DENR USE ONLY: ☐Paper Report ☐Electronic Data - Email CD (data loaded: Yes / No) Doc/Event #:

NC DENR
Division of Waste Management - Solid Waste

Environmental Monitoring Reporting Form

Notice: This form and any information attached to it are "Public Records" as defined in NC General Statute 132-1. As such, these documents are available for inspection and examination by any person upon request (NC General Statute 132-6).

Instructions:

- **Prepare one form for each individually monitored unit.**
- **Please type or print legibly.**
- Attach a notification table with values that attain or exceed NC 2L groundwater standards or NC 2B surface water standards. The notification must include a preliminary analysis of the cause and significance of each value. (e.g. naturally occurring, off-site source, pre-existing condition, etc.).
- Attach a notification table of any groundwater or surface water values that equal or exceed the reporting limits.
- Attach a notification table of any methane gas values that attain or exceed explosive gas levels. This includes any structures on or nearby the facility (NCAC 13B .1629 (4)(a)(i).
- Send the original signed and sealed form, any tables, and Electronic Data Deliverable to: Compliance Unit, NCDENR-DWM, Solid Waste Section, 1646 Mail Service Center, Raleigh, NC 27699-1646.

Solid Waste Monitoring Data Submittal Information

Name of entity submitting data (laboratory, consultant, facility owner):

Green Meadow - Charah, Inc.

Contact for questions about data formatting. Include data preparer's name, telephone number and E-mail address:

Name: Michael Plummer, P.E. Phone: 704 338-6843

E-mail: michael.plummer@hdrinc.com

Facility name:	Facility Address:	Facility Permit #	NC Landfill Rule: (.0500 or .1600)	Actual sampling dates (e.g., October 20-24, 2006)
Charah, Inc. Brickhaven No. 2 Mine Tract "A"	1271 Moncure-Flatwood Road Chatham County Moncure, North Carolina	1910- STRUC-2015	CAMA	May 25, 2016

Environmental Status: (Check all that apply)

☐ Initial/Background Monitoring ☒ Detection Monitoring ☐ Assessment Monitoring ☐ Corrective Action

Type of data submitted: (Check all that apply)

☒ Groundwater monitoring data from monitoring wells
☐ Groundwater monitoring data from private water supply wells
☒ Leachate monitoring data
☒ Surface water monitoring data
☐ Methane gas monitoring data
☐ Corrective action data (specify) ____
☐ Other(specify) ____

Notification attached?

☐ No. No groundwater or surface water standards were exceeded.
☒ Yes, a notification of values exceeding a groundwater or surface water standard is attached. It includes a list of groundwater and surface water monitoring points, dates, analytical values, NC 2L groundwater standard, NC 2B surface water standard or NC Solid Waste GWPS and preliminary analysis of the cause and significance of any concentration.
☐ Yes, a notification of values exceeding an explosive methane gas limit is attached. It includes the methane monitoring points, dates, sample values and explosive methane gas limits.

Certification

To the best of my knowledge, the information reported and statements made on this data submittal and attachments are true and correct. Furthermore, I have attached complete notification of any sampling values meeting or exceeding groundwater standards or explosive gas levels, and a preliminary analysis of the cause and significance of concentrations exceeding groundwater standards. I am aware that there are significant penalties for making any false statement, representation, or certification including the possibility of a fine and imprisonment.

Michael Plummer | Project Manager | 704 338-6843

Facility Representative Name (Print) | Title | (Area Code) Telephone Number

[signature] 9/9/2016

Signature | Date

Affix NC Licensed/ Professional Engineer Seal

NORTH CAROLINA PROFESSIONAL SEAL 025495 ENGINEER MICHAEL D. PLUMMER 9/9/16

HDR Engineering, Inc. of the Carolinas; 440 S. Church St. Suite 1000 Charlotte, NC 28202

Facility Representative Address

F-0116

NC PE Firm License Number (if applicable effective May 1, 2009)

Revised 6/2009

Background Sampling Report

Brickhaven No.2 Mine Tract "A" Structural Fill

Charah, Inc.

Moncure, Chatham County, North Carolina

September 9, 2016

This page intentionally left blank.

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Acronyms

µg/L	micrograms per liter
asl	above sea level
CAMA	North Carolina Coal Ash Management Act of 2014
CCP	Coal Combustion Products
EPA	United States Environmental Protection Agency
ft/ft	feet / foot
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NCGPS	North Carolina groundwater protection standard
NTU	Nephelometric turbidity units
msl	mean sea level
PVC	polyvinyl chloride
TDS	total dissolved solids
USGS	U.S. Geological Survey

1. Introduction

1.1 Purpose

This *Background Sampling Report* addresses results from the 7th and 8th Round events as well as the overall statistical results of the eight required sampling events at the Brickhaven No.2 Mine Tract "A" Structural Fill site in Moncure, Chatham County, North Carolina.

Groundwater monitoring and sampling prior to, during, and post-disposal of coal combustion products (CCPs) into the previously clay mined pits of the site shall be conducted in accordance with the following:

- Coal Ash Management Act (CAMA) of 2014 (Senate Bill 729, ratified by North Carolina General Assembly)
- Water Quality Monitoring Plan Brickhaven No.2 Mine Tract "A" Structural Fill, approved March 2015.
- North Carolina Department of Environmental Quality (NCDEQ)[1] Permit No. 1910-STRUC-2015, issued June 5, 2015.
- NCDEQ Solid Waste Section Guidelines for Groundwater, Soil, and Surface Water Sampling, April 2008.
- NCDEQ Division of Water Management memorandum concerning electronic document submittal for routine groundwater and surface water monitoring, November 5, 2014.
- U.S. Environmental Protection Agency (EPA) Region I, *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, January 19, 2010.

Per the approved permits and water quality monitoring plan, a minimum of eight groundwater monitoring events will be conducted at site over the course of one year, concluding on or about August 2016. A minimum of one independent background sample prior to placement of ash was specified in the permit to construct/operate.

The first sampling event occurred on August 12, 2015 and was addressed in detail in the *Initial Background Groundwater and Surface Water Monitoring Event Report* prepared by Buxton Environmental, Inc. (Buxton) on October 28, 2015. The 2nd and 3rd sampling events commenced on October 15, 2015 and November 18, 2015, respectively; these sampling events were addressed in detail in the *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* prepared by HDR Engineering of the Carolinas, Inc. (HDR) on December 31, 2015. The 1st and 2nd sampling events occurred prior to the placement of ash on October 23, 2015 and represent pre-existing site conditions. The 4th, 5th, and 6th sampling events commenced on January 4, February 16, and April 5, 2016, respectively; these sampling events were addressed in detail in the *2016 First Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* prepared by HDR on May 17, 2016 (HDR 2016a).

---

[1] Prior to September 18, 2015, the NCDEQ was referred to as the North Carolina Department of Environment and Natural Resources (NCDENR). Both naming conventions are used in this report, as appropriate.

