Northern Indiana Public Service Company (NIPSCO)

Bailly Generating Station – Primary 1, Primary 2, and Secondary 1 (collectively the CCR Unit)

Chesterton, Indiana

Certification of Assessment of Corrective Measures

40 CFR §257.96

I have personally reviewed this assessment of corrective measures (ACM), the subject of which is three impoundments (the Primary 1, Primary 2, and Secondary 1) at the NIPSCO Bailly Generating Station, prepared by Golder Associates Inc. and dated May 2019. 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 ACM is accurate and meets the applicable requirements of the CCR Final Rule. In consideration of the above, I certify to the best of my knowledge, information, and belief, that the ACM for the regulated CCR management unit referred to as the CCR Unit meets the applicable requirements of 40 CFR §257.96.

JOSEPH BERNARD GORMLEY JR.
REGISTERED
No. PE11900213
STATE OF
INDIANA
PROFESSIONAL ENGINEER

5/1/2019

Joseph Bernard Gormley, Jr.
Indiana Professional Engineer
License #: PE11900213

Date

CCR ASSESSMENT OF CORRECTIVE MEASURES PRIMARY 1, PRIMARY 2, AND SECONDARY 1

Northern Indiana Public Service Company
Bailly Generating Station

Chesterton, Indiana

Submitted to:

Northern Indiana Public Service Company
801 East 86th Avenue
Merrillville, Indiana 46410

Submitted by:

Golder Associates Inc.
670 North Commercial Street, Suite 103
Manchester, NH 03101
+1 603 668-0880

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Acronyms

ACM	Assessment of Corrective Measures
BGS	Bailly Generating Station
BSP	Boiler Slag Pond
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	Centimeter per second
COC	Constituents of Concern
CSM	Conceptual Site Model
ft bgs	feet below ground surface
ft amsl	feet above mean sea level
GMPIM	Groundwater Monitoring Program Implementation Manual
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
IDNP	Indiana Dunes National Park
IDNR	Indiana Department of Natural Resources
ISS	In situ Stabilization/Solidification
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
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
RCRA	Resource Conservation and Recovery Act
SSL	Statistically Significant Level
ug/L	microgram per liter
U.S. EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

Northern Indiana Public Service Company (NIPSCO) maintains the Bailly Generating Station (BGS or Site) located at 246 Bailly Station Road in Chesterton, Porter County, Indiana (Latitude 41° 38' 40" and Longitude 87° 05' 20") as shown in Figure 1. Although NIPSCO ceased coal-fired power generation at BGS in May 2018, the Site still manages coal combustion residuals (CCR) in surface impoundments subject to applicable requirements of 40 Code of Federal Regulations (CFR) Part 257 as amended (CCR Final Rule). Pursuant to 40 CFR §257.96(a), NIPSCO prepared an assessment of corrective measures (ACM) for Primary 1, Primary 2, and Secondary 1 (collectively the CCR Units), the results of which are presented in this document.

1.1 Background

Following the installation of a groundwater monitoring system in 2016, Golder collected background groundwater samples and performed Detection Monitoring at the CCR Units 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, NIPSCO posted a notification to the publicly-accessible website that there were detections of Appendix IV parameters downgradient of Primary 1, Primary 2, and Secondary 1 above the groundwater protection standards (GWPS). Consequently, as a result of the GWPS exceedances, NIPSCO performed the requisite assessment of corrective measures. To comply with the groundwater provisions of the CCR Final Rule and due to the CCR Units' proximity to one another and the similarities in closure schedule and approach for all three impoundments, NIPSCO is addressing the detections of Appendix IV parameters downgradient of Primary 1, Primary 2, and Secondary 1 above the GWPS in this ACM.

1.2 Overall ACM Approach

The purpose of this ACM is to identify remedial options for the detections of Appendix IV parameters downgradient of Primary 1, Primary 2, and Secondary 1 above the GWPS that will meet the requirements of 40 CFR §257.96. The ACM process included development/refinement of the conceptual site model (CSM); a review of the design and historical operation of BGS; discussions with NIPSCO representatives regarding current Site conditions and implications of possible infrastructure changes following station shutdown; an evaluation of the groundwater monitoring system and groundwater quality data with emphasis on the CCR Units constituents of concern (COCs); consideration of groundwater degree, rate, and extent of impacts; research of Federal and state groundwater quality health-based standards; and literature reviews and other research regarding identification and applicability of remedial technologies.

In conformance with the applicable requirements of 40 CFR §257.96, the ACM includes an analysis of the effectiveness of potential corrective measures based on their overall performance, reliability, ease of implementation, potential impacts of the remedy, time to complete the remedy, and institutional requirements. In the initial phases, Golder first identified potential response actions and then screened potential treatment technologies for further consideration in the ACM process. Based on this screening process, treatment technologies were eliminated if they were unlikely to perform satisfactorily or reliably, they were deemed difficult or impossible to implement, or they could not achieve corrective action objectives within a reasonable timeframe. The remaining technologies were retained for development as potential corrective measures and are described in this ACM.

NIPSCO will consider additional Site groundwater monitoring data, results of the closure-by-removal program, modifications to generating plant infrastructure and/or operations (e.g., shutdown activities), and new treatment technologies during the remedy selection process.

2.0 CONCEPTUAL SITE MODEL

Golder prepared this CSM to help frame and support the ACM. Golder's approach emphasized collection and evaluation of data in select key areas that can be expected to influence the identification of remedy options and evaluation of their potential feasibility. The CSM presents summaries of Site development activities, the CCR Units' construction and operational history, and geologic and hydrogeologic information, which together lay the groundwork for the development of the ACM.

2.1 Site and CCR Unit Description

BGS occupies approximately 350 acres and is located along the southern shoreline of Lake Michigan in northwestern Indiana. BGS is in an industrial area, bounded to the north and east by Lake Michigan and the Indiana Dunes National Park (IDNP, formerly Indiana Dunes National Lakeshore), and to the south and west by the Arcelor-Mittal Steel Mill. The integrated Arcelor-Mittal steel facility covers more than five square miles of land adjoining Lake Michigan and produces coke and unfinished and finished steel from iron ore, limestone, coal and other raw materials.

NIPSCO maintains a vegetated buffer zone, called the Greenbelt, which is owned by NIPSCO but acts as an easement with IDNP. The Greenbelt is located along the northern side of the developed portion of BGS and extends approximately 300 feet (ft) north of the CCR Units as shown in Figure 2. Any proposed field activities within the Greenbelt must first be proposed and approved in coordination with the U. S. Department of the Interior, National Park Service.

The Site can be divided into three general geographic areas:

- The northwestern portion of the Site abuts Lake Michigan and includes the power generating buildings, associated infrastructure, and coal storage. The former coal-fired generating units, now permanently shut down, were in operation from 1962 to 2018. A natural gas-fired peaking unit and a synchronous condenser unit are currently operational. Cooling tower blowdown wastewater from the condenser unit discharges to Secondary 2 or Primary 1.
- The central portion of the Site, which is the focus of the ACM, includes the CCR Units.
- The eastern portion of the Site includes former ash landfills (non-regulated under the CCR Final Rule) that are being addressed under a Resource Conservation and Recovery Act (RCRA) Administrative Order on Consent.

As shown in Figure 2, Primary 1, Primary 2, and Secondary 1 are in the central portion of BGS and include:

- Primary 1 – approximate 5.6-acre lined surface impoundment.
- Primary 2 – approximate 7.2-acre lined surface impoundment located east of Primary 1.
- Secondary 1 – approximate 2.5-acre lined impoundment located east of Primary 2.

Each CCR impoundment has a liner system (non-CCR Rule compliant) that includes slag armoring, sand layer, membrane, another sand layer, and a clay layer. To the west of the three CCR Units is a fourth CCR-regulated Unit, designated the Boiler Slag Pond (BSP). The BSP is an approximate 3.5-acre lined surface impoundment. To date, groundwater analytical data from the BSP has not indicated an exceedance of the GWPS; therefore, the BSP is not included in this ACM. A fifth surface impoundment not regulated under the CCR Final Rule, Secondary 2, is located between Primary 2 and Secondary 1 as also shown in Figure 2.

2.2 CCR Unit History and Operations

NIPSCO began construction of Unit 7, a 194-megawatt (MW) capacity high-pressure boiler and steam turbine in 1959, with power generation beginning in 1962. Unit 8, a 422-MW capacity high-pressure boiler and steam turbine came on-line in 1968. NIPSCO constructed a third unit (Unit No. 10), which burns natural gas, to generate electricity during periods of peak demand and it remains operational. During plant operations prior to 1980, CCR materials generated from Units 7 and 8 were sluiced to former unlined surface impoundments located in the same area of the Site as the current CCR Units. Before 1980, the former CCR impoundments managed non-hazardous air heater wash, precipitator wash, bottom ash, fly ash, and waste streams containing boiler chemical rinsate and boiler chemical cleaning waste (AMEC 2010). In 1980, NIPSCO removed the CCR and berm materials from the unlined impoundments and constructed new impoundments with a compacted clay and Hypalon liner system (i.e., present-day CCR management impoundments). Following the removal of the unlined impoundments and construction of new lined versions, the three CCR Units subject to this ACM received only non-hazardous industrial wastewater and overflow water from the BSP. Fly ash was segregated, dry handled, and no longer sluiced to any impoundments, and boiler slag was wet sluiced only to the BSP.

After 1980, primary wastewaters were discharged to these units for sequential settling and then recycled through the facility or discharged to Lake Michigan via NIPSCO’s primary National Pollutant Discharge Elimination System (NPDES) discharge point, Outfall 001. NIPSCO periodically treated the wastewaters via the Industrial Wastewater Treatment Plant (IWTP) between 1980 and 2003, as necessary. NIPSCO cleaned and shuttered the IWTP by 2006.

BGS ceased coal-fired power generation in May 2018. After plant shut down, water was last discharged to the BSP in August 2018 and all residual wastewater has since been routed directly to Primary 1 or Secondary 2.

2.3 Regional and Site Geology

BGS is located near the eastern end of the physiographic region of Indiana known as the Calumet Lacustrine Plain. The plain is a topographically-low region bordering Lake Michigan and is a remnant of the Lake Chicago stage of the Wisconsinan glaciations. According to the Hydrogeology and Hydrochemistry of Dunes and Wetlands along the Southern Shore of Lake Michigan, Indiana (Shedlock 1994), this province is primarily an abandoned lake bottom of late-glacial and post-glacial lakes that occupied the southern part of the Lake Michigan Basin. The Calumet Lacustrine Plain is bounded to the south by several end moraines of the Valparaiso Morainal Area (i.e., the Valparaiso, Tinley, and Lake Border Moraines) that form a series of arc-shaped uplands along the southern shore of Lake Michigan. The surficial sediment in the Valparaiso Morainal Area is primarily a pebbly clay that extends northward beneath the Calumet Lacustrine Plain. This clay is the foundation on which the dune, beach, and lacustrine sediments were deposited (Shedlock 1994).

The Lake Michigan basin deposits that are largely the result of glacial, glaciofluvial, shallow water coastal, lacustrine, wetland, and aeolian sedimentation characterize the unconsolidated geology of the Chesterton area. They consist of clay-rich till, sand and gravel glacial outwash, beach and dune sands, lake silts and clays, and peat. The thickness of the unconsolidated deposits range from about 50 feet near the Indiana-Illinois State line to approximately 350 feet at the basin divide located south of Michigan City, approximately 11 miles to the east (Fenelon 1994).

The bedrock geology of the south shore of Lake Michigan is characterized by Precambrian bedrock in the Lake Michigan Basin that is overlain by more than 4,000 ft of sedimentary bedrock. The majority of the sedimentary bedrock is of Cambrian and Ordovician age. The Cambrian and Ordovician bedrock consists of fine-grained to coarse-grained sandstones in the lower part and shale overlying dolomite and sandstone in the upper part (Fenelon 1994). The bedrock surface is a pre-glacial erosional feature that has been further modified by glacial erosion. The Silurian and Devonian carbonate rocks exposed at the bedrock surface contain significant fractures and solution features in the upper 100 ft (Fenelon 1994). The top of bedrock elevation near the Site is approximately 370 to 450 ft above mean sea level (ft amsl, Shedlock 1994), indicating that there is approximately 145 to 200 ft of unconsolidated materials overlying the bedrock.

Site surficial geology has been altered substantially to accommodate current industrial uses. Surficial deposits on Site were originally dune deposits that contain sand and some fine gravel. This series of dune complexes began forming in response to changes in lake level and changes in the amount of sediment supplied to the coastline. Golder's interpretation of the Site geology is based on soil borings advanced on- and off-Site (see Figure 3) and literature review and includes:

- Fill: A fill layer, comprised generally of sand and gravel with trace amounts of boiler slag (i.e., berm materials), is present around the CCR Units from ground surface to approximately three feet below ground surface (ft bgs, elevation of approximately 616 ft amsl) in some soil boring locations. Sand with higher concentrations of boiler slag and fly ash was observed in the borings advanced west of the CCR Units.
- Light Brown/Brown Sand: A loose to compact fine to coarse-grained light brown to brown dune-beach and lacustrine sand with varying quantities of fine gravels and silts underlies the fill material and varies in thickness from approximately 30 to 40 ft. This unit thickens to the south near piezometer GAMW-11B to an approximate depth of 77 ft bgs (545 ft amsl) and on the Arcelor-Mittal Steel Mill property (IDNR Well Database) to an approximate depth of 94 ft bgs (525 ft amsl).
- Silty Clay (upper clay unit): An approximate 10-foot thick interbedded till, glacial/lake clay sand and gravel underlies the light brown to brown sand beneath the CCR Units and is generally present at an approximate depth of 30 to 40 ft bgs (elevation of 589-579 ft amsl). The silty clay layer is not present south of Primary 1, near monitoring well GAMW-11B.
- Basal Clay and Till Unit: A basal clay and silt underlies the silty clay and delineates the base of the uppermost aquifer. The basal till and silt is approximately 95 to 105 feet thick. The thickness of the basal unit is highly variable due to erosion of the sediments and the underlying bedrock's relief.
- Bedrock: According to the Sargent and Lundy BGS Plan and Logs of Unit 7, Sheet B-4 – Boring A-3, dated February 17, 1961, bedrock (fractured dolomitic limestone) is present near the eastern portion of the Site at an approximate depth of 145 ft bgs (474 ft amsl).

2.4 Regional and Site Hydrogeology

The Calumet Aquifer System, an unconfined aquifer, underlies the Site and is underlain by the impermeable basal clay and till unit. Due to the confining layer, flow is primarily horizontal through the uppermost aquifer, which has been encountered consistently beneath all of the CCR Units. The Calumet Aquifer System, under natural flow conditions, discharges towards Lake Michigan and is recharged by infiltration of precipitation through the soils both upgradient of and on Site.

2.4.1 Description of the Site Uppermost Aquifer

Golder identified the shallow unconfined dune-beach and lacustrine sands that underlie all of the CCR Units as the uppermost aquifer based on a review of the information outlined above and an interpretation of the definition of the uppermost aquifer provided in 40 CFR §Part 257.53. The uppermost aquifer has consistently shown a saturated thickness of approximately 22 to 28 feet beneath the CCR Units based on an approximate clay elevation of 585 ft amsl and a water table elevation of 607 ft amsl while the generating station was in operation. Cross-sections showing the Site geology and groundwater elevations are provided in Figures 4 and 5.

Groundwater monitoring wells used to evaluate groundwater quality and flow direction is provided in Figure 3. Based upon an evaluation of regional and Site-specific conditions, groundwater within the uppermost aquifer is expected to flow to the north toward Lake Michigan. However, two factors appear to influence groundwater flow direction near the CCR Units. According to the Indiana Department of Natural Resources (IDNR), ArcelorMittal withdraws over 1,000 gallons per minute from multiple wells located south of the CCR units to depress groundwater levels that, in turn, reduce groundwater infiltration into deeply constructed pits and basements (reportedly 65 ft deep) associated with their manufacturing operations. The second factor that influences groundwater flow direction near the CCR Units is a historically consistent groundwater mounded area beneath the BSP. Groundwater contours based on water elevations measured before 2019 (i.e., before station shut down) showed significant groundwater mounding that flowed radially outwards from the BSP (Figure 6). Now that influent to and dewatering operations in that area have ceased, groundwater levels have dropped in the well network surrounding this unit. The BSP received water almost continuously while BGS was still operating, which would keep the groundwater levels beneath the BSP artificially higher than the surrounding groundwater levels. Groundwater flow direction prior to plant shut down was counter-intuitive from the expected northerly direction toward Lake Michigan and instead flowed west to east near the BSP and Primary 1 and east to west near Primary 2 and Secondary 1 as shown in Figure 6. Groundwater appears to eventually flow north near the central portion of Primary 2 (i.e., near monitoring well GAMW-16). Groundwater elevation data collected in April 2019 (i.e., post-station shut down) appears to be significantly different than groundwater elevation data collected while BGS was still in operation. In August 2018, sluice water was no longer being discharged to the BSP and slag stockpile dewatering activities had ceased. These operational changes have resulted in significant decreases in groundwater elevations and influenced groundwater flow directions. NIPSCO will continue to monitor groundwater elevation data to confirm the post-station shut down conditions. For consistency of this ACM, NIPSCO used the groundwater elevation data prior to plant shut down as a basis for this evaluation.

2.4.2 Hydraulic Conductivity Testing

Golder performed hydraulic conductivity testing (slug testing) in three shallow (GAMW-01, GAMW-08, and GAMW-11) and one deep monitoring well (GAMW-11B) in accordance with procedures in the Groundwater Monitoring Program Implementation Manual (GMPIM, Golder 2017). Golder field personnel used a pressure transducer and data logger to obtain the slug test data. Golder used Hvorslev and Bower and Rice Methods to calculate the hydraulic conductivity values. The slug test results, measurement data, and calculations are provided in Appendix A. The average hydraulic conductivity for the wells installed in the upper and lower portions of the uppermost aquifer is 3.64 x 10-2 centimeters per second (cm/sec) and 3.62 x 10-3 cm/sec, respectively.

The calculated hydraulic conductivity values appear to be consistent with dune deposits that contain sand and some fine gravel.

2.4.3 Horizontal Component of Flow

Golder calculated average hydraulic gradients for the unconfined aquifer near the CCR Units ranged from approximately 0.001 ft/ft to 0.009 ft/ft as shown on Figure 6 using groundwater elevation data collected from March 2018.

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: h_L = head loss (elevation difference - ft)
L = length (horizontal distance - ft)

Using an assumed effective porosity value of 30%, and the average hydraulic conductivity from slug tests for the shallow unconfined aquifer of 103 ft per day, and the calculated gradient, the rate of groundwater flow (V_{gw}) in the unconfined aquifer was calculated using the algorithm below.

$$V_{gw} = K\, i\, \left({}^{1}/_{n_e}\right)$$

Where:
V_{gw} = Groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity
$V_{gw(low)}$ = [(103 ft/day) x (1E-03)] / 0.30
$V_{gw(high)}$ = [(103 ft/day) x (9E-03)] / 0.30
V_{gw} = 0.343-3.09 ft/day, or 125-1128 ft/year

As calculated above, the estimated horizontal rate of groundwater flow in the shallow unconfined aquifer beneath the study area is expected to be approximately 125 to 1128 ft per year.

2.4.4 Vertical Component of Flow

Golder assessed groundwater elevation data for the well couplet GAMW-11/GAMW-11B. GAMW-11B was installed to the top of the basal clay/till unit that underlies the uppermost aquifer and was only used for water level measurements. Using groundwater level measurements recorded between July 2016 and March 2018 vertical gradients at this well pair average, -0.0871 feet per foot (Appendix B). Groundwater flow in the shallow unconfined aquifer has a steep horizontal component near the BSP and shallow horizontal gradients within the CCR Unit, especially Primary 1 and 2 and a moderate downward vertical component of flow south of Primary 1.

3.0 MONITORING WELL NETWORK

NIPSCO designed the monitoring network described herein to meet the performance standards specified in 40 CFR §Part 257.91 that will be protective of human health and the environment. The monitoring network was designed so that adequate monitoring coverage is provided to represent the quality of groundwater upgradient and downgradient of each CCR unit. Due to the effects of the off-Site groundwater ArcelorMittal extraction system on groundwater flow (i.e., west to east and east to west depending on the location of the CCR Unit), NIPSCO selected monitoring wells GAMW-01, GAMW-08, and GAMW-11, to represent background groundwater quality conditions for all four CCR Units as shown in Figure 6. The following table identifies current background and downgradient monitoring wells.

CCR Unit	Background Monitoring Wells	Downgradient Monitoring Wells
Primary 1	GAMW-01, GAMW-08, GAMW-11	MW-112, GAMW-09, GAMW-10, GAMW-15
Primary 2		GAMW-05, GAMW-06, GAMW-07, GAMW-16
Secondary 1		GAMW-02, GAMW-03, GAMW-04

Although NIPSCO detected statistically significant levels (SSLs) in groundwater samples collected from monitoring wells downgradient of Primary 1, Primary 2, and Secondary 1, NIPSCO determined that it was infeasible to install additional downgradient assessment monitoring wells due to the proximity of the property boundary, safety concerns, and difficult access conditions within the Greenbelt (e.g., steep dune terrain and Blag Slough).

4.0 NATURE AND EXTENT OF CONSTITUENTS OF CONCERN (COCS)

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 Units 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. Golder developed the GWPS by selecting 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. In August 2018, the United States Environmental Protection Agency (U.S. EPA) amended the CCR Final Rule (i.e., Phase 1 Part 1 amendment) and created health-based standards for cobalt, lead, lithium, and molybdenum, constituents that did 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. Table 1 summarizes the GWPS and the Indiana Department of Environmental Management (IDEM)-specific applicable cleanup standards. The analytical results are provided in Table 2.

Following the first and second Assessment Monitoring sampling events, including verification sampling, NIPSCO detected the following constituents at concentrations above the GWPS:

- Primary 1
  - Thallium at GAMW-09 and GAMW-10
- Primary 2
  - Arsenic at GAMW-16
  - Lithium at GAMW-16
  - Thallium at GAMW-07
- Secondary 1
  - Cadmium at GAMW-04
  - Thallium at GAMW-03

A summary of the parameters detected above applicable cleanup standards throughout the Site are provided below:

- **Arsenic:** The MCL for arsenic is 10 micrograms per liter (ug/L). Arsenic concentrations in samples collected from downgradient monitoring wells range from non-detect (<10 ug/L) to 18 ug/L. Arsenic concentrations only exceed the GWPS at monitoring well GAMW-16. Results have remained relatively constant in GAMW-16.
- **Cadmium:** The MCL for cadmium is 5 ug/L. Cadmium concentrations in samples collected from downgradient monitoring wells range from non-detect (<2 ug/L) to 20 ug/L. Cadmium concentrations only exceed the GWPS at monitoring well GAMW-04.
- **Lithium:** Lithium does not have an MCL. However, the CCR Final Rule Phase 1 Part 1 amendment includes a lithium health-based standard of 40 ug/L. Lithium concentrations range from non-detect (<8 µg/L) to 77 µg/L in groundwater samples collected from monitoring wells downgradient of the CCR Units. Lithium concentrations only exceed the health-based standard in groundwater samples collected from GAMW-16 and GAMW-04. Results varied in GAMW-04 from 32 to 63 ug/L but have remained relatively constant in GAMW-16.
- **Thallium:** The MCL for thallium is 2 ug/L. The GWPS for thallium is equal to the background tolerance limit, 3.9 ug/L. Thallium concentrations range from non-detect (<2 µg/L) to 15 µg/L in groundwater samples collected from monitoring wells downgradient of the CCR Units.

In accordance with the provisions of 40 CFR §257.95(g)(1), NIPSCO has defined the nature and extent of the release associated with the CCR Units in the uppermost aquifer using the current CCR Final Rule-compliant monitoring well network. The downgradient wells are placed and screened immediately adjacent to the CCR Units in approximately 10 ft of the 22 to 28 ft of saturated aquifer thickness. The close proximity of the downgradient well network should detect a release from the CCR Unit, if present, as shown by the results of the CCR Detection and Assessment groundwater monitoring programs. The shallow hydraulic gradients adjacent to Primary 1, Primary 2, and Secondary 1 should reduce the migration of impacted groundwater away from the CCR Units. The potential vertical migration and extent of groundwater impacts is limited by the low downward vertical component of flow, the design of the CCR Units with Hypalon liners, and the ability of the underlying clay liners to adsorb or contain metals. For purposes of this ACM, until further groundwater delineation activities are performed following the closure-by-removal of the impoundments NIPSCO assumes that groundwater beneath the entirety of each CCR Unit is potentially impacted. Use of these data and assumptions defining the nature and extent of groundwater impacts in conjunction with the closure approach (i.e., source removal) supports development of the conceptual areas for corrective measures applications.

4.1 Corrective Measure Areas

NIPSCO intends to close the CCR Units by removing source materials in accordance with the requirements of 40 CFR §257.102(c), with source removal (i.e., source control) being an integral component of its overall Corrective Measures strategy for groundwater. Therefore, this ACM assumes that the source has been removed and evaluates only those corrective measures that address residual impacts in saturated soils remaining under the CCR Units and in groundwater downgradient of the CCR Units.

5.0 PLANNED SOURCE CONTROL MEASURES

NIPSCO plans to close the CCR Unit by removal in accordance with 40 CFR §257.102(c) and an approved IDEM Closure Application. In order to meet the requirements of 40 CFR §257.97-98, NIPSCO's approach combines CCR source removal and groundwater monitoring to demonstrate achievement of applicable cleanup standards. The multi-part corrective action approach will be integrated, but may be sequenced, to allow for monitoring of results and optimization of subsequent steps following completion of the initial stages.

