the measurement of field parameters and the laboratory analysis of samples for total metals and major cations and anions. The field parameters and laboratory analyses included:

**Field Parameters:** Parameters measured in the field included pH, dissolved oxygen (DO), oxidation reduction potential (ORP), conductivity, and temperature. These measurements were used to determine general geochemical conditions in the groundwater and support geochemical modeling.

**Metals:** Analysis of Appendix III and IV metals concentrations was conducted to understand the geochemical composition of groundwater and porewater. Metals analysis allows for the delineation of a potential plume, evaluation of mineral saturation indices, development of partitioning coefficients (in conjunction with solid material analyses), and evaluation of background contributions from natural sources or anthropogenic sources.

**Major Cations and Anions:** Geochemical modeling of mineral solubility, metals attenuation and background contributions requires analysis of major cations and anions because they affect and participate in sorption and mineral dissolution or precipitation reactions.

The groundwater and porewater samples were analyzed using the following methods:

- pH following SW846 9040C “pH Electrometric Measurement” (USEPA 2004)
- Total dissolved solids standard method (SM) 2540C “Total Dissolved Solids Dried at 180°C” (USEPA 1993a)
- Total hardness following SM 2340B (USEPA 1997)
- Chloride, fluoride, and sulfide following USEPA SW846 9056A “Determination of Inorganic Anions by Ion Chromatography”, Revision 1 (USEPA 2007c)
- Nitrate and nitrite following USEPA 353.2 “Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Revision 2.0” (USEPA 1993b)
- Alkalinity following SM 2320B “Alkalinity by Titration” (USEPA 2005a)
- Phosphorous following SM 4500-P E “Phosphorous by Ascorbic Acid Method” (USEPA 2005b)
- Total Target Analyte List (TAL) metals following USEPA SW846 6010C “Inductively Coupled Plasma-Atomic Emission Spectrometry”, Revision 3, SW846 6020B “Inductively Coupled Plasma-Mass Spectrometry”, Revision 2, and SW846 6020A “Inductively Coupled Plasma-Mass Spectrometry”, Revision 1 (USEPA 1998a)

## 2.2 Overburden Soil Sampling and Analysis

### 2.2.1 Sample Collection

Golder subcontracted a licensed well driller to advance borings into the overburden soil and install monitoring wells using roto sonic drilling methods. During boring operations, the driller collected continuous drill cores from all deep wells (i.e. “B” flagged wells). From the drill cores, Golder staff collected overburden samples from the depth of the screened intervals (i.e. 10-foot screened interval) from one background well soil boring (SB-07B), two downgradient well soil borings (SB-08B and SB-18B) and from five Assessment Monitoring well soil borings (SB-52B, SB-53B, SB-54B, SB-55B, and SB-56B). Golder staff also collected an additional sample from SB-53B (25'-27') at the top of the screened interval due to minor unidentified visual soil staining encountered within the planned interval itself. An additional soil boring was completed just external to the slurry wall on the eastern side of the MCWB (OW-9) and samples were collected on approximately 10-foot intervals.

The driller used a “marsh buggy” with a hollow stem auger drill rig specifically designed to work in the wet, soft soil/ash conditions inside the CCR Unit to advance eight soil borings within the Drying Area. From these eight borings, 23 samples were analyzed for total metals with one of these samples (DA-14\_4-6') also analyzed using the 7-step sequential extraction. The only sample for which data are included in this report is DA-14\_4-6'; all other data, which were obtained for other purposes, are provided in the Ash Pond Assessment Report (Golder 2020).

Soil borings were numbered to match the equivalent monitoring wells, where applicable. Golder field staff prepared a composite overburden sample from boreholes by selecting a two-foot interval from each drill core and submitting it to the laboratory for analysis under chain-of-custody procedures. The unique descriptions used to

identify the samples included the boring name and depth of the sample below ground surface (e.g., SB-07B-35'-37'). The sample type and analytical testing conducted on each sample are provided in Table 2.

**Table 2: Summary of Overburden Soil Samples/Analyses**

Sample Location	Number of Samples	Analyses
Background boring (SB-07B) 35'-37'	1	Total metals, sequential extraction
Downgradient boring (SB-08B) 30'-32'	1	Total metals, sequential extraction
Downgradient boring (SB-18B) 32'-34'	1	Total metals, sequential extraction
Assessment boring (SB-52B) 35'-37'	1	Total metals, sequential extraction, mineralogical composition
Assessment boring (SB-53B) 25'-27' & 30'-32'	2	Total metals, sequential extraction
Assessment boring (SB-54B) 30'-32'	1	Total metals, sequential extraction, mineralogical composition
Assessment boring (SB-55B) 30'-32'	1	Total metals, sequential extraction
Assessment boring (SB-56B) 30'-32'	1	Total metals, sequential extraction, mineralogical composition
Downgradient boring (OW-9) 10'-12' & 18'-20'	2	Total metals, sequential extraction, mineralogical composition
Drying area boring (DA-14) 4'-6'	1	Total metals, sequential extraction

### 2.2.2 Overburden Soil Analyses

Multiple geochemical methods were used to assess the mineralogical and chemical composition of the overburden soil samples. The selected geochemical test methods included the following:

- Mineralogical composition:** The mineralogical analysis was used to identify and quantify the crystalline mineral phases in each sample. This information is required for geochemical modeling as the release or attenuation of constituents of interest is influenced by the mineral phase(s) present in the aquifer (Hem 1985). The mineralogical testing laboratory (SGS Minerals Services) performed the mineralogical analysis using quantitative (Rietveld) X-ray diffraction (XRD) and a Bruker AXS D8 Advance Diffractometer.
- Total metals:** This analysis was used to quantify the chemical composition of overburden soils. The total mass of metals, in combination with the results of sequential extraction testing, can be used to determine the provenance of metals and verify sequential extraction results. The laboratory analyzed a target analyte list of

metals following the methods USEPA SW846 6010C “Inductively Coupled Plasma-Atomic Emission Spectrometry”, Revision 3 (November 2000) and USEPA SW846 7471B “Mercury in Solid or Semisolid Wastes (Manual Cold-Vapor Technique)”, Revision 2.

- **Sequential extraction:** The sequential extraction procedure (SEP) consisted of a seven-step procedure to extract metals from solids, as per Tessier et al. (1979), to identify the provenance of constituents of interest (i.e. the operationally-defined fraction that contains the metal)<sup>1</sup> and determine their potential environmental mobility. For instance, metals bound in the carbonate fraction, or that are exchangeable, are much more likely to become mobile due to changes in groundwater conditions than metals bound within a sulfide or silicate fraction. The summed concentration of a metal measured from all seven steps (SEP SUM) can be compared to the concentration determined from a total metals analysis (SEP Total) for compositional accountability. The laboratory analyzed the metals content of the extracted samples using the method USEPA SW846 6020B “Inductively Coupled Plasma-Mass Spectrometry”, Revision 2 (July 2014).

## 2.3 Groundwater Assessment Monitoring

Following the installation of a groundwater monitoring system in 2016 and throughout calendar year 2017, Golder collected background groundwater samples and performed Detection Monitoring around the CCR Unit pursuant to the requirements of 40 CFR §257.94. In 2018, Golder performed the first and second Assessment Monitoring sampling events pursuant to the requirements of 40 CFR §257.95. Following the first Assessment Monitoring sampling event, including verification sampling, the constituents that were detected above the groundwater protection standards (GWPS) at SSLs included:

- Cobalt and Lithium at GAMW-08
- Molybdenum at GAMW-18

The GWPS is the larger value of the Maximum Contaminant Level (MCL) or the unit-specific background concentration for each analyte based on a tolerance/prediction limit statistical procedure. However, USEPA amended the CCR Rule (i.e., Phase 1 Part 1 amendment) and created health-based standards for cobalt, lead, lithium, and molybdenum, constituents that do not have MCLs, as of August 29, 2018. Pursuant to 40 CFR §257.95(h)(2), the health-based standards can be used in place of background levels to calculate the GWPS. Consequently, after the second Assessment Monitoring event (October 2018), cobalt in monitoring well GAMW-08 remained as the only constituent detected at an SSL. Arsenic has never been detected above the GWPS or at an SSL, however, Golder also assessed arsenic as part of this evaluation due to sporadic detections at or above the MCL.

<sup>1</sup> Sequential extraction of metals from overburden samples consisted of seven discrete steps for this investigation:

Step 1 - Exchangeable Phase: This extraction includes trace elements that are reversibly adsorbed to overburden minerals, amorphous solids, and/or organic material by electrostatic forces.

Step 2 - Carbonate Phase: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 – Non-Crystalline Materials Phase: This extraction targets trace elements that are complexed by amorphous minerals (e.g., iron).

Step 4 - Metal Hydroxide Phase: Trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Phase: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the overburden after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.



Although boron is not currently an Appendix IV constituent, USEPA is reportedly considering adding it to the Appendix IV list. The Indiana Department of Environmental Management (IDEM) has, however, established a health-based standard as part of the state cleanup program. Boron is frequently used as a tracer to indicate the extent of a release from a CCR management unit. Due to these characteristics and as a conservative measure, boron was selected by Golder to assess the nature and extent of groundwater impacts at the Site.

The health-based standards, unit-specific background concentration, and groundwater protection standards used in this evaluation are summarized in Table 3.

**Table 3: Summary of Health-Based Standards, Background Concentrations, and Groundwater Protection Standards for the Constituents of Interest**

Constituent	Health-Based Standard (mg/L)	Background Concentration (mg/L)	Groundwater Protection Standard (mg/L)
Arsenic	0.01	0.091	0.091
Boron	4 <sup>(1)</sup>		
Cobalt	0.006	0.01	0.01
Lithium	0.04	0.01	0.04
Molybdenum	0.1	0.05	0.1

(1) IDEM health-based standard, not currently part of the CCR Rule

## 2.4 Groundwater and Porewater Geochemical Analysis

### 2.4.1 Estimation of Attenuation Rates

To evaluate the attenuation of arsenic, boron, cobalt, lithium, and molybdenum in groundwater at the Site and to assess the rate of attenuation, Golder applied the point decay method (USEPA 2011). The point decay method is used to determine the rate at which a constituent's concentrations are increasing or decreasing in groundwater at a single well between sampling events and this method can thus be used to predict when the constituent's concentrations will fall back below regulatory limits. Equation 1 describes first-order decay for a constituent:

$$\ln(C_t) = kt + \ln(C_0) \quad (\text{Equation 1})$$

where  $C_0$  is the initial constituent concentration,  $C_t$  is the constituent concentration at time  $t$ ,  $t$  is the amount of time in years that has passed since the initial concentration measurement, and  $k$  is the first-order decay rate constant (1 per year). Equation 2 shows Equation 1 reorganized to solve for the decay rate constant:

$$k = (\ln(C_t) - \ln(C_0))/t \quad (\text{Equation 2})$$

Groundwater water quality data from the background and downgradient wells collected between July 2016 and November 2019 were used to determine the mean first-order decay rate for each constituent of interest. Due to variable detection limits, results that were reported as below detection limits were not used in the point decay analysis. Using Equation 1 and the mean first-order decay rate, Golder calculated the number of years that it would take for constituents of interest concentrations greater than the GWPS to decrease below their respective thresholds.

## 2.4.2 Geochemical Speciation Modeling Methods

Golder conducted geochemical modeling to evaluate general groundwater and porewater composition, determine the potential for precipitation of sorbent media, evaluate the potential for mineral precipitation or adsorption in the aquifer, and determine the speciation of metals of interest. The geochemical computer code developed by the United States Geological Survey (USGS), PHREEQC (Parkhurst and Appelo 2013), was used for these simulations. PHREEQC version 3.4 is a general-purpose geochemical modeling code used to simulate reactions in water and between water and solid mineral phases (e.g., rocks and sediments). Reactions include aqueous equilibria, mineral dissolution and precipitation, ion exchange, surface complexation, solid solutions, gas-water equilibrium, and kinetic biogeochemical reactions. The widely-accepted thermodynamic database, Minteq.v4, 2017 edition, was used as a basis for the thermodynamic constants required for modeling (USEPA 1998b).

The Geochemist's Workbench version 12 (Bethke 2015) was used to generate graphical representations of geochemical modeling outputs in the form of predominance, or Pourbaix diagrams (also known as Eh-pH diagrams) for the species of interest (i.e. arsenic, boron, cobalt, lithium, and molybdenum) and trilinear plots (also known as Piper plots) displaying the relative abundance of major ions. The Minteq.v4 database was used as the basis for the Pourbaix diagrams.

## 2.4.3 Predictive Geochemical Modeling Methods

Golder performed geochemical modeling to assess viable attenuation mechanisms and to predict the quantity and stability of the attenuated constituents of concern.

### 2.4.3.1 Capacity of Adsorption as an Attenuation Mechanism

Adsorption is an important mechanism by which constituents in groundwater can be attenuated. The adsorptive partitioning between dissolved and solid phases was simulated using a two-layer surface complexation model (SCM). The SCM approach is described in Davis and Kent (1990), with additional parameterization based on Dzombak and Morel (1990) and Karamalidis and Dzombak (2011) utilizing iron (hydrous ferric oxide [Hfo]) as ferrihydrite  $[\text{Fe}(\text{OH})_{3(\text{am})}]$ , and aluminum (hydrous aluminum oxide [Hao]) as gibbsite  $[\text{Al}(\text{OH})_{3(\text{am})}]$ , as adsorbing surfaces.

The amount of Hfo and Hao available at the site for attenuation was based on the amorphous and metal hydroxide phase iron and aluminum concentrations measured in the SEP as described in Section 3.2.2. The minimum, mean, and maximum concentrations in soil borings were used in the adsorption models to capture the range of expected site concentrations. The Hfo and Hao surface properties (i.e., surface area, site density, and types of sites) from Dzombak and Morel (1990) and Karamalidis and Dzombak (2011) were used to quantify the iron and aluminum adsorption sites per mole of mineral.

The calculation methodology of Appelo and Postma (2010) was used to determine the specific quantity of sites on each mineral surface type as a function of the amount of mineral available to participate in these reactions. The methodology assumes the number of surface sites (sites) equals the product of the moles of iron ( $[\text{Fe}]$ ) and the moles of surface sites per mole of iron ( $[\text{sites}]/[\text{Fe}] = 0.2$  moles of sites per mole of iron). For the amount of ferrihydrite available for sorption, the Appelo and Postma methodology further assumes the mass of ferrihydrite ( $M_{\text{HFO}}$ ) in grams (g) available equals the product of the  $[\text{Fe}]$  and the molecular weight of ferrihydrite ( $MW_{\text{HFO}} = 88.85$  g/mole). The same approach was used to calculate the number of sites from gibbsite, assuming the  $[\text{sites}]/[\text{Al}]$  is 0.41 moles of sites per mole of aluminum and the molecular weight of gibbsite is 78.003 g/mole.

The geochemical thermodynamic database Minteq V.4 was used to conduct adsorption modeling. However, new and updated thermodynamic data have been released in scientific literature. These new data are important to include in the geochemical modeling exercises for certain elements or minerals as they allow further refinement of potential reactions, or for correction of previous data that may have been less accurate or more broadly defined. For groundwater modeling at the Site, Golder made numerous updates to the Minteq V.4 database, including the addition of data relating to partitioning coefficients for metals on gibbsite, developed by Karamalidis and Dzombak (2011). Of the five constituents of interest, the database did not contain partitioning coefficients for ferrihydrite or gibbsite for lithium, so its potential for adsorption could not be assessed.

To quantify current levels of adsorption, the concentration of constituents that adsorb in soils (as milligram (mg) of constituent/kilogram (kg) of soil) was modeled for the minimum, maximum, and mean Hfo and Hao contents when equilibrated with the range of groundwater qualities observed at the Site. To quantify the capacity of soil to adsorb additional amounts of each constituent, Golder simulated a step-wise increase in arsenic, boron, cobalt, and molybdenum concentrations (similar in concept to a titration, using the mean proportions observed in porewater) into the range of observed groundwater qualities while allowing equilibration with the sorption surfaces in soils (minimum, maximum and mean Hfo and Hao). The model was then used to predict the quantity of each constituent that would adsorb with this titration of additional arsenic, boron, cobalt, and molybdenum.

#### **2.4.3.2 Mineral Precipitation and Co-precipitation**

The potential for mineral precipitation was assessed in PHREEQC using a saturation index (SI) calculated according to Equation 3.

$$SI = \log (IAP/Ksp) \quad (\text{Equation 3})$$

The saturation index is the ratio of the ion activity product (IAP) of a mineral to the solubility product (Ksp). An SI value greater than zero indicates that the solution is supersaturated with respect to a particular mineral phase and, therefore, precipitation of this mineral may occur. An evaluation of precipitation kinetics is then required to determine whether the supersaturated mineral will indeed form. An SI value less than zero indicates the solution is undersaturated with respect to a particular mineral phase. An SI value close to zero indicates equilibrium conditions exist between the mineral and the solution. SI values between -0.5 and 0.5 are considered to represent 'equilibrium' in this report to account for the uncertainties inherent in the analytical methods and geochemical modeling.

Co-precipitation was evaluated based on published literature and known association between minerals and constituents of concern. For example, cobalt is known to coprecipitate with iron oxyhydroxides as well as adsorb to Hfo (Norstrom and Alpers 1999). Therefore, to evaluate co-precipitation, minerals identified by PHREEQC to be at equilibrium (SI > -0.5) were evaluated for their potential to host arsenic, boron, cobalt, lithium, and molybdenum.

#### **2.4.3.3 Capacity of Dilution and Dispersion as Attenuation Mechanisms**

Dilution and dispersion are physical mechanisms of attenuation by which concentrations of constituents in groundwater decrease with migration along groundwater flowpaths.

To assess the potential for dilution and dispersion downgradient of the CCR Unit, Golder used MODPATH (Pollack 1989) and the calibrated Site Groundwater Flow model (discussed in Section 4.0 and Appendix B) to simulate travel times for particles released from the MCWB. The length of the particle traces produced by

MODPATH along with travel time estimates were used to calculate average groundwater velocities for the following flow paths: (see Figure 1):

- GAMW-16 to GAMW-53
- GAMW-18 to GAMW-55
- GAMW-17 to GAMW-54
- GAMW-09 to GAMW-54

The results of these flow path travel time simulations are presented in Table 4.

Golder estimated the capacity of dilution and dispersion to attenuate constituent concentrations from the CCR Unit using ratios of concentrations measured in monitoring wells along these flow paths, as presented in Table 8. For example, along the flow path from GAMW-16 to GAMW-53, concentrations of boron decreased from 9.7 milligram per liter (mg/L) to 3.1 mg/L, representing an estimated 68% decrease in concentration along the flow path due to dilution and attenuation.

#### 2.4.3.4 Long Term Stability of Attenuated Constituents

Three sensitivity analyses were performed to assess the stability of adsorbed constituents under variable pH, redox, and ionic strength conditions. Variations in pH, redox, and ionic strength are the most likely types of changes that will occur in an aquifer over time affecting the stability of the constituents of interest (ITRC 2010). The sensitivity analyses were conducted applying the minimum, mean, and maximum Hfo and Hao contents determined for the Site soils, equilibrated with the groundwater qualities observed at the Site at the measured pH and redox conditions. For each sensitivity analysis, a single parameter was varied:

- **pH** - Hydrochloric acid or sodium hydroxide addition was modeled to vary the pH between 4 and 12 standard units (SU). A pH range of 4 to 10 is the typical range considered for evaluating metal speciation.
- **Redox** - DO addition was simulated to adjust reduction potential (Eh) values between -200 and +700 millivolts (mV) based on the historical and anticipated range of Eh in the region.
- **Ionic Strength** - Total dissolved solids (TDS) concentrations were increased by titrating in calcium, magnesium, sodium, potassium, chloride, and sulfate in the proportions observed in porewater. TDS concentrations were evaluated up to 10,000 mg/L, which is approximately four times higher than the highest TDS concentration observed in groundwater at the CCR Unit.

#### 2.4.4 Geochemical Modeling Assumptions and Data Handling

Geochemical modeling assumptions and data handling included the following:

- **Groundwater continuity:** Three or four groundwater quality samples were collected from each well during sampling events conducted between September 2018 and November 2019. Samples from this period were selected for the geochemical modeling because all wells related to the CCR Unit were sampled and analyzed for the full suite of parameters described in Section 2.1.2 and the resulting data are assumed to provide a comprehensive overview of groundwater conditions. Temporal trend analysis for arsenic, boron, cobalt, lithium, and molybdenum made use of all available sampling events between July 2016 and November 2019.

- **Porewater chemistry:** Porewater samples collected from GAPIEZ-06 (three samples total in August, September, and October 2018), DAPZ-02A (one sample collected in March 2020), and DAPZ-02B (one sample collected in March 2020) were assumed to be representative of porewater found in the CCR Unit. Data from three sampling events from GAPIEZ-06 were used to evaluate porewater trends.
- **Redox values:** ORP values measured in the field were converted to Eh by adding 200 mV to the field-measured values as per YSI Tech Note (YSI 2015).
- **Non-detect values:** Constituents with concentrations less than their respective method reporting limits were assumed to have a concentration equal to half the reporting limit in model simulations.
- **Total recoverable concentrations:** Total recoverable fraction results were used for geochemical modeling.
- **Charge balance:** Groundwater and porewater compositions with charge balance errors less than 10% were considered valid. Compositions with charge balance errors greater than 10% were flagged as potentially less reliable, but still included in the geochemical modeling effort.

## 3.0 SUPPLEMENTAL ASSESSMENT RESULTS

### 3.1 Groundwater and Porewater

#### 3.1.1 Groundwater Characterization

Groundwater quality data for background, downgradient, and Assessment Monitoring wells used for this evaluation were collected from September 2016 to November 2019. Non-regulated (per the CCR Rule) groundwater parameters (e.g., alkalinity, potassium, sodium) are only available from September 2018 to November 2019. The assessment of trends in arsenic, boron, cobalt, lithium, and molybdenum concentrations in groundwater included observations of all validated data collected during that time frame. Groundwater quality monitoring data are presented in Appendix A and can be summarized as follows:

- **Charge balance error:** Charge balance errors could only be assessed for samples for which the full suite of cations and anions was reported. Eleven groundwater samples had charge balance errors greater than 10%. Eight out of the eleven samples (GAMW-07 in November 2019, GAMW-07B in November 2019, GAMW-08B October 2018, GAMW-08B in November 2019, GAMW-18 in October 2018, GAMW-18B in October 2018, GAMW-18B in November 2019 and GAMW-56B in April 2019) reported charge balance errors between 10% and 15%. Only samples from GAMW-07B in September 2018, GAMW-18B in April 2019, and GAMW-56 in April 2019 had a charge balance error greater than 40%. All eleven results were flagged (Table 5) and retained, with the understanding that they may be somewhat less reliable. Upon subsequent sampling, charges balance errors decreased to <10 % in these wells.
- **pH:** Groundwater pH across background, downgradient, and Assessment Monitoring wells ranged from 5.2 to 8.7. The geometric mean pH across all wells was 7.2. GAMW-07B, GAMW-52B, GAMW-54B were the only wells that produced samples with a pH exceeding 8.0.
- **ORP (Redox):** Field-measured redox, corrected to Eh (+200 millivolts [mV]) values, ranged from -115 to +335 mV in the background monitoring well, downgradient monitoring well, Assessment Monitoring well, and porewater samples collected between September 2018 to November 2019. There was no apparent trend in redox conditions based on sample location or depth.



- **Total Dissolved Solids:** Groundwater TDS concentrations were variable. Generally, the lowest TDS concentrations (less than 400 mg/L) were measured in groundwater at Assessment Monitoring wells (GAMW-46, GAMW-46B, GAMW-52, GAMW-53) while TDS concentrations up to an order of magnitude higher were determined in groundwater at wells located immediately downgradient of the CCR Unit (e.g., GAMW-08B). In general, deep wells demonstrated higher TDS concentrations than shallower companion wells at the same locations.
- **Major ion chemistry:** A Piper plot was generated for all porewater samples and groundwater samples from background, downgradient, and Assessment Monitoring wells to facilitate the identification of water types and changes in major ion chemistry over time (Figure 2a-c). The majority of background, downgradient, and porewater samples are calcium-sulfate dominated. In general, deep wells have a higher proportion of sodium and sulfate than the shallower companion wells. The differences between shallow and deep companion wells are more pronounced in the Assessment Monitoring wells. Except for GAMW-54 and GAMW-55, the shallow samples from the assessment wells are calcium-(bi)carbonate dominated and plot in a different location on the Piper plot than background, downgradient, and porewater samples. Shallow wells GAMW-54 and GAMW-55, along with all the deep Assessment Monitoring wells, are calcium-sulfate dominated and plot with background, downgradient, and porewater samples. The water types have remained generally unchanged between September 2018 and November 2019. Generally, this indicates that groundwater types are consistent. However, based on major ion chemistry, there are different water types on the site that are likely influenced by variable site geology.
- **Arsenic:** Arsenic concentrations in groundwater samples collected from downgradient monitoring and Assessment Monitoring wells between September 2016 to November 2019 ranged from non-detect (<0.005 mg/L) to 0.022 mg/L (Figure 4a-c). The highest measured arsenic concentration in groundwater at the CCR Unit (0.091 mg/L) was reported in a sample collected from background well GAMW-15 in September 2018 (Figure 4a). No downgradient monitoring well has ever exceeded the GWPS of 0.091 mg/L designated for the CCR Unit. Arsenic concentrations in groundwater appear to be stable or decreasing in all downgradient monitoring wells (Figure 4b). Arsenic concentrations in the CCR Unit porewater (GAPIEZ-06) ranged from 0.011 to 0.012 mg/L in August and October 2018 (Appendix A-2). Arsenic concentrations collected from the Drying Area in March 2020 (DAPZ-02A and DAPZ-02B) were an order of magnitude lower (<0.0010 and 0.0018 mg/L, respectively). Based on the observed pH and Eh conditions, arsenic predominately occurs as an oxidized arsenate ( $As^{+5}$ ) species, with arsenic in only a small number of samples present as a reduced arsenite ( $As^{+3}$ ) species (Figure 3a). Arsenite is less readily adsorbed than arsenate and is thus generally regarded to be more mobile in natural environments (Nordstrom 2014).
- **Boron:** Boron concentrations in downgradient groundwater samples collected between September 2016 to November 2019 ranged from 0.056 mg/L to 25 mg/L (Figure 5a-c). The highest boron concentration (25 mg/L) was measured in monitoring well GAMW-09B in September 2017. Two background wells (GAMW-07B and GAMW-15B), seven downgradient wells (GAMW-08B, GAMW-09, GAMW-09B, GAMW-16B, GAMW-17, GAMW-17B, and GAMW-18B) and two Assessment Monitoring wells (GAMW-54B and GAMW-55B) reported boron concentrations greater than the health-based standards (4 mg/L). Boron concentrations in porewater were between 7.4 mg/L and 13.8 mg/L. Based on pH conditions on the Site, boron in all wells occurs predominately in the form of protonated boric acid ( $H_3BO_3$ ) (Figure 3b). Generally, boron concentrations in the background and downgradient wells have remained stable or has decreased. This is also the case for all assessment and boundary well except for GAMW-55B, where boron has increased slightly. GAMW-55B is a deep well and heavily influenced by bedrock.

- **Cobalt:** Cobalt concentrations ranged from non-detect (<0.001 mg/L) to 0.059 mg/L in groundwater samples collected between September 2016 to November 2019 at the CCR Unit (Figure 6a-c). GAMW-08 had the highest cobalt concentration of all monitoring wells (0.059 mg/L in November 2016) and generally reported a decreasing trend thereafter (Figure 6b). The second highest concentration (0.010 mg/L in June 2017 and October 2018) occurred in GAMW-07, a background well (Figure 6a). GAMW-08 is the only well on Site to have reported a historic cobalt level greater than the GWPS (0.010 mg/L). Cobalt in porewater ranged from below the laboratory reporting limit (<0.0010 mg/L) to 0.0022 mg/L. Cobalt in all wells occurs predominately as the divalent cation  $\text{Co}^{+2}$ , based on pH and Eh conditions (Figure 3c). Cobalt concentrations appear to be stable or decreasing in groundwater samples collected from the upgradient, downgradient, and Assessment Monitoring wells.
- **Lithium:** Lithium concentrations in groundwater ranged from non-detect (<0.008 mg/L) to 0.025 mg/L between September 2016 to November 2019 (Figure 7a-c). Two downgradient wells, GAMW-18B and GAMW-08, located directly downgradient of the MCWB, have historically had the highest lithium concentrations (Figure 7b). Lithium concentrations historically have not exceeded 0.040 mg/L, the health-based standard. Lithium levels in GAMW-08 appear generally consistent over time, and a trend cannot be determined for GAMW-18B, as the well was recently installed and fewer than four sampling events have been conducted. Lithium concentrations in groundwater at all other wells downgradient of the CCR Unit appear to be stable. Lithium was not detected above the laboratory reporting limit (0.008 mg/L) in the CCR Unit porewater (GAPIEZ-06). Lithium concentrations collected from the Drying Area in March 2020 (DAPZ-02A and DAPZ-02B) were <0.008 mg/L and 0.016 mg/L, respectively. Lithium predominately occurs as the monovalent cationic species  $\text{Li}^+$  based on field pH and Eh conditions (Figure 3d).
- **Molybdenum:** Molybdenum concentrations in groundwater ranged from non-detect (<0.010 mg/L) to 0.18 mg/L (Figure 8a-c). Although GAMW-18 has reported historical levels of up to 0.18 mg/L, concentrations have been below 0.1 mg/L (the health-based standard) since August 2017. No other CCR Unit monitoring wells have reported concentrations exceeding 0.1 mg/L. The molybdenum concentration in porewater has ranged from 0.063 mg/L to 0.81 mg/L. Molybdenum is predominately present in the form of the divalent anionic molybdate ( $\text{MoO}_4^{-2}$ ) species based on field-measured pH and Eh conditions (Figure 3e).
- **Iron:** Total (un-filtered) iron concentrations were variable, ranging from non-detect (<0.1 mg/L) to 13 mg/L between September 2018 and November 2019 (Appendix A-1). The highest concentration of 13 mg/L was observed in the groundwater sample collected from Assessment Monitoring well GAMW-56. No geographical trend is apparent; however, deeper “B wells” generally tended to have higher total iron contents. Ferric iron ( $\text{Fe}^{+3}$ ) concentrations were higher than ferrous iron ( $\text{Fe}^{+2}$ ) concentrations in all samples, except for those collected from wells GAMW-15, GAMW-55B, and GAMW-56.
- **Nutrients:** Total nitrogen (nitrate + nitrite) was measured in groundwater samples collected in October 2018 and was present at low levels (i.e. less than 2.8 mg/L). Nitrate concentrations were measured in samples collected in 2019 and concentrations ranged from below the detection limit (<0.05 mg/L) to 7.7 mg/L. The highest reported nitrate concentration was found in GAMW-08 in May 2019 (7.7 mg/L-N). The presence of low-level nitrate confirms oxidized conditions surround the CCR Unit. Phosphate concentrations exceeding 1 mg/L were detected in groundwater samples from GAMW-15 and GAMW-16. Phosphate concentrations were below detection in groundwater samples collected from 18 of the 25 wells between September 2018 and November 2019. No geographical or temporal trend is apparent in the phosphate concentrations related to the CCR Unit (Appendix A).

The monitoring data also indicate that sulfate generally occurs at the highest concentrations immediately downgradient of the CCR Unit and in background monitoring wells (Figure 9a-c). As identified in Figure 2a-c, considering major groundwater chemistry and sulfate, the CCR Unit is likely influencing groundwater quality in Assessment Monitoring wells GAMW-54/54B and GAMW-55/55B. However, while affected by the CCR Unit, these wells report low concentrations of arsenic, cobalt, lithium, and molybdenum below health-based standards or below detection limits. Boron concentrations were elevated above its GWPS in both upgradient and downgradient wells, suggesting elevated concentrations are naturally occurring or due to an alternate source at the Site.

### 3.1.2 Evaluation of Attenuation Rates

The results of the point decay analysis for groundwater at background and downgradient wells (including Assessment Monitoring wells) between September 2016 and November 2019 are provided in Table 6, as mean site attenuation rates. This evaluation reveals that, despite concentrations generally increasing in background wells over time (as indicated by positive point decay constants), boron, cobalt, lithium, and molybdenum concentrations in downgradient wells have decreased (negative point decay constants) over that same monitoring period. The mean downgradient decay rates can be used to estimate the number of years it would take for elevated groundwater concentrations to decrease to the GWPS. Maximum concentrations of boron, cobalt and molybdenum observed in downgradient monitoring wells over the period of monitoring would take approximately 41 years, 39 years, and 20 years, respectively, to attenuate to concentrations below GWPS (or health-based standard for boron) based on these decay rates. The durations required to achieve regulatory standards for arsenic and lithium were not calculated because there are no exceedances of the GWPS for these constituents.

The positive mean point decay rate for arsenic in downgradient monitoring wells indicates that, on average, concentrations are increasing. Given the low concentrations in the porewater samples ( $\leq 0.012$  mg/L), this trend is unlikely to be caused by the CCR Unit. Low-level increasing arsenic concentrations in Assessment Monitoring wells GAMW-52B, GAMW-53B, GAMW-54, and GAMW-54B are driving the positive point decay rate, but the arsenic concentrations in these wells remain sufficiently low ( $\leq 0.005$  mg/L) and are likely caused by natural variability. Although an increasing trend of arsenic at these wells currently may exist, it is unlikely this trend will continue given the potential for attenuation (e.g., through sorption and dilution) to maintain arsenic concentrations below the GWPS.

### 3.1.3 Mineralogical Controls in Groundwater and Porewater

The results of speciation modeling of groundwater data from background, downgradient, and Assessment Monitoring wells between September 2018 and November 2019 are provided in Table 5, including saturation indices for relevant minerals. Mineral saturation can play an important role in attenuation of metals, either directly by their removal through mineral precipitation, or indirectly by providing sorptive surfaces or opportunities for co-precipitation.

- **Iron-bearing minerals:** Ferrihydrite was indicated to be at equilibrium with groundwater or oversaturated in nearly all samples, indicating a strong potential for ongoing precipitation of solid-phase iron oxides. Only two samples from Assessment Monitoring well GAMW-53 (April 2019 and November 2019) were modeled to be undersaturated with respect to ferrihydrite. Thus, it is assumed that iron (hydr)oxides are prevalent in the Site aquifers.
- **Other minerals:** Nearly all groundwater samples, with the exception of samples from GAMW-07 and GAMW-52, were simulated to be in equilibrium or oversaturated with respect to barite ( $\text{BaSO}_4$ ). Fluorite

(CaF<sub>2</sub>) equilibrium was indicated in wells GAMW-07B, GAMW-08/08B, GAMW-17, and GAMW-52B. Gypsum (CaSO<sub>4</sub>·2H<sub>2</sub>O) was modeled to be in equilibrium in seven wells (GAMW-07B, GAMW-08B, GAMW-15B, GAMW-16B, GAMW-18, GAMW-18B, and GAMW-55B), most of which were deeper “B-wells” nearer to bedrock. Calcite (CaCO<sub>3</sub>) equilibrium was indicated in all wells except GAMW-53.

In summary, several mineral phases likely control groundwater composition at some or all wells: barite, calcite, fluorite, ferrihydrite, and gypsum. In the case of ferrihydrite, the dissolved concentrations of constituents of interest can be reduced through its ability to act as a substrate for adsorption.

## 3.2 Overburden Soil

### 3.2.1 Mineralogical Composition

Quantitative XRD with Rietveld refinement was used to identify and quantify minerals in five overburden soil samples collected during the drilling activities (Table 7). Three of the samples were collected from the Assessment Monitoring well's soil borings and two samples were collected from the downgradient soil boring (OW-9). These samples were obtained to better understand the mineralogical composition of the aquifer system and identify any minerals that would potentially influence attenuation of constituents of interest. In addition, and in contrast, the presence of certain minerals could also indicate a potential for naturally occurring release of metals into groundwater, for instance due to oxidation of sulfide minerals.

The mineralogical analysis identified the iron sulfide minerals pyrite and marcasite at low levels in three of the five overburden soil samples, at concentrations up to 0.6 wt.%. These minerals can oxidize in the presence of even trace amounts of dissolved oxygen, which would lead to the liberation of trace metals or metalloids known to associate with sulfide minerals (e.g., arsenic, cobalt, and molybdenum) into groundwater (Smith and Huyck 1997). In addition, the associated release of iron creates the potential for formation of minerals with the ability to sorb trace elements.

The presence of the oxidized iron mineral hematite (Fe<sub>2</sub>O<sub>3</sub>) at 0.3 to 0.6 wt.% in three of the five overburden soil samples in the presence of reduced iron sulfide minerals indicates a spectrum of oxidation occurring in overburden soil samples. As pyrite or marcasite is oxidized, intermediate amorphous iron phases, such as ferrihydrite, would likely occur first. Over time, crystallization would progress, forming iron oxide-oxyhydroxides such as hematite or goethite (FeOOH). Therefore, it is likely a range of iron solid phases is present in the overburden soil, and the potential exists over time for an increased presence of amorphous and crystallized iron oxides-oxyhydroxides with a strong affinity to attenuate certain metals and metalloids (Dzombak and Morel 1990).

The mineralogical analysis also identified the carbonate minerals calcite (CaCO<sub>3</sub>) and dolomite (CaMg(CO<sub>3</sub>)<sub>2</sub>) in all overburden soil samples, with combined concentrations between 9 and 16 wt.%. Carbonate minerals are known to adsorb cobalt (Brady et al. 2003) while sorption and uptake of arsenic are possible as well (e.g., Romero et al. 2004). Carbonate minerals can dissolve when exposed to sulfuric acid formed by oxidation of sulfide minerals and release associated trace metals and metalloids (Section 3.2.2) into groundwater. Iron can also be released as carbonate minerals dissolve and potentially form metal hydroxide minerals.

### 3.2.2 Chemical Composition and Sequential Extraction

Chemical analysis and sequential extraction were conducted to determine the chemical composition and the distribution of constituents of interest over various operationally defined fractions of the overburden soil. This testing was completed per Table 2 on nine overburden soil samples from eight monitoring well locations, two samples from the OW-9 borehole, and one sample from within the Drying Area (reported in Table 8). Soil samples

from soil borings that correspond to well locations were collected from within the screened depth (except SB-53B 25'-27' which was collected above the screened depth).

A description of the individual fractions determined by sequential extraction is presented in Section 2.2.2, footnote 1. Metals extracted in steps 1 through 5 are considered environmentally available, whereas metals extracted in steps 6 and 7 are present in refractory fractions and are not expected to be released under conditions typically encountered in aquifers (Tessier et al. 1979). The sum of metal concentrations from the sequential extraction steps is expressed as "SEP SUM" in Table 8 and does not represent an analytically determined value. The concentration measured by total metals analysis is referred to as "SEP Total" in Table 8. Boron was not included in the SEP analysis due to method limitations.

The results from the chemical analysis and sequential extraction can be summarized as follows:

- **Iron:** Iron was present in all twelve samples analyzed, varying from 3,400 milligram per kilogram (mg/kg) (DA-14) to 9,900 mg/kg (SB-54B). In all samples, the refractory sulfide and residual fractions accounted for the largest proportion of total iron and, as such, most of the iron is not environmentally available (Figure 10). The labile fraction in steps 1 through 5 can generally be considered representative of the amount of iron in the overburden that may be available as a sorbing medium. While not a constituent of interest, iron and its minerals commonly represent the most important reservoir for metal/metalloid attenuation in soils or overburden. The labile fraction calculated from sequential extraction, therefore, can be used as a proxy for determining the total number of adsorption sites available for attenuation of arsenic, boron, cobalt, and molybdenum in the environment.
- **Arsenic:** Total arsenic in the soil overburden samples ranged from 1.9 to 6.2 mg/kg while the environmentally-available fraction ranged from 0.44 mg/kg in SB-55B to 3.0 mg/kg in SB-53B, representing from 31% to 59% of total arsenic (Figure 11). The majority of arsenic was present in the refractory fraction, predominantly associated with sulfide minerals. The amorphous metal and metal hydroxide fractions hosted all arsenic that was environmentally available except in SB-52B, where the carbonate fraction represented 8.5% of total arsenic. The highest concentrations of environmentally-available arsenic occurred in sample SB-56B, and the lowest concentrations were encountered in samples DA-14, SB-53B and SB-55B. The Drying Area sample (DA-14) had the second lowest environmentally-available arsenic concentrations (0.45 mg/kg) of all samples analyzed. Arsenic in DA-14 predominantly occurred in the sulfide and insoluble fractions.
- **Cobalt:** Total cobalt in soil borings ranged from 2.5 mg/kg to 6.1 mg/kg while the environmentally-available fraction ranged from 1.1 mg/kg in OW-9 to 2.9 mg/kg in SB-53B, representing from 27% to 60% of total cobalt (Figure 12). Those samples downgradient of the CCR Unit had similar total cobalt in the environmentally-available fraction as the background samples. In all boring samples, cobalt was most abundant in the metal hydroxide, sulfide, and residual fractions. Cobalt was also present in the carbonate phase in the nine soil bore samples (5% to 14% of total). Cobalt in the carbonate phase is most likely sorbed onto or coprecipitated with the calcite that was indicated to be in equilibrium with groundwater in geochemical modeling. Cobalt was not detected in the exchangeable phase. DA-14 reported the lowest total and environmentally-available cobalt concentrations (0.87 mg/L and 0.39 mg/L, respectively) of all samples analyzed, predominantly in the metal hydroxide and sulfide fractions.
- **Lithium:** Total lithium ranged from 4.2 to 11 mg/kg while the environmentally-available fraction ranged from 0.5 mg/kg in DA-14 to 11.4 mg/kg in SB-18B, representing from 12% to 74% of total lithium (Figure 13). The



majority of lithium was present in either the organic or the refractory fraction. The organic, carbonate, and metal hydroxide fractions hosted all lithium that was environmentally available. The highest concentrations of environmentally-available lithium occurred in samples SB-18B, SB-54B, SB-55B and SB-56B, and the lowest amount was encountered in SB-53B. Lithium concentrations in DA-14 were generally lower than in background and downgradient monitoring wells, with the majority of the lithium present in the sulfide and residual fractions.

- **Molybdenum:** Total molybdenum in overburden ranged from 0.15 to 3.8 mg/kg while the environmentally-available fraction ranged from non-detect to 2.83 mg/kg, in SB-53B (25'-27'), and accounted for 100% of all molybdenum in SB-18B and SB-53B (30'-32') (Figure 14). Molybdenum was most commonly present in the amorphous and metal hydroxide fractions. Notably, in background boring SB-07B and in SB-08B, a downgradient boring in close proximity of the CCR Unit, molybdenum was non-detect in overburden soil samples. The soil boring with the highest total molybdenum content, SB-53B, is located further downgradient from the CCR Unit. The Drying Area sample (DA-14) had the highest concentrations (15 mg/kg) of all samples analyzed. Molybdenum in DA-14 was present predominantly in the exchangeable fraction.

In summary, no definitive trends were present for arsenic, cobalt, lithium or molybdenum that indicated a higher concentration immediately downgradient of the CCR Unit relative to background locations or locations further downgradient. Based on the above results, attenuation by adsorption of all four constituents of interest is likely occurring, with the carbonates, amorphous metal oxides, and metal hydroxide fractions accounting for the majority of the attenuation.

## 4.0 GROUNDWATER MODELING RESULTS

Through standard numerical groundwater modeling procedures, Golder developed a steady state groundwater flow model for the Site that is considered calibrated and verified. Details of the flow model development are presented in Appendix B. This model was utilized to inform the natural attenuation study by simulating travel times for particles released from the MCWB, as presented in Table 4.

## 5.0 GEOCHEMICAL MODELING RESULTS

### 5.1 Identification and Capacity of Attenuation Mechanisms

#### 5.1.1 Adsorption to Iron and Aluminum Oxyhydroxides

The Hfo and Hao surface area and sorption site calculations for the minimum, mean, and maximum soil boring iron and aluminum concentrations are presented in Table 10. Adsorption modeling in PHREEQC revealed a large range of adsorption capacities expected for the different constituents at the site. Figure 15 displays the predicted trajectories of aqueous concentrations before and after adsorption onto Hfo and Hao in soils (minimum, mean and maximum Hfo and Hao), as additional arsenic, boron, cobalt, and molybdenum are titrated into solution. The bold lines display the geometric means for all groundwater scenarios within each soil scenario and the grey area represents the range for the 5<sup>th</sup> to 95<sup>th</sup> percentile of all soil scenarios. As mentioned in Section 2.4.3.1.2, lithium adsorption to iron and aluminum oxyhydroxides was not modeled due to a lack of available thermodynamic data.

The predicted trajectories are compared against the GWPS and porewater concentrations. On the plots, the further the predicted trajectories are to the right of the 1:1 line, the larger the amount of the constituent that has sorbed to Hfo and Hao surface sites in soils and is no longer predicted to reside in the aqueous phase. For boron, little to no adsorption is predicted by the model, so aqueous concentration before adsorption are almost identical to concentrations after adsorption. For arsenic, a large proportion is expected to adsorb, with a capacity to bring

average arsenic concentrations to below 0.01 mg/L when concentrations are at approximately 10 mg/L or lower prior to adsorption. At higher arsenic concentrations (> 10 mg/L), the relative sorption capacity is diminished as sorption sites are filled and aqueous concentrations after adsorption are predicted to increase above its GWPS. For cobalt and molybdenum, the trajectories run parallel to the 1:1 line, indicating that sorption capacity is directly proportional to the concentration before adsorption. The modeling results suggest that adsorption has the capacity to reduce cobalt concentrations below approximately 0.1 mg/L down to the GWPS of 0.01 mg/L and molybdenum concentrations below approximately 0.2 mg/L down to the GWPS of 0.1 mg/L. The 95<sup>th</sup> percentile of modeled trajectories show that a minority of pH and redox conditions at site were less favorable for attenuating cobalt or molybdenum, as seen by the proximity to the 1:1 line.

### 5.1.2 Co-precipitation

In addition to adsorption, co-precipitation or the direct incorporation of trace metals such as cobalt into precipitated iron oxide-oxyhydroxides has been well studied in literature (Butt et al. 2000; Dzombak and Morel 1990; Smith 1999). For the soils analyzed by sequential extraction (Section 3.2.2), all samples had higher concentrations of cobalt in the amorphous and metal hydroxide phases than indicated by adsorption modeling. This suggests that cobalt concentrations also may be attenuated during the formation of ferrihydrite (Butt et al. 2000; Tebo et al. 2004). Cobalt was also identified by SEP to be associated with carbonate minerals, likely due to co-precipitation with the dolomite or calcite identified by mineralogical analysis. Arsenic co-precipitation with amorphous phases of iron and other metal oxyhydroxides is also considered possible. However, per the SEP results, no arsenic was found to be associated with carbonate minerals. Co-precipitation is either not likely or relevant for boron, lithium, and molybdenum.

### 5.1.3 Physical Attenuation

Table 9 presents the predicted concentrations at Assessment Monitoring wells, assuming the minimum and maximum amount of dilution and dispersion downgradient of the CCR Unit (Section 4.0). The highest concentrations of arsenic, boron, cobalt, lithium, and molybdenum measured in porewater were “diluted” in the geochemical simulations with the maximum concentrations observed in side-gradient wells GAMW-52, GAMW-52B, GAMW-56, and GAMW-56B to provide a conservative estimate of dilution and dispersion.

For arsenic, cobalt, and lithium, the maximum concentrations in porewater were below the GWPS. Dilution and dispersion with groundwater from side-gradient wells generally resulted in a further decrease below the GWPS. At GAMW-56, arsenic and cobalt concentrations were elevated over those in porewater. Consequently, dilution/dispersion of porewater with water from GAMW-56 resulted in higher concentrations relative to porewater, though still below GWPS.

For boron the maximum porewater concentrations were elevated above the health-based standard (345%) and for molybdenum, the maximum porewater concentrations were elevated above the GWPS (810%). The 32 to 63 percent reduction in concentrations by dilution and dispersion alone was not sufficient to bring the maximum porewater concentrations below the relevant standards. For boron, concentrations in background monitoring well GAMW-15 were twice as high as those in porewater. Due to this background source, boron concentrations in side-gradient wells are also relatively high and limit the effectiveness of dilution to reduce boron concentrations downgradient of the CCR Unit. For molybdenum, concentrations in monitoring wells have been below GWPS since March 2018, indicating additional dilution/dispersion or other attenuating processes have reduced porewater concentrations between the CCR Unit and the monitoring wells. As a consequence, molybdenum concentrations will likely remain below the GWPS.

## 5.2 Long-Term Stability of Attenuated Constituents

The expected variations in dissolved concentration as a function of pH, Eh, and TDS are presented in Figures 16, 17, and 18, respectively. Results are presented along with GWPS values and the range of pH, Eh, or TDS values (5<sup>th</sup> percentile to 95<sup>th</sup> percentile) observed at the Site. Responses to changes in pH, Eh, and TDS vary widely by constituent. The results of the adsorption stability modeling for arsenic, boron, cobalt, and molybdenum can be summarized as follows:

- **Arsenic:** For the range of pH values observed at the site, greater than 95% of the arsenic is expected to sorb to Hfo and Hao (Figure 16a). At pH values below 6.0, a conversion of arsenate to arsenite is modeled to release the adsorbed arsenic into groundwater. For alkaline pH values between 8.0 and 10.0, there is a small amount of additional capacity for arsenic to adsorb. At extremely alkaline conditions (pH greater than 10.0), higher proportions of negatively-charged sorption sites on Hfo and Hao limit the effectiveness of sorption of anionic species, resulting in higher amounts of desorbed arsenic. Under reducing conditions (Eh less than -100 mV), arsenic is largely present as arsenite and sorption is limited (Figure 17a). Over intermediate redox conditions (Eh between 0 and 500 mV), adsorbed arsenic is relatively stable. Above 500 mV, arsenic is expected to desorb again. Under increasing TDS concentrations (Figure 18a), arsenic sorption declines as other anions compete with and replace arsenic from sorption surfaces. For arsenic, TDS concentrations at the Site could quadruple relative to observed values before aqueous concentrations increase above the GWPS.
- **Boron:** Based on the relatively small proportion of boron that can be adsorbed to Hfo and Hao surface sites, changes in pH, Eh, and TDS concentrations are modeled to have only a minor impact on aqueous concentrations, as evidenced by the horizontal trends in Figures 16b, 17b, and 18b.
- **Cobalt:** The pH response of cobalt (Figure 16c) is broadly similar to that of arsenic, with cobalt being nearly completely in dissolved form under acidic conditions but generally sorbed under alkaline conditions. Cobalt was generally modeled to be unresponsive to changes in redox conditions (Figure 17c), with little additional cobalt sorbing or desorbing over the range of tested Eh conditions. Cobalt was also not responsive to increases in TDS concentrations (Figure 18c), with sorption remaining relatively unchanged as TDS concentrations increased 4- to 40-fold above the commonly-observed range at the Site.
- **Molybdenum:** For molybdenum, lower pH values (more acidic conditions) were generally more favorable for adsorption (Figure 16d). At alkaline pH values (pH greater than 10), nearly all molybdenum is desorbed and present in the dissolved phase. Over the range of common Eh values at site (Figure 17d), molybdenum sorption is relatively stable. Highly reducing conditions are predicted to increase molybdenum adsorption and highly oxidizing conditions are predicted to reduce adsorption. Molybdenum adsorption is generally insensitive to increases in TDS concentrations (Figure 18d), with TDS concentrations up to 10,000 mg/L less than doubling the aqueous concentrations due to desorption.

