Shallow Groundwater
Conceptual Site Model Report
Western Hook Area
BMI Eastside Common Areas
Henderson, Nevada

Submitted to

NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

May 30, 2023

Prepared for

Basic Remediation COMPANY

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I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances.

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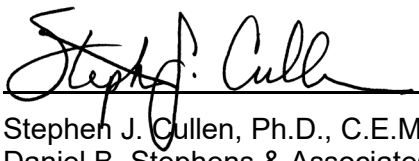

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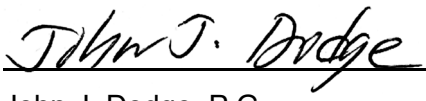

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1. Introduction

At the request of Basic Remediation Company (BRC), Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this conceptual site model (CSM) report for the portion of the Basic Management, Inc. (BMI) property known as the Western Hook (also referred to as the "Western Hook Area" or "Eastside Hook area" in other documents). The Western Hook is located in Henderson, Nevada (Figures 1 and 2) and is part of the BMI Common Areas (Figure 3). The BMI Common Areas are divided into the Eastside Main Area and Western Hook (Figure 4). The CSM and Remedial Alternatives Study (RAS) for the Eastside Main Area is presented under separate cover and was previously reported and submitted to the Nevada Division of Environmental Protection (NDEP). The geology, hydrogeology, chemical constituents of interest, and source of impact are similar between the Western Hook and Eastside Main Areas. Investigations have historically taken place that addressed the characteristics of both areas. In instances where the investigations addressed both areas, the areas are collectively herein referred to as the Eastside Properties.

The purpose of this document is to present and discuss the Western Hook (Site) history and operations, the physical hydrogeologic setting, the history of Site investigations, the distribution of Site groundwater impacts, the impact of various groundwater remediation programs in the Site vicinity, and the fate and transport of residual constituents in Site groundwater. This CSM is focused on Shallow Zone groundwater, and includes summaries and interpretations of multiple prior reports and documents prepared by BRC and others previously submitted to the NDEP for review and approval. As a result, this CSM is intended to be brief where possible, and the original documents are referenced for further detail and documentation of the subject matter as needed.

The Western Hook is downgradient of the BMI Industrial Complex (Plants Area) where shallow groundwater is impacted with multiple analytes from decades of chemical manufacturing and production. The Plants Area is a documented source area for groundwater impacts at downgradient properties including the Western Hook. As a result, groundwater quality in the Western Hook is dependent on the performance of ongoing remedial actions addressing Plants Area sources over the near term and the long term. Western Hook remedial alternatives will be

evaluated by BRC in the future once Plants Area cleanup efforts are nearing completion and continual analyte loading to Western Hook groundwater is largely mitigated or under control.

1.1 Program Summary

In 1991, Chemstar Inc., Kerr-McGee Chemical Corporation (KMC), Montrose Chemical Corporation (Montrose), Pioneer Chlor Alkali Company (Pioneer), Stauffer Management Company (Stauffer), and Titanium Metals Corporation (TIMET), (collectively the "Companies") and NDEP entered into a Consent Agreement regarding the first phase of a phased approach to the assessment and remediation, if necessary, of environmental conditions associated with the BMI Complex. In 1993, the Companies submitted a Phase I Environmental Conditions Assessment (ECA) for the BMI Industrial Complex (the BMI Complex) (G&M, 1993). NDEP determined that additional work was necessary and, in 1996, entered into a consent agreement with the 1991 Companies along with the added company of Basic Management, Inc. for the purpose of gathering additional information and data concerning the Site and the development and evaluation of appropriate remedial alternatives. The new group of companies became collectively known as the Henderson Industrial Site Steering Committee (HISSC).

In 2000, a final draft report of *Remedial Alternatives Study (RAS) for Soils and Sediments in the Upper and Lower Ponds at the BMI Complex* (BRC, 2000) was prepared in accordance with the 1991 and 1996 Consent Agreements. The RAS focused on the soils within portions of the BMI Common Areas, which were restricted to the Upper Ponds, Lower Ponds, Alpha Ditch, and Beta Ditch. A site-specific, baseline human health risk assessment was conducted to quantify the potential risks posed by chemicals of potential concern (COPCs) in site soils and develop site-specific cleanup goals that assumed unrestricted land uses and a residential receptor. These cleanup goals were used to identify remediation areas and to estimate approximate volumes of impacted soils. The report stated that the evaluation of COPC characteristics (e.g., occurrence and mobility in the subsurface) and site conditions demonstrated that soil remediation was not required to provide protection to groundwater quality under then-current conditions or in the future. Therefore, the report concluded that soil remediation was required for the protection of human health based on soil-related receptor exposure pathways, and was not required for the protection of groundwater quality or the Las Vegas Wash.

The 2000 RAS process also included risk assessments to evaluate whether known groundwater conditions underlying the BMI Common Areas posed a threat to human health via complete exposure pathways (i.e., volatilization from groundwater to air) or hypothetical incidental direct contact pathways. The reported findings of the risk assessments indicated that known groundwater conditions beneath the BMI Common Areas did not pose an unacceptable risk to human health under complete exposure pathways or future incidental direct contact pathways. The report concluded that the drinking water pathway was not a potential exposure pathway.

In 2006, BRC, other private companies, and the NDEP agreed to the Settlement Agreement and Administrative Order on Consent for the BMI Common Areas, Phase 3 (AOC3) (NDEP, 2006a). The BMI Common Areas as defined in AOC3 included what are now referred to as the Corrective Action Management Unit (CAMU) area, Parcel 9, the Eastside Hook area (herein referred to as the Western Hook), the Eastside Main Area, and associated subareas and parcels (Figures 3 through 5). The parties to AOC3 agreed that the work specified in the AOC3 should be performed in a manner consistent with the National Contingency Plan (NCP).

The AOC3 Scope of Work section detailed the need for development of a CSM, defined the CSM, and described the issues that must be addressed within the CSM (NDEP, 2006a):

> The site-wide CSM is a comprehensive description of the conditions at the site. This CSM document will replace the need to generate a separate, stand-alone Phase II site characterization report. Additionally, this report may result in the generation of other work plans to address data gaps identified in the CSM.

Examples of issues that must be addressed as part of this CSM are as follows:

- A comprehensive list of site-related chemicals and/or surrogate indicator chemicals with proposed analytical methods
- An evaluation of background conditions
- Delineation of all source areas
- Presentation of the three-dimensional nature and extent of groundwater contamination

- Detailed evaluation of hydrogeological conditions including cross-sections, evaluation of the interconnectivity of water-bearing zones, descriptions and illustrations regarding the thickness of saturated zones, structure maps on top of the Muddy Creek Formation, and other descriptions and illustrations that fully describe the hydrogeological conditions regarding the site

In May 2007, the BRC Closure Plan (BRC et al., 2007) articulated the history of the BMI Eastside Common Areas, future uses of the BMI Eastside Common Areas, BRC's characterization and remediation plans with respect to soils and to waters, the objectives and methods of such remediation plans, and various maps, tables, figures and other references useful to regulators and other stakeholders. The 2007 Closure Plan conceptually described the steps that BRC planned to undertake to assess risks at the BMI Eastside Common Areas, and therefore to make risk-based remediation decisions. The Closure Plan stated why BRC was choosing to progress down certain paths and how BRC intended to proceed through characterization, remediation, and assessment activities to effect site closure—the ultimate aim of AOC3.

1.2 Purpose and Scope

This CSM has been developed consistent with *U.S. EPA Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) under CERCLA* (U.S. EPA, 1988). The U.S. Environmental Protection Agency (EPA) RI/FS process, as with the CSM process, is the methodology for characterizing and reporting the nature and extent of risks posed by the release of potentially hazardous chemicals. As discussed by U.S. EPA (1988), the objective of the process is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support informed risk management decision-making for a given site. U.S. EPA (1988) states:

> The appropriate level of analysis to meet this objective can only be reached through constant strategic thinking and careful planning concerning the essential data needed to reach a remedy selection decision. As hypotheses are tested and either rejected or confirmed, adjustments or choices as to the appropriate course for further investigations and analyses are required. These

choices, like the remedy selection itself, involve the balancing of a wide variety of factors and the exercise of best professional judgment.