The 7th and final 8th sampling events commenced on May 25 and July 11, 2016, respectively. The results of the 7th and 8th sampling events with overall statistical results of the eight required events are described herein.

1.2 Regulatory Background

CAMA Section §130A-309.216 requires implementation of a groundwater monitoring system as described in the requirements as follows:

"§ 130A-309.216. Design, construction, and siting requirements for projects using coal combustion products for structural fill.

(b) Liners, Leachate Collection System, Cap, and Groundwater Monitoring System Required for Large Structural Fills. –

(4) A groundwater monitoring system, that shall be approved by the Department and, at a minimum, consists of all of the following:

a. A sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that represent the quality of groundwater passing the relevant point of compliance as approved by the Department. A down-gradient monitoring system shall be installed at the relevant point of compliance so as to ensure detection of groundwater contamination in the uppermost aquifer.

b. A proposed monitoring plan, which shall be certified by a licensed geologist or professional engineer to be effective in providing early detection of any release of hazardous constituents from any point in a structural fill or leachate surface impoundment to the uppermost aquifer, so as to be protective of public health, safety, and welfare; the environment; and natural resources.

c. A groundwater monitoring program, which shall include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and down-gradient wells. Monitoring shall be conducted through construction and the post-closure care period. The sampling procedures and frequency shall be protective of public health, safety, and welfare; the environment; and natural resources.

d. A detection monitoring program for all Appendix I constituents. For purposes of this subdivision, the term "Appendix I" means Appendix I to 40 C.F.R. Part 258, "Appendix I Constituents for Detection Monitoring," including subsequent amendments and editions.

e. An assessment monitoring program and corrective action plan if one or more of the constituents listed in Appendix I is detected in exceedance of a groundwater protection standard."

On April 17, 2015, EPA published its final rule *Disposal of Coal Combustion Residuals from Electric Utilities* to regulate the disposal of CCP as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA). Among other requirements, the final rule established requirements for a groundwater monitoring program consisting of detection monitoring and, if necessary, assessment monitoring and corrective action. EPA selected constituents for detection monitoring that are present in CCP, would be expected to migrate rapidly, and would thereby provide early detection as to whether contaminants were migrating from the disposal unit (80 FR 74: 21397).

As stated in the Federal Register (80 FR 74: 21342)

> *These detection monitoring constituents or inorganic indicator parameters are: boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids (TDS). These inorganic indicator parameters are known to be leading indicators of releases of contaminants associated with CCR and the Agency strongly recommends that State Directors add these constituents to the list of indicator parameters to be monitored during detection monitoring of groundwater if and when a MSWLF decides to accept CCR.*

Groundwater analytical results for the constituents in 40 CFR 257, Appendix III detection monitoring and 40 CFR 257, Appendix IV assessment monitoring are included below.

Constituents for detection monitoring listed in 40 CFR 257 Appendix III are:

- Boron
- Calcium
- Chloride
- Fluoride
- pH
- Sulfate
- Total dissolved solids (TDS)

Constituents for assessment monitoring listed in 40 CFR 257 Appendix IV includes:

- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Fluoride
- Lead
- Lithium
- Mercury

- Molybdenum
- Selenium
- Thallium
- Radium 226 and 228 combined

Aluminum, copper, iron, manganese, and sulfide were included in the Appendix IV constituents in the draft rule; EPA removed these constituents in the final rule. Therefore, these constituents are not included.

1.2.1 Site Specific Regulatory Background

In accordance with CAMA, the *Water Quality Monitoring Plan* (Buxton, 2015a) for the site was designed to effectively provide early detection of any release, as to be protective of human health and the environment. The *Design Hydrogeologic Report* (HDR, 2014*)* specified a groundwater monitoring network would comprise of seven downgradient/side-gradient monitoring wells and one upgradient background monitoring well. Four pre-existing piezometers (PZM-1, PZM-22, PZM-27, and PZM-28) were to be converted to monitoring wells (MW-4, MW-5, MW-7, and MW-8, respectively); PZM-28 remained dry during investigations and was unable to be utilized for monitoring well MW-8 as originally specified. PZM-28 was subsequently abandoned in accordance with North Carolina standards and its abandonment was documented in the *Report of Abandonment of Piezometer PZM-28,* submitted to NCDEQ on October 5, 2015. Therefore, only MW-4, MW-5, and MW-7 were successfully converted to monitoring wells during the August through December 2015 time period (**Table 1**).

Four downgradient/side-gradient compliance monitoring wells (MW-2, MW-3, MW-6, and MW-8 replacement) and one upgradient background monitoring well (MW-1) were installed from June 19 through July 30, 2015. On July 17, 2015, Mr. Ross Klingman, P.G. with Buxton, contacted Ms. Elizabeth Werner, Permitting Hydrogeologist with NCDEQ SWS, via telephone to request the installation of an additional background monitoring well (BG-1). The additional background well would assist with current background and future semi-annual groundwater quality monitoring at the site. During the conversation, Ms. Werner verbally approved the installation of the additional background monitoring well (Buxton, 2015b).

1.3 Site Location, Operation and Background

The site is located in Chatham County, approximately four miles southwest of central Moncure, North Carolina (**Figure 1**). The owner of the site is Green Meadow, LLC (Green Meadow) and Charah, Inc. (Charah) is responsible for the operation and maintenance of the site. The mine property is approximately 301 acres in total; the structural fill area for CCP placement will comprise of approximately 145 acres; and the fill area including associated perimeter berms, channels, and haul roads encompasses 166 acres. The remaining acreage is still utilized for clay mining activities.

The property located within the structural fill area was previously owned by General Shale Brick, Inc., which operated the site as a clay mine since 1985 for their off-site brick manufacturing facility. Mined clay was stockpiled and then transported approximately 3.5 miles south to Brickhaven, North Carolina for brick manufacturing.

The area immediately surrounding the site primarily consists of rural residential (approximately 2,500 feet east, 1,000 feet southeast and 1,000 feet southwest), commercial, industrial, wooded and agricultural property. According to information obtained from the Chatham County GIS website, municipal water supply is available to the surrounding area.

Charah began CCP placement in the first composite liner containment system (Cell 1, Subcell 1A) on October 23, 2015. Charah plans to place approximately 1,600,000 tons of CCP per year in the 12,000,000 ton structural fill capacity; therefore, the placement phase should last approximately eight years or less depending of importation rate. CCPs (including fly ash, bottom ash, boiler slag, and/or flue gas desulfurization materials) are brought to the site by truck, rail, or combination thereof, from the Duke Energy Carolinas (DEC) Riverbend Steam Station and Duke Energy Progress (DEP) L.V. Sutton Energy Complex (Sutton Plant) sites. CCPs could eventually be brought to the site from other DEC and/or DEP sites.