According to the Surface Impoundment Closures (CCR Final Rule) Draft Closure Application for the Bailly Generating Station, prepared by Wood Environment & Infrastructure Solutions, Inc., dated April 12, 2019, "closure by removal of the surface impoundments will include removing the impoundment contents as determined from the Sargent and Lundy construction documents. Visual observation will also be used as the surface impoundments contents are removed for identifying the impoundment side walls/slopes and bottom. The liner component of the surface impoundments and an additional one foot of material beneath the bottom of the surface impoundment's liner will also be removed for off-Site disposal. Upon completion of the surface impoundment material excavation, visual verification of the surface impoundment bottom will be performed."

During closure implementation and post-closure, NIPSCO will continue performing groundwater monitoring activities. The results obtained from this additional monitoring will be used to help inform and refine the remedy selection process as needed.

6.0 GROUNDWATER CORRECTIVE MEASURE OBJECTIVES

6.1 CCR Rule Objectives

In accordance with 40 CFR §257.96(a), within 90 days of finding that any Appendix IV constituent was detected at a statistically significant level exceeding the GWPS, NIPSCO was required to initiate an ACM for these CCR Units. Per the regulations, the ACM must evaluate corrective measures that will prevent further releases, remediate any releases, and restore the affected area to original conditions.

Furthermore, the ACM must include an analysis of the effectiveness of potential corrective measures in meeting all the requirements and objectives of the remedy as described under 40 CFR §257.97.

6.2 Groundwater Standards

As described in Section 2.8, CCR Final Rule Appendix IV parameters are compared to GWPS, which is the larger value of the MCL or the unit-specific background concentration, for each analyte based on a tolerance/prediction limit procedure. As of August 29, 2018, for cobalt, lead, lithium, and molybdenum, constituents that do not have MCLs, designated health-based standards can be used in place of the MCLs. Additionally, IDEM has Remediation Closure Guide (RCG) screening levels for many of the CCR parameters. The applicable residential groundwater IDEM RCG screening levels are provided in IDEM Table A-6 (revised March 7, 2018). The IDEM screening levels are not necessarily closure levels; however, when an investigation of a release indicates results below these screening levels, the release is typically eligible for closure (IDEM 2012). Table 1 summarizes the GWPS and the IDEM RCGs.

6.3 Points of Compliance

40 CFR §257.98(c) indicates that the remedy is complete when compliance with the GWPS is "achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system." To measure compliance, the current monitoring well network for Primary 1, Primary 2, and Secondary 1, or a modified post-

closure groundwater monitoring network as approved by IDEM as part of the BGS Surface Impoundments Closure Application, will be sampled on a routine basis, and compliance with the GWPS will be considered achieved when Appendix IV constituents have not exceeded the GWPS at any of the downgradient monitoring wells located within the plume for three consecutive years.

7.0 GENERAL GROUNDWATER RESPONSE ACTIONS

For the BGS ACM Golder considered the following general response actions in addition to source removal.

- **Limited Action** - Limited actions include access restriction, institutional controls, land use restrictions, environmental monitoring, and natural attenuation. They are generally used in combination with other response actions and are easily implemented.
- **Containment** - Containment actions include physical barriers that contain the source material such as caps, slurry walls, and sheet piles. They are designed to isolate the source material and prevent migration of the source water beyond the area of control. The benefits to containment actions are they are relatively simple to design, can be implemented quickly, and can address large areas and volumes of waste. However, there can be uncertainty with verifying their connection with natural subsurface barriers (e.g., low permeability layers, bedrock, etc.) and their long-term effectiveness.
- **Removal** - Removal actions include extraction of groundwater through a series of extraction wells or extraction trenches to control the flow of impacted groundwater beyond the area of control. The effectiveness of groundwater removal actions is dependent on-Site characteristics such as soil permeability and the capture zone of a pumping well. The unknown extent and location of underground utilities may make it difficult to implement removal actions at this Site.
- **Treatment** - Treatment actions can include either in situ or ex situ treatment technologies and are designed to reduce the toxicity, mobility, or volume of COCs in groundwater.
  - **In Situ Treatment** - In situ treatment technologies include 1) stabilization/solidification 2) permeable reactive barriers, 3) precipitation/co-precipitation, 4) adsorption, and 5) biological processes. They are used to reduce the toxicity, mobility, or volume of COCs. The primary advantage to in situ treatment is that the groundwater does not have to be extracted to be treated. The primary disadvantage to in situ treatment is that the treatment process cannot be controlled as well as the same treatment in a reactor or other process equipment. The decreased control results from difficulty achieving desired process conditions and the inherent heterogeneity of the subsurface.
  - **Ex Situ Treatment** - Ex situ treatment technologies include 1) precipitation/co-precipitation 2) adsorption 3) membrane filtration 4) ion exchange and 5) electrolysis. They are used to reduce the toxicity, mobility, or volume of material affected by COCs. Many ex situ treatment technologies convert COCs to less toxic forms. The main advantage of ex situ treatment is that it generally requires shorter time periods than in situ treatment. Ex situ treatment requires removal and treatment of impacted groundwater, which increases engineering for equipment, permitting, and material handling and requires worker safety considerations.
- **Disposal** - Disposal actions are final disposition options for removal and ex situ treatment actions. They can consist of piping or off-Site transport to a Publicly Owned Treatment Works (POTW) or other off-Site

wastewater treatment facility. They can also include discharge or re-injection of treated groundwater to surface water or groundwater, respectively.

The general response actions developed for further consideration at each of the corrective measure areas identified above are summarized in Table 3.

8.0 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURE TECHNOLOGIES

Following development of response actions, Golder screened applicable technologies for further consideration in remediating groundwater for the respective corrective measure areas. The potential remedial technology type is a general category of technology, while the process options are specific methods within each remedial technology type. The initial technology screening results for each response action are summarized below and in Table 4. Information regarding potential remediation technologies that may be applicable based on contaminant groups is available on EPA's clean-up information website at www.clu-in.org. Information available on the website has been used as a guide for screening technologies based on the COCs and its location at the site.

8.1 Limited Action

Evaluated limited actions include institutional controls, short and long-term environmental monitoring, future land use restrictions, and monitored natural attenuation. These limited actions could be applicable remedial alternatives for the corrective measure area.

8.1.1 Institutional Controls

Institutional controls include administrative and legal restrictions such as orders or permits intended to reduce the potential for human exposure to contamination by limiting land or resource use. Institutional controls may be used to supplement access restrictions and must be operated, monitored, and evaluated for as long as the risks are present. Informational devices such as signs, state registries, and deed restrictions are common forms of institutional controls. Deed restrictions and notices are retained for further consideration.

Access restrictions are physical restrictions or structures designed to monitor and minimize exposure of COCs at the site. Access restrictions are effective, easily implemented, and low in cost. Access restrictions prevent access by unauthorized persons. Fencing, combined with warning signs, is the most common means of restricting access. Fencing provides a physical barrier to site access. Warning signs discourage trespass by informing potential intruders of the site hazards. Security patrols are sometimes included for high-risk areas but are not warranted for this site. Fencing and warning signs are retained for further consideration.

8.1.2 Monitoring

Site monitoring is a required component of any site remedy under the CCR Final Rule. Short-term monitoring ensures that potential risks to human health and the environment are controlled while a site remedy is being implemented. Long-term monitoring measures the effectiveness of the remedy and ensures that the remedy continues to be protective of human health and the environment. Long-term monitoring includes routine site inspections as necessary to determine maintenance needs. A monitoring plan is retained for further consideration and will be developed based on the selected remedy.

8.1.3 Use Restrictions

Land use restrictions are legal controls such as deed restrictions that guide development or activities at the site. Deed restrictions are legally binding notices of land use restrictions that accompany the property deed and transfer to any subsequent property owner. Deed restrictions include a description of the site and reasons for the limits on future activity. Such restrictions would prevent activities or development that would cause direct exposure to COCs or compromise the integrity of the remedy. Land use restrictions are required for this portion on the Site per the U.S. EPA RCRA Corrective Action Administrative Order on Consent.

8.1.4 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) refers to physical, chemical, or biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. Instead of implementing active controls (e.g., engineered remedies), MNA consists of naturally occurring processes that will reduce the risk of exposure to acceptable levels within an acceptable timeframe. MNA is retained for further evaluation.

8.2 Containment

Containment options considered include capping and vertical barriers. The objective of the containment is to isolate the source material and prevent migration of the source water through the area of control. Containment process options are applicable to the corrective measure area.

8.2.1 Capping

Capping is a proven method of containment. Capping provides reliable, long-term containment to prevent, or significantly reduce exposure to the source material and migration of water through the source area. Capping minimizes risk by preventing direct contact with the source material and low-permeability caps minimize stormwater infiltration, thereby, reducing the potential for additional COC migration into groundwater. NIPSCO's closure plan for the impoundments includes source removal and filling/grading to promote positive stormwater drainage. Therefore, capping has not been retained for further evaluation for this ACM.

8.2.2 Vertical Barriers

Vertical barriers are physical barriers designed to control the horizontal migration of groundwater. Vertical barriers include slurry walls, which are typically constructed of some combination of soil, bentonite, and cement, as well as geomembrane or sheet pile walls. The vertical barrier must be keyed into a confining layer, such as the clay. Due to constructability constraints associated with varying depths of, and in some cases, lack of, a confining layer, vertical walls were not retained for further evaluation.

8.3 Removal

Removal of contaminated groundwater could be completed through a series of extraction wells or extraction trenches. Typically, extraction requires either off-Site disposal or ex-situ treatment to meet discharge criteria.

8.3.1 Extraction Wells

Extraction wells could be used to remove contaminated groundwater and control groundwater movement within capture zones. The effectiveness of groundwater removal would be dependent on-Site characteristics such as the capture zone of a pumping well. Due to the ecologically sensitive areas downgradient of the CCR Units, which include wetlands, groundwater extraction would likely not be permitted in these areas. However, within the facility property boundaries, extraction wells are retained for further evaluation for extraction of groundwater under the CCR Units.

8.3.2 Extraction Trenches

Collection trenches could also be used to extract contaminated groundwater. For the reasons stated above, groundwater extraction trenches would likely not be permitted in the wetland areas. Extraction trenches are retained for further evaluation for extraction of groundwater under the CCR Units.

8.4 In Situ Treatment

The purpose of in situ treatment is to reduce the toxicity, mobility, or volume of COCs. The primary advantage of in situ treatment is that the water does not have to be extracted to be treated. The primary disadvantage of in situ treatment is that the treatment process cannot be controlled as well as the same treatment process in a reactor or other process equipment. The decreased control results from the inherent heterogeneity of the subsurface soils and the difficulty that presents in achieving desired process conditions.

In situ treatment processes include precipitation or co-precipitation, adsorption, or degradation. Precipitation occurs when a constituent exceeds its solubility in water and can occur when the concentration of the constituent increases or there is a change in pH, Eh, temperature, or ionic strength. Adsorption is a surface-chemical phenomenon wherein accumulation of a constituent occurs at the interface between the aqueous phase and solids materials in contact with the aqueous phase. Possible substrates include zero valent iron, zeolites, and granular activated carbon. The purpose of degradation is to form a less toxic or less mobile form of a toxic constituent.

This section considers in situ treatment technologies including 1) stabilization/solidification, 2) a permeable reactive barrier, 3) precipitation/co-precipitation, 4) adsorption, and 5) biological treatment. In situ treatment processes are generally less reliable in achieving uniform treatment than the corresponding ex situ treatment process.

8.4.1 Stabilization/Solidification

In situ stabilization/solidification (ISS) could be used in saturated soil below the CCR Unit to bind the COCs to soil and reduce their potential to leach into groundwater. Following excavation of solids from the CCR Unit, the saturated soils would be mixed with large augers to a fixed depth with a grout mixture generally composed of cement and/or bentonite, and water. ISS was retained for further evaluation for the corrective measure area.

8.4.2 Permeable Reactive Barrier

A permeable reactive barrier (PRB) "is an in situ, permeable treatment zone designed to intercept and remediate a contaminant plume."[1] "The primary use of a PRB is to eliminate or substantially reduce the mass discharge of contaminant(s) downgradient of the barrier. The PRB is not typically used as a source remediation technology; however, it may be used as a source control technology depending on the placement of the PRB relative to the location of the contaminant source."[2] Inorganics have shown to be amendable to remediation using PRB technology with the appropriate reactive media. Potential reactive media include zero valent iron, zeolites, and granular activated carbon and COCs are removed by precipitation and/or adsorption. A PRB can be installed through trenching or soil excavation. A permeable reactive barrier was retained for further evaluation.

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[1] Pg. 2, Permeable Reactive Barrier: Technology Update, The Interstate Technology & Regulatory Council (ITRC), June 2011.
[2] Pg 12, Permeable Reactive Barrier: Technology Update, The Interstate Technology & Regulatory Council (ITRC), June 2011.

8.4.3 Chemical Addition/Treatment

In situ chemical addition/treatment generally consists of adding reagents into groundwater through a series of injection probes/wells or through soil mixing to precipitate or reduce the COCs to less mobile or toxic forms.

Chemical precipitation occurs when a constituent exceeds its solubility in water. Precipitation can occur when the concentration of the constituent increases or there is a change in pH, Eh, temperature, or ionic strength. Co-precipitation is the removal of a COC by precipitation of another constituent. The COC is removed by trapping within or adsorption to the precipitates as they form. In situ precipitation/co-precipitation can be a viable groundwater treatment strategy provided conditions are sufficiently stable that re-dissolution and remobilization do not occur. In situ precipitation/co-precipitation has limited effectiveness for treating the Site COCs, such as lithium.

Chemical reduction involves the placement of a reductant or reductant generating material into the subsurface to degrade or immobilize (through adsorption or precipitation) toxic constituents and is generally an effective technology for treating metals. In situ chemical addition/treatment was retained for further evaluation.

8.4.4 Biological Treatment

Biological treatment exploits natural biological processes that allow certain microorganisms and plants to aid in the remediation of metals. The mobility of metal contaminants is influenced by their oxidation state. Some microorganisms can oxidize/reduce metal contaminants directly while others produce chemical oxidizing/reducing agents that interact with the metals to effect a change in oxidation state. In addition, dissolved inorganics can be treated by adsorption or precipitation onto plant roots or absorption into plant roots (i.e., phytoremediation). However, phytoremediation of dissolved organics is generally applicable at relatively low concentrations and is limited to shallow soils and groundwater. Because of its limited effectiveness in treating the Site COCs, biological treatment was not retained for further evaluation.

8.5 Ex Situ Treatment

Similar to in situ treatment, ex situ treatment is intended to reduce the toxicity, mobility, or volume of material affected by COCs. Many ex situ treatment technologies convert COCs to less toxic forms. The main advantage of ex situ treatment is that it generally requires shorter time periods and the treatment process can be controlled better than the same in situ treatment. Ex situ treatment requires extraction of all impacted water prior to treatment of the groundwater, which increases the costs associated with engineering design, permitting, construction/equipment installation, and material handling. Also, ex situ treatment would require additional on-Site worker safety considerations. This ex situ treatment options considered assume the installation or modification of an on-Site treatment facility. This section considers ex situ treatment processes including 1) precipitation/co-precipitation, 2) adsorption, 3) membrane filtration, 4) ion exchange, and 5) electrolysis. These processes are evaluated individually in this section, however, two or more of these treatment options could be combined to treat all Site COCs.

8.5.1 Precipitation/Co-Precipitation

As noted above, precipitation occurs when a constituent of concern exceeds its solubility in water and co-precipitation occurs when the constituent of concern is removed by trapping within or adsorption to the precipitates of another constituent. Ex situ precipitation/co-precipitation via pump and treat technologies allows separation of the aqueous phase from the precipitate with subsequent disposal/recovery of the precipitated material. Both physical and chemical precipitation are considered. Precipitation/co-precipitation was retained for further evaluation.

8.5.2 Adsorption

Adsorption is a surface-chemical phenomenon wherein accumulation of a constituent occurs at the interface between the aqueous phase and solid materials in contact with the aqueous phase. Possible substrates include zeolites and granular activated carbon. Adsorption was retained for further evaluation.

8.5.3 Membrane Filtration

Membrane filtration is a physical process that uses a semi-permeable membrane to separate contaminants. Reverse osmosis is the most effective membrane filtration process. Reverse osmosis has been shown to be effective for all the COCs and has been retained for further evaluation.

8.5.4 Ion Exchange

Ion exchange is the exchange of one adsorbed, readily exchangeable ion on the surface of a supporting substrate with another ion. Ion exchange is relatively low cost, simple, and a well-known treatment technology. However, ion exchange was not retained due to its limited effectiveness for the Site COCs, such as lithium, cadmium, and thallium.

8.5.5 Electrolysis

Electrolysis is the application of an electric current through a liquid using at least two electrodes. The current results in migration of ions in the liquid to the electrode of the opposite charge. Metallic ions and metalloids will precipitate out onto the surface, or in the vicinity of the surface of the electrode. Electrolysis is most efficient in low ionic strength solutions and for heavy metals. Electrolysis was not retained due to its limited effectiveness for the Site COCs (U.S. EPA 2014).

8.6 Disposal

8.6.1 Off-Site Treatment

Municipal wastewater treatment plants could be considered for disposal of contaminated groundwater. Due to higher safety concerns and impact on the local community associated with transporting the waste off-Site, off-Site disposal was not retained for further evaluation.

8.6.2 On-Site Discharge

Treated water is discharged to a local water body pursuant to a NPDES permit. Treated groundwater could be discharged similarly under a revised NPDES permit. This option has been retained for further evaluation. Another option for on-Site disposal is to pump the treated groundwater back into the ground through reinjection. This option has also been retained for further evaluation. A third option is to discharge treated groundwater to a POTW under a discharge authorization; however, there are no existing sanitary sewers in close proximity to the Site. On-site discharge to a POTW is not retained for further consideration.

8.7 Additional Evaluation of Retained Technologies

The potential remedial types and process options and the results of their initial screening are summarized in Table 3. The retained technology/process options for each of the corrective measure areas were assembled to provide potential corrective measures. These potential corrective measures are described in Section 9.0.

9.0 IDENTIFICATION AND ASSESSMENT OF POTENTIAL CORRECTIVE MEASURES

Based on the technology screening above, Golder assembled several potential corrective measures, or combinations of remedial technologies, that could be both effective and implementable at this Site. These potential corrective measures will be further evaluated for their effectiveness in meeting all the requirements and objectives of the remedy using the evaluation criteria described in the CCR Final Rule. The potential correctives measures and evaluation criteria are described below.

9.1 Potential Corrective Measures

Site permitting and deed restrictions are considered effective and implementable treatment options and will be considered as part of all corrective measure alternatives. Permitting would be used to restrict the Site and groundwater use until the groundwater presents no unacceptable risk. A deed restriction would be used to permanently document site and groundwater use restrictions, even after Site closure.

Environmental monitoring is also considered an effective and implementable treatment technology and is required by the CCR Final Rule. An environmental monitoring plan will be part of the final remedy selection. Short-term groundwater monitoring would be used to ensure that potential risks to human health and the environment are controlled while a site remedy is being implemented. Long-term monitoring would be used to measure the effectiveness of the remedy and ensure that the remedy continues to be protective of human health and the environment.

Site permitting, deed restrictions, and environmental monitoring will be considered as part of all corrective measure alternatives. Based on the technology screening performed in Section 8.0, the following five potential corrective measures have been selected to remediate residual impacts after excavation and to address COC impacts in groundwater:

1) Golder has completed an initial screening of the effectiveness of MNA at this Site and demonstrated that 1) the groundwater plume is not expanding and 2) sorption of the contaminant onto aquifer solids is occurring where immobilization is the predominant attenuation process. As a follow up, Golder began evaluating the feasibility of monitored natural attenuation for reducing Site COCs in groundwater at the Site to concentrations below the GWPS. Based on the findings of this evaluation thus far, the Site is a viable candidate for MNA as a corrective measure and a further evaluation will be completed to further assess the long-term viability of MNA at BGS.

2) ISS for the saturated soil below the former CCR Units. ISS would be used to bind the COCs to soil and reduce their potential to leach into groundwater mitigating further impacted groundwater migration.

3) PRB at the downgradient edge of the former CCR Units. A PRB with reducing agents would be used to passively treat/remove COCs from groundwater as it moves beyond the former CCR Units mitigating further impacted groundwater migration.

4) Groundwater Injections in the footprint of the former CCR Units. Groundwater injections with reducing agents would be used to actively treat/remove COCs in groundwater beneath the former CCR Units before it moves beyond the former CCR Units mitigating further impacted groundwater migration.

5) Groundwater extraction and ex situ treatment technology/process options to extract the impacted groundwater through a series of extraction wells or trenches in the footprint of the former CCR Units. This

potential corrective measure alternative would be collectively referred to as pump-and-treat. Extraction wells or trenches installed within the former CCR Units would be effective in reducing the volume and mobility of dissolved COCs within groundwater and mitigate further impacted groundwater migration. The extracted water would be treated in an on-Site treatment facility using one or more of the ex situ treatment technologies described in Section 8 to reduce their toxicity and volume. The treated groundwater would be discharged in one of the following methods:

a. Discharged to surface water subject to an NPDES permit.

b. Discharged to groundwater subject to an underground injection control permit.

All of the above corrective measure alternatives would be used in combination with permitting and monitoring components. Permanent features (i.e., barriers, treatment systems) would also include operations & maintenance (O&M) components.

9.2 Evaluation Criteria

In conformance with the applicable requirements of 40 CFR §257.96, the ACM includes the analysis of the effectiveness of potential corrective measures 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 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.
- **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 of 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.

9.3 Summary of Potential Corrective Measures

Based on the above evaluation, Golder had identified the following corrective measure alternatives for further consideration at BGS. The potential corrective measures and their key components are summarized in Table 4. A summary of the corrective measure alternatives evaluation, including all of the evaluation criteria presented in Section 9.2, is provided in Table 5. Each of these potential corrective measures will be applied following excavation and closure of the CCR Unit.

- Limited actions with monitored natural attenuation
- Limited actions with ISS and monitored natural attenuation
- Limited actions with permeable reactive barrier and monitored natural attenuation
- Limited actions with injections of a reducing agent and monitored natural attenuation
- Limited actions with a pump-and-treat system and monitored natural attenuation
  - Discharge to surface water
  - Discharge to groundwater

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TABLES

Table 1: Applicable Groundwater Cleanup Standards
NIPSCO Bailly Generating Station
Chesterton, Indiana

Analyte	MCL (mg/L)	GWPS (mg/L)	IDEM RCG (mg/L)
Appendix III Constituents			
Boron	-	NA	4
Calcium	-	NA	-
Chloride	-	NA	-
Fluoride	4	4	0.8
pH	-	NA	-
Sulfate	-	NA	-
Total Dissolved Solids	-	NA	-
Appendix IV Constituents			
Antimony	0.006	0.006	0.006
Arsenic	0.01	0.01	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(1)	0.006	0.006	0.006
Fluoride	4	4	0.8
Lead(1)	0.015	0.015	0.015
Lithium(1)	0.04	0.04	0.04
Mercury	0.002	0.002	0.002
Molybdenum(1)	0.1	0.1	0.1
Radium 226+228	5	5	-
Selenium	0.05	0.09	0.05
Thallium	0.002	0.0039	0.002

Notes:
MCL= Environmental Protection Agency Maximum Contaminant Level
GWPS= Groundwater Protection Standard calculated September 2018.
IDEM RCG= Indiana Department of Environmental Management Remediation Closure Guidance- Table A-6 2018 Revision
mg/L= milligrams per liter
NA= not applicable; GWPS are calculated for Appendix IV constituents only
1) As of August 29, 2018, these four constituents have health-based standards that can be used when calculating the GWPS, these health-based standards are not MCLs *per se* but are provided in the MCL column.