## 6.0 TIER I EVALUATION

The potential for natural attenuation of arsenic, boron, cobalt, lithium, and molybdenum was evaluated in accordance with recommended practices and guidance promulgated by the USEPA and the ITRC (USEPA 2007a; USEPA 2007b; ITRC 2010). According to USEPA (USEPA 2007a), the purpose of the Tier 1 evaluation is to “Demonstrate that the groundwater plume is not expanding and that sorption of the contaminant onto aquifer solids is occurring where immobilization is the predominant attenuation process.” Based on this definition, the following observations support MNA as a viable corrective measure for the CCR Unit:

- **Plume Stability:** Based on the water quality monitoring data presented in this Assessment Monitoring, groundwater concentrations of arsenic, boron, cobalt, lithium, and molybdenum outside of the CCR Unit appear to be stable or decreasing. Evaluation of trend charts generally did not reveal increasing trends in wells downgradient of the CCR Unit (Figures 4 to 8), including for parameters such as boron and sulfate, which are considered common indicators of CCR leaching (Figures 5 and 10). These observations indicate that the distribution of arsenic, boron, cobalt, lithium, and molybdenum in the aquifer is stable.
- **Magnitude of Exceedances:** Arsenic has remained below the CCR Unit GWPS (0.091 mg/L) in all downgradient monitoring wells. Boron concentrations exceed the health-based standard (4 mg/L) in nine of the downgradient (Downgradient Monitoring and Assessment Monitoring) wells, but concentrations are generally within the range of background monitoring well concentrations, suggesting naturally-elevated levels or an alternative source of boron causing the concentrations in groundwater at the Site. The cobalt concentration in groundwater at GAMW-08, the only downgradient monitoring well exceeding the GWPS, has shown a decreasing trend since 2016. The most recent concentration of cobalt (0.011 mg/L in November 2019) was just 0.001 mg/L above the GWPS of 0.010 mg/L. No wells exceed the health-based lithium standard (0.04 mg/L). Molybdenum concentrations in all wells have been consistently below the health-based standard of 0.1 mg/L since August 2017, indicating a low likelihood of a future exceedances based on historical trends.
- **CCR Unit Porewater:** The CCR Unit at RMSGS was placed into service in 1976 and historical records are not available for ash additions or porewater concentrations over the CCR Unit's lifespan. However, based on recent porewater data, the arsenic concentration in the CCR Unit (0.011 mg/L to 0.018 mg/L) is well below the GWPS of 0.091 mg/L. Cobalt and lithium concentrations in porewater in the CCR Unit were low and only detected above their laboratory reporting limit in a single sample (0.0022 mg/L and 0.016 mg/L, respectively). This indicates that the CCR Unit is not a potential source for these metals. Boron concentrations in the porewater (8.3 mg/L to 13.8 mg/L) are elevated above the health-based standard of 4 mg/L but are below levels observed in the two deep background monitoring wells GAMW-07B (15-23 mg/L) and GAMW-15B (13-18 mg/L). Molybdenum in the CCR Unit was measured at concentrations up to 0.81 mg/L, above its GWPS. Even so, molybdenum concentrations in groundwater downgradient of the CCR Unit are currently below the GWPS.
- **Groundwater Chemistry:** The groundwater monitoring results and the findings of the geochemical modeling support the potential for natural attenuation of arsenic, boron, cobalt, lithium, and molybdenum. Equilibrium of groundwater with the mineral phase ferrihydrite was modeled to occur in all groundwater samples and calcite equilibrium was indicated in all downgradient monitoring wells except GAMW-53. This is consistent with the results from the sequential extraction analysis that indicate carbonate, amorphous, and metal hydroxide fractions sequester arsenic, boron, cobalt, lithium, and molybdenum.
- **Confirmation of Attenuation/Immobilization:** Based on both mineralogical and chemical analysis, it is evident that attenuation of arsenic, cobalt, lithium, and molybdenum by aquifer materials is occurring. Iron, capable of forming (hydr)oxide phases that facilitate metals attenuation (Dzombak and Morel 1990), was identified in all overburden samples. Mineralogical analysis confirmed iron was present as an oxide phase in the form of hematite in all overburden samples. Arsenic, cobalt, lithium, and molybdenum demonstrated a high degree of immobilization due to attenuation on carbonate, amorphous, and metal hydroxide fractions. This indicates that these phases have been and are scavenging or attenuating constituents that were once present in solution. Groundwater samples from Assessment Monitoring wells GAMW-53/53B, GAMW-

54/54B, GAMW-55/55B, and GAMW-56/56B report a similar major ion signature as groundwater in monitoring wells proximal to the CCR Unit. However, no arsenic, cobalt, lithium, or molybdenum has been detected in these wells above background levels. In addition, soil borings from these wells contained significant proportions of constituents attenuated in various phases, especially in the case of lithium. As a result, the groundwater concentrations of these constituents are maintained at low levels, demonstrating attenuation.

Based on these findings, arsenic, boron, cobalt, lithium, and molybdenum were considered candidates for an MNA remedy application and were deemed to meet the criteria for Tier I MNA in accordance with USEPA guidance (USEPA 2007a,b).

## 7.0 TIER II EVALUATION

The purpose of the Tier II evaluation is to “Identify mechanisms and rates of the operative attenuation process.” Based on this definition, the following modeling results and observations support MNA as a viable corrective measure for the CCR Unit:

- **Adsorption Capacity Modeling:** PHREEQC modeling results show that adsorption is likely attenuating arsenic, cobalt and, to a lesser degree, molybdenum downgradient of the CCR Unit. This is concluded based on equilibration of site-specific groundwater compositions with the range of Hfo and Hao concentrations observed in SEP results of Site overburden soils. Minor amounts of boron are also expected to attenuate. The sorbing capacity of Hfo and Hao surface sites is partially dependent on the concentrations of the constituents of interest in groundwater. The titration modeling (Figure 15) shows how the soil’s capacity to adsorb constituents increases if groundwater concentrations of arsenic, boron, cobalt, and molybdenum were to increase above current levels. In addition to metal oxyhydroxides, clay minerals and/or particular organics can also act as a substrate for attenuation (Goldberg et al. 1993; Goldberg and Forster 1996), but this mechanism was not included in the current evaluation.

The findings from the modeling are supported by the results of the sequential extraction testing. The presence of arsenic, cobalt, lithium, and molybdenum in the amorphous and metal oxyhydroxide fractions of soils indicates that adsorption is occurring spatially across the monitored area downgradient of the CCR Unit.

- **Co-precipitation:** In addition to adsorption, co-precipitation or the direct incorporation of trace metals such as cobalt into precipitated iron oxide-oxyhydroxides has been well studied in literature (Butt et al. 2000; Dzombak and Morel 1990; Smith 1999). For the soils analyzed by sequential extraction (Section 3.2.2), all samples had higher concentrations of cobalt in the amorphous and metal hydroxide phases than indicated by adsorption modeling. This suggests that cobalt concentrations also may be attenuated during the formation of ferrihydrite (Butt et al. 2000; Tebo et al. 2004). Cobalt was also identified by SEP to be associated with carbonate minerals, likely the result of co-precipitation with dolomite or calcite, which were identified by mineralogical analysis. Arsenic co-precipitation with amorphous phases of iron and other metal oxyhydroxides is also possible. However, there was no arsenic associated with carbonate minerals as identified by SEP. Co-precipitation is either not likely or relevant for boron, lithium, and molybdenum.
- **Estimated Site Attenuation Rates:** Concentrations of boron, cobalt, lithium, and molybdenum are decreasing in downgradient monitoring wells, resulting in negative calculated point decay rates. A positive point decay rate for arsenic suggests that its concentrations are increasing, but low concentrations in porewater indicate that the trend does not imply an impact from the CCR Unit. Increasing arsenic concentrations in Assessment Monitoring wells GAMW-52B, GAMW-53B, GAMW-54, and GAMW-54B are



driving the positive point decay rate, but the arsenic concentrations in these wells are low (less than 0.005 mg/L) and are likely driven by natural variability. Using the mean decay rate, maximum concentrations of boron, cobalt and molybdenum observed in downgradient and Assessment monitoring wells would take approximate 41 years, 39 years, and 20 years, respectively, to attenuate to below GWPS. Arsenic and lithium concentrations in downgradient and Assessment Monitoring wells are already below the GWPS.

- **Advanced Groundwater Modeling:** Groundwater flow results indicate between 32% and 63% dilution and dispersion of groundwater at monitoring wells with upgradient and side-gradient water as it flows towards the Assessment Monitoring wells. This dilution and dispersion attenuate concentrations along the flow paths. Arsenic, cobalt, and lithium concentrations in porewater are already below GWPS in the available monitoring data (August 2018 to March 2020). Dilution and dispersion with groundwater from side-gradient Assessment Monitoring wells (GAMW-52/52B and GAMW-56/56B) would further reduce these concentrations relative to the GWPS. Boron and molybdenum concentrations are elevated above the health-based standards in porewater (and in background wells for boron). As such, while dilution and dispersion reduce concentrations by about 30% to 60%, this is insufficient to dilute porewater to such a degree that the resulting boron and molybdenum concentration decline to below the health-based standards. The concentrations of molybdenum measured in downgradient groundwater at Assessment Monitoring wells have remained below the GWPS, so additional physical and/or chemical attenuation is likely occurring between the CCR Unit and the Assessment Monitoring wells. Modeled groundwater velocities indicate that travel times between downgradient and Assessment Monitoring wells are between 4.5 and 31 years. The modeling results also indicate that groundwater would take between 27 and 130 years to travel from the downgradient monitoring wells to the property boundary (GAMW-46/46B).

Based on these findings, arsenic, boron, cobalt, lithium, and molybdenum were considered to be candidates for an MNA remedy application and deemed to meet the criteria for Tier II MNA in accordance with USEPA guidance (USEPA 2007a and 2007b).

## 8.0 TIER III EVALUATION

According to USEPA (USEPA 2007a), the purpose of the Tier III evaluation is to eliminate sites for an MNA remedy where (1) "Capacity of the aquifer is insufficient to attenuate the COC mass to regulatory standards" and/or (2) "Stability of the immobilized COC is insufficient to prevent remobilization due to future changes in groundwater chemistry". Based on this definition, the following observations support MNA as a viable corrective measure for the CCR Unit:

- **Adsorption Capacity Modeling:** For arsenic, titration modeling shows that groundwater concentrations could increase up to approximately 2.5 mg/L before exceeding the capacity of soils (95<sup>th</sup> percentile of scenarios) to attenuate arsenic below the GWPS (0.091 mg/L). Groundwater arsenic concentrations up to 10 mg/L are predicted to attenuate below the GWPS for the average soil capacity scenario. Similarly, cobalt concentrations in groundwater could increase up to approximately 0.02 mg/L before exceeding the capacity of soils (95<sup>th</sup> percentile of scenarios) to attenuate cobalt below the GWPS (0.01 mg/L). Under the average soil capacity scenario, the aquifer has the capacity to reduce cobalt concentrations as high as 0.1 mg/L to below the GWPS.

For boron and molybdenum, modeling suggests that adsorption can reduce a portion of the dissolved load, but that there is not sufficient adsorption capacity alone to reduce the concentrations observed in porewater below the health-based standard. However, current molybdenum concentrations observed in downgradient

and Assessment Monitoring wells indicate that the combined long-term attenuation from sorption, dilution, and dispersion is sufficient to reduce concentrations below health-based standards. In addition to iron oxyhydroxides, molybdenum and boron (as well as arsenic and cobalt) are known to adsorb to other metal (hydr)oxides (e.g., manganese, aluminum), clay minerals and particulate organic matter, providing additional sorption capacity in the soils.

- **Stability Modeling for Adsorbed Constituents:** Stability modeling indicates that for the conditions (i.e. pH, Eh, and TDS ranges) determined in groundwater at the Site, adsorbed species of arsenic, boron, cobalt, and molybdenum are relatively stable and remain attenuated. The modeling results further suggest that the adsorption of arsenic, cobalt, and molybdenum could be reversed with sufficiently large fluctuations in pH and Eh conditions at the Site, but there is no historical basis to expect such occurrences. Based on the mineralogical test results for Site soils, carbonate minerals are widely distributed downgradient of the CCR Unit. Groundwater that is in contact with carbonate minerals is typically buffered against large fluctuations in pH. Total alkalinity concentrations in groundwater at the Site (generally between 50 and 410 mg CaCO<sub>3</sub>/L) support the notion that the groundwater has significant buffering capacity.

Modeling results also indicate that increasing TDS concentrations could result in an increase in aqueous concentrations of arsenic, cobalt, and molybdenum due to competition for sorption sites. However, the impact is predicted to be relatively minor over the range of TDS concentrations observed at the site. The maximum TDS concentration measured in porewater was 3,830 mg/L and even at those levels, there is sufficient attenuation capacity from the soils to maintain arsenic, boron, cobalt, and molybdenum concentrations below GWPS

## 9.0 CONCLUSIONS

Golder performed a supplemental Assessment Monitoring followed by an attenuation evaluation, which serve as the Tier I, II, and III evaluation of MNA feasibility at RMSGS for arsenic, boron, cobalt, lithium, and molybdenum with respect to the CCR Unit. This evaluation has been completed in accordance with guidance and best practices promulgated by the USEPA (USEPA 2007a and 2007b) and the ITRC (ITRC 2010). Based on the results of this evaluation, Golder makes the following assessment for the individual parameters:

- **Arsenic:** Physical and chemical attenuation is occurring and co-precipitation is possible, levels are stable, and the aquifer has the capacity to attenuate arsenic. Arsenic is a candidate for MNA at the RMSGS Site.
- **Boron:** Physical attenuation of boron is occurring at the RMSGS based on substantial decreases of boron in assessment wells. However, the high levels of boron upgradient of the CCR impoundments make it difficult to determine if the evaluation of if MNA will be successful. An alternative or natural source of boron should be further investigated prior to making a MNA determination for boron based on current findings.
- **Cobalt:** Chemical and physical attenuation is occurring and co-precipitation is possible, levels are stable, and the aquifer has the capacity to attenuate arsenic. Cobalt is a candidate for MNA at the RMSGS Site.
- **Lithium:** Physical attenuation is occurring, levels are stable, and the aquifer has the capacity to attenuate arsenic. Lithium is a candidate for MNA at the RMSGS Site.
- **Molybdenum:** Physical and some chemical attenuation is occurring, levels are stable, and the aquifer has the capacity to attenuate arsenic. Molybdenum is a candidate for MNA at the RMSGS Site.

Therefore, it is recommended that a Tier IV evaluation be completed to design a long-term monitoring plan and contingent remedy for arsenic, boron, cobalt, lithium, and molybdenum.

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## Signature Page

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Tables

**Table 4: Summary of Travel Time Simulations and Attenuation Estimates**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

	Shallow Flow Paths				Deep Flow Paths			
Starting Well	GAMW-16	GAMW-18	GAMW-17B	GAMW-09B	GAMW-16B	GAMW-18B	GAMW-17B	GAMW-09B
Ending Well	GAMW-53	GAMW-55	GAMW-54B	GAMW-54B	GAMW-53B	GAMW-55B	GAMW-54B	GAMW-54B
Distance (ft)	1521	1964	1200	1714	1521	1964	1200	1714
<b>Effective Porosity = 16%</b>								
Travel Time (years)	4.8	11.0	4.5	8.9	5.0	11.0	5.5	9.0
Velocity (ft/year)	317	179	267	193	304	179	218	190
Time to Davis Ditch (years)	5.5	-	-	-	6	-	-	-
Time to property boundry near GAMW46B (years)	-	27	49	41	-	28.5	45	41
<b>Effective Porosity = 30%</b>								
Travel Time (years)	8.5	19.8	8.0	16.0	8.9	20.0	10.0	16.5
Velocity (ft/year)	179	99	150	107	171	98	120	104
Time to Davis Ditch (years)	10	-	-	-	9.9	-	-	-
Time to property boundry near GAMW46B (years)	-	49.8	79	75	-	51.5	80	76
<b>Effective Porosity = 46%</b>								
Travel Time (years)	13.0	31.0	12.0	25.0	13.5	29.0	15.0	25.0
Velocity (ft/year)	117	63	100	69	113	68	80	69
Time to Davis Ditch (years)	15	-	-	-	15	-	-	-
Time to property boundry near GAMW46B (years)	-	76.8	122	117	-	77	130	120
<b>Estimate of Dilution/Attenuation Along Flow Path</b>								
Starting concentration (mg/L)	9.7	13	12	12	9.7	13	12	12
End concentration (mg/L)	3.1	8.2	6.4	6.4	3.1	8.2	6.4	6.4
End Concentration as % of starting concentration	32%	63%	53%	53%	32%	63%	53%	53%
Dilution/Attenuation along flow path	68%	37%	47%	47%	68%	37%	47%	47%

**Notes:**

ft = feet

mg/L = milligrams per liter

Prepared by: GOL  
 Checked by: PJN  
 Reviewed by: RWB

**Table 5: Groundwater Geochemical Modeling Results**  
**Monitored Natural Attenuation Evaluation**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAPIEZ06	GAPIEZ06	GAPIEZ06	DAPZ-02A	DAPZ-02B	GAMW04	GAMW04	GAMW04	GAMW07	GAMW07	GAMW07	GAMW07B	GAMW07B	GAMW07B	GAMW07B
		08-2018	09-2018	10-2018	03-2020	03-2020	10-2018	04-2019	11-2019	10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019
Charge Balance	% error	-3.9	-1.3	-5.5	-7.8	-4.3	5.1	-1.3	-9.0	-3.7	-3.7	<b>-10.8</b>	<b>82.8</b>	-6.8	-7.0	<b>-10.1</b>
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>																
Otavite	CdCO <sub>3</sub>	-2.3	-2.3	-1.1	-3.2	-2.6	-2.9	-3.1	-2.4	-3.8	-2.3	-2.1	-1.5	-3.2	-2.4	-2.8
Ferrihydrite	Fe(OH) <sub>3</sub>	<b>2.1</b>	<b>2.1</b>	<b>3.1</b>	<b>0.5</b>	<b>2.2</b>	<b>2.9</b>	<b>1.4</b>	<b>0.5</b>	-6.6	<b>1.9</b>	<b>0.4</b>	<b>3.6</b>	-1.6	<b>4.2</b>	<b>-0.2</b>
Siderite	FeCO <sub>3</sub>	<b>-0.1</b>	<b>-0.1</b>	-0.8	<b>-0.4</b>	-0.7	-2.1	<b>0.5</b>	-1.7	-3.3	-3.6	-1.4	<b>1.1</b>	-0.5	-0.7	<b>-0.3</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-4.9	-5.0	-7.2	-4.5	-5.1	-6.1	-4.0	-6.5	-6.7	-8.3	-6.5	-6.8	-4.4	-5.3	-4.5
Anglesite	PbSO <sub>4</sub>	-4.5	-4.5	-6.1	-4.2	-4.4	-4.0	-4.2	-4.5	-4.2	-4.5	-4.7	-7.4	-4.0	-4.3	-4.1
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-0.6	-0.6	-0.6	-0.7	-1.0	<b>0.0</b>	<b>-0.4</b>	-0.7	-0.6	-0.7	-0.7	-2.5	<b>-0.2</b>	<b>-0.2</b>	<b>-0.2</b>
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-7.1	-6.9	-11.4	-7.6	-5.6	-3.6	-8.9	-10.7	-26.4	-6.7	-12.2	-10.2	-15.0	-0.7	-12.1
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>-0.4</b>	<b>-0.3</b>	-3.0	-2.1	<b>1.3</b>	<b>4.5</b>	-1.3	-4.3	-21.4	<b>0.2</b>	-5.3	-2.2	-8.4	<b>6.8</b>	-5.1
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-2.5	-2.4	-4.9	-5.0	-1.8	<b>1.6</b>	-3.0	-6.7	-24.5	-3.0	-8.6	-4.3	-10.6	<b>4.5</b>	-7.6
Calcite	CaCO <sub>3</sub>	<b>0.3</b>	<b>0.2</b>	<b>1.8</b>	-0.6	<b>-0.4</b>	<b>0.0</b>	<b>0.1</b>	<b>0.1</b>	-1.2	<b>0.2</b>	<b>0.4</b>	<b>1.3</b>	<b>-0.3</b>	<b>0.4</b>	<b>0.0</b>
Magnesite	MgCO <sub>3</sub>	-0.9	-1.0	<b>0.5</b>	-2.1	-1.7	-1.5	-1.4	-1.3	-2.6	-1.1	-0.9	<b>0.0</b>	-1.5	-0.8	-1.3
Barite	BaSO <sub>4</sub>	<b>0.7</b>	<b>0.6</b>	<b>0.7</b>	<b>1.0</b>	<b>0.9</b>	<b>0.9</b>	<b>1.1</b>	<b>0.9</b>	<b>0.9</b>	<b>0.9</b>	<b>0.7</b>	-1.2	<b>1.2</b>	<b>1.1</b>	<b>1.0</b>
Witherite	BaCO <sub>3</sub>	-3.8	-3.9	-2.3	-4.4	-3.9	-4.4	-3.7	-3.6	-5.1	-3.7	-3.5	-2.7	-4.3	-3.6	-4.1
Fluorite	CaF <sub>2</sub>	-1.0	-0.8	-1.0	-2.0	-2.4	-2.3	-1.5	-2.1	-1.1	-0.8	-1.0	<b>0.8</b>	<b>-0.4</b>	-0.6	-0.6
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-4.2	-4.4	-2.9	-4.3	-4.2	-4.1	-4.2	-4.3	-4.3	-3.1	-3.0	-3.2	-5.0	-4.2	-4.6
Cerrusite	PbCO <sub>3</sub>	-2.0	-2.1	-2.1	-2.6	-2.0	-2.2	-2.0	-2.1	-3.2	-2.0	-2.0	-1.9	-2.5	-2.0	-2.2
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-2.3	-2.2	-4.5	-1.0	-1.8	-2.4	-2.4	-1.7	<b>-0.3</b>	-1.8	-2.1	-3.2	-1.6	-2.4	-2.0

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW08	GAMW08	GAMW08	GAMW08B	GAMW08B	GAMW08B	GAMW08B	GAMW09	GAMW09	GAMW09	GAMW09B	GAMW09B	GAMW09B	GAMW09B
		10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019	10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019
Charge Balance	% error	-2.9	-3.7	-6.6	-9.7	<b>-12.2</b>	-8.3	<b>-11.7</b>	-5.0	-5.0	-6.0	-5.7	-6.7	-3.0	-6.5
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>															
Otavite	CdCO <sub>3</sub>	-2.5	-2.1	-2.0	-2.3	-2.5	-2.5	-2.2	-3.0	-2.8	-2.8	-2.4	-2.3	-2.2	-2.2
Ferrihydrite	Fe(OH) <sub>3</sub>	<b>1.7</b>	<b>2.3</b>	<b>2.4</b>	<b>1.8</b>	<b>3.1</b>	<b>4.1</b>	<b>3.6</b>	<b>0.2</b>	<b>1.3</b>	<b>0.7</b>	<b>2.0</b>	<b>2.5</b>	<b>3.7</b>	<b>2.2</b>
Siderite	FeCO <sub>3</sub>	-1.8	-2.2	-2.1	<b>0.2</b>	<b>0.1</b>	<b>-0.4</b>	<b>0.1</b>	-2.3	-3.1	-2.5	<b>-0.2</b>	<b>-0.1</b>	<b>-0.2</b>	<b>0.1</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-6.7	-7.3	-7.2	-4.5	-4.4	-4.9	-4.6	-6.7	-7.3	-7.0	-5.1	-5.1	-5.2	-5.0
Anglesite	PbSO <sub>4</sub>	-4.6	-4.8	-4.8	-4.4	-4.2	-4.2	-4.4	-4.3	-4.2	-4.3	-4.5	-4.6	-4.7	-4.7
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-0.7	-0.6	-0.5	<b>-0.2</b>	<b>-0.2</b>	<b>-0.2</b>	<b>-0.2</b>	-0.7	-0.6	-0.8	-0.8	-0.7	-0.8	-0.9
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-6.6	-6.5	-6.5	-8.4	-3.5	-0.9	-3.6	-10.6	-8.2	-10.1	-6.8	-6.1	-2.6	-7.3
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>0.0</b>	<b>0.9</b>	<b>1.0</b>	-1.3	<b>3.4</b>	<b>6.2</b>	<b>4.0</b>	-4.3	-1.3	-3.7	<b>-0.3</b>	<b>0.5</b>	<b>4.2</b>	-0.7
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-2.9	-2.1	-1.9	-3.1	<b>1.4</b>	<b>4.3</b>	<b>2.0</b>	-7.1	-4.2	-6.5	-2.2	-1.5	<b>2.1</b>	-2.9
Calcite	CaCO <sub>3</sub>	<b>0.2</b>	<b>0.5</b>	<b>0.7</b>	<b>0.6</b>	<b>0.3</b>	<b>0.3</b>	<b>0.6</b>	<b>-0.3</b>	<b>-0.3</b>	<b>-0.4</b>	<b>0.0</b>	<b>0.3</b>	<b>0.2</b>	<b>0.2</b>
Magnesite	MgCO <sub>3</sub>	-1.2	-0.7	-0.6	-0.9	-1.1	-1.2	-0.8	-2.0	-1.8	-2.0	-1.0	-0.8	-0.8	-0.8
Barite	BaSO <sub>4</sub>	<b>0.7</b>	<b>0.9</b>	<b>1.0</b>	<b>1.0</b>	<b>0.9</b>	<b>0.8</b>	<b>0.8</b>	<b>0.6</b>	<b>0.8</b>	<b>0.6</b>	<b>0.8</b>	<b>0.8</b>	<b>0.7</b>	<b>0.5</b>
Witherite	BaCO <sub>3</sub>	-3.7	-3.3	-3.2	-3.6	-4.0	-4.0	-3.7	-4.3	-4.2	-4.3	-3.7	-3.6	-3.6	-3.7
Fluorite	CaF <sub>2</sub>	<b>-0.4</b>	<b>-0.1</b>	<b>-0.2</b>	<b>-0.4</b>	<b>-0.5</b>	<b>-0.2</b>	<b>-0.3</b>	-1.9	-1.9	-1.9	-0.5	-0.6	-0.6	-0.6
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-2.9	-2.8	-2.5	-4.0	-4.4	-4.3	-4.0	-4.8	-4.7	-4.8	-4.1	-4.3	-4.4	-4.0
Cerrusite	PbCO <sub>3</sub>	-2.2	-1.9	-1.9	-2.0	-2.1	-2.1	-1.9	-2.4	-2.2	-2.3	-2.1	-2.0	-2.0	-2.0
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-1.5	-1.8	-2.0	-2.6	-2.3	-2.5	-2.7	-1.7	-2.1	-2.0	-2.1	-2.2	-2.2	-2.4

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW15	GAMW15	GAMW15	GAMW15B	GAMW15B	GAMW15B	GAMW15B	GAMW16	GAMW16	GAMW16	GAMW16B	GAMW16B	GAMW16B	GAMW16B
		10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019	10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019
Charge Balance	% error	0.4	-4.5	-7.1	-5.7	-3.8	-5.0	-5.3	-0.7	-7.5	8.2	-3.0	-2.7	-4.4	-8.7
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>															
Otavite	CdCO <sub>3</sub>	-4.3	-2.6	-2.3	-2.0	-3.0	-2.5	-2.3	-2.3	-2.2	-4.1	-1.8	-2.7	-2.4	-2.1
Ferrihydrite	Fe(OH) <sub>3</sub>	-6.2	<b>2.7</b>	<b>2.5</b>	<b>3.3</b>	-2.6	<b>3.8</b>	<b>1.1</b>	<b>0.0</b>	<b>3.3</b>	<b>4.1</b>	<b>4.1</b>	<b>0.5</b>	<b>4.2</b>	<b>3.8</b>
Siderite	FeCO <sub>3</sub>	-1.6	<b>0.1</b>	<b>0.2</b>	<b>0.0</b>	-0.9	-0.8	<b>0.0</b>	<b>-0.3</b>	-0.7	-3.0	<b>0.6</b>	<b>-0.1</b>	<b>-0.1</b>	<b>0.5</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-4.7	-4.4	-4.9	-5.1	-5.0	-5.2	-4.8	-5.3	-5.6	-6.2	-4.8	-4.6	-4.8	-4.5
Anglesite	PbSO <sub>4</sub>	-4.3	-4.4	-4.7	-4.7	-4.1	-4.2	-4.5	-4.6	-4.5	-4.1	-4.9	-4.3	-4.4	-4.6
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-1.1	-0.9	-1.1	-0.6	-0.6	<b>-0.3</b>	<b>-0.4</b>	-0.9	-0.6	-0.6	<b>-0.4</b>	<b>-0.4</b>	<b>-0.3</b>	<b>-0.3</b>
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-23.5	-4.2	-5.9	-4.8	-18.1	-1.4	-10.2	-13.0	-3.6	-2.5	-2.9	-9.9	-0.7	-3.0
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-19.4	<b>2.5</b>	<b>0.5</b>	<b>2.3</b>	-12.0	<b>5.9</b>	-3.2	-6.6	<b>3.4</b>	<b>4.5</b>	<b>4.3</b>	-3.7	<b>6.4</b>	<b>4.3</b>
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-21.9	<b>-0.1</b>	-2.0	<b>0.3</b>	-13.9	<b>3.9</b>	-5.3	-9.1	<b>0.8</b>	<b>1.9</b>	<b>2.1</b>	-5.9	<b>4.1</b>	<b>2.6</b>
Calcite	CaCO <sub>3</sub>	-2.1	<b>-0.3</b>	<b>-0.1</b>	<b>0.6</b>	<b>-0.4</b>	<b>0.2</b>	<b>0.4</b>	<b>0.1</b>	<b>0.3</b>	-1.5	<b>0.9</b>	<b>0.1</b>	<b>0.4</b>	<b>0.7</b>
Magnesite	MgCO <sub>3</sub>	-3.4	-1.4	-1.3	-0.8	-1.8	-0.9	-1.0	-1.4	-1.1	-3.0	<b>-0.5</b>	-1.4	-0.9	-0.7
Barite	BaSO <sub>4</sub>	<b>0.5</b>	<b>0.8</b>	<b>0.5</b>	<b>1.1</b>	<b>1.0</b>	<b>1.4</b>	<b>1.0</b>	<b>0.5</b>	<b>0.7</b>	<b>0.6</b>	<b>1.0</b>	<b>1.0</b>	<b>1.2</b>	<b>1.1</b>
Witherite	BaCO <sub>3</sub>	-5.8	-4.0	-3.8	-3.1	-4.2	-3.5	-3.5	-3.9	-3.7	-5.6	-3.0	-3.9	-3.4	-3.2
Fluorite	CaF <sub>2</sub>	-1.3	-1.5	-1.3	-1.4	-1.3	-1.0	-0.9	-0.8	-0.8	-0.8	-1.0	-1.1	-1.0	-0.9
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-5.5	-3.6	-3.6	-4.0	-4.8	-4.3	-4.1	-4.1	-4.0	-5.8	-3.6	-4.5	-4.2	-3.9
Cerrusite	PbCO <sub>3</sub>	-3.7	-2.1	-2.1	-1.9	-2.4	-2.0	-2.0	-2.1	-2.0	-3.4	-1.9	-2.3	-2.0	-2.0
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	<b>0.1</b>	-1.9	-2.1	-2.6	-1.5	-2.2	-2.4	-2.0	-2.2	-4.8	-2.7	-1.7	-2.3	-2.6

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm



**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW17	GAMW17	GAMW17	GAMW17B	GAMW17B	GAMW17B	GAMW17B	GAMW18	GAMW18	GAMW18	GAMW18B	GAMW18B	GAMW18B	GAMW18B
		10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019	10-2018	04-2019	11-2019	09-2018	10-2018	04-2019	11-2019
Charge Balance	% error	0.8	-0.5	-6.6	-3.6	1.1	0.6	-4.3	<b>-10.9</b>	-6.4	-9.2	-3.2	<b>-10.4</b>	<b>-48.7</b>	<b>-10.9</b>
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>															
Otavite	CdCO <sub>3</sub>	-2.8	-2.2	-1.9	-2.0	-2.2	-2.3	-2.0	-3.0	-3.0	-2.5	-2.0	-2.9	-4.7	-2.1
Ferrihydrite	Fe(OH) <sub>3</sub>	-2.9	<b>2.5</b>	<b>2.9</b>	<b>3.3</b>	<b>0.1</b>	<b>3.6</b>	<b>4.3</b>	-0.7	<b>1.7</b>	<b>0.9</b>	<b>2.8</b>	<b>0.6</b>	<b>2.1</b>	<b>2.2</b>
Siderite	FeCO <sub>3</sub>	-2.1	-2.6	-2.6	<b>0.4</b>	<b>0.3</b>	<b>0.1</b>	<b>-0.1</b>	-2.5	-2.9	-1.8	<b>0.6</b>	-0.5	-5.1	<b>0.1</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-6.8	-7.7	-8.1	-5.0	-4.9	-5.0	-5.5	-6.7	-6.8	-6.4	-4.5	-4.7	-7.3	-4.9
Anglesite	PbSO <sub>4</sub>	-4.5	-4.8	-5.0	-4.9	-4.8	-4.8	-4.9	-4.3	-4.1	-4.3	-4.6	-4.1	-3.7	-4.6
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-0.8	-1.0	-1.1	-0.9	-0.9	-1.0	-0.9	-0.6	<b>-0.4</b>	<b>-0.3</b>	<b>-0.4</b>	<b>-0.5</b>	<b>-0.4</b>	-0.6
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-19.9	-6.7	-6.3	-4.5	-13.3	-2.1	-1.6	-12.0	-5.3	-9.3	-5.6	-8.8	-5.3	-7.6
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-14.0	<b>0.2</b>	<b>0.6</b>	<b>2.5</b>	-6.5	<b>4.7</b>	<b>5.5</b>	-6.4	<b>0.8</b>	-2.8	<b>1.6</b>	-2.6	<b>1.1</b>	-0.5
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-16.7	-2.4	-2.1	<b>0.2</b>	-8.8	<b>1.8</b>	<b>2.9</b>	-9.0	-1.7	-5.3	<b>-0.3</b>	-4.4	-2.5	-2.4
Calcite	CaCO <sub>3</sub>	<b>-0.2</b>	<b>0.1</b>	<b>0.4</b>	<b>0.5</b>	<b>0.3</b>	<b>0.2</b>	<b>0.4</b>	<b>-0.4</b>	<b>-0.4</b>	<b>0.3</b>	<b>0.6</b>	<b>-0.3</b>	-2.1	<b>0.4</b>
Magnesite	MgCO <sub>3</sub>	-1.4	-0.8	-0.7	-0.9	-1.0	-0.9	-0.7	-2.2	-2.1	-1.5	-0.6	-1.5	-4.6	-0.7
Barite	BaSO <sub>4</sub>	<b>0.8</b>	<b>0.6</b>	<b>0.6</b>	<b>0.7</b>	<b>0.8</b>	<b>0.9</b>	<b>0.8</b>	<b>0.7</b>	<b>0.9</b>	<b>1.0</b>	<b>1.0</b>	<b>0.9</b>	<b>1.0</b>	<b>0.6</b>
Witherite	BaCO <sub>3</sub>	-4.0	-3.6	-3.3	-3.2	-3.4	-3.3	-3.2	-4.5	-4.5	-3.8	-3.3	-4.3	-6.0	-3.7
Fluorite	CaF <sub>2</sub>	<b>-0.5</b>	-0.6	-0.6	-1.1	-1.3	-1.3	-1.3	-3.3	-2.9	-2.3	-1.2	-1.3	-0.9	-1.0
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-4.6	-4.0	-3.8	-4.0	-4.0	-4.2	-3.8	-4.8	-5.2	-4.3	-4.1	-5.0	-6.8	-4.3
Cerrusite	PbCO <sub>3</sub>	-2.4	-2.0	-2.0	-2.0	-2.0	-2.1	-2.0	-2.5	-2.4	-2.1	-2.0	-2.3	-3.8	-2.0
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-1.6	-2.4	-2.6	-2.3	-2.1	-1.7	-2.4	-1.2	-1.5	-1.8	-2.4	-1.5	-3.9	-2.4

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW52	GAMW52	GAMW52	GAMW52	GAMW52B	GAMW52B	GAMW52B	GAMW52B	GAMW53	GAMW53	GAMW53	GAMW53	GAMW53B	GAMW53B
		09-2018	10-2018	05-2019	11-2019	09-2018	10-2018	05-2019	11-2019	09-2018	10-2018	04-2019	11-2019	09-2018	10-2018
Charge Balance	% error	-2.9	3.4	4.0	-1.3	-7.2	1.1	-1.7	-6.4	3.9	2.9	-1.5	1.3	-0.7	-1.6
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>															
Otavite	CdCO <sub>3</sub>	-1.9	-2.7	-2.3	-1.9	-1.6	-2.9	-2.3	-2.4	-3.5	-3.0	-4.0	-3.5	-2.2	-2.2
Ferrihydrite	Fe(OH) <sub>3</sub>	<b>2.9</b>	<b>2.2</b>	<b>2.3</b>	<b>2.3</b>	<b>3.4</b>	<b>1.5</b>	<b>3.8</b>	<b>2.0</b>	<b>-0.1</b>	-1.9	-0.8	-1.1	<b>1.1</b>	<b>1.3</b>
Siderite	FeCO <sub>3</sub>	-1.0	-2.7	-3.1	-1.3	<b>1.2</b>	<b>-0.1</b>	<b>-0.4</b>	<b>-0.1</b>	-1.4	-1.1	-2.9	-2.3	<b>0.1</b>	<b>0.1</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-6.9	-8.4	-8.9	-7.3	-5.2	-5.3	-5.7	-5.3	-5.9	-6.0	-6.7	-6.7	-5.1	-5.1
Anglesite	PbSO <sub>4</sub>	-5.4	-5.3	-5.5	-5.5	-5.9	-4.9	-5.0	-4.8	-4.4	-4.6	-4.5	-4.7	-4.8	-4.7
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-1.6	-2.0	-2.3	-1.7	-1.2	-1.2	-1.3	-1.1	-2.0	-1.9	-2.4	-2.3	-0.8	-0.7
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-6.2	-7.4	-7.9	-8.7	-7.5	-8.4	-2.7	-7.4	-9.6	-16.9	-11.6	-13.6	-9.8	-9.2
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>0.3</b>	-1.3	-1.7	-2.0	<b>0.1</b>	-1.9	<b>4.2</b>	-0.7	-5.0	-11.7	-6.6	-8.6	-3.6	-2.8
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-2.4	-4.1	-4.5	-4.7	-1.8	-3.8	<b>2.2</b>	-2.6	-7.9	-14.6	-9.6	-11.7	-5.6	-4.8
Calcite	CaCO <sub>3</sub>	<b>0.2</b>	<b>-0.4</b>	<b>-0.4</b>	<b>0.2</b>	<b>1.1</b>	<b>0.0</b>	<b>0.1</b>	<b>0.1</b>	-1.7	-1.1	-2.6	-2.0	<b>0.3</b>	<b>0.3</b>
Magnesite	MgCO <sub>3</sub>	-1.1	-1.6	-1.5	-1.0	<b>-0.2</b>	-1.3	-1.1	-1.2	-2.9	-2.4	-3.5	-3.0	-1.3	-1.3
Barite	BaSO <sub>4</sub>	<b>0.0</b>	-0.6	-0.8	<b>-0.3</b>	<b>1.1</b>	<b>1.1</b>	<b>1.1</b>	<b>1.3</b>	<b>-0.3</b>	<b>-0.3</b>	<b>-0.3</b>	<b>-0.3</b>	<b>0.6</b>	<b>0.7</b>
Witherite	BaCO <sub>3</sub>	-3.5	-4.3	-4.3	-3.7	-1.9	-3.1	-2.8	-2.9	-5.3	-4.8	-5.9	-5.3	-3.5	-3.5
Fluorite	CaF <sub>2</sub>	-2.0	-2.2	-2.4	-2.1	<b>0.4</b>	-2.4	-2.4	-2.3	-2.8	-2.7	-4.8	-4.7	-1.5	-1.6
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-3.7	-4.4	-4.2	-3.8	-3.2	-4.5	-4.0	-4.1	-5.1	-4.6	-5.9	-5.4	-4.0	-4.0
Cerrusite	PbCO <sub>3</sub>	-2.0	-2.1	-2.0	-2.0	-2.0	-2.2	-2.0	-2.1	-2.6	-2.3	-3.1	-2.8	-2.1	-2.1
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-2.1	-1.8	-1.9	-2.3	-3.0	-1.8	-2.1	-2.1	-0.9	-1.3	-1.2	-1.3	-1.9	-2.0

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW53B	GAMW53B	GAMW54	GAMW54	GAMW54	GAMW54	GAMW54B	GAMW54B	GAMW54B	GAMW54B	GAMW55	GAMW55	GAMW55B	GAMW55B
		04-2019	11-2019	09-2018	10-2018	04-2019	11-2019	09-2018	10-2018	05-2019	11-2019	09-2018	10-2018	09-2018	10-2018
Charge Balance	% error	-2.8	-2.7	-1.7	2.0	-3.0	-3.0	-1.5	1.8	-6.0	-3.8	-1.3	0.7	-6.0	-2.6
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>															
Otavite	CdCO <sub>3</sub>	-2.1	-2.1	-3.3	-1.7	-2.8	-2.3	-2.7	-1.2	-2.4	-2.4	-2.8	-2.5	-2.6	-2.5
Ferrihydrite	Fe(OH) <sub>3</sub>	<b>4.1</b>	<b>3.3</b>	<b>1.5</b>	<b>-0.3</b>	<b>1.4</b>	<b>1.0</b>	<b>1.0</b>	<b>2.9</b>	<b>3.4</b>	<b>2.8</b>	<b>2.1</b>	<b>0.9</b>	<b>1.2</b>	<b>1.7</b>
Siderite	FeCO <sub>3</sub>	<b>-0.4</b>	<b>0.1</b>	-2.5	-0.6	-2.1	-1.1	<b>-0.1</b>	<b>1.5</b>	<b>0.1</b>	<b>0.1</b>	-1.2	-1.4	<b>-0.1</b>	<b>0.0</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-5.8	-5.3	-6.7	-6.6	-6.6	-6.5	-4.7	-4.7	-4.8	-4.7	-5.8	-6.1	-4.7	-4.7
Anglesite	PbSO <sub>4</sub>	-4.9	-4.9	-4.5	-5.4	-4.5	-5.1	-4.3	-5.8	-4.5	-4.5	-4.4	-4.5	-4.4	-4.4
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-0.9	-1.0	-1.3	-1.4	-1.2	-1.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.5	-0.5	<b>-0.5</b>
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-1.4	-4.2	-4.8	-17.1	-7.5	-10.3	-8.3	-9.7	-2.4	-3.8	-4.3	-9.0	-7.9	-6.8
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>5.2</b>	<b>2.4</b>	<b>0.0</b>	-10.5	-1.7	-4.4	-2.1	-1.6	<b>4.2</b>	<b>2.7</b>	<b>1.7</b>	-2.6	-1.7	<b>-0.4</b>
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>3.0</b>	<b>0.2</b>	-2.4	-12.9	-4.1	-7.0	-4.0	-3.6	<b>2.2</b>	<b>0.7</b>	-0.9	-5.2	-3.6	-2.3
Calcite	CaCO <sub>3</sub>	<b>0.4</b>	<b>0.3</b>	-1.1	<b>0.5</b>	-0.7	<b>-0.2</b>	<b>-0.1</b>	<b>1.6</b>	<b>0.2</b>	<b>0.2</b>	<b>-0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.2</b>
Magnesite	MgCO <sub>3</sub>	-1.1	-1.2	-2.5	-0.8	-1.8	-1.5	-1.5	<b>0.2</b>	-1.1	-1.1	-1.7	-1.4	-1.4	-1.2
Barite	BaSO <sub>4</sub>	<b>0.5</b>	<b>0.7</b>	<b>0.4</b>	<b>0.3</b>	<b>0.4</b>	<b>-0.1</b>	<b>1.1</b>	<b>1.1</b>	<b>1.1</b>	<b>1.1</b>	<b>1.0</b>	<b>0.9</b>	<b>1.3</b>	<b>1.2</b>
Witherite	BaCO <sub>3</sub>	-3.5	-3.3	-4.8	-3.2	-4.4	-4.0	-3.7	-2.1	-3.5	-3.5	-3.8	-3.7	-3.5	-3.4
Fluorite	CaF <sub>2</sub>	-1.5	-1.3	-2.6	-2.6	-2.7	-2.2	-1.7	-1.5	-1.4	-1.3	-1.4	-1.5	-2.0	-2.1
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-3.9	-3.9	-5.1	-3.5	-4.6	-4.2	-4.5	-3.0	-4.2	-4.2	-3.5	-3.4	-4.6	-4.3
Cerrusite	PbCO <sub>3</sub>	-2.0	-2.1	-2.8	-2.0	-2.2	-2.1	-2.3	-2.0	-2.1	-2.1	-2.4	-2.2	-2.3	-2.2
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-2.0	-2.2	-1.0	-2.7	-1.6	-1.7	-1.6	-3.5	-1.9	-1.8	-1.4	-1.7	-1.7	-1.9

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

**Table 5: Groundwater Geochemical Modeling Re  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Parameter	Units	GAMW55B	GAMW55B	GAMW55R	GAMW56	GAMW56	GAMW56	GAMW56	GAMW56B	GAMW56B	GAMW56B	GAMW56B
		05-2019	11-2019	11-2019	09-2018	10-2018	04-2019	11-2019	09-2018	10-2018	04-2019	11-2019
Charge Balance	% error	-5.4	-6.2	-5.5	4.4	-1.6	<b>61.8</b>	3.5	0.7	2.6	<b>-13.1</b>	-4.8
<b>MINERAL PHASES - Saturation Indices <sup>(a)</sup></b>												
Otavite	CdCO <sub>3</sub>	-2.4	-2.2	-2.3	-2.4	-2.0	-2.7	-2.2	-2.3	-2.3	-2.3	-2.3
Ferrihydrite	Fe(OH) <sub>3</sub>	<b>3.0</b>	<b>2.0</b>	<b>1.4</b>	<b>1.5</b>	<b>2.5</b>	<b>2.9</b>	<b>1.7</b>	<b>1.2</b>	<b>2.0</b>	<b>3.7</b>	<b>1.7</b>
Siderite	FeCO <sub>3</sub>	<b>0.0</b>	<b>0.2</b>	-1.9	<b>0.5</b>	<b>0.8</b>	-0.7	<b>0.1</b>	<b>0.2</b>	<b>0.1</b>	<b>0.2</b>	<b>0.1</b>
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	-4.8	-4.8	-6.9	-5.1	-5.1	-5.9	-5.6	-5.0	-5.2	-4.8	-4.9
Anglesite	PbSO <sub>4</sub>	-4.5	-4.6	-4.6	-5.4	-5.5	-5.1	-5.4	-5.0	-5.1	-4.7	-4.7
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	-0.6	-0.6	-0.8	-1.7	-1.7	-1.9	-1.7	-1.2	-1.3	-1.0	-0.9
Jarosite-H	(H <sub>3</sub> O)Fe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	-3.6	-7.1	-8.6	-8.3	-6.6	-4.3	-8.7	-8.8	-6.6	-1.5	-7.8
Jarosite-K	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>2.9</b>	<b>-0.5</b>	-1.9	-2.5	<b>-0.4</b>	<b>2.4</b>	-2.6	-2.6	<b>-0.4</b>	<b>4.6</b>	-1.2
Jarosite-Na	NaFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	<b>1.0</b>	-2.4	-4.4	-5.4	-3.2	<b>0.4</b>	-5.7	-5.0	-2.7	<b>1.7</b>	-3.5
Calcite	CaCO <sub>3</sub>	<b>0.2</b>	<b>0.4</b>	<b>0.2</b>	<b>-0.1</b>	<b>0.2</b>	-0.6	<b>0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.1</b>
Magnesite	MgCO <sub>3</sub>	-1.1	-1.0	-1.2	-1.5	-1.1	-1.2	-1.2	-1.2	-1.1	-1.3	-1.1
Barite	BaSO <sub>4</sub>	<b>1.0</b>	<b>1.0</b>	<b>0.6</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.1</b>	<b>0.6</b>	<b>0.4</b>	<b>0.8</b>	<b>0.9</b>
Witherite	BaCO <sub>3</sub>	-3.5	-3.4	-3.8	-3.7	-3.5	-4.2	-3.7	-3.6	-3.6	-3.5	-3.5
Fluorite	CaF <sub>2</sub>	-2.0	-2.0	-1.3	-0.8	-1.0	-1.7	-1.2	-1.7	-1.9	-1.7	-1.7
CoCO <sub>3</sub>	CoCO <sub>3</sub>	-4.2	-4.0	-4.1	-3.8	-2.9	-3.4	-2.9	-4.2	-4.2	-4.2	-4.2
Cerrusite	PbCO <sub>3</sub>	-2.1	-2.1	-2.1	-2.2	-2.0	-2.2	-2.1	-2.1	-2.1	-2.0	-2.0
Carbon Dioxide	pCO <sub>2</sub> (g) <sup>(b)</sup>	-2.0	-2.1	-2.0	-1.2	-1.6	-1.6	-1.6	-1.4	-1.3	-1.6	-1.8

**Notes:**

Charge balances errors highlighted in **red** are greater than +/-10%

Non-detect values assumed equal to 1/2 analytical detection limit

Redox converted from field ORP to Eh by +200 mV

<sup>(a)</sup> Saturation indices greater than -0.5 are identified by bold type and grey shading

<sup>(b)</sup> pCO<sub>2</sub>(g) values presented at 10<sup>value</sup> atm

Prepared by: GOL

Checked by: PJN

Reviewed by: RV

**Table 6: Average Point Decay Rates in Background and Downgradient Wells  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Constituent	Units	Point Decay Constants (first-order decay)	
		Background Wells	All Downgradient Wells (including Assessment Wells)
Arsenic	yr <sup>-1</sup>	-0.33	<b>0.11</b>
Boron	yr <sup>-1</sup>	0.04	<b>-0.04</b>
Cobalt	yr <sup>-1</sup>	0.36	<b>-0.05</b>
Lithium	yr <sup>-1</sup>	0.20	<b>-0.06</b>
Molybdenum	yr <sup>-1</sup>	0.28	<b>-0.03</b>

**Notes:**

yr<sup>-1</sup> = rate per year

Prepared by: GOL  
 Checked by: PJN  
 Reviewed by: RV

**Table 7: Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Mineral	Mineral Formula	OW-9 18-20'	OW-9 10-12'	SB-52B-35'-37'	SB-54B-30'-32'	SB-56B-30'-32'
		(wt %)	(wt %)	(wt %)	(wt %)	(wt %)
Quartz	SiO <sub>2</sub>	69	60	53	61	72
Pyrite	FeS <sub>2</sub>	-	-	0.39	0.10	0.12
Marcasite	FeS <sub>2</sub>	-	-	0.22	-	-
Muscovite	KAl <sub>2</sub> (AlSi <sub>3</sub> O <sub>10</sub> )(OH) <sub>2</sub>	3.6	3.5	7.8	1.7	1.3
Biotite	K(Mg,Fe) <sub>3</sub> (AlSi <sub>3</sub> O <sub>10</sub> )(OH) <sub>2</sub>	-	-	1.1	0.57	0.16
Chlorite	(Fe,(Mg,Mn) <sub>5</sub> ,Al)(Si <sub>3</sub> Al)O <sub>10</sub> (OH) <sub>8</sub>	-	-	2.6	1.0	1.1
Microcline	KAlSi <sub>3</sub> O <sub>8</sub>	5.2	9.1	9.2	7.5	6.6
Orthoclase	KAlSi <sub>3</sub> O <sub>8</sub>	-	-	2.2	0.65	0.57
Hematite	Fe <sub>2</sub> O <sub>3</sub>	-	-	0.26	0.44	0.57
Dolomite	CaMg(CO <sub>3</sub> ) <sub>2</sub>	6.5	9.8	7.9	9.6	5.3
Calcite	CaCO <sub>3</sub>	4.8	3.6	4.7	5.8	3.9
Albite	NaAlSi <sub>3</sub> O <sub>8</sub>	8.3	11	7.3	9.1	6.4
Epidote	Ca <sub>2</sub> (Al,Fe)Al <sub>2</sub> O(SiO <sub>4</sub> )(Si <sub>2</sub> O <sub>7</sub> )(OH)	1.6	1.5	2.8	2.1	1.9
Anatase	TiO <sub>2</sub>	-	-	-	-	-
Cancrinite	Na <sub>6</sub> Ca(CO <sub>3</sub> )(AlSiO <sub>4</sub> ) <sub>6</sub> ·2H <sub>2</sub> O	0.87	1.7	-	-	-
TOTAL		100	100	100	100	100

**Notes:**

wt % = percent by weight of each mineral

Non-detect minerals within a sample are represented with "-"

Prepared by: GOL

Checked by: PJN

Reviewed by: RV



**Table 8: Sequential Extraction Procedure and Total Metal Solids Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Sample Location		SB-07B	DA-14	OW-9	OW-9	SB-08B	SB-52B	SB-53B	SB-53B	SB-54B	SB-55B	SB-56B
Sample Start Depth (ft bgs)		35	4	10	18	30	35	25	30	30	30	30
Sample End Depth (ft bgs)		37	6	12	20	32	37	27	32	32	32	32
Well Type		Background	Drying Well	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analyte	SEP Step											
Aluminum	Total Metal Result	1900	3100 J+	2200 J+	1100	1300	3200	1500	1400	2000	2200	1600
Aluminum	SEP Step 1	52 U	48 U	47 U	47 U	51 U	44 U	48 U	44 U	49 U	48 U	49 U
Aluminum	SEP Step 2	15 J	63 J	16 J	35 UJ	38 UJ	8.8 J	11 J	33 UJ	12 J	36 UJ	5.9 J
Aluminum	SEP Step 3	44	540	60	15	31	33	75	30	34	23	29
Aluminum	SEP Step 4	300	1600	280	160	130	110	130	100	130	100	360
Aluminum	SEP Step 5	200 UJ	80 J	180 U	170 U	190 UJ	28 J	31 J	34 J	180 UJ	180 UJ	180 UJ
Aluminum	SEP Step 6	1000	1600	840	520	1100	1200	750	820	1400	1200	1300
Aluminum	SEP Step 7	22000	11000	23000	15000	23000	25000	16000	19000	23000	21000	25000
Aluminum	SEP SUM	23000	15000	24000	16000	24000	26000	17000	20000	24000	22000	27000
Aluminum	SEP TOTAL	25000	21000	29000	19000	23000	28000	18000	20000	29000	31000	23000
Antimony	Total Metal Result	7.7 U	18 U	17 U	17 U	7 U	6.3 UJ	6.9 UJ	6.6 UJ	7 U	7 U	7 U
Antimony	SEP Step 1	16 U	14 U	14 U	14 U	15 U	13 U	14 U	13 U	15 U	14 U	15 U
Antimony	SEP Step 2	12 U	11 U	11 U	10 U	12 U	10 U	11 U	10 U	11 U	11 U	11 U
Antimony	SEP Step 3	3.9 U	3.6 U	3.5 U	3.5 U	3.8 U	3.3 U	3.6 U	3.3 U	3.7 U	3.6 U	3.6 U
Antimony	SEP Step 4	3.9 U	3.6 U	3.5 U	3.5 U	3.8 U	3.3 U	3.6 U	3.3 U	3.7 U	3.6 U	3.6 U
Antimony	SEP Step 5	59 U	54 U	53 U	52 U	58 U	50 U	53 U	50 U	55 U	54 U	55 U
Antimony	SEP Step 6	3.9 U	3.6 U	3.5 U	3.5 U	3.8 U	3.3 U	3.6 U	3.3 U	3.7 U	3.6 U	3.6 U
Antimony	SEP Step 7	0.45 J	3.6 U	3.5 U	3.5 U	0.54 J	3.3 U	3.6 U	0.16 J	0.29 J	3.6 U	0.3 J
Antimony	SEP SUM	0.45 J	3 U	3 U	3 U	0.54 J	3 U	3 U	0.16 J	0.29 J	3 U	0.3 J
Antimony	SEP TOTAL	0.53 J	3.6 U	3.5 U	3.5 U	0.27 J	3.3 U	3.6 J	3.3 U	0.33 J	3.6 U	0.29 J
Arsenic	Total Metal Result	1.7 J	0.62 J	1.7 J	0.69 J	1.9 J	5.4 J	5	1.3 J	2.3	2 J	5
Arsenic	SEP Step 1	2.6 U	2.4 U	2.3 U	2.3 U	2.6 U	2.2 U	2.4 U	2.2 U	2.4 U	2.4 U	2.4 U
Arsenic	SEP Step 2	2 U	1.8 UJ	1.8 U	1.7 U	1.9 U	0.46 J	1.8 U	1.7 U	1.8 UJ	1.8 UJ	1.8 UJ
Arsenic	SEP Step 3	0.37 J	0.45 J	0.43 J	0.17 J	0.27 J	0.83	0.83	0.44 J	0.45 J	0.37 J	1.9
Arsenic	SEP Step 4	0.69	0.6 U	0.94	0.73	0.66	0.71 J+	0.59 U	0.56 U	0.68	0.5 J	1.1
Arsenic	SEP Step 5	9.8 U	9 U	8.8 U	8.7 U	9.6 U	8.3 UJ	8.9 UJ	8.3 UJ	9.1 U	9 U	9.1 U
Arsenic	SEP Step 6	1.2	0.3 J	0.56 J	0.54 J	1.7	2.2	1.6	0.89	1.8	1.4	3.8
Arsenic	SEP Step 7	1.3 U	0.7	0.39 J	0.34 J	1.3 U	1.2	1	0.88	1.2 U	0.6 U	1.2 U
Arsenic	SEP SUM	2.2	1.4	2.3	1.8	2.6	5.4	4	2.7	2.9	2.7	7.3
Arsenic	SEP TOTAL	2.1	2.2	1.9	3	3.1	5.4 J	5.6	2.5	4.7	3.9	6.2