Leachate (i.e. product generated from the liquids present in the fill at the time of placement and/or stormwater that infiltrates the fill) is managed on-site through collection, storage, and disposal of the resultant liquid. Green Meadow LLC has an approved pump and haul permit to dispose of leachate at either the City of Sanford's Big Buffalo Creek Wastewater Treatment Plant or to VLS Recovery Services LLC in Mauldin, South Carolina. In addition to the first leachate sample initially collected during the 3rd Round Sampling Event (HDR, 2015), leachate samples were subsequently collected during the 4th through 8th sampling events; analytical leachate results are discussed in **Section 3.3**.

1.4 Site Topography and Geographical Setting

According to the 1993 USGS topographic quadrangle (**Figure 2**), the topography of the site and immediately surrounding area can be characterized by moderately rolling hills, which are dissected by dendritic creeks. The northwestern portion of the site generally slopes to the north and northwest from three topographically high ridges with interconnected saddles ranging from approximately 260 to 270 feet above sea level (asl), towards off-site intermittent tributary. The southeastern portion of the site generally slopes to the southeast, south and west from the three topographic high ridges with similar interconnected saddles ranging from approximately 260 to 270 feet asl, towards on-site intermittent tributary creeks that drain from the southern property boundary at approximately 205 feet asl.

1.5 Geologic and Hydrogeologic Setting

1.5.1 Regional Geology

The site is located within the Piedmont physiographical province of North Carolina, which is a northeast-southwest trending region extending from New York to Alabama.

According to the 1985 North Carolina Geologic Map prepared by the North Carolina Geological Survey, the site is located in the Triassic Basin Belt of the Piedmont physiographic province. The basement rocks of the Triassic Basin Belt include conglomerate, sandstone, mudstone, limestone, coal, and shale. The majority of the subject property is located within the Sanford Formation which contains conglomerate, fanglomerate, sandstone, and mudstone. The far western portion of the site is located in the Cummock Formation which contains sandstone, mudstone, gray and black coal, and carbonaceous shale. The Triassic Basin is bounded by felsic metavolcanic rock within the Carolina Slate Belt approximately 6.5 miles to the northwest; and is contacted by metamorphosed granite and by biotite gneiss and schist of the Raleigh Belt along a normal fault approximately 2.5 miles to the southeast. The Triassic Basin formations have been intruded by north northwest-south southeast trending igneous diabase dikes during the Jurassic Period (~144 to 208 Ma), and contain northeast-southwest trending normal faults, however, none of these were indicated to exist at the subject site on the 1985 geologic map (NCDENR, 1985).

In the Piedmont, the bedrock is typically overlain by a mantle of weathered rock (residuum/saprolite), which has an average thickness of approximately 25 feet. The residuum/saprolite consists of varying amounts of unconsolidated clays, silts and sands, with lesser amounts of rock fragments. Due to the range of the parent rock composition and the variable susceptibility to weathering of each rock type, the residuum/saprolite ranges widely in color, texture and thickness. Generally, the residuum/saprolite is thickest near inter-stream divides (ridges) and thins toward stream beds. In profile, the residuum/saprolite normally grades from clayey soils near the land surface to sandier, partially weathered rock above the competent bedrock (Buxton, 2014).

1.5.2 Regional Hydrogeology

The occurrence and movement of groundwater in the Piedmont physiographic province is within two separate but interconnected water-bearing zones that typically comprise one aquifer. A shallow water-bearing zone occurs within the residuum/saprolite and a deeper zone within the underlying bedrock.

Groundwater in the residuum/saprolite zone occurs in the interstitial pore spaces between the individual grains comprising the residuum/saprolite. Groundwater in this zone is typically under water table conditions and generally flows from topographic highs to topographic lows. The occurrence and movement of groundwater in the underlying bedrock zone is controlled by joints and fractures within the bedrock. Groundwater within this deeper zone may occur under confined or semi-confined conditions, depending on the extent of fracturing at the saprolite/bedrock interface. Deeper groundwater movement is typically controlled by the distribution of openings in the bedrock and can be variable.

No naturally occurring springs or creeks with actively flowing water recharged by the subsurface aquifer were observed within the site boundary during this reporting period.

2 Sampling Procedures

2.1 Groundwater Sampling Procedures

A total of eight monitoring wells, one background monitoring well, and two surface water samples were collected on three separate occasions in 2015 and five separate occasions in 2016, to date (**Figure 3**). All sampling events have been now conducted prior to August 2016 in compliance of the site's Water Quality Monitoring Plan. The 1st and 2nd monitoring events

(August 12, 2015 and October 15, 2015 respectively) occurred prior to the placement of ash at the site on October 23, 2015 and therefore constitute pre-existing site conditions. The 3rd monitoring event (November 18, 2015) and each subsequent event since has occurred after the placement of CCP. A single leachate sample was collected during each of the 3rd through 8th monitoring events. The 1st monitoring event was conducted by Buxton; the 2nd through 8th monitoring events were conducted by Pace Analytical Services, Inc. Field data sheets and sampling logs along with the analytical laboratory results for the 7th and 8th monitoring events are provided in **Appendices A, B, and C**. Analytical laboratory results for the first through 3rd monitoring events were included under separate cover in the *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2015) while results for the 4th through 6th events were included in the *2016 First Semi-Annual Groundwater* Surface Water, and Leachate Sampling Report* (HDR, 2016a).

Prior to commencing groundwater sampling, new plastic sheeting was placed around the well head, in order to prevent the sampling equipment from contacting the ground surface. The well lock was then removed from the protective stand-up-cover. New nitrile gloves were donned and static groundwater levels were obtained from below the measuring point (top-of-well polyvinyl chloride (PVC) casing) at each monitoring well to the nearest 0.01 foot with a depth-to-water electrode at each monitoring well. Low flow purging and sampling was conducted utilizing a stainless-steel Proactive SS Mega Monsoon pump with flow rate controller, which was plumbed to new polyethylene sample tubing (1/2-inch outer diameter (OD) 3/8-inch inner diameter (ID)). In the event of low recharge a peristaltic pump was utilized to purge and sample the well. The base of the pump was set at approximately two feet off the bottom depth above the well base to reduce turbidity. The following information was recorded at timed intervals during the purging process: 1) water levels (below top of casing), 2) purge flow rate, 3) purge rate and cumulative water pumped, and 4) field parameters. Temperature, conductivity, pH, oxygen reduction potential (ORP), and dissolved oxygen (DO) were recorded with a Horiba U-52 meter; and turbidity was recorded with a Micro-TPW meter. The Horiba U-52 and Micro-TPW meters were rented and calibrated by Enviro-Equipment, Inc. of Pineville, North Carolina for the first monitoring event. Horiba U-52 and Micro-TPW/LaMotte turbidity meters, property of Pace Analytical, were calibrated prior to use and on-site during the sampling events.