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

Table 2: Analytical Results for the CCR Units Monitoring Wells
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Background											
				GAMW-01											
				2016-07-14	2016-09-09	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-26	2018-10-15
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters															
Boron		4	mg/L	0.2	0.19	0.17 J	0.17 J	0.2 U	0.11 U	0.099 J	0.079 J	0.2 U		0.24	0.23
Calcium			mg/L	94	87	64	63	62	96	68	65	63		130	88
Chloride			mg/L	13	44	21	15	44	170	130	160	98		130	27
Fluoride	4	0.8	mg/L	0.46 J	0.65 J	0.79 J	0.79 J	0.82 J	0.5 J	0.64 J	0.69 J	0.76 J	0.48 J	0.38 J	0.41
pH			SU	7.36	6.7	6.76	7.17	7.54	6.73	6.93	5.66	5.76	7.07	6.54	7.38
Sulfate			mg/L	51	41	32	35	32	27	22	21	29		55	44
Total Dissolved Solids			mg/L	400	410 J	360	360	370	520	430	490	400		610	400
Appendix IV Parameters															
Antimony	0.006	0.006	mg/L	0.002 U	0.0015 J	0.0011 J	0.0026	0.0024 J+	0.0011 J	0.00063 J	0.00063 J		0.00075 J		0.00068 J
Arsenic	0.01	0.01	mg/L	0.0026 J	0.0022 J	0.0019 J	0.0021 J	0.005 U	0.0016 J	0.0013 J	0.001 J		0.005 U		0.005 U
Barium	2	2	mg/L	0.028	0.032	0.028	0.026	0.028	0.044	0.034	0.038		0.045		0.027
Beryllium	0.004	0.004	mg/L	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
Cadmium	0.005	0.005	mg/L	0.001 U	0.00047 J	0.00034 J	0.001 U	0.001 U	0.00036 J	0.001 U	0.001 U		0.00034 J		0.00025 J
Chromium	0.1	0.1	mg/L	0.002 U	0.00093 J	0.0022	0.0018 J	0.002 U	0.002 U	0.0012 J	0.0013 J		0.002 U		0.002 U
Cobalt		0.006	mg/L	0.001 U	0.00032 J	0.001 U	0.00027 J	0.001 U	0.0002 J	0.001 U	0.001 U		0.001 U		0.001 U
Fluoride	4	0.8	mg/L	0.46 J	0.65 J	0.79 J	0.79 J	0.82 J	0.5 J	0.64 J	0.69 J	0.76 J	0.48 J	0.38 J	0.41
Lead		0.015	mg/L	0.001 U	0.00038 J	0.001 U	0.001 U	0.001 U	0.00052 J	0.001 U	0.001 U		0.001 U		0.001 U
Lithium		0.04	mg/L	0.008 U	0.008 U	0.0027 J	0.0016 J	0.008 U	0.003 J	0.008 U	0.002 J		0.008 U		0.002 J
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 UJ	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	0.03	0.024	0.021	0.031	0.025	0.017	0.013	0.0086 J		0.028		0.03
Radium, Total	5		pCi/L	0.49 U	1.58 O	0.468 J+	0.394	0.461 U	0.455 U	0.6 J+	0.492 UJ		0.379 U		
Radium-226			pCi/L	0.143 U	1.02 O	0.394 U	0.167 J+	0.123 U	0.155 J+	0.326 J+	0.123 J		0.121		
Radium-228			pCi/L	0.49 U	0.678 U	0.431 U	0.387 U	0.461 U	0.455 U	0.28 U	0.492 UJ		0.379 U		
Selenium	0.05	0.05	mg/L	0.026	0.018	0.012	0.014	0.0084	0.0074	0.0057	0.0027 J		0.019		0.016
Thallium	0.002	0.002	mg/L	0.0021	0.003	0.003	0.0025	0.0027	0.0032	0.0031	0.0039		0.003		0.0026
Field Parameters															
Dissolved Oxygen			mg/L	5.92	5.61	5.62	5.04	5.88	6.14	7.26	6.44	5.8	6.9	8.4	0.25
Oxidation-Reduction Potential			millivolts	52.2	119.8	-38.4	199.7	46.9	144.2	151.5	140	109.8	-49.6	-53.4	54.8
pH			SU	7.36	6.7	6.76	7.17	7.54	6.73	6.93	5.66	5.76	7.07	6.54	7.38
Specific Conductance			uS/cm	504	677	501	536	629	855	738	851	708	602	900	634
Temperature			deg C	15.38	17.25	17.09	13.19	11.32	11.96	14.85	16.8	16.95	11.4	11	15.9
Turbidity			NTU	1.1	0.66	0.53	0.33	0.4	0.97	0.77	0.77	0.32	0.35	1.05	0.68

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Background													
				GAMW-08													
				2016-07-14	2016-09-12	2016-11-14	2017-01-13	2017-03-03	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-20	2018-03-20	2018-04-26	2018-10-16
Analyte	MCL	Table A-6	Unit	N	N	N	N	FD	N	N	N	N	N	FD	N	N	N
Appendix III Parameters																	
Boron		4	mg/L	0.14	0.13	0.12 J	0.13 J	0.2 U	0.2 U	0.12 U	0.11 J	0.1 J	0.2 U			0.12	0.11
Calcium			mg/L	59	56	58	66	67	66	69	57	55	52			64	58
Chloride			mg/L	2.1	2.1	2	2.2	2.3	2.3	3.5	2.1	2.4	2.6			1.2	2.3
Fluoride	4	0.8	mg/L	1.3	1.4	1.1	1.1 J	1.2	1.2	1.3 J	1.2	1.2	1.5	1.1	1.1	1.1	1.2
pH			SU	7.23	6.99	7.21	7.38		7.16	7.46	7.4	7.45	7.63		7.57	7.43	7.11
Sulfate			mg/L	22	18	14	16	22	22	65	25	19	17			21	21
Total Dissolved Solids			mg/L	250	210	230	270	290	260	300	220	220	200			240	220
Appendix IV Parameters																	
Antimony	0.006	0.006	mg/L	0.002 U	0.0016 J	0.0017 J	0.002 U	0.002 U	0.002 U	0.0013 J	0.0012 J	0.0016 J		0.0018 J	0.0014 J		0.0013 J
Arsenic	0.01	0.01	mg/L	0.0024 J	0.0019 J	0.0018 J	0.0022 J	0.005 U	0.005 U	0.0036 J	0.0033 J	0.0031 J		0.0024 J	0.0026 J		0.0045 J
Barium	2	2	mg/L	0.025	0.021	0.021	0.024	0.026	0.026	0.03	0.022	0.022		0.022	0.022		0.02
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
Cadmium	0.005	0.005	mg/L	0.0014	0.0012	0.0016	0.0015	0.0015	0.0015	0.0018	0.0014	0.0015		0.0018	0.0017		0.0014
Chromium	0.1	0.1	mg/L	0.0016 J	0.0016 J	0.0015 J	0.002 U	0.002 U	0.002 U	0.0015 J	0.0016 J	0.0013 J		0.001 J	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		0.001 U	0.001 U		0.001 U
Fluoride	4	0.8	mg/L	1.3	1.4	1.1	1.1 J	1.2	1.2	1.3 J	1.2	1.2	1.5	1.1	1.1	1.1	1.2
Lead		0.015	mg/L	0.001 U	0.00016 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		0.04	mg/L	0.017	0.019	0.023	0.016	0.017	0.018	0.019	0.013	0.016		0.016	0.015		0.015
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 UJ	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	0.015	0.016	0.013	0.015	0.015	0.02	0.015	0.015		0.012	0.011		0.013
Radium, Total	5		pCi/L	0.354 U	0.589	0.564 J+	0.424	0.451 U	0.357 U	0.329 U	0.325 U	0.49 UJ		0.304 U	0.393		
Radium-226			pCi/L	0.166	0.0906 U	0.424 U	0.167 U	0.121 U	0.124 U	0.124 U	0.135 J+	0.0605 UJ		0.0685 U	0.0884 U		
Radium-228			pCi/L	0.354 U	0.582 U	0.391 U	0.396 U	0.451 U	0.357 U	0.329 U	0.325 U	0.49 UJ		0.304 U	0.368		
Selenium	0.05	0.05	mg/L	0.0062	0.0054	0.0041 J	0.0064	0.0062	0.0063	0.0095	0.0053	0.0046 J		0.0064	0.0057		0.0068
Thallium	0.002	0.002	mg/L	0.0029	0.0024	0.0022	0.002	0.0023	0.0022	0.0023	0.0021	0.0024		0.0018	0.0017		0.0017
Field Parameters																	
Dissolved Oxygen			mg/L	6.5	5.93	7.96	6.47		6.31	7.86	9.1	8.83	6.89		5.97	9.05	7.44
Oxidation-Reduction Potential			millivolts	130.9	109	132.4	110.9		87.5	110.7	196.9	98.3	87.5		-69.1	-53.6	-14.1
pH			SU	7.23	6.99	7.21	7.38		7.16	7.46	7.4	7.45	7.63		7.57	7.43	7.11
Specific Conductance			uS/cm	346	365	324	375		413	495	334	326	332		297	378	382
Temperature			deg C	15.4	18	17.1	14.3		12.83	13	15.3	16.8	17.2		12.2	12.2	16
Turbidity			NTU	0.95	1.98	2.88	1.34		1.94	0.9	1.34	0.43	0.34		0.36	0.71	0.69

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Background														
				GAMW-11														
				2016-07-15	2016-09-12	2016-11-15	2017-01-13	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-08-28	2017-10-05	2017-10-05	2018-03-20	2018-04-26	2018-04-26	2018-10-17
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	FD	N	FD	N	N	FD	N	N
Appendix III Parameters																		
Boron		4	mg/L	0.25	0.22	0.29	0.31	0.31	0.28	0.31	0.25	0.25	0.28	0.27		0.23	0.23	0.21
Calcium			mg/L	77	71	84	79	82	81	92	91	93	86	88		77	75	67
Chloride			mg/L	11	15	11	12	15	12	8.9	12	11	12	11		8	8.2	6.4
Fluoride	4	0.8	mg/L	1.1	1.1	1.1	1.2 J	1.1	1.3 J	1.4 J	1.3 J	1.3 J	1.8 J	1.8 J	1.6 J	1.6 J	1.6 J	2
pH			SU	7.06	7.04	7.63	6.96	6.93	7.23	6.93		7.16		7.21	7.24		7.31	7.18
Sulfate			mg/L	120	120	130	94	100	110	110	140	130	150	160		91	92	88
Total Dissolved Solids			mg/L	430	400	420	370	420	390	430	460	450	440	470		350	360	330
Appendix IV Parameters																		
Antimony	0.006	0.006	mg/L	0.002 U	0.0003 J	0.00036 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0008 J			0.002 U			0.002 U
Arsenic	0.01	0.01	mg/L	0.0035 J	0.0018 J	0.0087	0.006	0.0082	0.0043 J	0.0043 J	0.0039 J	0.0043 J			0.005 U			0.005 U
Barium	2	2	mg/L	0.03	0.028	0.034	0.03	0.034	0.033	0.031	0.041	0.042			0.037			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	0.00044 J			0.001 U			0.001 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	0.00036 J			0.001 U			0.001 U
Chromium	0.1	0.1	mg/L	0.0016 J	0.0012 J	0.0008 J	0.002 U	0.002 U	0.002 U	0.0013 J	0.002 U	0.001 J			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	0.00043 J			0.00021 J			0.001 U
Fluoride	4	0.8	mg/L	1.1	1.1	1.1	1.2 J	1.1	1.3 J	1.4 J	1.3 J	1.3 J	1.8 J	1.8 J	1.6 J	1.6 J	1.6 J	2
Lead		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
Lithium		0.04	mg/L	0.00043 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 UJ	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	0.052	0.037	0.05	0.047	0.052	0.049	0.054	0.045	0.046			0.058			0.056
Radium, Total	5		pCi/L	0.376 U	0.613 U	0.508 J+	0.367 U	0.402 U	0.657	0.528 J+	0.348 UJ	0.415 J			0.369			
Radium-226			pCi/L	0.149 U	0.127 U	0.409 U	0.148 U	0.105	0.173 J+	0.0858 U	0.0924 J	0.102 J			0.145 J+			
Radium-228			pCi/L	0.376 U	0.613 U	0.375 U	0.367 U	0.402 U	0.484 J+	0.455 J+	0.348 UJ	0.337 UJ			0.369 U			
Selenium	0.05	0.05	mg/L	0.039	0.017	0.09	0.073	0.057	0.035	0.033	0.033	0.034			0.029			0.019
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	0.00025 J	0.00044 J			0.001 U			0.001 U
Field Parameters																		
Dissolved Oxygen			mg/L	5.88	3.86	6.45	6.53	5.1	5.07	6.89		7.53		6.53	7.24		6.72	6.26
Oxidation-Reduction Potential			millivolts	115.5	124.5	109.2	118.4	132.4	99.9	240.4		82.5		110.1	-66.3		-47.8	33.6
pH			SU	7.06	7.04	7.63	6.96	6.93	7.23	6.93		7.16		7.21	7.24		7.31	7.18
Specific Conductance			uS/cm	525	610	601	541	600	566	558		672		663	508		537	529
Temperature			deg C	15.3	17.7	16.1	13.7	12.53	12.53	14.8		16		16.5	11.8		12.5	15
Turbidity			NTU	1.1	3.31	2.15	2.39	1.86	0.99	1.17		0.74		0.73	0.74		1.1	2.12

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 1											
				GAMW-09											
				2016-07-14	2016-09-09	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-20	2018-04-26	2018-10-17
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters															
Boron		4	mg/L	0.27	0.26	0.31	0.25	0.24	0.26	0.26	0.26	0.23		0.28	0.28
Calcium			mg/L	60	57	59	59	59	67	75	72	60		76	84
Chloride			mg/L	8.4	17	14	13	13	13	12	11	13		13	7.5
Fluoride	4	0.8	mg/L	2.3	1.6	1.7 J	2	1.5	1.9 J	1.6 J	1.6 J	1.6	2	1.3 J	1.8
pH			SU	7.21	7.28	7.1	7.34	7.2	7.41	7.3	7.15	7.28	7.33	7.54	7.29
Sulfate			mg/L	90	120	100	93	99	110	97	86	79		85	78
Total Dissolved Solids			mg/L	350	320 J	330	320	290	340	360	360	290		360	370
Appendix IV Parameters															
Antimony	0.006	0.006	mg/L	0.002 U	0.00071 J	0.00078 J	0.002 U	0.002 U	0.0008 J	0.00072 J	0.002 O		0.00084 J		0.00078 J
Arsenic	0.01	0.01	mg/L	0.0021 J	0.0015 J	0.0016 J	0.0017 J	0.005 U	0.0022 J	0.0023 J	0.0026 J		0.0016 J		0.0015 J
Barium	2	2	mg/L	0.029	0.025	0.025	0.026	0.025	0.03	0.03	0.03		0.034	0.033	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	0.00039 J+		0.001 U		0.001 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00026 J	0.001 U	0.00053 J		0.00031 J		0.00031 J
Chromium	0.1	0.1	mg/L	0.00086 J	0.00037 J	0.00042 J	0.00038 J	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	0.00038 J		0.001 U		0.001 U
Fluoride	4	0.8	mg/L	2.3	1.6	1.7 J	2	1.5	1.9 J	1.6 J	1.6 J	1.6	2	1.5 J	1.8
Lead		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
Lithium		0.04	mg/L	0.008 U	0.008 U	0.007 J	0.0064 J	0.0083	0.0088	0.0079 J	0.0074 J		0.0074 J		0.008
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 UJ	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	0.019	0.016	0.018	0.017	0.019	0.017	0.02	0.023		0.02	0.022	0.025
Radium, Total	5		pCi/L	0.446	0.71 U	0.407 U	0.409 U	0.43 U	0.361 U	0.288 U	0.454 UJ		0.376	0.225	
Radium-226			pCi/L	0.146 U	0.146	0.398 U	0.177 U	0.125 U	0.136 U	0.0911 U	0.086 UJ		0.0813 U	0.0875	
Radium-228			pCi/L	0.382 U	0.71 U	0.407 U	0.409 U	0.43 U	0.361 U	0.288 U	0.454 UJ		0.299 U	0.137	
Selenium	0.05	0.05	mg/L	0.0075	0.0012 J	0.0027 J	0.0028 J	0.0066	0.0062	0.0082	0.0093		0.0055	0.0053	0.012
Thallium	0.002	0.002	mg/L	0.0039	0.0033	0.0038	0.0036	0.0039	0.0043	0.0043	0.0046		0.0047	0.0045	0.0043
Field Parameters															
Dissolved Oxygen			mg/L	4.28	6.1	8.42	5.56	3.71	4.82	5.56	3.96	1.26	3.18	3.58	2.37
Oxidation-Reduction Potential			millivolts	117.7	110	137.2	103.1	99	113.7	218.9	131.1	71	-36.2	-105.6	-6.5
pH			SU	7.21	7.28	7.1	7.34	7.2	7.41	7.3	7.15	7.28	7.33	7.54	7.29
Specific Conductance			uS/cm	479	534	482	462	493	536	484	518	471	482	559	616
Temperature			deg C	16.5	17.4	17.7	16.9	17.4	17.2	18.2	17.9	18.1	16.1	16.1	15.2
Turbidity			NTU	0.79	1.21	0.72	1.14	0.9	0.7	1.06	0.24	0.1	0.3	0.51	1.7

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 1												
				GAMW-10												
				2016-07-15	2016-07-15	2016-09-12	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-20	2018-04-26	2018-10-17
Analyte	MCL	Table A-6	Unit	FD	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters																
Boron		4	mg/L	0.32	0.33	0.33	0.31	0.47	0.58	0.31	0.26	0.2	0.58		0.57	0.36
Calcium			mg/L	43	44	50	49	66	68	63	55	52	53		60	44
Chloride			mg/L	11	11	15	12	14	16	9.8	6.2	12	12		5.9	5.2
Fluoride	4	0.8	mg/L	2.7	2.7	1.9	1.7	1.8 J	1.7	2.3	2.5	2.6	3.2	2.5	2.2	1.8
pH			SU		7.22	7.29	7.19	7.29	7.05	7.34	7.36	7.4	7.37	7.46	7.56	7.34
Sulfate			mg/L	89	88	120	94	130	140	98	59	66	110		83	66
Total Dissolved Solids			mg/L	270	280	280	280	330	330	330	270	270	300		300	230
Appendix IV Parameters																
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00065 J	0.00071 J	0.002 U	0.002 U	0.00058 J	0.00069 J	0.00063 J		0.00074 J		0.002 U
Arsenic	0.01	0.01	mg/L	0.0012 J	0.0011 J	0.0009 J	0.00094 J	0.0012 J	0.005 U	0.0015 J	0.0016 J	0.005 U		0.001 J		0.005 U
Barium	2	2	mg/L	0.031	0.031	0.033	0.036	0.042	0.043	0.033	0.025	0.024		0.031	0.03	0.017
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
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.00031 J	0.001 U	0.001 U	0.001 U	0.00028 J		0.00024 J		0.00025 J
Chromium	0.1	0.1	mg/L	0.002 U	0.00061 J	0.00063 J	0.00044 J	0.00046 J	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		0.001 U		0.001 U
Fluoride	4	0.8	mg/L	2.7	2.7	1.9	1.7	1.8 J	1.7	2.3	2.5	2.6	3.2	2.5	2.3	1.8
Lead		0.015	mg/L	0.001 U	0.001 U	0.00025 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		0.04	mg/L	0.0064 J	0.0063 J	0.008 U	0.0067 J	0.0066 J	0.008 U	0.0065 J	0.0045 J	0.0043 J		0.0041 J		0.0075 J
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 UJ	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	0.11	0.069	0.037	0.034	0.036	0.018	0.025	0.046		0.025	0.029	0.12
Radium, Total	5		pCi/L	0.382 U	0.383	0.547 U	0.416 U	0.789	0.37 U	0.423	0.366 U	0.486 UJ		0.403	0.0816	
Radium-226			pCi/L	0.267	0.138 U	0.128	0.416 U	0.28 J+	0.116 U	0.191 J+	0.105 J+	0.0943 J		0.0717 U	0.0503	
Radium-228			pCi/L	0.382 U	0.337 U	0.547 U	0.342 U	0.508 J+	0.37 U	0.418 U	0.366 U	0.486 UJ		0.346	0.0314	
Selenium	0.05	0.05	mg/L	0.0051	0.005 U	0.0025 J	0.0027 J	0.0068	0.0063	0.0072	0.0074	0.0039 J		0.0086	0.0075	0.0051
Thallium	0.002	0.002	mg/L	0.0053	0.0053	0.0059	0.0073	0.0067	0.0077	0.0046	0.0042	0.0049		0.004	0.0042	0.0036
Field Parameters																
Dissolved Oxygen			mg/L		7.99	6.99	10.3	6.88	6.97	6.93	6.81	7.22	6.74	6.53	8.74	6.77
Oxidation-Reduction Potential			millivolts		163	126.7	123.4	132.1	102.5	113.5	240.1	139.9	81.6	-26.9	-89.8	8.3
pH			SU		7.22	7.29	7.19	7.29	7.05	7.34	7.36	7.4	7.37	7.46	7.56	7.34
Specific Conductance			uS/cm		315	470	384	488	555	494	370	383	407	406	465	349
Temperature			deg C		15.34	19.1	18.8	17	16.52	15.6	17.4	17.2	18.2	15	15.1	15.7
Turbidity			NTU		1.02	1.11	1.03	1.41	1.2	1.39	1.13	0.57	0.3	0.45	0.81	4.76

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 1												
				GAMW-15												
				2017-03-06	2017-03-29	2017-05-01	2017-05-24	2017-06-15	2017-07-06	2017-08-02	2017-08-28	2017-10-05	2018-03-20	2018-04-26	2018-04-26	2018-10-18
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	FD	N	N
Appendix III Parameters																
Boron		4	mg/L	0.23	0.29	0.21	0.25	0.22	0.21	0.22	0.2	0.21		0.46	0.47	0.27
Calcium			mg/L	58	61	57	57	63	57	59	56	60		76	75	58
Chloride			mg/L	16	15	16	16	14	14	14	11	14		16	16	10
Fluoride	4	0.8	mg/L	0.65 J	1.1	0.93 J	1	0.99 J	0.87 J	0.81 J	0.76 J	0.96 J	1 J	0.73 J	0.74 J	0.7
pH			SU	6.99	6.73	7.3	7.1	7.07	7.21	6.82	7.23	7.11	7.21		7.27	7.5
Sulfate			mg/L	100	120	92	95	86	85	80	75	89		140	130	79
Total Dissolved Solids			mg/L	310	280	280	290	280	310	280	290	320		400	380	300
Appendix IV Parameters																
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.00093 J	0.00094 J	0.002 U	0.002 U		0.00057 J			0.002 U
Arsenic	0.01	0.01	mg/L	0.0022 J	0.00084 J	0.00096 J	0.00087 J	0.0011 J	0.0013 J	0.0021 J	0.0012 J		0.005 U			0.005 U
Barium	2	2	mg/L	0.03	0.034	0.028	0.027	0.029	0.026	0.027	0.026		0.037		0.039	0.022
Beryllium	0.004	0.004	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00035 J	0.001 U	0.001 U		0.001 U			0.001 U
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.00023 J	0.00028 J	0.00031 J	0.001 U	0.00033 J	0.00027 J		0.00045 J			0.00025 J
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
Cobalt		0.006	mg/L	0.00024 J	0.00013 J	0.001 U	0.001 U	0.00019 J	0.001 U	0.001 U	0.001 U		0.001 U			0.001 U
Fluoride	4	0.8	mg/L	0.65 J	1.1	0.93 J	1	0.99 J	0.87 J	0.81 J	0.76 J	0.96 J	1 J	0.73 J	0.74 J	0.7
Lead		0.015	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.00062 J	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	0.0021 J	0.008 U	0.008 U	0.002 J	0.0024 J	0.0017 J		0.0021 J			0.002 J
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
Molybdenum		0.1	mg/L	0.028	0.025	0.021	0.024	0.032	0.047	0.029	0.022		0.022		0.024	0.028
Radium, Total	5		pCi/L	0.502 U	0.485 U	0.346 U	0.404 U	0.342 U	0.41 U	0.301 U	0.575 J		0.616		0.381	
Radium-226			pCi/L	0.127 U	0.138 U	0.123 U	0.117 U	0.0925 U	0.138 U	0.0683 U	0.0762 UJ		0.0828 U		0.102	
Radium-228			pCi/L	0.502 U	0.485 U	0.346 U	0.404 U	0.342 U	0.41 U	0.301 U	0.537 J		0.545		0.279	
Selenium	0.05	0.05	mg/L	0.0027 J	0.0037 J	0.0033 J	0.0035 J	0.0057	0.0057	0.0075	0.0066		0.0081		0.015	0.0077
Thallium	0.002	0.002	mg/L	0.0024	0.0025	0.0024	0.0024	0.0024	0.0026	0.0027	0.0027		0.0029		0.0031	0.0019
Field Parameters																
Dissolved Oxygen			mg/L	0.59	1.56	1.89	1.44	1.77	3.16	2.67	4.67	2.9	2.46		2.9	2.88
Oxidation-Reduction Potential			millivolts	-12.5	29.2	106.7	-50	51.1	213.2	202.6	133.2	74.3	-77.6		-81	-17.2
pH			SU	6.99	6.73	7.3	7.1	7.07	7.21	6.82	7.23	7.11	7.21		7.27	7.5
Specific Conductance			uS/cm	479	465	465	471	456	420	441	442	579	526		587	515
Temperature			deg C	19.3	19.01	17.8	18.2	18.87	19	18.6	18.2	18.1	16.4		16.5	15.5
Turbidity			NTU	0.37	0.59	1.61	0.45	1.05	1.19	0.56	2.1	0.46	0.65		0.65	2.65