This report presents the results of groundwater studies that have been conducted at the Site and vicinity over the course of approximately 18 years, beginning in 2000. Each successive study has built upon the knowledge and data derived from the previous groundwater study. Together, that collective work is used in this report to provide the basis for articulation of the Site CSM.

1.3 Western Hook (Site)

The Site is a hook-shaped portion of land bounded on the west by Wiesner Way. The "hook" portion of the Site wraps around and borders the City of Henderson Bird Viewing Preserve to the west, north, and east. Clark County Wetlands Park forms the northern boundary of the Site. An unpaved extension of Pabco Road forms the eastern Site boundary; E. Galleria Drive forms the approximate southern boundary of the eastern portion of the "hook." The Site is downgradient of the BMI Industrial Complex in Clark County, Nevada, approximately 13 miles southeast of Las Vegas. The BMI Industrial Complex is also referred to as the "BMI Industrial Area" and the BMI "Plants Area" in other documents. The Site represents a portion of a larger property known as the BMI Common Areas. The total extent of the BMI Common Areas property is approximately 2,400 acres and generally consists of the "Eastside Area" of approximately 2,287 contiguous acres located east of Boulder Highway and the "CAMU" area of approximately 130 acres to the west of Boulder Highway. The Eastside Area consists of the Eastside Main area and the Western Hook (Site).

This CSM is focused solely on the Western Hook (Site), and excludes the Eastside Main area. The area of the Site is approximately 475 acres. The Site consists of:

- Land on which unlined wastewater effluent ponds (and associated conveyance ditches and piping) were built and into which various plant wastewaters were discharged from 1942 through 1976. A portion of this land has since been scraped and graded.

- Land that BMI conveyed to the City of Henderson and upon which the City of Henderson built a wastewater treatment plant (the Water Reclamation Facility [WRF]).

- Land that appears to have never had historical use (BRC et al., 2007).

1.3.1 Historical Operations

In 1941, approximately 5,000 acres of undeveloped desert in the southeastern quadrant of the Las Vegas Valley was deeded by the U.S. for use as the site of what was to become at that time the world's largest magnesium plant, a plant that would play a critical role in World War II. Since that time, parts of the original 5,000 acres were used for industrial purposes and the disposal of a variety of industrial and other wastes. Other portions of the original 5,000 acres were abandoned, converted to other uses, or have remained undeveloped desert. Over the past 65 years, more than 80 private and public entities have owned, leased, or operated facilities on the original 5,000 acres, engaging in a wide range of commercial and other activities, including the manufacture of chemicals and metals. A detailed history of the original 5,000 acres and site ownership is presented in the Closure Plan (BRC et al., 2007).

Historically, there has never been a manufacturing complex on the Site similar to the type of infrastructure that was constructed and operated on the Plants Area to the west of the Site. Further, the Site has historically contained no underground storage tanks. The Site contained a network of ditches, canals, flumes, pipelines, and unlined ponds that were used for the disposal of effluent waste from the original magnesium plant in the Plants Area and, later, other industrial plants and the municipality adjacent to it. This disposal network comprised less than half of the Site area.

This CSM addresses shallow groundwater in the approximate 475 acres of the Western Hook area. The Western Hook formerly included unexcavated ponds, previously excavated ponds, three ditches, and areas that were not used for any known waste disposal (BRC et al., 2007). The Western Hook also includes an area that was conveyed to the City of Henderson upon which it has built a portion of the WRF (BRC et al., 2017). The ponds previously located in the Western Hook were also referred to as the “Lower Ponds.”

Effluent wastes generally discharged to the BMI ponds from the war-time Basic Magnesium, Inc. (Basic) operation can be characterized as salts from the production process (chloride salts of magnesium, sodium, calcium, etc.) and organic and inorganic solids of various types. Chlorinated organics formed by the reaction of chlorine with carbon at elevated temperatures were included in the effluent. Processes that contributed to the waste stream from Basic included the Chlorine/Caustic Plant, the chlorinator furnaces, magnesium cells, magnesium casting, the flux plant, and cell demolition. These effluent wastes left behind a residual evaporite in the soils of the BMI ponds.

After 1945, other contributors to the BMI ponds have included the following entities, among others: Stauffer, KMC, Montrose, TIMET, and the City of Henderson. Effluents included waste products associated with the manufacture of chlorinated organic pesticides, chlor-alkali manufacture, titanium manufacture, perchlorate manufacture, and municipal wastewater.

In 1976, under the federal National Pollutant Discharge Elimination System (NPDES) program, the operating companies within the BMI Complex discontinued the use of the original Upper and Lower Ponds in compliance with zero discharge waste requirements. These ponds have remained out of service since then.

Beginning in 1991 and continuing for the next several years, Phase I and Phase II environmental investigations at the Eastside Common Areas were performed under NDEP oversight. These investigations led to the NDEP Record of Decision in 2001, which ordered that impacted soils at the Eastside Common Areas be excavated and interred in a private landfill off-site. Impacted soils posing unacceptable health risks were not to be left in place (BRC, 2014a). Implementation of the remedy began in 2008 and impacted soils from the Eastside Common Areas were removed and placed in an engineered landfill known as a Corrective Action Management Unit (CAMU), located on property owned by BRC west of Boulder Highway.

BRC completed soil remediation activities at the BMI Common Areas (BRC, 2014b) under NDEP oversight. BRC received No-Further-Action Determinations (NFADs) for the impacted soils in the BMI Common Areas during the third quarter of 2015. The last two NFADs were received on September 29, 2015.

1.3.2 Future Development

Landwell Company redevelopment activities commenced as soils in the Eastside Commons Area were remediated. Ultimately, the entire 2,200-acre site will be restored and redeveloped as a mixed use, master-planned community. There are currently over 800 homes constructed and sold. Upon completion, the 2,200-acre master planned community will feature more than 13,250 homes (Cadence, 2018). As advertised, the finished community will feature a variety of amenities including a 50-acre central park that includes a resident-only lap pool complex, a 2,000-square-foot splash wading pool, a 5-acre adventure playground for kids of all ages, an amphitheater, picnic areas, and trails for hiking and biking. The final development will also include a nearly 100-acre sports park that will include basketball courts, baseball diamonds, and soccer fields.

1.4 BMI Plants Area and AMPAC

A comprehensive history of the BMI Industrial Complex is found in Section 2 of the final Closure Plan (BRC et al., 2007). Briefly, the BMI Industrial Complex was originally owned by and constructed under the direction of the U.S. government in early 1941 to 1942 for the production of magnesium to support the war effort. The plant, initially built and operated by Basic, operated from 1942 to 1944 and was America's largest producing magnesium plant during World War II. From 1945 to 1952, after Basic operations were ended, a number of private chemical companies leased and operated at the Basic plant site under the U.S. government and then under State of Nevada ownership (G&M, 1993; BRC et al., 2007).

Later, five principal operating companies at the Basic site formed BMI for the purpose of owning and operating certain utilities in common to the Basic plant site, including electrical and water transmission assets and common disposal areas (including the BMI Landfill and ponds, plant effluent, and storm drainage systems). The five principal companies consisted of Stauffer, Western Electrochemical Company (WECCO, a predecessor to KMC, now Tronox), United States Lime Corporation (U.S. Lime), National Lead (the predecessor of TIMET), and Combined Metals Reduction Co.

The BMI Plants Area and AMPAC are located upgradient of the Western Hook, and constitute known source areas of chemical constituents that have impacted shallow groundwater that flows toward and beneath the Western Hook. It is in this context that the following descriptions of various company operations that were conducted in the Plants Area are presented.

1.4.1 Pioneer/Stauffer/Montrose

Operations performed by Stauffer and Montrose were somewhat similar in nature and resulted in the production of similar waste streams. Stauffer initiated chemical manufacturing operations south of the current CAMU site in 1945, and occupied about 458 acres. Stauffer leased and then owned and operated the property from 1945 to 1988 to produce chloral (1945 to 1988), hydrochloric acid (1945 to 1988), Lindane (1946 to 1958), Trithion/Imidan (1958 to 1984), parachlorophenol/thiophenol, benzene hexachloride, several other agricultural chemical products, chlorine, and sodium hydroxide (caustic soda). Section 2 of the Closure Plan (BRC et al., 2007) provides details of historical chemical production. Stauffer was known to operate two impoundments, with waste materials also being conveyed via a ditch system to the area of what was known as the former BMI North Landfill Lobe.