**Table 8: Sequential Extraction Procedure and Total Metal Solids Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Sample Location		SB-07B	DA-14	OW-9	OW-9	SB-08B	SB-52B	SB-53B	SB-53B	SB-54B	SB-55B	SB-56B
Sample Start Depth (ft bgs)		35	4	10	18	30	35	25	30	30	30	30
Sample End Depth (ft bgs)		37	6	12	20	32	37	27	32	32	32	32
Well Type		Background	Drying Well	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analyte	SEP Step											
Barium	Total Metal Result	6.9 J+	7.3 J+	13	4.1	4.3 J+	8.4 J+	4.6 J+	4.3 J+	6.2	6.1	6.1
Barium	SEP Step 1	13 U	1.1 J	0.58 J	12 U	13 U	11 U	12 U	11 U	12 U	12 U	12 U
Barium	SEP Step 2	0.5 J	1.7 J	0.62 J	8.7 UJ	0.46 J	0.52 J	0.54 J	0.54 J	0.56 J	0.44 J	0.96 J
Barium	SEP Step 3	3.3 U	3.6	2.9 U	2.9 U	3.2 U	2.8 U	3 U	2.8 U	3 U	3 U	3 U
Barium	SEP Step 4	2.2 J	2.6 J	5.3	1.6 J	1.4 J	2.4 J	0.97 J	1.1 J	2.2 J	1.9 J	2.2 J
Barium	SEP Step 5	49 UJ	45 UJ	44 UJ	44 UJ	48 UJ	42 UJ	45 UJ	42 UJ	46 UJ	45 UJ	46 UJ
Barium	SEP Step 6	2.3 J	2.2 J	2.2 J	1.2 J	1.9 J	2 J	1.6 J	1.5 J+	2.3 J	2 J	2.4 J
Barium	SEP Step 7	250	230	350	220	220	250 J	190	220	230	190	260
Barium	SEP SUM	250	240	360	220	230	250	190	220	240	190	260
Barium	SEP TOTAL	270	300	390	210	190	200	170	200	220	200	230
Beryllium	Total Metal Result	1.3 U	0.053 J	0.12 J	0.064 J	1.2 U	0.19 J	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U
Beryllium	SEP Step 1	1.3 U	1.2 U	1.2 U	1.2 U	1.3 U	1.1 U	1.2 U	1.1 U	1.2 U	1.2 U	1.2 U
Beryllium	SEP Step 2	0.98 UJ	0.9 UJ	0.88 UJ	0.87 UJ	0.96 UJ	0.83 UJ	0.89 UJ	0.83 UJ	0.91 UJ	0.9 UJ	0.91 UJ
Beryllium	SEP Step 3	0.33 U	0.026 J	0.021	0.29 U	0.32 U	0.28 U	0.3 U	0.28 U	0.3 U	0.3 U	0.3 U
Beryllium	SEP Step 4	0.33 U	0.026 J	0.024 J	0.02 J	0.32 U	0.28 U	0.3 U	0.28 U	0.3 U	0.3 U	0.03 J
Beryllium	SEP Step 5	4.9 UJ	4.5 UJ	4.4 UJ	4.4 UJ	4.8 UJ	4.2 UJ	4.5 UJ	4.2 UJ	4.6 UJ	4.5 UJ	4.6 UJ
Beryllium	SEP Step 6	0.045 J	0.024 J	0.036 J	0.027 J	0.039 J	0.042 J	0.026 J	0.027 J	0.045 J	0.037 J	0.067 J
Beryllium	SEP Step 7	0.29 J	0.21 J	0.39	0.24 J	0.31 J	0.35	0.23 J	0.28	0.3	0.25 J	0.46
Beryllium	SEP SUM	0.34	0.29	0.47	0.28	0.35	0.39	0.25	0.31	0.34	0.29	0.56
Beryllium	SEP TOTAL	0.37	0.3	0.41	0.28 J	0.26 J	0.35	0.25 J	0.27 J	0.33	0.27 J	0.33
Boron	Total Metal Result	26 U	5.5	7.4	3.6	23 U	21 U	23 U	22 U	23 U	23 U	23 U
Cadmium	Total Metal Result	0.64 U	0.24 U	0.11 J	0.072 J	0.59 U	0.53 U	0.57 U	0.55 U	0.58 U	0.58 U	0.3 J
Cadmium	SEP Step 1	1.3 U	1.2 U	1.2 U	1.2 U	1.3 U	1.1 U	1.2 U	1.1 U	1.2 U	1.2 U	1.2 U
Cadmium	SEP Step 2	0.98 U	0.9 U	0.88 U	0.87 U	0.96 U	0.83 U	0.89 U	0.83 U	0.91 U	0.9 U	0.91 U
Cadmium	SEP Step 3	0.33 U	0.3 UJ	0.29 UJ	0.29 UJ	0.32 U	0.28 UJ	0.3 UJ	0.28 UJ	0.3 UJ	0.3 UJ	0.3 UJ
Cadmium	SEP Step 4	0.077 J	0.059 J	0.09 J	0.083 J	0.076 J	0.086 J	0.08 J	0.076 J	0.069 J	0.065 J	0.059 J
Cadmium	SEP Step 5	4.9 U	4.5 U	4.4 U	4.4 U	4.8 U	4.2 U	4.5 U	4.2 U	4.6 U	4.5 U	4.6 U
Cadmium	SEP Step 6	0.33 U	0.3 U	0.29 U	0.29 U	0.32 U	0.28 U	0.3 U	0.28 U	0.026 J	0.013 J	0.3 U
Cadmium	SEP Step 7	0.33 U	0.3 U	0.29 U	0.29 U	0.32 U	0.28 U	0.3 U	0.28 U	0.3 U	0.3 U	0.3 U
Cadmium	SEP SUM	0.077 J	0.11 J	0.09 J	0.083 J	0.076 J	0.086 J	0.08 J	0.076 J	0.095 J	0.077 J	0.059 J
Cadmium	SEP TOTAL	0.015 J	0.3 U	0.29 U	0.29 U	0.065 J	0.28 U	0.3 U	0.28 U	0.18 J	0.12 J	0.058 J

**Table 8: Sequential Extraction Procedure and Total Metal Solids Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Sample Location		SB-07B	DA-14	OW-9	OW-9	SB-08B	SB-52B	SB-53B	SB-53B	SB-54B	SB-55B	SB-56B
Sample Start Depth (ft bgs)		35	4	10	18	30	35	25	30	30	30	30
Sample End Depth (ft bgs)		37	6	12	20	32	37	27	32	32	32	32
Well Type		Background	Drying Well	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analyte	SEP Step											
Chromium	Total Metal Result	4.3	2.9	4.4	2.5	2.8	8.2 J	5.1	3.4	5	6	3.2
Chromium	SEP Step 1	2.6 U	2.4 U	2.3 U	2.3 U	2.6 U	2.2 U	2.4 U	2.2 U	2.4 U	2.4 U	2.4 U
Chromium	SEP Step 2	2 UJ	1.8 U	0.28 J	1.7 U	1.9 UJ	0.37 J	0.37 J	1.7 U	0.31 J	1.8 U	1.8 U
Chromium	SEP Step 3	0.29 J	0.37 J	0.52 J	0.16 J	0.17 J	1.1	0.97	0.27 J	1.1	0.14 J	0.19 J
Chromium	SEP Step 4	1.2	1.1	0.94	0.57 J	0.55 J	0.68	0.58 J	0.51 J	0.73	0.6	1
Chromium	SEP Step 5	9.8 U	9 UJ	1.5 J	1.3 J	9.6 U	8.3 U	8.9 U	8.3 U	9.1 U	9 U	9.1 U
Chromium	SEP Step 6	2.5	0.99	2.1	1.7	3.1	3.5	2.2	2.2	3.7	3.3	3
Chromium	SEP Step 7	5.5	3.7	7.3	5.2	7.2	9	5	7.3	8.5	6.7	13
Chromium	SEP SUM	9.4	8.1	13	8.8	11	15	9.1	10	14	11	17
Chromium	SEP TOTAL	9.5	6.9	11	8.3	8.8	16 J	10	8.7	17	13	9.2
Cobalt	Total Metal Result	3.5 J	1.1	1.8	2.2	2.9 J	5.2 J	5.7	2.6 J	5.7 J	3.9 J	3 J
Cobalt	SEP Step 1	13 U	12 U	12 U	12 U	13 U	11 U	12 U	11 U	12 U	12 U	12 U
Cobalt	SEP Step 2	0.54 J	9 U	8.8 U	8.7 U	0.35 J	0.44 J	0.63 J	0.38 J	0.62 J	0.41 J	0.26 J
Cobalt	SEP Step 3	0.55 J	0.1 J	0.27 J	0.19 J	0.37 J	0.45 J	1.2 J	0.53 J	0.47 J	0.39 J	0.37 J
Cobalt	SEP Step 4	0.83 J	0.29 J	0.87 J	1.2 J	0.97 J	0.71 J	1.1 J	0.66 J	1.6 J	0.91 J	0.76 J
Cobalt	SEP Step 5	49 UJ	45 UJ	44 UJ	44 UJ	48 UJ	42 UJ	45 UJ	42 UJ	46 UJ	45 UJ	46 UJ
Cobalt	SEP Step 6	1.3 J	0.3 J	0.66 J	0.68 J	1.8 J	2.1 J	1.5 J	0.97 J	2.5 J	1.5 J	2.9 J
Cobalt	SEP Step 7	0.8 J	3 U	0.69 J	0.69 J	1.1 J	0.82 J	0.44 J	0.43 J	1.5 J	0.8 J	0.81 J
Cobalt	SEP SUM	4	0.69 J	2.5	2.8	4.6	4.5	4.8	3	6.7	4	5.1
Cobalt	SEP TOTAL	4.2 J	0.87 J	2.5 J	3.2	4.8 J	4.7 J	5.2 J	3.2	6.1	4.3	4.5 J
Iron	Total Metal Result	4900	1500	4400	2600	3400	6800	7900	3700	5800	5900	5600
Iron	SEP Step 1	26 U	24 U	23 U	23 U	26 U	22 U	24 U	22 U	24 U	24 U	24 U
Iron	SEP Step 2	260 J	31 J	61 J	29 J	190 J	130 J	200 J	99 J	280 J	160 J	140 J
Iron	SEP Step 3	950	280	710	150	600	590	2600	470	740	700	1200
Iron	SEP Step 4	1100	770	1700	1100	1000	1200	1100	830	1400	1500	1400
Iron	SEP Step 5	98 UJ	90 UJ	88 UJ	87 UJ	96 UJ	83 UJ	89 UJ	83 UJ	91 UJ	90 UJ	91 UJ
Iron	SEP Step 6	2600	870	2100	1500	2800	3300	2600	2000	3800	3300	4600
Iron	SEP Step 7	1800	1300	2400	2000	2900	2500	2000	2100	3700	2400	3100
Iron	SEP SUM	6700	3200	7100	4700	7600	7700	8500	5500	9900	8100	10000
Iron	SEP TOTAL	6300	3400	7500	5500	7000	8400	8700	5700	9900	8600	6800

**Table 8: Sequential Extraction Procedure and Total Metal Solids Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Sample Location		SB-07B	DA-14	OW-9	OW-9	SB-08B	SB-52B	SB-53B	SB-53B	SB-54B	SB-55B	SB-56B
Sample Start Depth (ft bgs)		35	4	10	18	30	35	25	30	30	30	30
Sample End Depth (ft bgs)		37	6	12	20	32	37	27	32	32	32	32
Well Type		Background	Drying Well	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analyte	SEP Step											
Lead	Total Metal Result	4.4	1.4	3.1	1.8	2.9	6.6 J	3.2	2.4	4.2	3.7	3.5
Lead	SEP Step 1	2.6 U	2.4 U	2.3 U	2.3 U	2.6 U	2.2 U	2.4 U	2.2 U	2.4 U	2.4 U	2.4 U
Lead	SEP Step 2	1.9 J	1.8 U	1.8 U	1.7 U	0.92 J	0.85 J	1.8 U	0.66 J	0.86 J	0.82 J	0.75 J
Lead	SEP Step 3	0.66 UJ	0.61 J	0.59 UJ	0.58 UJ	0.64 UJ	0.55 UJ	0.59 UJ	0.56 UJ	0.61 UJ	0.6 UJ	0.61 UJ
Lead	SEP Step 4	1.2	0.65	1.7	1.2	1.4	2.3	1.8	1.5	2.3	1.8	2
Lead	SEP Step 5	9.8 UJ	9 UJ	8.8 UJ	8.7 UJ	9.6 UJ	8.3 UJ	8.9 UJ	8.3 UJ	9.1 UJ	9 UJ	9.1 UJ
Lead	SEP Step 6	1.1	0.67	0.67	0.35 J	0.78	1.8	1.1	0.72	1.6	1.3	3.4
Lead	SEP Step 7	3.2	3.1	5.3	3.2	3.5	3.3	2.5	2.6	2.8	4.7	2.9
Lead	SEP SUM	7.4	5	7.7	4.8	6.6	8.2	5.3	5.5	7.5	8.6	9.1
Lead	SEP TOTAL	7	5.7	7.4	5.6	5	7.5 J	4.9	5.1	6.7	5.6	6.2
Lithium	Total Metal Result	4.6 J	1.4 J	3.6 J	2.2 J	3.3 J	6.6 J+	3.1 J+	3.4 J+	5.4 J	5.2 J	3.5 J
Lithium	SEP Step 1	13 U	12 U	12 U	12 U	13 U	11 U	12 U	11 U	12 U	12 U	12 U
Lithium	SEP Step 2	9.8 U	9 U	8.8 U	8.7 U	9.6 U	8.3 U	8.9 U	8.3 U	0.71 J	0.72 J	9.1 U
Lithium	SEP Step 3	3.3 U	3 U	2.9 U	2.9 U	3.2 U	2.8 U	3 U	2.8 U	3 U	3 U	3 U
Lithium	SEP Step 4	0.78 J	0.5 J	0.81 J	0.55 J	0.62 J	1 J	0.64 J	0.71 J	1.1 J	1 J	1.3 J
Lithium	SEP Step 5	49 U	45 U	44 U	44 U	48 U	42 U	45 U	42 U	46 U	45 U	46 U
Lithium	SEP Step 6	2.3 J	1.1 J	1.8 J	1.2 J	2.2 J	3	1.7 J	1.9 J	3.5	2.9 J	2.8 J
Lithium	SEP Step 7	4.4	2.5 J	3.4	2.1 J	3.8	6.1	2.6 J	3.1	5.6	4.2	7.1
Lithium	SEP SUM	12	4.1	6	3.8	11	14	7.8	5.7	19	18	19
Lithium	SEP TOTAL	8	4.2	6.8	5.4	7.5	10	6	7.5	11	10	7.2
Molybdenum	Total Metal Result	5.1 U	6.3	1.1 U	1.1 U	4.7 U	3.8 J	4 J	4.4 U	0.88 J	4.7 U	2.1 J
Molybdenum	SEP Step 1	10 U	13	9.4 U	9.3 U	10 U	8.9 U	9.5 U	8.9 U	9.8 U	9.6 U	9.7 U
Molybdenum	SEP Step 2	7.9 U	0.51 J	7 U	7 U	7.7 U	6.7 U	7.1 U	6.7 U	7.3 U	7.2 U	7.3 U
Molybdenum	SEP Step 3	2.6 U	1.2 J	2.3 U	2.3 U	2.6 U	0.51 J	2.2 J	0.27 J	0.59 J	2.4 U	0.5 J
Molybdenum	SEP Step 4	2.6 U	1.3 J	2.3 U	2.3 U	2.6 U	0.39 J	0.63 J	0.24 J	0.53 J	2.4 U	0.36 J
Molybdenum	SEP Step 5	39 U	36 U	35 U	35 U	38 U	33 U	36 U	33 U	37 U	36 U	1.7 J
Molybdenum	SEP Step 6	2.6 U	0.13 J	2.3 U	2.3 U	2.6 U	0.21 J	0.13 J	2.2 U	0.18 J	0.2 J	1.5 J
Molybdenum	SEP Step 7	2.6 U	2.4 U	2.3 U	2.3 U	2.6 U	2.2 U	2.4 U	2.2 U	2.4 U	2.4 U	0.16 J
Molybdenum	SEP SUM	2 U	16	2 U	2 U	2 U	1.1 J	3	0.51 J	1.3 J	0.2 J	4.3
Molybdenum	SEP TOTAL	0.94 J	15	0.22 J	0.15 J	0.54 J	2.4	3.8	0.67 J	2.4	0.48 J	2.4

**Table 8: Sequential Extraction Procedure and Total Metal Solids Results  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Sample Location		SB-07B	DA-14	OW-9	OW-9	SB-08B	SB-52B	SB-53B	SB-53B	SB-54B	SB-55B	SB-56B
Sample Start Depth (ft bgs)		35	4	10	18	30	35	25	30	30	30	30
Sample End Depth (ft bgs)		37	6	12	20	32	37	27	32	32	32	32
Well Type		Background	Drying Well	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analyte	SEP Step											
Selenium	Total Metal Result	1.9 U	4.8 U	4.6 U	4.6 U	0.53 J	1.6 U	0.51 J	0.74 J	0.68 J	0.65 J	1.8 U
Selenium	SEP Step 1	2.6 U	2.4 U	2.3 U	2.3 U	2.6 U	2.2 U	2.4 U	2.2 U	2.4 U	2.4 U	2.4 U
Selenium	SEP Step 2	2 U	1.8 U	1.8 U	1.7 U	1.9 U	1.7 U	1.8 U	1.7 U	1.8 UJ	1.8 UJ	1.8 UJ
Selenium	SEP Step 3	0.66 U	0.6 U	0.22 J	0.58 U	0.64 U	0.55 U	0.59 U	0.56 U	0.61 U	0.6 U	0.61 U
Selenium	SEP Step 4	1.1 J	0.6 UJ	0.6 J+	0.75 J+	1.3 J	0.64 J	0.59 UJ	0.56 UJ	0.71 J	0.6 UJ	0.59 J
Selenium	SEP Step 5	9.8 U	9 U	8.8 U	8.7 U	9.6 U	8.3 U	3.3 J	8.3 U	9.1 U	9 U	9.1 U
Selenium	SEP Step 6	0.66 U	0.6 U	0.59 U	0.58 U	0.64 U	0.55 U	0.59 U	0.56 U	0.61 U	0.6 U	0.61 U
Selenium	SEP Step 7	1.3 U	0.6 U	0.59 U	0.58 U	1.3 U	1.1 U	0.59 U	0.56 U	0.74 J	0.6 U	1.2 U
Selenium	SEP SUM	2.7	0.5 U	0.82	0.75	2.5	0.64	3.3	0.5 U	1.5	0.5 U	0.59
Selenium	SEP TOTAL	1.3 U	1.2 U	0.59 U	0.58 U	1.3 U	1.1 U	1.2 U	0.56 U	0.61 U	0.24 J	1.2 U
Thallium	Total Metal Result	4.5 U	7.2 U	6.9 U	6.8 U	4.1 U	3.7 u	4 U	3.9 U	4.1 U	4.1 U	4.1 U
Thallium	SEP Step 1	9.2 U	8.4 U	8.2 U	8.2 U	8.9 U	7.8 U	8.3 U	7.8 U	8.5 U	8.4 U	8.5 U
Thallium	SEP Step 2	6.9 U	6.3 U	6.2 U	6.1 U	6.7 U	5.8 U	6.2 U	5.8 U	6.4 U	6.3 U	6.4 U
Thallium	SEP Step 3	2.3 U	2.1 U	2.1 U	2 U	2.2 U	1.9 U	2.1 U	1.9 U	2.1 U	2.1 U	2.1 U
Thallium	SEP Step 4	2.3 U	2.1 U	2.1 UJ	2 UJ	2.2 U	1.9 U	2.1 U	1.9 U	2.1 U	2.1 U	2.1 U
Thallium	SEP Step 5	34 UJ	31 UJ	31 UJ	31 UJ	34 UJ	29 UJ	31 UJ	29 UJ	32 UJ	32 UJ	32 UJ
Thallium	SEP Step 6	2.3 U	2.1 U	2.1 U	2 U	2.2 U	1.9 U	2.1 U	1.9 U	2.1 U	2.1 U	2.1 U
Thallium	SEP Step 7	0.48 J	2.1 U	0.62 J	0.56 J	1.1 J	3.9 U	2.1 U	1.9 U	0.97 J	0.74 J	1.3 J
Thallium	SEP SUM	0.48 J	1.8 U	0.62 J	0.56 J	1.4 J	1.8 U	1.8 U	1.8 U	0.97 J	0.74 J	1.3 J
Thallium	SEP TOTAL	0.87 J	4.2 U	0.58 J	0.47 J	0.9 J	3.9 U	4.2 U	1.9 U	0.88 J	0.85 J	1.3 J

Notes:

All results displayed in milligram per kilogram (mg/kg).

ft bgs = feet below ground surface

SEP: Sequential Extraction Procedure

Step 1 - Exchangeable Phase: This extraction includes trace elements that are reversibly adsorbed to soil minerals, amorphous solids, and organic material by electrostatic forces.

Step 2 - Carbonate Phase: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 - Non-Crystalline Materials Phase: This extraction targets trace elements that are complexed by amorphous minerals (e.g. iron).

Step 4 - Metal Hydroxide Phase: This extraction targets trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Phase: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the soil after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

U= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

UJ= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit, the quantitation limit is considered estimated.

J= The analyte was positively identified. The associated numerical value is the approximate concentration.

J+= The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample and biased high.

Total Metal Results are the results of the 6010C analysis

Prepared by: DFSC

Checked by: KMC

Reviewed by: MAH

**Table 9: Predicted Range of COI Concentrations in Assessment Wells Assuming Only Dilution and Dispersion  
Monitored Natural Attenuation Evaluation  
NIPSCO LLC R. M. Schahfer Generating Station**

Constituent	Units	Site-Specific Groundwater Protection Standard <sup>2</sup>	Health-Based Standard	Maximum concentration observed in Porewater	Maximum concentration at side-gradient Assessment Wells:				Concentration at Assessment Wells assuming 32% <sup>3</sup> dilution of porewater with maximum concentration measured at:				Concentration at Assessment Wells assuming 63% <sup>4</sup> dilution of porewater with maximum concentration measured at:			
					GAMW-52	GAMW-52B	GAMW-56	GAMW-56B	GAMW-52	GAMW-52B	GAMW-56	GAMW-56B	GAMW-52	GAMW-52B	GAMW-56	GAMW-56B
Arsenic	mg/L	0.091	0.010	0.012	0.0025	0.0016	0.022	0.0025	0.0090	0.0087	0.015	0.0090	0.0060	0.0054	0.018	0.0060
Boron <sup>1</sup>	mg/L	-	4.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Cobalt	mg/L	0.010	0.0060	0.0022	0.00058	0.00050	0.0084	0.00050	0.0017	0.0017	0.0042	0.0017	0.0012	0.0011	0.0061	0.0011
Lithium	mg/L	0.040	0.040	0.016	0.0062	0.0071	0.0053	0.0062	0.013	0.013	0.013	0.013	0.0098	0.010	0.0093	0.0098
Molybdenum	mg/L	0.10	0.10	0.81	0.0064	0.015	0.013	0.0064	0.55	0.56	0.55	0.55	0.30	0.31	0.31	0.30

Arsenic	Percentage relative to Groundwater Protection Standard	100%	-	13%	3%	2%	24%	3%	10%	10%	17%	10%	7%	6%	20%	7%
Boron		100%	-	345%	80%	33%	7%	80%	260%	245%	237%	260%	178%	148%	132%	178%
Cobalt		100%	-	22%	6%	5%	84%	5%	17%	17%	42%	17%	12%	11%	61%	11%
Lithium		100%	-	40%	16%	18%	13%	16%	32%	33%	31%	32%	25%	26%	23%	25%
Molybdenum		100%	-	810%	6%	15%	13%	6%	553%	556%	555%	553%	304%	309%	308%	304%

**Notes:**

- (1) Boron does not have a groundwater protection standard, results are compared to the health-based standard
  - (2) The groundwater protection standard is equal to the higher of the background tolerance limit and the relevant health-based standard
  - (3) 32% dilution was minimum dilution predicted in Table 8
  - (4) 63% dilution was maximum dilution predicted in Table 8
- ft = feet  
mg/L = milligrams per liter

Prepared by: GOL  
Checked by: PJN  
Reviewed by: RV



**Table 10: Sorption Site and Surface Area Calculations**  
**Monitored Natural Attenuation Evaluation**  
**NIPSCO LLC R. M. Schahfer Generating Station**

	Units	Minimum	Mean	Maximum
<b>Ferrihydrite</b>				
Amorphous Iron (Step 3 SEP) + Metal Hydroxide Iron (Step 4 SEP)	Sample Name	SB-18B-32/34	Mean of all samples	SB-53B-25-27
	ppm of Fe	1278	2006	3787
	millimoles of Fe	22.9	35.9	67.8
	moles of Fe	0.0229	0.0359	0.0678
Specific Surface Area	m <sup>2</sup> /g	600		
Surface Site Concentration	moles weak sites/ mole of Fe	0.2		
Surface Sites	moles of weak sites	0.00458	0.00719	0.01356
Mass of Ferrihydrite	g	2.03	3.19	6.03
<b>Gibbsite</b>				
Amorphous Aluminum (Step 3 SEP) + Metal Hydroxide Aluminum (Step 4 SEP)	Sample Name	SB-53B-30-32	Mean of all samples	OW-9-10-12
	ppm of Al	130	221	408
	millimoles of Al	4.8	8.2	15.1
	moles of Al	0.0048	0.0082	0.0151
Specific Surface Area	m <sup>2</sup> /g	32		
Surface Site Concentration	moles weak sites/ mole of Al	0.41		
Surface Sites	moles of weak sites	0.00198	0.00335	0.00619
Mass of Gibbsite	g	0.38	0.64	1.18

**Notes:**

ppm = parts per million

m<sup>2</sup>/g = meters squared per gram

g = grams

Prepared by: GOL

Checked by: PJN

Reviewed by: RV

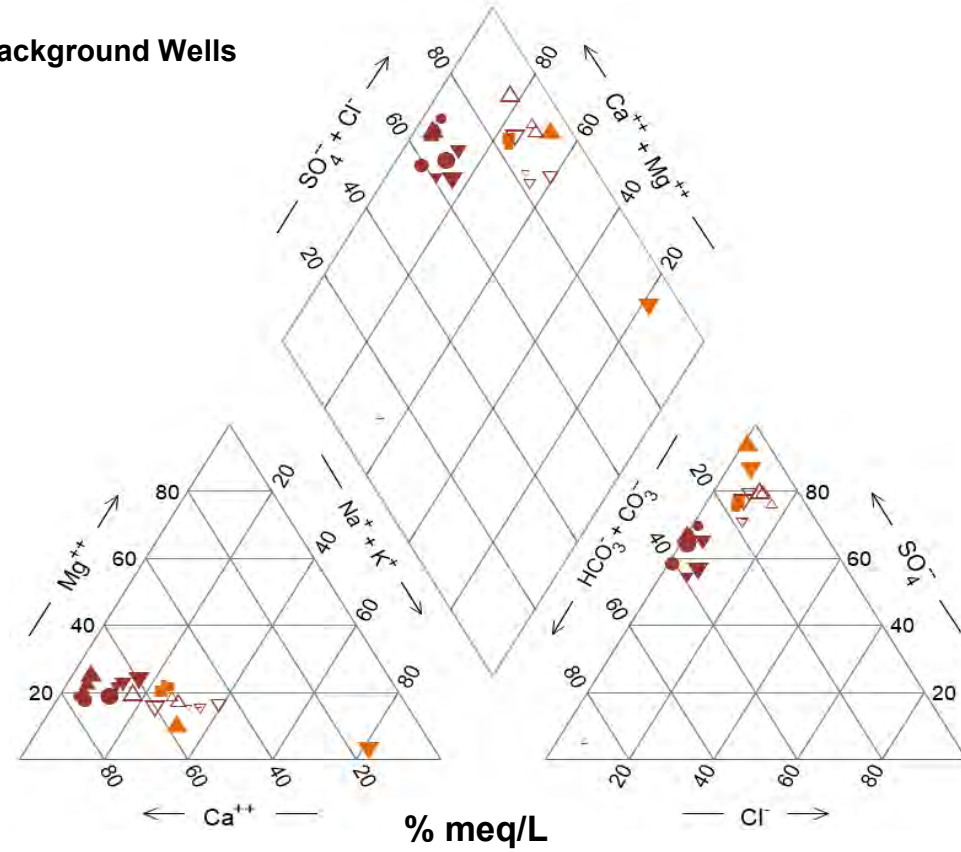
## Figures



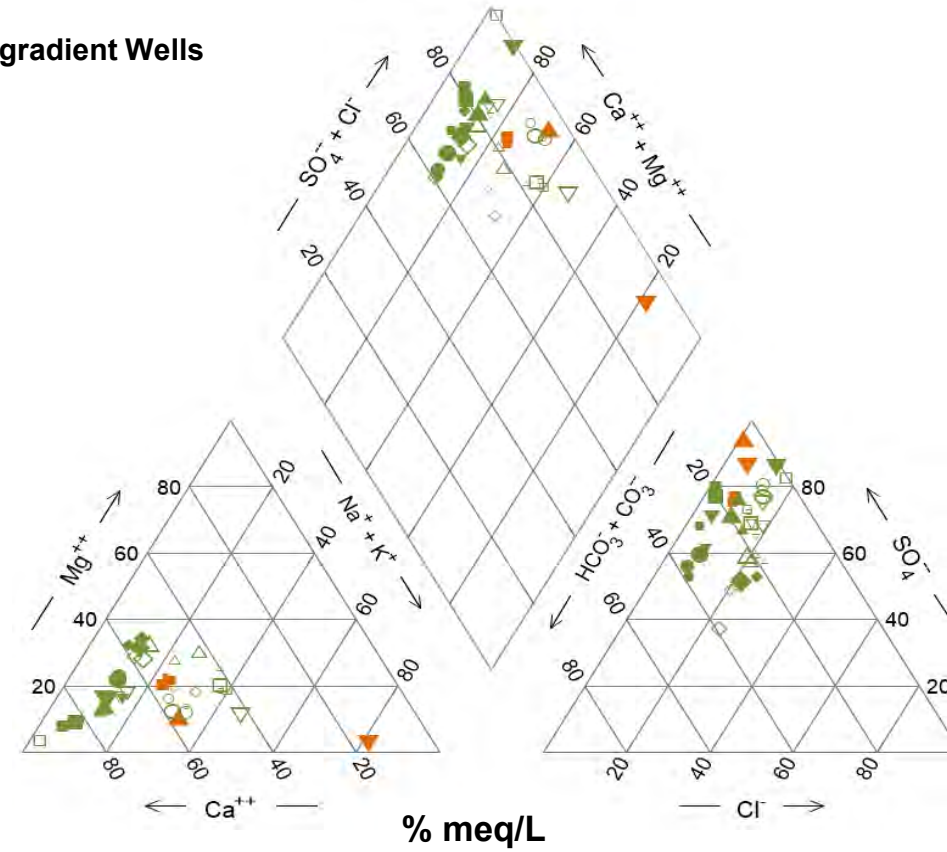




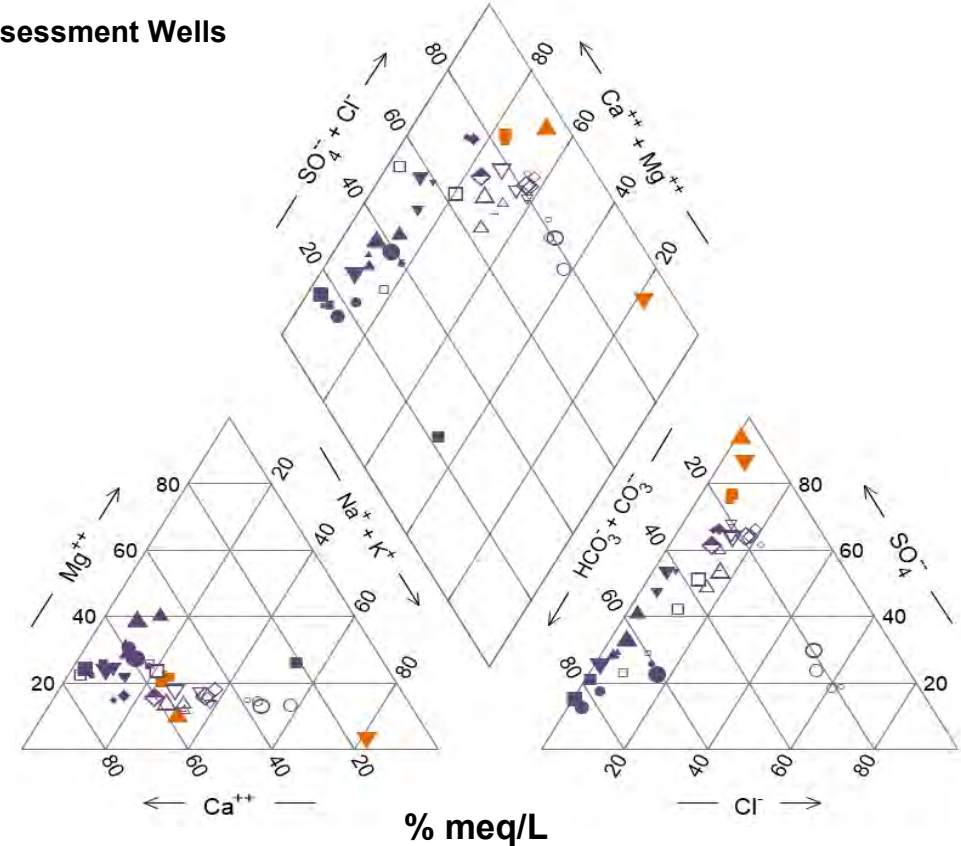
(a) Background Wells



(b) Downgradient Wells



(c) Assessment Wells



**Porewater**

- GAPIEZ-06
- ▲ DAPZ-02A
- ▼ DAPZ-02B

**Upgradient Wells**

- GAMW-04
- ▲ GAMW-07
- △ GAMW-07B
- ▼ GAMW-15
- ▽ GAMW-15B

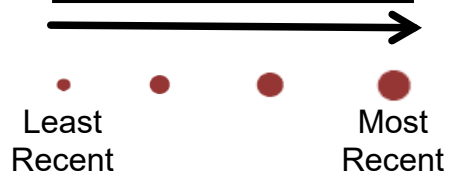
**Downgradient Wells**

- GAMW-08
- GAMW-08B
- ▲ GAMW-09
- △ GAMW-09B
- ▼ GAMW-16
- ▽ GAMW-16B
- ◆ GAMW-17
- ◇ GAMW-17B
- GAMW-18
- GAMW-18B

**Assessment Wells**

- GAMW-52
- GAMW-52B
- ▲ GAMW-53
- △ GAMW-53B
- ▼ GAMW-54
- ▽ GAMW-54B
- ◆ GAMW-55
- ◇ GAMW-55R
- ◇ GAMW-55B
- GAMW-56
- GAMW-56B

**Sample Collection Date**



CLIENT  
NIPSCO LLC

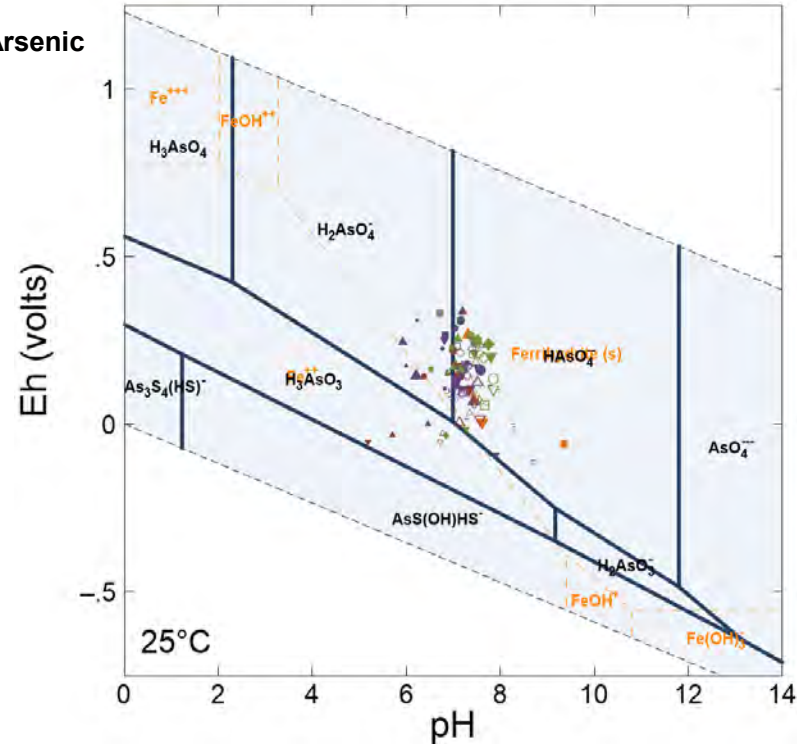
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Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

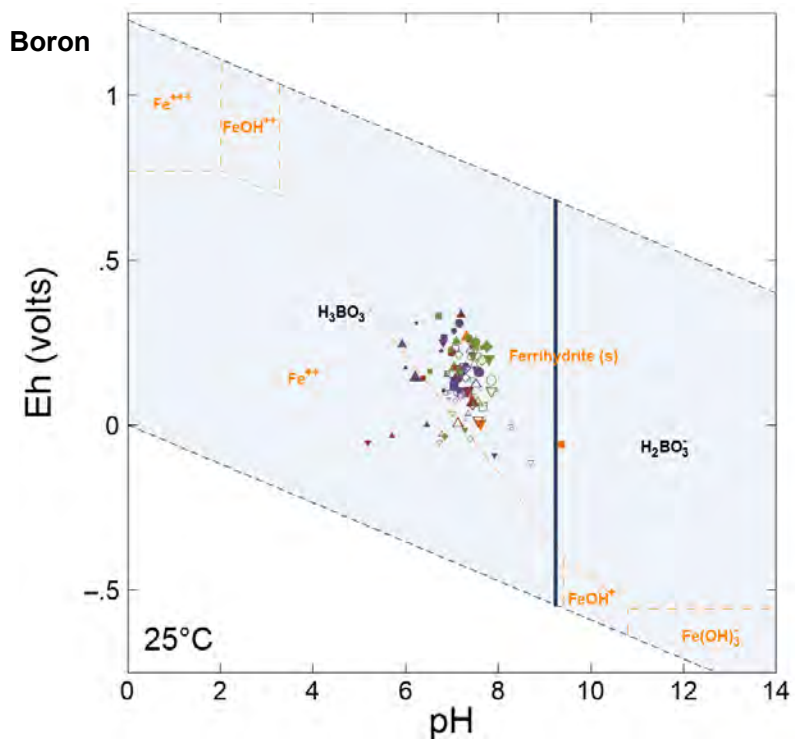


TITLE  
**Piper Diagrams - Groundwater Characterization of Background, Monitoring, and Assessment Wells**

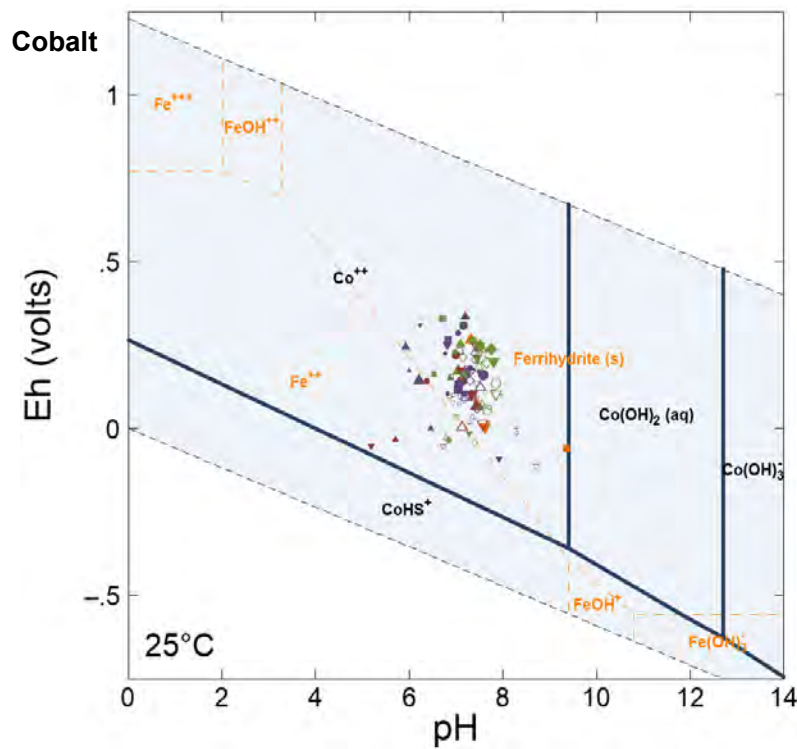
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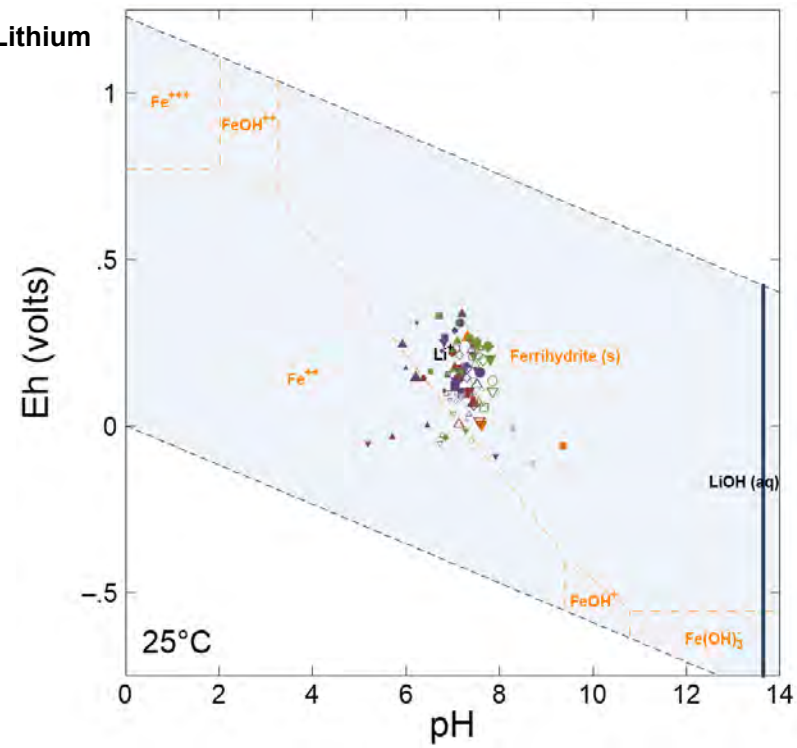
(b) Boron



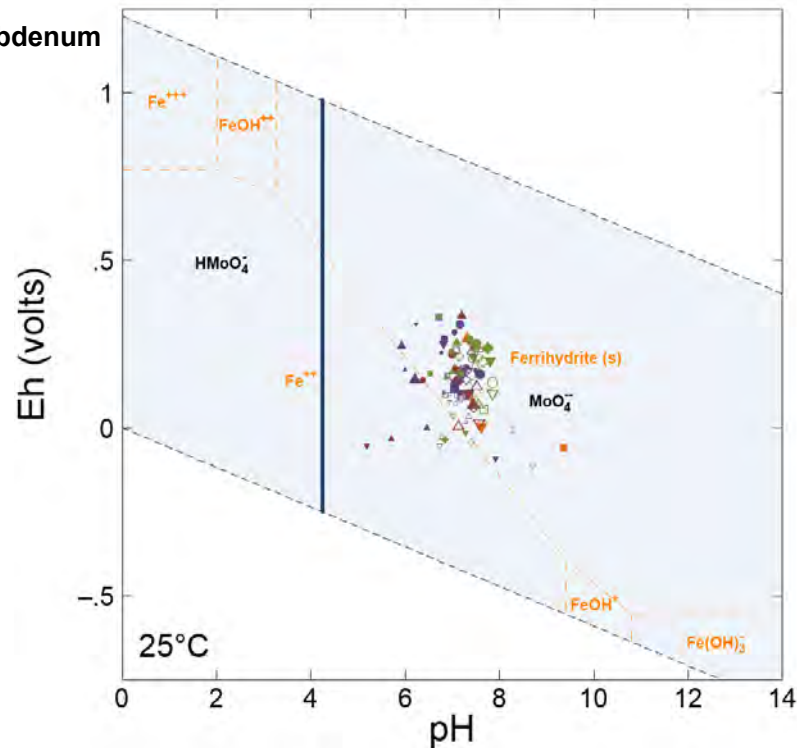
(c) Cobalt



(d) Lithium



(e) Molybdenum



**Porewater**

- GAPIEZ-06
- ▲ DAPZ-02A
- ▼ DAPZ-02B

**Upgradient Wells**

- GAMW-04
- ▲ GAMW-07
- △ GAMW-07B
- ▼ GAMW-15
- ▽ GAMW-15B

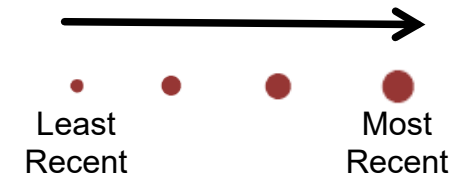
**Downgradient Wells**

- GAMW-08
- GAMW-08B
- ▲ GAMW-09
- △ GAMW-09B
- ▼ GAMW-16
- ▽ GAMW-16B
- ◆ GAMW-17
- ◇ GAMW-17B
- GAMW-18
- GAMW-18B

**Assessment Wells**

- GAMW-52
- GAMW-52B
- ▲ GAMW-53
- △ GAMW-53B
- ▼ GAMW-54
- ▽ GAMW-54B
- ◆ GAMW-55
- ◇ GAMW-55R
- ◇ GAMW-55B
- GAMW-56
- GAMW-56B

**Sample Collection Date**



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PROJECT  
Monitored Natural Attenuation Evaluation  
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NIPSCO LLC R. M. Schahfer Generating Station

TITLE  
Pourbaix Diagrams For Arsenic, Boron, Cobalt, Lithium,  
and Molybdenum

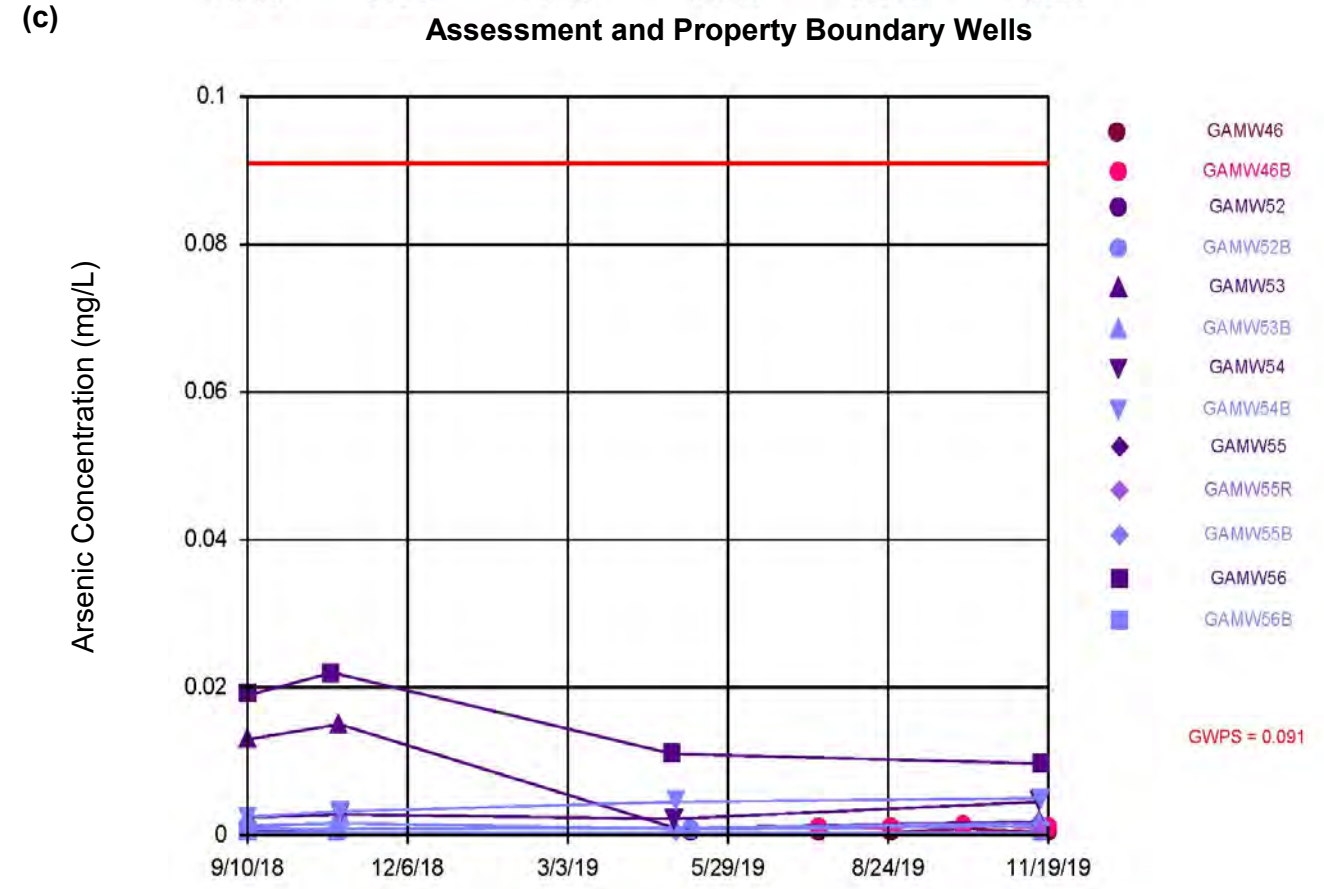
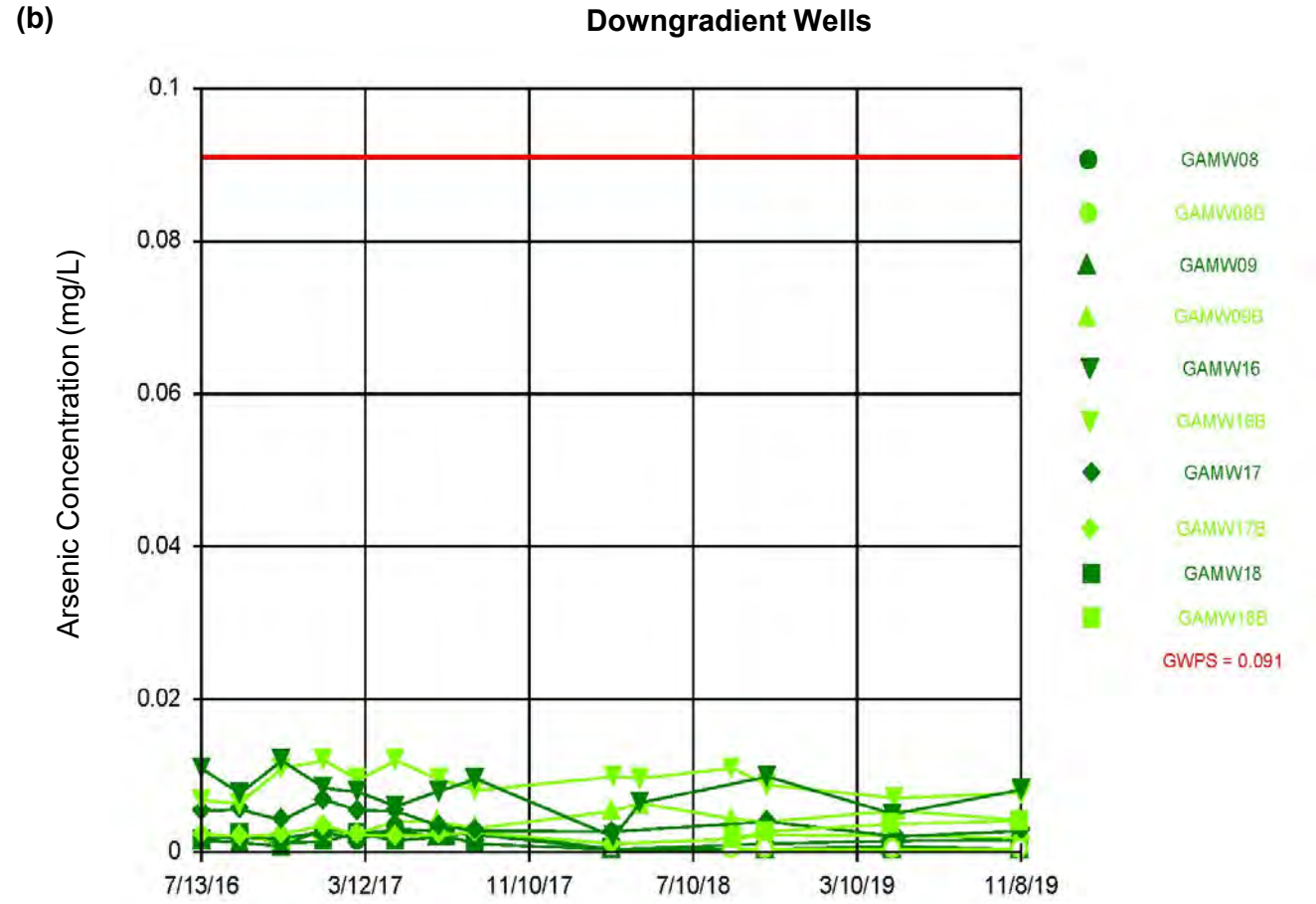
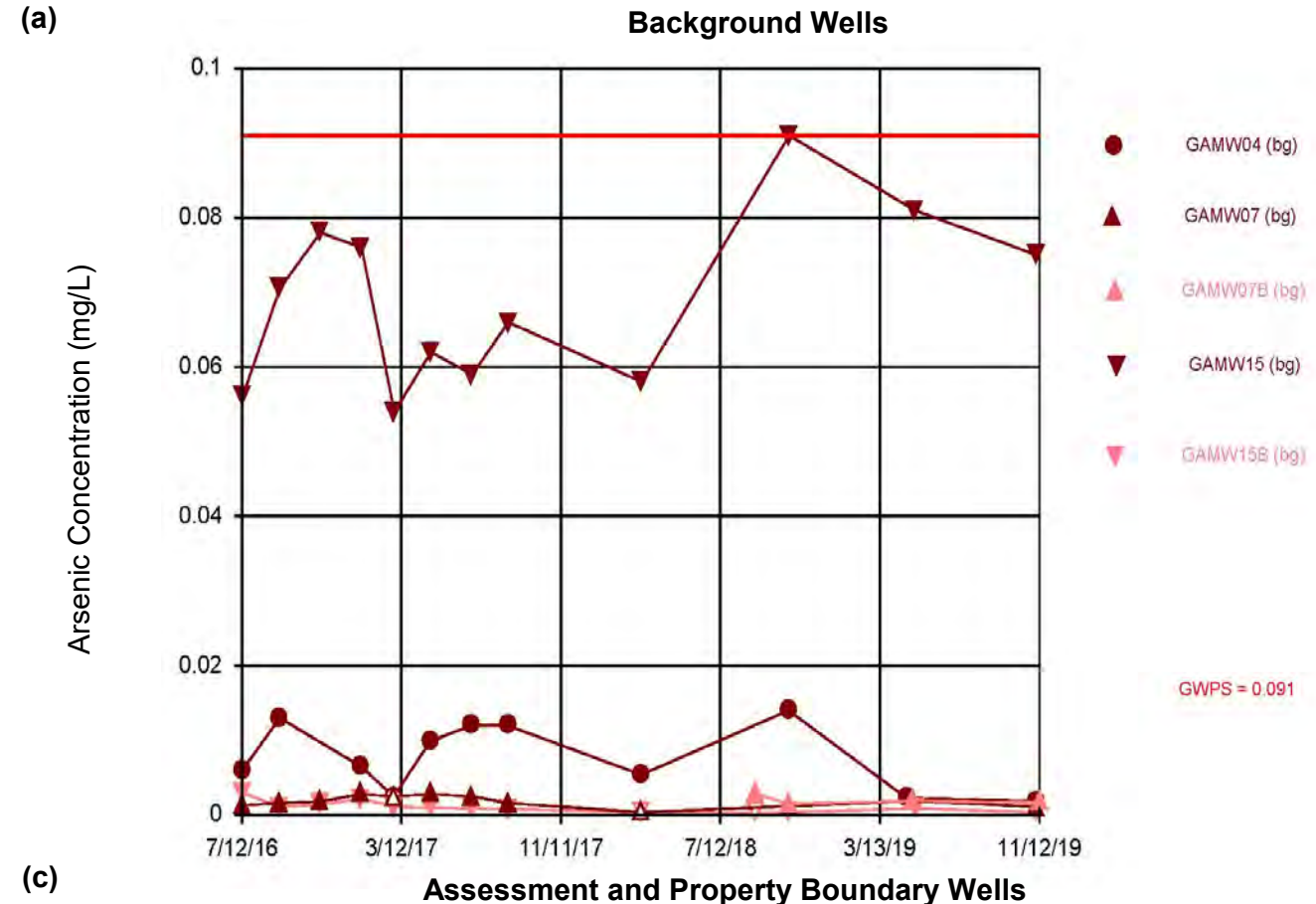
PROJECT NO.  
19121567

PHASE  
192

REV.  
A

FIGURE  
3a-e





Note: Open symbols reflect sample measurements below the laboratory method detection limit.