Purging was conducted until a minimum of three well volumes of water had been removed and the below field parameters requirements have been met and stabilized. All measurements, except turbidity, were obtained using a flow-through-cell, while turbidity measurements are obtained before water enters the flow-through-cell.

- Turbidity (10% for values greater than 5 NTU (if three turbidity values are less than 5 NTU, the values are considered stabilized)
- DO (10% for values greater than 0.5 mg/L, if three DO values are less than 0.5 mg/L, the values are considered stabilized)
- Specific conductance (3%)
- Temperature (3%)
- pH ($\pm$ 0.1 unit)

- ORP ($\pm$ 10 millivolts)

If field parameters had stabilized prior to purging three well volumes, or the well was going dry, groundwater samples were then collected. The water level meter and low flow pump were decontaminated in the field with a distilled water rinse, Alconox® wash, and a distilled water rinse, prior to and following sampling at each monitoring well. Following sampling, locks were placed back on the well stand-up covers. Purge water was discharged to the ground surface at respective well heads.

All samples for this current reporting period were shipped under proper management and Chain of Custody (COC) procedures to Pace Analytical Services, Inc. laboratory in Huntersville, North Carolina (Cert IDs #37706 and #5342). Sample handling and custody was performed according to the EPA Guidance for Field Samplers.

2.2 Surface Water Sampling Procedures

Surface water samples were collected from two locations outside of the structural fill boundary to provide for potential groundwater to surface water interactions and evaluation of potential off-site impacts. The SW-1 sampling location is downgradient of the site, approximately 3,000 feet south of the structural fill boundary along an unnamed tributary of Gulf Creek. The SW-2 sampling location is upgradient of the site, approximately 3,200 feet west of the structural fill boundary along Shaddox Creek. Approximate surface water sampling locations are depicted on **Figure 4**.

New nitrile gloves were donned prior to collecting surface water samples. Field parameters (including temperature, conductivity, pH, ORP, and DO) were recorded with a Horiba U-52 meter; turbidity was recorded with a Micro-TPW meter.

Gulf Creek and Shaddox Creek are classified as Class WS-IV Waters by NCDEQ and as such are evaluated under North Carolina Surface Water and Wetland Standards (15A NCAC 02B).

3 Results

Groundwater analytical results for the constituents in 40 CFR 257 Appendix III detection monitoring and 40 CFR 257 Appendix IV assessment monitoring (as previously discussed in **Section 1.2**) were compared to background concentrations to determine if any impact to groundwater is indicated. If any impact to groundwater is inferred from groundwater detection monitoring or if a potential impact is detected, Charah must notify NCDEQ of any exceedance(s) within 14 days. In the event no exceedances are observed, Charah must submit a report of the sampling results to NCDEQ with 120 days of the sampling event.

Groundwater samples were also analyzed for constituents of assessment monitoring (EPA 40 CFR 257 Appendix IV). Assessment monitoring typically occurs if a statistically significant increase in a detection monitoring constituent is noted and will be further assessed in subsequent reporting. Appendix IV constituents were analyzed for background events and will continue to be assessed during future semi-annual monitoring events. Groundwater monitoring samples were also analyzed for 40 CFR Part 258 Appendix I metals and volatile organic compounds (VOCs).

A summary of the laboratory parameters detected during the 7th and 8th monitoring events, along with the highest detected concentration result, is provided in the sections below. Field and Sampling Logs are provided in **Appendix A**. Full laboratory data from the 7th and 8th monitoring events is provided in **Appendix B** and electronic data deliverables (EDDs) in **Appendix C**.

3.1 Groundwater Analytical Results

3.1.1 Background Site Conditions Summary

Pre-CCP Placement groundwater site conditions (i.e. laboratory analysis from the first and second monitoring events) generally exhibited high background chloride and TDS concentrations. Several monitoring wells additionally showed exceedances of NC 2L Standards for antimony, arsenic, barium, chromium, cobalt, copper, and vanadium.

Bromodichloromethane and dibromochloromethane detected above NCGPS in groundwater samples from MW-2, MW-3, and MW-7 during the first monitoring event were the result of municipal water utilized during previous development activities. These trihalomethanes were only detected in the first sampling event; all VOCs were non-detect for the second through 8th sampling events. VOCs are not present at naturally occurring background concentrations at the site.

A detailed discussion of background groundwater conditions can be found in the *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2015). **Section 4.0** of this report will further discuss statistical results of the cumulative 8 rounds for a better understanding of predictive limits for the background well location BG-1 as well as Interwell interactions.

3.1.2 Conditions Following CCP Placement

CCP placement began at the site on October 23, 2015; six monitoring events (3rd through 8th rounds) have been conducted following CCP placement. The 3rd monitoring event was discussed in detail in the *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2015); while the 4th through 6th was discussed in detail in the *2016 First Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2016a); the primary focus of this section is the analytical results of Rounds 7 and Round 8.

The eight monitoring wells and single background monitoring well continue to show consistently elevated chloride and TDS which was also observed in pre-CCP placement (Rounds 1 and 2) and following CCP placement (3rd Round). In Rounds 3 through Round 8, antimony, arsenic, barium, chromium, vanadium and pH additionally showed several intermittent exceedances that were similarly noted in both pre-CCP placement monitoring events (Rounds 1 and 2). Naturally occurring metals exceeding NCGPS are common in North Carolina due to various geologic conditions (i.e. weathering of crystalline parent material). pH levels were detected below

NCGPS in MW-4 (6.30 to 6.50 SU) for all six post-CCR placement monitoring events and appear to be the result of naturally occurring conditions.

Ranges of constituent concentrations for Rounds 3 through Round 8 are given below. The monitoring well location of the highest concentration and the sampling event in which the concentration was detected for a given constituent is provided in parentheses. Data packages are included in **Appendix B** with EDDs in **Appendix C**. A summary of the findings from the 7th through 8th monitoring events is provided below and in **Table 6-1** and **Table 6-2**:

EPA Appendix III Constituent Detections (Post-CCP Placement Site Conditions)

- Boron: 5.5 to 49.4 µg/L (MW-7 – 3rd Round)
- Calcium: 9,990 to 207,000 µg/L (MW-2 – 5th Round)
- Chloride: 17,600 to 1,280,000 µg/L (MW-3 – 5th Round)
- Fluoride: <20 to 590 µg/L (MW-5 – 3rd Round)
- pH: 6.30 to 7.95 SU
- Sulfate: 10,900 to 247,000 µg/L (MW-2 – 5th Round)
- Total Dissolved Solids: 194,000 to 3,290,000 µg/L (MW-2 – 8th Round)

EPA Appendix IV Constituent Detections (Post-CCP Placement Site Conditions)