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 1											
				MW-112											
				2016-07-15	2016-09-12	2016-11-15	2017-01-12	2017-03-06	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-20	2018-04-30	2018-10-18
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters															
Boron		4	mg/L	0.19	0.2	0.28	0.21	0.2 U	0.098 U	0.08 J	0.12 J	0.2 U		0.14	0.097 J
Calcium			mg/L	98	90	98	100	98	87	96	96	99		100	100
Chloride			mg/L	2.7	6	10	6.8	6.1	21	33	3.2	3.8		8.4	26
Fluoride	4	0.8	mg/L	1.5	1.7	1.5	1.5 J	1.5	1.6 J	1.6 J	1.6 J	1.9 J	1.5 J	1.2 J	1.1
pH			SU	7.13	7.14	7.86 O	7.22	7.26	7.33	7.35	7.4	7.23	7.38	7.31	7.06
Sulfate			mg/L	69	66	120	87	76	55	56	64	78		87	74
Total Dissolved Solids			mg/L	410	380	440	470	370	340	380	370	390		360	380
Appendix IV Parameters															
Antimony	0.006	0.006	mg/L	0.002 U	0.00068 J	0.00065 J	0.002 U	0.002 U	0.002 U	0.002 U	0.00067 J		0.002 U		0.002 U
Arsenic	0.01	0.01	mg/L	0.0014 J	0.0011 J	0.0009 J	0.001 J	0.0019 J	0.00092 J	0.001 J	0.001 J		0.005 U		0.0014 J
Barium	2	2	mg/L	0.034	0.034	0.036	0.036	0.033	0.028	0.029	0.035		0.024	0.034	0.042
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
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
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		0.0012 J		0.002 U
Cobalt		0.006	mg/L	0.001 U	0.0005 J	0.00055 J	0.00051 J	0.00087 J	0.00043 J	0.001 U	0.00053 J		0.001 U		0.0014
Fluoride	4	0.8	mg/L	1.5	1.7	1.5	1.5 J	1.5	1.6 J	1.6 J	1.6 J	1.9 J	1.5 J	1.2 J	1.1
Lead		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
Lithium		0.04	mg/L	0.007 J	0.008 U	0.0081	0.0065 J	0.008 U	0.0046 J	0.0026 J	0.0046 J		0.0027 J		0.018
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 UJ	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	0.052	0.054	0.067	0.056	0.051	0.025	0.03	0.034		0.031	0.034	0.04
Radium, Total	5		pCi/L	0.478 U	0.559 U	0.498 U	0.525	0.596	0.323 U	0.361 U	0.44 UJ		0.418	0.438	
Radium-226			pCi/L	0.183 U	0.124	0.498 U	0.153 U	0.174	0.155 J+	0.0998 J+	0.0666 UJ		0.0805 U	0.0568	
Radium-228			pCi/L	0.478 U	0.559 U	0.443 U	0.422 J+	0.422 J+	0.323 U	0.361 U	0.44 UJ		0.349	0.381	
Selenium	0.05	0.05	mg/L	0.0074	0.0068	0.0037 J	0.0063	0.0059	0.0036 J	0.005	0.0062		0.0091	0.0031 J	0.0059
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
Field Parameters															
Dissolved Oxygen			mg/L	1.63	0.99	0.52	0.59	0.21	0.3	0.53	0.56	0.56	3.86	1.91	2.91
Oxidation-Reduction Potential			millivolts	148.2	116.8	94.8	132.4	6.6	101.1	235.4	141	89.5	-58.6	-114.7	23.7
pH			SU	7.13	7.14	7.86 O	7.22	7.26	7.33	7.35	7.4	7.23	7.38	7.31	7.06
Specific Conductance			uS/cm	529	578	608	574	595	541	440	519	568	340	643	633
Temperature			deg C	16	19.7	18.3	15.1	14.2	13.8	16.5	17.7	18.5	13.3	13.7	16.7
Turbidity			NTU	0.36	0.72	1.1	0.31	0.79	0.86	1.01	0.31	0.2	0.28	0.38	1.81

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 2											
				GAMW-05											
				2016-07-14	2016-09-12	2016-11-15	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-26	2018-10-16
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters															
Boron		4	mg/L	0.15	0.16	0.21	0.21	0.2 U	0.11 U	0.13 J	0.15 J	0.2 U		0.098 J	0.077 J
Calcium			mg/L	46	48	57	52	44	44	50	46	45		41	36
Chloride			mg/L	1.2	2.1	1.7	1.7	0.71 J	0.9 J	1.2	1	1		0.98 J	1.5
Fluoride	4	0.8	mg/L	0.53 J	0.98 J	0.7 J	0.6 J	0.76 J	0.98 J	0.86 J	0.69 J	0.82 J	0.85 J	0.64 J	0.54
pH			SU	6.94	6.92	7.13	6.93	7.1	7	8.23	6.38	5.88	7.14	6.75	6.34
Sulfate			mg/L	19	23	20	18	22	21	22	18	21		20	16
Total Dissolved Solids			mg/L	190	200	210	220	220	180	180	200	170		160	140
Appendix IV Parameters															
Antimony	0.006	0.006	mg/L	0.002 U	0.00067 J	0.0015 J	0.002 U	0.002 U	0.00087 J	0.002 U	0.002 U		0.002 U		0.002 U
Arsenic	0.01	0.01	mg/L	0.0023 J	0.002 J	0.0024 J	0.0025 J	0.005 U	0.002 J	0.0022 J	0.0036 J		0.0032 J		0.0047 J
Barium	2	2	mg/L	0.017	0.019	0.023	0.021	0.017	0.015	0.017	0.02		0.017	0.016	0.013
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		0.00079 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		0.00033 J
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00039 J	0.00047 J	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	0.00024 J	0.00044 J	0.00044 J	0.001 U	0.00025 J	0.001 U	0.00068 J		0.00026 J		0.00071 J
Fluoride	4	0.8	mg/L	0.53 J	0.98 J	0.7 J	0.6 J	0.76 J	0.98 J	0.86 J	0.69 J	0.82 J	0.85 J	0.64 J	0.54
Lead		0.015	mg/L	0.001 U	0.00027 J	0.00024 J	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	0.008 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 UJ	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	0.025	0.026	0.026	0.027	0.017	0.018	0.023	0.023		0.016	0.018	0.012
Radium, Total	5		pCi/L	0.35 U	0.685 U	0.788 J+	0.479	0.392 U	0.385 U	0.277 U	0.506 J		0.31 U	0.635	
Radium-226			pCi/L	0.191 U	0.0833 U	0.436 U	0.287 J+	0.0836	0.131 U	0.123 J+	0.06 UJ		0.0827 U	0.0772	
Radium-228			pCi/L	0.35 U	0.685 U	0.449 U	0.423 U	0.392 U	0.385 U	0.277 U	0.479 J		0.31 U	0.558	
Selenium	0.05	0.05	mg/L	0.005 U	0.0043 J	0.005	0.0031 J	0.005 U	0.0043 J	0.0043 J	0.0029 J		0.0034 J		0.0017 J
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		0.00023 J
Field Parameters															
Dissolved Oxygen			mg/L	1.8	2.34	1.45	0.55	1.15	2.33	1.84	0.69	0.23	1.92	0.67	0.11
Oxidation-Reduction Potential			millivolts	7.3	76.8	-77.1	84.5	61	54.8	55.5	123.2	96.9	-68.7	-99.6	2.1
pH			SU	6.94	6.92	7.13	6.93	7.1	7	8.23	6.38	5.88	7.14	6.75	6.34
Specific Conductance			uS/cm	225	317	287	304	288	261	274	269	253	198	242	253
Temperature			deg C	14.57	15.97	15.67	13.34	12.46	12.12	14.08	15.47	15.37	11.9	12.1	14.9
Turbidity			NTU	4.22	3.44	1.45	0.54	0.76	1.67	2.59	3.97	3.82	4.76	4.88	2.95

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.
"J+" = Indicates the result was estimated and may be biased high.
"J-" = Indicates the result was estimated and may be biased low.
"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 2													
				GAMW-06													
				2016-07-15	2016-09-09	2016-11-14	2017-01-12	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-26	2018-04-26	2018-10-16
Analyte	MCL	Table A-6	Unit	N	N	N	FD	N	N	N	N	N	N	N	FD	N	N
Appendix III Parameters																	
Boron		4	mg/L	0.19	0.2	0.25	0.22	0.22	0.2 U	0.19 U	0.18 J	0.19 J	0.2 U			0.15	0.16
Calcium			mg/L	72	68	83	81	84	77	72	78	78	72			69	66
Chloride			mg/L	2.2	4.5	2.2	1.9 J	1.9 J	1.7	1.4 J	1.4 J	1.3 J	1.5			1.7	1.7
Fluoride	4	0.8	mg/L	0.12 J	0.32 J	0.37 J	0.48 J	0.49 J	0.57 J	0.78 J	0.8 J	0.86 J	1	1	1.1	0.96 J	1.1
pH			SU	6.77	6.82	7.14		6.81	7.2	7	8.23	6.45	5.97	7.36		7.13	6.53
Sulfate			mg/L	54	64	51	50	50	49	46	48	49	46			50	44
Total Dissolved Solids			mg/L	300	280 J	340	330	330	330	290	300	320	300			270	260
Appendix IV Parameters																	
Antimony	0.006	0.006	mg/L	0.002 U	0.0012 J	0.0023	0.002 U	0.002 U	0.002 U	0.0012 J	0.0014 J	0.0018 J		0.0022	0.0012 J	0.001 J	0.0011 J
Arsenic	0.01	0.01	mg/L	0.0016 J	0.0015 J	0.002 J	0.0017 J	0.0017 J	0.005 U	0.0023 J	0.0028 J	0.0023 J		0.0016 J	0.005 U		0.0011 J
Barium	2	2	mg/L	0.024	0.023	0.027	0.025	0.026	0.023	0.022	0.024	0.025		0.022	0.02	0.02	0.022
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	0.00032 J	0.001 U		0.001 U			0.0007 J
Cadmium	0.005	0.005	mg/L	0.001 U	0.001 U	0.00043 J	0.001 U	0.001 U	0.001 U	0.00024 J	0.001 U	0.00045 J		0.00043 J	0.00028 J		0.00041 J
Chromium	0.1	0.1	mg/L	0.002 U	0.00033 J	0.002 U	0.002 U	0.00059 J	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	0.00026 J		0.001 U	0.001 U		0.001 U
Fluoride	4	0.8	mg/L	0.12 J	0.32 J	0.37 J	0.48 J	0.49 J	0.57 J	0.78 J	0.8 J	0.86 J	1	1	1.1	1	1.1
Lead		0.015	mg/L	0.001 U	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
Lithium		0.04	mg/L	0.0013 J	0.008 U	0.00085 J	0.00046 J	0.00051 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 UJ	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	0.02	0.048	0.027	0.027	0.026	0.022	0.023	0.023		0.022	0.021	0.021	0.019
Radium, Total	5		pCi/L	0.385 U	0.69 U	0.411 U	0.625	0.399 U	0.401 U	0.41 U	0.303 U	0.454 UJ		0.333 U	0.223	0.145	
Radium-226			pCi/L	0.169	0.0869	0.379 U	0.203 U	0.164 U	0.117	0.182 J+	0.125 J+	0.0828 J		0.122	0.0494	0.0523	
Radium-228			pCi/L	0.385 U	0.69 U	0.411 U	0.495	0.399 U	0.401 U	0.41 U	0.303 U	0.454 UJ		0.333 U	0.174	0.0927	
Selenium	0.05	0.05	mg/L	0.0092	0.0096	0.012	0.01	0.011	0.011	0.011	0.012	0.011		0.012	0.0098	0.0087	0.0081
Thallium	0.002	0.002	mg/L	0.0039	0.004	0.0047	0.0038	0.0039	0.0038	0.0032	0.0039	0.0047		0.0038	0.0034	0.0034	0.0045
Field Parameters																	
Dissolved Oxygen			mg/L	1.26	2.52	2.19		1.64	1.54	2.18	2.16	1.45	1.04	2.56		4.41	1.51
Oxidation-Reduction Potential			millivolts	181.2	109.4	143.4		221	63.9	80.3	76.6	141.4	114.4	-62.1		-93.4	-7
pH			SU	6.77	6.82	7.14		6.81	7.2	7	8.23	6.45	5.97	7.36		7.13	6.53
Specific Conductance			uS/cm	411	484	488		483	508	415	445	468	452	315		401	466
Temperature			deg C	14.1	18.4	16.9		13.9	12.66	11.88	14.65	16.19	16.63	11.8		11.9	15.9
Turbidity			NTU	1.44	1.22	0.74		0.68	1.31	0.51	0.6	0.77	0.37	0.35		0.84	0.83

Note:

mg/L = milligrams per liter

uS/cm = micro Siemens per centimeter

deg C = degrees Celsius

NTU = Nephelometric Turbidity Units

SU = Standard Units

pCi/L = picocuries per liter

"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 2															
				GAMW-07															
				2016-07-14	2016-09-09	2016-09-09	2016-11-14	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-27	2018-10-16	2018-10-16
Analyte	MCL	Table A-6	Unit	N	FD	N	FD	N	N	N	FD	N	N	N	N	N	N	FD	N
Appendix III Parameters																			
Boron		4	mg/L	0.2	0.27	0.27	0.28	0.27	0.28	0.22	0.23	0.23	0.21	0.15 J	0.2 U		0.2	0.14	0.13
Calcium			mg/L	60	55	52	61	59	67	69	78	76	69	57	73		68	55	52
Chloride			mg/L	9.1	9.8 J+	9.8	4	3.9	3.3	2.2	1.9 J	1.9 J	1.6	1.2	1.1		1.4	1.4	1.3
Fluoride	4	0.8	mg/L	2.9	2.7 J+	2.6	2.2 J	2.3	2.3	2.5	2.1	2.3	2.7	2.4	3	2.7	2.5	2.6	2.6
pH			SU	6.5		6.83		6.95	7	6.53		6.65	7.08	6.95	6.97	7.27	7.46		6.78
Sulfate			mg/L	84	99	99	82	82	88	94	110	120	77	50	90		96	59	59
Total Dissolved Solids			mg/L	310	270 J	250 J	270	300	310	340	350	350	280	250	300		310	250	230
Appendix IV Parameters																			
Antimony	0.006	0.006	mg/L	0.002 U	0.0011 J	0.001 J	0.0009 J	0.001 J	0.002 U	0.002 U	0.0011 J	0.00099 J	0.00065 J	0.002 U		0.0011 J		0.00085 J	0.00079 J
Arsenic	0.01	0.01	mg/L	0.0048 J	0.0055	0.0049 J	0.0052	0.0052	0.0052	0.005 U	0.005	0.005	0.0068	0.0059		0.0046 J		0.0038 J	0.0038 J
Barium	2	2	mg/L	0.017	0.015	0.014	0.014	0.013	0.015	0.015	0.019	0.018	0.017	0.017		0.023	0.02	0.014	0.013
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
Cadmium	0.005	0.005	mg/L	0.001 U	0.0008 J	0.00073 J	0.00086 J	0.00086 J	0.001	0.0013	0.0011	0.0011	0.0014	0.00073 J		0.0011	0.0014	0.00084 J	0.00084 J
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	0.00064 J	0.00062 J	0.00072 J	0.00068 J	0.00079 J	0.001 U	0.00058 J	0.0006 J	0.001 U	0.00082 J		0.00042 J		0.00042 J	0.00041 J
Fluoride	4	0.8	mg/L	2.9	2.7 J+	2.6	2.2 J	2.3	2.3	2.5	2.1	2.3	2.7	2.4	3	2.7	2.8	2.6	2.6
Lead		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	0.023	0.026	0.025	0.03	0.031	0.025	0.026	0.016	0.016	0.018	0.024		0.018	0.023	0.028	0.028
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 UJ	0.0002 UJ	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	0.023	0.027	0.025	0.02	0.022	0.019	0.021	0.04	0.041	0.019	0.0063 J		0.04	0.029	0.014	0.014
Radium, Total	5		pCi/L	0.382 U	0.801 U	0.697 U	0.63 J+	0.455 U	0.478 U	0.36 U	0.46	0.45 U	0.312 U	0.471 UJ		0.404	0.484		
Radium-226			pCi/L	0.15 U	0.0986 U	0.0905 U	0.417 U	0.455 U	0.174 U	0.0889 U	0.14 J+	0.15 U	0.0956 U	0.0893 J		0.09	0.0569		
Radium-228			pCi/L	0.382 U	0.801 U	0.697 U	0.548 U	0.421 U	0.478 U	0.36 U	0.424 U	0.45 U	0.312 U	0.471 UJ		0.316 U	0.427		
Selenium	0.05	0.05	mg/L	0.0061	0.0055	0.0059	0.004 J	0.0035 J	0.0036 J	0.005 U	0.007	0.0065	0.0039 J	0.005 U		0.0044 J		0.0058	0.0063
Thallium	0.002	0.002	mg/L	0.0073	0.011	0.01	0.013	0.013	0.015	0.014	0.0074	0.0074	0.0096	0.012		0.011	0.01	0.012	0.011
Field Parameters																			
Dissolved Oxygen			mg/L	0.48		1.45		0.62	0.52	0.37		0.54	0.87	0.42	0.79	0.37	2.11		1.82
Oxidation-Reduction Potential			millivolts	137.8		107.8		136	65.8	50.1		94.9	226.7	121.4	25.2	-165.6	-88.4		-18.9
pH			SU	6.5		6.83		6.95	7	6.53		6.65	7.08	6.95	6.97	7.27	7.46		6.78
Specific Conductance			uS/cm	399		444		412	429	466		572	377	344	410	393	470		407
Temperature			deg C	15		18.3		17.8	14.5	13.16		13.1	15.2	16.7	17.4	12.8	12.8		16.4
Turbidity			NTU	0.97		1.09		1.13	0.71	1.5		2.68	1.91	2.97	2.73	1.48	3.54		1.4

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Primary 2											
				GAMW-16											
				2017-03-06	2017-03-29	2017-05-01	2017-05-24	2017-06-15	2017-07-06	2017-08-02	2017-08-28	2017-10-05	2018-03-20	2018-04-27	2018-10-18
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters															
Boron		4	mg/L	0.43	0.44	0.4	0.42	0.37	0.39	0.37	0.31	0.35		0.47	0.28
Calcium			mg/L	88	86	88	91	96	85	75	78	86		100	73
Chloride			mg/L	9.4	7.7	6.8	6.9	5.5	6	7.4	7.1	8.3		6.2	5
Fluoride	4	0.8	mg/L	1.4	1.9	1.9 J	2.1	1.9 J	2	2	2.2	2.1	1.9 J	1.6 J	1.7
pH			SU	7.81	7.34	7.41	7.72	7.67	7.53	6.89	7.46	7.62	7.8	7.93	7.5
Sulfate			mg/L	140	160	150	170	160	150	120	120	170		190	110
Total Dissolved Solids			mg/L	430	390	400	440	420	430	330	360	450		490	340
Appendix IV Parameters															
Antimony	0.006	0.006	mg/L	0.002 U	0.0027 O	0.0011 J	0.00099 J	0.0013 J	0.0012 J	0.0011 J	0.0012 J		0.0012 J		0.001 J
Arsenic	0.01	0.01	mg/L	0.012	0.016	0.018	0.017	0.018	0.017	0.013	0.013		0.017	0.013	0.013
Barium	2	2	mg/L	0.013	0.013	0.012	0.014	0.014	0.013	0.011	0.01		0.015	0.015	0.0082
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
Cadmium	0.005	0.005	mg/L	0.001 U	0.00032 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
Chromium	0.1	0.1	mg/L	0.0015 J	0.0015 J	0.0011 J	0.0011 J	0.002 U	0.001 J	0.0013 J	0.0014 J		0.002 U		0.0019 J
Cobalt		0.006	mg/L	0.001 U	0.00033 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
Fluoride	4	0.8	mg/L	1.4	1.9	1.9 J	2.1	1.9 J	2	2	2.2	2.1	1.9 J	1.6 J	1.7
Lead		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
Lithium		0.04	mg/L	0.068	0.077	0.076	0.067	0.065	0.063	0.064	0.063		0.063	0.066	0.059
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
Molybdenum		0.1	mg/L	0.17	0.068	0.065	0.086	0.08	0.079	0.12	0.041		0.087	0.098	0.033
Radium, Total	5		pCi/L	0.489 U	0.44 U	0.381 U	0.325 U	0.295 U	0.473 J+	0.301 U	0.605 J		0.319 U	-0.0407	
Radium-226			pCi/L	0.129 U	0.126 U	0.0888 U	0.117 U	0.0852 U	0.189 J+	0.0814 U	0.0757 UJ		0.0818 U	0.0168	
Radium-228			pCi/L	0.489 U	0.44 U	0.381 U	0.325 U	0.295 U	0.405 U	0.301 U	0.561 J		0.319 U	-0.0575	
Selenium	0.05	0.05	mg/L	0.011	0.014	0.012	0.014	0.014	0.014	0.0091	0.0078		0.016	0.013	0.01
Thallium	0.002	0.002	mg/L	0.0021	0.0024	0.0023	0.0024	0.0026	0.0028	0.0024	0.0027		0.0033	0.0028	0.0023
Field Parameters															
Dissolved Oxygen			mg/L	2.79	5.53	6.79	6.89	6.81	7.81	6.96	6.64	5.06	6.29	7.73	7.24
Oxidation-Reduction Potential			millivolts	53.8	45.9	101.2	-31.7	58.2	188.3	195.7	131.2	54.2	-61.1	-66.2	3.2
pH			SU	7.81	7.34	7.41	7.72	7.67	7.53	6.89	7.46	7.62	7.8	7.93	7.5
Specific Conductance			uS/cm	595	536	607	637	602	509	479	502	596	571	606	486
Temperature			deg C	14.46	13.86	13.7	13.84	15.17	15.5	15.5	16.3	16.7	13.7	13.2	15.6
Turbidity			NTU	0.62	0.35	0.73	0.32	0.19	0.93	0.69	0.44	0.34	0.45	0.57	1.35

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Secondary 1															
				GAMW-02															
				2016-07-14	2016-07-14	2016-09-09	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-27	2018-04-27	2018-10-15	2018-10-15
Analyte	MCL	Table A-6	Unit	FD	N	N	N	N	N	N	FD	N	N	N	N	FD	N	FD	N
Appendix III Parameters																			
Boron		4	mg/L	0.27	0.28	0.3	0.31	0.27	0.32	0.33	0.33	0.34	0.34	0.39			0.27	0.28	0.29
Calcium			mg/L	86	86	78	97	99	96	82	79	80	83	77			74	77	81
Chloride			mg/L	2.8	2.8	7	4.1	3.3	2.3	1.9 J	1.7 J	1.8 J	1.9 J	1.9 J			1.5 J	1.4	1.4
Fluoride	4	0.8	mg/L	3.1	3.2	3.3	2.9	2.7	3	3.2	2.9	3	2.8	3.7	3	3	2.9	2.7	2.7
pH			SU		7.54	7.25	6.86	7.04	7.56	7.19		6.66	6.37	6.34	7.53		7.75		7.38
Sulfate			mg/L	110	110	99	110	97	100	100	81	82	90	91			73	100	100
Total Dissolved Solids			mg/L	440	420	380 J	450	420	420	370	360	360	390	380			340	360	360
Appendix IV Parameters																			
Antimony	0.006	0.006	mg/L	0.002 U	0.002 U	0.00085 J	0.00072 J	0.002 U	0.002 U	0.00069 J	0.002 U	0.002 U	0.002 U		0.00057 J	0.002 U		0.002 U	0.002 U
Arsenic	0.01	0.01	mg/L	0.0022 J	0.0021 J	0.0018 J	0.0033 J	0.0024 J	0.005 U	0.0032 J	0.0031 J	0.0029 J	0.0026 J		0.005 U	0.005 U		0.005 U	0.005 U
Barium	2	2	mg/L	0.038	0.038	0.03	0.035	0.031	0.029	0.027	0.026	0.026	0.031		0.025	0.023	0.023	0.024	0.025
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
Cadmium	0.005	0.005	mg/L	0.0021	0.0021	0.0019	0.0023	0.0022	0.0021	0.0016	0.0017	0.0017	0.0021		0.0015	0.0015	0.0015	0.0017	0.0018
Chromium	0.1	0.1	mg/L	0.002 U	0.002 U	0.00036 J	0.00028 J	0.00035 J	0.002 U	0.002 U	0.002 U	0.0014 J	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	0.00014 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
Fluoride	4	0.8	mg/L	3.1	3.2	3.3	2.9	2.7	3	3.2	2.9	3	2.8	3.7	3	3	2.9	2.7	2.7
Lead		0.015	mg/L	0.001 U	0.001 U	0.00025 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		0.04	mg/L	0.018	0.018	0.02	0.022	0.016	0.017	0.016	0.013	0.012	0.017		0.012	0.014	0.015	0.015	0.015
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002 U	0.0001 J	0.0002 UJ	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	0.033	0.034	0.023	0.044	0.041	0.043	0.039	0.037	0.037	0.035		0.03	0.03	0.03	0.025	0.027
Radium, Total	5		pCi/L	0.489 U	0.397	0.644 U	0.496 U	0.734	0.416 U	0.52	0.38 J+	0.333 U	0.431 UJ		0.366 U	0.187	0.249		
Radium-226			pCi/L	0.178	0.121 U	0.0844 U	0.496 U	0.169 U	0.147	0.225 J+	0.274 J+	0.169 J+	0.0825 UJ		0.0984 U	0.0307	0.116		
Radium-228			pCi/L	0.489 U	0.397 U	0.644 U	0.439 U	0.628 J+	0.416 U	0.318 U	0.332 U	0.333 U	0.431 UJ		0.366 U	0.156	0.133		
Selenium	0.05	0.05	mg/L	0.018	0.017	0.013	0.027	0.021	0.025	0.024	0.021	0.02	0.02		0.017	0.018	0.017	0.019	0.022
Thallium	0.002	0.002	mg/L	0.0035	0.0035	0.0038	0.0044	0.0033	0.0038	0.0035	0.0038	0.0039	0.0035		0.0033	0.0035	0.0033	0.0034	0.0036
Field Parameters																			
Dissolved Oxygen			mg/L		4.39	2.84	2.54	2.52	2.16	1.73		2.45	3.15	1.55	3.3		3.66		3.54
Oxidation-Reduction Potential			millivolts		55.3	104.1	-24.4	171.1	45.2	136.8		174.4	122.9	93	-80.6		-32.8		70.9
pH			SU		7.54	7.25	6.86	7.04	7.56	7.19		6.66	6.37	6.34	7.53		7.75		7.38
Specific Conductance			uS/cm		517	589	585	643	661	565		522	572	584	384		476		546
Temperature			deg C		16.73	18.87	17.22	13	12.08	12.61		16.35	18.19	18.27	11.4		11		16.3
Turbidity			NTU		1.58	0.34	0.49	0.48	0.69	0.78		0.91	0.62	0.4	0.43		0.67		0.61