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Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

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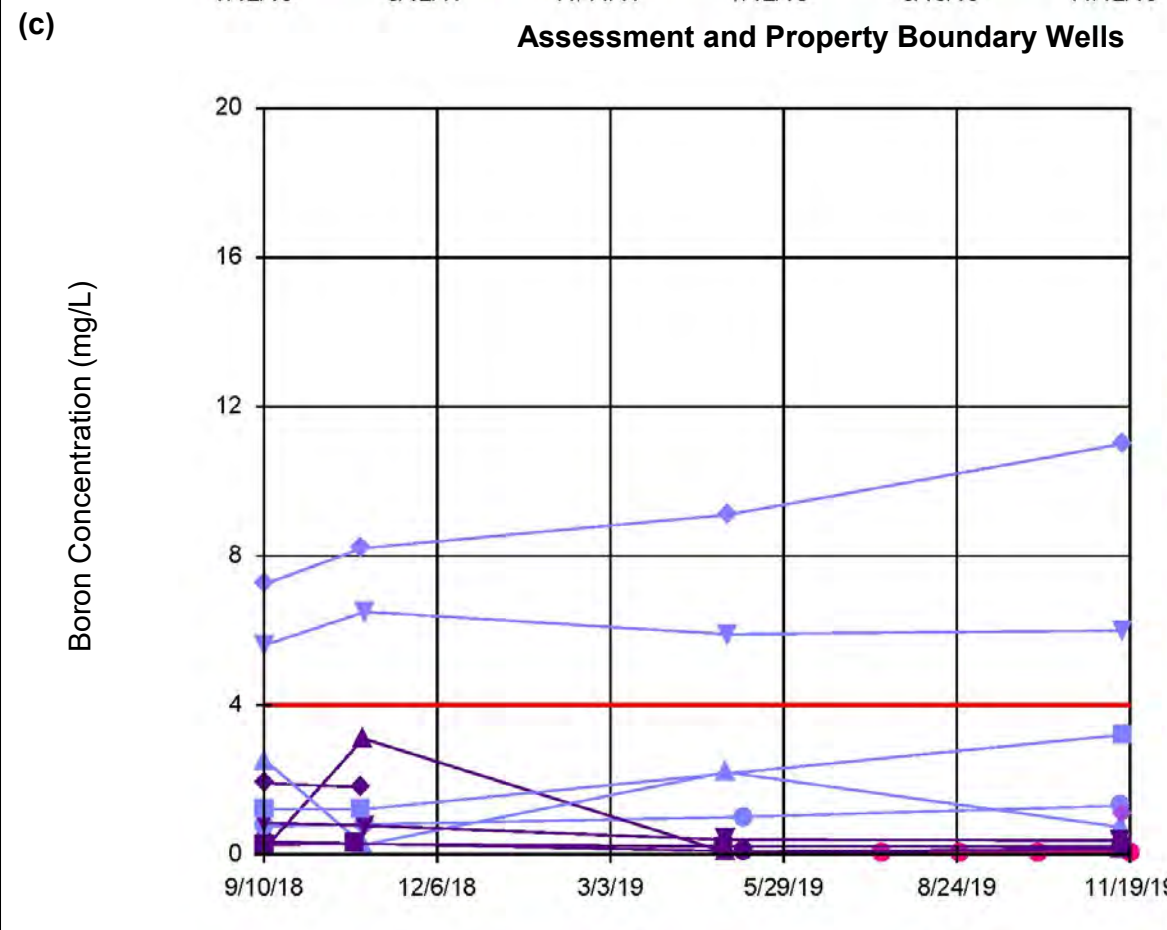
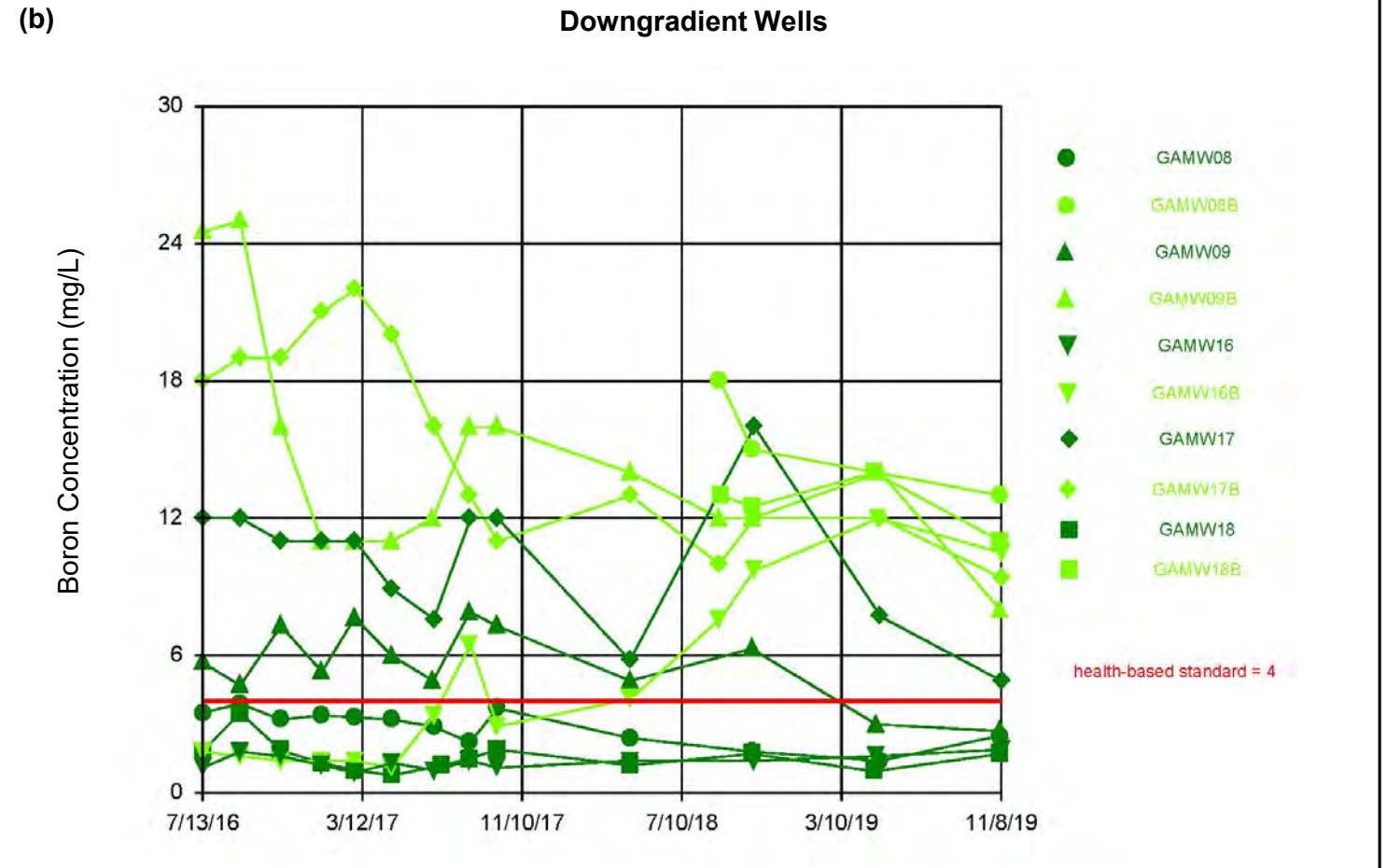
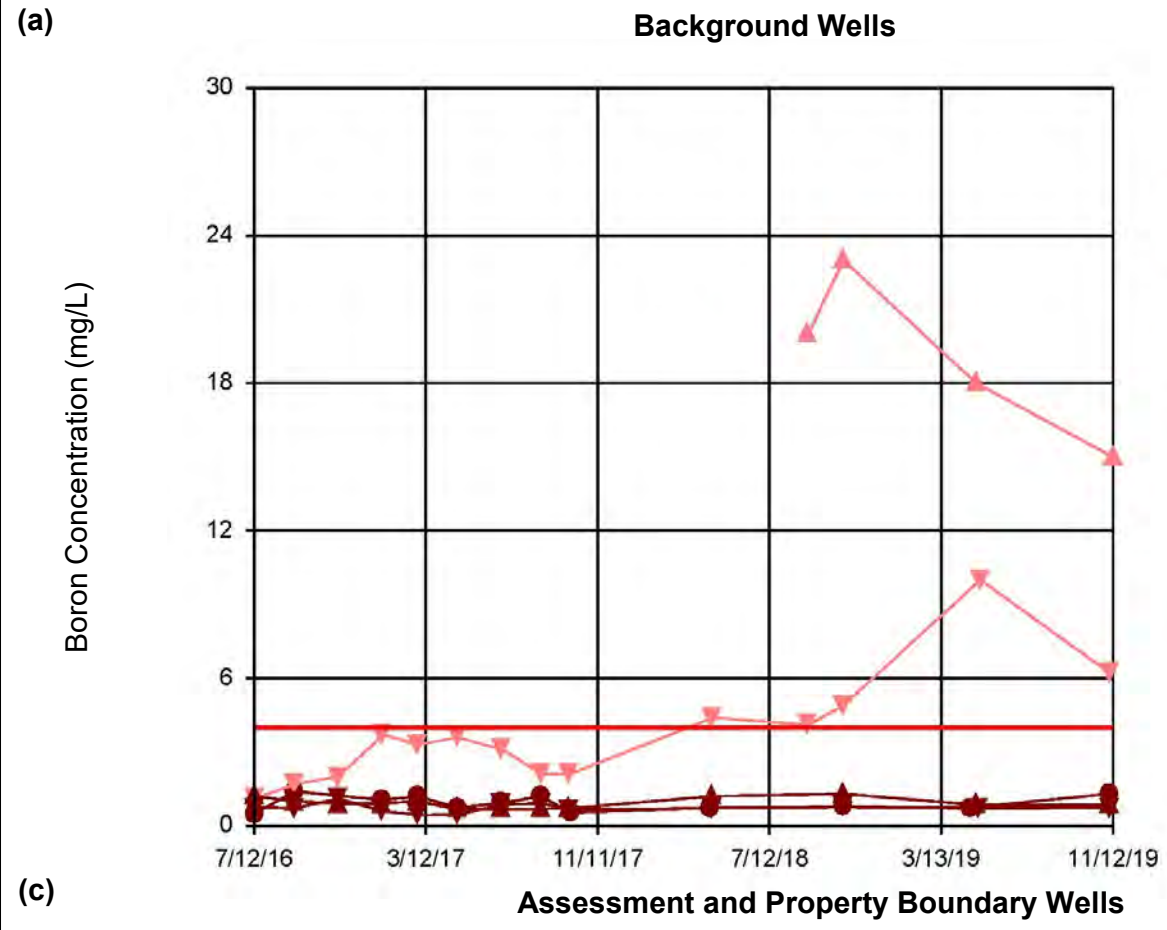


TITLE  
**Arsenic Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

PROJECT NO. 19121567	PHASE 192	REV. A	FIGURE 4a-c
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





Note: Open symbols reflect sample measurements below the laboratory method detection limit

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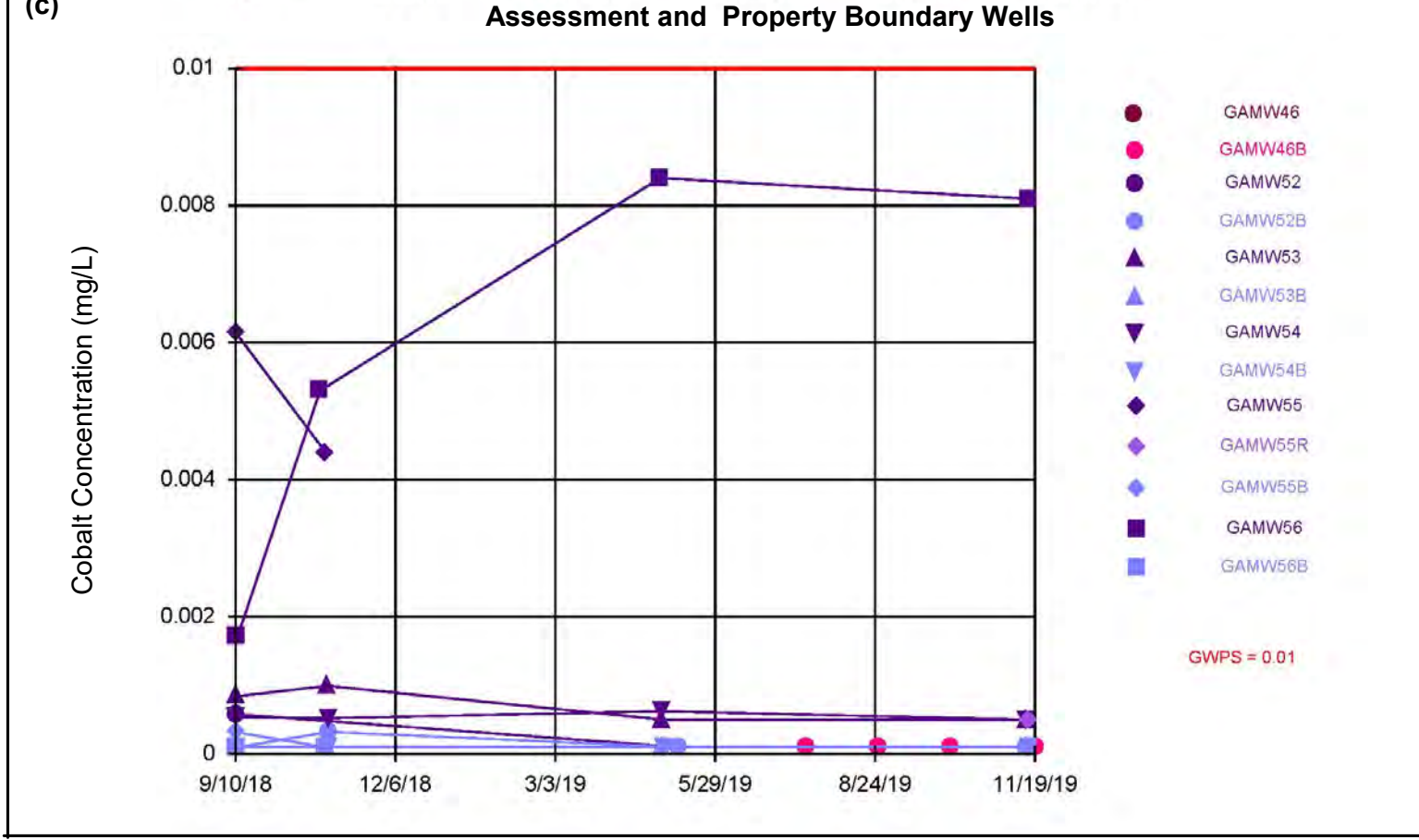
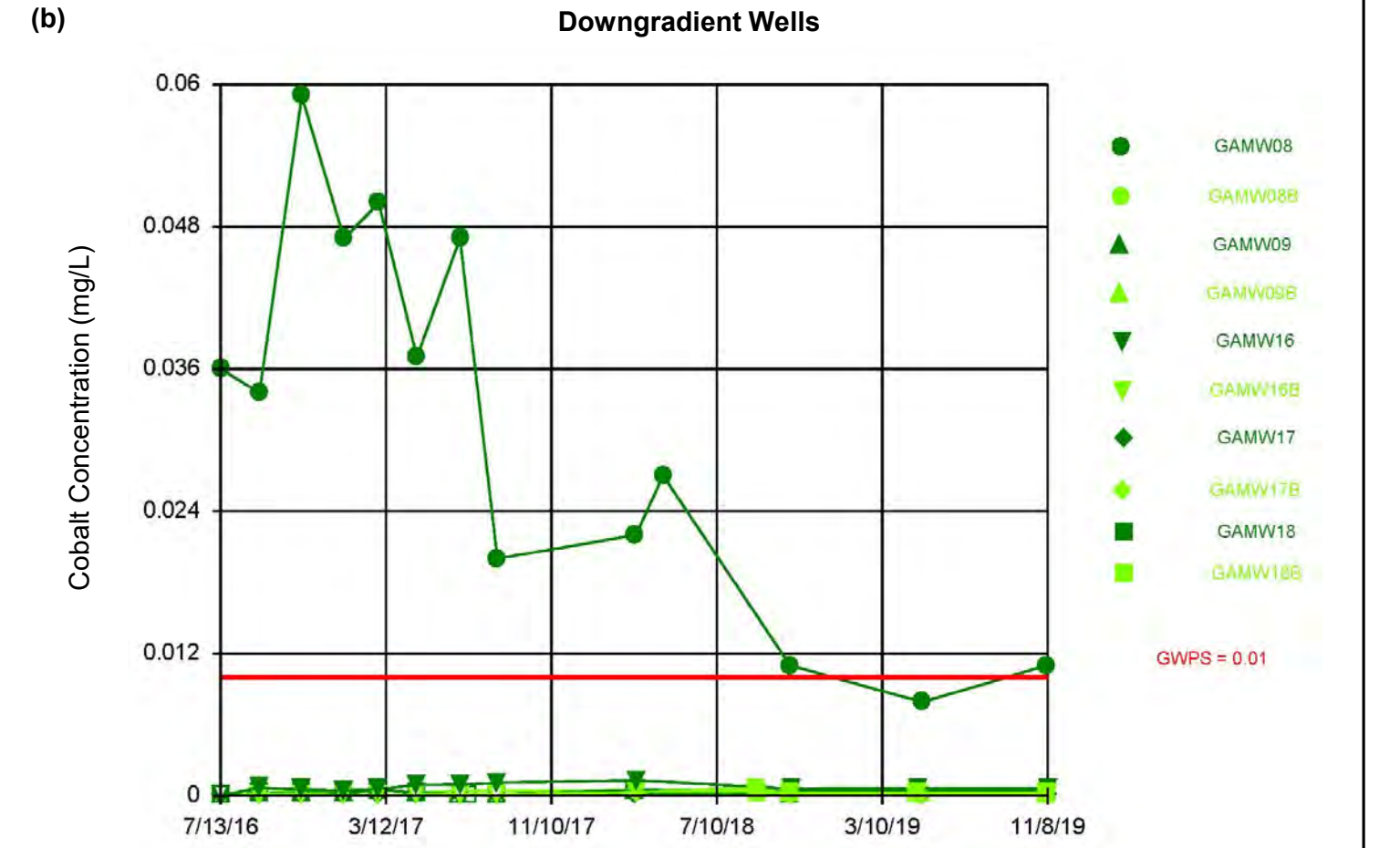
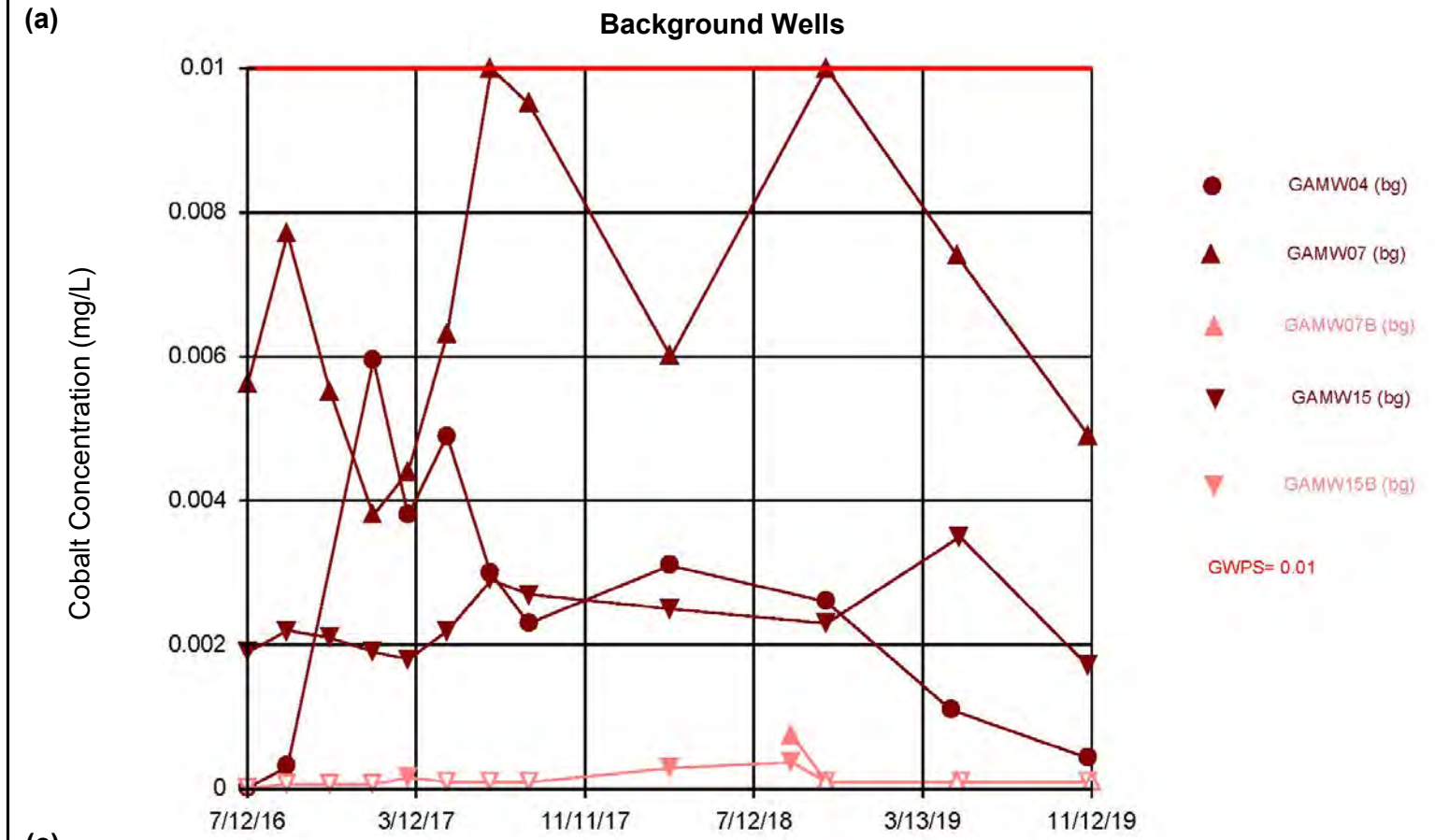
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MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT



TITLE  
**Boron Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

PROJECT NO. 19121567	PHASE 192	REV. A	FIGURE 5a-c
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Note: Open symbols reflect sample measurements below the laboratory method detection limit

CLIENT  
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PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

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TITLE  
**Cobalt Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

PROJECT NO.  
19121567

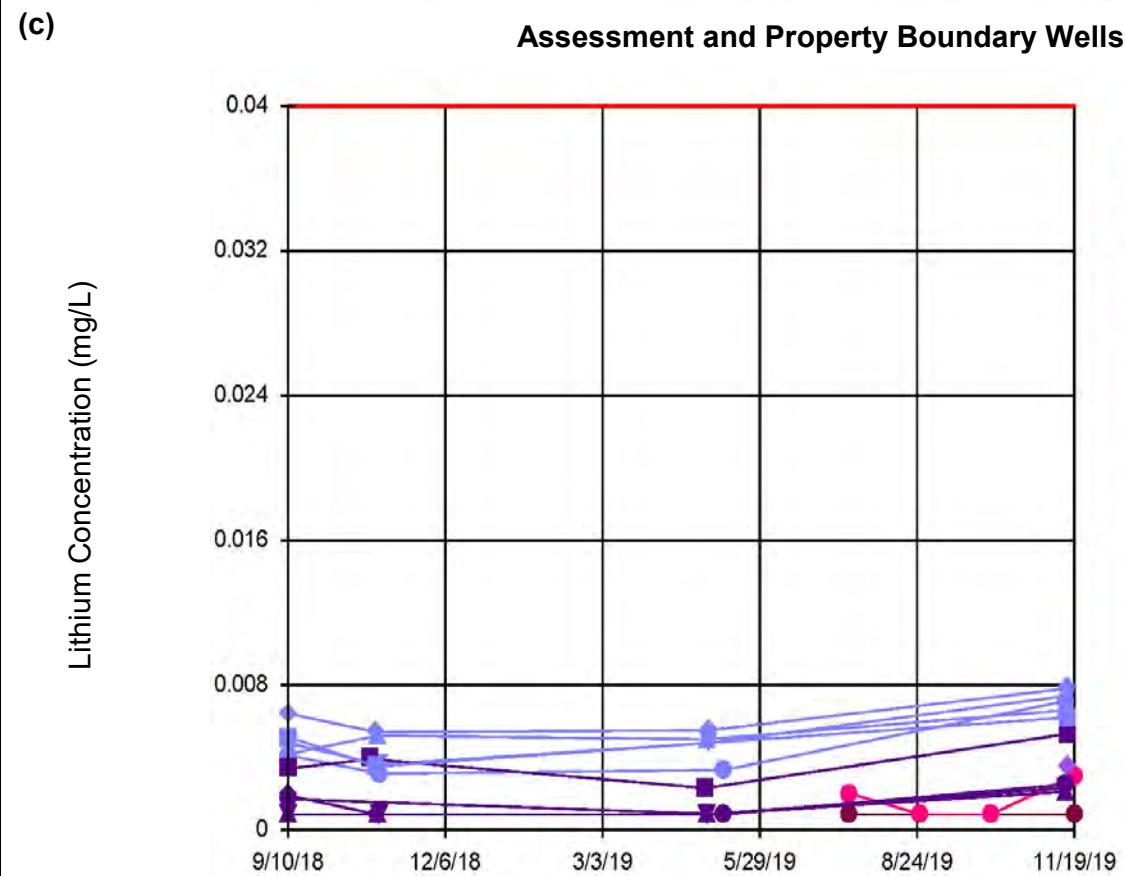
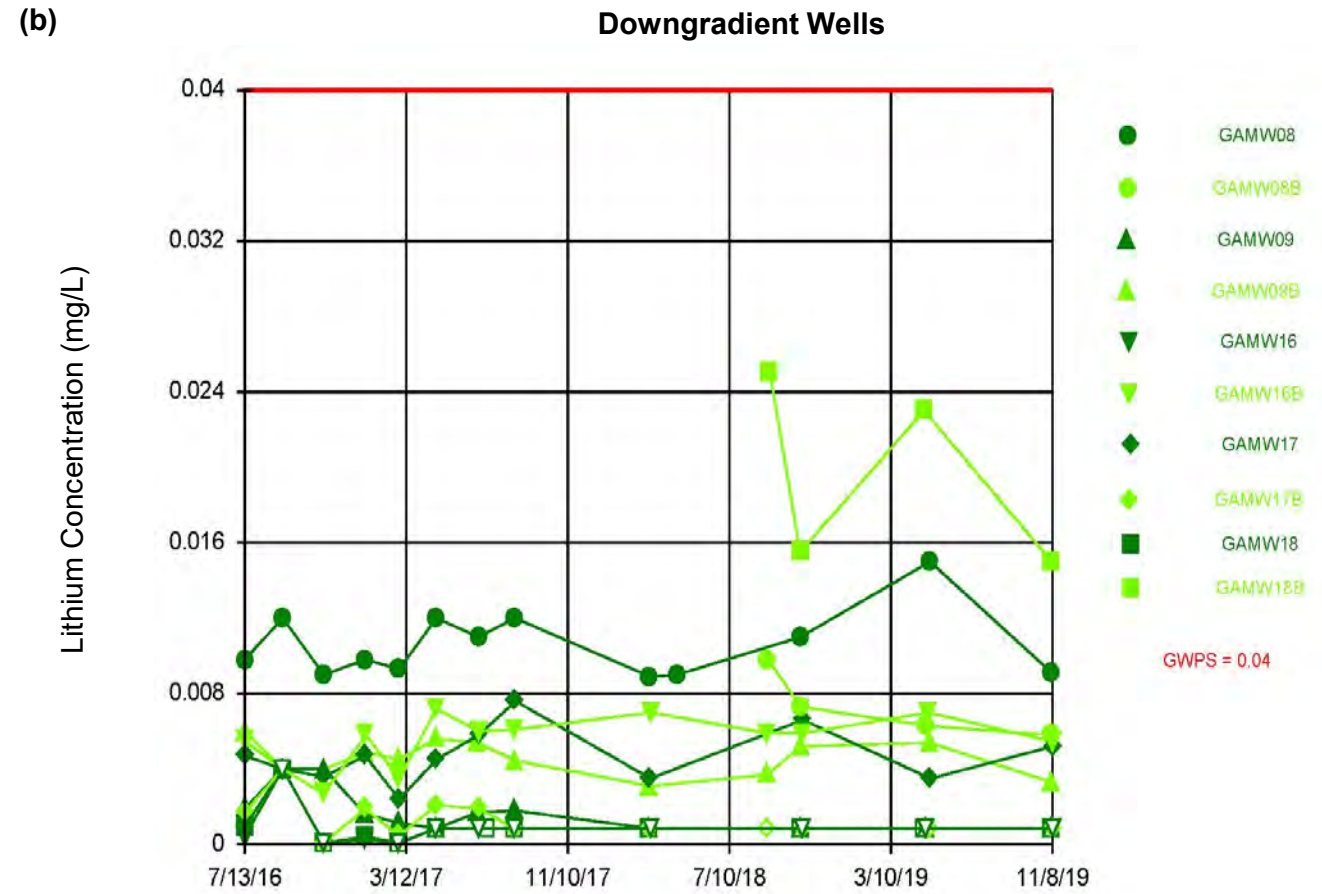
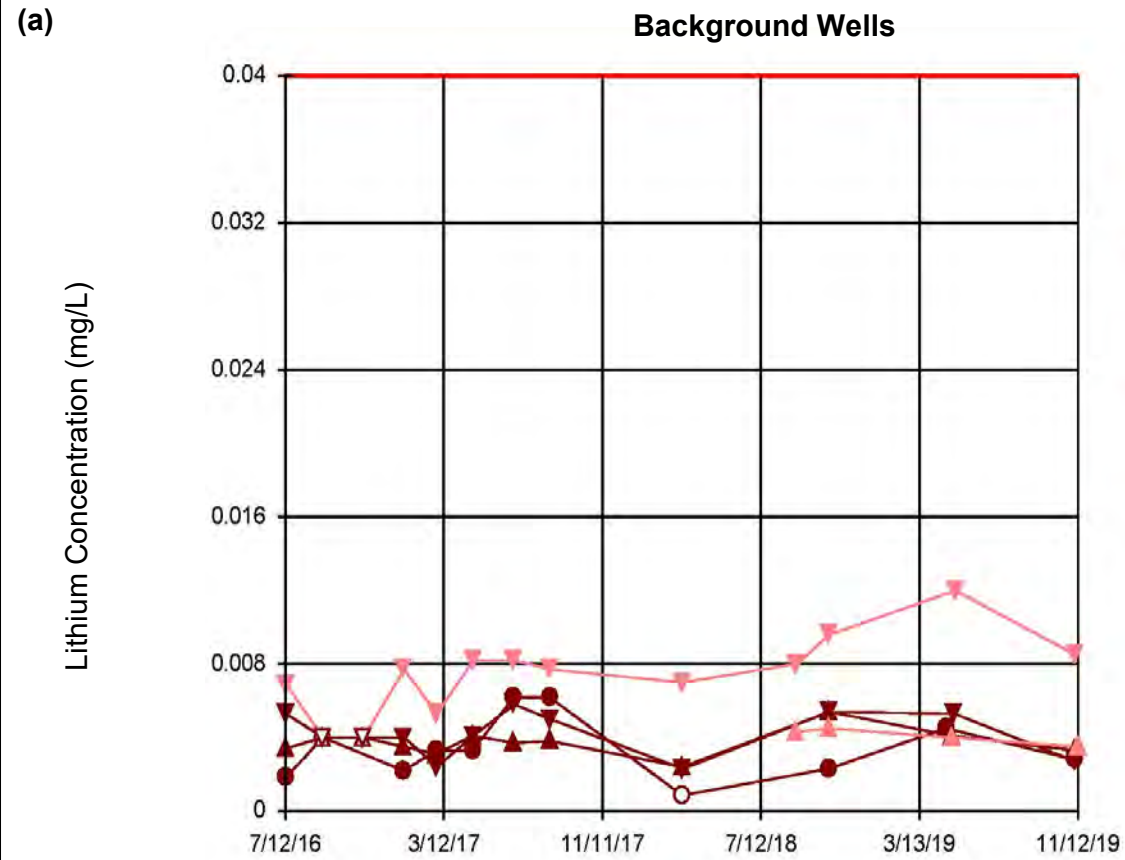
PHASE  
192

REV.  
A

FIGURE  
6a-c

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





Note: Open symbols reflect sample measurements below the laboratory method detection limit

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT



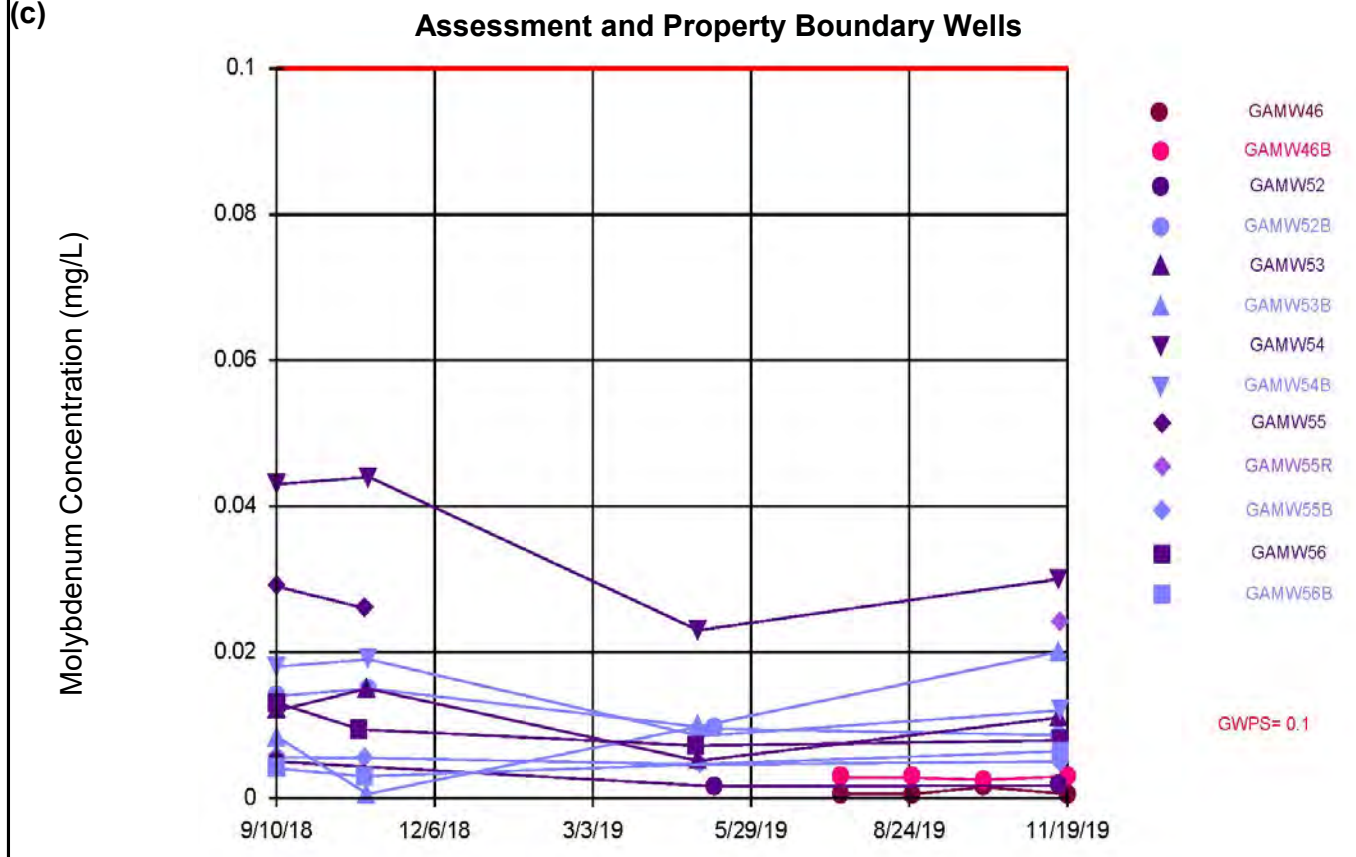
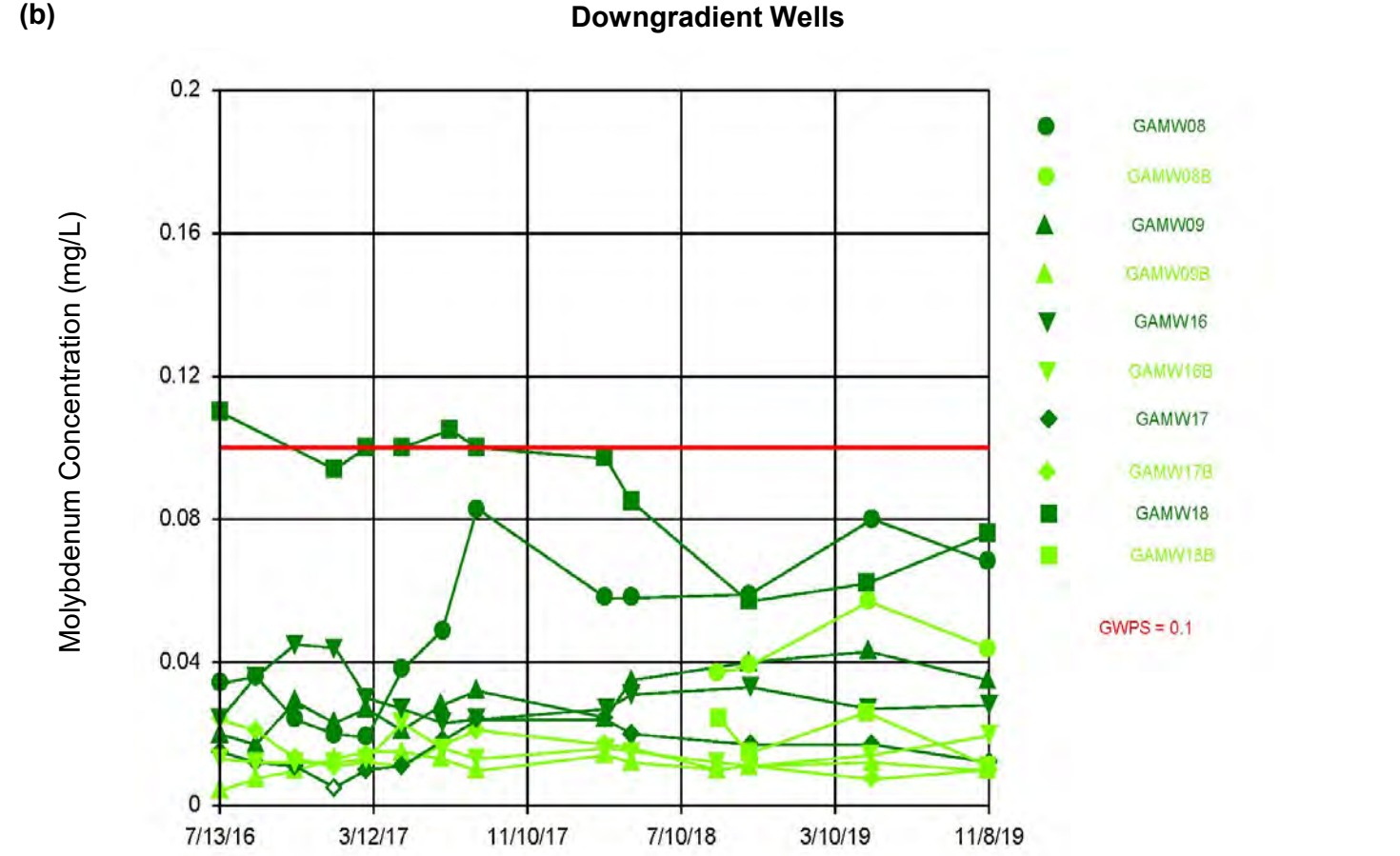
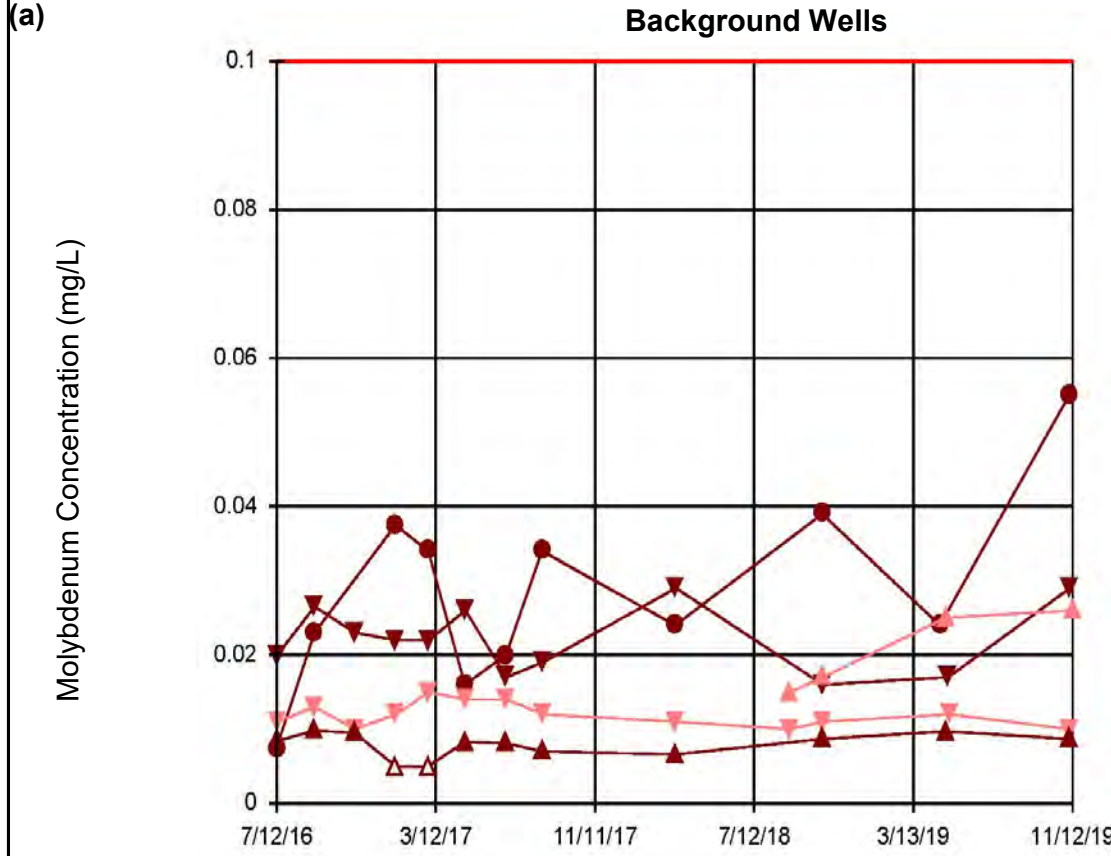
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**Lithium Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

PROJECT NO.  
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PHASE  
192

REV.  
A

FIGURE  
7a-c



Note: Open symbols reflect sample measurements below the laboratory method detection limit

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PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