North of the CAMU site, Stauffer purchased a 7.4-acre property containing a silica precipitate pond from BMI in 1984. Stauffer was reported to use this parcel for groundwater treatment activities. Stauffer's Lindane plant operated from 1946 through 1958. Stauffer reportedly dismantled its Agricultural Chemical Division (ACD) plant in 1984. The various production processes operated by Stauffer and others at the Site since 1942 have resulted in the generation of different waste streams, including aqueous organic waste, caustic water, byproducts from the production of pesticide products, phosphoric acid, and chlorine cell waste materials. These materials were managed in various waste management areas, both on-site and in the BMI Common Areas, and were transported off-site to regulated commercial disposal facilities. From 1945 through approximately 1975, process waste effluent from both Montrose and Stauffer operations and stormwater runoff from the two facilities were discharged into the industrial sewer system. This system included a series of evaporation ponds connected by process piping and surface drainage ditches (BRC et al., 2007).

In 1947, Montrose subleased approximately 10 acres of property from Stauffer and built an organic chemical manufacturing plant. Between 1947 and 1983, Montrose produced a variety of organic and inorganic chemicals at this manufacturing plant, including monochlorobenzene, polychlorinated benzene, chloral, muriatic acid (hydrochloric acid), ethyl chloride, and dichlorobenzil. Montrose also produced certain byproducts at its organic chemical manufacturing plant, including ethyl chloride (which it marketed from 1958 through 1961). In 1954, Montrose built a synthetic hydrochloric acid plant on the same property. Between 1954 and 1985, Montrose produced industrial grade muriatic acid (hydrochloric acid), both as a byproduct and at its synthetic hydrochloric acid plant. Industrial process descriptions (including multimedia waste management practices) include the use of parachlorothiophenol/thiophenol, Trithion/Imidan, Lindane, and hydrochloric acid production processes (BRC et al., 2007).

Montrose's facilities included chemical production occurring on 2 acres, rail car loading and benzene tank storage on 1 acre, and a tank farm encompassing 2 acres, with the remaining acreage being used for five wastewater impoundments and one still-bottom residue (SBR) impoundment. Four of these ponds (Nos. 1 through 4) were constructed between 1973 and 1975 and contained liners (SECOR, 2002). Pond No. 5 was constructed in 1979, and was used for the storage of hydrochloric acid (BRC et al., 2007).

Montrose also produced hydrochloric acid at the synthetic hydrochloric acid production facilities from 1954 through 1985, when the plant was leased to Pioneer. Montrose ceased operations at the organic chemical plant in 1983 and demolished the plant in 1984. Various plant and site closure activities continued until 1989 (NDEP, 2018b). Montrose reports that waste streams generated from 1947 through 1983 from the manufacture of hydrochloric acid included impurities of benzene, chlorobenzene, acetaldehyde, chloroacetaldehyde, dichloroacetaldehyde, chloral, chloroform, carbon tetrachloride, spent sulfuric acid, and washwater containing sulfonated metabolites of dichlorodiphenyl-trichloroethane (DDT). These wastes were disposed of into the industrial sewer system, Wastewater Ponds 1 and 2 or the BMI Ponds, and on-site Montrose Ponds. In January 1986, Montrose leased to Stauffer the hydrochloric acid plant it owned and operated on property leased from Stauffer.

Pioneer has operated the site since 1988 following the transfer of ownership from Stauffer. In the mid-1990s, when Pioneer acquired the chlor alkali facility, it became the lessee of the hydrochloric acid plant. Pioneer is now doing business as Olin Chlor Alkali Products and continues to operate the chlor alkali production facilities at the Site for the manufacture of liquid chlorine, caustic soda, hydrochloric acid, and bleach.

Products at the Chlor Alkali Plant are shipped via pipeline, rail cars, and trucks. The process facilities include the brine makeup area, chlorine area, caustic plant, acid plant, and steam plant. The primary waste streams generated to date by Pioneer are related to the Diamond Shamrock Cell process and associated wastes. Process recyclable waters and neutralized wastewaters are currently discharged to lined evaporation/containment CAPD Ponds 6A, 7, and 9, and filtered brine mud is disposed in CAPD Pond 2. All other former and existing inactive ponds are reported to receive no process waters. These ponds include CAPD Pond 1, CAPD Pond 3, CAPD Pond 4, CAPD Pond 5, CAPD Pond 6, CAPD Pond 8, ACD Pond 1, and ACD Pond 2.

Stauffer ceased operations at their property in 1988 when the property was purchased by Pioneer Chlor Alkali, Inc. Many of the waste management areas that were used by Stauffer were decommissioned in subsequent years and are now inactive (NDEP, 2018b).

In order to prevent groundwater contaminated with volatile organic compounds (VOCs) from migrating off-site, a groundwater extraction and treatment system (GWTS) was installed downgradient (north) of the plant in 1983. The GWTS is currently active and is collectively operated by Montrose, Pioneer Americas, LLC d/b/a Olin Chlor Alkali Products, Syngenta, and Stauffer (NDEP, 2018b). In the last half of 2016, the system treated over 29 million gallons of groundwater and removed approximately 5,000 pounds of dissolved VOCs. Since its startup, the system has removed approximately 1,000 tons of VOCs (NDEP, 2018b).

1.4.2 Kerr McGee/Tronox/Nevada Environmental Response Trust (NERT)

As reported by NDEP (2018b), after World War II, Western Electrochemical Company (WECCO) leased a portion of the BMI industrial complex, and by August 1952, WECCO had purchased several other portions of the BMI complex for its various production lines. In 1954,

American Potash and Chemical Company (AP&CC) acquired WECCO and continued the chemical manufacturing operations. AP&CC purchased an existing ammonium perchlorate production plant in 1962 that was located within the BMI complex; the plant was constructed by WECCO for the U.S. Navy in the early 1950s. AP&CC merged with Kerr-McGee Chemical Corporation (KMC) in 1967, and operations continued under the KMC name. KMC continued its operations and a subsequent environmental investigation and characterization of the groundwater beneath the property in the 1980s led to the installation of a treatment system for the removal of hexavalent chromium from groundwater.

In 1997, perchlorate was discovered in the vicinity of the Las Vegas Wash. In 1999, KMC began operation of a temporary treatment system for environmental remediation of the perchlorate-impacted groundwater. In 2002, the treatment system was replaced with the currently existing groundwater extraction and treatment system (GWETS). In 2005, KMC spun off a subsidiary company named Tronox LLC. In 2009, Tronox LLC filed for bankruptcy. Subsequently, the Nevada Environmental Response Trust (NERT) was established in February 2011 and became the owner of the property that was previously owned by Tronox while NERT performs its purpose to remediate historical legacy contamination.

The northern border of a system of holding ponds operated by Tronox is located northeast of the BRC's CAMU site. The Henderson Tronox facility (and the former Kerr-McGee Chemical LLC) manufactured manganese dioxide, elemental boron, and boron trichloride. Tronox's corporate predecessors also manufactured a number of chlorate and perchlorate-based compounds including ammonium perchlorate. Perchlorate production ceased at this facility in July 1998, and the perchlorate production equipment was dismantled in March 2002 (NDEP, 2006a; DBS&A, 2007a).

Tronox operated five double-lined, zero-discharge holding ponds (ponds GW-11, WC-West, WC-East, MN-1, and AP-5) for which separate zero-discharge permits were tentatively issued by the Nevada Bureau of Pollution Control for a period of 5 years. The permit did not allow for direct discharge of pond contents to any ground or surface waters of the State of Nevada. The ponds are double-lined and have leak detection sumps between the primary and secondary liners to detect any leakage in the primary (surface) high-density polyethylene (HDPE) liners. A

monthly water balance (mass balance) for each holding pond was also required to account for all inflow (process inputs and incident precipitation), outflow (recycle to process), and evaporative losses.

Tronox operated a perchlorate treatment system under an NDEP Bureau of Corrective Actions Consent Agreement. The perchlorate treatment system consisted of a two-stage fluidized bed reactor (FBR) biological treatment system. Prior to, and as part of, the FBR treatment system, extracted groundwater and other water was treated for chromium, nitrate, chlorate, perchlorate, and other chemicals present in the influent water. The remediation process used several biological reactors arranged in series to allow for the reduction of nitrate, chlorate, and perchlorate. Chromium was reduced and/or removed from the influent water through several methods including reduction and precipitation by electrolytic methods and through the introduction of ferrous sulfate.