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Secondary 1														
				GAMW-03														
				2016-07-14	2016-09-09	2016-11-14	2016-11-14	2017-01-12	2017-01-12	2017-03-03	2017-05-01	2017-05-01	2017-07-06	2017-08-28	2017-10-05	2018-03-19	2018-04-27	2018-10-15
Analyte	MCL	Table A-6	Unit	N	N	FD	N	FD	N	N	FD	N	N	N	N	N	N	N
Appendix III Parameters																		
Boron		4	mg/L	0.35	0.47	0.33	0.33	0.32	0.32	0.3	0.28	0.29	0.28	0.28	0.29		0.29	0.33
Calcium			mg/L	97	110	99	100	110	110	80	87	83	97	89	84		91	89
Chloride			mg/L	6.9	7.8	4.4	4.4	4.8 J	4.8 J	2.5	3.2	3.1	4.1	3.7	4.1		4	3.8
Fluoride	4	0.8	mg/L	1.2	1.3 J	1.4 J	1.5	1.2 J	1.2 J	1.8	1.8 J	1.9 J	1.2 J	1.2 J	1.7 J	1.5 J	1.2 J	1.3
pH			SU	7.13	6.58		6.46		7.04	7.13		6.9	5.56	6.15	5.59	7.2	7.21	7.12
Sulfate			mg/L	200	270	180	180	220	220	110	150	150	170	160	160		200	190
Total Dissolved Solids			mg/L	530	590 J	480	460	520	530	380	400	400	450	440	410		450	450
Appendix IV Parameters																		
Antimony	0.006	0.006	mg/L	0.002 U	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
Arsenic	0.01	0.01	mg/L	0.0031 J	0.004 J	0.00089 J	0.00097 J	0.0011 J	0.0011 J	0.005 U	0.00081 J	0.00088 J	0.005 U	0.005 U		0.005 U		0.005 U
Barium	2	2	mg/L	0.037	0.039	0.035	0.035	0.035	0.036	0.025	0.027	0.027	0.029	0.029		0.029	0.028	0.03
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
Cadmium	0.005	0.005	mg/L	0.0014	0.0019	0.0017	0.0017	0.002	0.0021	0.0014	0.0014	0.0014	0.0018	0.0017		0.0017	0.0015	0.0018
Chromium	0.1	0.1	mg/L	0.002 U	0.00039 J	0.00027 J	0.00027 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	0.00027 J	0.00022 J	0.00024 J	0.00019 J	0.00021 J	0.001 U	0.001 U	0.00019 J	0.001 U	0.00024 J		0.001 U		0.00021 J
Fluoride	4	0.8	mg/L	1.2	1.3 J	1.4 J	1.5	1.2 J	1.2 J	1.8	1.8 J	1.9 J	1.2 J	1.2 J	1.7 J	1.5 J	1.2 J	1.3
Lead		0.015	mg/L	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	0.0087	0.0099	0.0092	0.0088	0.0088	0.0079 J	0.008 U	0.0066 J	0.0065 J	0.0063 J	0.0089		0.0062 J		0.0081
Mercury	0.002	0.002	mg/L	0.0002 U	0.0002	0.0002 UJ	0.0002 UJ	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	0.086	0.091	0.073	0.072	0.078	0.081	0.071	0.07	0.071	0.084	0.085		0.086	0.088	0.1
Radium, Total	5		pCi/L	0.372 U	1.38	0.981 J+	0.434 U	0.564	0.49 U	0.49 U	0.818 J	0.417 J	0.595 J+	0.542 J		0.411	0.671	
Radium-226			pCi/L	0.236	0.134	0.425 U	0.425 U	0.285	0.221 J+	0.177	0.176 J+	0.276 J+	0.402 J+	0.177 J		0.123	0.241	
Radium-228			pCi/L	0.372 U	1.24	0.686 J+	0.434 U	0.434 U	0.49 U	0.49 U	0.641 J+	0.354 U	0.269 U	0.394 UJ		0.315 U	0.43	
Selenium	0.05	0.05	mg/L	0.035	0.049	0.0046 J	0.0049 J	0.0098	0.0099	0.005 U	0.0018 J	0.0019 J	0.0014 J	0.0014 J		0.0067	0.0038 J	0.01
Thallium	0.002	0.002	mg/L	0.0073	0.0083	0.008	0.0082	0.0071	0.0073	0.0066	0.0056	0.0054	0.0069	0.0074		0.007	0.0068	0.0076
Field Parameters																		
Dissolved Oxygen			mg/L	2.94	2.78		1.04		2.31	0.24		0.69	1.54	0.66	0.7	1.21	1.91	0.26
Oxidation-Reduction Potential			millivolts	66.5	118		-35.8		170.3	61.1		157.9	211.2	142.5	121.8	-65.2	-151.6	90.5
pH			SU	7.13	6.58		6.46		7.04	7.13		6.9	5.56	6.15	5.59	7.2	7.21	7.12
Specific Conductance			uS/cm	596	837		578		717	601		580	603	600	574	490	600	623
Temperature			deg C	15.98	17.15		16.96		14.25	13.46		13.17	15.67	17.04	17.49	12.7	12.3	16.1
Turbidity			NTU	1.07	0.63		0.65		0.21	0.54		0.48	0.44	0.54	0.23	0.31	0.56	0.57

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

Table 2: Analytical Results for the CCR Units Monitoring
NIPSCO Bailly Generating Station
Chesterton, Indiana

				Secondary 1														
				GAMW-04														
				2016-07-14	2016-09-09	2016-11-14	2017-01-12	2017-03-03	2017-05-01	2017-07-06	2017-08-28	2017-08-28	2017-10-05	2017-10-05	2018-03-19	2018-03-19	2018-04-27	2018-10-15
Analyte	MCL	Table A-6	Unit	N	N	N	N	N	N	N	FD	N	FD	N	FD	N	N	N
Appendix III Parameters																		
Boron		4	mg/L	0.66	0.55	0.58	0.87	0.53	0.59	0.39	0.73	0.74	0.37	0.72			0.59	0.68
Calcium			mg/L	190	150	130	220	150	170	140	180	180	76	180			160	140
Chloride			mg/L	6.6	4.3	2.2 J	7.8 J	3.8	6.8	2.4	6	6.1	2	7			4.6 J	5.6
Fluoride	4	0.8	mg/L	0.3 J	2.5	2.8 J	1.1 J	3	2.1 J	3.8	2.7 J	2.5	3.6	2.5 J	2.1 J	2.1 J	2.4 J	2.2
pH			SU	6.46	8.11	6.36	6.77	6.86	6.52	7.95		5.89		5.48		6.72	6.81	6.63
Sulfate			mg/L	560	330	200	530	250	370	140	350	340	86	360			310	380
Total Dissolved Solids			mg/L	1100	750 J	670	1100	720	790	610	920	900	390	890			770	780
Appendix IV Parameters																		
Antimony	0.006	0.006	mg/L	0.002 U	0.00054 J	0.00064 J	0.002 U	0.002 U	0.002 U	0.002 U	0.00057 J	0.002 U			0.0016 J	0.002 U		0.002 U
Arsenic	0.01	0.01	mg/L	0.0071	0.005	0.0034 J	0.0015 J	0.005 U	0.0014 J	0.0042 J	0.0026 J	0.0028 J			0.003 J	0.002 J		0.0028 J
Barium	2	2	mg/L	0.061	0.062	0.056	0.11	0.058	0.063	0.046	0.096	0.1			0.065	0.065	0.068	0.084
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	0.0004 J	0.00046 J			0.00055 J	0.001 U		0.0004 J
Cadmium	0.005	0.005	mg/L	0.001 UO	0.0054	0.0081	0.0073	0.0095	0.005	0.0098	0.019	0.02			0.0073	0.0072	0.019	0.019
Chromium	0.1	0.1	mg/L	0.00083 J	0.00054 J	0.00044 J	0.00073 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U			0.002 U	0.002 U		0.0012 J
Cobalt		0.006	mg/L	0.001 U	0.00064 J	0.00026 J	0.0018	0.001 U	0.00098 J	0.001 U	0.0019	0.0021			0.0026	0.0021	0.0014	0.004
Fluoride	4	0.8	mg/L	0.3 J	2.5	2.8 J	1.1 J	3	2.1 J	3.8	2.7 J	2.5	3.6	2.5 J	2.1 J	2.1 J	2.4 J	2.2
Lead		0.015	mg/L	0.001 U	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
Lithium		0.04	mg/L	0.008 U	0.049	0.06	0.032	0.058	0.035	0.055	0.063	0.063			0.032	0.032	0.043	0.049
Mercury	0.002	0.002	mg/L	0.0002 U	0.00012 J	0.0002 UJ	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	0.032	0.029	0.033	0.033	0.033	0.03	0.026	0.029	0.03			0.033	0.032	0.022	0.02
Radium, Total	5		pCi/L	0.909	0.661 U	0.449 U	1.26	0.422	0.819	0.515 J+	0.403 J	0.374 UJ			0.568	0.66	0.468	
Radium-226			pCi/L	0.291	0.284	0.449 U	0.374 J+	0.123	0.278 J+	0.106 J+	0.181 J	0.191 J			0.114	0.159	0.253	
Radium-228			pCi/L	0.618	0.661 U	0.4 U	0.887 J+	0.417 U	0.541 J+	0.41 J+	0.378 UJ	0.374 UJ			0.455	0.5	0.215	
Selenium	0.05	0.05	mg/L	0.005 U	0.012	0.017	0.002 J	0.013	0.0052	0.022	0.012	0.012			0.0059	0.0047 J		0.002 J
Thallium	0.002	0.002	mg/L	0.001 UO	0.0016	0.0028	0.0013	0.0026	0.0016	0.0026	0.0047	0.0045			0.0022	0.002	0.0028	0.0036
Field Parameters																		
Dissolved Oxygen			mg/L	1.07	2.15	2.15	2	1.78	0.68	3.15		0.36		0.53		0.6	1.26	0.61
Oxidation-Reduction Potential			millivolts	-1.8	782.6	-35.1	45.2	82	95.8	80.8		148.4		124.9		-64.1	-167.7	104
pH			SU	6.46	8.11	6.36	6.77	6.86	6.52	7.95		5.89		5.48		6.72	6.81	6.63
Specific Conductance			uS/cm	1044	965	747	1331	986	962	790		825		1086		663	80.2	940
Temperature			deg C	15.67	17.63	16.97	14.17	13.01	13.14	15.57		16.73		17.01		12.6	12.2	16.1
Turbidity			NTU	1.7	1.03	0.7	0.67	0.76	2.44	1.73		1.51		0.84		2.71	4.16	3.77

Note:
mg/L = milligrams per liter
uS/cm = micro Siemens per centimeter
deg C = degrees Celsius
NTU = Nephelometric Turbidity Units
SU = Standard Units
pCi/L = picocuries per liter
"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 was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"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 background data set.

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

Table 3: General Groundwater Response Actions
NIPSCO Bailly Generating Station
Chesteron, Indiana

General Response Action	Comments
Limited Action	Access Restrictions Institutional Controls Use Restrictions Environmental Monitoring Monitored Natural Attenuation
Containment	Physical
Removal	Extraction
Treatment	In-Situ Ex-Situ
On-Site Disposal	Surface Water Discharge Groundwater Discharge POTW Discharge
Off-Site Disposal	Permitted Disposal Facility

Note:
POTW = Publicly Owned Treatment Works

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

Table 4: Initial Screening of Corrective Measures Technologies / Process Options for Groundwater
NIPSCO Bailly Generating Station
Chesterton, Indiana

General Response Action	Remedial Technology	Process Option	Description	Screening Comments	Retained for Further Evaluation
Limited Action	Institutional Controls	Permitting and Notices	Administrative controls to restrict groundwater use.	Potentially implementable.	Yes
		Access Restrictions	Physical restrictions or structures that prevent access by unauthorized persons.	Potentially implementable.	Yes
	Monitoring	Groundwater Monitoring	Periodic sampling and analyses of groundwater as a means of detecting unacceptable changes in constituent concentrations.	Potentially implementable.	Yes
	Use Restrictions	Deed Restrictions	Administrative controls to provide future land use restrictions.	Potentially implementable.	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
Containment	Physical	Capping	Low-permeable cap covering the former CCR Units.	Limited effectiveness. Current closure plan includes source removal and filling/grading to promote positive stormwater drainage.	No
	Containment	Vertical Barriers	Vertical barriers including slurry walls and sheet piling placed around the area of contamination to contain groundwater.	Limited constructability due to lack of, or great depth to, confining layer to key into.	No
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
		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
In Situ Treatment	Stabilization/ Solidification	Solidification	Blending soil with grout to contain and immobilize COCs in saturated soils.	Potentially implementable for the soils below the former CCR Units. Reduces mobility of COCs and the potential for plume migration.	Yes
	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.	Potentially implementable, to reduce or eliminate the mass of most COCs downgradient of the barrier.	Yes
	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
		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.	Potentially implementable, to treat most COCs in situ.	Yes
	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

Table 4: Initial Screening of Corrective Measures Technologies / Process Options for Groundwater
NIPSCO Bailly Generating Station
Chesterton, Indiana

General Response Action	Remedial Technology	Process Option	Description	Screening Comments	Retained for Further Evaluation
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
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
		On-Site Discharge to Groundwater	Treated groundwater discharged to groundwater within the Station Area.	Potentially implementable.	Yes
		POTW Discharge	Treated groundwater discharged to POTW under a discharge authorization.	No existing sanitary sewers in close proximity to BGS's to discharge to a POTW.	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

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 Corrective Measure Alternatives
NIPSCO Bailly Generating Station
Chesterton, Indiana

Alternative	Key Components
Excavation with monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Implementation of deed restrictions Environmental monitoring
Excavation with in situ stabilization/solidification and monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Implementation of deed restrictions *In situ* stabilization/solidification of saturated soil below the CCR Unit Environmental monitoring Long-term maintenance
Excavation with installation of a permeable reactive barrier and monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Installation of a permeable reactive barrier at downgradient edge of former CCR Units Implementation of deed restrictions Environmental monitoring Long-term maintenance
Excavation with injection of a reducing agent and monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Injection of reducing agents within saturated zone of former CCR Units Implementation of deed restrictions Environmental monitoring
Excavation with pump and treat, on-Site discharge and monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Implementation of deed restrictions Installation of extraction wells or extraction trenches *Ex situ* treatment of pumped groundwater with an on-Site treatment facility Disposal of treated groundwater to on-Site surface water NPDES permit Environmental monitoring Long-term maintenance
Excavation with pump and treat, on-site re-injection, and monitored natural attenuation	Removal and disposal of CCR source material from CCR Unit Permitting Implementation of deed restrictions Installation of extraction wells or extraction trenches *Ex situ* treatment of pumped groundwater with an on-Site treatment facility Re-injection of treated groundwater to on-Site groundwater NPDES permit Environmental monitoring Long-term maintenance

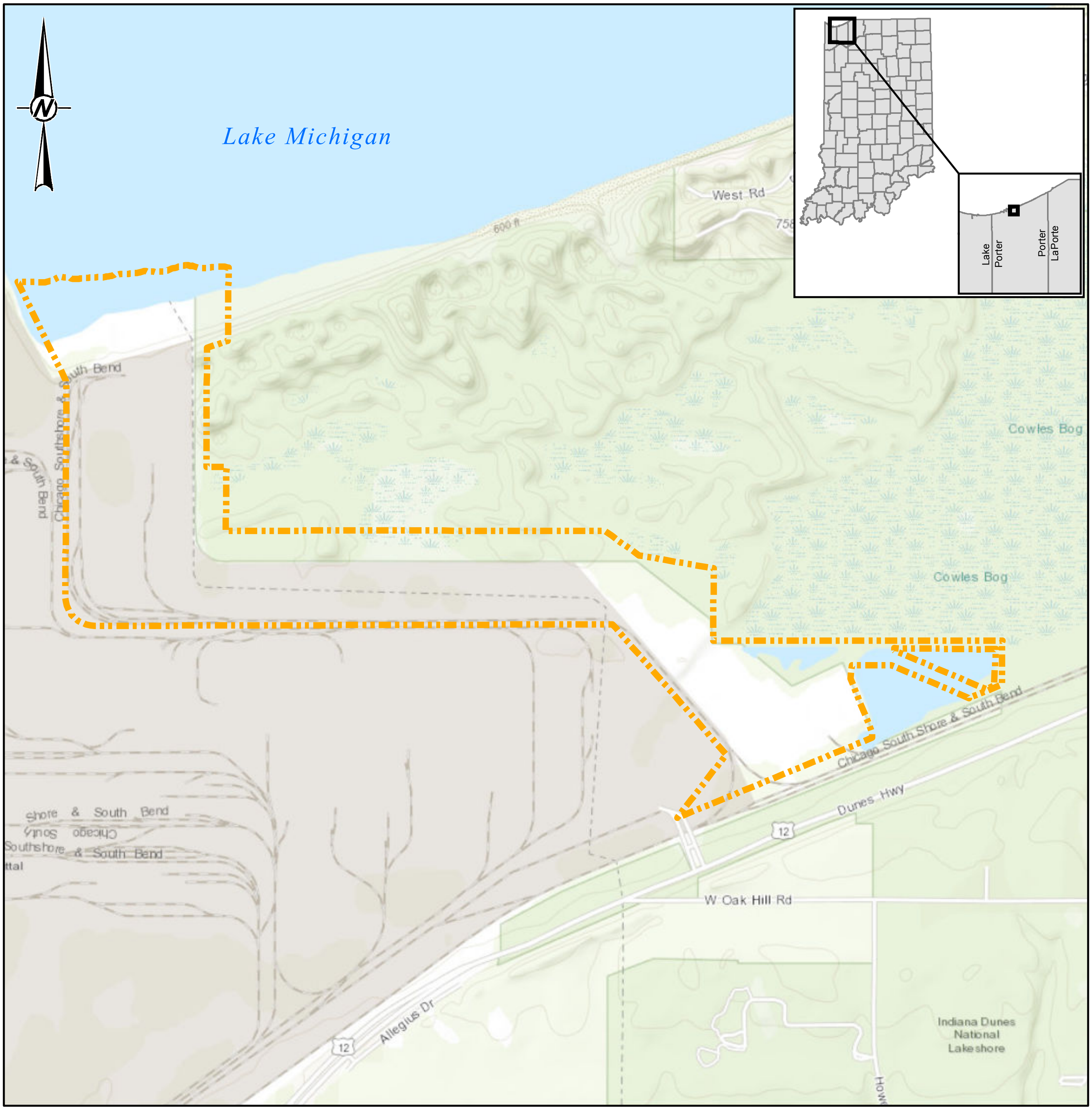
Prepared by: DFS
Checked by: KMC
Reviewed by: MAH

Table 6: Evaluation of Corrective Measure Alternatives
NIPSCO Bailly Generating Station
Chesterton, Indiana

	Corrective Measure Alternatives				
Evaluation Criteria	**Excavation with monitored natural attenuation**	**Excavation with in situ stabilization/solidification and monitored natural attenuation**	**Excavation with installation of a permeable reactive barrier and monitored natural attenuation**	**Excavation with injection of a reducing agent and monitored natural attentuation**	**Excavation with pump and treat and monitored natural attenuation**
Performance	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 unknown short-term effectiveness depending on success of excavation to remove entire source.	ISS is an effective means of immobilizing metals in saturated soil and preventing further release to groundwater; relatively effective both short-term and long-term.	A permeable reactive barrier could be an effective in reducing or eliminating the mass of most COCs downgradient of the barrier. The relative short-term and long-term effectiveness is limited by the ability of the media/injectate to treat all Site COCs.	Injection of a reducing agent could be effective in treating the Site COCs. The relative short-term and long-term effectiveness is limited by the ability of the media/injectate to treat all Site COCs.	If implemented to hydraulically control the extent of the groundwater COC plume, groundwater extraction of the contaminated groundwater could be potentially effective in reducing the volume and mobility of dissolved COCs in groundwater and preventing further migration. Relatively effective both short-term and long-term.
Reliability	Reliable due to source removal.	Stabilization should be relatively reliable.	Moderate, may not be reliable in treating all Site COCs.	Moderate, may not be reliable in treating all Site COCs.	Moderate, some O&M required and potential treatment replacement.
Ease of Implementation	Readily implementable and commonly used technologies.	Direct mixing is straightforward; some uncertainty in full extent/contact unless it can be verified; potential unseen factors, etc.	Technology is common; some installation challenges expected due to Site geology.	Technology is common; some drilling challenges expected; additional wells may be required.	Technology is common; some drilling challenges expected; additional wells may be required.
Potential Impacts	If performed properly, will reduce long-term cross media impacts, some safety concerns related to excavation.	Stabilization controls cross media impacts, some safety concerns related to excavation and augering/mixing of soils.	May not be reliable in reducing cross-media impacts for all Site COCs. Some safety concerns related to excavation and more complex construction and media change-out.	May not be reliable in reducing cross-media impacts for all Site COCs. Some safety concerns related to excavation and drilling.	Collection and treatment have good control of cross media impacts, some safety concerns related to excavation and drilling.
Time Requirements	Relatively long, no active remediation.	Moderate, likely shorter than MNA alone.	Relatively long, however, active treatment alternatives generally have shorter time requirements than MNA.	Relatively long, however, active treatment alternatives generally have shorter time requirements than MNA.	Relatively long, however, active treatment alternatives generally have shorter time requirements than MNA.
Institutional Requirements	Low permitting requirements	Low permitting requirements	Low permitting requirements	Low permitting requirements	Could require NPDES permit modifications, overall low permitting requirements
Relative Costs	Low Capital Low O&M	High Capital Low O&M	High Capital Low O&M	High Capital Moderate O&M	High Capital Moderate O&M

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

FIGURES



LEGEND

Approximate Property Line

0 1,500 3,000

1 " = 1,500 feet Feet

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION
CHESTERTON, INDIANA

TITLE

SITE LOCATION MAP

CONSULTANT

GOLDER

YYYY-MM-DD	4/12/2019
DESIGNED	DFS
PREPARED	SHL
REVIEWED	JSP
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
164-8171.01	A	0	1

REFERENCE(S)

SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

PATH: V:\001 GIS Projects\NIPSCO\Bailly\99_PROJ\164817101_EA40_PROD\0008_MNA_Feasibility_Report\164817101-0008-HS-0003.mxd PRINTED ON: 2019-04-12 AT: 3:11:31 PM

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

0 1 in

LEGEND

- CCR Unit
- Approximate Property Line

0 900 1,800

1 " = 900 feet

Feet

REFERENCE(S)

SERVICE LAYER CREDITS: © 2019 MICROSOFT CORPORATION © 2019 DIGITALGLOBE ©CNES (2019) DISTRIBUTION AIRBUS DS

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION
CHESTERTON, INDIANA

PROJECT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION

TITLE

SITE WIDE OVERVIEW

CONSULTANT

GOLDER

YYYY-MM-DD	5/1/2019
DESIGNED	JSP
PREPARED	SHL
REVIEWED	DFS
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
1527742	A	0	2

LEGEND

- Background
- Downgradient
- Non-CCR
- CCR Unit
- Approximate Property Line

0 400 800

1 " = 400 feet Feet

NOTE(S)

REFERENCE(S)

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CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION
CHESTERTON, INDIANA