- Antimony: <3.8 to 12.3 µg/L (MW-2 – 7th Round)
- Barium: 86 to 1,550 µg/L (MW-8 – 3rd Round)
- Chromium: <2.50 µg/L to 23.7 µg/L (MW-2 – 5th Round)
- Lithium: 6.3 µg/L to 356 µg/L (MW-2 – 8th Round)
- Molybdenum: <2.50 µg/L to 21.1 µg/L (MW-2 – 3rd Round)
- Thallium: <5.0 µg/L to 14.8 µg/L (MW-5 – 5th Round)
- Radium-226: 0.0638J to 1.16 pCi/L (MW-8 – 3rd Round)
- Radium-228: 0.174J to 1.95J pCi/L (MW-3 – 3rd Round)

EPA Appendix I Metal Detections (Post-CCP Placement Site Conditions)

- Nickel: <2.5 µg/L to 13.5 (MW-2 – 5th Round)
- Vanadium: <2.5 µg/L to 6.2 µg/L (MW-1 – 4th Round)
- Zinc: <5.0 µg/L to 50.7 (MW-2 – 3rd Round)

EPA Appendix I VOC Detections (Post-CCP Placement Site Conditions)

- All VOCs have been reported as ND in all wells for 3rd through 8th Rounds

Antimony increased slightly during the 7th Round at MW-2, but remained consistent with only slight changes from 8.9 to 12.3 µg/L. Laboratory analytical results from the 7th and 8th Round generally showed a decrease or remained constant in groundwater TDS concentrations in all monitoring wells with the exception of MW-2. TDS concentrations increased for the three subsequent sampling events (4th, 5th and 6th Rounds) and returned to levels similarly observed during pre-CCP placement (1st and 2nd Rounds). Kevin Godwin, Project Manager of Pace Analytical, verified the 3rd Round sampling, analytical, and quality control procedures were performed in accordance with all other monitoring events.

3.2 Surface Water Analytical Results

Surface water samples (**Figure 4**) prior to and following CCP placement had few constituents above established North Carolina Surface Water and Wetland Standards (15A NCAC 02B) or EPA National Criteria standards (utilized by North Carolina Division of Water Quality as default standards for non listed parameters). Laboratory analytical results from the 7th Round of sampling indicated pH and copper in surface water samples SW-1 (5.8 SU) and SW-1 (7.9 µg/L) were in exceedance of their respective 15A NCAC 2B standard. No other surface water exceedances were detected during the 7th Round of sampling. Results from the 8th Round of sampling indicated cobalt (19.1 µg/L) in SW-2 was in exceedance of its respective 15A NCAC 2B standards. No detections above the 15A NCAC 2B standards were observed during the 8th Round of surface water sampling.

3.3 Leachate Analytical Results

Leachate generated on-site was collected during the 7th through 8th monitoring events to geochemically characterize the nature of CCP leachate (**Figure 5**). Leachate parameter concentrations are evaluated against the NC Groundwater Protection Standards. EPA Appendix III parameters generally increased from the 3rd through 7th Rounds but were within the standard. Round 8 reported boron (1,150 µg/L), sulfate (276,000 µg/L) and TDS (711,000 µg/L) exceedances for EPA Appendix III parameters. EPA Appendix IV and EPA Appendix I metals parameters remained stable or also increased slightly. Antimony, selenium and vanadium were in exceedance during the 7th and 8th Rounds, while arsenic and chromium were in exceedance for only the 8th Round.

3.4 Groundwater Flow Characteristics

Prior to each of 7th Round and 8th Round sampling events, a synoptic event occurred to establish depth-to-water below top of casing for the seven monitoring wells, one upgradient monitoring well, and one background monitoring well. Depths-to-water ranged from 6.78 feet below top of casing (MW-6; May 25, 2016) to 58.57 feet below top of casing (MW-1; July 11, 2016). Groundwater elevations ranged from 199.82 mean sea level (msl) (MW-8; July 11, 2016) to 224.1 msl (MW-6; July 11, 2016). The greatest groundwater elevation change observed between Round 4 through Round 6 events occurred at MW-5 (230.1 msl on January 4, 220.1 msl on April 5, 2016; an approximate 10 foot drop in three months). Due to on-site liner construction and storm water pond construction, groundwater levels have fluctuated during this reporting period. This has remained constant since that construction related activities.

3.4.1 Groundwater Direction

Groundwater generally flows toward the southeastern portion of the site, although radial flow away from two topographic high points is depicted on **Figure 6**. A potentiometric surface map for groundwater elevations measured during July 2016 event is shown in **Table 2** and **Figure 6**.

3.4.2 Hydraulic Conductivity

Hydraulic conductivity is the capacity of a porous medium to transmit water (K, coefficient of permeability). This property is primarily dependent upon the size, shape, and interconnectedness of pores, and is governed secondarily by the properties of the fluid (i.e., viscosity, a temperature-dependent phenomenon). Horizontal hydraulic conductivity of aquifer materials adjacent to the well screen was estimated through in-situ slug testing. On September 10, 2015, Buxton conducted rising head slug tests at monitoring wells BG-1, MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, and MW-8, to determine hydraulic conductivity (Buxton, 2015b). Results are provided in **Table 3**.

Prior to conducting slug tests, static water levels were obtained at each well to the nearest one-hundredth of a foot (0.01 feet) with an electronic water level indicator. Slug tests were conducted by lowering one or two disposable PVC bailer(s) attached to new nylon rope below the water level at each well. Water levels were allowed to equilibrate to near static conditions (at least 90% recharge). A slug of water was then removed from the well by withdrawing the bailer(s) and water levels were measured with time.

The slug and recovery test data were evaluated using AQTESOLV® software developed by Hydrosolv, Inc. (2007) and in accordance with the methods developed by Bouwer and Rice in 1976 and 1987. The Bouwer-Rice method utilized to evaluate the slug test data was developed to determine the hydraulic conductivity of the aquifer immediately surrounding the screened portion of the partially or fully penetrating wells in unconfined aquifers.

Monitoring wells were generally screened within residuum or partially weathered rock; hydraulic conductivity ranged from 4.08E-07 cm/sec at MW-3 (0.422 ft/year) to 4.11E-04 at MW-1 (425.5 ft/year).

3.4.3 Horizontal Hydraulic Gradients

Horizontal hydraulic gradient is calculated by taking the difference in hydraulic head over the length of the flow path between two wells of similar construction; BG-1, MW-1, MW-2, MW-3, MW-6, and MW-8 were installed with 15-foot screens, while MW-4, MW-5, and MW-7 (i.e. converted piezometers) were installed with ten-foot screens. Hydraulic gradients at the site during the 8th Round of sampling ranged from 0.001 between MW-1 and MW-6 (as well as other pairings) to 0.02 between MW-7 and MW-8 (**Table 4**).

3.4.4 Groundwater Flow Velocity

Darcy's Law is an equation that describes the flow rate or flux of fluid through a porous media. To calculate the velocity that moves through a porous media, the specific discharge, or Darcy flux, is divided by the effective porosity, P_e. The result is the average linear velocity, or seepage velocity, of groundwater between two points.