The majority of this treatment occurred east of BRC's CAMU site on what was the Tronox site in the BMI Complex. Ferrous sulfate was also added approximately 8,700 feet downgradient near the Western Hook Site at the location known as the Athens Road Lift Station. Approximately 5,500 feet farther downgradient toward the Las Vegas Wash, a line of nine extraction wells, oriented orthogonal to flow of groundwater (the "Seep Wellfield"), captured groundwater that was subsequently treated to remove perchlorate. Remediated water from the FBR was treated to remove solids, disinfected with a UV system, and then discharged via pipeline to the Las Vegas Wash (NDEP, 2006b; DBS&A, 2007a).

NDEP currently reports (NDEP, 2018a) that a revised groundwater monitoring program for the NERT Site was approved by NDEP on June 24, 2016. A semiannual performance memorandum containing streamlined data transmittals and summaries of remedial performance with respect to the performance metrics and objectives of the Continuous Optimization Program was submitted to NDEP on April 28, 2017. The NERT removed 371,000 pounds of perchlorate in 2016, yielding a grand total of 9,574,000 pounds removed since the perchlorate was initially intercepted at the seep. A Continuous Optimization Program was initialized in 2015 and has made good progress in increasing both mass removed and extraction flow rates from the Athens Well Field and the Seep Well Field.

An ion exchange remediation system installed near Las Vegas Wash at Lift Station #1 gives the GWETS flexibility in managing water levels, the ability to extract additional groundwater, better emergency response to GWETS operation, and increased mass and hydraulic capture in the Seep Well Field. Infrastructure improvements in 2016 included upgrading pumps in the lift stations and extraction wells and a GWETS computer system that allows NERT better management of the extraction fields by providing real time water levels and well extraction rates. As part of the infrastructure upgrades, a secondary containment system was installed at Lift Station #1 to capture any spills.

In remedial investigations in 2016, a phased approach was used, with three distinct phases. A Phase I remedial investigation data report and a Phase II remedial investigation work plan were approved in 2016. A Phase III remedial investigation work plan focused on investigating perchlorate in groundwater underneath eastern BMI ponds. In addition, Unit Building #4 demolition and two mobilizations to investigate Unit Buildings #4 and #5 were completed onsite. The two mobilizations confirmed that a large amount of perchlorate mass existed in both soils and groundwater underneath Unit Buildings #4 and #5.

One of the milestones for the NERT site in 2016 was that the pumpable liquids from pond AP-5 containing high perchlorate concentration were safely transferred into three on-site 600,000-gallon stainless steel tanks. Abandoned equipment from the AP-5 pond operation was properly disposed of. The liquids containing the perchlorate will be treated through the GWETS. The AP-5 pond closure request has also been approved by the Bureau of Water Pollution Control and will be completed sometime in future.

1.4.3 TIMET

In 1950, TIMET was formed by a joint venture agreement between Allegheny Ludlum Steel Corporation and National Lead Company to manufacture titanium metal, including titanium ingots, titanium tetrachloride, titanium sponge, and titanium fines.

Over the operational period of TIMET, various buildings and parcels of land were leased to industrial or commercial companies. Other portions of land were also transferred via easement

to utility providers. Detailed information on the tenants and easements granted has been compiled in the BRC Closure Plan (BRC et al., 2007).

Historically, TIMET operated the Pabco Road Ponds, which are located on the northeast side of Boulder Highway. The Pabco Road Ponds were originally part of the former wastewater effluent ponds and conveyance ditches into which various wastewaters from the BMI Complex were discharged from the early 1940s through 1976. From the 1940s to the mid-1970s, the unlined Upper and Lower Ponds were used as evaporation ponds for process effluent from the BMI Industrial Complex. TIMET built 31 lined ponds on top of the southwestern portion of the Upper Ponds from 1976 to 1982. The ponds received four waste streams generated as process effluent from the facility. The waste streams included effluent from the continuous sludge dryer (CSD), leach liquor, other process wastes (OPW), and spent caustic. This process effluent was piped under permit to the Pabco Road Ponds area for neutralization and evaporative treatment.

As part of the Liability Transfer and Assumption Agreement between TIMET and BRC, TIMET had to eliminate discharge of their process effluent to the Pabco Road Ponds. As a result, TIMET elected to construct a wastewater conservation facility (WCF) on the plant site. The purpose of the WCF was to treat process effluent on-site and, in doing so, discontinue use of the Pabco Road Ponds.

TIMET currently operates an integrated titanium metals production facility (Hargis, 2008; GEI, 2015). The principal products manufactured by TIMET are titanium ingots, titanium tetrachloride, titanium sponge, and titanium fines. The manufacturing process results in the generation of both solid and liquid waste streams that are managed and disposed of on-site and off-site.

The TIMET CSM report states that the conditions under which TIMET reduces magnesium chloride, including high heat and the presence of chlorine, are favorable for the inadvertent generation of chlorinated organic compounds. However, this can only occur if carbon sources are also present either in the raw materials or as products of combustion. Specifically, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans (PCDD/

PCDF), and hexachlorobenzene are chemicals of concern for inadvertent generation under these conditions (GEI, 2015).

1.4.4 AMPAC

The former American Pacific Corporation (AMPAC) plant was operational and manufactured perchlorate from 1959 to 1988 at a site located approximately 6,000 feet southwest of the CAMU Site. Pacific Engineering and Production Company of Nevada (PEPCON) was built near Henderson Nevada in 1958. PEPCON was a chemical plant that specialized in the production of ammonium perchlorate, a chemical compound (an oxidizer) that was, and continues to be, primarily used as the oxidizer component of solid propellant for rockets and missiles. In 1982, PEPCON was acquired by AMPAC (NDEP, 2018c).

The plant catastrophically exploded in May 1988 and was destroyed. AMPAC released perchlorate, and there is a significant groundwater plume that emanates from its former plant site and migrates northward toward the Las Vegas Wash, just west of the CAMU Site. NDEP has described the AMPAC perchlorate plume as smaller and much less concentrated than the Tronox plume. The AMPAC plume is being investigated and remediated. AMPAC conducted an in situ bioremediation pilot study from December 2002 to April 2003. The pilot was successful, reducing perchlorate concentrations from about 500,000 parts per billion (ppb) to less than 2 ppb. During 2003 and 2004, AMPAC conducted additional investigation of the nature and extent of its perchlorate plume. The NDEP required AMPAC to install a remediation system at the leading edge of its plume by February 2006. This system has been installed and is operating.

1.4.5 Plants Area Release History

The history of releases at the Plants Area is relatively extensive. Between 1945 and 1975, process waste effluent from both Stauffer and Montrose operations and stormwater runoff from the two facilities were reportedly discharged into Stauffer's industrial sewer system. This system included a series of evaporation ponds connected by process piping and surface

drainage ditches (PES, 2006). No indication was reported that the evaporation ponds were lined.

By 1976, Montrose directed efforts to minimize the volume of water it drained into the storm sewer system. When the NPDES program was implemented in 1976, both Stauffer and Montrose reportedly constructed new lined evaporation ponds for the purpose of containing process waste effluent from each respective facility (PES, 2006). To the extent that stormwater runoff entered the storm sewers after 1976 and before 1986, Montrose apparently operated under Stauffer's NPDES permits (DBS&A, 2007a).

Beginning in November 1973, as part of a water conservation program, Montrose began construction of a 7-acre lined wastewater pond evaporation system (Ponds No. 1 through 4) on an additional 21 acres of property leased from Stauffer. The system was put into service by May 1976. Montrose disposed of waste (primarily waste acid streams from the dichlorobenzil process washing and product drying steps and sulfide wastes from the polychlorinated benzene and chloral process) in Ponds No. 1, 3, and 4. Pond No. 2 was used as a hydrochloric acid wastewater evaporation pond. Converse (1993) stated that various constituents potentially could have accidentally migrated to the soils or groundwater through pond lining damage or overflow (DBS&A, 2007a).