TITLE

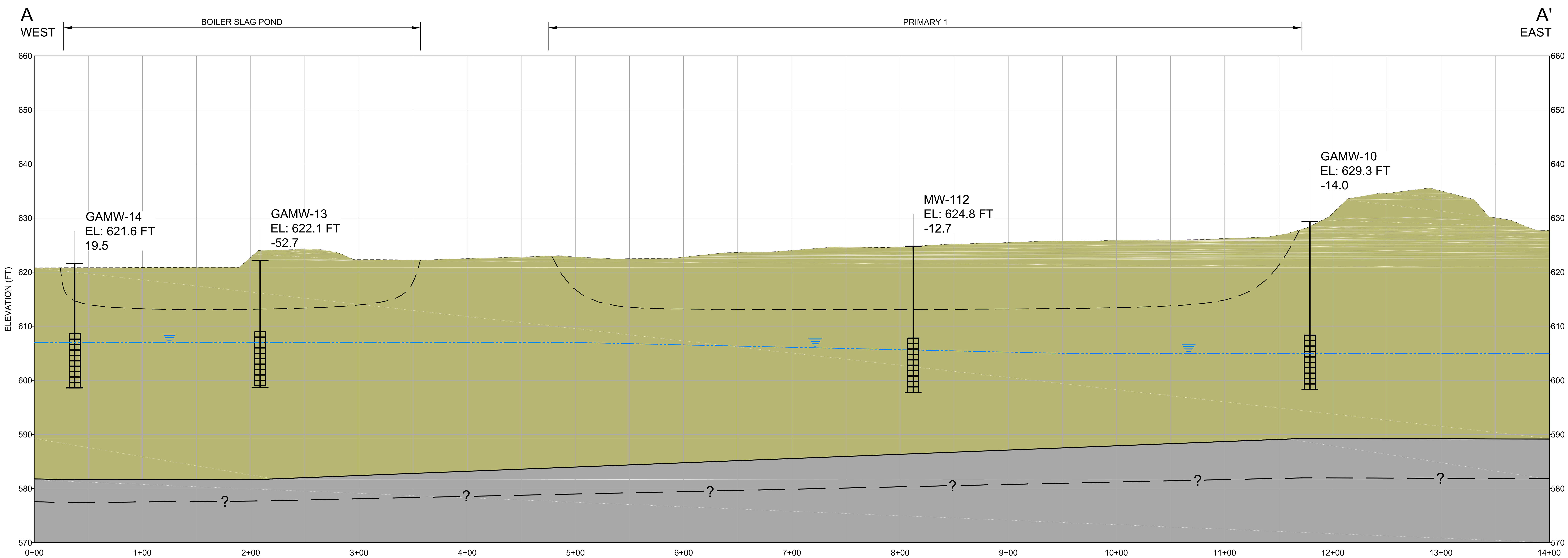
MONITORING WELL NETWORK

CONSULTANT

GOLDER

YYYY-MM-DD	5/1/2019
DESIGNED	JSP
PREPARED	SHL
REVIEWED	DFS
APPROVED	MAH

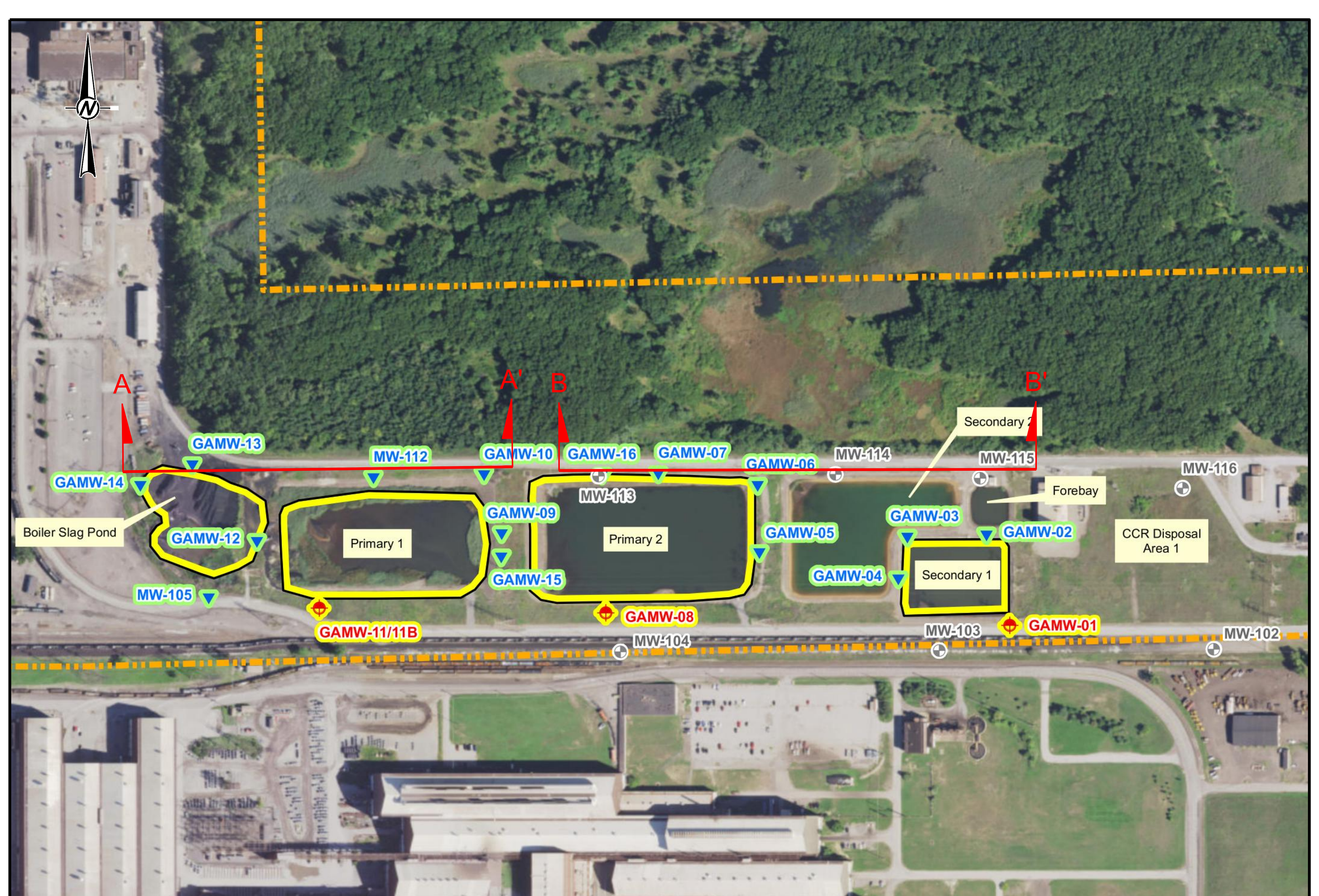
PROJECT NO.	CONTROL	REV.	FIGURE
164-8171.01	A	0	3



A-A'

VERTICAL SCALE: 0 10 20 1" = 10' FEET

HORIZONTAL SCALE: 0 50 100 1" = 50' FEET



LEGEND

GAMW-13	= WELL I.D.
EL: 622.1	= GROUND SURFACE ELEVATION
-52.7	= OFFSET DISTANCE C/L = CENTERLINE
	= GROUNDWATER ELEVATION (10/15/18)
	= WELL SCREEN
	= END OF BORING LOCATION
— ? —	CONTACT UNKNOWN
— — — —	APPROXIMATE DEPTH OF POND SUPERIMPOSED ON CROSS-SECTION
	SAND
	CLAY

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

CONSULTANT
GOLDER

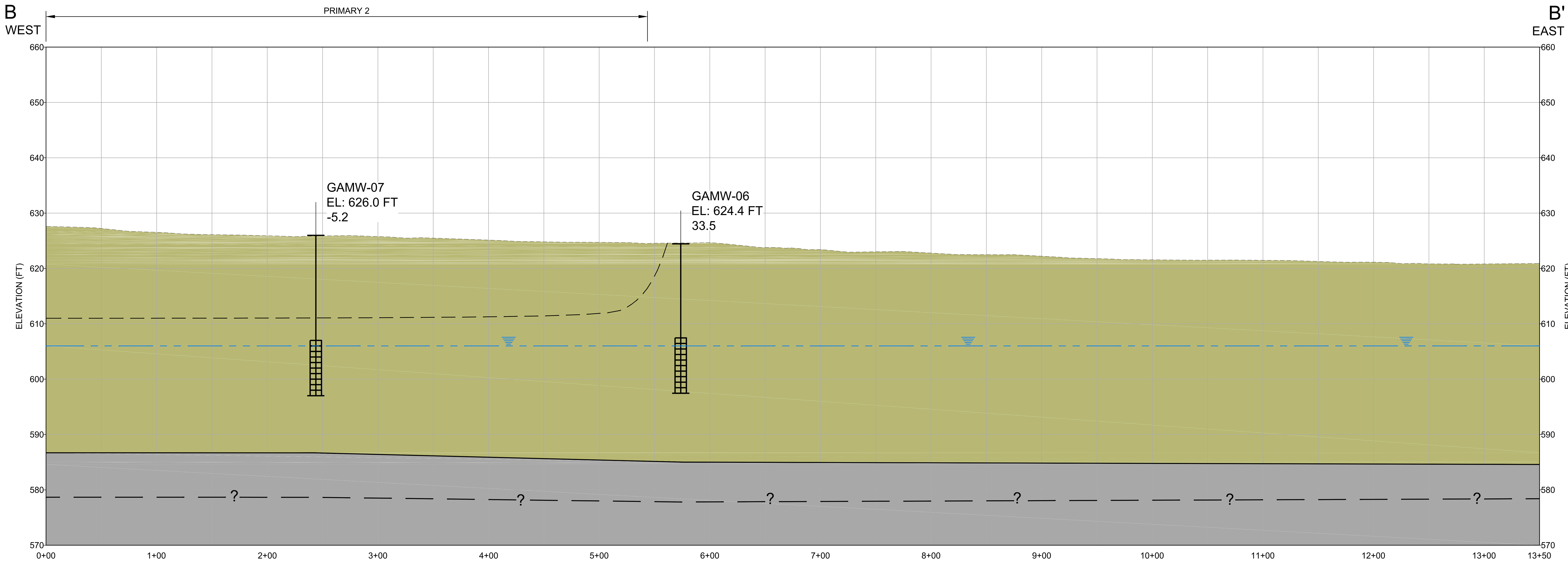
YYYY-MM-DD	2019-03-01
DESIGNED	RWC
PREPARED	RWC
REVIEWED	JSP
APPROVED	MAH

PROJECT
NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION
CHESTERTON, INDIANA

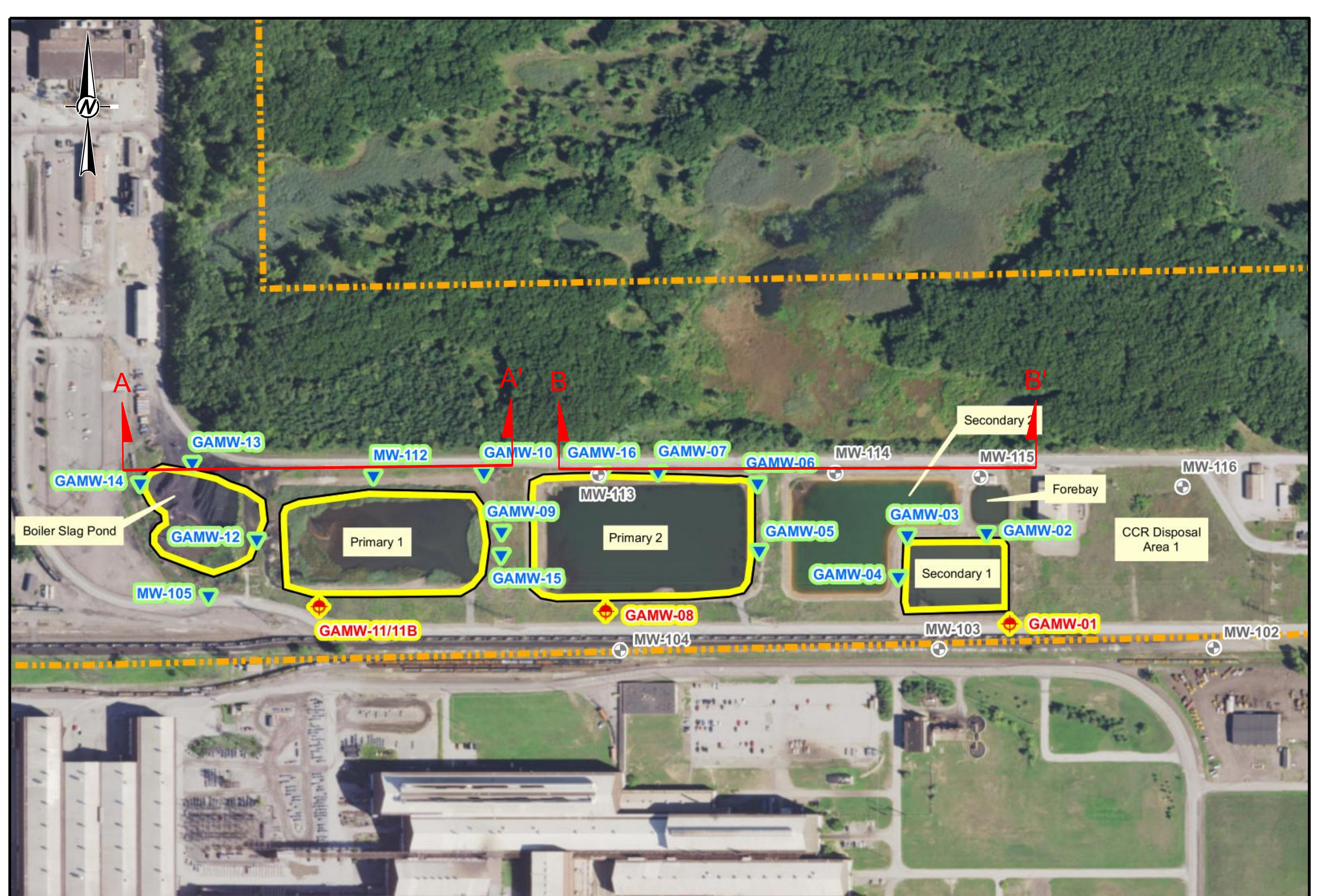
TITLE
GEOLOGIC INTERPRETATION
CROSS SECTION A-A'

PROJECT NO.	CONTROL	REV.	FIGURE
1648171	01	0	4

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



B-B'



VERTICAL SCALE: 0 10 20 — 1" = 10' FEET

HORIZONTAL SCALE: 0 50 100 — 1" = 50' FEET

LEGEND

GAMW-06	= WELL I.D.
EL: 624.4	= GROUND SURFACE ELEVATION
33.5	= OFFSET DISTANCE C/L = CENTERLINE
	= GROUNDWATER ELEVATION (10/15/18)
	= WELL SCREEN
	= END OF BORING LOCATION
—— ? ——	CONTACT UNKNOWN
— — — —	APPROXIMATE DEPTH OF POND SUPERIMPOSED ON CROSS-SECTION
	SAND
	CLAY

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
BAILLY GENERATING STATION
CHESTERTON, INDIANA

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-01
DESIGNED	RWC
PREPARED	RWC
REVIEWED	JSP
APPROVED	MAH

TITLE
GEOLOGIC INTERPRETATION
CROSS SECTION B-B'

PROJECT NO.	CONTROL	REV.	FIGURE
1648171	01	0	5

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

LEGEND

- Background Well Location
- Downgradient Well Location
- Non-CCR Well Location
- March 2018 Groundwater Elevation Contour
- Hydraulic Gradient
- CCR Unit
- Approximate Property Line
- Generalized Groundwater Flow Direction

0 400 800
1 " = 400 feet Feet

FIGURE NARRATIVE

THIS FIGURE DEPICTS THE GROUNDWATER ELEVATION 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 MARCH 19, 2018.

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.

THIS FIGURE ALSO SHOWS THE APPROXIMATE LOCATIONS OF THE NEW CCR COMPLIANT MONITORING WELL LOCATIONS BASED ON GOLDER'S KNOWLEDGE OF THE SITE AND EXISTING DATA.

REFERENCE(S)

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CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION
CHESTERTON, INDIANA

TITLE

MARCH 2018 GROUNDWATER ELEVATION

CONSULTANT

GOLDER

YYYY-MM-DD	5/1/2019
DESIGNED	JSP
PREPARED	SHL
REVIEWED	DFS
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
164-8171.01	A	0	6

APPENDIX A

SLUG TEST DATA AND CALCULATIONS

Appendix A
HYDRAULIC CONDUCTIVITY TESTING RESULTS

Well	Date	Screened Interval	Type	Test Duration	Test Number	Hvorslev Method		Bouwer and Rice Method		Hvorslev/Bouwer and Rice Average	
						cm/sec	ft/day	cm/sec	ft/day	cm/sec	ft/day
Average Shallow (13-25 ft-bgs)						**4.45E-02**	**1.26E+02**	**2.82E-02**	**7.99E+01**	**3.64E-02**	**1.03E+02**
GAMW-01	7/6/2016	13-23	Transducer (Rising)	<2 min	1	6.22E-02	1.76E+02	4.16E-02	1.18E+02	5.19E-02	1.47E+02
					2	4.04E-02	1.15E+02	2.03E-02	5.75E+01	3.04E-02	8.60E+01
GAMW-08	7/6/2016	15-25	Transducer (Rising)	<2 min	1	5.36E-02	1.52E+02	3.57E-02	1.01E+02	4.47E-02	1.27E+02
					2	9.68E-02	2.74E+02	6.19E-02	1.75E+02	7.94E-02	2.25E+02
GAMW-11	7/6/2016	14-24	Transducer (Rising)	<2 min	1	7.79E-03	2.21E+01	4.31E-03	1.22E+01	6.05E-03	1.71E+01
					2	6.25E-03	1.77E+01	5.40E-03	1.53E+01	5.83E-03	1.65E+01
Average Deep (70-75 ft-bgs)						**3.76E-02**	**1.07E+02**	**3.48E-02**	**9.86E+01**	**3.62E-02**	**1.03E+02**
GAMW-11B	7/6/2016	70-75	Transducer (Falling)	<2 min	1	3.95E-02	1.12E+02	3.91E-02	1.11E+02	3.93E-02	1.11E+02
					2	3.62E-02	1.03E+02	3.28E-02	9.30E+01	3.45E-02	9.78E+01
			Transducer (Rising)	<2 min	1	3.45E-02	9.78E+01	3.17E-02	8.99E+01	3.31E-02	9.38E+01
					2	4.02E-02	1.14E+02	3.56E-02	1.01E+02	3.79E-02	1.07E+02

Notes:

ft/day = feet per day

cm/sec = centimeters per second

Prepared by: DFS

Checked by: JRS

Reviewed by: JSP

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-01 (TEST 1)

$$K = \frac{r_c^2}{2L_e} \ln\frac{L_e}{R_e}\left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)}\right]30.48$$

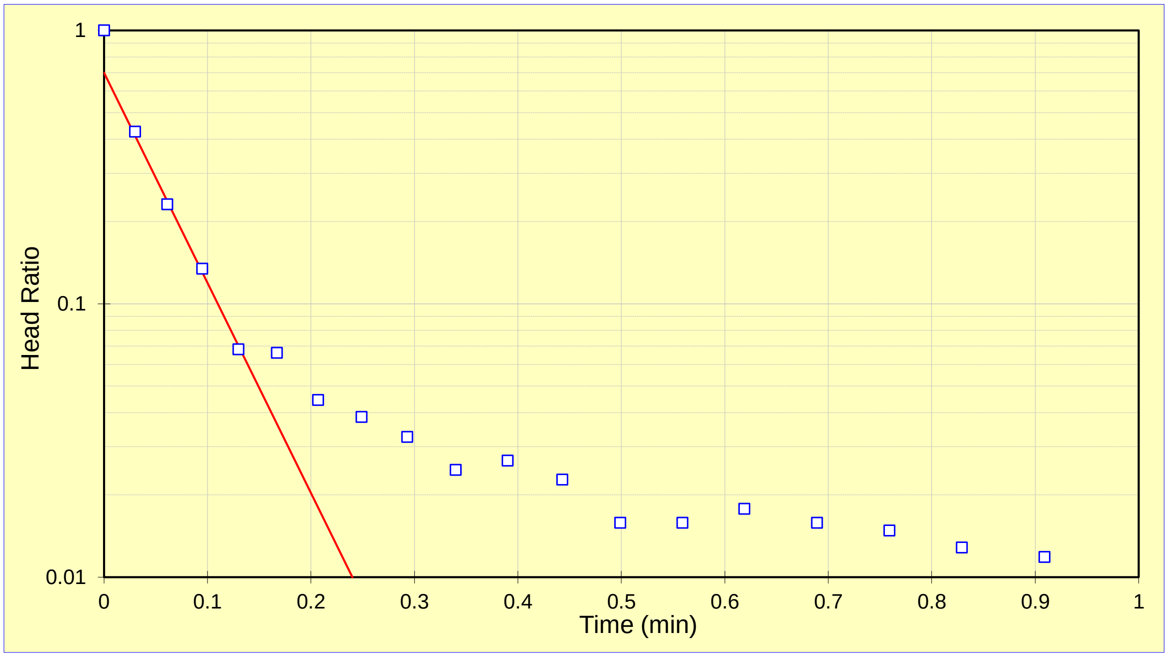
where:
- r_c = casing radius (feet)
- R_e = equivalent radius (feet)
- L_e = length of screened interval (feet)
- t = time (minutes)
- h_t = head at time t (feet)

INPUT PARAMETERS

r_c =	0.20
R_e =	0.34
L_e =	9.75
t_1 =	0
t_2 =	0.24
h_1/h_0 =	0.70
h_2/h_0 =	0.01

RESULTS

K=	6.22E-02	cm/sec
K=	1.76E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-01 (TEST 1)

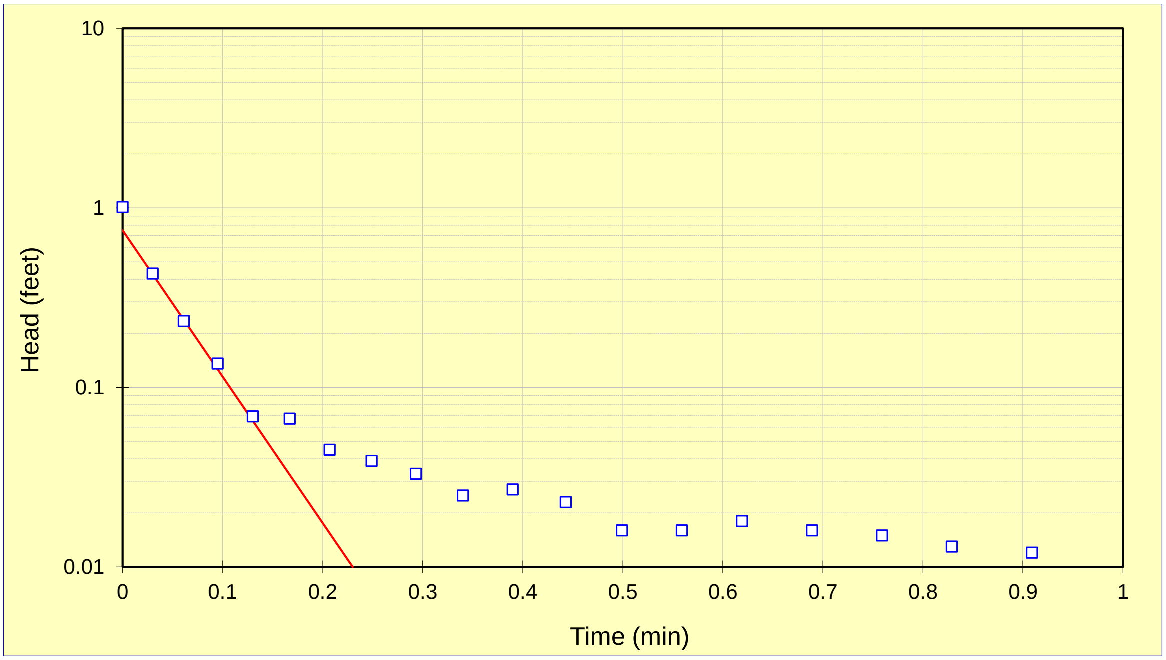
$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

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	
r_c =	0.20
r_w =	0.34
L_e =	9.75
$\ln(R_e/r_w)$=	2.11
y_0 =	0.75
y_t =	0.010
t =	0.2

RESULTS		
K=	4.16E-02	cm/sec
K=	1.18E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

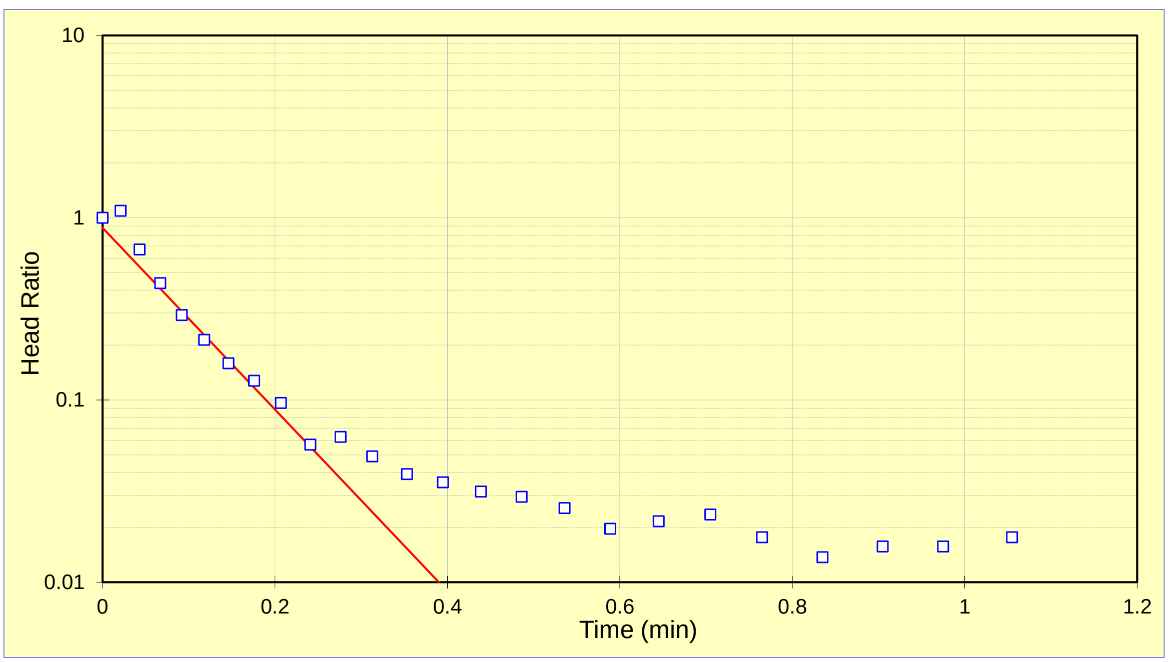
Analysis By: DFS
Checked By: JRS
Analysis Date: 7/25/2016

HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-01 (TEST 2)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