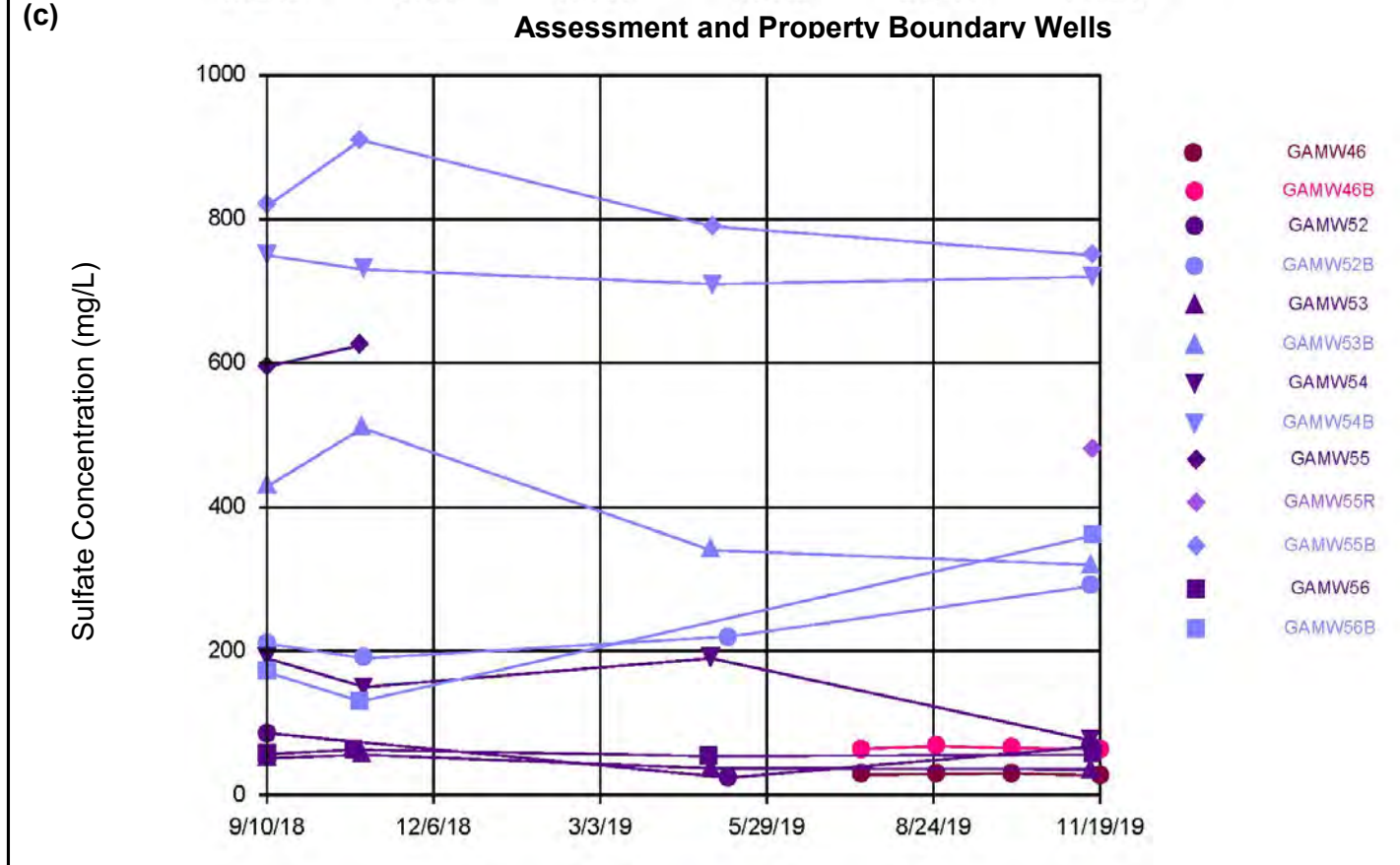
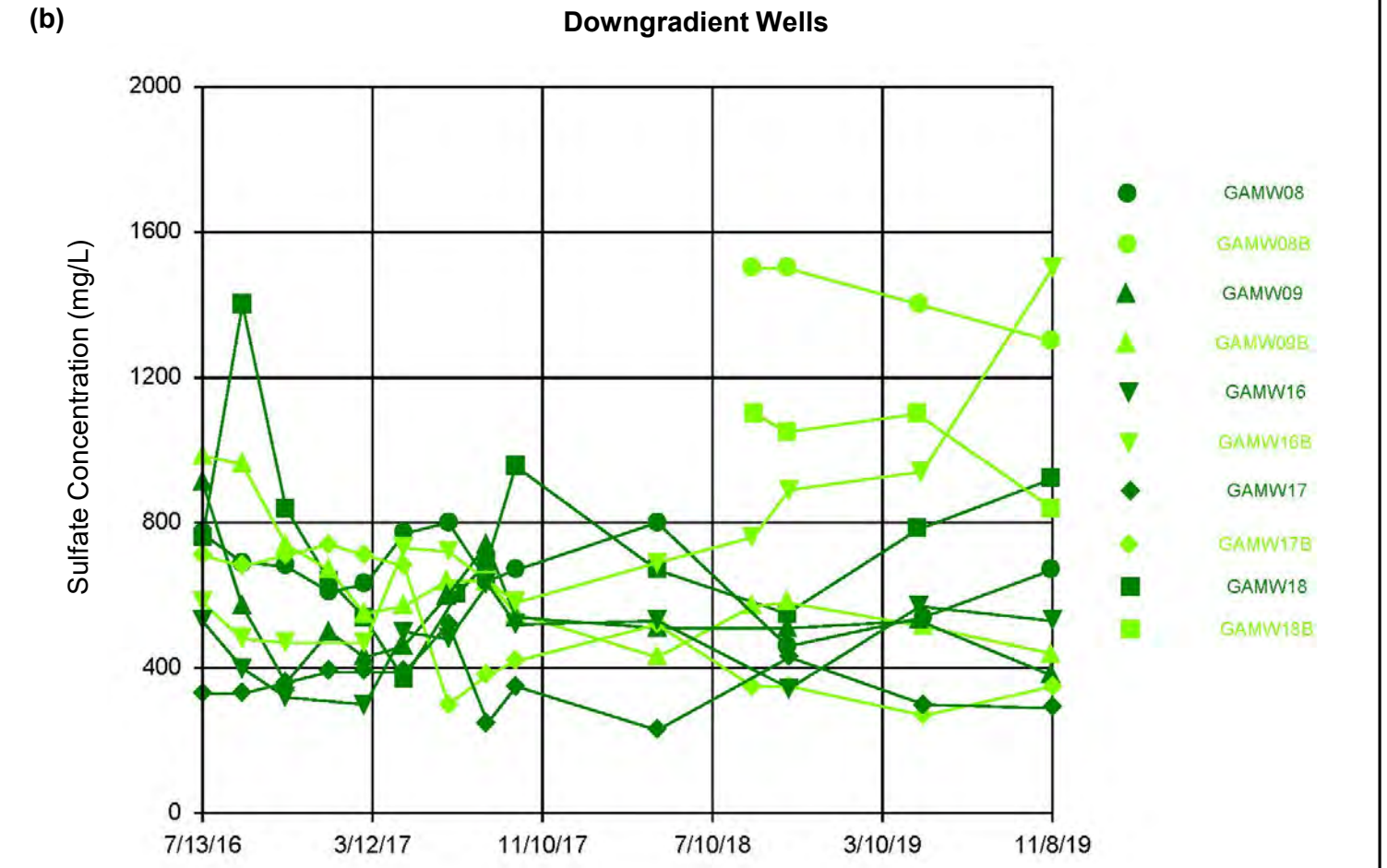
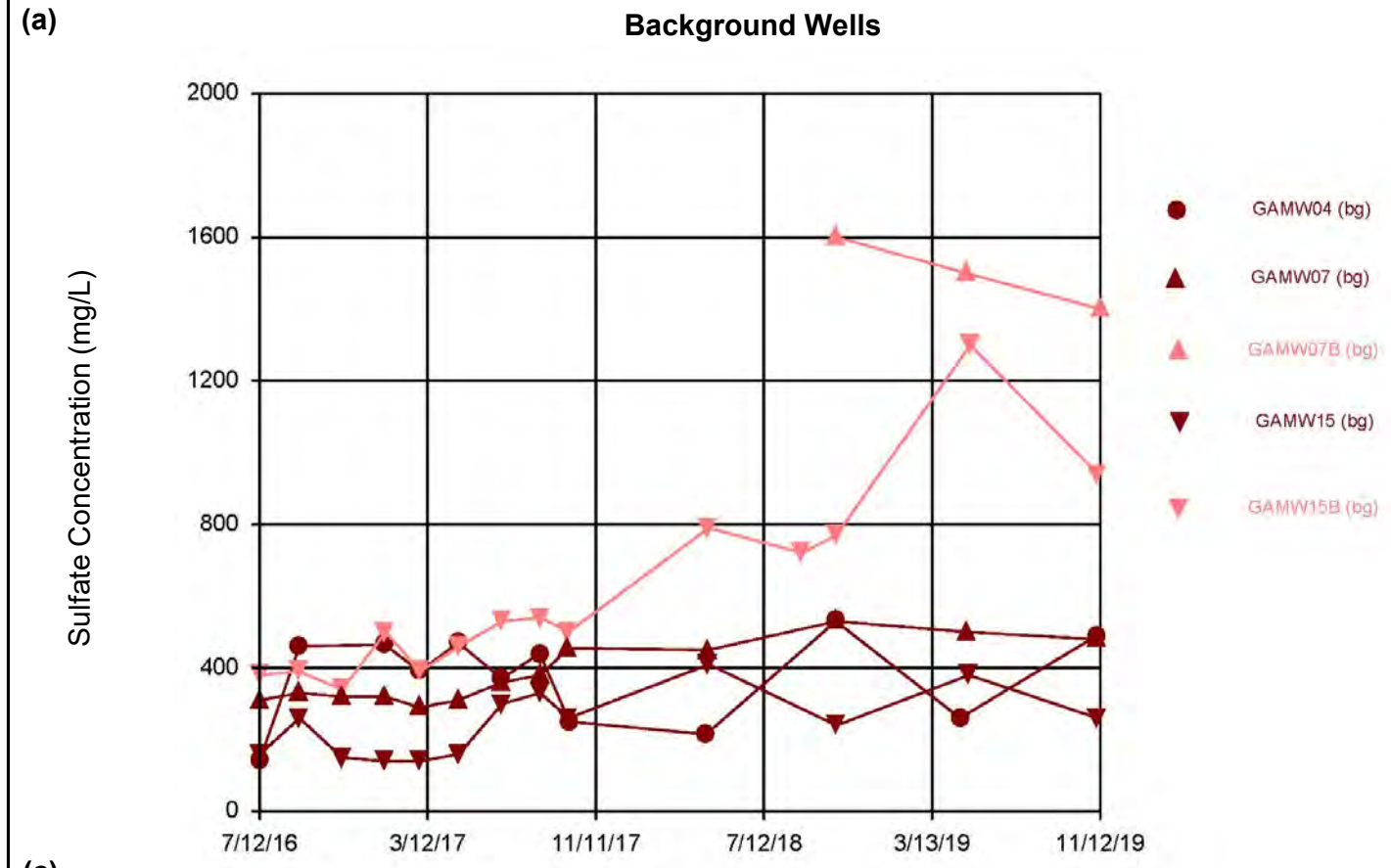


TITLE  
**Molybdenum Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

PROJECT NO. 19121567	PHASE 192	REV. A	FIGURE 8a-c
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





Note: Open symbols reflect sample measurements below the laboratory method detection limit

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

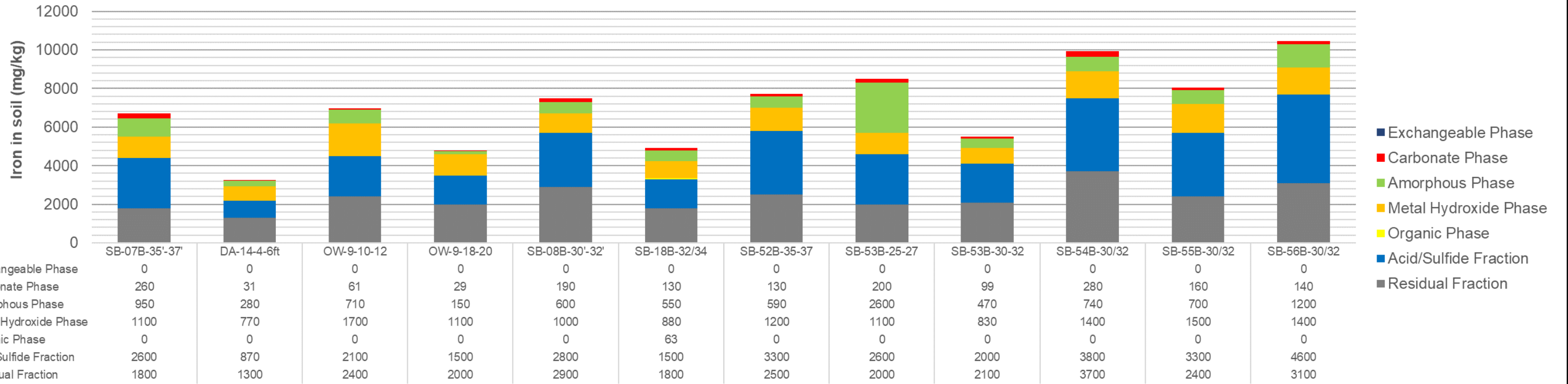


TITLE  
**Sulfate Time Series for Background, Monitoring, and Assessment and Property Boundary Wells**

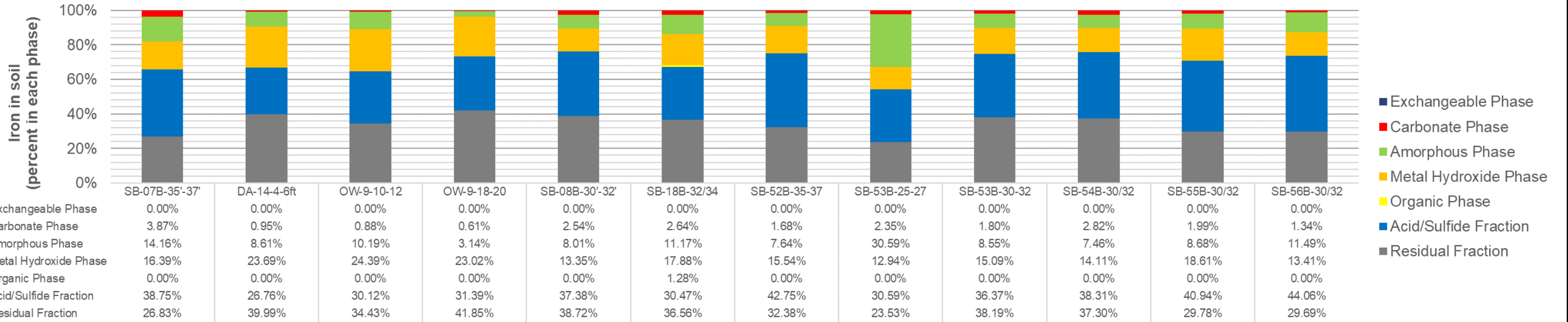
PROJECT NO. 19121567	PHASE 192	REV. A	FIGURE 9a-c
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





Borehole and depth below ground surface (Iron in mg/kg soil)



Borehole and depth below ground surface (Iron in percent of total)

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

TITLE  
Iron Sequential Extraction Results

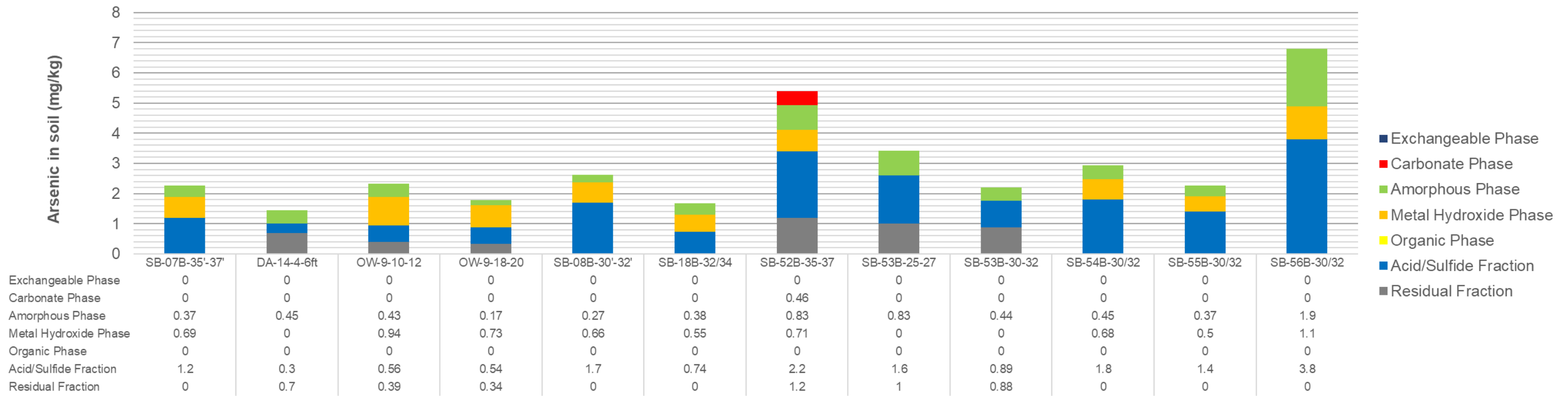


PROJECT NO.  
19121567

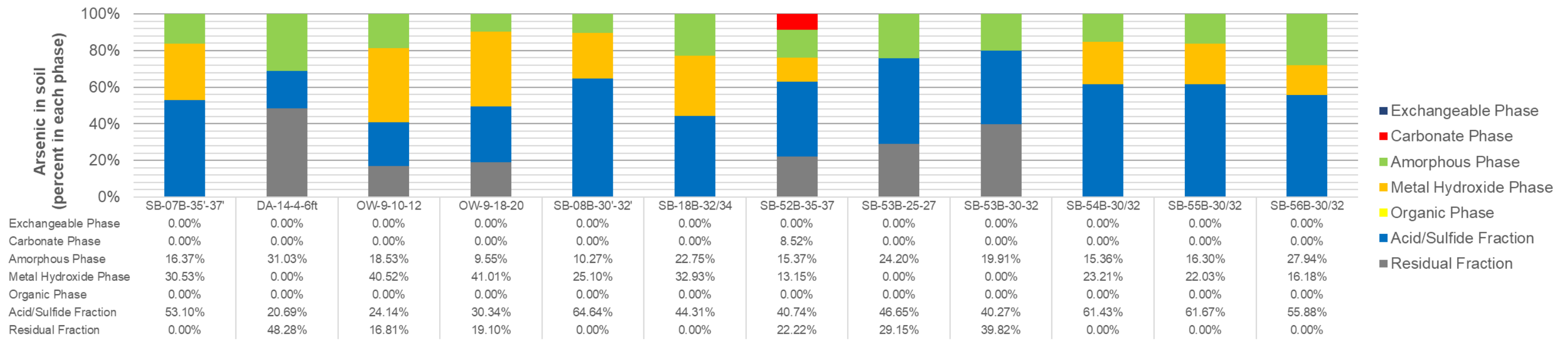
PHASE  
192

REV.  
A

FIGURE  
10



Borehole and depth below ground surface (Arsenic in mg/kg soil)



Borehole and depth below ground surface (Arsenic in percent of total)

CLIENT  
NIPSCO LLC

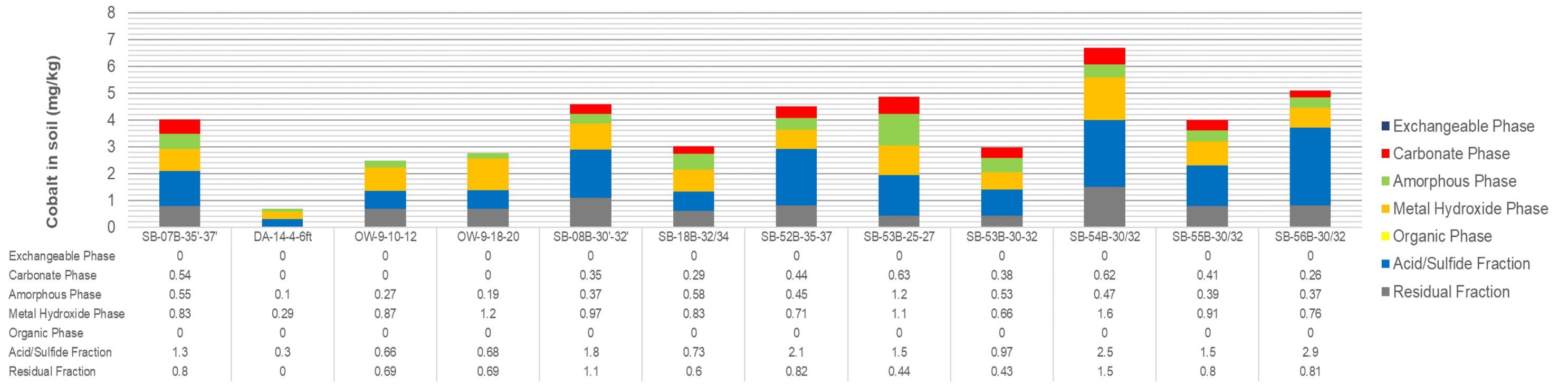
PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

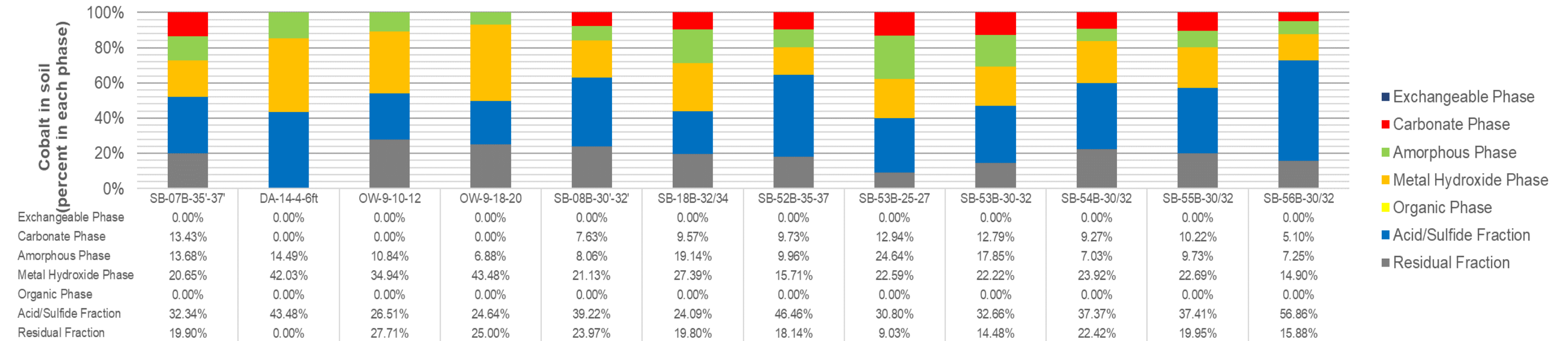
TITLE  
Arsenic Sequential Extraction Results



IF THIS MEASUREMENT DOES NOT MATCH WHAT'S SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A



Borehole and depth below ground surface (Cobalt in mg/kg soil)



Borehole and depth below ground surface (Cobalt in percent of total)

CLIENT  
NIPSCO LLC

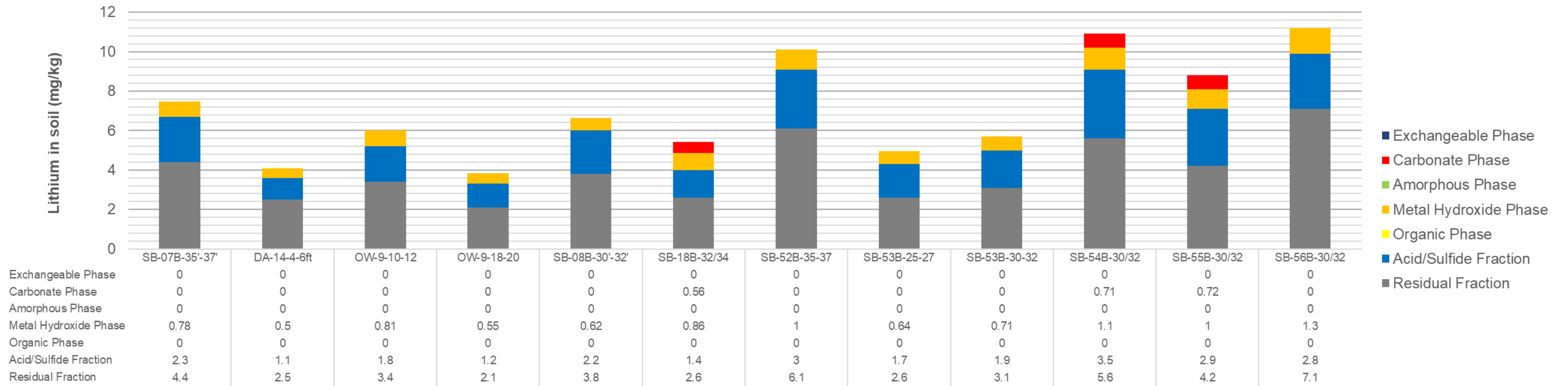
PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

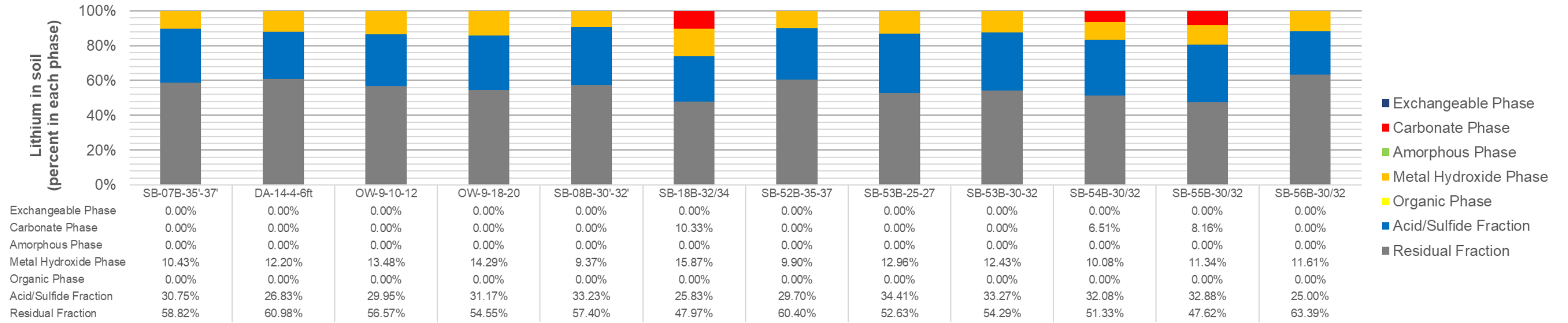
TITLE  
Cobalt Sequential Extraction Results



IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A



Borehole and depth below ground surface (Lithium in mg/kg soil)



Borehole and depth below ground surface (Lithium in percent of total)

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT

TITLE  
Lithium Sequential Extraction Results

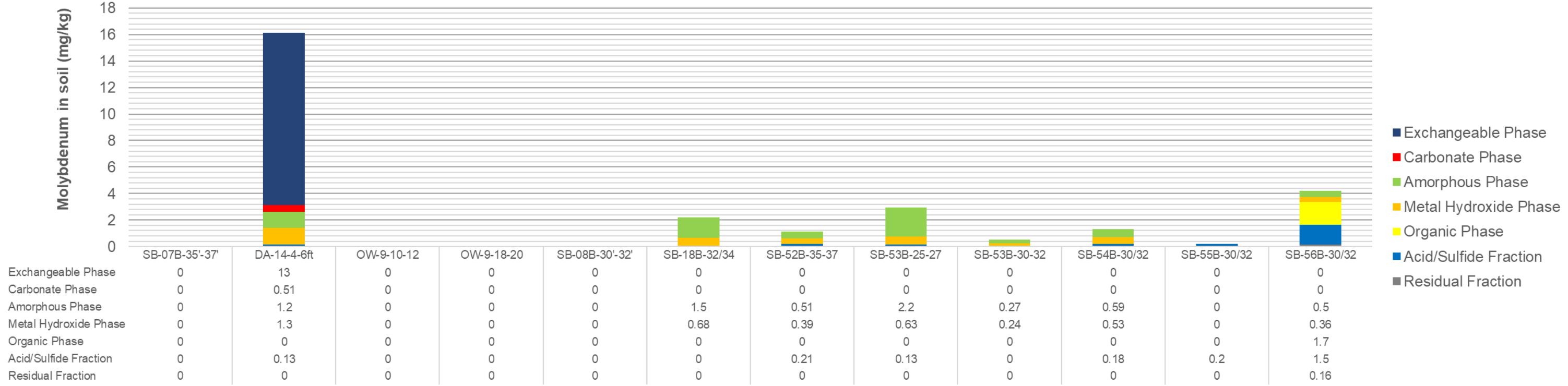


PROJECT NO.  
19121567

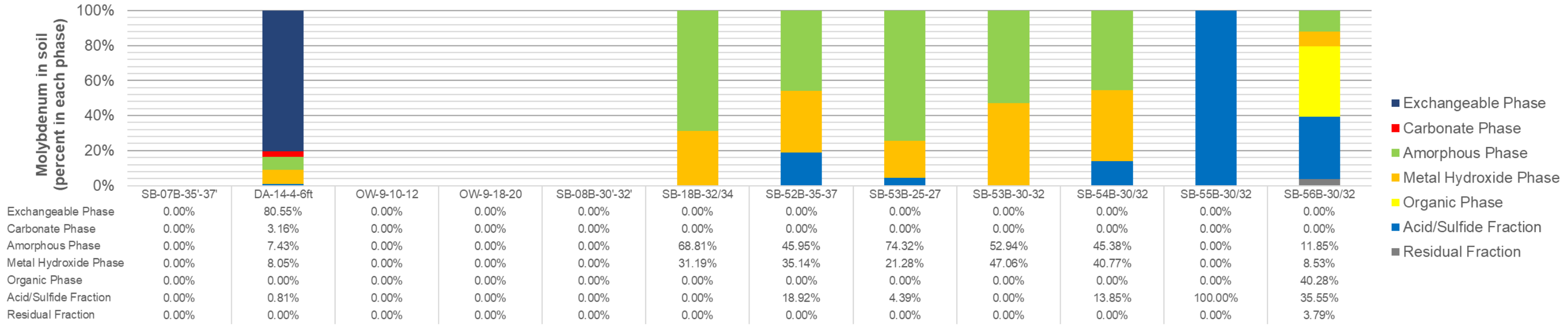
PHASE  
192

REV.  
A

FIGURE  
13



Borehole and depth below ground surface (Molybdenum in mg/kg soil)



Borehole and depth below ground surface (Molybdenum in percent of total)

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

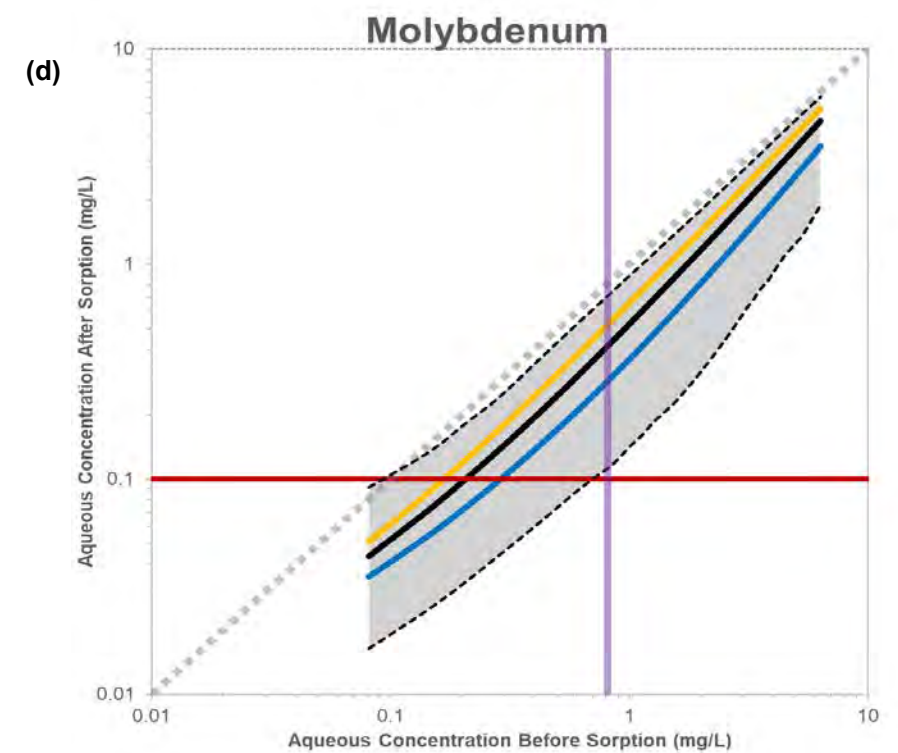
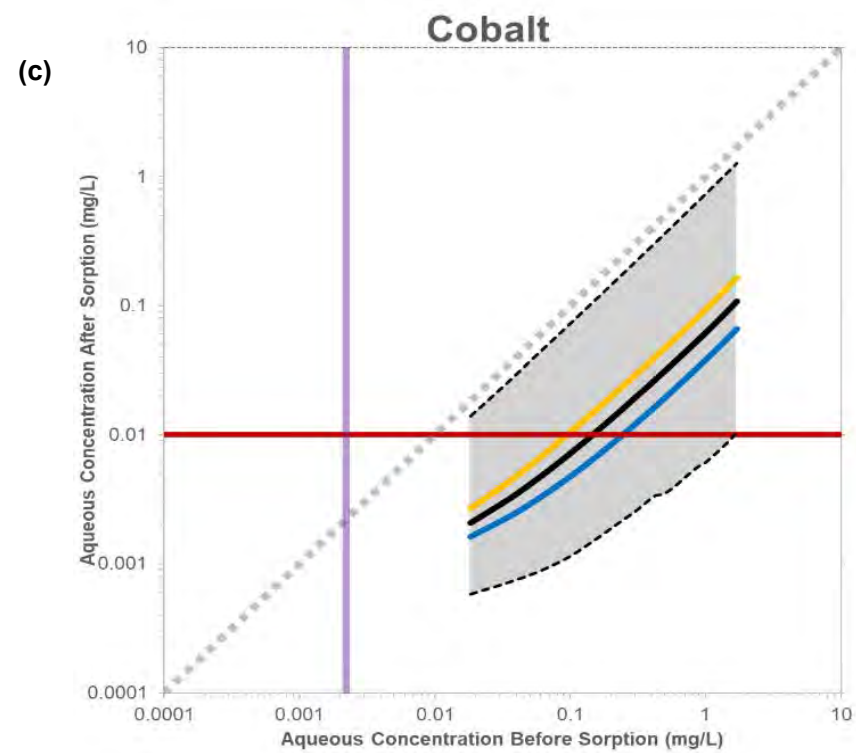
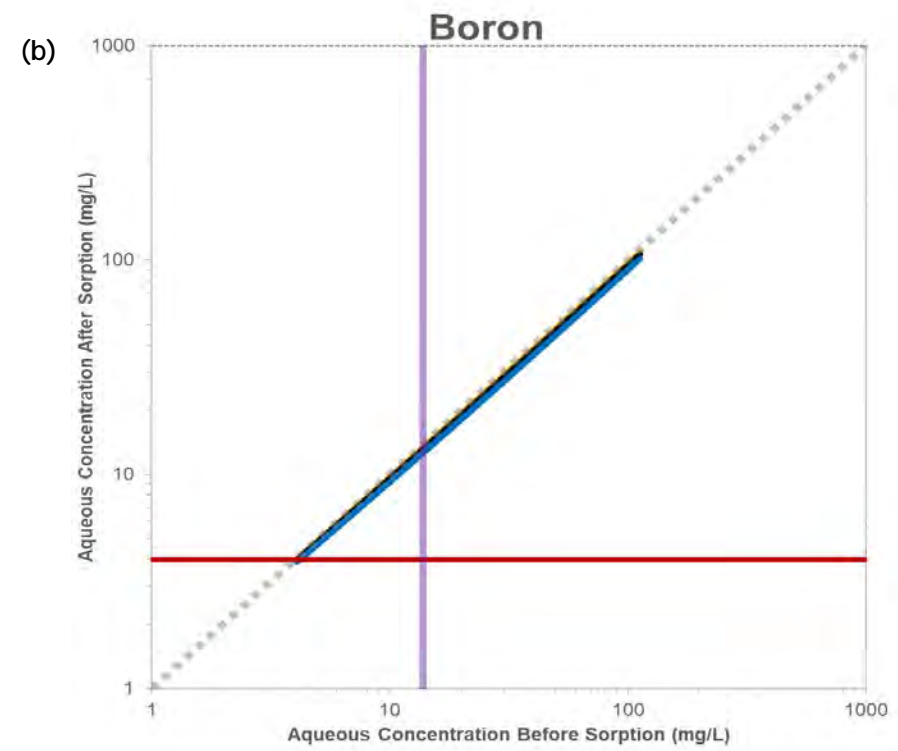
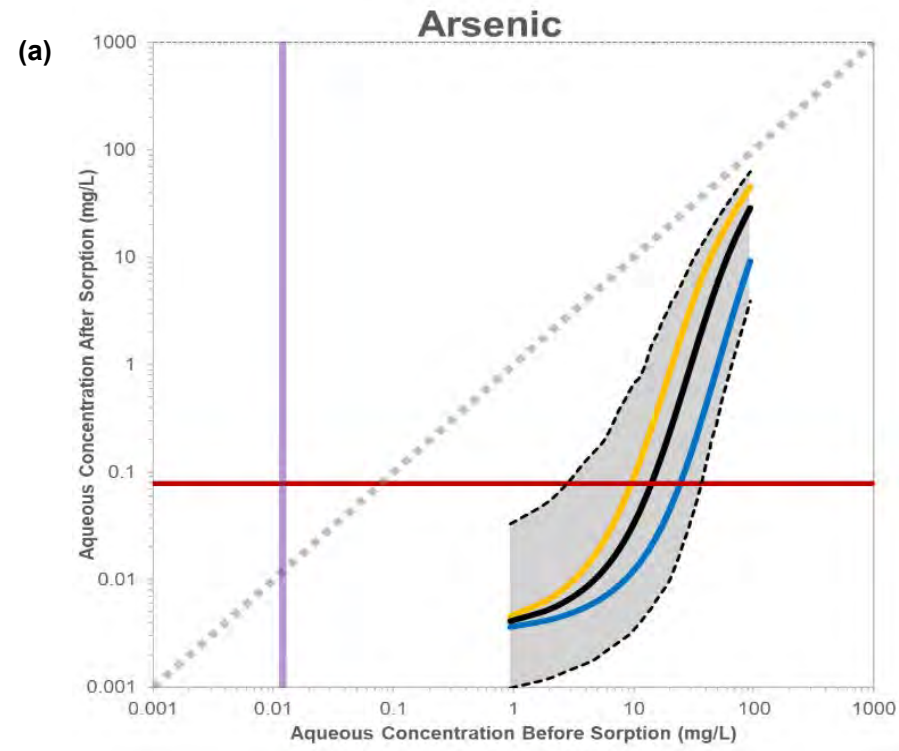
CONSULTANT

TITLE  
Molybdenum Sequential Extraction Results



IF THIS MEASUREMENT DOES NOT MATCH WHAT'S SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





- Minimum Hfo and Hao Contents (Geometric mean of all simulations)
- Mean Hfo and Hao Contents (Geometric mean of all simulations)
- Maximum Hfo and Hao Contents (Geometric mean of all simulations)
- 5th to 95th Percentile of Min, Mean, and Max Simulations
- Groundwater Protection Standard
- Porewater
- - - 1:1 Line

CLIENT  
NIPSCO LLC

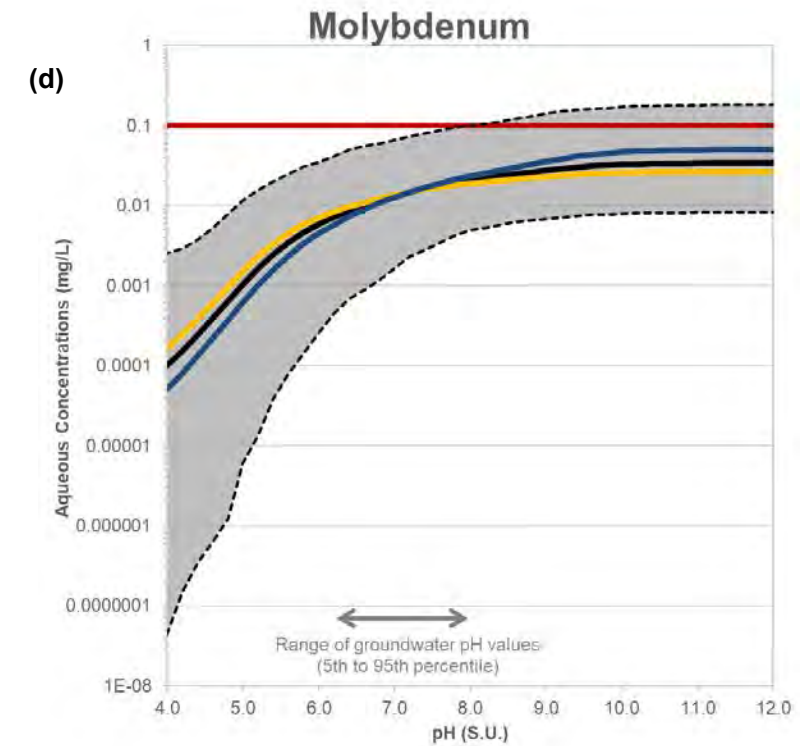
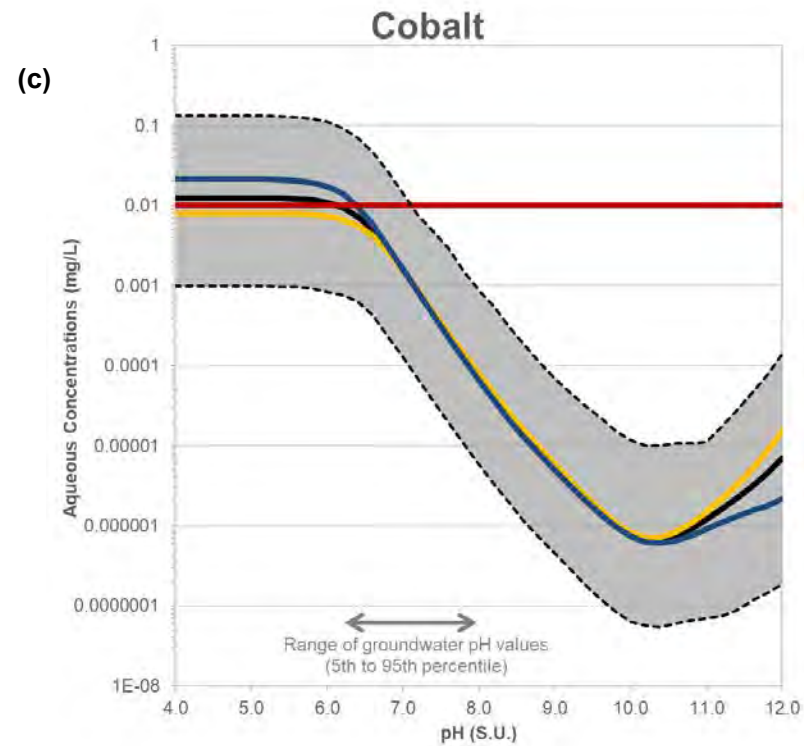
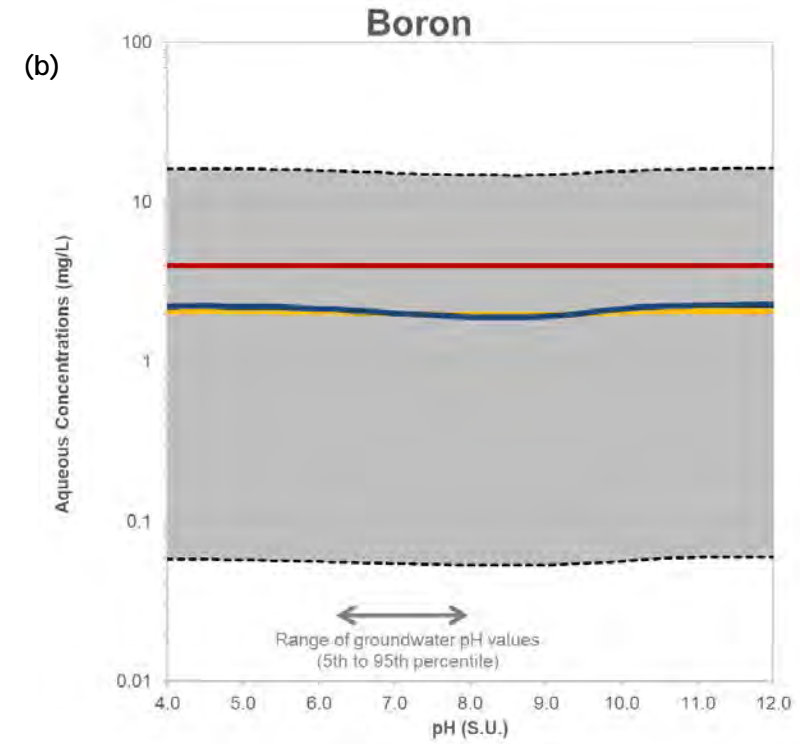
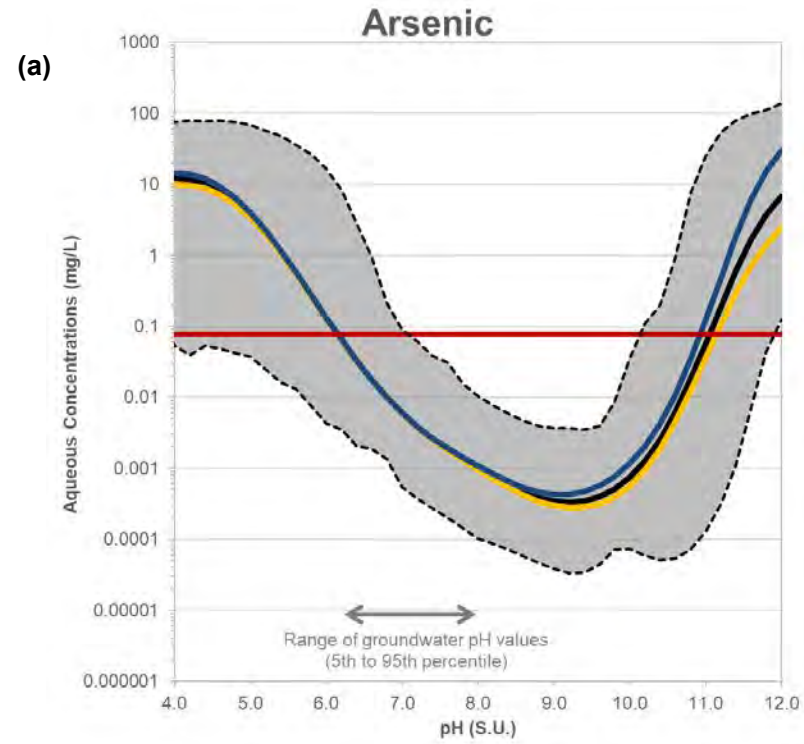
PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT



TITLE  
**Capacity of Soils to Adsorb Constituents: Aqueous Concentrations Prior to Equilibrating with Hfo and Hao versus Aqueous Concentrations After Equilibrating**

PROJECT NO. 19121567	PHASE 192	REV. A	FIGURE 15
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- Minimum Hfo and Hao Contents (Geometric mean of all simulations)
- Mean Hfo and Hao Contents (Geometric mean of all simulations)
- Maximum Hfo and Hao Contents (Geometric mean of all simulations)
- 5th to 95th Percentile of Min, Mean, and Max Simulations
- Groundwater Protection Standard

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

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TITLE  
**Stability of Adsorbed Constituents Versus pH**

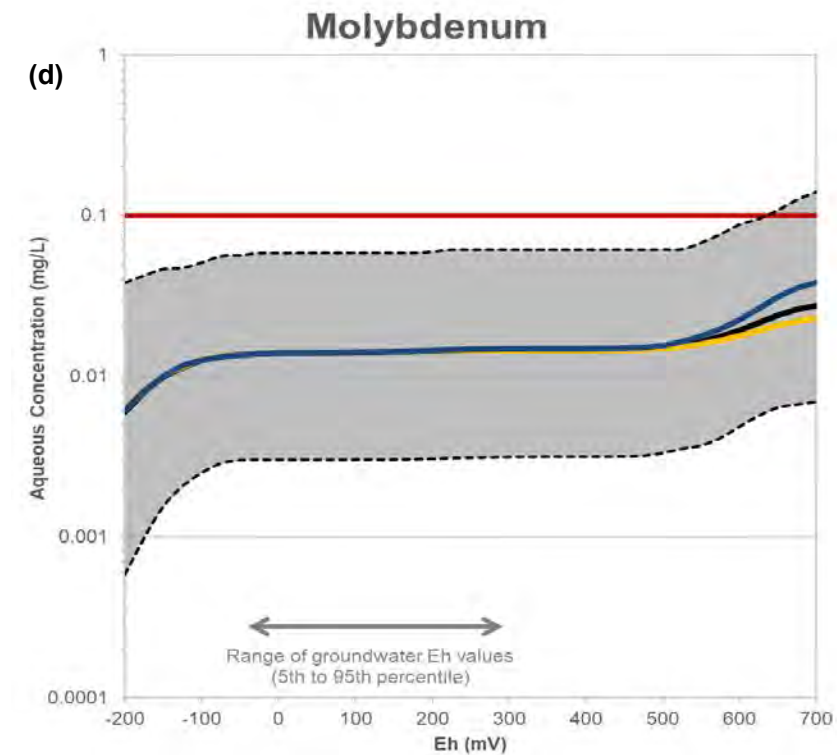
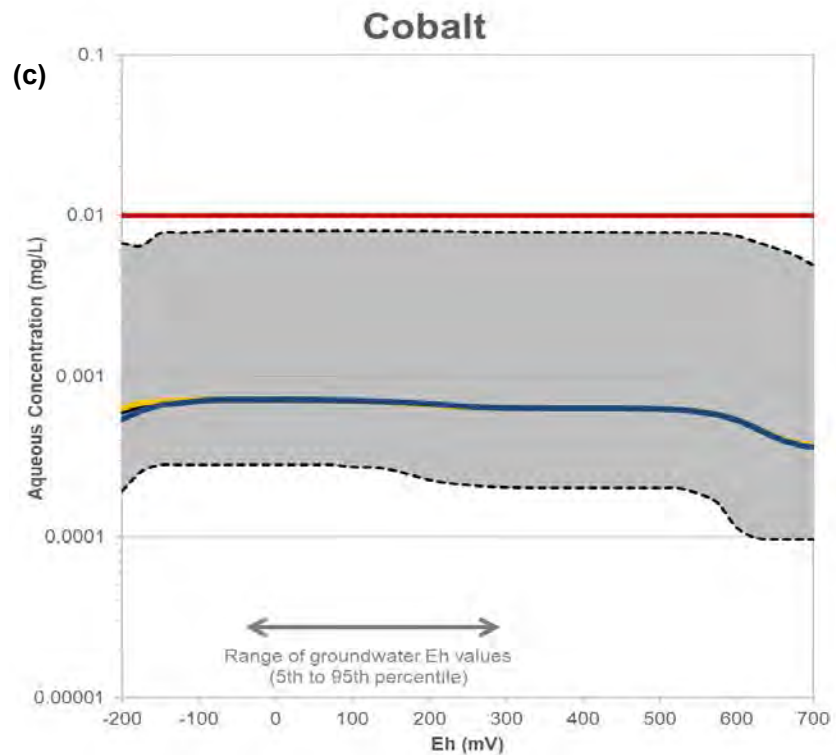
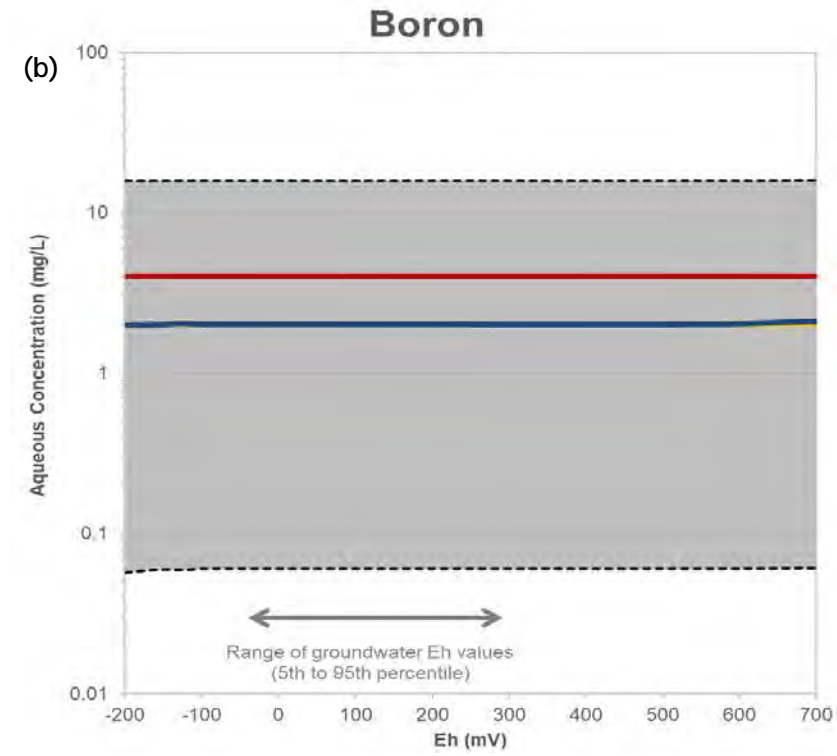
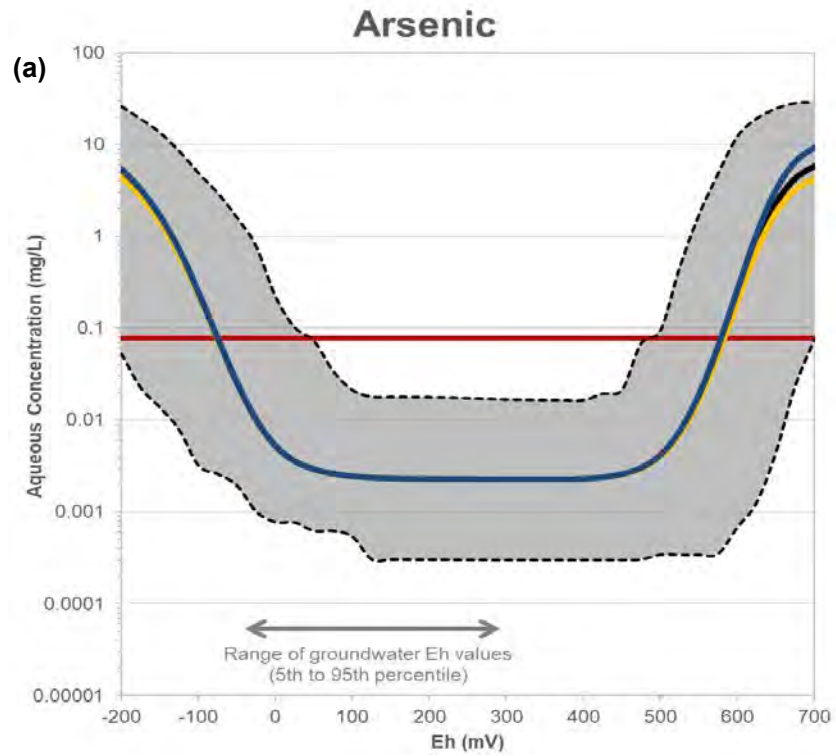
PROJECT NO.  
19121567

PHASE  
192

REV.  
A

FIGURE  
16





- Minimum Hfo and Hao Contents (Geometric mean of all simulations)
- Mean Hfo and Hao Contents (Geometric mean of all simulations)
- Maximum Hfo and Hao Contents (Geometric mean of all simulations)
- 5th to 95th Percentile of Min, Mean, and Max Simulations
- Groundwater Protection Standard