In approximately 1976, Montrose constructed a waste tank in the southwest portion of the Montrose site to store sulfuric acid wash waters generated from the polychlorinated benzene and the dichlorobenzene processes prior to disposal in Ponds No. 1, 3, and 4. Montrose discovered evidence indicating that the waste acid tank experienced a number of accidental releases (reported to be minor) in 1981 (DBS&A, 2007a).

In August 1976, Montrose constructed a lined pond, Pond No. 6, to accept polychlorinated benzene SBR from the chlorinated benzene distillation process (prior to mid-1976, the material was disposed of at the BMI Landfill). Montrose disposed of between 730 and 800 tons of SBR in Pond No. 6 until March 1980, when further use was discontinued pursuant to an NDEP order. Montrose reportedly discovered no evidence that SBR escaped from Pond No. 6 (Converse, 1993; DBS&A, 2007a).

In late 1978, Montrose put into service a redwood tank to collect hydrochloric acid wastes prior to discharge in Pond No. 2. The redwood tank also collected wastewater and spills from surface drains that serviced the acid loading docks, “benzolator” or polychlorinated benzene distillation dike areas, and the acid recovery area. The tank, which was installed partly below ground in the northwest portion of the Montrose site, has been taken out of service. The aboveground portion of the tank was removed, and the portion at or below grade remains on-site (DBS&A, 2007a).

In early 1979, Montrose completed the construction of, and put into service, a fifth pond, Pond No. 5, to hold hydrochloric acid wastes. Pond No. 2, which was originally put into service in 1976 to hold sulfuric acid wastewater for evaporation, was converted sometime between August and October 1979 to handle overflow hydrochloric acid wastes from Pond No. 5. Montrose disposed of its hydrochloric acid wastes in Ponds No. 2 and 5 until March 1985, when Montrose discontinued further use of these ponds (Converse, 1993; DBS&A, 2007a).

Inactive on-site waste management areas described by Converse (1993) include Wastewater Ponds 1 and 2, Chlor Alkali Products Division (CAPD) Pond 8, Wastewater Conveyance System (inactive), Leach Bed, Phosphoric Acid Pond and Trenches, Alpha Beta Cake Pile Nos. 1, 2, and 3, Agricultural Chemical Division (ACD) Drum Burial, and ACD Vapor Incinerator. Active on-site waste management areas included ACD Ponds No. 1 and 2, CAPD Ponds No. 1 (Pittman/Surge), 2 (Hypo Pond), and 3 through 7, Stormwater System, and Drum Storage Area (Converse, 1993). Off-site waste management areas are also discussed. On June 1, 1980, Montrose completed construction of a concrete surface water settling basin to hold and clarify neutralized surface water runoff from the facilities area, plus the benzolator cooling water, for use as cooling tower makeup (DBS&A, 2007a).

In addition to the above disposals, Montrose experienced the following known or suspected releases or spills: (1) a 2,300-gallon monochlorobenzene spill in March 1974, (2) minor air emission from the facilities, and (3) possible process losses tentatively identified through production reports (DBS&A, 2007a).

Montrose disposed of polychlorinated benzene SBR, empty DDT paper bags, and miscellaneous mechanical equipment and non-metallic scrap in the former BMI landfill until mid-1976. Empty DDT bags were also discovered in the Slit Trench Area (STA) of the BMI landfill, and other evidence of Montrose wastes have likewise been found in the STA (DBS&A, 2007a).

High-paraffin fuel oil was released in September 1978, solidified on the ground, and was likely taken to the BMI Landfill (DBS&A, 2007a).

In 1979, Stauffer discovered that approximately 30,000 gallons of benzene had leaked from an underground tank in the production area. On April 4, 1983, the NDEP, Montrose, and Stauffer agreed to a consent order for a groundwater cleanup program. The agreement was prompted by the discovery of a groundwater plume containing benzene, chlorinated benzene, and chloroform. In 1983 to 1984, in response to the consent order, Stauffer and Montrose installed the GWTS about 1,000 feet downgradient (north) of the former BMI landfill area to provide capture and treatment of groundwater contaminated with VOCs from the BMI Complex before it could migrate off-site. Since its discovery, however, the plume has migrated northeast, passing under the former BMI landfill area and toward the Pittman community and the Las Vegas Wash (DBS&A, 2007a).

NDEP asked Stauffer/Pioneer/Montrose to re-evaluate the efficacy of the capture and treatment of groundwater by the GWTS. In Attachment A (dated January 2005) entitled “Comparison of 1983 Consent Order with Current Methodologies and Knowledge” to its letter dated March 9, 2005, NDEP stated that several of the decisions and statements in the Consent Order appear out of date and no longer valid and summarized the current conditions as of the letter date. In summary, NDEP stated that the GWTS was originally designed to only treat VOCs but will be modified to remove semivolatile organic compounds (SVOCs) and pesticides from groundwater. Even after the upgrades, compounds that might not be treated include (1) total dissolved solids (TDS) and other chemicals not treatable by air stripping or activated carbon, (2) chemicals denser than water, (3) chemicals migrating beneath the well screens, and (4) chemicals migrating around the cones of depression. NDEP also stated that only 16 chemicals were selected for monitoring, and that the analyte list needed to be expanded to include all chemicals present (DBS&A, 2007a).

Transformer PCB spills are reported as having occurred on the Stauffer site from June 1981 to January 1989, when response measures included cleaning with trichloroethene (TCE) followed by a washdown of industrial soap. A monochlorobenzene spill occurred on the Stauffer site in November 1983, when a pipe rupture released 173 gallons that was allowed to evaporate and seep into the soil within a diked area. Magnesium chloride was intentionally released from trucks on the Stauffer site in May 1985 and was cleaned up by a Stauffer contractor. The Henderson Rail yard hydrochloric acid spill occurred on the Stauffer site in August 1988 due to a leaking railcar that released 851 gallons. The spill was neutralized with lime chips (DBS&A, 2007a).

Montrose began closing its on-site ponds in 1984 and completed closure in 1989. The closure process involved evaporating the ponds until they were dry and then mixing the remaining sludge with crushed limestone to neutralize residual acid. The ponds were then covered with a 12-inch layer of compacted clay, followed by a 20-mil polyvinyl chloride (PVC) membrane. On top of the membrane, Montrose placed 9 inches of sand and then 12 inches of native soil. Pond No. 6 was permanently closed in October 1981. The NDEP-approved closure activities consisted of removing the SBR and storing them in an approved aboveground tank (DBS&A, 2007a).

Montrose dismantled its manufacturing plant in 1983 by removing all equipment and structures that had been associated with its operations (DBS&A, 2007a). In 1989, Ponds No. 2 and 5 were closed by Montrose pursuant to Resource Conservation and Recovery Act (RCRA) regulations (Converse, 1993). The closure process involved evaporating the ponds until they were dry and then filling them to grade with dry soil. Next, a 20-mil PVC membrane was installed over the soil filling, followed by a 9-inch layer of sand and an 18-inch layer of native soil to prevent erosion. Pond No. 2 was graded and filled along with Ponds No. 1, 3, and 4. Pond No. 5 was filled and graded separately (DBS&A, 2007a).

Montrose also had a tank farm on which it stored raw material used in manufacturing its organic chemicals. Montrose discovered evidence of a few reportedly minor accidental releases and spills associated with the tank farm. A 1991 visual inspection and a review of 1989 aerial photographs indicate that all of the tanks located in the tank farm had been removed. A release

of hydrochloric acid occurred in December 1990 to January 1991 due to structural failure of ponds, resulting in the release of 65,000 gallons of dilute (0.5 percent) hydrochloric acid. This release was determined to be relatively innocuous due to the presence of alkali material in the soils surrounding the spill, effectively neutralizing the acids (DBS&A, 2007a).

A release of hydrochloric acid/bischloromethylether was reported to have occurred in April 1984, with unknown quantities released to the air. Miscellaneous small-quantity releases have been described as having occurred from March 1983 to January 1990 (DBS&A, 2007a).

1.4.6 Future Operations

The Plants Area location of TIMET, NERT (formerly KMC/Tronox), Olin Chlor Alkali Products (formerly Pioneer), and the legacy site of Stauffer and Montrose will continue to be the subject and focus of environmental investigation and remediation. The most likely future use of the area will be as a location for continued commercial industrial activities. Downgradient (north and northeast) of the Plants Area and of the former AMPAC site, other properties (both residential and commercial) are underlain by groundwater impacted by various chemicals.