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			
R_e =	0.34			
L_e =	9.713	K=	4.04E-02	cm/sec
t_1 =	0	K=	1.15E+02	ft/day
t_2 =	0.39			
h_1/h_0 =	0.88			
h_2/h_0 =	0.01			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

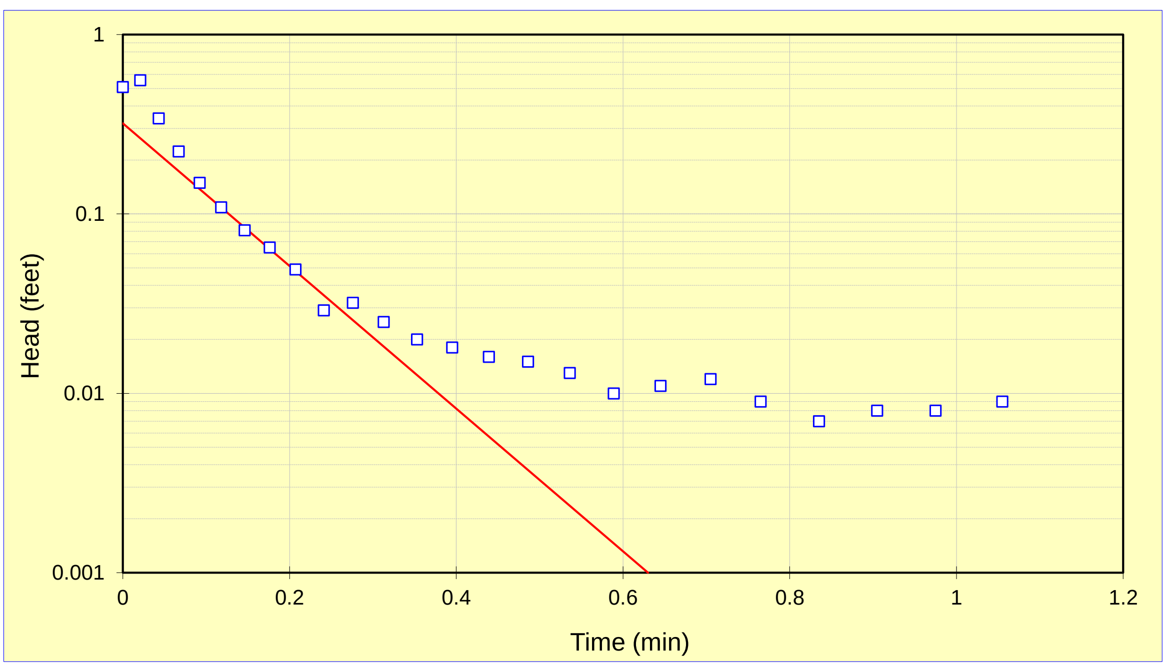
BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-01 (TEST 2)

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

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			
r_w =	0.34			
L_e =	9.713	K=	2.03E-02	cm/sec
$ln(R_e/r_w)$=	2.10	K=	5.76E+01	ft/day
y_0 =	0.32			
y_t =	0.001			
t =	0.6			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

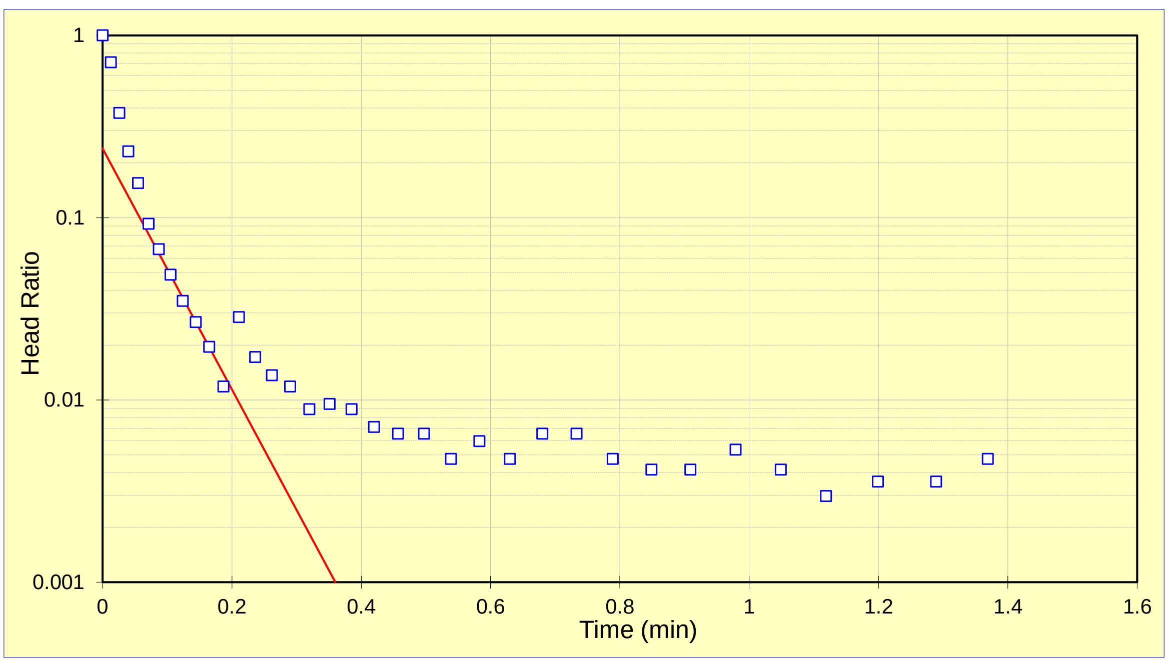
Analysis By: DFS
Checked By: JRS
Analysis Date: 7/25/2016

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-08 (TEST 1)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

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			
R_e =	0.34			
L_e =	9.73	K=	5.36E-02	cm/sec
t_1 =	0	K=	1.52E+02	ft/day
t_2 =	0.36			
h_1/h_0 =	0.24			
h_2/h_0 =	0.00			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

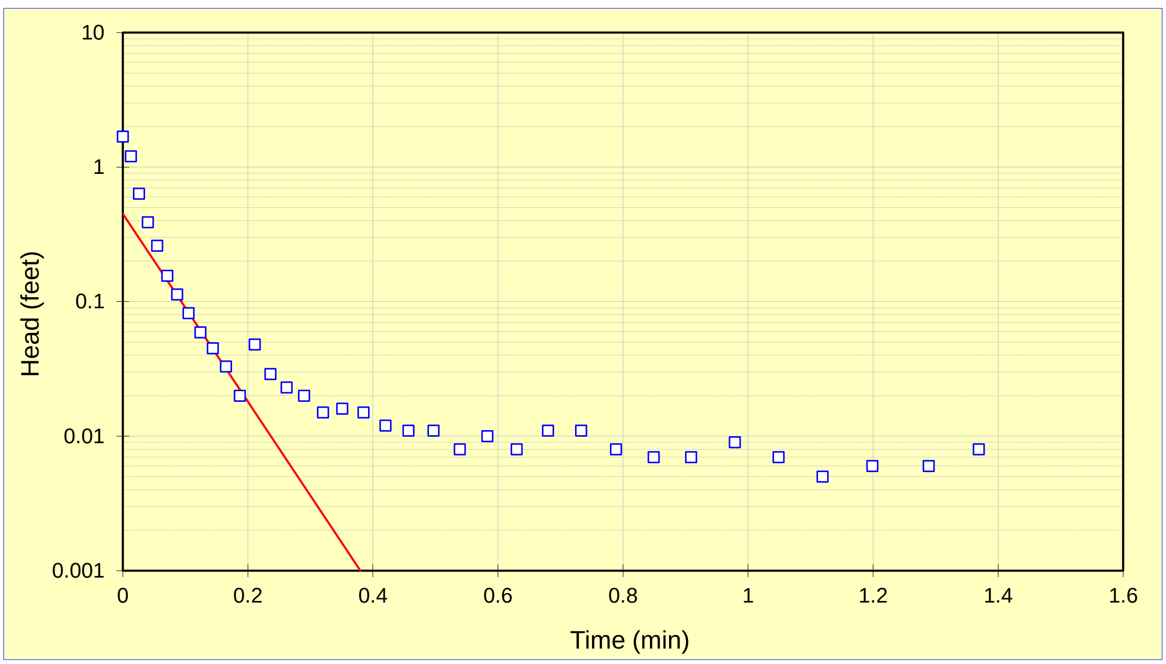
BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-08 (TEST 1)

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

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			
r_w =	0.34			
L_e =	9.73	K=	3.57E-02	cm/sec
$ln(R_e/r_w)$=	2.11	K=	1.01E+02	ft/day
y_0 =	0.45			
y_t =	0.001			
t =	0.4			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-08 (TEST 2)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

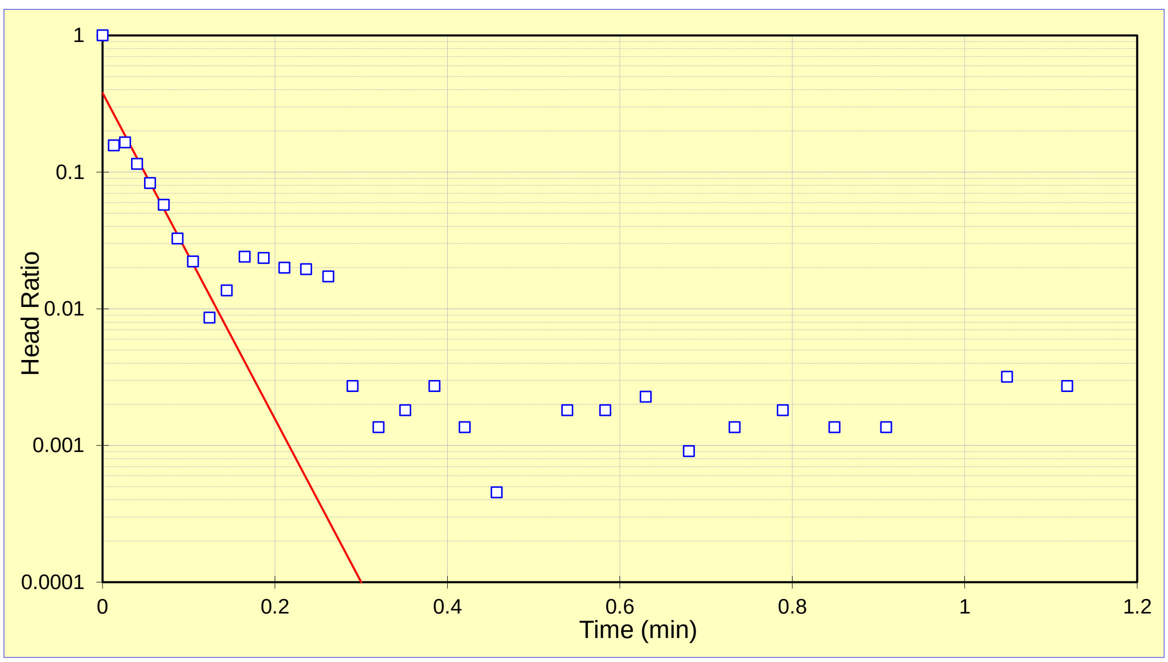
where:
- r_c = casing radius (feet)
- R_e = equivalent radius (feet)
- L_e = length of screened interval (feet)
- t = time (minutes)
- h_t = head at time t (feet)

INPUT PARAMETERS

r_c =	0.20
R_e =	0.34
L_e =	9.707
t_1 =	0
t_2 =	0.3
h_1/h_0 =	0.38
h_2/h_0 =	0.00

RESULTS

K=	9.68E-02	cm/sec
K=	2.74E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

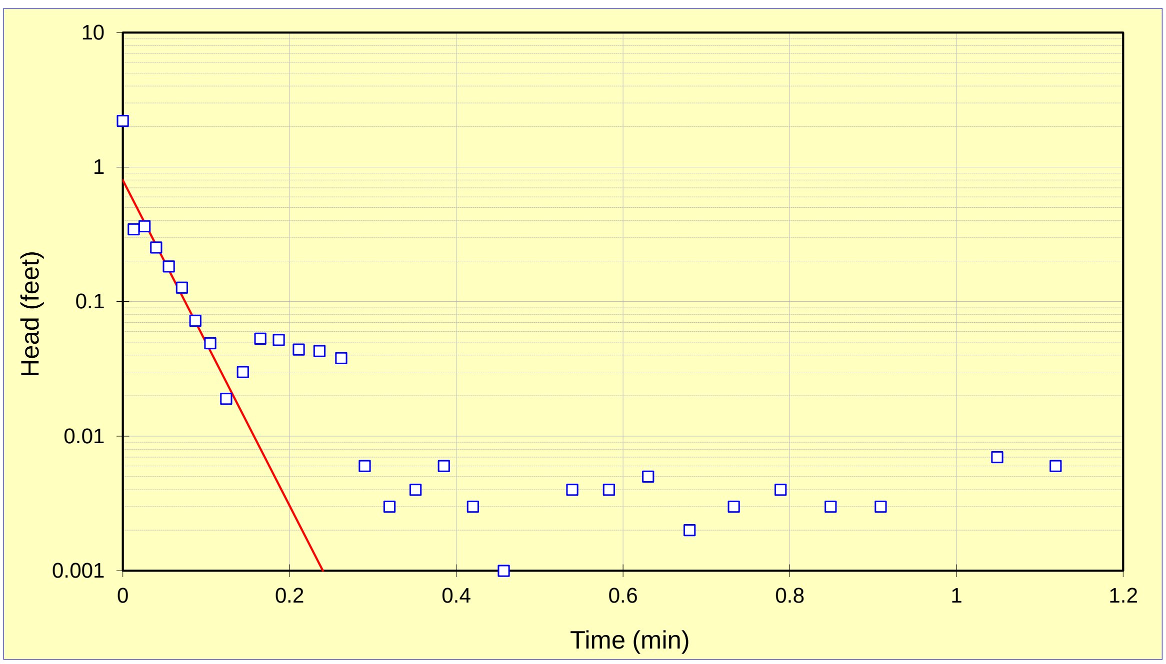
BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-08 (TEST 2)

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

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			
r_w =	0.34			
L_e =	9.707	K=	6.19E-02	cm/sec
$\ln(R_e/r_w)$=	2.11	K=	1.75E+02	ft/day
y_0 =	0.80			
y_t =	0.001			
t =	0.2			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

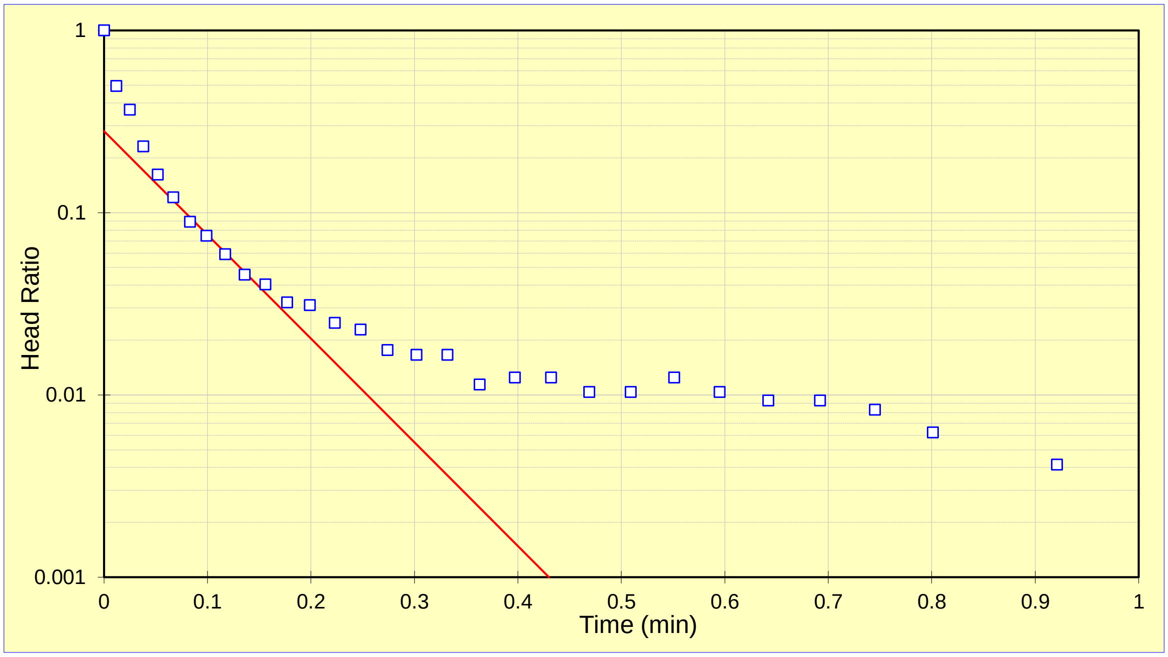
Analysis By: DFS
Checked By: JRS
Analysis Date: 7/25/2016

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11 (TEST 1)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

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			
R_e =	0.34			
L_e =	10	K=	7.79E-03	cm/sec
t_1 =	0	K=	2.21E+01	ft/day
t_2 =	0.43			
h_1/h_0 =	0.28			
h_2/h_0 =	0.00			



Project Name:	NIPSCO Bailly	Analysis By:	DFS
Project No.:	164-8171	Checked By:	JRS
Test Date:	07/06/16	Analysis Date:	7/25/2016

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11 (TEST 1)

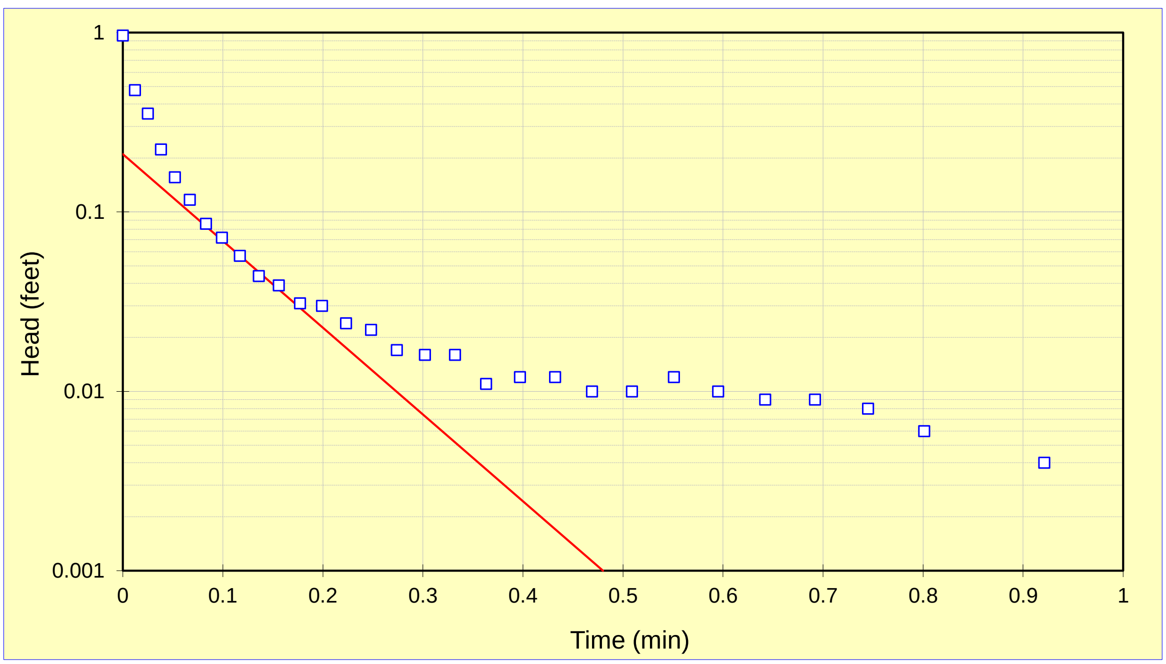
$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

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	
r_c =	0.08
r_w =	0.34
L_e =	10
$ln(R_e/r_w)$=	2.19
y_0 =	0.21
y_t =	0.001
t =	0.5

RESULTS		
K=	4.31E-03	cm/sec
K=	1.22E+01	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11 (TEST 2)

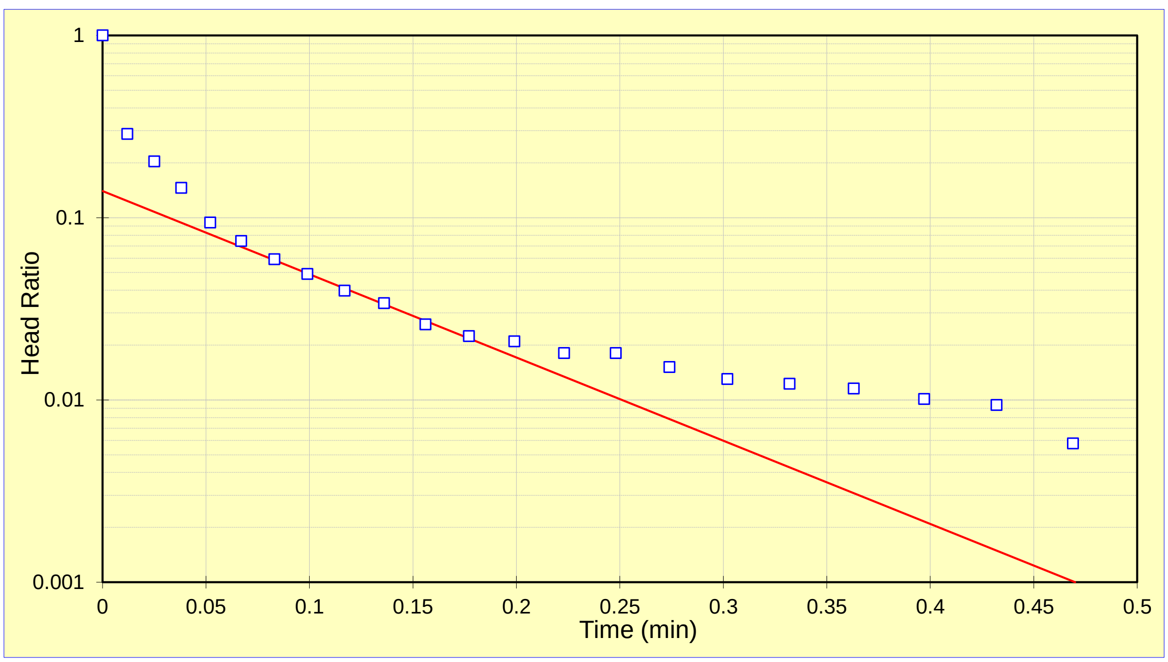
$$K = \frac{r_c^2}{2L_e} \ln\frac{L_e}{R_e}\left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)}\right]30.48$$

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	
r_c =	0.08
R_e =	0.34
L_e =	10
t_1 =	0
t_2 =	0.47
h_1/h_0 =	0.14
h_2/h_0 =	0.00

RESULTS

K=	6.25E-03	cm/sec
K=	1.77E+01	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11 (TEST 2)

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

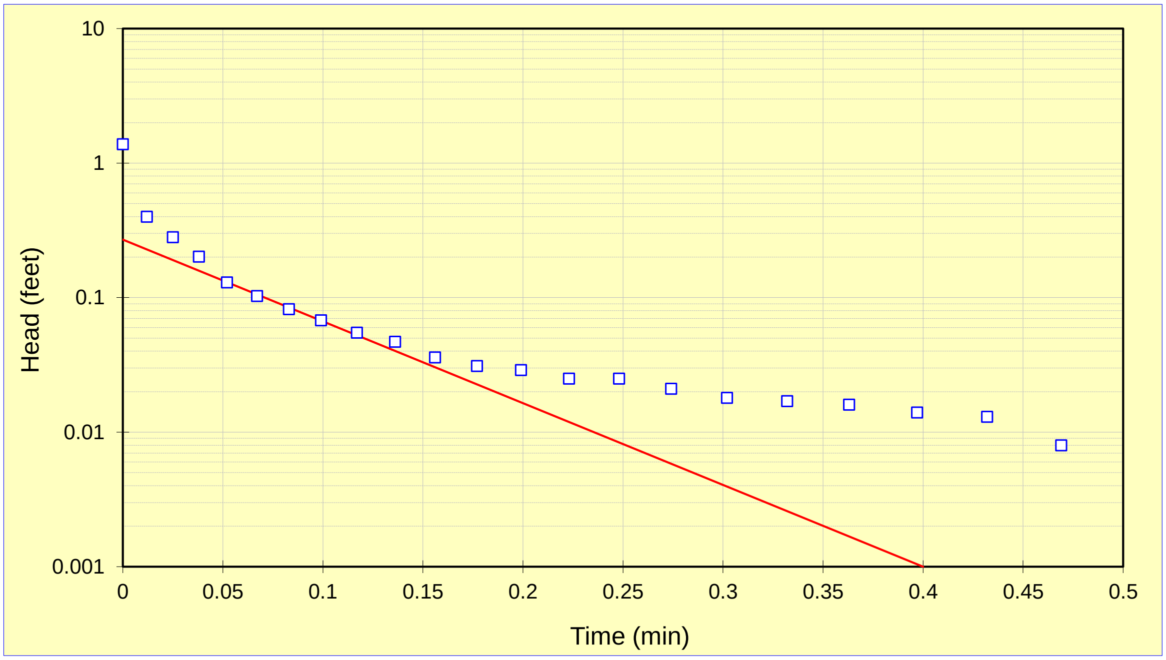
where:

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	
r_c =	0.08
r_w =	0.34
L_e =	10
$\ln(R_e/r_w)$=	2.19
y_0 =	0.27
y_t =	0.001
t =	0.4