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT



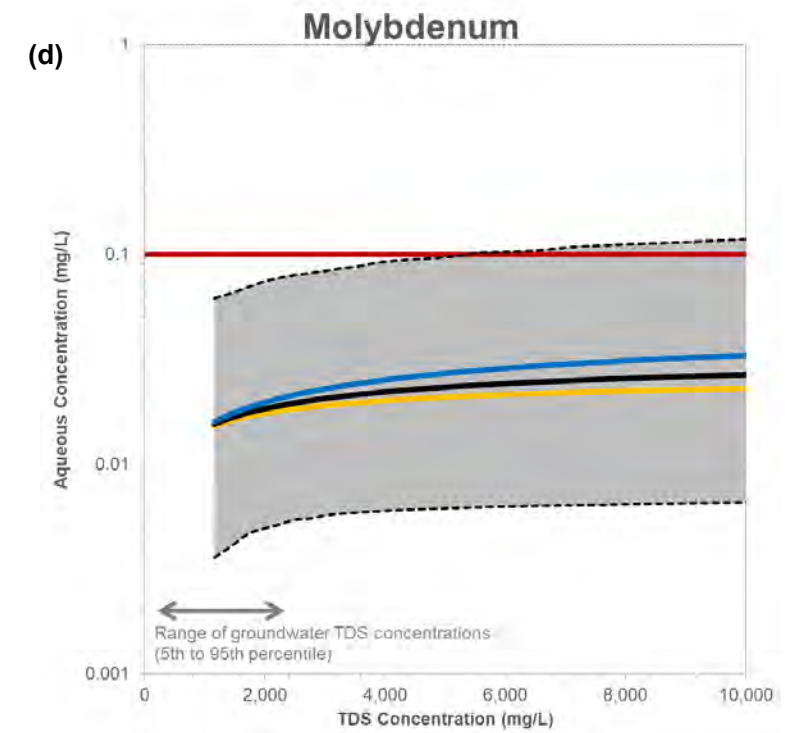
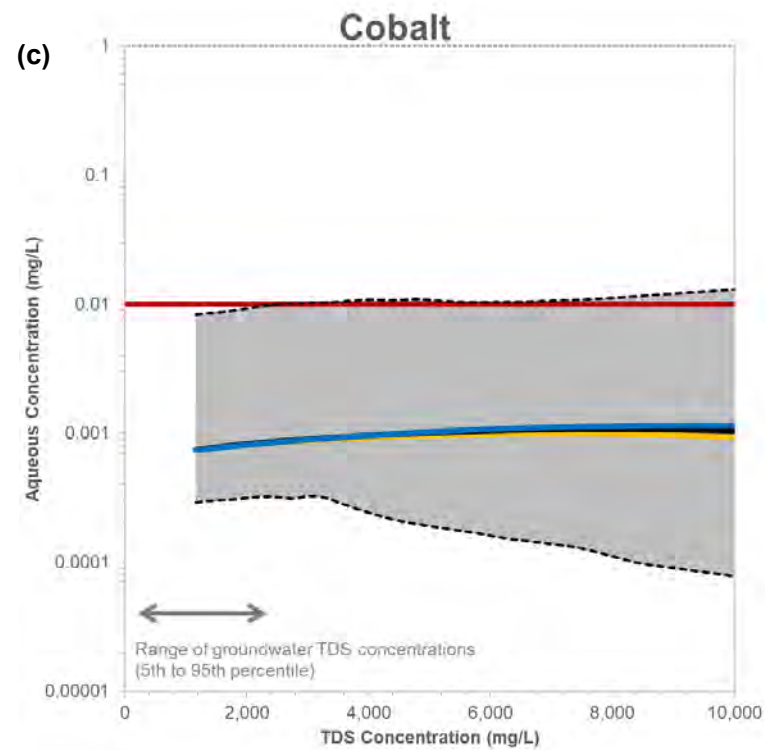
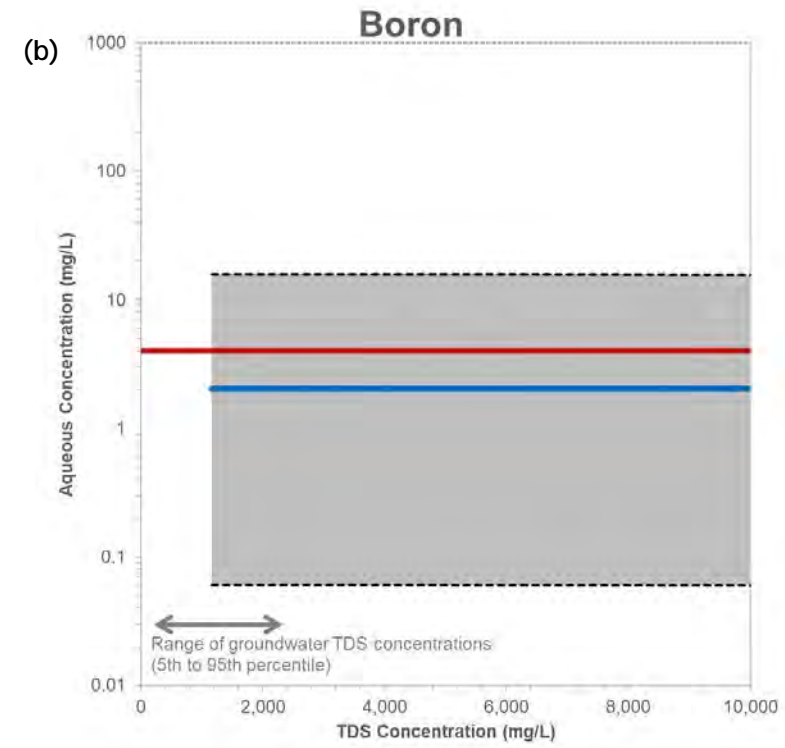
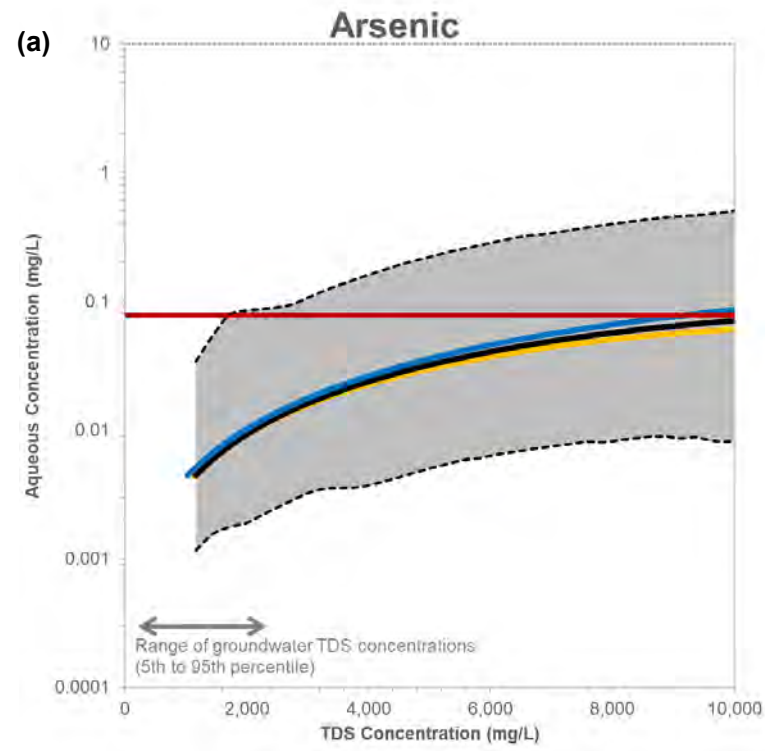
TITLE  
Stability of Adsorbed Constituents Versus Eh

PROJECT NO.  
19121567

PHASE  
192

REV.  
A

FIGURE  
17



- Minimum Hfo and Hao Contents (Geometric mean of all simulations)
- Mean Hfo and Hao Contents (Geometric mean of all simulations)
- Maximum Hfo and Hao Contents (Geometric mean of all simulations)
- 5th to 95th Percentile of Min, Mean, and Max Simulations
- Groundwater Protection Standard

CLIENT  
NIPSCO LLC

PROJECT  
Monitored Natural Attenuation Evaluation  
MSRB, MCWB, and Drying Area  
NIPSCO LLC R. M. Schahfer Generating Station

CONSULTANT



TITLE  
**Stability of Adsorbed Constituents Versus TDS**

PROJECT NO.  
19121567

PHASE  
192

REV.  
A

FIGURE  
18

**APPENDIX A**

**Groundwater and Porewater  
Monitoring Data**



**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW04																	
Sample Date		2016-07-12	2016-09-08	2016-11-09	2017-01-10		2017-03-01	2017-04-26	2017-06-28	2017-08-22	2017-10-04	2018-03-13		2018-04-20		2018-10-25	2019-04-23	2019-11-07	
Sample Type		N	N	N	FD	N	N	N	N	N	N	FD	N	FD	N	N	N	N	N
Chemical Name	Unit																		
<b>CCR Appendix III</b>																			
Boron	mg/L	0.48	1.4	2.4	1.1	1	1.2	0.74	0.92	1.2	0.54			0.74	0.72	0.78	0.74	1.3	
Calcium	mg/L	110	230	300	270	240	230	220	200	200	140			140	140	210	130	190	
Chloride	mg/L	2.2	27	69	13	14	13	5.4	12	13	4.5			3.7 J	4.4	10	3.7	9.5	
Fluoride	mg/L	0.92 J+	0.2 J	10 U	0.19 J	0.17 J	5 U	5 U	0.19 J	0.21 J	0.24 J	0.15 J	5 U	5 U	0.17 J-	0.26	0.16 J+	0.23	
pH	SU	7.22	6.83	6.75		6.93	7.01	6.76	6.88	7.21	7.28		6.95		7.2	6.39	7	7.14	
Sulfate	mg/L	140 J-	460	480	460	470	390	470	370	440	250			220	210	530	260	490	
Total Dissolved Solids	mg/L	420	990	1400	1000	1000	890	870	880	920	610			580 J	580	980	600	900	
<b>CCR Appendix IV</b>																			
Antimony	mg/L	0.002 U	0.002 U	0.00027 J	0.002 U	0.00057 J	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U	0.002 U		0.002 U	0.00065 J	0.00092 J	
Arsenic	mg/L	0.0059	0.013	0.0052	0.0058	0.0072	0.005 U	0.0099	0.012	0.012			0.004 J	0.0054		0.014	0.0023 J	0.0018 J	
Barium	mg/L	0.041	0.077	0.11	0.095	0.079	0.089	0.069	0.084	0.09			0.11	0.077		0.074	0.068	0.066	
Beryllium	mg/L	0.00027 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U		0.00048 J	0.00053 J	0.001 U	
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	
Chromium	mg/L	0.002 U	0.002 U	0.00036 J	0.00036 J	0.0052 J	0.002 U	0.002 U	0.002 U	0.002 U			0.0011 J	0.0012 J		0.002 U	0.002 U	0.002 U	
Cobalt	mg/L	0.001 U	0.00031 J	0.00064 J	0.0061	0.0058	0.0038	0.0049	0.003	0.0023			0.0028	0.0031		0.0026	0.0011	0.00043 J	
Fluoride	mg/L	0.92 J+	0.2 J	10 U	0.19 J	0.17 J	5 U	5 U	0.19 J	0.21 J	0.24 J	0.15 J	5 U	5 U	0.17 J-	0.26	0.16 J+	0.23	
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	
Lithium	mg/L	0.0018 J	0.008 U	0.008 U	0.0021 J	0.0023 J	0.0033 J	0.0033 J	0.0062 J	0.0062 J			0.008 U	0.008 U		0.0023 J	0.0045 J	0.0028 J	
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U			0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	
Molybdenum	mg/L	0.0075 J	0.023	0.073	0.037	0.038	0.034	0.016	0.02	0.034			0.0048 J	0.024		0.039	0.024	0.055	
Radium, Total	pci/L	5 U	0.583	0.697	0.804	0.515 U	0.362 U	0.379 U	0.364 U	0.352 U			1.35 J+	0.778 J+		0.473	0.591		
Radium-226	pci/L	1 U	0.138 U	0.346 U	0.301 U	0.242 U	0.121 U	0.117 U	0.119 J+	0.118			0.177	0.0881		0.306	0.311 U		
Radium-228	pci/L	1 U	0.498 U	0.495 U	0.677 J+	0.515 U	0.362 U	0.379 U	0.364 U	0.352 U			1.17 J+	0.69 J+		0.462 U	0.405		
Selenium	mg/L	0.005 U	0.005 U	0.00064 J	0.0017 J	0.0021 J	0.005 U	0.005 U	0.005 U	0.005 U			0.001 J	0.001 J		0.005 U	0.0013 J	0.0052	
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	
<b>Supplemental Parameters</b>																			
Alkalinity, Bicarbonate (HCO3)	mg/L																		
Alkalinity, Carbonate (CO3)	mg/L																		
Alkalinity, Hydroxide (OH)	mg/L																		
Alkalinity, Total	mg/L															230	190	270	
Ferric Iron	mg/L															6.9			
Ferrous Iron	mg/L															3.1 J			
Iron	mg/L																2.3	0.083 J	
Magnesium	mg/L															31	18	31	
Manganese	mg/L																0.012 J-	0.0078 J	
Nitrate as N	mg/L																0.1 U	0.1 U	
Nitrite as N	mg/L																		
Nitrogen, Nitrate-Nitrite	mg/L															0.39			
Phosphorus (as phosphate)	mg/L															0.9	0.31 U	0.31 UJ	
Potassium	mg/L															3.3 J	3.1 J	3.2 J	
Sodium	mg/L															13	12	36	
<b>Sample Parameters</b>																			
Dissolved Oxygen	mg/L	0.09	0.58	0.37		1.82	1.47	0.12	0.3	0.52	0.09		0.66		2.3	0.15	7.08	2.55	
Oxidation Reduction Potential	mV	59.6	-24	-6.9		-31.7	14	-57.8	-45	-27	-105.8		-181.8		-81.2	-58.1	19	-60.7	
Eh	mV	259.6	176.0	193.1		168.3	214.0	142.2	155.0	173.0	94.2		18.2		118.8	141.9	219.0	139.3	
pH	SU	7.22	6.83	6.75		6.93	7.01	6.76	6.88	7.21	7.28		6.95		7.2	6.39	7	7.14	
Specific Conductance	uS/cm	595	1345	1681		1109	910	1137	911	1153	813		562		770	1311	549	866	
Temperature	deg C	13	17.3	16.3		10.5	8.05	10.2	13.1	15.9	16.1		7.55		3.5	15.5	4.2	13.2	
Turbidity	NTU	4.04	1.48	2.21		2.28	4.26	4.04	4.88	1.65	0.51		4.92		3.12	1.92	4.48	1.38	

Notes:  
CCR = coal combustion residual  
mg/L = milligrams per liter  
mV= millivolts  
pci/L= picoCuries per liter  
uS/cm = micro Siemens per centimeter  
deg C = degrees Celsius  
NTU = Nephelometric Turbidity Units  
SU = Standard Units  
"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
"J" = Indicates the result is estimated.  
"J+" = Indicates the result is estimated and may be biased high.  
"UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
"R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	Sample Date	GAMW07														GAMW07B					
		2016-07-12	2016-09-08	2016-11-09	2017-01-10	2017-03-01	2017-04-26	2017-06-29	2017-08-23	2017-10-03		2018-03-15	2018-04-23	2018-10-26	2019-05-02	2019-11-08	2018-09-06	2018-10-26	2019-05-02	2019-11-12	
Chemical Name	Unit	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
<b>CCR Appendix III</b>																					
Boron	mg/L	1.2	1	0.91	0.91	1	0.68	0.67	0.68	0.71	0.72		1.2	1.3	0.85	0.85	20	23	18	15	
Calcium	mg/L	170	190	200	170	170	190	220	190	220	220		210	230	220	180	370	430	380	400	
Chloride	mg/L	7.8	6.6	5.3	6	7.6	2.8	3 J	3.2 J	3 J	3.6 J		4.7 J	6.3	6.5	4.8	10 U	250	170	150	
Fluoride	mg/L	0.72 J+	0.91 J	0.8 J	0.85 J	0.66 J	0.76 J	0.79 J	0.66 J	1.1 J	0.93 J		0.58 J	0.57 J	0.73	0.97	0.88	10 U	1.5	1.3	1.2
pH	SU	7.03	7.27	7.04	7.15	7.2	7.17	6.57	7.2	7.1	7.28		7.35	5.71	7.2	7.44	8.29	6.78	7.58	7.13	
Sulfate	mg/L	310 J-	330	320	320	290	310	360	380	460	450		450	530	500	480	10 U	1600	1500	1400	
Total Dissolved Solids	mg/L	770	830	840	750	710	810	970	910	970	1000		900	970	1100	940	2700	2600	920	2300	
<b>CCR Appendix IV</b>																					
Antimony	mg/L	0.00035 J	0.00039 J	0.00035 J	0.00028 J	0.002 U	0.002 U	0.002 U	0.002 U				0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	
Arsenic	mg/L	0.0013 J	0.0016 J	0.0018 J	0.0028 J	0.005 U	0.0028 J	0.0025 J	0.0016 J				0.005 U		0.0012 J	0.0019 J	0.0011 J	0.0028 J	0.0015 J	0.0019 J	0.0017 J
Barium	mg/L	0.052	0.055	0.056	0.042	0.05	0.05	0.059	0.059				0.056		0.064	0.053	0.043	0.072	0.063	0.053	0.043
Beryllium	mg/L	0.00011 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U				0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0003 J	0.00022 J				0.001 U		0.00047 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.00047 J	0.00046 J	0.002 U	0.002 U	0.002 U	0.002 U				0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.0056	0.0077	0.0055	0.0038	0.0044	0.0063	0.01	0.0095				0.006		0.01	0.0074	0.0049	0.00074 J	0.001 U	0.001 U	0.001 U
Fluoride	mg/L	0.72 J+	0.91 J	0.8 J	0.85 J	0.66 J	0.76 J	0.79 J	0.66 J	1.1 J	0.93 J		0.58 J	0.57 J	0.73	0.97	0.88	10 U	1.5	1.3	1.2
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0007 J				0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0034 J	0.008 U	0.008 U	0.0035 J	0.0031 J	0.0041 J	0.0037 J	0.0038 J				0.0024 J		0.0054 J	0.0041 J	0.0033 J	0.0043 J	0.0045 J	0.004 J	0.0035 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U				0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0084 J	0.0098 J	0.0095 J	0.01 U	0.01 U	0.0083 J	0.0081 J	0.007 J				0.0066 J		0.0087 J	0.0097 J	0.0087 J	0.015	0.017	0.025	0.026
Radium, Total	pci/L	1.59	0.696	0.548	0.412 U	0.42 U	0.371 U	0.45	0.588				0.749 J+		0.823 J+	0.37 U		2.63	2.6 J+	2.31	
Radium-226	pci/L	0.667 J+	0.289	0.374	0.237 U	0.186	0.155	0.232 J+	0.3				0.163		0.483 J+	0.305 U		1.16	1.56 J+	1.17	
Radium-228	pci/L	0.923	0.406	0.462 U	0.412 U	0.42 U	0.371 U	0.262 U	0.413 U				0.585 J+		0.365 U	0.37 U		1.47	1.04	1.14	
Selenium	mg/L	0.005 U	0.005 U	0.003 J	0.003 J	0.005 U	0.008	0.0054	0.005				0.0028 J		0.0016 J	0.0045 J	0.0019 J	0.0012 J	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.00011 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U				0.001 U		0.00024 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																					
Alkalinity, Bicarbonate (HCO3)	mg/L																	180			
Alkalinity, Carbonate (CO3)	mg/L																	5 U			
Alkalinity, Hydroxide (OH)	mg/L																	5 U			
Alkalinity, Total	mg/L														260	270	250	180	180	170	170
Ferric Iron	mg/L														0.035 J			6.7 J	6.8		
Ferrous Iron	mg/L														0.05 UJ			0.1 R	1.1 J		
Iron	mg/L																			5.3	5.5
Magnesium	mg/L														39	41	38	72	87	73	72
Manganese	mg/L															0.46	0.61			0.46	0.49
Nitrate as N	mg/L															3.3	1.6	0.05 R		0.1 U	0.1 U
Nitrite as N	mg/L																	0.05 R			
Nitrogen, Nitrate-Nitrite	mg/L														0.53				0.049 J		
Phosphorus (as phosphate)	mg/L														0.31 U	0.31 U	0.31 U	0.031 U	0.31 U	0.31 U	0.31 U
Potassium	mg/L														6.6	5.5	6.5	12	13	13	13
Sodium	mg/L														14	14	9.9	290	240	230	120
<b>Sample Parameters</b>																					
Dissolved Oxygen	mg/L	0.6	1.81	0.59	0.52	0.51	1.96	1.02	0.84	0.48	0.8	3.52	2.64	0.81	0.38	0.13	0.67	0.19	0.2		
Oxidation Reduction Potential	mV	111.2	64.2	-6.4	71.3	65.3	76.9	291.1	8.5	95.4	-55	-98.7	-233.3	135.1	-131.8	-197.6	-230.2	34.9	-196.7		
Eh	mV	311.2	264.2	193.6	271.3	265.3	276.9	491.1	208.5	295.4	145.0	101.3	-33.3	335.1	68.2	2.4	-30.2	234.9	3.3		
pH	SU	7.03	7.27	7.04	7.15	7.2	7.17	6.57	7.2	7.1	7.28	7.35	5.71	7.2	7.44	8.29	6.78	7.58	7.13		
Specific Conductance	uS/cm	966	1072	1106	928	832	1121	1151	1157	1273	760	1060	1240	975	828	5178	3237	2357	1686		
Temperature	deg C	14.4	19.2	16.7	12.9	10.63	11.8	14.6	16.5	18	10	10	16.95	10.3	15.3	15.03	13.86	12.4	12.9		
Turbidity	NTU	4.6	4.51	1.26	3.2	4.76	2.17	2.87	0.9	0.49	1.3	1.75	1.08	2.72	4.58	4.48	3.01	2.86	1.11		

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Chemical Name	Unit	GAMW08														GAMW08B				
		2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-04	2018-03-14	2018-04-23	2018-10-26	2019-05-08	2019-11-07	2018-09-07	2018-10-26	2019-05-03	2019-11-07	
		N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	FD	N	N
<b>CCR Appendix III</b>																				
Boron	mg/L	3.5	3.9	3.2	3.4	3.3	3.2	2.9	2.2	3.7		2.4	1.8	1.4	2.5		18	15	14	13
Calcium	mg/L	310	310	300	260	270	310	340	270	290		360	230	250	280		380	370	350	340
Chloride	mg/L	88	71	89	99	110	86	83	39	87		64	56	49	66		240	180	160	180
Fluoride	mg/L	1 J+	1.2 J	0.73 J	0.87 J	0.94 J	0.92 J	1.3 J	2 J	0.68 J	1.2 J	1.3 J-	1.6	2.2	1.9		1.6 J	1.5	1.9	1.7
pH	SU	6.92	7.03	6.85	7.02	7.09	6.93	7	7.27	6.89	7.41	7.41	6.99	7.37	7.5		7.7	7.45	7.57	7.85
Sulfate	mg/L	770 J-	690	680	610	630	770	800	640	670		800	460	540	670		1500	1500	1400	1300
Total Dissolved Solids	mg/L	1600	1500	1600	1300	1400	1700	2000	1400	1500		1700	1100	1300	1300		1900 J+	2300	2300	2200
<b>CCR Appendix IV</b>																				
Antimony	mg/L	0.00073 J	0.00069 J	0.0014 J	0.00041 J	0.00043 J	0.002 U	0.00059 J	0.00075 J		0.002 U		0.00082 J	0.00076 J	0.00077 J		0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.0018 J	0.0019 J	0.0018 J	0.0027 J	0.0016 J	0.0031 J	0.0027 J	0.0023 J		0.005 U		0.0011 J	0.0015 J	0.0016 J		0.005 U	0.005 U	0.005 U	0.005 U
Barium	mg/L	0.068	0.065	0.065	0.05	0.055	0.064	0.074	0.077		0.066	0.069	0.053	0.058	0.066		0.042	0.03	0.025	0.023
Beryllium	mg/L	0.00017 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.0004 J	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	7.4E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.00037 J	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.00029 J	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.036	0.034	0.059	0.047	0.05	0.037	0.047	0.02		0.022	0.027	0.011	0.0079	0.011		0.00066 J	0.001 U	0.001 U	0.001 U
Fluoride	mg/L	1 J+	1.2 J	0.73 J	0.87 J	0.94 J	0.92 J	1.3 J	2 J	0.68 J	1.2 J	1.3 J-	1.6	2.2	1.9		1.6 J	1.5	1.9	1.7
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0098	0.012	0.009	0.0098	0.0093	0.012	0.011	0.012		0.0089	0.009	0.011	0.015	0.0091		0.0098	0.0073 J	0.0063 J	0.0058 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.034	0.036	0.024	0.02	0.019	0.038	0.049	0.083		0.058	0.058	0.059	0.08	0.068		0.037	0.039	0.057	0.044
Radium, Total	pci/L	1.07	1.08	1.09	0.581	0.777	0.632	1.11	0.762		1.13 J+	0.99	1 J+	0.473			1.67 J+	1.02 J+	0.704	
Radium-226	pci/L	0.501 J+	0.469	0.557	0.375	0.368	0.383	0.613 J+	0.591		0.267	0.437	0.582 J+	0.312 U			1.09 J+	0.596 J+	0.438	
Radium-228	pci/L	1 U	0.609	0.533	0.43 U	0.423 U	0.365 U	0.499	0.341 U		0.865 J+	0.552	0.423	0.456 U			0.579	0.454 U	0.518 U	
Selenium	mg/L	0.005 U	0.0065	0.0033 J	0.0014 J	0.0032 J	0.011	0.0088	0.0081		0.024	0.022	0.0021 J	0.016	0.0036 J		0.0014 J	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.00045 J	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																				
Alkalinity, Bicarbonate (HCO3)	mg/L																160	160		
Alkalinity, Carbonate (CO3)	mg/L																5 U	5 U		
Alkalinity, Hydroxide (OH)	mg/L																5 U	5 U		
Alkalinity, Total	mg/L												350	380	380		160	160	160	130
Ferric Iron	mg/L												0.083 J				6.1 J	6.9 J	6.5	6.2
Ferrous Iron	mg/L												0.05 UJ				0.1 R	0.1 R	0.79 J	0.98 J
Iron	mg/L																			5.6
Magnesium	mg/L												44	53	56		58	66	63	62
Manganese	mg/L																			0.49
Nitrate as N	mg/L																			0.43
Nitrite as N	mg/L																			0.075 J
Nitrogen, Nitrate-Nitrite	mg/L																			0.05 U
Phosphorus (as phosphate)	mg/L																			0.05 U
Potassium	mg/L																			0.31 U
Sodium	mg/L																			0.31 U
<b>Sample Parameters</b>																				
Dissolved Oxygen	mg/L	1.9	0.38	1.62	1.27	0.96	0.63	1.96	0.93	0.21	0.97	5.09	0.21	0.44	4.2		0.42		0.12	0.13
Oxidation Reduction Potential	mV	159.7	64.6	-8	58.4	49.9	60.4	242.5	61.9	-15.9	110.1	-106.4	27.7	62.2	44.1		-185.5		-67	7.9
Eh	mV	359.7	264.6	192.0	258.4	249.9	260.4	442.5	261.9	184.1	310.1	93.6	227.7	262.2	244.1		14.5	200.0	133.0	207.9
pH	SU	6.92	7.03	6.85	7.02	7.09	6.93	7	7.27	6.89	7.41	7.41	6.99	7.37	7.5		7.7	7.45	7.57	7.85
Specific Conductance	uS/cm	1925	1807	1664	1517	1494	2098	1834	1713	1840	1121	1732	1440	1102	1322		2538	2375	2190	1896
Temperature	deg C	15.5	18.78	17.75	12.2	10.06	11.1	15.8	18.5	18.3	9.6	10.2	17.2	11	10.84		14.6	14.5	12.8	8.05
Turbidity	NTU	2.3	3.22	0.58	1.26	1.56	1.1	2.41	0.68	4.38	1.11	1.54	1.4	1.81	0.31		3.4	1.63	1.72	2.89

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW09																	
Sample Date		2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-01		2017-04-26		2017-06-28	2017-08-23	2017-10-03	2018-03-14	2018-04-23	2018-10-25	2019-05-02		2019-11-07	
Sample Type		N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	FD	N	N	
Chemical Name	Unit																		
<b>CCR Appendix III</b>																			
Boron	mg/L	5.7	4.7	7.3	5.3	7.7	7.6	5.9	6.1	4.9	7.9	7.3		4.9	6.3	3	3	2.7	
Calcium	mg/L	320	240	210	210	200	200	220	240	270	280	220		220	220	200	200	150	
Chloride	mg/L	63	55	58	58	75	73	71	67	53	39	64		58	82	46	46	39	
Fluoride	mg/L	0.15 J+	10 U	10 U	0.22 J	0.13 J	0.14 J	0.16 J	0.13 J	0.18 J	2 J	0.21 J	5 U	0.26 J-	0.28	0.27	0.27	0.33	
pH	SU	7.27	7.25	7.12	6.68	7.44	7.44	7.15	7.25	7.31	7.3	7.28	6.87	6.88			7.1	7.06	
Sulfate	mg/L	910 J-	570	360	500	440	420	460	460	600	740	540		510	510 J-	530	530	380	
Total Dissolved Solids	mg/L	1500	1100	880	980	1000	990	1000	960	1300	1400	1100		930	1100	970	980	770	
<b>CCR Appendix IV</b>																			
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	
Arsenic	mg/L	0.0015 J	0.0013 J	0.00076 J	0.0031 J	0.005 U	0.005 U	0.0028 J	0.0029 J	0.002 J	0.0027 J			0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	
Barium	mg/L	0.059	0.043	0.036	0.039	0.035	0.037	0.039	0.042	0.047	0.054		0.041	0.039	0.039	0.041	0.041	0.036	
Beryllium	mg/L	0.00012 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00036 J	0.001 U	0.001 U	0.001 U		0.001 U		0.00092 J	0.00058 J	0.00052 J	0.00049 J	
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.00033 J	0.001 U	0.001 U	0.001 U	
Chromium	mg/L	0.0036	0.002 U	0.00062 J	0.0013 J	0.002 U	0.002 U	0.002 U	0.002 U	0.0011 J	0.0015 J		0.0016 J		0.002 U	0.0012 J	0.0012 J	0.002 U	
Cobalt	mg/L	0.001 U	0.00018 J	0.0002 J	0.0002 J	0.001 U	0.001 U	0.00029 J	0.00025 J	0.001 U	0.001 U		0.001 U		0.00038 J	0.00049 J	0.00055 J	0.00035 J	
Fluoride	mg/L	0.15 J+	10 U	10 U	0.22 J	0.13 J	0.14 J	0.16 J	0.13 J	0.18 J	2 J	0.21 J	5 U	0.26 J-	0.28	0.27	0.27	0.33	
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	
Lithium	mg/L	0.0019 J	0.008 U	0.008 U	0.0016 J	0.0011 J	0.0012 J	0.008 U	0.008 U	0.0017 J	0.0018 J		0.008 U		0.008 U	0.008 U	0.008 U	0.008 U	
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	
Molybdenum	mg/L	0.02	0.017	0.029	0.023	0.027	0.027	0.021	0.021	0.028	0.032		0.025	0.035	0.04	0.043	0.043	0.035	
Radium, Total	pci/L	1.5	0.568	0.477 U	0.467 U	0.55	0.469	0.593	0.414	0.707	0.803		1.45 J+	0.096	0.679	0.505	0.427 U		
Radium-226	pci/L	0.506 J+	0.231	0.397 U	0.257	0.134	0.166	0.194	0.205	0.255 J+	0.357		0.188	0.204	0.446	0.33	0.355 U		
Radium-228	pci/L	0.994	0.349 U	0.477 U	0.467 U	0.427 U	0.432 U	0.398	0.36 U	0.452	0.446		1.26 J+	-0.108	0.361 U	0.428 U	0.427 U		
Selenium	mg/L	0.014	0.0091	0.0049 J	0.011	0.014	0.014	0.019	0.02	0.013	0.027		0.0082	0.011	0.0098	0.012	0.012	0.0077	
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	
<b>Supplemental Parameters</b>																			
Alkalinity, Bicarbonate (HCO3)	mg/L																		
Alkalinity, Carbonate (CO3)	mg/L																		
Alkalinity, Hydroxide (OH)	mg/L																		
Alkalinity, Total	mg/L														150	110	100	110	
Ferric Iron	mg/L														0.042 J				
Ferrous Iron	mg/L														0.05 UJ				
Iron	mg/L															0.027 J	0.038 J	0.037 J	
Magnesium	mg/L														21	21	19	16	
Manganese	mg/L															0.011 J	0.013 J	0.0083 J	
Nitrate as N	mg/L															5.6	5.6	7.1	
Nitrite as N	mg/L																		
Nitrogen, Nitrate-Nitrite	mg/L														1.4				
Phosphorus (as phosphate)	mg/L														0.31 U	0.31 U	0.31 U	0.31 UJ	
Potassium	mg/L														9	7.2	7.1	5.6	
Sodium	mg/L														38	35	33	28	
<b>Sample Parameters</b>																			
Dissolved Oxygen	mg/L	3.59	6.69	1.98	6.1		3.41		3.92	5.27	3.24	5.98	6.71	5.43	0.22			5.82	5.54
Oxidation Reduction Potential	mV	-1.4	75.7	27.6	236		90.5		152.6	280.8	58.9	139.5	-116.3	-90.8	-48.8			53.6	-25.7
Eh	mV	198.6	275.7	227.6	436.0		290.5		352.6	480.8	258.9	339.5	83.7	109.2	151.2			253.6	174.3
pH	SU	7.27	7.25	7.12	6.68		7.44		7.15	7.25	7.31	7.3	7.28	6.87	6.88			7.1	7.06
Specific Conductance	uS/cm	1671	736	1110	822		1041		1209	702	1542	1331	600	1156	1274			888	685
Temperature	deg C	14.4	18.4	16.9	11.9		10.75		11.9	14.7	17.2	18.2	10.2	10.6	17.9			11.4	15.9
Turbidity	NTU	1.59	3.92	1.15	1.34		3.12		1.88	1.91	0.91	0.39	0.82	2.44	2.41			3.41	1.55

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	Sample Date	GAMW09B																		
		2016-07-13		2016-09-08	2016-11-09	2017-01-10	2017-03-01	2017-04-26	2017-06-28	2017-08-23		2017-10-03	2018-03-14	2018-04-23	2018-09-06	2018-10-26	2019-05-08	2019-11-07		
Chemical Name	Unit	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
<b>CCR Appendix III</b>																				
Boron	mg/L	24	25	25	16	11	11	11	12	16	16	16		14	12	12		14	8	
Calcium	mg/L	260	280	270	190	200	170	170	180	180	180	160		160	150	180		150	150	
Chloride	mg/L	210	180	190	130	110	120	130	150	170	160	140		150	180	150		140	110	
Fluoride	mg/L	0.54 J+	0.55 J+	0.67 J	0.68 J	0.1 J	1.3 J	1.2 J	1.4 J	1.2 J	0.37 J	1.5 J	1.4 J	1.6 J	1.8 J	1.6		1.6	1.5	
pH	SU		7.08	7.15	6.96	7.36	7.44	7.29	7.36		7.46	7.36	7.56	7.43	7.32	7.46		7.49	7.56	
Sulfate	mg/L	970 J-	1000 J-	960	740	670 J+	550	570	640	630	650	550		430	570	580		520	440	
Total Dissolved Solids	mg/L	2100	2000	2100	1700	1300	1200	1200	1500	1500	1500	1300		990	1300	1200		1200	990	
<b>CCR Appendix IV</b>																				
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	
Arsenic	mg/L	0.0024 J	0.0026 J	0.002 J	0.0014 J	0.0027 J	0.005 U	0.004 J	0.004 J	0.0031 J	0.0031 J			0.0054	0.0064	0.0044 J	0.004 J		0.0057	0.0042 J
Barium	mg/L	0.069	0.071	0.076	0.062	0.048	0.04	0.046	0.055	0.062	0.058			0.045	0.04	0.049	0.047		0.041	0.029
Beryllium	mg/L	0.00012 J	9.1E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Cadmium	mg/L	0.00027 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U		0.002 U	0.002 U
Cobalt	mg/L	0.001 U	0.001 U	0.00069 J	0.00028 J	0.00045 J	0.001 U	0.00028 J	0.00045 J	0.00041 J	0.00041 J			0.001 U		0.00058 J	0.00028 J		0.00025 J	0.001 U
Fluoride	mg/L	0.54 J+	0.55 J+	0.67 J	0.68 J	0.1 J	1.3 J	1.2 J	1.4 J	1.2 J	0.37 J	1.5 J	1.4 J	1.6 J	1.8 J	1.6		1.6	1.5	
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.00017 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Lithium	mg/L	0.0055 J	0.0065 J	0.008 U	0.008 U	0.0049 J	0.0045 J	0.0056 J	0.0054 J	0.0047 J	0.0042 J			0.0031 J		0.0037 J	0.0052 J		0.0055 J	0.0033 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U		0.0002 U	0.0002 U
Molybdenum	mg/L	0.01 U	0.0079 J	0.0075 J	0.0097 J	0.013	0.015	0.015	0.013	0.0094 J	0.01			0.014	0.012	0.01	0.011		0.012	0.0096 J
Radium, Total	pci/L	1.12	1.86	1.65	1.14	0.453	1.09	0.774	1.85	1.01	1.27			1.18 J+	0.868	1.04	1.24 J+		1.01	
Radium-226	pci/L	0.809 J+	0.947 J+	0.907	0.579	0.476	0.585	0.316	0.781 J+	0.585	0.709			0.482	0.301	0.653	0.69 J+		0.449	
Radium-228	pci/L	1 U	0.913	0.743	0.559	0.41 U	0.508	0.458	1.07	0.422	0.563			0.699 J+	0.567	0.386	0.546		0.564	
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U	0.0014 J	0.001 J	0.0015 J	0.0016 J			0.005 U		0.002 J	0.0019 J		0.005 U	0.0011 J
Thallium	mg/L	0.0003 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U		0.0002 J	0.001 U
<b>Supplemental Parameters</b>																				
Alkalinity, Bicarbonate (HCO3)	mg/L															190				
Alkalinity, Carbonate (CO3)	mg/L															5 U				
Alkalinity, Hydroxide (OH)	mg/L															5 U				
Alkalinity, Total	mg/L															190	200	200	200	170
Ferric Iron	mg/L															2.5 J	2.1			
Ferrous Iron	mg/L															0.1 R	0.55 J			
Iron	mg/L																	3.2	3.2	3
Magnesium	mg/L															57	60	64	63	54
Manganese	mg/L																	1.2	1.2	1.2
Nitrate as N	mg/L															0.05 R		0.1 U	0.1 U	0.12
Nitrite as N	mg/L															0.05 R				
Nitrogen, Nitrate-Nitrite	mg/L																0.077			
Phosphorus (as phosphate)	mg/L															0.09	0.31 U	0.31 U	0.31 U	0.31 UJ
Potassium	mg/L															4 J	3.8 J	4 J	4 J	2.4 J
Sodium	mg/L															150	94	110	110	46
<b>Sample Parameters</b>																				
Dissolved Oxygen	mg/L		0.44	1.06	0.43	0.38	0.44	0.61	0.71			0.57	0.45	0.1	0.04	0.61	0.28		0.04	0.35
Oxidation Reduction Potential	mV		-57.7	67.3	-76.4	-100.1	-80.6	-102.6	68.2			19.7	-46.8	-121.6	-130.5	-100.5	-101.1		-16.8	-131.8
Eh	mV		142.3	267.3	123.6	99.9	119.4	97.4	268.2			219.7	153.2	78.4	69.5	99.5	98.9		183.2	68.2
pH	SU		7.08	7.15	6.96	7.36	7.44	7.29	7.36			7.46	7.36	7.56	7.43	7.32	7.46		7.49	7.56
Specific Conductance	uS/cm		2356	2435	2088	1559	1352	1592	1561			1922	1722	1053	1301	1556	1693		1165	9.24
Temperature	deg C		14.1	14.7	15.1	13.6	13.45	14.5	14.8			15.5	16	14	14.4	16.1	16		14.2	14.4
Turbidity	NTU		3.48	4.29	2.17	0.99	2.58	1.88	1.69			2.54	1.96	4.18	4.11	2.96	1.39		4.7	3.36

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.



**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW15														
Sample Date		2016-07-13	2016-09-08		2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-03	2018-03-15	2018-04-24	2018-10-26	2019-05-06	2019-11-08
Sample Type		N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N
Chemical Name	Unit															
<b>CCR Appendix III</b>																
Boron	mg/L	0.75	0.45 J	1 J	1.1	0.6	0.44	0.45	0.87	0.91	0.66		0.72	0.76	0.71	0.73
Calcium	mg/L	100	130	120	100	82	81	95	160	150	77		170	120	140	100
Chloride	mg/L	28	31	31	27	28	27	27	27	25	19		24	21	22	28
Fluoride	mg/L	1.2 J+	0.85 J	0.85 J	0.74 J	0.8 J	0.77 J	0.74 J	0.82 J	0.82 J	0.93 J	0.67 J	0.76 J	0.69	0.52	0.73
pH	SU	6.88		6.98	6.83	6.96	6.99	6.76	6.61	6.96	6.88	6.95	6.89	5.2	7.1	7.34
Sulfate	mg/L	160 J-	260	260	150	140	140	160	300	330	260		410	240	380	260
Total Dissolved Solids	mg/L	570	660	630	520	400	400	420	780	750	660		790	5900	740	640
<b>CCR Appendix IV</b>																
Antimony	mg/L	0.002 U	0.00041 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.056	0.072	0.069	0.078	0.076	0.054	0.062	0.059	0.066		0.058		0.091	0.081	0.075
Barium	mg/L	0.044	0.053	0.053	0.039	0.032	0.031	0.034	0.054	0.058		0.047		0.046	0.047	0.037
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.00027 J	0.00028 J	0.00029 J	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.0019	0.0022	0.0022	0.0021	0.0019	0.0018	0.0022	0.0029	0.0027		0.0025		0.0023	0.0035	0.0017
Fluoride	mg/L	1.2 J+	0.85 J	0.85 J	0.74 J	0.8 J	0.77 J	0.74 J	0.82 J	0.82 J	0.93 J	0.67 J	0.76 J	0.69	0.52	0.73
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0053 J	0.008 U	0.008 U	0.008 U	0.004 J	0.0024 J	0.0041 J	0.0058 J	0.005 J		0.0023 J		0.0054 J	0.0053 J	0.0027 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.02	0.027	0.026	0.023	0.022	0.022	0.026	0.017	0.019		0.029		0.016	0.017	0.029
Radium, Total	pci/L	5 U	0.479	0.513	0.646 U	0.555 J+	0.339 U	0.463 U	0.335	0.342 U		0.657 J+		0.858 J+	0.476 U	
Radium-226	pci/L	1 U	0.202	0.145	0.337 U	0.38	0.127 U	0.1	0.0965 J+	0.104		0.0817		0.527 J+	0.28 U	
Radium-228	pci/L	1 U	0.397 U	0.382 U	0.646 U	0.401 U	0.339 U	0.463 U	0.278 U	0.342 U		0.576 J+		0.407 U	0.476 U	
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U		0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																
Alkalinity, Bicarbonate (HCO3)	mg/L															
Alkalinity, Carbonate (CO3)	mg/L															
Alkalinity, Hydroxide (OH)	mg/L															
Alkalinity, Total	mg/L												180	180	170	
Ferric Iron	mg/L												4.3			
Ferrous Iron	mg/L												5.2 J			
Iron	mg/L													11	5.4	
Magnesium	mg/L												24	30	24	
Manganese	mg/L													0.089	0.055	
Nitrate as N	mg/L													0.1 U	0.1 U	
Nitrite as N	mg/L															
Nitrogen, Nitrate-Nitrite	mg/L													0.05 U		
Phosphorus (as phosphate)	mg/L													4	1.4	1.3
Potassium	mg/L													2.6 J	3.2 J	3.3 J
Sodium	mg/L													24	32	30
<b>Sample Parameters</b>																
Dissolved Oxygen	mg/L	0.48		0.48	0.14	0.25	0.16	0.19	1	0.32	0.29	0.06	0.02	1.97	0.15	0.12
Oxidation Reduction Potential	mV	-79.2		-60.1	-111	-114.3	-104.1	-104.4	-46.9	-43.7	-13.8	-56.8	-99.1	-254.7	-27.5	-100
Eh	mV	120.8		139.9	89.0	85.7	95.9	95.6	153.1	156.3	186.2	143.2	100.9	-54.7	172.5	100.0
pH	SU	6.88		6.98	6.83	6.96	6.99	6.76	6.61	6.96	6.88	6.95	6.89	5.2	7.1	7.34
Specific Conductance	uS/cm	779		909	733	594	584	674	9.32	1004	901	581	933	855	730	598
Temperature	deg C	15.3		20.3	19.9	14.6	12.1	11.6	14.6	16.6	18.1	10.8	10.6	17.1	8.3	15.8
Turbidity	NTU	4.48		2.96	3.41	3.98	4.4	4.92	4.2	3.1	4.11	3.98	4.29	3.1	4.9	6.9

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW15B															
Sample Date		2016-07-13	2016-09-08	2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-03	2018-03-15	2018-04-24	2018-09-06	2018-10-26	2019-05-08	2019-11-08	
Sample Type		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Chemical Name	Unit												FD	N	N	N	
<b>CCR Appendix III</b>																	
Boron	mg/L	1.1	1.7	2	3.7	3.3	3.6	3.1	2.1	2.1		4.4		4.1	4.9	10	6.2
Calcium	mg/L	160	160	160	180	160	170	190	170	73		230		200	210	280	280
Chloride	mg/L	52	58	62	81	64	65	71	64	64		87		89	93	110	80
Fluoride	mg/L	0.65 J+	0.62 J	0.46 J	0.74 J	0.77 J	0.75 J	0.72 J	0.61 J	0.5 J	0.69 J	0.79 J		0.6 J	0.6	0.84 J+	0.89
pH	SU	7.81	7.49	7.04	7.52	7.48	7.11	7.26	7.37	7.42	7.45	7.36		7.8	6.74	7.43	7.57
Sulfate	mg/L	380 J-	390	340	500	390	460	530	540	500		790		720	770	1300	940
Total Dissolved Solids	mg/L	830	800	840	1000	890	980	1200	1100	1100		1400		1400	1400	2100	1600
<b>CCR Appendix IV</b>																	
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.003 J	0.0011 J	0.0014 J	0.0022 J	0.0011 J	0.00098 J	0.00084 J	0.00081 J		0.005 U			0.005 U	0.005 U	0.00088 J	0.005 U
Barium	mg/L	0.054	0.053	0.056	0.056	0.051	0.052	0.064	0.069		0.068			0.07	0.064	0.081	0.054
Beryllium	mg/L	7.8E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.00062 J	0.002 U	0.002 U	0.00033 J	0.00034 J	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.00016 J	0.001 U	0.001 U	0.001 U	0.001 U		0.00029 J		0.00037 J	0.001 U	0.001 U	0.001 U
Fluoride	mg/L	0.65 J+	0.62 J	0.46 J	0.74 J	0.77 J	0.75 J	0.72 J	0.61 J	0.5 J	0.69 J	0.79 J		0.6 J	0.6	0.84 J+	0.89
Lead	mg/L	0.001 U	0.001 U	0.00023 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U			0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0069 J	0.008 U	0.008 U	0.0077 J	0.0053 J	0.0082	0.0082	0.0077 J		0.007 J			0.008	0.0096	0.012	0.0085
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.011	0.013	0.01	0.012	0.015	0.014	0.014	0.012		0.011			0.01	0.011	0.012	0.01
Radium, Total	pci/L	1.26	0.594	0.61	1.14 J+	0.876	0.687	0.789	0.872		1.69 J+			1.31	1.51 J+	1.61	
Radium-226	pci/L	0.607 J+	0.442	0.361 U	0.785	0.441	0.442	0.537 J+	0.547		0.752			0.711	0.837 J+	1.07	
Radium-228	pci/L	1 U	0.389 U	0.498 U	0.502 U	0.435	0.378 U	0.329 U	0.363 U		0.94 J+			0.603	0.676	0.544	
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U			0.0017 J	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U			0.001 U	0.001 U	0.0003 J	0.001 U
<b>Supplemental Parameters</b>																	
Alkalinity, Bicarbonate (HCO3)	mg/L												180	180			
Alkalinity, Carbonate (CO3)	mg/L												5 U	5 U			
Alkalinity, Hydroxide (OH)	mg/L												5 U	5 U			
Alkalinity, Total	mg/L												180	180	200	200	180
Ferric Iron	mg/L												2 J	2.1 J	1.8		
Ferrous Iron	mg/L												0.1 R	0.1 R	0.38 J		
Iron	mg/L															4.6	3
Magnesium	mg/L												36	39	39	62	43
Manganese	mg/L															0.59	0.54
Nitrate as N	mg/L												0.05 R	0.05 R		0.1 U	0.1 U
Nitrite as N	mg/L												0.05 R	0.05 R			
Nitrogen, Nitrate-Nitrite	mg/L														0.05 U		
Phosphorus (as phosphate)	mg/L												0.031 U	0.031 U	0.31 U	0.14 J	0.31 U
Potassium	mg/L												4.5 J	5	4.7 J	7.2	5.1
Sodium	mg/L												140	150	170	280	130
<b>Sample Parameters</b>																	
Dissolved Oxygen	mg/L	0.22	0.91	0.56	0.22	0.46	0.3	0.43	0.64	0.23	0.08	0.04		0.29	2.06	0.23	0.16
Oxidation Reduction Potential	mV	-129.7	-21.6	-94.6	-132.6	-81.7	-79.6	-21.3	-36.5	-42.6	-64	-102.4		-91.2	-256.1	46.3	-189.2
Eh	mV	70.3	178.4	105.4	67.4	118.3	120.4	178.7	163.5	157.4	136.0	97.6		108.8	-56.1	246.3	10.8
pH	SU	7.81	7.49	7.04	7.52	7.48	7.11	7.26	7.37	7.42	7.45	7.36		7.8	6.74	7.43	7.57
Specific Conductance	uS/cm	834	1049	1060	1237	940	1096	1099	1110	1294	1255	1612		2757	1889	1798	1384
Temperature	deg C	12.71	15.9	16.1	13.9	13.6	13	13.8	14.2	14.5	13.3	13		14.13	13.6	8.1	13.8
Turbidity	NTU	4.72	1.56	1.48	3.8	2.23	3.65	3.16	1.78	0.4	4.59	4.88		3.59	1.35	3.56	1.49

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW16															
Sample Date		2016-07-13	2016-09-08	2016-11-09	2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-15	2018-04-24	2018-10-29		2019-05-03	2019-11-08	
Sample Type		N	N	N	N	N	N	N	N	N	N	N	FD	N	N	FD	N
Chemical Name	Unit																
<b>CCR Appendix III</b>																	
Boron	mg/L	1.1	1.8	1.6	1.2	0.89	1.3	1	1.4	1.1		1.4	1.4	1.4	1.6		1.9
Calcium	mg/L	230	180	170	120	160	210	220	240	57		220	160	160	210		210
Chloride	mg/L	53	37	30	28	24	25	28	31	42		58	36	36	28		59
Fluoride	mg/L	1.4 J+	1.6 J	1.3 J	1.5	1.3 J	1.3 J	1.2 J	1.3 J	1.5 J	1 J	1.2 J	1.1	1.1	0.99		1.1
pH	SU	7.92	7.18	7.48	7.5	7.58	7.17	7.36	7.06	7.62	7.41	7.67		7.28	7.46		7.8
Sulfate	mg/L	530 J-	400	320	47	300	500	480	630	520		530	340	350	570		530
Total Dissolved Solids	mg/L	1100	810	790	570	670	930	1000	1100	980		1100	740	730	1100		1100
<b>CCR Appendix IV</b>																	
Antimony	mg/L	0.002 U	0.002 U	0.00028 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U
Arsenic	mg/L	0.011	0.0077	0.012	0.0084	0.0079	0.006	0.008	0.0096		0.002 J	0.0065	0.01	0.0098	0.005		0.0082
Barium	mg/L	0.049	0.042	0.035	0.024	0.029	0.043	0.044	0.054		0.057	0.045	0.035	0.035	0.034		0.034
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U
Chromium	mg/L	0.00062 J	0.002 U	0.002 U	0.0031	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U		0.002 U
Cobalt	mg/L	0.001 U	0.00068 J	0.00051 J	0.00046 J	0.00055 J	0.00092 J	0.00094 J	0.0011		0.0013		0.00059 J	0.00061 J	0.00066 J		0.00061 J
Fluoride	mg/L	1.4 J+	1.6 J	1.3 J	1.5	1.3 J	1.3 J	1.2 J	1.3 J	1.5 J	1 J	1.2 J	1.1	1.1	0.99		1.1
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U
Lithium	mg/L	0.00043 J	0.008 U	0.008 U	0.00023 J	0.008 U	0.008 U	0.008 U	0.008 U		0.008 U		0.008 U	0.008 U	0.008 U		0.008 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U
Molybdenum	mg/L	0.024	0.036	0.045	0.044	0.03	0.027	0.023	0.024		0.027	0.031	0.033	0.033	0.027		0.028
Radium, Total	pci/L	1.68	0.543	0.527 U	0.629 U	0.648	0.392 U	0.339 U	0.429		0.862 J+	0.29	0.862 J+	1.32 J+	0.685 U		
Radium-226	pci/L	0.537 J+	0.249	0.363 U	0.256 U	0.129 U	0.094	0.106 J+	0.246		0.1	0.0822	0.214 J+	0.278 J+	0.277 U		
Radium-228	pci/L	1.14	0.395 U	0.527 U	0.629 U	0.528	0.392 U	0.339 U	0.322 U		0.762 J+	0.208	0.648 J+	1.04 J+	0.685 U		
Selenium	mg/L	0.005 U	0.005 U	0.0005 J	0.0005 J	0.005 U	0.0012 J	0.005 U	0.005 U		0.0015 J		0.005 U	0.005 U	0.005 U		0.0015 J
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U		0.001 U
<b>Supplemental Parameters</b>																	
Alkalinity, Bicarbonate (HCO3)	mg/L																
Alkalinity, Carbonate (CO3)	mg/L																
Alkalinity, Hydroxide (OH)	mg/L																
Alkalinity, Total	mg/L													180	200	5 U	210
Ferric Iron	mg/L													1.8			
Ferrous Iron	mg/L													0.19 J			
Iron	mg/L														1.4	1.6	1.7
Magnesium	mg/L													23	29	29	31
Manganese	mg/L														0.35	0.29	0.31
Nitrate as N	mg/L														0.042 J	0.1 U	0.1 U
Nitrite as N	mg/L																
Nitrogen, Nitrate-Nitrite	mg/L													0.056			
Phosphorus (as phosphate)	mg/L													1.2	0.55	0.47	0.42
Potassium	mg/L													4.3 J	4.2 J	4.9 J	5.2
Sodium	mg/L													41	41	36	38
<b>Sample Parameters</b>																	
Dissolved Oxygen	mg/L	0.16	0.27	0.48	0.31	0.36	0.14	0.5	0.14	0.06	0.22	0.22		1.27	0.29		4.02
Oxidation Reduction Potential	mV	-18.06	711.6	-124.8	-78.8	-136.9	-73.6	-114.2	9.6	-158.4	-55.9	-106.5		-216.8	8		-2
Eh	mV	181.9	911.6	75.2	121.2	63.1	126.4	85.8	209.6	41.6	144.1	93.5		-16.8	208.0		198.0
pH	SU	7.92	7.18	7.48	7.5	7.58	7.17	7.36	7.06	7.62	7.41	7.67		7.28	7.46		7.8
Specific Conductance	uS/cm	1331	1112	927	751	821	1257	1123	1406	1254	1029	1239		1046	1001		1014
Temperature	deg C	15.02	18.8	18.15	12.1	9.72	10.6	15.41	18	17.8	8.71	9.2		17.81	10.5		17.52
Turbidity	NTU	3.89	2.16	1.93	3.16	4.14	3.25	4.33	2.45	4.95	4.62	12.81		3.64	4.65		3.98