In 2015, Endeavour, LLC was formed to continue operation of the AMPAC treatment facility and the ongoing perchlorate remediation effort. Endeavour now has remediation responsibilities previously undertaken by AMPAC in the June 2013 Administrative Order on Consent with NDEP (NDEP, 2018c).

1.4.7 Regulatory Status

In 1991, the NDEP entered into Consent Agreements with six of the companies that had facilities at the BMI Complex in Henderson, Nevada. Present and former owners and operators entering into this agreement included TIMET, Chemstar Corporation, KMC, Montrose Chemical Corporation of California, Inc., Pioneer Chlor Alkali Company, Inc., and Stauffer Management Company, Inc. The following three phases were identified in the Consent Agreement:

- Phase I: Develop Phase I ECA reports for the BMI Common Area, which consists of the Upper and Lower Ponds, conveyance ditches and the Pabco Road Ponds Area, and each individual company site.

- Phase II: Perform an environmental conditions investigation (ECI) to fill data gaps identified during Phase I, if determined necessary by NDEP.

- Phase III: Identify and implement appropriate remedial measures to address conditions identified during Phases I and II, if determined necessary by NDEP.

The results of the Phase I ECA were presented in G&M (1993). Based on the information in the TIMET Phase I ECA and subsequent discussions with TIMET, NDEP issued a letter of understanding (LOU) dated August 16, 1994 that identified 54 study items where additional information or further investigation were recommended. On June 7, 1996, TIMET submitted complete responses to some of the LOU items, including identifying LOU items requiring additional investigation. In June 1996, NDEP entered into a Consent Agreement (Phase II) with TIMET to perform an ECI, remedial alternative studies (RAS), interim remedial measures (IRM), and additional work.

In August 2003, TIMET received correspondence from NDEP that recommended accelerated work to abate, mitigate, and eliminate environmental contaminants in groundwater. TIMET subsequently developed a series of framework documents outlining a course of action. Based on the results of investigation activities in 2006 through 2007, the NDEP requested development of a RAS for the first water-bearing zone pursuant to the Consent Agreement. Work was immediately undertaken to address the NDEP request and meet the stipulated deliverable schedule.

According to NDEP, in order for the work to no longer be subject to the requirements of the Consent Agreement:

> [The] Division may consider within its statutory discretion any and all relevant factors including . . . applicable or relevant and appropriate environmental cleanup standards including, without limitation, any Division policies regarding contaminated soil and groundwater remediation.

In 2014, NDEP issued a letter to the BMI plants sites, including BRC, that provided guidance regarding regional groundwater goals and objectives (NDEP, 2014). NDEP proposed to develop a work plan to develop upgradient groundwater concentrations for project-specific use. In addition, NDEP proposed to develop a list of regional indicator parameters for project-specific use. NDEP (2014) described that the ultimate remedial action objective is to permanently restore the downgradient aquifer from project property boundaries to the Las Vegas Wash to below remediation standards. This CSM was developed to be consistent with the NDEP (2014) guidance.

2. Summary of Site Groundwater Investigations

This section summarizes the numerous environmental and hydrogeologic investigations completed at the Site. The work was conducted in accordance with the work plans, standard operating procedures (SOPs), laboratory and data validation methods, and quality assurance/quality control (QA/QC) protocol outlined in Section 2.1.

2.1 Methodology

2.1.1 Work Plans

Hydrogeologic characterization, well installation, aquifer testing, groundwater monitoring, and numerical modeling tasks conducted for the Site CSM development were completed in accordance with NDEP-approved task-specific work plans prepared to specify field methodology and objectives. Work plans were prepared for NDEP review and approval for the following events:

- 2003 Hydrogeologic Characterization (MWH, 2003)
- 2006 Groundwater Flow Modeling (DBS&A, 2006a; DBS&A, 2006b; DBS&A, 2009b)
- 2007 Shallow Well Installation and Soil Sampling Northeast Area (DBS&A, 2007b)
- 2007 Aquifer Testing (DBS&A, 2007a)
- 2008 Deep Well Installation (DBS&A, 2008a)
- 2009 Eastside Well Installation (DBS&A, 2009a)
- 2009 Groundwater Solute Transport Modeling (DBS&A, 2009c)

Groundwater monitoring has been conducted at the Site since 2006, with the most recent supplemental event completed in 2016. Groundwater monitoring was completed in accordance with the following work plans:

- 2006 Revised Periodic Groundwater Monitoring Plan (MWH, 2006a)

- 2009 Revised Eastside Groundwater Monitoring Plan (DBS&A, 2009e)
- 2014 Eastside Groundwater Monitoring Plan 2014 Event (DBS&A, 2014)
- 2016 Eastside Groundwater Monitoring Plan Supplemental Event (DBS&A, 2016a)

Sections 2.2 through 2.12 summarize the results of the investigation and monitoring tasks.

2.1.2 Standard Operating Procedures

In 2006 BRC developed a field SOPs document for field investigation tasks (MWH, 2006c). This document describes SOPs for field tasks to be completed during Site investigation, groundwater monitoring, and other field activities at the BMI Common Areas. The SOPs describe the methods used to collect environmental samples, measure aquifer properties, manage investigation-derived wastes, decontaminate equipment, and transport samples to laboratories for analysis. These procedures were developed as general descriptions of field methods that may be employed at various locations and stages of the field investigation. The purpose of the SOPs is to standardize and document field procedures and the collection of field data. In the event that the procedures outlined in the SOPs contradict Nevada regulations, the Nevada regulations take precedence.

Each SOP describes the purpose, equipment needs, proper field documentation forms, and methodology for a general field task. Each SOP is not intended to provide an all-inclusive discussion of all procedures. Specific problems may require the adaptation of existing equipment or design of new equipment. Such innovations are described in the project-specific sampling plans and approved by BRC and NDEP. Specific health and safety procedures and information are presented in the project-specific health and safety plan (MWH, 2005). Field personnel are required to be familiar with the health and safety plan prior to implementing field procedures. Specific quality assurance (QA) and quality control (QC) policies associated with the collection of environmental data for characterization activities at the Site are presented in the project-specific quality assurance project plan (QAPP) (MWH, 2006b).

2.1.3 Site Related Chemicals List

In conjunction with the NDEP, BRC developed the site related chemicals (SRC) list (BRC, 2006), which considers: (1) all chemicals known to have been manufactured or used at the BMI Complex and later industrial operations, (2) potential degradation and recombination products from such chemicals, (3) broad-suite analysis for selected chemical families, and (4) chemicals detected at the Site. The SRC list contains 483 individual chemicals.

The list of program analytes is shorter than the SRC list, and consists of 416 compounds. This shorter list takes into account that several compounds are composed of analytes already being tested. For example, magnesium chloride is on the SRC list. However both magnesium and chloride are already being analyzed. As a result of the addition of new chemicals to the analytical program over time, samples collected from the Site investigations prior to 2003 were not analyzed for every site-related chemical now included on the SRC list. In addition, analytical methodologies have changed over time with respect to a number of substances. The SRC list now comprises 416 substances and includes the following 15 chemical classes:

- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- Polychlorinated biphenyls (PCBs)
- Metals (including cyanide)
- Aldehydes
- Radionuclides
- Asbestos
- Perchlorate
- Herbicides
- Dioxins/furans
- Organochlorine pesticides
- Organic acids
- Organophosphate pesticides
- Polycyclic aromatic hydrocarbons (PAHs)
- Glycols and alcohols

A broad-suite analytical list was subsequently developed for investigation tasks based on the SRC list. Groundwater monitoring program samples (Section 2.11) were analyzed for a short list of analytes with NDEP approval:

- General chemistry (cations and anions)
- Metals
- Organochlorine pesticides
- Perchlorate
- Radionuclides
- VOCs
- Water quality parameters (pH, conductivity, total dissolved solids, alkalinity, hardness)

2.1.4 Data Validation

Data generated in the field and at the laboratories were verified and validated according to criteria and procedures described in the QAPP (MWH, 2006b). Data quality and usability were evaluated, and a discussion was included in the applicable report for each sampling event.