RESULTS

K=	5.40E-03	cm/sec
K=	1.53E+01	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-11B (TEST 1)

$$K = \frac{r_c^2}{2L_e} \ln\frac{L_e}{R_e}\left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)}\right]30.48$$

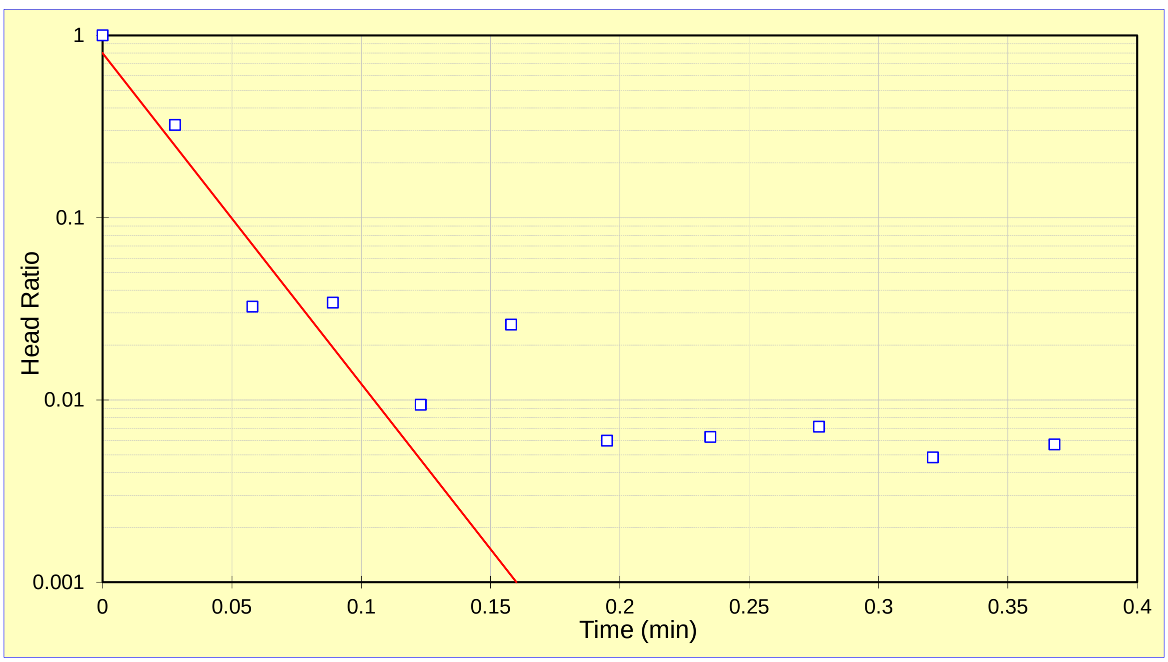
where:
r_c = casing radius (feet)
R_e = equivalent radius (feet)
L_e = length of screened interval (feet)
t = time (minutes)
h_t = head at time t (feet)

INPUT PARAMETERS

r_c =	0.08
R_e =	0.34
L_e =	5
t_1 =	0
t_2 =	0.16
h_1/h_0 =	0.80
h_2/h_0 =	0.00

RESULTS

K=	3.95E-02	cm/sec
K=	1.12E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-11B (TEST 1)

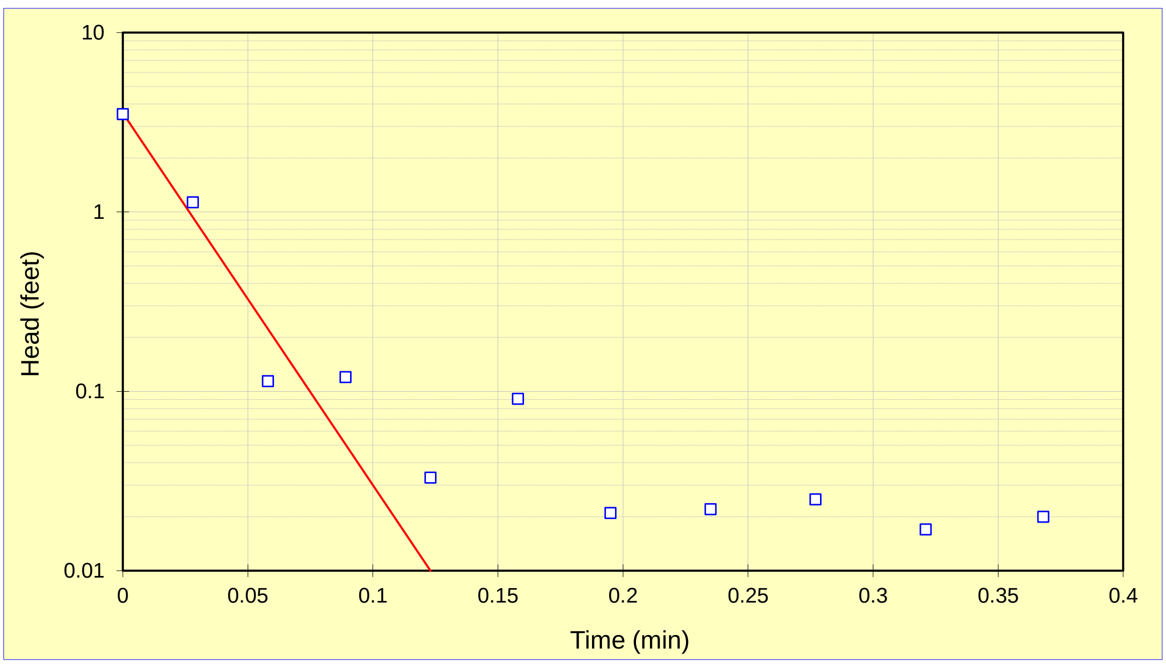
$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

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	
r_c =	0.08
r_w =	0.34
L_e =	5
$\ln(R_e/r_w)$=	2.32
y_0 =	3.56
y_t =	0.010
t =	0.1

RESULTS		
K=	3.91E-02	cm/sec
K=	1.11E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-11B (TEST 2)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

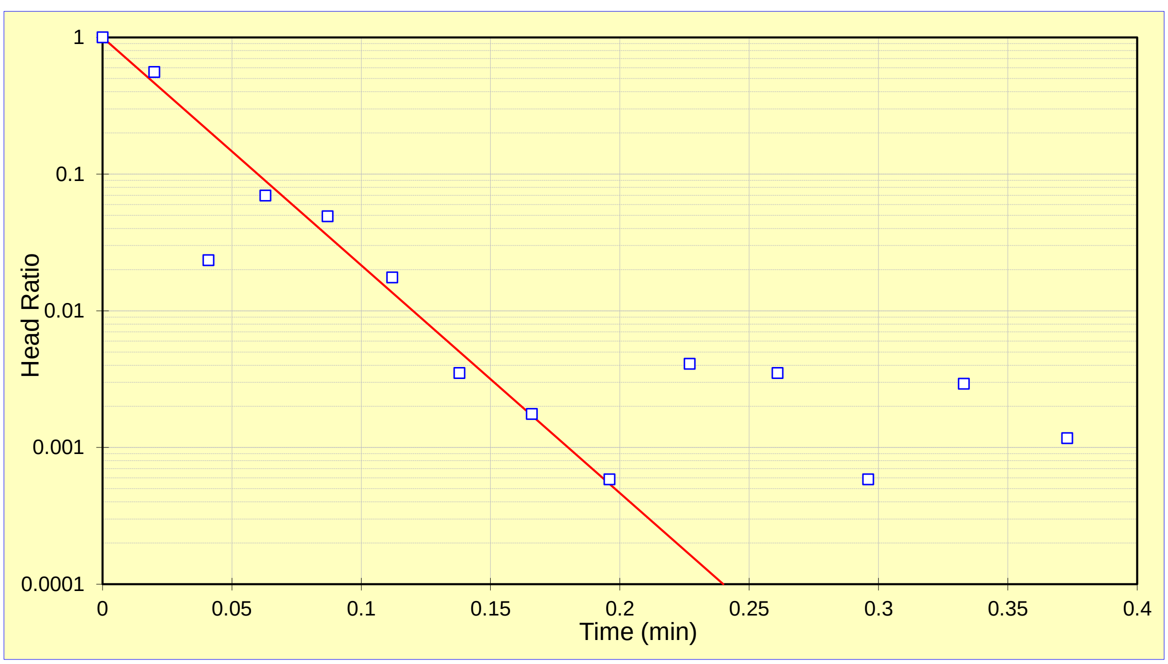
where: r_c = casing radius (feet)
R_e = equivalent radius (feet)
L_e = length of screened interval (feet)
t = time (minutes)
h_t = head at time t (feet)

INPUT PARAMETERS

r_c =	0.08
R_e =	0.34
L_e =	5
t_1 =	0
t_2 =	0.24
h_1/h_0 =	1.00
h_2/h_0 =	0.00

RESULTS

K=	3.62E-02	cm/sec
K=	1.03E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST GAMW-11B (TEST 2)

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

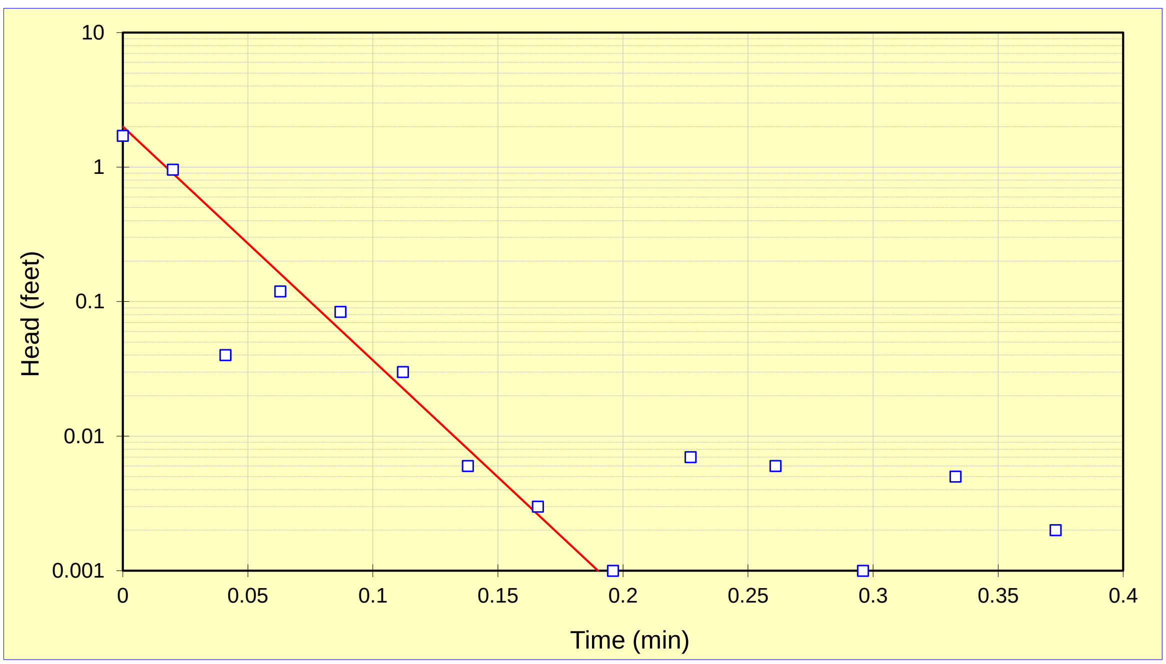
where:

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	
r_c =	0.08
r_w =	0.34
L_e =	5
$ln(R_e/r_w)$=	2.32
y_0 =	2.00
y_t =	0.001
t =	0.2

RESULTS

K=	3.28E-02	cm/sec
K=	9.29E+01	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

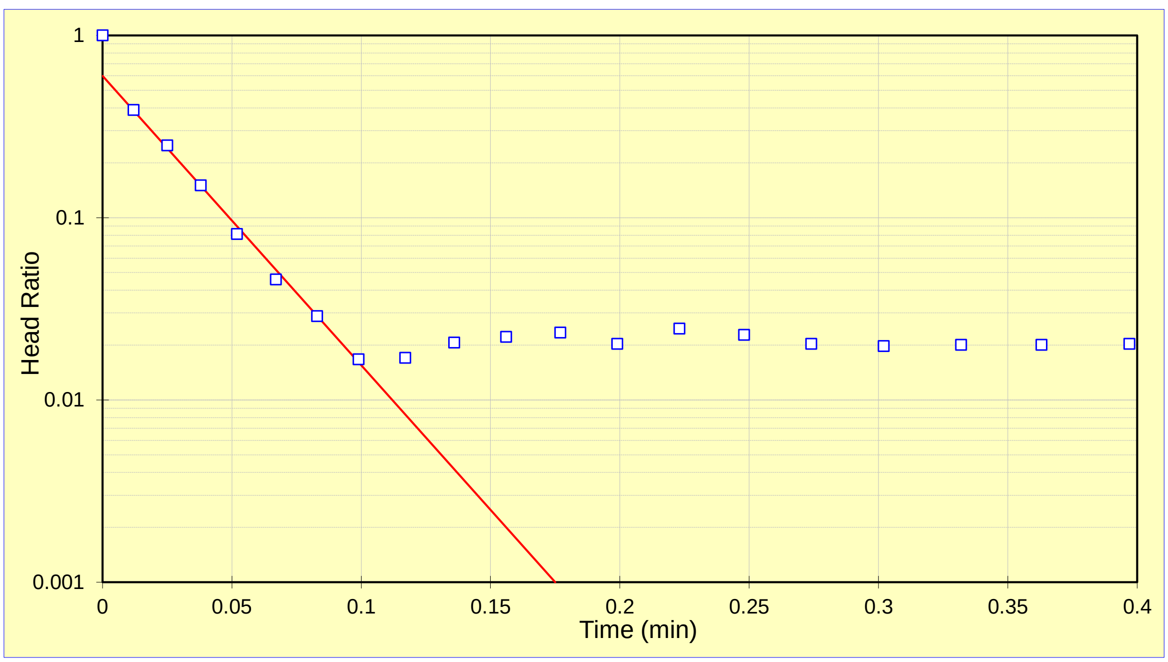
Analysis By: DFS
Checked By: JRS
Analysis Date: 7/25/2016

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11B (TEST 1)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

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			
R_e =	0.34			
L_e =	5	K=	3.45E-02	cm/sec
t_1 =	0	K=	9.79E+01	ft/day
t_2 =	0.175			
h_1/h_0 =	0.60			
h_2/h_0 =	0.00			



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11B (TEST 1)

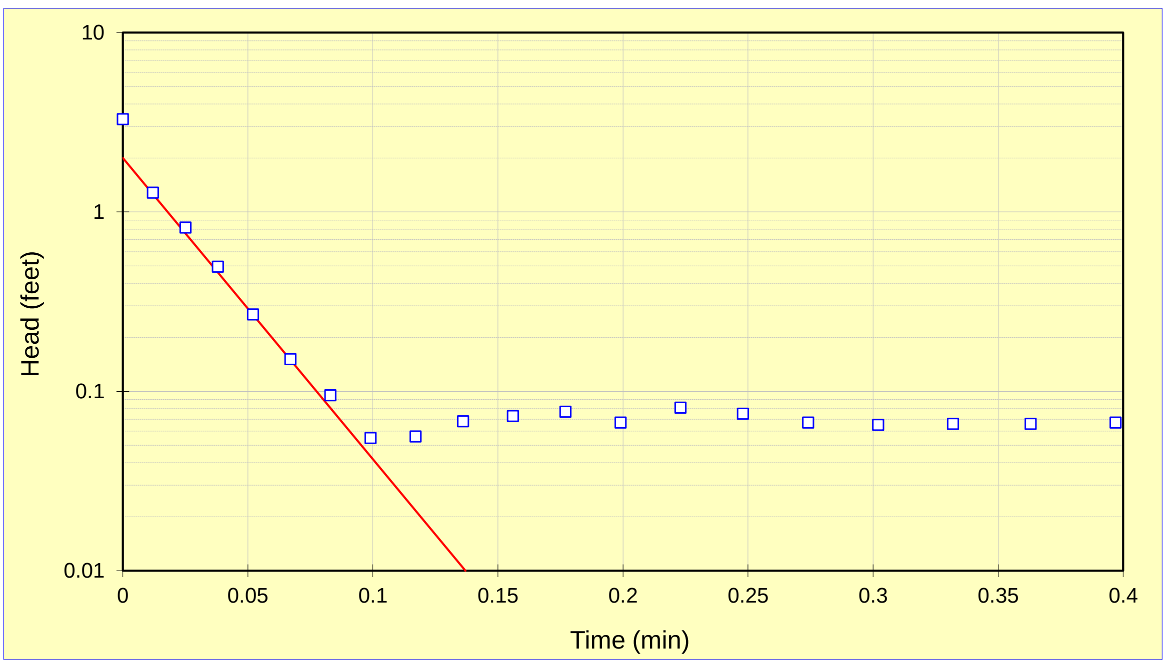
$$K = \frac{r_c^{\,2} \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

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	
r_c =	0.08
r_w =	0.34
L_e =	5
$\ln(R_e/r_w)$=	2.32
y_0 =	2.00
y_t =	0.010
t =	0.1

RESULTS		
K=	3.17E-02	cm/sec
K=	8.98E+01	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11B (TEST 2)

$$K = \frac{r_c^2}{2L_e} \ln \frac{L_e}{R_e} \left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t2 - t1)} \right] 30.48$$

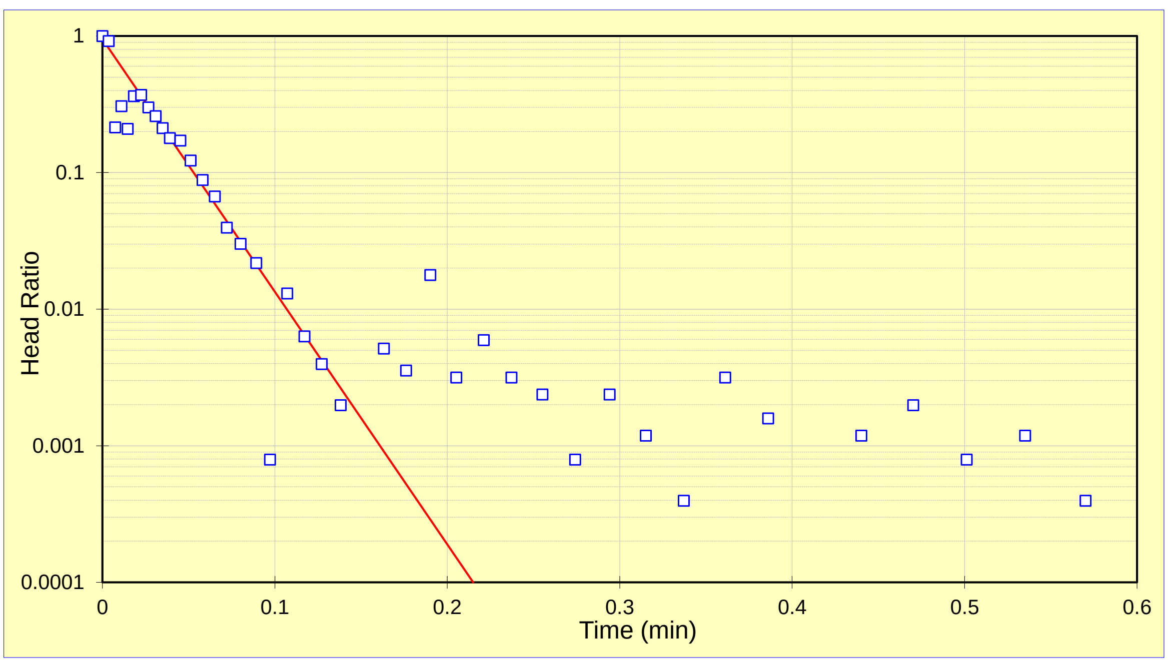
where:
- r_c = casing radius (feet)
- R_e = equivalent radius (feet)
- L_e = length of screened interval (feet)
- t = time (minutes)
- h_t = head at time t (feet)

INPUT PARAMETERS

r_c =	0.08
R_e =	0.34
L_e =	5
t_1 =	0
t_2 =	0.215
h_1/h_0 =	0.95
h_2/h_0 =	0.00

RESULTS

K=	4.02E-02	cm/sec
K=	1.14E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST GAMW-11B (TEST 2)

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

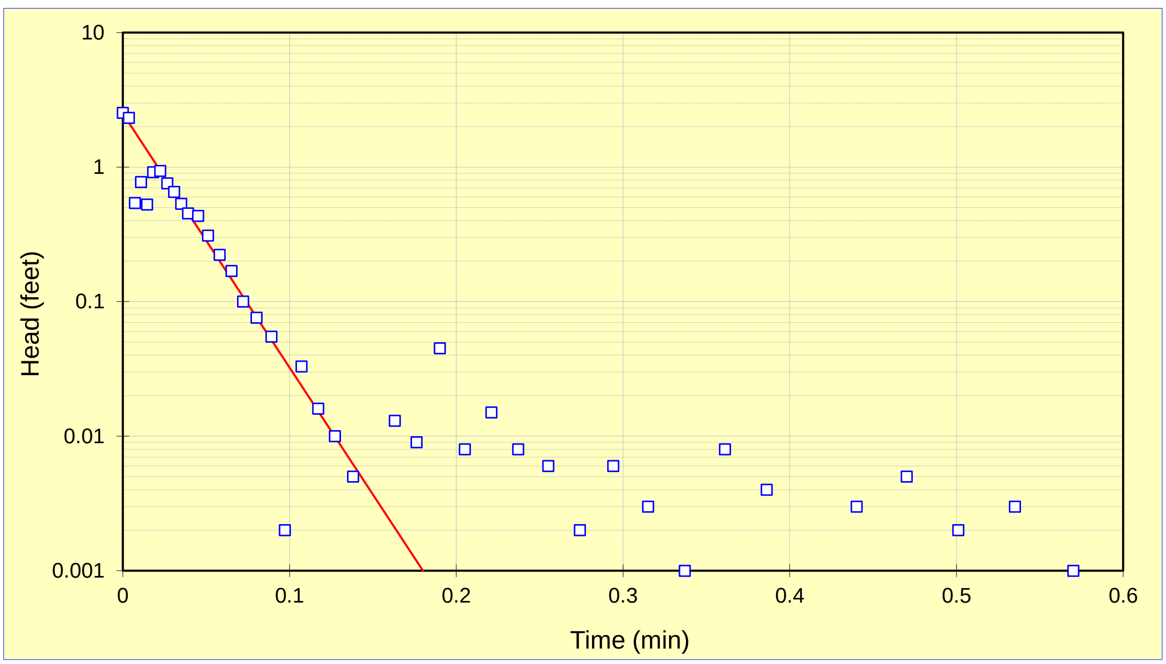
where:

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	
r_c =	0.08
r_w =	0.34
L_e =	5
$\ln(R_e/r_w)$=	2.32
y_0 =	2.50
y_t =	0.001
t =	0.2

RESULTS

K=	3.56E-02	cm/sec
K=	1.01E+02	ft/day



Project Name: NIPSCO Bailly
Project No.: 164-8171
Test Date: 07/06/16

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

APPENDIX B

VERTICAL GROUNDWATER FLOW CALCULATION

Appendix B
VERTICAL GROUNDWATER FLOW CALCULATION

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				July 14, 2016				September 9, 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
GAMW-11	621.99	625.04	14.0	24.0	19.0	606.04	17.26	607.78	-8.00E-02	Down	16.07	608.97	-8.41E-02	Down
GAMW-11B	622.07	624.89	70.0	75.0	72.5	552.39	21.40	603.49			20.43	604.46		

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

Appendix B
VERTICAL GROUNDWATER FLOW CALCULATION

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				November 14, 2016				January 11, 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
GAMW-11	621.99	625.04	14.0	24.0	19.0	606.04	16.93	608.11	-7.03E-02	Down	17.23	607.81	-7.05E-02	Down
GAMW-11B	622.07	624.89	70.0	75.0	72.5	552.39	20.55	604.34			20.86	604.03		

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

Appendix B
VERTICAL GROUNDWATER FLOW CALCULATION

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				March 3, 2017				May 1, 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
GAMW-11	621.99	625.04	14.0	24.0	19.0	606.04	16.83	608.21	-7.03E-02	Down	16.45	608.59	-6.41E-02	Down
GAMW-11B	622.07	624.89	70.0	75.0	72.5	552.39	20.45	604.44			19.74	605.15		

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

Appendix B
VERTICAL GROUNDWATER FLOW CALCULATION

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				July 6, 2017				August 28, 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
GAMW-11	621.99	625.04	14.0	24.0	19.0	606.04	16.92	608.12	-6.80E-02	Down	16.30	608.74	-8.70E-02	Down
GAMW-11B	622.07	624.89	70.0	75.0	72.5	552.39	20.42	604.47			20.82	604.07		

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

Appendix B
VERTICAL GROUNDWATER FLOW CALCULATION

Monitoring Well Locations	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Screen Interval				October 5, 2017				March 19, 2018				Average
			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	
GAMW-11	621.99	625.04	14.0	24.0	19.0	606.04	10.77	614.27	-1.99E-01	Down	16.84	608.20	-7.85E-02	Down	-8.71E-02
GAMW-11B	622.07	624.89	70.0	75.0	72.5	552.39	21.28	603.61			20.90	603.99			

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

Prepared by: ERW

Checked by: SKB

Reviewed by: MAH

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