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW16B																
Sample Date		2016-07-13	2016-09-08	2016-11-09		2017-01-11	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-15	2018-04-24	2018-09-07	2018-10-29	2019-05-06	2019-11-08	
Sample Type		N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	FD	N
Chemical Name	Unit																	
<b>CCR Appendix III</b>																		
Boron	mg/L	1.8	1.6	1.4	1.4	1.4	1.4	1.1	3.4	6.5	2.9		4.1	7.6	9.7	12	11	10
Calcium	mg/L	230	190	180	180	210	210	270	220	260	100		250	310	350	350	300	280
Chloride	mg/L	63	56	57	55	57	47	71	71	120	78		140	160	150	190	220	210
Fluoride	mg/L	1.1 J+	1.1 J	0.84 J	0.73 J	0.99 J	0.87 J	0.83 J	0.76 J	0.78 J	1 J	0.8 J	0.76 J	0.73 J	0.64	0.76	1	1
pH	SU	7.76	7.47		7.41	7.57	7.55	7.3	7.51	7.28	7.54	7.6	7.65	7.97	7.02	7.49		7.85
Sulfate	mg/L	580 J-	480	500	440	50	470	730	720	640	580		690	760	890	940	1500	1500
Total Dissolved Solids	mg/L	1100	1000	1000	1000	1000	1000	1300	1200	1400	1200		1400	20 U	1600	1800	2400	2400
<b>CCR Appendix IV</b>																		
Antimony	mg/L	0.002 U	0.002 U	0.00057 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.00095 J		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.0068	0.0064	0.011	0.011	0.012	0.0095	0.012	0.0096	0.0081		0.0099	0.0097	0.011	0.0088	0.0071	0.0079	0.0076
Barium	mg/L	0.072	0.04	0.036	0.035	0.038	0.039	0.055	0.043	0.046		0.053	0.058	0.068	0.071	0.079	0.055	0.054
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.00022 J		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.00029 J	0.002 U	0.00026 J	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.001 U	0.00016 J	0.00019 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.0003 J		0.00054 J	0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	mg/L	1.1 J+	1.1 J	0.84 J	0.73 J	0.99 J	0.87 J	0.83 J	0.76 J	0.78 J	1 J	0.8 J	0.76 J	0.73 J	0.64	0.76	1	1
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0055 J	0.008	0.0032 J	0.0022 J	0.0058 J	0.0035 J	0.0072 J	0.006 J	0.0061 J		0.007 J		0.0059 J	0.0059 J	0.007 J	0.0054 J	0.0055 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.013	0.012	0.012	0.012	0.012	0.013	0.023	0.016	0.013		0.016	0.015	0.012	0.011	0.014	0.02	0.019
Radium, Total	pci/L	1.31	1.05	0.866	0.794	0.998 J+	0.577	1.23	0.795	1.21		1.11 J+	0.99	1.17 J+	1.64 J+	0.984		
Radium-226	pci/L	0.651 J+	0.458	0.427	0.412 U	0.507	0.348	0.635	0.54 J+	0.559		0.443	0.535	0.724 J+	0.719 J+	0.753		
Radium-228	pci/L	0.66	0.59	0.467 U	0.435 U	0.491 J+	0.399 U	0.597	0.287 U	0.647		0.671 J+	0.455	0.522 U	0.919 J+	0.459 U		
Selenium	mg/L	0.005 U	0.005 U	0.00061 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U		0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																		
Alkalinity, Bicarbonate (HCO3)	mg/L													200				
Alkalinity, Carbonate (CO3)	mg/L													5 U				
Alkalinity, Hydroxide (OH)	mg/L													5 U				
Alkalinity, Total	mg/L													200	210	190		200
Ferric Iron	mg/L													6 J	5.1			
Ferrous Iron	mg/L													0.1 R	1.8 J			
Iron	mg/L															9.2		7.5
Magnesium	mg/L													46	53	58		49
Manganese	mg/L															0.49		0.39
Nitrate as N	mg/L													0.05 R		0.018 J		0.1 U
Nitrite as N	mg/L													0.05 R				
Nitrogen, Nitrate-Nitrite	mg/L														0.063			
Phosphorus (as phosphate)	mg/L													0.19	0.28 J	0.22 J		0.17 J
Potassium	mg/L													4.9 J	5.2	5.5		6.3
Sodium	mg/L													84	84	97		380
<b>Sample Parameters</b>																		
Dissolved Oxygen	mg/L	1.23	1.63		0.39	0.3	0.21	0.12	0.32	0.16	0.15	0.28	0.25	1.02	4.23	0.33		3.41
Oxidation Reduction Potential	mV	-122.6	-89		-126.3	-148.5	-132.2	-130.2	-123.1	-32.7	-135.8	-75.5	-117.8	-101.5	-166.8	21.2		-99.5
Eh	mV	77.4	111.0	200.0	73.7	51.5	67.8	69.8	76.9	167.3	64.2	124.5	82.2	98.5	33.2	221.2		100.5
pH	SU	7.76	7.47		7.41	7.57	7.55	7.3	7.51	7.28	7.54	7.6	7.65	7.97	7.02	7.49		7.85
Specific Conductance	uS/cm	1147	1297		1158	1230	1192	1645	1333	1665	1461	1142	1653	3104	2098	1692		2340
Temperature	deg C	13.04	14.44		15.27	14.3	13.37	12.3	13.48	14.3	15	12.6	12.3	15	17.7	11.2		14.65
Turbidity	NTU	4.1	3.99		1.8	2.76	4.21	4.58	3.27	2.48	3.9	4.08	4.2	4.99	3.49	3.72		2.81

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
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**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location		GAMW17															
Sample Date		2016-07-14	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-24	2017-10-04	2018-03-14		2018-04-23		2018-10-29	2019-05-09	2019-11-08
Sample Type		N	N	N	N	N	N	N	N	N	FD	N	FD	N	N	N	N
Chemical Name	Unit																
<b>CCR Appendix III</b>																	
Boron	mg/L	12	12	11	11	11	8.9	7.6	12	12			5.8	5.8	16	7.7	4.9
Calcium	mg/L	150	160	170	180	200	180	120	150	64			110	110	200	130	120
Chloride	mg/L	110	100	130	150	140	81	170	130	160			40	38	150	90	92
Fluoride	mg/L	1.8 J+	2.2 J	2 J	1.9 J	1.6 J	1.6 J	0.79 J	1.9 J	2.4 J	5 U	1.7 J	1.9 J	1.9 J-	1.7	1.6	1.7
pH	SU	7.56	7.27	7.21	7.33	7.54	7.23	7.4	7.16	7.22		7.62		7.82	6.85	7.53	7.75
Sulfate	mg/L	330 J-	330	360	390	390	390	520	250	350			240	220	430	300	290
Total Dissolved Solids	mg/L	940	920	940	1000	1100	950	1400	890	1000			630	620	1100	800	860
<b>CCR Appendix IV</b>																	
Antimony	mg/L	0.00034 J	0.00032 J	0.00032 J	0.002 U	0.00028 J	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U			0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.0054	0.0056	0.0042 J	0.0069	0.0055	0.0054	0.0035 J	0.0028 J		0.005 U	0.0027 J			0.004 J	0.0021 J	0.0028 J
Barium	mg/L	0.047	0.056	0.054	0.05	0.054	0.048	0.044	0.06		0.041	0.058		0.029	0.073	0.041	0.052
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.00076 J	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.0015 J	0.002 U	0.0011 J	0.0011 J	0.0012 J	0.0012 J	0.002 U	0.002 U		0.0017 J	0.0014 J			0.002 U	0.002 U	0.002 U
Cobalt	mg/L	6.3E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U
Fluoride	mg/L	1.8 J+	2.2 J	2 J	1.9 J	1.6 J	1.6 J	0.79 J	1.9 J	2.4 J	5 U	1.7 J	1.9 J	1.9 J-	1.7	1.6	1.7
Lead	mg/L	0.00018 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0047 J	0.008 U	0.0036 J	0.0047 J	0.0024 J	0.0045 J	0.0058 J	0.0076 J		0.008 U	0.0035 J			0.0066 J	0.0035 J	0.0052 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U			0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.015	0.012	0.011	0.01 U	0.01	0.011	0.018	0.024		0.024	0.024		0.02	0.017	0.017	0.012
Radium, Total	pci/L	0.569	0.451 U	0.447 U	0.553 U	0.428	0.477	0.403 U	0.71		0.816 J+	0.384 U		0.205	1.1 J+	0.518 U	
Radium-226	pci/L	1 U	0.331	0.415 U	0.246 U	0.222	0.23	0.191 J+	0.215		0.202	0.112		0.0399	0.315 J+	0.26 U	
Radium-228	pci/L	1 U	0.451 U	0.447 U	0.553 U	0.402 U	0.406 U	0.403 U	0.495		0.614 J+	0.384 U		0.166	0.783 J+	0.518 U	
Selenium	mg/L	0.019	0.03	0.018	0.023	0.028	0.026	0.0081	0.0032 J		0.0074	0.021		0.015	0.022	0.004 J	0.011
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.00063 J	0.001 U
<b>Supplemental Parameters</b>																	
Alkalinity, Bicarbonate (HCO3)	mg/L																
Alkalinity, Carbonate (CO3)	mg/L																
Alkalinity, Hydroxide (OH)	mg/L																
Alkalinity, Total	mg/L														190	160	160
Ferric Iron	mg/L														0.1 U		
Ferrous Iron	mg/L														0.05 UJ		
Iron	mg/L															0.2 U	0.2 U
Magnesium	mg/L														67	49	40
Manganese	mg/L															0.015 U	0.015 U
Nitrate as N	mg/L															0.97	2
Nitrite as N	mg/L																
Nitrogen, Nitrate-Nitrite	mg/L														2.8		
Phosphorus (as phosphate)	mg/L														0.47	0.28 J	0.3 J
Potassium	mg/L														5.3	3.5 J	5
Sodium	mg/L														34	31	28
<b>Sample Parameters</b>																	
Dissolved Oxygen	mg/L	5.78	1.7	1.8	1.01	2.35	7.33	3.18	4.33	3.3			4.99	9	1.78	5.75	6.47
Oxidation Reduction Potential	mV	45.8	825.9	6.1	82.3	6.6	67.9	23.3	8	57.9			-90.2	-90.2	-237	53.1	35
Eh	mV	245.8	1025.9	206.1	282.3	206.6	267.9	223.3	208.0	257.9	200.0	109.8	109.8	109.8	-37.0	253.1	235.0
pH	SU	7.56	7.27	7.21	7.33	7.54	7.23	7.4	7.16	7.22		7.62		7.82	6.85	7.53	7.75
Specific Conductance	uS/cm	1059	1287	1141	1272	1541	1290	902	1151	1357			832	675	1513	894	798
Temperature	deg C	17.23	20.6	18.63	13.6	10.95	11.8	17.71	24.4	22.3			10.9	11.4	20	12.1	17.23
Turbidity	NTU	1.56	1.09	0.58	2.58	0.44	2.21	1.02	1.5	2.51			0.54	1.19	0.45	0.44	0.86

Notes:

- CCR = coal combustion residual
- mg/L = milligrams per liter
- mV= millivolts
- pci/L= picoCuries per liter
- uS/cm = micro Siemens per centimeter
- deg C = degrees Celsius
- NTU = Nephelometric Turbidity Units
- SU = Standard Units
- "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.
- "J" = Indicates the result is estimated.
- "J+" = Indicates the result is estimated and may be biased high.
- "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.
- "R" = Result was rejected during data validation.



**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	GAMW17B															
	Sample Date	2016-07-13	2016-09-08	2016-11-09	2017-01-10	2017-03-02	2017-04-27	2017-06-29	2017-08-23	2017-10-04	2018-03-14	2018-04-23	2018-09-06	2018-10-29	2019-05-09	2019-11-08
Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Chemical Name	Unit															
<b>CCR Appendix III</b>																
Boron	mg/L	18	19	19	21	22	20	16	13	11		13	10	12	12	9.4
Calcium	mg/L	230	250	240	250	270	250	240	160	57		180	150	150	180	150
Chloride	mg/L	180	170	180	190	200	200	71	99	130		140	120	110	130	110
Fluoride	mg/L	0.9 J+	0.98 J	0.68 J	0.58 J	0.6 J	0.6 J	2.1 J	1.3 J	1.1 J	0.55 J	0.58 J	0.84 J	0.71	0.62	0.67
pH	SU	7.43	7.37	7.1	7.24	7.44	7.02	7.25	7.19	7.38	7.48	7.39	7.63	7.4	7.15	7.66
Sulfate	mg/L	710 J-	680	710	740	710	680	300	380	420		520	350	350	270	350
Total Dissolved Solids	mg/L	1500	1400	1400	1500	1700	1500	660	1000	960		1100	940	950	980	990
<b>CCR Appendix IV</b>																
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.0024 J	0.0021 J	0.0024 J	0.0035 J	0.0023 J	0.0022 J	0.0023 J	0.0026 J		0.0011 J		0.0017 J	0.0023 J	0.0022 J	0.0019 J
Barium	mg/L	0.078	0.079	0.086	0.092	0.1	0.089	0.065	0.06		0.085	0.069	0.066	0.073	0.11	0.074
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.00033 J
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U		0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.0003 J	0.001 U	0.001 U
Fluoride	mg/L	0.9 J+	0.98 J	0.68 J	0.58 J	0.6 J	0.6 J	2.1 J	1.3 J	1.1 J	0.55 J	0.58 J	0.84 J	0.71	0.62	0.67
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0017 J	0.008 U	0.008 U	0.0019 J	0.00046 J	0.0021 J	0.0019 J	0.008 U		0.008 U		0.008 U	0.008 U	0.008 U	0.008 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U		0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.024	0.021	0.013	0.011	0.012	0.011	0.017	0.021		0.017	0.016	0.01	0.011	0.0073 J	0.01
Radium, Total	pci/L	1.79	1.84	2.53	2.58	1.25	1.94	1.03	2.4			1.21	1.47	2.48 J+	1.71	
Radium-226	pci/L	0.882 J+	0.864	1.28	1.4	1.01	1.09	0.639 J+	0.867			0.518	0.945	1.15 J+	0.964	
Radium-228	pci/L	0.913	0.98	1.25	1.17	0.423 U	0.846	0.395	1.53			0.696	0.524	1.33 J+	0.748	
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.00053 J	0.00051 J	0.005 U	0.005 U	0.005 U		0.005 U		0.0011 J	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U		0.001 U	0.001 U	0.00022 J	0.001 U
<b>Supplemental Parameters</b>																
Alkalinity, Bicarbonate (HCO3)	mg/L												210			
Alkalinity, Carbonate (CO3)	mg/L												5 U			
Alkalinity, Hydroxide (OH)	mg/L												5 U			
Alkalinity, Total	mg/L												210	230	300	190
Ferric Iron	mg/L												4.1 J	3		
Ferrous Iron	mg/L												0.1 R	1.5 J		
Iron	mg/L														6.8	5.1
Magnesium	mg/L												32	33	53	44
Manganese	mg/L														1	0.76
Nitrate as N	mg/L												0.05 R		0.1 U	0.1 U
Nitrite as N	mg/L												0.05 R			
Nitrogen, Nitrate-Nitrite	mg/L													0.23		
Phosphorus (as phosphate)	mg/L												0.46	0.17 J	0.31 U	0.31 U
Potassium	mg/L												5.7	6.2	9.5	6.1
Sodium	mg/L												83	110	39	42
<b>Sample Parameters</b>																
Dissolved Oxygen	mg/L	0.33	0.24	0.67	0.36	0.13	0.13	0.18	0.14	0.09	0.16	0.11	0.2	0.88	0.23	4.2
Oxidation Reduction Potential	mV	-115	654	-100.8	-119.6	-91.8	102.3	-98.6	-51.1	-129.4	-95.2	-131.9	-91.9	-244.5	11.8	-3.6
Eh	mV	85.0	854.0	99.2	80.4	108.2	302.3	101.4	148.9	70.6	104.8	68.1	108.1	-44.5	211.8	196.4
pH	SU	7.43	7.37	7.1	7.24	7.44	7.02	7.25	7.19	7.38	7.48	7.39	7.63	7.4	7.15	7.66
Specific Conductance	uS/cm	1525	1734	1568	171.9	2251	1950	1488	1244	1337	1235	1463	2077	1380	1060	890
Temperature	deg C	15.29	16.16	15.77	15	14.8	14.4	15.62	16.5	16.6	15.2	15.2	16.55	16.1	13.6	15.05
Turbidity	NTU	4.09	2.48	0.62	0.92	0.58	2.11	2.35	1.86	3.45	3.76	3.88	3.55	4.86	3.61	2.68

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	GAMW18														GAMW18B								
	2016-07-13	2016-09-08	2016-11-09		2017-01-10	2017-03-01	2017-04-26	2017-07-12		2017-08-23	2017-10-03		2018-03-14	2018-04-23	2018-10-25	2019-04-29	2019-11-07	2018-09-10	2018-10-25		2019-04-29	2019-11-07	
Sample Date	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N
Sample Type	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N
Chemical Name	Unit																						
<b>CCR Appendix III</b>																							
Boron	mg/L	1.8	3.5	1.9	1.8	1.3	1	0.77	1.2	1.2	1.5	1.9	1.9		1.2	1.7	0.95	1.7	13	12	13	14	11
Calcium	mg/L	320	610	370	360	330	280	210	280	290	300	380 J	64 J		320	230	320	360	260	200	220	240	180
Chloride	mg/L	17	39	17	17	9.3	5	4.3	10	10	11	23	23		7.3	22	12	27	150	140	140	170	140
Fluoride	mg/L	0.047 J+	0.036 J	10 U	10 U	5 U	5 U	2 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	0.057	0.074	0.15	0.77 J	0.74	0.73	0.88	0.99
pH	SU	6.95	6.83		6.7	6.88	7.11	6.6		6.96	7.02	6.91	7.2	7.21	6.54	6.71	7.18	7.73		6.86	7.15	7.68	
Sulfate	mg/L	760 J-	1400	850	830	640	540	370	600	610	690	960	950		670	550	780	920	1100	1000	1100	1100	840
Total Dissolved Solids	mg/L	1300	2200	1500	1500	1200	1000	730	1100	1100	1300	1600	1500		2400	1100	1400	1500	2100	2000	2000	2100	1500
<b>CCR Appendix IV</b>																							
Antimony	mg/L	0.002 U	0.002 U	0.00096 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.0014 J	0.0023 J	0.0014 J	0.00091 J	0.0014 J	0.005 U	0.0015 J	0.0021 J	0.0021 J	0.0011 J			0.005 U		0.005 U	0.00079 J	0.005 U	0.0018 J	0.0026 J	0.0028 J	0.0037 J	0.0041 J
Barium	mg/L	0.038	0.047	0.041	0.039	0.037	0.024	0.021	0.051	0.052	0.055			0.048	0.035	0.037	0.039	0.05	0.048	0.035	0.039	0.039	0.024
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.00094 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00053 U	0.001 U
Cadmium	mg/L	8.1E-05 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.00067 J	0.00046 J	0.0005 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.001 U	0.00023 J	0.00047 J	0.0002 J	0.00024 J	0.001 U	0.00023 J	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.00028 J	0.001 U	0.00027 J	0.00026 J	0.00028 J	0.00024 J	0.00024 J
Fluoride	mg/L	0.047 J+	0.036 J	10 U	10 U	5 U	2 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	0.057	0.074	0.15	0.77 J	0.74	0.73	0.88	0.99
Lead	mg/L	0.001 U	0.001 U	0.00051 J	0.00025 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.00067 J		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.00096 J	0.008 U	0.008 U	0.008 U	0.00042 J	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U			0.008 U		0.008 U	0.008 U	0.008 U	0.025	0.015	0.016	0.023	0.015
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U			0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.11	0.18	0.14	0.13	0.094	0.1	0.1	0.1	0.11	0.1			0.097	0.085	0.057	0.062	0.076	0.024	0.014	0.015	0.026	0.011
Radium, Total	pci/L	5 U	0.803	0.474	0.449	0.581 U	0.398 U	0.384 U	0.493	0.337 U	0.629			0.373 U	0.259	0.477	0.365 U		1.7	1.28	1.46		
Radium-226	pci/L	1 U	0.348	0.334 U	0.33 U	0.325	0.13	0.131 U	0.166 J+	0.179 J+	0.332			0.111	0.0715	0.291	0.325 U		0.773 J+	0.717	0.748	0.41	
Radium-228	pci/L	1 U	0.49 U	0.455 U	0.413 U	0.581 U	0.398 U	0.384 U	0.381 U	0.337 U	0.369 U			0.373 U	0.187	0.357 U	0.365 U		0.928	0.562	0.708	0.941	
Selenium	mg/L	0.01	0.018	0.0065	0.0052	0.0099	0.011	0.0053	0.012	0.012	0.006			0.009	0.0084	0.015	0.015	0.012	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																							
Alkalinity, Bicarbonate (HCO3)	mg/L																		230				
Alkalinity, Carbonate (CO3)	mg/L																		5 U				
Alkalinity, Hydroxide (OH)	mg/L																		5 U				
Alkalinity, Total	mg/L																		240	190	250	230	210
Ferric Iron	mg/L																		0.032 J			6.8 J	2.9
Ferrous Iron	mg/L																		0.05 UJ			0.1 R	1.3 J
Iron	mg/L																						
Magnesium	mg/L																		16	17	23	66	58
Manganese	mg/L																						3.6
Nitrate as N	mg/L																						67
Nitrite as N	mg/L																						51
Nitrogen, Nitrate-Nitrite	mg/L																						0.69
Phosphorus (as phosphate)	mg/L																						0.66
Potassium	mg/L																						0.1 U
Sodium	mg/L																						0.1 U
<b>Sample Parameters</b>																							
Dissolved Oxygen	mg/L	4.83	4.77		5.93	7.52	8.86	7.79		6.04	4.52		5.32	6.5	8.49	3.78	7.01	2.95	0.24		0.29	0.92	0.36
Oxidation Reduction Potential	mV	98.9	76.8		28.7	106.8	97.9	209.2		203.2	24.7		121.9	-129.6	-51.6	-36.6	129.2	-41.1	-140.7		-103.4	109.2	-144.8
Eh	mV	298.9	276.8		228.7	306.8	297.9	409.2		403.2	224.7		321.9	70.4	148.4	163.4	329.2	158.9	59.3		96.6	309.2	55.2
pH	SU	6.95	6.83		6.7	6.88	7.11	6.6		6.96	7.02	6.91	7.2	7.21	6.54	6.71	7.18	7.73		6.86	7.15	7.68	
Specific Conductance	uS/cm	1474	2362		1740	1255	986	970		1299	1414		1760	905	1170	1230	1060	1338	3311		2147	1902	1475
Temperature	deg C	16.3	20.1		16.6	9.65	8.47	11.2		17.9	19.8		19.3	8.1	8.9	17.4	8.8	14.2	15.39		14.9	11.8	13.7
Turbidity	NTU	3.32	1.63		2.38	3.05	4.44	2.48		1.71	1.03		4.16	4.59	0.71	1.29	4.55	2.04	2.78		3.58	3.21	3.14

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	Sample Date	GAMW46								GAMW46B								GAMW52						
		2018-06-13	2019-03-01	2019-04-17	2019-06-06	2019-07-18	2019-08-26	2019-10-04	2019-11-19	2018-06-13	2019-03-04	2019-04-17	2019-06-07	2019-07-18	2019-08-26	2019-10-04	2019-11-19	2018-09-10	2018-10-31	2019-05-09	2019-11-14			
Chemical Name	Unit	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	FD	N
<b>CCR Appendix III</b>																								
Boron	mg/L	0.055 J	0.1 U	0.033 J	0.1 U	0.032 J	0.053 J	0.043 J	0.049 J	0.05 J	0.05 J	0.037 J	0.047 J	0.03 J	0.05 J	0.047 J	0.046 J	0.34		0.17	0.077 J		0.13	
Calcium	mg/L	56	14	28	25 J-	25	25	23	27	25	58	58	56	52	58	49	56	75		59	52		72	
Chloride	mg/L	8.4	2.4	1.9		1.8	1.6	1.6	1.6	3	7.9	7.9		7.2	8	7.1	6.9	34		9.1	5.5		37	
Fluoride	mg/L	0.052 J	0.068	0.063		0.065	0.06	0.079 J+	0.062	0.048 J	0.066	0.076		0.072	0.069	0.073 J+	0.072	0.36 J		0.3	0.25 J+		0.3	
pH	SU	7.93	8.17	8.23	7.52	8.15	7.9	7.81	7.77	8.2	7.11	7.99	7.58	8.18	7.62	7.44	7.47	7.5		7.06	7.17		7.59	
Sulfate	mg/L	55	34	30		28	29	30	27	29	64	64		64	68	65	64	86		39	24		67	
Total Dissolved Solids	mg/L	260	160	150		130	150	140 J+	140	150	260	290		240	220 J	250	240	400		250	240		350	
<b>CCR Appendix IV</b>																								
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U		0.002 U	
Arsenic	mg/L	0.0014 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.00086 J	0.005 U	0.0015 J	0.0012 J	0.00076 J	0.005 U	0.00091 J	0.00095 J	0.0013 J	0.001 J	0.005 U		0.005 U	0.005 U		0.005 U	
Barium	mg/L	0.027	0.0028 J	0.0059	0.0065	0.0054	0.0054	0.0049 J	0.0059	0.0086	0.027	0.026	0.025	0.023	0.024	0.021	0.025	0.039		0.019	0.015		0.02	
Beryllium	mg/L	0.001 U	0.005 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00054 J	0.001 U	0.001 U	0.0011	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0011	0.001 U		0.001 U	0.001 U		0.001 U	
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.00024 J	0.001 U		0.001 U	
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0014 J	0.002 U	0.002 U	0.0021	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U		0.002 U	
Cobalt	mg/L	0.0002 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00034 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00058 J			0.00031 J	0.001 U		0.001 U	
Fluoride	mg/L	0.052 J	0.068	0.063		0.065	0.06	0.079 J+	0.062	0.048 J	0.066	0.076		0.072	0.069	0.073 J+	0.072	0.36 J		0.3	0.25 J+		0.3	
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	
Lithium	mg/L	0.008 U	0.04	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.0017 J	0.008 U	0.008 U	0.008 U	0.002 J	0.008 U	0.008 U	0.003 J	0.0017 J		0.008 U	0.008 U		0.0025 J	
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U		0.0002 U	
Molybdenum	mg/L	0.0031 J	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.0015 J	0.01 U	0.0018 J	0.0024 J	0.0022 J	0.0025 J	0.0028 J	0.0028 J	0.0025 J	0.003 J	0.005 J		0.0035 J	0.0016 J		0.0017 J	
Radium, Total	pci/L	0.384 U	0.486 U	0.33 U		0.427 U	0.505 U	0.566		0.392 U	0.402 U	0.308 U		0.427 U	0.609 U	0.408 U		0.796		1 J+	0.53 U			
Radium-226	pci/L	0.244 U	0.103 U	0.0708 U		0.214 U	0.0925 UJ	0.179 J+		0.223 U	0.286	0.108		0.232 U	0.105 UJ	0.192 J+		0.46 J+		0.299 J+	0.436			
Radium-228	pci/L	0.384 U	0.486 U	0.33 U		0.427 U	0.505 UJ	0.481 U		0.392 U	0.402 U	0.308 U		0.427 U	0.609 UJ	0.408 U		0.392 U		0.706 J+	0.53 U			
Selenium	mg/L	0.001 J	0.025 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0017 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0014 J		0.0017 J	0.0014 J		0.0011 J	
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00059 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00068 J	0.001 U		0.001 U	0.001 U		0.001 U	
<b>Supplemental Parameters</b>																								
Alkalinity, Bicarbonate (HCO3)	mg/L																	210						
Alkalinity, Carbonate (CO3)	mg/L																	5 U						
Alkalinity, Hydroxide (OH)	mg/L																	5 U						
Alkalinity, Total	mg/L			82						73			140					130		210	180	190	170	190
Ferric Iron	mg/L																	0.2 J	0.1 U	0.1 U				
Ferrous Iron	mg/L																	0.1 R	0.05 J	0.05 UJ				
Iron	mg/L			0.054 J					0.2 U			1.5					1.6				0.2 U	0.2 U	0.2 U	
Magnesium	mg/L			9.7					7.8			15					14	20	16	15	16	20	21	
Manganese	mg/L			0.0066 J					0.015 U			0.26					0.23				0.0022 J	0.017	0.02	
Nitrate as N	mg/L			0.58					0.48			0.1 U					0.1 U			1 J		1.9	1.1	
Nitrite as N	mg/L																	0.089 J						
Nitrogen, Nitrate-Nitrite	mg/L																			1.3	1.3			
Phosphorus (as phosphate)	mg/L			0.16 J					0.31 U			0.15 J					0.31 U	0.031 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	
Potassium	mg/L			0.97 J					1 J			0.83 J					0.82 J	4.7	3 J	2.9 J	2.1 J	3.1 J	3.3 J	
Sodium	mg/L			4.6 J					2.4 J			5.4					4.6 J	25	13	13	9.8	18	21	
<b>Sample Parameters</b>																								
Dissolved Oxygen	mg/L	0.12	1.85	4.18	6.44	6.58	4.03	2.44	3.36	3.59	0.08	1.9	0.3	1.4	1.25	0.31	0.3	0.48		0.21	6.42		2.2	
Oxidation Reduction Potential	mV	-171.4	1.9	7.7	157.6	25.5	40.6	9.16	-141.1	-29.4	111.9	-111.1	-133.1	-93.9	-119.9	33.7	-229.6	-30.3		85.1	108.2		-43.2	
Eh	mV	28.6	201.9	207.7	357.6	225.5	240.6	209.2	58.9	170.6	311.9	88.9	66.9	106.1	80.1	233.7	-29.6	169.7		285.1	308.2	200.0	156.8	
pH	SU	7.93	8.17	8.23	7.52	8.15	7.9	7.81	7.77	8.2	7.11	7.99	7.58	8.18	7.62	7.44	7.47	7.5		7.06	7.17		7.59	
Specific Conductance	uS/cm	367	155	161	179	153	153	152	132	211	268	294	282	274	284	260	242	0.896		448	308		320	
Temperature	deg C	11.4	8	9.1	11.1	13.2	14.2	14.8	11.7	11.3	9.6	10.8	11	11.9	12.3	12.3	11.3	19.97		17.6	14.2		15.3	
Turbidity	NTU	3.96	1.91	1.33	0.51	0.82	0.69	0.89	0.66	3.45	3.26	4.3	3.25	3.11	1.15	4.16	2.84	0.45		0.83	0.42		0.74	

Notes:  
 CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units  
 "U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
 "J" = Indicates the result is estimated.  
 "J+" = Indicates the result is estimated and may be biased high.  
 "UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
 "R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Location	GAMW52B				GAMW53				GAMW53B				GAMW54				GAMW54B						
	2018-09-11	2018-10-31	2019-05-09	2019-11-14	2018-09-11	2018-10-30	2019-04-30	2019-11-14	2018-09-11	2018-10-30	2019-04-30	2019-11-14	2018-09-10	2018-10-31	2019-04-30	2019-11-14	2018-09-10	2018-10-31	2019-05-01	2019-11-15			
Sample Date	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N			
Sample Type																							
Chemical Name	Unit																						
<b>CCR Appendix III</b>																							
Boron	mg/L	0.75	0.8	1	1.3	0.19	0.25	0.056 J	0.13	2.5		3.1	2.2	0.73	0.84	0.77	0.39	0.37	5.6	6.5	5.9	6	
Calcium	mg/L	160	160	110	130	45	53	17	25	180		190	150	140	93	88	93	81	210	220	200	240	
Chloride	mg/L	530	470	380	370	4.9	4.6	1.9	3.6	90		85	81	74	15	10	10	4	100	95	110	120	
Fluoride	mg/L	10 U	0.18	0.21 J+	0.23	0.17 J	0.17	0.05 U	0.05 U	0.52 J		0.46	0.51	0.7	0.18 J	0.17	0.14	0.28	0.41 J	0.52	0.59	0.58	
pH	SU	8.3	7.1	7.42	7.34	6	6.47	5.93	6.21	7.3		7.35	7.41	7.52	6.24	7.92	6.82	7.08	6.95	8.71	7.27	7.2	
Sulfate	mg/L	210	190	220	290	51	56	37	36	430		510	340	320	190	150	190	76	750	730	710	720	
Total Dissolved Solids	mg/L	1500	1300	1100	1100	240	250	130	160	1100		1100	900	770	500	400	470	350	1600	1400	1500	1400	
<b>CCR Appendix IV</b>																							
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.00061 J	0.002 U		0.002 U	0.002 U	0.002 U	0.0011 J	0.00074 J	0.00078 J	0.001 J	0.002 U	0.002 U	0.002 U	0.002 U	
Arsenic	mg/L	0.0013 J	0.0016 J	0.00083 J	0.0012 J	0.013	0.015	0.00097 J	0.0018 J	0.00079 J		0.00083 J	0.001 J	0.0016 J	0.0024 J	0.0028 J	0.0022 J	0.0045 J	0.0025 J	0.0032 J	0.0045 J	0.005	
Barium	mg/L	0.32	0.31	0.25	0.28	0.027	0.028	0.019	0.026	0.052		0.054	0.044	0.072	0.043	0.039	0.031	0.031	0.098	0.093	0.08	0.084	
Beryllium	mg/L	0.001 U	0.00042 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.00059 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	
Cadmium	mg/L	0.001 U	0.00029 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.0019 J	0.0018 J	0.0012 J	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	
Cobalt	mg/L	0.001 U	0.00032 J	0.001 U	0.001 U	0.00084 J	0.00099 J	0.0005 J	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.00053 J	0.00052 J	0.00062 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	
Fluoride	mg/L	10 U	0.18	0.21 J+	0.23	0.17 J	0.17	0.05 U	0.05 U	0.52 J		0.46	0.51	0.7	0.18 J	0.17	0.14	0.28	0.41 J	0.52	0.59	0.58	
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.0014	0.00089 J	0.00057 J	0.00063 J	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	
Lithium	mg/L	0.0041 J	0.0031 J	0.0033 J	0.0071 J	0.008 U	0.008 U	0.008 U	0.0021 J	0.0042 J		0.0052 J	0.005 J	0.0066 J	0.008 U	0.008 U	0.008 U	0.0023 J	0.0048 J	0.0036 J	0.0048 J	0.0074 J	
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	
Molybdenum	mg/L	0.014	0.015	0.0095 J	0.0086 J	0.012	0.015	0.0051 J	0.011	0.0083 J		0.0075 J	0.0098 J	0.02	0.043	0.044	0.023	0.03	0.018	0.019	0.0085 J	0.012	
Radium, Total	pci/L	3.52	5.55 J+	2.63		0.547 U	1.45 J+	0.344 U		1.69		0.48 J+	1.26		0.5	1.08 J+	0.393 U		2.03	2.7 J+	1.82		
Radium-226	pci/L	2.11	2.76 J+	1.2		0.257	0.795 J+	0.316 U		0.789		0.238 J+	0.544		0.385 J+	0.237 J+	0.337 U		1.18 J+	1.35 J+	0.956		
Radium-228	pci/L	1.41	2.79 J+	1.44		0.547 U	0.658 J+	0.344 U		0.897		0.347 U	0.719		0.385 U	0.843 J+	0.393 U		0.849	1.35 J+	0.865		
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		0.005 U	0.005 U	0.005 U	0.0017 J	0.0012 J	0.0043 J	0.0035 J	0.005 U	0.005 U	0.005 U	0.005 U	
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.00049 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	
<b>Supplemental Parameters</b>																							
Alkalinity, Bicarbonate (HCO3)	mg/L	220				120				250					150				240				
Alkalinity, Carbonate (CO3)	mg/L	5 U				5 U				5 U					5 U				5 U				
Alkalinity, Hydroxide (OH)	mg/L	5 U				5 U				5 U					5 U				5 U				
Alkalinity, Total	mg/L	220	230	220	200	120	140	53	73	250	240	250	260	190	150	160	160	230	240	230	230	250	260
Ferric Iron	mg/L	5 J	3.4			2 J	1			3.2 J	2.3	2.7			0.13 J	0.14			5.9 J	4.5	3.4		
Ferrous Iron	mg/L	0.1 R	0.32 J			0.1 R	0.5 J			0.1 R	0.56 J	1 J			0.1 R	0.029 J			0.1 R	0.94 J	1.6 J		
Iron	mg/L			2.7	2.5			0.25	0.28							0.14 J	0.31				5.4	5.4	
Magnesium	mg/L	37	38	30	28	15	15	8.9	11	23	24	25	23	19	19	18	21	17	38	38	36	42	46
Manganese	mg/L			0.21	0.25			0.0079 J	0.015 U								0.0097 J	0.015 U			0.48	0.51	
Nitrate as N	mg/L	0.05 UJ		0.1 U	0.1 U	1.3 J		1.4	0.4	0.05 UJ				0.1 U	0.1 U		0.028 J		0.49	0.15	0.05 UJ	0.1 U	0.1 U
Nitrite as N	mg/L	0.05 UJ				0.03 J				0.05 UJ					0.05 UJ				0.05 UJ				
Nitrogen, Nitrate-Nitrite	mg/L		0.052				0.05 U					0.099	0.74 J-				0.21			0.15	0.091		
Phosphorus (as phosphate)	mg/L	0.056	0.21 J	0.31 U	0.11 J	0.32	0.31 U	0.31 U	0.31 U	0.031 U	0.14 J	0.52	0.31 U	0.31 U	0.031 U	0.31 U	0.11 J	0.31 U	0.079	0.31 U	0.39	0.38	0.3 J
Potassium	mg/L	6	6.4	7	6.5	2.2	5 U	1.3 J	1.6 J	4.6	5.2	5.4	4.9 J	4.5 J	1.9	1.8 J	1.2 J	1.6 J	6.8	6.8	6.2	6.3	5.6
Sodium	mg/L	220	250	250	210	6.5	7.8	4.9 J	3.9 J	120	130	130	99	75	21	21	15	11	200	200	180	160	140
<b>Sample Parameters</b>																							
Dissolved Oxygen	mg/L	0.44	0.1	0.15	0.19	0.53	0.86	3.11	0.84	0.26		0.8	0.36	0.09	0.61	1.41	0.72	0.26	0.42		2.12	0.42	0.31
Oxidation Reduction Potential	mV	-214.9	-103.5	6.31	-102.9	-24.6	-199.5	43.7	-54.8	-183.2		-168	27.7	-75.3	107.8	-294.7	48.4	-69.5	-123.4		-315.7	-23.1	-43.3
Eh	mV	-14.9	96.5	206.3	97.1	175.4	0.5	243.7	145.2	16.8		32.0	227.7	124.7	307.8	-94.7	248.4	130.5	76.6	200.0	-115.7	176.9	156.7
pH	SU	8.3	7.1	7.42	7.34	6	6.47	5.93	6.21	7.3		7.35	7.41	7.52	6.24	7.92	6.82	7.08	6.95	8.71	7.27	7.2	
Specific Conductance	uS/cm	1934	2005	1652	1353	307	400	125	155	1354		1620	1160	870	675	630	493	374	1816	1983	1636	1310	
Temperature	deg C	17.26	16.6	15.3	16.1	21.3	20.1	11.4	17.5	20.89		20.4	18.7	19.7	21.2	18.53	10.5	15.3	17.6	17.29	15.5	15.8	
Turbidity	NTU	1.6	0.88	2.35	1.01	9.93	5.17	4.76	4.8	2.43		3	3.45	2.5	2.03	1	3.24	2.31	4.2	1.64	4.49	1.67	

Notes:  
CCR = coal combustion residual  
mg/L = milligrams per liter  
mV= millivolts  
pci/L= picoCuries per liter  
uS/cm = micro Siemens per centimeter  
deg C = degrees Celsius  
NTU = Nephelometric Turbidity Units  
SU = Standard Units  
"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.  
"J" = Indicates the result is estimated.  
"J+" = Indicates the result is estimated and may be biased high.  
"UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.  
"R" = Result was rejected during data validation.

**Appendix A-1: Groundwater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

Chemical Name	Unit	Location		GAMW55				GAMW55R	GAMW55B				GAMW56				GAMW56B								
		Sample Date	Sample Type	2018-09-10		2018-10-29		2019-11-15	2018-09-11		2018-10-29	2019-05-01	2019-11-15		2018-09-11	2018-10-26	2019-04-29	2019-11-15		2018-09-11	2018-10-29	2019-04-29	2019-11-15		
		FD	N	FD	N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
<b>CCR Appendix III</b>																									
Boron	mg/L	1.9	1.9	1.8	1.8	1.1	7.1	7.4	8.2	9.1	11	0.26	0.28	0.21	0.2	1.2	1.2	2.3	3.2						
Calcium	mg/L	260	250	270	260	180	250	250	260	210	210	130	110	91	120	140	140	150	150						
Chloride	mg/L	58	59	69	70	61	220	220	190	170	150	3.1	2.4	3.2	2.1	50	36	55	64						
Fluoride	mg/L	0.51 J	0.52 J	0.47	0.47	0.62	0.29 J	10 U	0.25	0.31	0.31	1.2 J	0.99	0.53	0.71	0.41 J	0.33	0.4	0.44						
pH	SU		6.77		7.04	7.46	7.31		7.07	7.19	7.31	6.82	7.17	6.83	7.06	6.95	6.91	7.08	7.21						
Sulfate	mg/L	590	600	630	620	480	820	820	910	790	750	57	63	54	56	170	130	260	360						
Total Dissolved Solids	mg/L	1200	1300	1300	1300	950	1800	1900	1800	1700	1400	470	480	420	440	740	690	830	860						
<b>CCR Appendix IV</b>																									
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.00083 J	0.005 U	0.005 U	0.005 U	0.005 U	0.0014 J	0.0011 J	0.005 U	0.005 U	0.005 U	0.019	0.022	0.011	0.0097	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Barium	mg/L	0.099	0.097	0.068	0.069	0.035	0.14	0.14	0.12	0.074	0.067	0.068	0.049	0.044	0.04	0.076	0.072	0.082	0.076						
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.0065	0.0058	0.0044	0.0044	0.001 U	0.00034 J	0.00028 J	0.001 U	0.001 U	0.001 U	0.0017	0.0053	0.0084	0.0081	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Fluoride	mg/L	0.51 J	0.52 J	0.47	0.47	0.62	0.29 J	10 U	0.25	0.31	0.31	1.2 J	0.99	0.53	0.71	0.41 J	0.33	0.4	0.44						
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.0021 J	0.0017 J	0.008 U	0.008 U	0.0035 J	0.0064 J	0.0064 J	0.0054 J	0.0055 J	0.0078 J	0.0034 J	0.0039 J	0.0023 J	0.0053 J	0.0051 J	0.0035 J	0.0044	0.0062 J						
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.03	0.028	0.026	0.026	0.024	0.0057 J	0.0055 J	0.0055 J	0.0046 J	0.005 J	0.013	0.0094 J	0.0072 J	0.0079 J	0.004 J	0.003 J	0.0031	0.0064 J						
Radium, Total	pci/L	1.4	0.802	0.922 J+	1.24 J+		3.35	3.18	3.66 J+	2.08		0.728	0.698 J+			1.26	1.28 J+								
Radium-226	pci/L	0.574 J+	0.474 J+	0.363 J+	0.447 J+		1.72	1.75	1.86 J+	1.15		0.504	0.357 J+	0.334 U		0.763	0.578 J+	0.506							
Radium-228	pci/L	0.824	0.403 U	0.559 J+	0.796 J+		1.63	1.43	1.79 J+	0.926		0.371 U	0.429 U	0.373 U		0.493	0.698 J+	0.571							
Selenium	mg/L	0.0037 J	0.0031 J	0.0027 J	0.0027 J	0.0046 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Thallium	mg/L	0.00021 J	0.001 U	0.00023 J	0.00022 J	0.00022 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>																									
Alkalinity, Bicarbonate (HCO3)	mg/L		240						230			370				370									
Alkalinity, Carbonate (CO3)	mg/L		5 U						5 U			5 U				5 U									
Alkalinity, Hydroxide (OH)	mg/L		5 U						5 U			5 U				5 U									
Alkalinity, Total	mg/L		240		240	230			230	220	230	230	370	370	300	330	370	410	330	270					
Ferric Iron	mg/L		0.65 J		0.19				5.2 J	2.5		13 J	5.5			6.4 J	3.5								
Ferrous Iron	mg/L		0.1 R		0.058 J				0.1 R	2.8 J		0.1 R	6.5 J			0.1 R	1.7 J								
Iron	mg/L					0.044 J				4.2	4.1		10	3.9			5.7	4.3							
Magnesium	mg/L		32		39	28		46	51	50	42	24	25	27	24	37	38	40	38						
Manganese	mg/L					0.22				0.58	0.46			0.25	0.45		0.33	0.29							
Nitrate as N	mg/L		0.68 J			1.4		0.05 UJ		0.1 U	0.1 U	0.05 UJ		1.5	0.13	0.05 UJ		0.1 U	0.1 U						
Nitrite as N	mg/L		0.058 J					0.05 UJ				0.05 UJ				0.05 UJ									
Nitrogen, Nitrate-Nitrite	mg/L				0.44					0.05 U				0.062			0.05 U								
Phosphorus (as phosphate)	mg/L		0.031 U		0.31 U	0.31 U		2.1	0.7	0.31 U	0.16 J	0.031 U	0.31 U	0.12 J	0.31 U	0.045	0.15 J	0.14 J	0.31 U						
Potassium	mg/L		8.3		9.5	7.2		6	6.6	6.2	4.8 J	2.6	2.4 J	1.6 J	1.9 J	3.3	3.6 J	3.7 J	3.6 J						
Sodium	mg/L		58		72	79		200	230	200	180	11	12	6.3	5.5	50	49	58	62						
<b>Sample Parameters</b>																									
Dissolved Oxygen	mg/L		1.73		0.33	0.17	0.72		0.37	0.17	0.11	0.99	0.28	1.3	0.34	0.29	0.26	0.79	0.18						
Oxidation Reduction Potential	mV		21.6		-69.4	-137.9	-28.9		-129.5	-115.9	-57.5	-97.4	-95.4	64	-86.6	-102.8	-44.4	31.8	-105.7						
Eh	mV		221.6	200.0	130.6	62.1	171.1		70.5	84.1	142.5	102.6	104.6	264.0	113.4	97.2	155.6	231.8	94.3						
pH	SU		6.77		7.04	7.46	7.31		7.07	7.19	7.31	6.82	7.17	6.83	7.06	6.95	6.91	7.08	7.21						
Specific Conductance	uS/cm		1493		1574	1491	1017		2109	2201	1967	749	835	460	466	928	1036	856	741						
Temperature	deg C		21.1		19.4	17.9	16.7		19.2	18.5	18.1	17	15.7	8.7	14	13.9	13.8	11.6	12.9						
Turbidity	NTU		1.74		0.66	3.92	2.26		4.38	1.74	4.77	2.91	2.99	2.31	2.01	2.96	1.45	4.77	1.4						

Notes:

CCR = coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 pci/L= picoCuries per liter  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units

"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.

"J" = Indicates the result is estimated.

"J+" = Indicates the result is estimated and may be biased high.

"UJ" = Indicates the result was not detected above the MDL, the estimated RL is provided.

"R" = Result was rejected during data validation.

Prepared by: DFSC  
 Checked by: KMC  
 Reviewed by: MAH



**Appendix A-2: Porewater Analytical Data**  
**CCR Unit Schahfer MSRB, MCWB, and Drying Area**  
**NIPSCO LLC R. M. Schahfer Generating Station**  
**Wheatfield, Indiana**

SYS_LOC_CODE	DAPZ-02A	DAPZ-02B	GAPIEZ06	GAPIEZ06	GAPIEZ06	
SAMPLE_DATE_YYYY-MM-dd	2020-03-03	2020-03-03	2018-08-09	2018-09-13	2018-10-31	
FRACTION	T	T	D	T	T	
Chemical Name	Unit					
<b>CCR Appendix III</b>						
Boron	mg/L	7.4	13.8	9.6	8.6	8.3
Calcium	mg/L	489	175	210	210	210
Chloride	mg/L	21.9	119	56	58	55
Fluoride	mg/L	0.16	0.72	0.91	1.1 J	0.92
pH	SU	7.33	7.62	7.51	7.43	9.37
Sulfate	mg/L	1760	2420	750	720	740
Total Dissolved Solids	mg/L	2810	3830		1300	1300
<b>CCR Appendix IV</b>						
Antimony	mg/L	0.001 U	0.001 U	0.0014 J	0.002 U	0.002 U
Arsenic	mg/L	0.001 U	0.0018	0.011	0.011	0.012
Barium	mg/L	0.028	0.033	0.03	0.029	0.03
Beryllium	mg/L	0.0002 U	0.0002 U	0.001 U	0.00052 J	0.001 U
Cadmium	mg/L	0.00052	0.0002 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.0038	0.0023 J+	0.002 U	0.002 U
Cobalt	mg/L	0.0022	0.001 U	0.0004 J	0.00029 J	0.001 U
Fluoride	mg/L	0.16	0.72	0.91	1.1 J	0.92
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.008 U	0.016	0.0041 J	0.0038 J	0.0033 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.81	0.063	0.079	0.094	0.11
Selenium	mg/L	0.011	0.001 U	0.001 J	0.005 U	0.005 U
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
<b>Supplemental Parameters</b>						
Alkalinity, Bicarbonate (HCO3)	mg/L				170	
Alkalinity, Carbonate (CO3)	mg/L				5 U	
Alkalinity, Hydroxide (OH)	mg/L				5 U	
Alkalinity, Total	mg/L	99.6	224	170	170	160
Ferric Iron	mg/L			2.8 J	2.7 J	0.19
Ferrous Iron	mg/L			0.1 U	0.1 R	0.088 J
Iron	mg/L	0.61	14.2			
Magnesium	mg/L	48.9	18.4	53	51	45
Manganese	mg/L	0.12	0.7			
Nitrate	mg/L			0.031 J		
Nitrate as N	mg/L	0.75 J+	0.1 U		0.05 U	
Nitrite as N	mg/L				0.05 U	
Nitrogen, Nitrate-Nitrite	mg/L					0.038 J
Phosphorus (as phosphate)	mg/L			0.031 U	0.028 J	0.12 J
Potassium	mg/L	59.1	17.5	3.9 J	4.1	5 U
Sodium	mg/L	286	1050	100	110	99
<b>Field Parameters</b>						
Dissolved Oxygen	mg/L	0.61	0.00	1.33	0.7	0.80
Oxidation-Reduction Potential	mV	66.9	-197.4	-130.8	-118.2	-261
Eh	mV	266.9	2.6	69.2	81.8	-61
pH	SU	7.33	7.62	7.51	7.43	9.37
Specific Conductance	uS/cm	3025	4772	1518	1371	1672
Temperature	deg C	9.4	11.7	15.91	16.1	15.1
Turbidity	NTU	28.9	2.74	3.73	4.29	3.4

Notes:

CCR= coal combustion residual  
 mg/L = milligrams per liter  
 mV= millivolts  
 uS/cm = micro Siemens per centimeter  
 deg C = degrees Celsius  
 NTU = Nephelometric Turbidity Units  
 SU = Standard Units

Prepared by: DFSC  
 Checked by: KMC  
 Reviewed by: MAH

"U" = Indicates the result was not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.

"J" = Indicates the result is estimated.

"J+" = Indicates the result is estimated and may be biased high.

"R" = Indicates the result was rejected during data validation.

**APPENDIX B**

# Groundwater Flow Model Technical Memorandum

## TECHNICAL MEMORANDUM

**DATE** November 12, 2020

**TO** Danielle Sylvia Cofelice, PE and PJ Nolan, Ph.D.

**CC** Mark Haney, Joe Gormley, and Rens Verburg

**FROM:** Ross Bennett, PE(NH) and Brandon Poiencot, PE

### **GROUNDWATER FLOW MODEL TECHNICAL MEMORANDUM R.M. SCHAHFER GENERATING STATION**

## **1.0 GROUNDWATER MODELING**

This Memorandum presents Golder's summary of groundwater modeling activities associated with the evaluation of hydrogeologic conditions and potential remedial designs at the R.M. Schahfer Generating Station in Wheatfield, Indiana (the Site).

A steady state groundwater flow model was developed and calibrated. This memorandum includes the following to document development of the groundwater flow model and includes:

- 1) Objectives;
- 2) Groundwater Flow Model Development
- 3) Model selection (numerical);
- 4) Model Geometry
- 5) Boundary Conditions
- 6) Input Parameters
- 7) Model Calibration and Verification
- 8) Parameter Sensitivity analysis
- 9) Design Simulations
- 10) Summary

The conceptual model (including geology, hydrology, lithology and analytical data) used to support numerical model development is described Section 2.0 of the CCR Assessment of Corrective Measures Report (Golder, 2019).

## 1.1 Objectives

The primary objective of the modeling was to simulate the groundwater flow conditions in the area surrounding R.M. Schahfer Generating Station to support evaluation of the remedy design including the feasibility of Monitored Natural Attenuation (MNA) as part of the assessment of corrective measures process for the Coal Combustion Residuals (CCR) surface impoundments for the Site.

The general scope of the groundwater modeling is to:

- Simulate the groundwater flow regimes on Site;
- Predict the travel times and flow paths of unattenuated particles originating at areas impacted by metals contamination;
- Inform remedy design (e.g., groundwater pump and treat design);
- Inform the groundwater monitored natural attenuation study.