The following equation was used to calculate groundwater velocities between specific wells:

$$V_S = \frac{Ki}{P_e}$$

Where:

V_s = seepage velocity
K = horizontal hydraulic conductivity
i = horizontal hydraulic gradient
P_e = effective porosity

Seepage velocities for groundwater were calculated using horizontal hydraulic gradients established in **Section 3.2.3**, horizontal hydraulic conductivity values established in **Section 3.2.2**, and estimated effective porosity values from geotechnical testing and from the literature where geotechnical data was not available. (Buxton, 2014; Sinhal and Gupta, 2010). If geotechnical data was unavailable, an effective porosity of 0.15 was used for wells primarily screened in residuum/PWR and an effective porosity of 0.075 was used for wells primarily screened in layered rock/PWR.

Flow velocity varies with hydraulic conductivity as well as hydraulic gradient and effective porosity of the soil, and therefore this approximated value varies on a well-by-well basis. Throughout the study area, flow velocity ranged from nearly 0.0 feet per year (between MW-2 and MW-3 as wells as between MW-3 and MW-7) to approximately 36.6 feet per year (between MW-1 and MW-8). The site average flow velocity is approximately three feet per year for the evaluated screen intervals. Flow velocity values are summarized in **Table 5**; flow velocity was estimated with the most recent groundwater level measurements (July 11, 2016).

4 Statistics

4.1 Methodology

An analysis of the data set including the recent sampling event was performed. The data was statistically analyzed using a combination of Starpoint Software, Inc.'s ChemPoint® and ChemStat® as well as EPA's ProUCL statistical software packages. Prediction Limits (PL) and proposed site standards for constituents measured in background well BG-1 for the Site were developed in accordance with Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance. Additionally, Interwell statistical analysis was conducted for the detected groundwater results during the July 2016 sampling event in the Brickhaven No. 2 Mine Tract "A" Structure Fill Site.

The statistical summary for each parameter and well is included in **Appendix D**. The data analysis includes the following.

- Test for Outliers
- Adjustment of Non-Detects (NDs)
- Distribution Assessment
- Trend Analysis
- Prediction Limits
- Interwell Comparison

A more detailed report can be provided upon request.

4.1.1 Test for Outliers

Parameters measured during prior sampling events and the most recent monitoring period (i.e., the entire record for a parameter pooled over the 8 downgradient wells and the background well) are tested for outliers using Dixon's test (valid for sample sizes < 25). Any values identified as outliers are noted in a statistical summary table included in **Appendix D** in more detail.

However, outliers are not removed from subsequent analyses unless the analytical result's quality assurance review determined that values in question were impacted and sources of impact were known. Outlier tests are not performed for Parameters that do not have any measured values greater than its MRL.

Test results identified the following outliers: Barium detected at MW-8, lithium, sulfate, and zinc detected at MW-2 during the July 2016 monitoring event are outliers relative to all these parameters' values collected over the eight sampling events from all wells. The outliers are included in the Interwell statistics.

4.1.2 Adjustment for Non-Detects (NDs)

NDs (commonly described as "non-detects") represent analytical results reported as below their Method Reporting Limits (bMRL) and are adjusted based on the percentage of bMRL values. When less than 15 percent of values for a Parameter are NDs, those values are replaced with a value equal to half of the MRL. When 15 percent to 50 percent of values are reported below the MRL, the Aitcheson Adjustment is used for the ND data. The values for the NDs are set equal to their respective MRLs when more than 50 percent of values for a Parameter are below its MRL, and a non-parametric method is used.

4.1.3 Distribution Assessment

Data are evaluated to determine whether the distribution of each Parameter satisfies normality assumptions for further statistical analysis when less than 50 percent of the data for the Parameter are bMRL (<50% ND). Normality is evaluated using the Shapiro-Wilks test, which applies to cases where there are fewer than 50 samples. Distributions are first evaluated using non-transformed data and then, if the distribution does not satisfy normality constraints, it is tested again using natural log (ln) transformed data.

4.1.4 Trend Analysis

The background well concentration data are evaluated to determine if seasonal trends exist if there are any detected results. Trends are evaluated using the Mann-Kendall test (a non-parametric test for trend).

4.1.5 Predictive Limits Determination

Data are evaluated to determine whether a Parametric Prediction Limit (PPL) or a Non-parametric Prediction Limit (NPPL) can be used to estimate prediction limits for each Parameter at the background well. This evaluation depends on the percentage of measurements below their MRL and whether a distribution satisfies normality assumptions. For Parameters with less than 50 percent of measurements reported as below their MRL and a distribution that satisfies normality assumptions, a PPL is calculated. For Parameters with more than 50 percent of measurements reported as below their MRL or having a distribution that does not satisfy normality constraints, a NPPL is calculated.

The background well calculated PLs are tabulated and compared to 2L Standards or EPA Maximum Concentration Limit (MCL) in Table 1 in **Appendix D**.

4.1.6 Interwell Comparison

Parameter concentrations from compliance wells are compared to corresponding Prediction Limits (PLs) from the background well. Concentrations measured during the most recent sampling event represent the compliance well condition in the Interwell comparison. As previously described in the report "Prediction Limit for Background Well Parameters", the entire record of measurements from the background well is evaluated to determine whether a Parametric Prediction Limit (PPL) or a Non-parametric Prediction Limit (NPPL) can be used to estimate background well PLs. This evaluation depends on the percentage of measurements bMRL and whether a distribution satisfies normality assumptions. For parameters with less than 50 percent of measurements from all wells reported as bMRL and a distribution that satisfies normality assumptions from the background well, a PPL is calculated. For Parameters with more than 50 percent of measurements reported as bMRL or having a distribution that does not satisfy normality assumptions, a NPPL is calculated.

The detected parameters above the MRL But from each compliance well during the July 2016 sampling event is compared to the background well Parametric or non-parametric Prediction Limit. Parameters are considered to be within compliance limits if the July 2016 sampled concentration from the compliance well is less than the background well PL. Otherwise, compliance well values are evaluated to determine the nature of any increases and trends over time.

4.2 Statistical Analysis & Results

The ChemStat® statistical analysis identified the parameters with a statistically significant increase (SSI) over the background levels for the down-gradient wells. The results are summarized in Table 1 and Table 2 of **Appendix D**.