All data underwent a standard QC review. When a more vigorous review was warranted for a specified data set, data validation included a review of raw data submitted by the laboratory to verify instrument calibration, performance data, and recalculations of results. At a minimum, 20 percent of the data underwent validation consistent with the procedures described in the National Functional Guidelines. Data validation criteria for this project are derived from the National Functional Guidelines, which provide specific data validation criteria that were applied to the data generated from the groundwater investigations.

Laboratory data were reviewed for compliance with the applicable method and the quality of the data reported. To facilitate this data review, computerized data validation tools developed for EarthSoft's EQuIS® Data Management System were employed. The following parameters summarize the specific criteria and scope of the standard data review:

- Data completeness

- Holding times
- Blanks
- Laboratory control samples (LCSs)
- Matrix spike (MS)/matrix spike duplicates (MSDs)
- Surrogates/internal standards (as applicable)
- Field QC samples
- Compound identification and quantification

The application of QC review criteria was a function of project-specific data quality objectives (DQOs). The BRC QA Manager determined if the DQOs for the analytical data were met based on data that met and/or exceeded validation criteria. Results of the data validation review were documented and summarized together with the data in data validation summary reports (DVSRs). All the resulting documentation is maintained in the BRC project files.

2.1.5 Quality Assurance/Quality Control

The chemical data collected as part of the Site project sampling effort were used to determine the nature and extent of contamination, and to support further evaluations, such as risk assessment. Therefore, it was critical that the chemical data was of the highest confidence and quality. Consequently, QA/QC procedures were strictly adhered to. These procedures included:

- Adherence to established protocols for field sampling, decontamination procedures, and analytical methods.

- Collection and laboratory analysis of appropriate field equipment and trip blanks to monitor for possible contamination of samples in the field or the laboratory.

- Collection and laboratory analysis of MS, MSD, and field duplicate samples to evaluate precision and accuracy.

- Attainment of both qualitative and quantitative completeness goals.

Complete QA/QC procedures are described in the BRC QAPP (MWH, 2006b).

2.2 2003 Geophysical Survey

To support subsequent hydrogeologic investigations, a geophysical survey was conducted in 2003 in the BMI Common Areas north of Boulder Highway, as reported by Geovision (2003). The survey was conducted to map the elevation of the UMCf surface and the presence of potential paleochannels incised into the UMCf surface. A frequency domain electromagnetic (FDEM) method and a time domain electromagnetic (TDEM) method were selected for the survey. Downhole electromagnetic (EM) induction logs were also collected in 16 monitoring wells.

A total of 10 traverse lines (A through H, X, and Y) were located in advance by a land surveyor in preparation for the geophysical survey (DBS&A, 2019). A total of 380 TDEM soundings were made along the 10 lines to image the electrical properties of the subsurface down to approximately 150 feet below ground surface (bgs). Of the 10 lines, 2 were located exclusively in the Western Hook. In addition, a total of approximately 14 miles of FDEM profiling data were acquired along the lines (Appendix A).

The downhole EM logs confirmed that the relatively high electrical conductivity of the underlying UMCf significantly contrasts with the overlying alluvium characterized by relatively low electrical conductivity. This contrast enabled the UMCf to be mapped across the survey area using TDEM and FDEM.

The survey data were used to create cross-sectional images showing the change in electrical conductivity between alluvium and UMCf with distance across each of the 10 traverse lines. The depth to the UMCf surface in each line is delineated by the contrast in electrical conductivity with depth. The data were also processed to generate a contour map of apparent electrical conductivity for the survey area and a structure contour elevation map of the UMCf.

Several interpreted paleochannels identified in the survey area were later incorporated into subsequent hydrogeologic investigations or paleochannel mapping efforts.

2.3 2004 Hydrogeologic Characterization

While limited hydrogeologic investigation of portions of the Eastside Properties had been performed prior to 2004, the first detailed, comprehensive groundwater investigation was conducted in 2004 in accordance with the 2003 hydrogeologic characterization work plan (MWH, 2003). The 2004 hydrogeologic characterization had the following objectives:

- Evaluate the nature and extent (vertical and lateral) of Eastside Properties groundwater impacts by chemical constituents
- Evaluate the nature and extent (vertical and lateral) of groundwater relative to previously known potential source areas
- Analyze a representative set of the groundwater samples for a broad suite of chemical analytes
- Evaluate the presence, hydrogeologic characteristics, orientation, and geometry of paleochannels in the Site subsurface
- Characterize Eastside Properties background groundwater quality
- Refine the stratigraphic model of the Eastside Properties geology
- Describe the hydrostratigraphy beneath the Eastside Properties, including the Quaternary alluvial sediments (collectively referred to in this report as the Qal) and the underlying upper Tertiary Muddy Creek Formation (UMCf)
- Quantify the groundwater flow regime in the UMCf
- Determine and evaluate the hydraulic connectivity between the aquifers underlying the site and the Las Vegas Wash
- Determine whether groundwater is a source of discharge to the Las Vegas Wash and, if so, quantify the amount as well as any potential mass loading of chemicals that may originate from the Eastside Properties

- Collect suitable data for use in subsequent risk assessment

The 2004 investigation involved the design, construction, and monitoring of 44 new wells (17 completed in the Qal and 27 completed in the UMCf), including well pairs at 9 locations (BRC et al., 2007). Two shallow zone wells AA-08 and AA-10 were completed in the Western Hook area to supplement existing PC-series wells installed by others (Figure 6). Shallow zone well DBMW-10 was installed in the Western Hook area in later efforts to further characterize shallow zone groundwater occurrence, flow direction, and quality.

During well installation, geophysical logs, including guard, electric, caliper, spontaneous potential, sonic, and microguard logs, were taken in 13 Eastside locations. Subsurface conditions were described by the field geologist, based on logging over 12,000 linear feet of continuous soil core. DBS&A originally reported the hydrogeologic characterization and identified water-bearing zones (Shallow, Middle, and Deep Zones) in an internal report to BRC. The report was subsequently incorporated into the CSM overview that was submitted with the BRC closure plan (BRC et al., 2007). This information, used in conjunction with other data from the geophysical investigation (Section 2.2) and data from previous Eastside investigations, has been used to develop the Western Hook hydrogeologic CSM as presented in Section 5. Specifically the data collected was used to describe the Eastside Properties stratigraphy, identify paleochannels, locate the occurrence of groundwater in the uppermost water-bearing units, and delineate the vertical and lateral extent of soil and groundwater chemical impacts. For the 2004 Eastside program, BRC and MWH:

- Advanced 13 exploratory borings to a depth of approximately 400 feet bgs
- Conducted geophysical logging of the 13 borings to a depth of approximately 400 feet bgs
- Drilled 50 additional boreholes at 27 locations throughout the Eastside using mud rotary, hollow-stem auger, and rotary sonic drilling methods
- Collected continuous core soil samples from three of the 400-foot mud-rotary borings (locations 1, 4, and 6) and from all of the boreholes drilled with the rotary sonic drilling method (18 locations)

- Collected 94 saturated soil samples and 12 in situ groundwater samples from the various water-bearing zones at the Eastside for fast turnaround analysis of perchlorate using U.S. EPA method 314.0
- Installed 44 groundwater monitoring wells, including 8 wells in the Qal and 27 wells in the UMCf

Characterization of groundwater at the larger regional level, which incorporated characterization of the Western Hook, served to provide the basis for developing an understanding of groundwater flow pathways and the sources of groundwater quality impacts that specifically affect the Western Hook.

2.4 Deep Zone Well Installation

Geotechnical and Environmental Services, Inc. (GES) implemented the 2008 deep well installation work plan for BRC and prepared an interim report dated June 16, 2008 to present the results of the field event (GES, 2008). The interim GES report summarized well construction activities for newly installed Deep Zone wells MCF-06A-R and MCF-08B-R, and wells MCF-17A through MCF-25A, three of which were located in the Western Hook.

A 2009 report (GES, 2009) summarized the installation of Deep Zone and Middle Zone wells AA-30, MCF-24B, and MCF-28A/B through 32A/B, two pairs of which were located in and near to the Western Hook. Deep Zone wells carry the “A” designation, while Middle Zone wells carry the “B” designation.