## 2.0 GROUNDWATER FLOW MODEL DEVELOPMENT

### 2.1 Numerical Implementation

Golder developed the groundwater flow model for the site using the USGS MODFLOW-2005 Modular Three-Dimensional Finite-Difference Groundwater Flow Model (Harbaugh, 2005). The pre- and post-processing software used for the modeling was Groundwater Vistas (Vistas) Version 7.24 (Environmental Simulations Inc.).

Development of a numerical groundwater flow model involved the following steps:

- Definition of the model geometry including lateral and vertical extent, number and thickness of model layers, and grid spacing
- Definition and placement of model boundary conditions
- Selection of input parameters such as hydraulic conductivity (horizontal and vertical) and precipitation recharge

The following sections describe the steps used to develop the model.

### 2.2 Model Geometry

The finite-difference model grid location is shown on Attachment A. The model area (excluding no-flow cells) is approximately 10,800 feet (along x-axis) by 12,300 feet (along y-axis) at the widest points. The southwest corner of the model grid (model coordinates 0, 0) corresponds with Site coordinates 2165530.5N and 2962863.0 W (Indiana State Plane West). The model grid is oriented parallel with cardinal directions. The model grid contains 504 rows and 432 columns. The grid cell size in the XY direction is uniform, at 25 feet by 25 feet across the entire model domain. Based on geologic and hydrogeologic conditions discussed in Section 2.0 of the CCR Assessment of Corrective Measures Report (Golder, 2019), the model utilizes three layers, with the lowermost layer representing the medium to coarse sand and the upper two layers representing the fine sands. Layers 1 and 2 have the same hydraulic properties, but they were divided to focus boundary condition cells in the upper portion of the aquifer using Layer 1. The base of Layer 3 is the top of the shale bedrock surface and ranges from 597 to 624

feet mean sea level (MSL). The surface topography is based on publicly available lidar data and ranges from 646 to 723 feet MSL. A cross section of model geometry along model column 200 is shown on Attachment B.

## 2.3 Model Boundary Conditions

Boundary conditions in groundwater models consist of physical and hydraulic boundaries within the model area. Physical boundary conditions are well-defined geologic and hydrologic features that influence groundwater flow patterns. The following sections describe the boundary conditions used in the model.

### 2.3.1 Constant Head Boundaries

Constant head boundaries (CHB) were assigned along an unnamed stream in Layer 1 in the southwestern corner of the model to recreate the approximate constant hydraulic heads where long-term average stream water levels are expected to remain relatively constant. Constant heads were also used within the basins that are surrounded slurry walls to simulate the average surface water elevations in the basins. The modeled CHBs are shown on Attachment C and summarized on Table B-1.

### 2.3.2 River Boundary Conditions

River boundary conditions are a head-dependent boundary condition, where the model computes the difference in head between the boundary and the model cell where the boundary is defined. River Boundary condition cells were used for the Kankakee River, as shown in Attachment A. River heads were defined by two USGS gauging stations that fell within the model grid, downstream at USGS station 05517530 in Kouts and upstream at USGS 05517500 at Dunns Bridge. The river width was estimated from satellite imagery, the river bottom elevation was assumed to be three feet lower than the stage, and the bed thickness was assumed to be 10 feet. The hydraulic conductivity of the river was set through calibration at 64.5 feet/day which is slightly lower than aquifer hydraulic conductivities discussed in Section 1.1.2.4.1.

### 2.3.3 Stream Boundary Conditions

Stream boundary conditions are a simplified version of river boundary conditions where surface water flow is monitored by MODFLOW and water is added or removed from the model based on the stream stage. Stream boundary conditions were used in the Model for Davis Ditch and Stalbaum Ditch, as shown in Attachment C. The stream width was estimated from satellite imagery, the stream bottom elevation was assumed to be 0.5 to 2 feet lower than the stage depending on size of the stream, and the bed thickness was assumed to be 5 feet. The hydraulic conductivity of the river was set at 100 feet/day for Davis Ditch where losing stream conditions were expected, and at 0.5 feet per day in Stalbaum ditch where perched conditions were assumed to exist. Stream stage was set off two gauging stations in Stalbaum, SW-04 and SW-10. Elsewhere stream stage was estimated from surface elevations and then refined through model calibration.

### 2.3.4 Drain Boundary Conditions

Drain boundary conditions are a version of river/stream boundary conditions that can only remove water from the model. Drain boundary conditions were used in the Model for intermittent streams and drainage ditches, as shown in Attachment C. The drain width was estimated from satellite imagery, the drain bottom elevation was assumed to be 1 to 2 feet lower than the stage depending on size of the drain, and the bed thickness was assumed to be 1 foot. The hydraulic conductivity of the drains was set at 100 feet/day. Drain stage was estimated from surface elevations and then refined through model calibration.



### 2.3.5 No Flow Boundaries

No flow boundaries were assigned to the northeast side of the Kankakee River, as shown in Attachment C.

### 2.3.6 Horizontal Flow Barriers

A hydraulic flow barrier (HFB) or wall is a condition that limits flow between adjacent cells based on an assigned thickness and hydrologic conductivity. To model the slurry walls that are present around ponds, Golder used the HFB boundary condition with an assigned thickness of 1 foot and a horizontal hydraulic conductivity (K) value of 0.0000001 to model slurry walls that surround the basins. The location of HFB boundaries are presented in Attachment C

## 2.4 Model Input Parameters

The following paragraphs describe the input parameter data used for the model. Golder simulated steady state conditions in the model. Transient dependent parameters such as porosity and storage/storativity were not included in the model calibration process.

### 2.4.1 Hydraulic Conductivity

Golder based hydraulic conductivity values for the Site model on pumping test analysis results as discussed in Section 6.0 of the AT-01 Aquifer Test Report (Golder, 2020) and summarized in Table B-2. Golder used these results to assign initial hydraulic conductivity values to the groundwater flow model, and to check that the hydraulic conductivity values resulting from model calibration were within the range of values observed. Golder assigned a uniform  $K_x/K_y$  hydraulic conductivity value of 215 feet/day and a  $K_z$  of 21.5 feet/day across the entire model area for Layers 1 and 2. Layer 3 had a slightly lower hydraulic conductivity of 200 feet/day and a  $K_z$  of 20.0 feet/day across the entire model area. These hydraulic conductivities are based on a best fit from model calibration, and are within range of measured conductivities.

### 2.4.2 Precipitation Recharge

Precipitation recharge is the amount of precipitation that recharges the aquifer, which is generally the precipitation rate minus losses due to runoff and evapotranspiration. Recharge rates calculated for the area were presented in Letsinger (2015) and used in the model. After model calibration a best fit recharge value of 7.1 inches per year (0.00162 feet/day) was established, which was similar to the published rates. A recharge rate of 0.04 inches/year (0.00001 ft/day) was used for the capped landfill areas. Precipitation recharge rates are shown in Attachment D.

### 2.4.3 Groundwater Extraction and Recharge Wells

Groundwater extraction or recharge wells are present on and adjacent to the Site and were modeled in all versions of the model, as shown in Attachment D. The well field located on the northeast corner of the model contains eight wells that remove a total of 55,343 cubic feet/day. In the central portion of the Site the 5 cooling tower wells and two Miox wells remove a total of 7,701 cubic feet/day, and just west of the Site on well on the adjacent property removes 9,625 cubic feet/day.

## 3.0 MODEL CALIBRATION AND VERIFICATION

Model calibration consists of successive refinement of the model property assignments and input data from initial assumptions/estimates to improve the fit between observed and model-predicted results. A solution of a groundwater flow model problem requires information including aquifer parameters such as hydraulic conductivity, spatial boundary conditions, and the location and magnitude of applied stresses, such as recharge and drainage.

A solution is attained only when the proper combination of the above parameters and inputs are selected such that the physical problem is accurately represented by the model. The calibrated model described below should be considered a limited hydrologic effort founded on the available information within the context of necessary simplifying assumptions.

The purpose of the calibration effort was to simulate "steady-state" groundwater flow conditions that approximate the general flow patterns inferred from September 2019 groundwater level measurements. The model was calibrated through trial-and-error adjustment of model parameter values and through use of Model-Independent PEST, developed by Watermark Computing, to refine aquifer parameters. PEST allows model input parameters to be adjusted automatically over a given range until the model predicted head matches the observed head with the lowest possible numerical difference, referred to as the calibration residual (Doherty, 2016). Golder set the allowable range of parameter adjustment in PEST to represent realistic values as determined by previously published literature for the region and aquifer tests at the Site.

At each well location, the head residuals were calculated in Groundwater Vistas as the difference between the measured and simulated head values. Positive residual values indicate simulated head values were lower than measured elevations, while negative residual values indicate simulated head values were higher than measured elevations.

As a measure of the accuracy of the model, Groundwater Vistas calculates summary statistics using calculated residuals, which are used as measures of error in the calibrated model. The residual mean (RM) is the arithmetic mean of all calculated residual values. The absolute residual mean (ARM) is the arithmetic mean of the absolute value of the residuals (i.e., all negative residuals are considered positive). The root mean square error (RMSE) is the square root of the mean of the squared value of target residuals. Other statistics such as the residual standard deviation (RSD) (i.e., the square root of the variance [the average of the squared deviations from the mean]), and the sum of squared residuals (SSR) (computed by squaring each residual and adding them together) can also be useful in evaluation of the calibration process. While calibrating the model, Golder selected parameters estimated by PEST that were within a valid range from published literature or Site-specific data that resulted in improved calibration summary statistics.

### 3.1 Simulated Heads Calibrated to September 2019 Conditions

Measured groundwater elevations for 112 monitoring points from September 2019 were used for calibration, as presented in Table B-3. The model files for September 2019 calibration simulation use the root file name *V12\_2019*. The simulated heads and residuals for targets screened in Layer 1 are presented in Attachment F. Based on the simulated contours of groundwater elevation, groundwater flows from the south/southwest toward the Site before it travels to the Kankakee River in the north/northeast.

A comparison of model-predicted versus observed September 2019 potentiometric heads for the 112 selected calibration points resulted in a RM of -0.36 feet and a RMSE of 0.72 feet. The calibration statistics for the model are presented in Table B-4. The RM of -0.36 feet, represents 4.9 percent of the total measured head difference for the model area (approximately 7.41 feet). The absolute residual mean for the model run is 0.57 feet, which is 7.7 percent of the total hydraulic head difference for the entire modeling area. The residual mean and the absolute residual mean are within the generally accepted standard of 10 percent of the total hydraulic head difference for the modeling area.

### 3.1.1 Water Balance

An effective measure of model calibration is the analysis of the water budget calculated by MODFLOW. The model provides flows across boundaries, flows to and from all sources and sinks, and flows generated by storage. Inflows into the model include:

- Constant head boundaries: 16,716 ft<sup>3</sup>/d,
- Rivers: 165,339 ft<sup>3</sup>/d,
- Streams: 182,984 ft<sup>3</sup>/d and
- Recharge: 545,949 ft<sup>3</sup>/d.

Outflows in the model include

- Constant head boundaries: 5,640 ft<sup>3</sup>/d,
- Wells: 70,469 ft<sup>3</sup>/d,
- Rivers: 474,633 ft<sup>3</sup>/d,
- Streams: 400,512 ft<sup>3</sup>/d, and
- Drains: 45,574 ft<sup>3</sup>/d.

The outflow deficit is 85,842 cubic feet per day (ft<sup>3</sup>/d), which is equivalent to error between outflow and inflow estimates of approximately 8.9 percent.

### 3.1.2 Numerical Model Verification

Model verification was performed using a second water level calibration data set from October 2018. The model input parameter values defined in the September 2019 simulation were maintained. The verification data is presented in Table B-5. The model files for the October 2018 conditions use the root file name *V12.1\_2019*. The verification results indicate a RM of 0.33 feet, which represents 4.1 percent of the total hydraulic head difference for the model area. The absolute residual mean for this simulation was 0.52 feet, which is 6.5 percent of the total hydraulic head difference for the entire model area. The verification statistics suggests that the model is calibrated and verified.

## 4.0 DESIGN SIMULATIONS

Using the calibrated model, Golder used MODPATH (Pollack, 1989) to simulate travel times for particles released from the metals cleaning basin. Particles were started in Layer 3 of the model to simulate the release of contaminants in the deeper part of the aquifer where Boron concentrations exceeded 10 micrograms/liter. Effective porosity of the aquifer was varied between 0.16, 0.3, and 0.46 to represent values within the expected range for medium to fine sand. The length of the particle traces produced by MODPATH along with travel time estimates were used to calculate average groundwater velocities. These travel time calculations are presented in Table B-6.

## 5.0 GROUNDWATER MODELING SUMMARY

Through standard numerical groundwater modeling procedures, Golder developed a steady state groundwater flow model for the Site that is considered calibrated and verified. This model was utilized to inform the groundwater monitored natural attenuation study by simulating travel times for particles released from the metals cleaning basin.

## 6.0 REFERENCES

Doherty, 2016. PEST, Model-Independent Parameter Estimation. User Manual 6<sup>th</sup> Edition.

Golder, 2019, CCR Assessment of Corrective Measures Northern Indiana Public Service Company Rollin M Schahfer Generating Station Wheatfield, Indiana. April 2019.

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Harbaugh, Arlen W, 2005. MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model—the Ground-Water Flow Process. U.S. Geological Survey Techniques and Methods 6-A16

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Pollock, D.W., 1989 Documentation of computer programs to compute and display pathlines using results from the U.S. Geological Survey modular three-dimensional finite-difference groundwater flow model. U.S. Geological Survey, Open File Report 89-381.

### List of Attachments:

- Attachment A Model Grid
- Attachment B Cross Section of Model Grid
- Attachment C Boundary Conditions
- Attachment D Precipitation Recharge Zones
- Attachment E Active Pumping Wells
- Attachment F Model Calibration – September 2019

### List of Tables

- Table B-1 Boundary Conditions
- Table B-2 Site Pumping Test Results
- Table B-3 Measured Groundwater Elevations - September 2019
- Table B-4 Calibration Residuals and Summary Statistics - September 2019
- Table B-5 Verification Residuals and Summary Statistics – October 2018
- Table B-6 Travel Time Simulations

[https://golderassociates.sharepoint.com/sites/nipsccocgrwmonitoring/shared documents/rmsgsgs/evs and gw models/2020 model memo/rmsgsgs gw modeling .docx](https://golderassociates.sharepoint.com/sites/nipsccocgrwmonitoring/shared%20documents/rmsgsgs/evs%20and%20gw%20models/2020%20model%20memo/rmsgsgs%20gw%20modeling%20.docx)

**Table B-1: Boundary Conditions**  
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Constant Head Boundaries											
Name	Layer	Reach	Starting Head (ft)	Ending Head (ft)							
Intake Settling Basin	1	104	675.0	675.0							
Final Settling Basin	1	101	675.0	675.0							
Drying Area	1	100	672.0	672.0							
Unnamed SW. Stream	1	1	663.17	661.20							
Rivers											
Name	Layer	Starting Stage (ft)	Starting Bed Elevation (ft)	Ending Stage (ft)	Ending Bed Elevation (ft)	Starting Width (ft)	Ending Width (ft)	Length (ft)	Thickness of Bed (ft)	Hydraulic Conductivity (ft/d)	
Kakakane River	1	651.82	649.10	646.72	644.01	135.28	159.88	24.0	10.0	64.41	
Streams											
Name	Layer	Starting Stage (ft)	Starting Bed Elevation (ft)	Ending Stage (ft)	Ending Bed Elevation (ft)	Starting Width (ft)	Ending Width (ft)	Length (ft)	Thickness of Bed (ft)	Hydraulic Conductivity (ft/d)	Slope of Channel (ft/ft)
Davis Ditch	1	661.99	659.99	650.29	646.31	20.05	74.80	50	10.0	63.41	0.001
Stalbaum Ditch	1	660.74	659.74	654.5	652.0	10.07	50	28	1.0	50	0.001
Fisher Ditch	1	661.49	659.49	660.88	658.88	30.04	32.08	51	5.0	100	0.001
Stalbaum South Ancillary Ditch	1	661.50	660.0	659.21	657.76	2.06	29.93	31	1.0	10	0.001
Stalbaum East Ancillary Ditch	1	661.0	655.36	657.17	655.21	18.80	30.36	13	5.0	0.1	0.001
Coal Yard Ditch	1	660.7	659.00	660.7	659	5.0	5.0	50	1.0	50	0.001
Drains											
Name	Layer	Starting Stage (ft)	Ending Stage (ft)	Starting Width (ft)	Ending Width (ft)	Length (ft)	Thickness of Bed (ft)	Hydraulic Conductivity (ft/d)			
Sands Ditch	1	662.0	654.1	1.0	5	38	1	50			
W. Sands Drain	1	660.0	655.6	2	2	27	1	50			
Hilliard St Ditch	1	659	659	2	2	24	1	10			
N. LF Drain	1	661	661	8.8	8.8	50.0	1.0	62.0			
S. LF Drain	1	661	661	8.8	8.8	50.0	1.0	62.0			
W. LF Drain	1	661	661	5	5	50	2	100			
Hydraulic Flow Barriers (Slurry Walls)											
Name	First Layer	Last Layer	Thickness (ft)	Hydraulic Conductivity (ft/d)							
Intake Settling Basin Slurry Wall	1	3	1	1.00E-07							
Final Settling Basin Slurry Wall	1	3	1	1.00E-07							
Drying Area Slurry Wall	1	3	1	1.00E-06							



**Table B-2: Site Pumping Test Results**  
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Pumping Test Results		Estimated Hydraulic Conductivity (ft/d)
SHALLOW WELLS	<i>Minimum:</i>	192
	<i>Maximum:</i>	363
	<i>Arithmetic Mean:</i>	266
DEEP WELLS	<i>Minimum:</i>	234
	<i>Maximum:</i>	320
	<i>Arithmetic Mean:</i>	268

**Table B-3: Measured Groundwater Elevations - September 2019**  
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**NIPSCO LLC R. M. Schahfer Generating Station**

Well ID	Layer	Groundwater Elevation (ft msl)
GAMW01	1	658.89
GAMW01B	3	658.72
GAMW03	1	659.84
GAMW03B	3	659.26
GAMW07	1	660.74
GAMW07B	3	660.79
GAMW08	1	658.87
GAMW08B	3	658.98
GAMW09	1	659.27
GAMW09B	3	658.87
GAMW12	1	658.64
GAMW12B	3	658.66
GAMW13	1	658.35
GAMW13B	3	658.37
GAMW14	1	658.14
GAMW14B	3	658.12
GAMW15	1	660.35
GAMW15B	3	660.33
GAMW16	1	659.31
GAMW16B	3	659.46
GAMW17B	3	658.92
GAMW18	1	658.92
GAMW18B	3	659.17
GAMW20	1	658.21
GAMW24	1	658.66
GAMW24B	2	658.73
GAMW25	1	658.41
GAMW25B	2	658.41
GAMW26	1	658.33
GAMW26B	3	658.26
GAMW27	1	658.29
GAMW27B	3	658.32
GAMW29	1	657.48
GAMW29B	3	657.48
GAMW30	1	657.42
GAMW30B	3	657.51
GAMW31	1	657.24
GAMW31B	2	657.25
GAMW32	1	657.19
GAMW32B	3	657.15
GAMW33	1	657.04
GAMW33B	3	657.13
GAMW34	1	657.58

**Table B-3: Measured Groundwater Elevations - September 2019**  
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Well ID	Layer	Groundwater Elevation (ft msl)
GAMW34B	3	657.59
GAMW35B	2	658.16
GAMW36	1	656.67
GAMW36B	3	656.69
GAMW37B	2	657.26
GAMW38	1	657.91
GAMW38B	3	657.91
GAMW39	2	657.88
GAMW39B	3	657.84
GAMW40	1	657.66
GAMW40B	3	657.65
GAMW42	1	658.12
GAMW42B	3	658.13
GAMW43	1	657.83
GAMW43B	3	657.83
GAMW44	1	657.71
GAMW44B	3	657.69
GAMW45B	3	654.52
GAMW46	1	655.22
GAMW46B	3	655.21
GAMW48	1	654.5
GAMW48B	3	654.51
GAMW49	1	656.26
GAMW49B	3	656.34
GAMW50	1	656.37
GAMW50B	3	656.35
GAMW51	1	658.07
GAMW51B	3	658.19
GAMW52	1	657.81
GAMW52B	3	657.82
GAMW53	1	658.04
GAMW53B	3	658.21
GAMW54	1	657.87
GAMW54B	3	657.82
GAMW55B	3	657.78
GAMW56	1	657.81
GAMW56B	3	657.77
GAMW02	1	660.14
GAMW05	1	658.17
GAMW06	1	659.65
GAMW10	1	657.63
GAMW11	1	657.37
GAMW20B	3	658.25

**Table B-3: Measured Groundwater Elevations - September 2019**  
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Well ID	Layer	Groundwater Elevation (ft msl)
MW-1D	3	659.11
MW-1S	2	659.09
MW-2S	2	657.7
MW-3D	3	656.68
MW-4S	2	657.08
MW-5D	3	658.17
MW-5S	2	658.14
MW-6D	3	654.1
MW-6S	2	654.07
MW-7D	3	656.12
MW-7S	2	656.1
MW-8S	3	654.65
MW-9D	3	655.18
MW-9S	3	655.14
MW-10D	3	658.66
MW-10S	1	658.61
MW-11D	3	656.75
MW-11S	2	656.73
MW-12D	3	656.97
MW-12S	2	656.95
MW-13D	3	657.2
MW-13S	2	657.17
MW-14D	2	656.51
MW-14S	2	656.54
SW-4	1	661.48
SW-10	1	660

**Table B-4: Calibration Residuals and Summary Statistics - September 2019**  
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Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
<b>Layer 1</b>			
GAMW01	658.89	658.87	0.02
GAMW03	659.84	660.22	-0.38
GAMW07	660.74	662.14	-1.40
GAMW08	658.87	658.87	0.00
GAMW09	659.27	659.05	0.22
GAMW12	658.64	658.58	0.06
GAMW13	658.35	658.50	-0.15
GAMW14	658.14	658.57	-0.43
GAMW15	660.35	662.08	-1.73
GAMW16	659.31	659.11	0.20
GAMW18	658.92	659.30	-0.38
GAMW20	658.21	658.72	-0.51
GAMW24	658.66	659.16	-0.50
GAMW25	658.41	658.67	-0.26
GAMW26	658.33	658.34	-0.01
GAMW27	658.29	658.09	0.20
GAMW29	657.48	658.19	-0.71
GAMW30	657.42	658.20	-0.78
GAMW31	657.24	658.12	-0.88
GAMW32	657.19	657.99	-0.80
GAMW33	657.04	657.92	-0.88
GAMW34	657.58	658.44	-0.86
GAMW36	656.67	657.59	-0.92
GAMW38	657.91	658.24	-0.33
GAMW40	657.66	658.27	-0.61
GAMW42	658.12	658.62	-0.50
GAMW43	657.83	658.54	-0.71
GAMW44	657.71	658.56	-0.85
GAMW46	655.22	654.39	0.83
GAMW48	654.5	654.25	0.25
GAMW49	656.26	656.37	-0.11
GAMW50	656.37	656.86	-0.49
GAMW51	658.07	658.84	-0.77
GAMW52	657.81	657.89	-0.08
GAMW53	658.04	658.21	-0.17
GAMW54	657.87	658.36	-0.49
GAMW56	657.81	658.51	-0.70
GAMW02	660.14	659.81	0.33
GAMW05	658.17	658.77	-0.60
GAMW06	659.65	660.42	-0.77



**Table B-4: Calibration Residuals and Summary Statistics - September 2019**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
GAMW10	657.63	658.34	-0.71
GAMW11	657.37	658.19	-0.82
MW-10S	658.61	659.16	-0.55
SW-4	661.48	657.77	3.71
SW-10	660	659.21	0.79
<b>Layer 2</b>			
GAMW24B	658.73	659.16	-0.43
GAMW25B	658.41	658.67	-0.26
GAMW31B	657.25	658.12	-0.87
GAMW35B	658.16	659.00	-0.84
GAMW37B	657.26	658.24	-0.98
GAMW39	657.88	658.29	-0.41
MW-1S	659.09	659.72	-0.63
MW-2S	657.7	658.54	-0.84
MW-4S	657.08	657.79	-0.71
MW-5S	658.14	658.13	0.01
MW-6S	654.07	654.60	-0.53
MW-7S	656.1	656.26	-0.16
MW-11S	656.73	657.28	-0.55
MW-12S	656.95	657.48	-0.53
MW-13S	657.17	657.95	-0.78
MW-14S	656.54	657.27	-0.73
<b>Layer 3</b>			
GAMW01B	658.72	658.87	-0.15
GAMW03B	659.26	660.22	-0.96
GAMW07B	660.79	660.99	-0.20
GAMW08B	658.98	658.87	0.11
GAMW09B	658.87	659.05	-0.18
GAMW12B	658.66	658.58	0.08
GAMW13B	658.37	658.50	-0.13
GAMW14B	658.12	658.57	-0.45
GAMW15B	660.33	662.22	-1.89
GAMW16B	659.46	659.11	0.35
GAMW17B	658.92	659.55	-0.63
GAMW18B	659.17	659.30	-0.13
GAMW26B	658.26	658.34	-0.08
GAMW27B	658.32	658.13	0.19
GAMW29B	657.48	658.19	-0.71
GAMW30B	657.51	658.20	-0.69
GAMW32B	657.15	657.98	-0.83
GAMW33B	657.13	657.92	-0.79

**Table B-4: Calibration Residuals and Summary Statistics - September 2019**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
GAMW34B	657.59	658.44	-0.85
GAMW36B	656.69	657.59	-0.90
GAMW38B	657.91	658.24	-0.33
GAMW39B	657.84	658.29	-0.45
GAMW40B	657.65	658.27	-0.62
GAMW42B	658.13	658.62	-0.49
GAMW43B	657.83	658.54	-0.71
GAMW44B	657.69	658.56	-0.87
GAMW45B	654.52	653.66	0.86
GAMW46B	655.21	654.39	0.82
GAMW48B	654.51	654.24	0.27
GAMW49B	656.34	656.36	-0.02
GAMW50B	656.35	656.86	-0.51
GAMW51B	658.19	658.84	-0.65
GAMW52B	657.82	657.88	-0.06
GAMW53B	658.21	658.21	0.00
GAMW54B	657.82	658.36	-0.54
GAMW55B	657.78	658.47	-0.69
GAMW56B	657.77	658.51	-0.74
GAMW20B	658.25	658.72	-0.47
MW-1D	659.11	659.72	-0.61
MW-3D	656.68	657.50	-0.82
MW-5D	658.17	658.13	0.04
MW-6D	654.1	654.61	-0.51
MW-7D	656.12	656.26	-0.14
MW-8S	654.65	654.32	0.33
MW-9D	655.18	654.27	0.91
MW-9S	655.14	654.28	0.86
MW-10D	658.66	659.16	-0.50
MW-11D	656.75	657.27	-0.52
MW-12D	656.97	657.48	-0.51
MW-13D	657.2	657.95	-0.75
MW-14D	656.51	657.27	-0.76
Calibration Parameter			Value
Residual Mean (ft)			-0.36
Residual Standard Deviation (ft)			0.63
Absolute Residual Mean (ft)			0.57
Residual Sum of Squares			59
RMS Error			0.72
Minimum Residual (ft)			-1.89
Maximum Residual (ft)			3.71

**Table B-4: Calibration Residuals and Summary Statistics - September 2019**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
Range of Observations (ft)			7.41
Scaled Residual Standard Deviation			0.085
Scaled Absolute Mean			0.076
Scaled RMS (%)			9.8
Number of Observations			112

**Table B-5: Verification Residuals and Summary Statistics – October 2018**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
<b>Layer 1</b>			
GAMW01	659.19	658.87	0.32
GAMW03	660.82	660.22	0.60
GAMW07	659.27	660.62	-1.35
GAMW08	659.06	658.87	0.19
GAMW09	660.34	659.05	1.29
GAMW12	658.84	658.58	0.26
GAMW13	658.72	658.50	0.22
GAMW14	659.55	658.57	0.98
GAMW15	659.10	660.00	-0.90
GAMW16	659.07	659.11	-0.04
GAMW18	659.57	659.30	0.27
GAMW20	659.81	658.72	1.09
GAMW24	659.90	659.16	0.74
GAMW25	659.67	658.67	1.00
GAMW26	659.73	658.34	1.39
GAMW27	659.67	658.09	1.58
GAMW29	658.28	658.19	0.09
GAMW30	658.62	658.20	0.42
GAMW31	658.13	658.12	0.01
GAMW32	657.99	657.99	0.00
GAMW33	657.84	657.92	-0.08
GAMW34	658.47	658.44	0.03
GAMW36	657.71	657.59	0.12
GAMW38	659.19	658.24	0.95
GAMW40	658.76	658.27	0.49
GAMW42	658.40	658.62	-0.22
GAMW43	658.16	658.54	-0.38
GAMW44	657.95	658.56	-0.61
GAMW46	655.25	654.39	0.86
GAMW48	654.68	654.25	0.43
GAMW49	656.86	656.37	0.49
GAMW50	657.22	656.86	0.36
GAMW51	658.42	658.84	-0.42
GAMW52	657.99	657.89	0.10
GAMW53	658.14	658.21	-0.07
GAMW54	658.47	658.36	0.11
GAMW56	658.86	658.51	0.35
GAMW02	660.52	659.81	0.71
GAMW05	658.53	658.77	-0.24
GAMW06	658.63	660.42	-1.79

**Table B-5: Verification Residuals and Summary Statistics – October 2018**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
GAMW10	658.61	658.34	0.27
GAMW11	657.97	658.19	-0.22
MW-10S	659.83	659.16	0.67
SW-4	662.48	657.77	4.71
SW-10	660.45	659.21	1.24
<b>Layer 2</b>			
GAMW24B	659.95	659.16	0.79
GAMW25B	659.69	658.67	1.02
GAMW31B	658.14	658.12	0.02
GAMW35B	659.16	659.00	0.16
GAMW37B	658.42	658.24	0.18
GAMW39	659.08	658.29	0.79
MW-1S	659.76	659.72	0.04
MW-2S	658.58	658.54	0.04
MW-4S	657.62	657.79	-0.17
MW-5S	659.47	658.13	1.34
MW-6S	654.83	654.60	0.23
MW-7S	656.72	656.26	0.46
MW-11S	657.55	657.28	0.27
MW-12S	657.68	657.48	0.20
MW-13S	657.97	657.95	0.02
MW-14S	657.49	657.27	0.22
<b>Layer 3</b>			
GAMW01B	659.23	658.87	0.36
GAMW03B	660.31	660.22	0.09
GAMW07B	659.29	660.56	-1.27
GAMW08B	659.12	658.87	0.25
GAMW09B	659.94	659.05	0.89
GAMW12B	657.90	658.58	-0.68
GAMW13B	658.70	658.50	0.20
GAMW14B	658.50	658.57	-0.07
GAMW15B	659.13	660.03	-0.90
GAMW16B	659.14	659.11	0.03
GAMW17B	659.18	658.84	0.34
GAMW18B	660.15	659.30	0.85
GAMW26B	659.66	658.34	1.32
GAMW27B	659.70	658.13	1.57
GAMW29B	658.43	658.19	0.24
GAMW30B	658.71	658.20	0.51
GAMW32B	657.95	657.98	-0.03
GAMW33B	657.89	657.92	-0.03



**Table B-5: Verification Residuals and Summary Statistics – October 2018**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
GAMW34B	658.46	658.44	0.02
GAMW36B	657.72	657.59	0.13
GAMW38B	659.21	658.24	0.97
GAMW39B	659.04	658.29	0.75
GAMW40B	658.68	658.27	0.41
GAMW42B	658.41	658.62	-0.21
GAMW43B	658.10	658.54	-0.44
GAMW44B	657.91	658.56	-0.65
GAMW45B	654.52	653.66	0.86
GAMW46B	655.24	654.39	0.85
GAMW48B	654.67	654.24	0.43
GAMW49B	656.94	656.36	0.58
GAMW50B	657.25	656.86	0.39
GAMW51B	658.58	658.84	-0.26
GAMW52B	658.00	657.88	0.12
GAMW53B	658.24	658.21	0.03
GAMW54B	658.42	658.36	0.06
GAMW55B	658.68	658.47	0.21
GAMW56B	658.87	658.51	0.36
GAMW20B	659.85	658.72	1.13
MW-1D	659.76	659.72	0.04
MW-3D	657.50	657.50	0.00
MW-5D	659.47	658.13	1.34
MW-6D	654.86	654.61	0.25
MW-7D	656.70	656.26	0.44
MW-8S	654.80	654.32	0.48
MW-9D	655.15	654.27	0.88
MW-9S	655.14	654.28	0.86
MW-10D	659.83	659.16	0.67
MW-11D	657.52	657.27	0.25
MW-12D	657.64	657.48	0.16
MW-13D	657.96	657.95	0.01
MW-14D	657.46	657.27	0.19
<b>Calibration Parameter</b>			<b>Value</b>
Residual Mean (ft)			0.33
Redsidual Standard Deviation (ft)			0.71
Absolute Residual Mean (ft)			0.52
Residual Sum of Squares			69
RMS Error			0.78
Minimum Residual (ft)			-1.79
Maximum Residual (ft)			4.71

**Table B-5: Verification Residuals and Summary Statistics – October 2018**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

Name	Observed Groundwater Elevation (ft msl)	Computed Groundwater Elevation (ft msl)	Residual (ft)
Range of Observations (ft)			7.96
Scaled Residual Standard Deviation			0.09
Scaled Absolute Mean			0.066
Scaled RMS (%)			9.9
Number of Observations			112

**Table B-6: Travel Time Simulations**  
**Groundwater Flow Model Technical Memorandum**  
**NIPSCO LLC R. M. Schahfer Generating Station**

	Shallow Flow Paths				Deep Flow Paths			
Starting Well	GAMW-16	GAMW-18	GAMW-17B	GAMW-09B	GAMW-16B	GAMW-18B	GAMW-17B	GAMW-09B
Ending Well	GAMW-53	GAMW-55	GAMW-54B	GAMW-54B	GAMW-53B	GAMW-55B	GAMW-54B	GAMW-54B
Distance (ft)	1521	1964	1200	1714	1521	1964	1200	1714
<b>Effective Porosity = 16%</b>								
Travel Time (years)	4.8	11.0	4.5	8.9	5.0	11.0	5.5	9.0
Velocity (ft/year)	317	179	267	193	304	179	218	190
Time to Davis Ditch (years)	5.5	-	-	-	6	-	-	-
Time to property boundry near GAMW46B (years)	-	27	49	41	-	28.5	45	41
<b>Effective Porosity = 30%</b>								
Travel Time (years)	8.5	19.8	8.0	16.0	8.9	20.0	10.0	16.5
Velocity (ft/year)	179	99	150	107	171	98	120	104
Time to Davis Ditch (years)	10	-	-	-	9.9	-	-	-
Time to property boundry near GAMW46B (years)	-	49.8	79	75	-	51.5	80	76
<b>Effective Porosity = 46%</b>								
Travel Time (years)	13.0	31.0	12.0	25.0	13.5	29.0	15.0	25.0
Velocity (ft/year)	117	63	100	69	113	68	80	69
Time to Davis Ditch (years)	15	-	-	-	15	-	-	-
Time to property boundry near GAMW46B (years)	-	76.8	122	117	-	77	130	120

**Notes:**

ft = feet





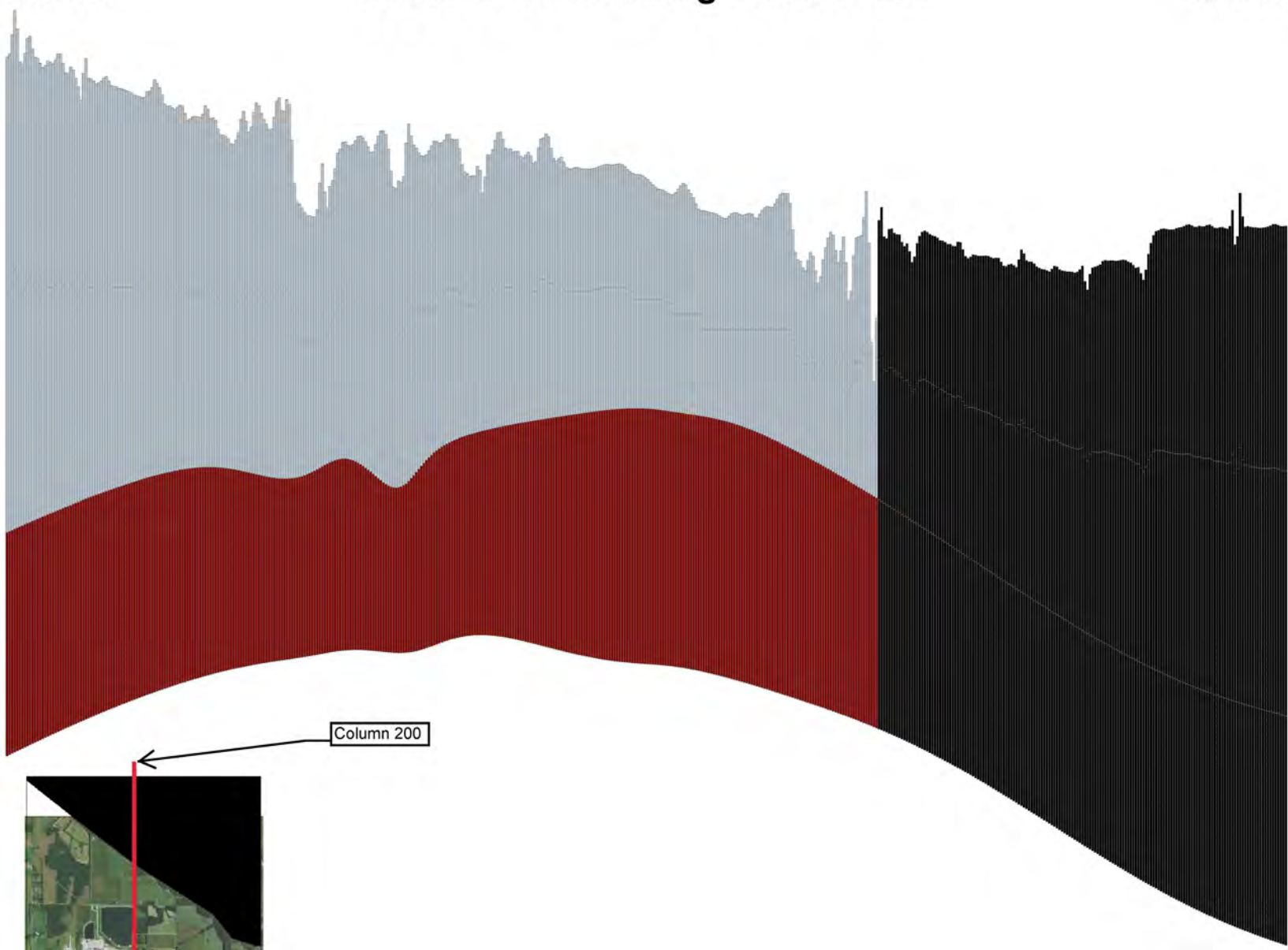




South

### Cross-Section Along Column 200

North



Column 200



PLAN VIEW

LEGEND

NOTE(S)

1. BASED ON MODEL V12\_2019.

REFERENCE(S)

1. COORDINATE SYSTEM: WGS 1984 WEB MERCATOR AUXILIARY SPHERE

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT

GROUNDWATER FLOW MODEL TECHNICAL MEMORANDUM  
MSRB, MCWB, AND DRYING AREA  
NIPSCO LLC R. M. SCHAFER GENERATING STATION

TITLE

CROSS SECTION OF MODEL GRID

CONSULTANT	YYYY-MM-DD	2020-10-23
DESIGNED		RWB
PREPARED		SHL
REVIEWED		BP
APPROVED		RWB



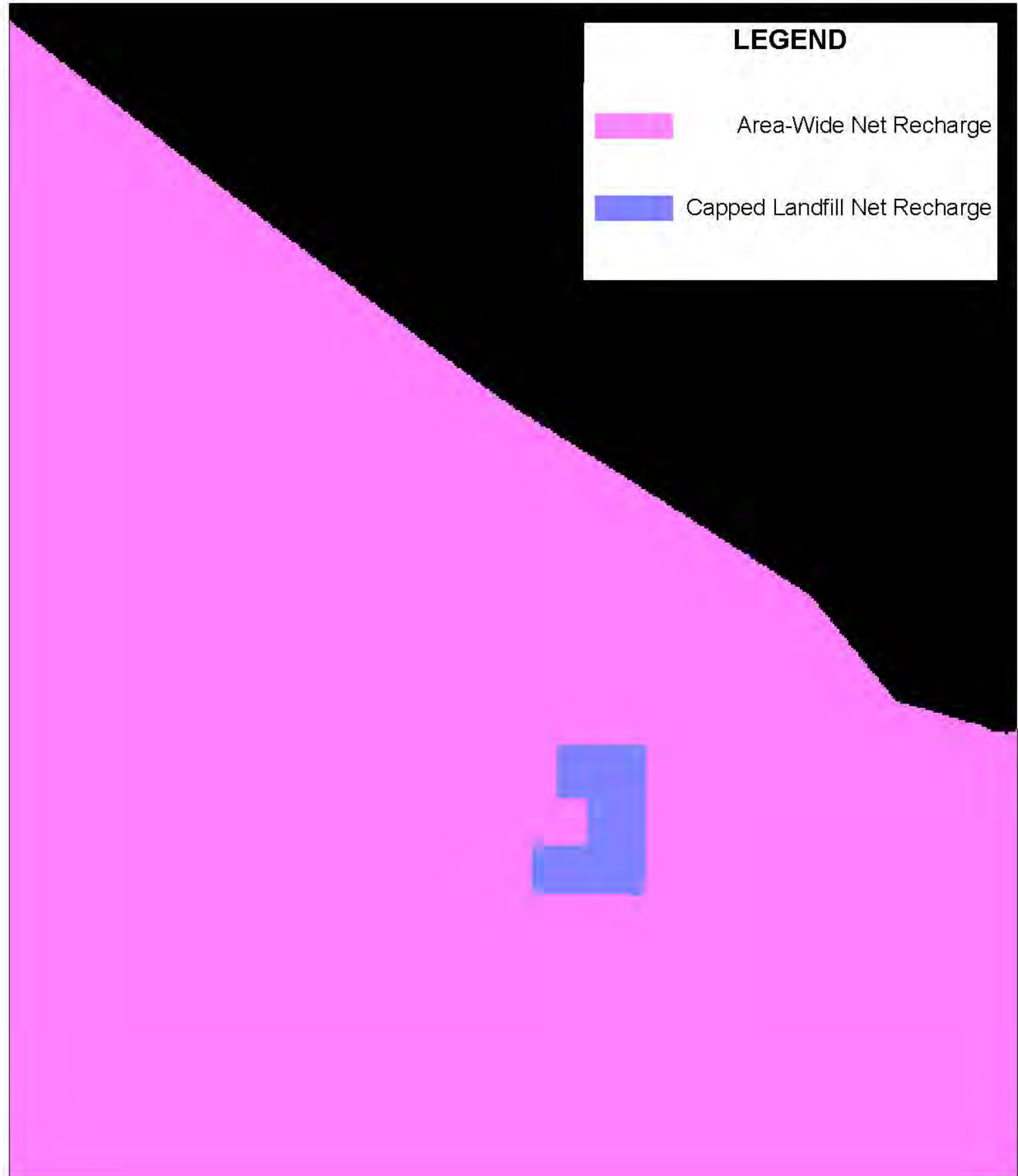
PROJECT NO.	CONTROL	REV.	ATTACHMENT
19121567	-	-	B

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1in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B







**LEGEND**

Area-Wide Net Recharge

Capped Landfill Net Recharge

**LEGEND**

**NOTE(S)**

1. BASED ON MODEL V12\_2019.

**REFERENCE(S)**

1. COORDINATE SYSTEM: WGS 1984 WEB MERCATOR AUXILIARY SPHERE

**CLIENT**

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

**PROJECT**

GROUNDWATER FLOW MODEL TECHNICAL MEMORANDUM  
MSRB, MCWB, AND DRYING AREA  
NIPSCO LLC R. M. SCHAFER GENERATING STATION

**TITLE**

**PRECIPITATION RECHARGE ZONES**

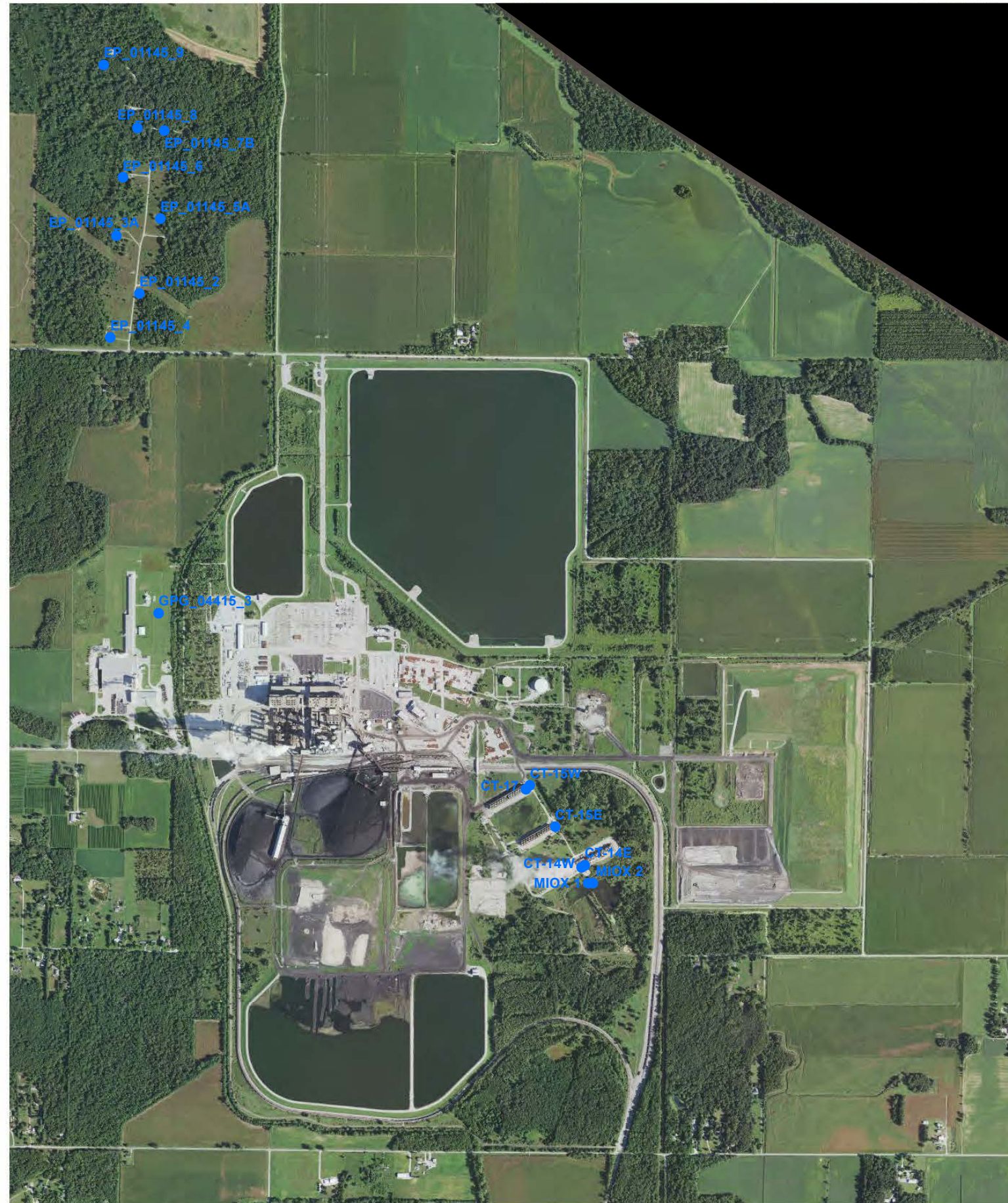
CONSULTANT	YYYY-MM-DD	2020-10-23
	DESIGNED	RWB
	PREPARED	SHL
	REVIEWED	BP
	APPROVED	RWB

PROJECT NO.	CONTROL	REV.	ATTACHMENT
19121567	-	-	D

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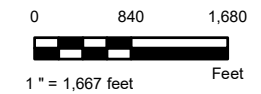
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LEGEND

- Well Location



NOTE(S)

1. BASED ON MODEL V12\_2019.

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 STATEPLANE INDIANA WEST FIPS 1302 FEET
2. 2016 NAIP IMAGERY SOURCED FROM AGOL ONLINE FEATURE SERVICE LAYER.

CLIENT


NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT

GROUNDWATER FLOW MODEL TECHNICAL MEMORANDUM  
MSRB, MCWB, AND DRYING AREA  
NIPSCO LLC R. M. SCHAFER GENERATING STATION

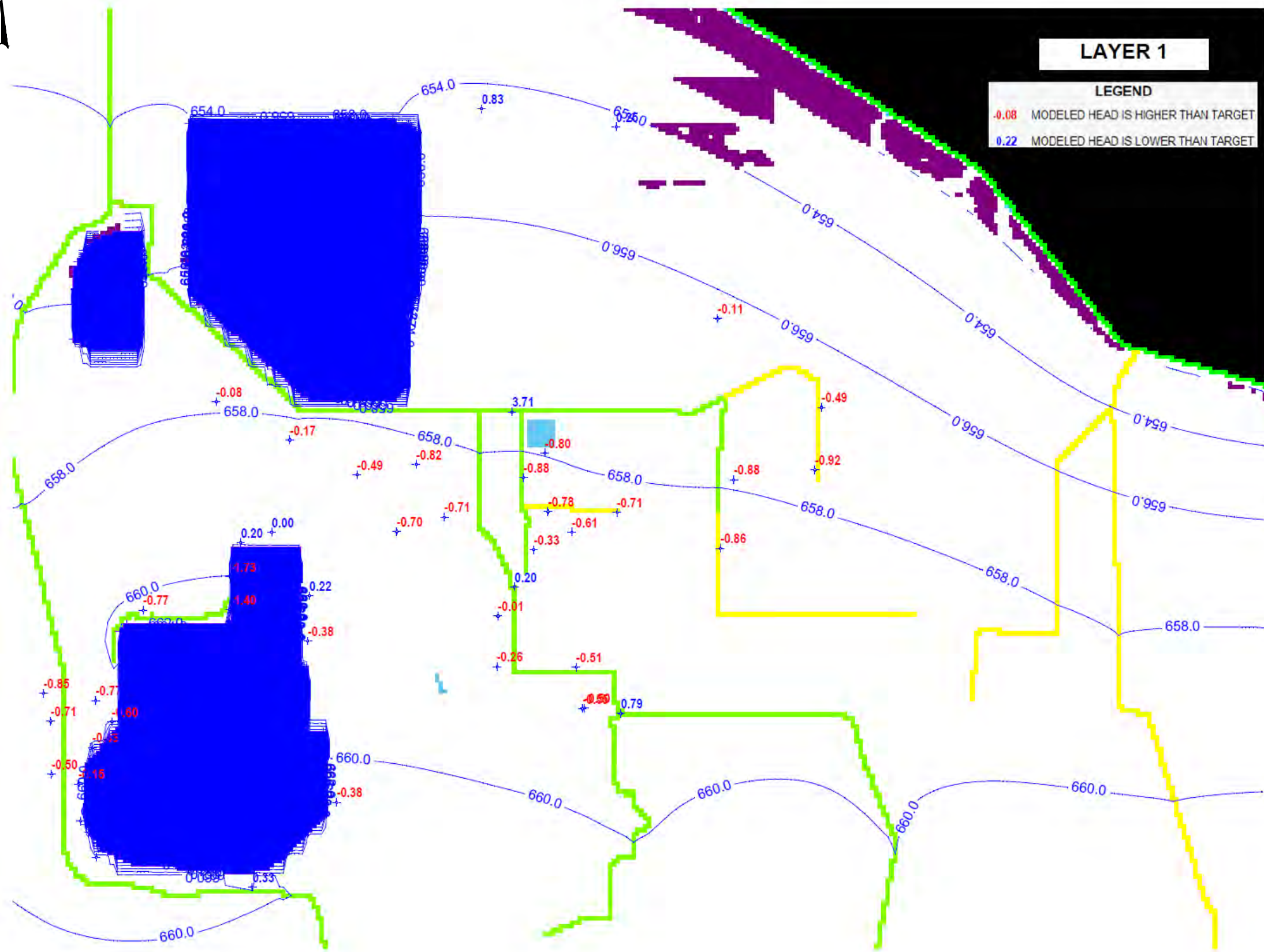
TITLE

ACTIVE PUMPING WELLS

CONSULTANT	YYYY-MM-DD	2020-10-26
	DESIGNED	RWB
	PREPARED	SHL
	REVIEWED	BP
	APPROVED	RWB

PROJECT NO.	CONTROL	REV.	ATTACHMENT
19121567	-	-	E





**LAYER 1**

**LEGEND**

-0.08 MODELED HEAD IS HIGHER THAN TARGET

0.22 MODELED HEAD IS LOWER THAN TARGET

**LEGEND**

**NOTE(S)**

1. BASED ON MODEL V12\_2019.

**REFERENCE(S)**

1. COORDINATE SYSTEM: WGS 1984 WEB MERCATOR AUXILIARY SPHERE

**CLIENT**

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

**PROJECT**

GROUNDWATER FLOW MODEL TECHNICAL MEMORANDUM  
MSRB, MCWB, AND DRYING AREA  
NIPSCO LLC R. M. SCHAFER GENERATING STATION

**TITLE**

**MODEL CALIBRATION - SEPTEMBER 2019**

CONSULTANT	YYYY-MM-DD	2020-10-23
DESIGNED	RWB	
PREPARED	SHL	
REVIEWED	BP	
APPROVED	RWB	

PROJECT NO.	CONTROL	REV.	ATTACHMENT
19121567	-	-	F

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1in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANS I B



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