4.2.1 Predictive Limits Results

PL calculations and proposed site standards for the Site are presented in Table 1 (**Appendix D**) and summarized as follows:

- The following Parameters had more than 50 percent of measurements reported as being below their MRL: antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. For these parameters, the background well PL was calculated using Non-Parametric Prediction Limit (equal to maximum MRL or Maximum background concentration, whichever is larger); but for vanadium and zinc, the Chebyshev Inequality UPL Method was used (Table 1).
- The following Parameters had less than 50 percent of measurements reported as being below their MRL, with distributions that satisfy normality assumptions: barium, boron, calcium, chloride, lithium, radium-226, radium-228, sulfate, and TDS. For these Parameters, the background well upper PL was calculated using equation 18.3 of the Unified Guidance (95% Upper Prediction Limit).
- Fluoride had less than 50 percent of measurements reported as being below its MRL, with distributions that met normality assumptions when measurements were natural log-

transformed. The parametric prediction limit was calculated using equation 18.5 of the Unified Guidance (95% Upper Prediction Limit).

- The PL for field measured pH was calculated as a 95% (2 sided) parametric prediction interval.
- The calculated PL for antinomy, arsenic, cobalt, thallium, TDS, and vanadium from the background well were higher than their respective 2L, MCL, or groundwater protection limits. However, the PL for antinomy, arsenic, cobalt equal to the MRLs for these parameters and there was only one detection from 8 monitoring events at levels below their respective MRLs.

4.2.2 Interwell Comparison Results

Based on the results from the Prediction Limits for Background Well Parameters, the parameters Ba, B, Ca, Cl, F, Li, Ra-226, Ra-228, SO4, and TDS from the background wells follow normal distributions. Parametric 95 percent prediction limits were estimated for these parameters. Compliance observations for these parameters from the July 2016 sampling event were compared to their respective prediction limits. A one-sided (upper) parametric prediction limit (UPLs) was used to estimate limits for all parameters with the exception that a two-sided parametric prediction limit was chosen for pH (field) in accordance with the Unified Guidance direction for prediction limits for these parameters.

For parameters with detections fewer than twice during the 8 sampling events from the background well (including Tl, Cr, and Mo), non-parametric methods were used to estimate their respective prediction limits, where either the larger of the MRL or the detected result from the background well is used as the UPL. The UPLs for Vanadium and Zn were calculated using 95% Chebyshev UPL method in which these two parameters were detected more than twice from the background well during the 8 sampling events.

All the results are shown in the summary table (Table 2 in **Appendix D**). The results are summarized as follows:

<u>Parameters with Statistically Significant Increase above Background PL (SSI)</u>

- **Antimony**: Antimony observations from MW-1 to MW-3, and MW-8 show statistical significance compared to the background well NPPL. But the results show no trend over time at MW-2, MW-3 and MW-8 using Sen's slope estimator tests. Sen's slope estimator test was not conducted for MW-1 because only a single detection was found above the MRL during the 8 monitoring events.

- **Barium:** Barium observations from MW-3 and MW-8 have statistically significant increases (SSIs) above the background 95% UPL. But barium results show no trend over time for these wells using Sen's slope estimator tests.

- **Boron**: Boron observations from MW-2, MW-3, and MW-7 have SSIs compared to the background 95% UPL. But the results show no trend or downward trend over time using Sen's slope estimator tests.

- **Calcium**: Calcium observations from MW-1 to MW-4 and from MW-7 to MW-8 have SSIs compared to the background 95% UPL. But the results show no trend or downward trend over time except at MW-7, which showed an upward trend using Sen's slope estimator tests.

- **Chloride**: Chloride observations from MW-1 to MW-4, MW-7, and MW-8 have SSIs compared to the background 95% UPL. But the results show no trend or downward trend over time using Sen's slope estimator tests.

- **Chromium**: Chromium detected at MW-2 has an SSI compared to the background NPPL; but there is no trend in the chromium results over time at this well using Sen's slope estimator test.

- **Fluoride**: Fluoride observations from MW-4 to MW-6 have SSIs compared to the background 95% UPL. But the fluoride results showed no trend or downward trend over time for these wells using Sen's slope estimator tests.

- **Lithium**: Lithium observations from MW-2 and MW-3 have SSIs compared to the background 95% UPL. The results at MW-2 showed an upward trend, but there is no trend at MW-3 over time using Sen's slope estimator tests.

- **Molybdenum**: Molybdenum observations detected at MW-2 and MW-3 show SSIs above the background NPPL.

- **pH (field)**: The pH (field) observations from MW-2 and MW-3 have SSIs outside the background 95% Prediction Interval Limit. But the pH (field) results do not show a trend over time for both wells using Sen's slope estimator tests.

- **Sulfate**: Sulfate observations from MW-2, MW-3, and MW-6 have SSIs over the background 95% UPL. But the results showed no trend over time for these wells using Sen's slope estimator tests.

- **Total Dissolved Solids (TDS)**: TDS observations from MW-1, MW-2, MW-3, MW-4, MW-7, and MW-8 have SSIs from the background 95% UPL. But the results show no trend over time for all wells except at MW-2 where TDS shows an upward trend using Sen's slope estimator tests.

- **Zinc**: Zinc observations detected from MW-1, MW-2, MW-5, MW-6, and MW-8 have SSIs above the background well 95% Chebyshev UPL, but Sen's slope estimator test did not show any increasing trend for zinc from all these wells.

<u>99 Percent LCL (99%LCL) Compared to UPL of Background Well, 2L Standard, MCL or GWPS</u>

The calculated 99%LCL from the downgradient wells for the parameters has SSI is compared to the higher value of the groundwater standards (including 2L, MCL, GWPS, or UPL of background well). The 99%LCL for calcium and molybdenum are not used to compare with their respective background well PLs because standards for these parameters have not been established by EPA or the state. Therefore it is unknown whether the standards are required for these parameters. The 99% LCL above the standard are noted and listed below.

- **Antimony**: The 99%LCL for antimony from MW-8 is above the 2L standard (1 µg/L); but the results do not show any increasing trend based on time series plots and Sen's Slope estimator tests.

- **Barium:** The 99%LCL for barium from MW-8 is above the 2L standard (700 µg/L); but the results do not show any increasing trend based on time series plots and Sen's Slope estimator tests.

- **Chloride**: The 99%LCLs for chloride from MW-2, MW-3, and MW-8 are above the UPL of the background well (345.2 mg/L); but these results do not show any increasing trend based on time series plots and Sen's Slope estimator tests.

- **TDS**: The 99%LCLs for TDS from MW-2, MW-3, MW-7, and MW-8 are above the 95% UPPL of the background well; but these results do not show any increasing trend except at MW-2 based on the time series plots and Sen's Slope estimator tests.

The remaining monitored parameters either are not detected, not above the MRL or are not statistically significant above the background concentration levels.

5 Conclusions

Rounds 7 and 8 of the required eight monitoring events were conducted at Brickhaven No. 2 Mine Tract "A" Structural Fill site from May to July 2016. In conjunction with the 3rd monitoring event discussed in the *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2015) and 4th through 6th monitoring events discussed in the *2016 First Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report* (HDR, 2016a), these events represent post-CCP placement conditions at the site. The first and second monitoring events were conducted prior to the placement of CCP on October 23, 2015, and therefore represent pre-existing site conditions; these results were also previously discussed in detail in the 2015 Semi-annual report (HDR, 2015). The requisite one minimum independent background monitoring event specified in Permit No. 1910-STRUC-2015 have thus been met. No further background monitoring events will occur as a total of six post-CCP placement events and two pre-CCP placement events are now completed.

A summary of the findings from the 7th and 8th monitoring events is provided below and in **Table 6-1** and **Table 6-2**:

- Groundwater was encountered at the site from approximately six feet below top of casing to approximately 60 feet below top of casing.
- Groundwater samples collected at monitoring wells BG-1, MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, and MW-8 indicated the presence of constituents above established NCGPS.

- Groundwater in the vicinity of the CCR structural fill generally flows from the central portion of the Site to the west and east toward Shaddox Creek and Gulf Creek, respectively.
- Chloride exceeded its NCGPS in several separate wells during the 7th and 8th Rounds. Exceedances of chloride were similarly detected in the background monitoring events (i.e. 1st and 2nd Rounds) and during the post-CCP placement monitoring event (i.e. Round 3 to present). Chloride is likely naturally occurring due to site geological conditions. MW-5 has not exceeded its NCGPS during any monitoring event.
- TDS consistently exceeded its NCGPS in eight of nine wells, including background well BG-1, during the 7th and 8th Rounds. MW-5 has not exceeded its NCGPS for TDS during any monitoring event. Elevated TDS concentrations remain and are likely naturally occurring throughout the site.
- Groundwater pH was in exceedance in MW-4 for all 4th through 8th monitoring events and was in exceedance in MW-6 for Round 8. Low pH previously observed at BG-1 has continued to stabilize above the NCGPS threshold during the 7th and 8th monitoring events. Intermittently low pH is likely naturally occurring at the site, with several field pH values only slightly above the 6.5 SU threshold for multiple monitoring events; occasional fluctuations around this NCGPS threshold will likely continue.
- Antimony exhibited multiple intermittent exceedances in different wells during the 7th and 8th Rounds, at MW-1, MW-2, MW-3, and MW-8. These detection patterns and concentration levels are similar to pre-CCP placement and are likely naturally occurring.
- Barium and vanadium exhibited multiple exceedances in different wells during the two monitoring events. These constituents are likely naturally occurring.
- Analytical data from the 7th and 8th monitoring events indicate placement of CCP has not impacted groundwater at the site.
- Surface water collected at two off-site locations exhibited exceedances of pH and copper during the 7th Rounds and cobalt during the 8th Round. Analytical data from the 7th and 8th monitoring events indicate surface water has not been impacted by the placement of CCP at the site.
- Leachate samples generally exhibited an increase in exceedance frequency and parameter concentrations relative to the first leachate sample collected in Round 3. NCGPS exceedances during the 4th through 8th Rounds included antimony, boron, selenium, sulfate, TDS, and vanadium.
- Antimony, barium, chloride, pH, TDS, and vanadium were evaluated to be naturally occurring constituents in site background groundwater and pre-CCP Placement events. Further sampling and analysis are necessary to refine naturally occurring conditions, as may be required.
- Analytical data from the 3rd through 8th monitoring events indicate placement of CCP has not impacted groundwater at the site.

A summary of the statistical analysis is provided below and in **Appendix D**:

- The following Parameters had more than 50 percent of measurements reported as being below their MRL: antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. While barium, boron, calcium, chloride, fluoride, lithium, radium-226, radium-228, sulfate, and TDS had less than 50 percent of measurements reported as being below their MRL, with distributions that satisfy normality assumptions.

- The calculated PL for antinomy, arsenic, cobalt, thallium, TDS, and vanadium from the background well were higher than their respective 2L, MCL, or groundwater protection limits.
- Based on the results from the Prediction Limits for Background Well Parameters, the parameters Ba, B, Ca, Cl, F, Li, Ra-226, Ra-228, SO4, and TDS from the background wells follow normal distributions.
- Numerous parameters including antimony, barium, boron, calcium, chloride, chromium, fluoride, molybdenum, pH, sulfate, and zinc show statistical significance compared to the background well NPPL, 95% UPL, or 99% UCL. But the results show no trend and/or downward trend over time at a number of the wells using Sen's slope estimator tests.
- Lithium observations from MW-2 and MW-3 have SSIs compared to the background 95% UPL. The results at MW-2 showed an upward trend, but there is no trend at MW-3 over time using Sen's slope estimator tests.
- TDS observations from MW-1, MW-2, MW-3, MW-4, MW-7, and MW-8 have SSIs from the background 95% UPL. But the results show no trend over time for all wells except at MW-2 where TDS shows an upward trend using Sen's slope estimator tests. The 99%LCLs for TDS from MW-2, MW-3, MW-7, and MW-8 are above the 95% UPPL of the background well; but these results do not show any increasing trend except at MW-2 based on the time series plots and Sen's Slope estimator tests.
- Subsequent groundwater sampling and refinement of the background statistical analysis will continue to be monitored and evaluated to determine if modifications to detection monitoring is required.

6 Recommendations

Based on the findings of this assessment, HDR makes the following recommendations:

- Groundwater, surface water and leachate sampling is recommended to be conducted on a semi-annual basis commencing 180 days from the acceptance of this report.
- Continued discussion with NCDEQ related to ongoing detection monitoring and further refinement of the background statistical analysis.
- Further evaluation of naturally occurring constituents at the Site.

7 References

Buxton Environmental. 2015a. *Water Quality Monitoring Plan for Brickhaven No.2 Mine Tract "A" Structural Fill.*

Buxton Environmental. 2015b. *Compliance Groundwater Well Installation, Development, Surveying and Hydraulic Conductivity Determination Activities Report for Brickhaven No.2 Mine Tract "A" Structural Fill.*

HDR. 2014. *Permit Application for Brickhaven No.2 Mine Tract "A" Structural Fill including Design Hydrogeological Report.*

HDR. 2015. *2015 Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report. December 2015.*

HDR. 2016a. *2016 First Semi-Annual Groundwater, Surface Water, and Leachate Sampling Report. May 2016.*

North Carolina Department of Natural Resources and Community Development. 1985. *North Carolina Geologic Map.*

North Carolina General Assembly. *Coal Ash Management Act (CAMA) of 2014 (Senate Bill 729).* Ratified.

NCDEQ. 2008. *Solid Waste Section Guidelines for Groundwater, Soil, and Surface Water Sampling.*

Singhal, B. B.S. and R. P. Gupta. 2010*. Applied Hydrogeology of Fractured Rocks: Springer, 2nd Edition*, 408p. (Table 8-1, p. 140)

United States Geological Survey. 2004. *Arsenic, Nitrate, and Chloride in Groundwater, Oakland County, Michigan.*

This page intentionally left blank.