2.5 Upgradient Wells

This DBS&A report dated May 14, 2010 (DBS&A, 2010c) identifies and provides technical justification for the selection of upgradient wells for use in monitoring groundwater quality in the Shallow Zone at the Eastside Main area. Upgradient wells were designated at the Eastside Main Area in order to document and evaluate the quality of groundwater flowing onto the Eastside Main Area from off-site areas. It is not possible to install background monitoring wells in the Eastside Main Area due to limited shallow groundwater occurrence in the southeast area

(Section 3.6). As a result, upgradient wells were proposed for use in data evaluation. The upgradient wells were located according to the following selection criteria:

- Hydraulically upgradient
- Along the majority of the upgradient site boundary
- Where off-site upgradient groundwater impacts, if present, are well characterized

Though upgradient wells were not specifically identified for the Western Hook in DBS&A (2010c), concepts relevant to the transport of COCs in groundwater beneath the Western Hook were identified in the report. Based solely on elevation, the upper Middle Zone at the Plants Area corresponds to the Shallow Zone at the BRC Eastside Main Area because the Plants Area is topographically higher than the BRC Eastside Main Area. That is, 130 feet bgs at the Plants Area, which is approximately an elevation of 1,700 feet above mean sea level (feet msl), corresponds to approximately 50 feet bgs at the Eastside Main Area. As a result, Middle Zone and Layer 2 Shallow Zone impacts at the Plants Area may be contributing to Shallow Zone Layer 1 impacts at the Eastside Main Area. A similar relationship also exists between groundwater occurrence in the Plants Area and the Western Hook. As discussed in Section 2.8, the Plants Area is located closer to the regional recharge area, while the Western Hook is located in the downgradient “pressure area.” The Plants Area is interpreted to be the source of the groundwater impacts detected in wells upgradient of the Western Hook (Section 4).

As discussed in Section 2.10, particle tracking performed as part of solute transport modeling confirmed that paleochannels incised into the UMCf are primary transport pathways due to relatively elevated hydraulic conductivity. Modeled particles released in upgradient wells transported overall north-northeasterly across the model domain about 2.8 miles horizontally in the alluvium to the Las Vegas Wash.

2.6 Aquifer Testing

Kleinfelder produced a report of aquifer testing dated August 22, 2007 (Kleinfelder, 2007a) for BRC summarizing field activities conducted in accordance with the DBS&A aquifer testing work

plan dated January 9, 2007 (DBS&A, 2007a). Slug tests and pumping tests were completed in the Eastside Main Area in June and July 2007 with DBS&A oversight. Slug tests were conducted in wells 8 wells (MCF-03B, MCF-16C, MCF-06C, AA-07, AA-22, AA-13, AA-20, and AA-09). The observed hydraulic conductivity ranged from 0.18 feet per day (ft/d) (6.35×10^{-5} centimeters per second [cm/s]) (MCF-03B) to 67.3 ft/d (2.37×10^{-2} cm/s) (AA-09).

Pumping tests were subsequently completed in Eastside Main Area Shallow Zone wells AA-09 and AA-20 in addition to Western Hook Shallow Zone well AA-08. A step-drawdown test was conducted in well AA-09 on June 26, 2007 with pumping rates ranging from 5 to 15 gallons per minute (gpm). The rate of 5 gpm was selected for the AA-09 constant rate test completed on June 27, 2007. AA-09 was pumped at 5 gpm for 13 hours, and maximum drawdown was measured at 4.2 feet. An increase in drawdown at 12.7 hours was interpreted to indicate a probable boundary condition had been encountered. The pumping test data indicated hydraulic conductivity values of 54.0 ft/d (1.91×10^{-2} cm/s) for well AA-09 and 87.8 ft/d (3.1×10^{-2} cm/s) for nearby observation well AA-09OW installed for the testing (14.6 feet away). Storage coefficients of 0.0044 for AA-09 and 0.0170 for AA-09OW were reported.

A step-drawdown test was also conducted in well AA-20, just outside the southeastern boundary of the Western Hook, on July 10, 2007 with pumping rates ranging from 3 to 30 gpm. The rate of 3 gpm was selected for the AA-20 constant rate test completed on July 11, 2007. AA-09 was pumped at 3 gpm for 8.2 hours, and maximum drawdown was measured at 2.4 feet. A decrease in drawdown at 3.7 hours was interpreted to indicate a probable boundary condition (recharge source) had been encountered. The pumping test data indicated hydraulic conductivity values of 18.5 ft/d (6.53×10^{-3} cm/s) for well AA-20 and 366 ft/d (1.29×10^{-1} cm/s) for nearby observation well AA-20OW installed for the testing (14.08 feet away). Storage coefficients of 0.009 for AA-20 and 0.012 for AA-20OW were reported.

A step-drawdown test was also conducted in well AA-08, located within the Western Hook, on July 18, 2007 with pumping rates ranging from 15 to 30 gpm. The rate of 30 gpm was selected for the AA-08 constant rate test completed on July 19, 2007. AA-08 was pumped at 30 gpm for 24 hours, and maximum drawdown was measured at 0.33 foot. A decrease in drawdown rate was interpreted to indicate that a probable boundary condition (recharge source) had been

encountered, possibly related to recharge from nearby wastewater ponds. In addition, an increase in observation wells water level was observed that was interpreted to indicate that a recharge source was encountered.

The hydraulic conductivity results from the pumping test in AA-08 and associated test observation wells in the Western Hook ranged from 192 to 846 ft/d. These hydraulic conductivities are consistent with values commonly associated with sandy gravels and gravels. The storativity values ranged from 0.148 to 0.0292 indicating unconfined conditions (Kleinfelder, 2007a; 2007b).

An additional slug testing report was prepared by Converse Consultants (2009) dated November 2, 2009. The report summarized slug testing conducted in wells AA-30, MCF-24B, MCF-28A/B (within the Western Hook), MCF-29A/B, MCF-30A/B, MCF-31A/B, and MCF-32B (Converse, 2009). The average hydraulic conductivity for the Middle Zone wells ("B" designation) was 0.038 ft/d (1.34×10^{-5} cm/s). Hydraulic conductivity ranged from 0.02 to 0.08 ft/d (7.06×10^{-6} to 2.82×10^{-5} cm/s) for the tested Middle Zone wells. The average hydraulic conductivity for the Deep Zone wells ("A" designation) was 0.041 ft/d (1.45×10^{-5} cm/s). Hydraulic conductivity ranged from 0.004 to 0.10 ft/d (1.41×10^{-6} to 3.53×10^{-5} cm/s) for the Deep Zone wells. Hydraulic conductivity for the tested alluvial well AA-30 was 26.83 ft/d (0.47×10^{-3} cm/s).

2.7 Vertical Gradient Evaluation

Per NDEP request in their letter to BRC and the plants sites dated May 19, 2008, BRC characterized vertical hydrogeologic gradients in Shallow, Middle ("Intermediate"), and Deep Zone well pairs on the Eastside Properties (DBS&A, 2008c). BRC compiled and reviewed the available data for the following:

- Deep/Shallow, Middle/Shallow, and Deep/Middle Zone vertical gradient well pairs for the Eastside Properties, including well pairs in the Western Hook (Figures 7 and 8).
- Historical groundwater elevation data and vertical gradient calculations (DBS&A, 2008c)

- Validated total dissolved solids (TDS) and electrical conductance (EC) data
- Relevant Eastside Properties boring logs

The vertical gradient well pairs were selected such that they are:

- Located close enough to each other for vertical gradient calculations
- Screened in the Shallow, Intermediate, and Deep water-bearing zones
- Located around the property perimeter and within the property interior
- Laterally and vertically distributed across the Eastside Properties
- Measured for water levels contemporaneously

The initial vertical gradient submittal was subsequently revised in 2009 to include groundwater density corrections and corrections for lateral distance between wells per NDEP request. The majority of the well pairs demonstrated an upward vertical gradient. The final calculations dated October 13, 2009 showed the following well pairs have an upward vertical gradient:

- Deep/Shallow Zone well pairs MCF-01A/AA-01, MCF-08A/AA-08 (Western Hook), MCF-10A/AA-10 (Western Hook), MCF-16A/MCF-16C, MCF-27/AA-27, and MCF-09A/AA-09
- Middle/Shallow Zone well pairs MCF-10B/AA-10 (Western Hook), MCF-11/AA-11, MCF-16B/MCF-16C, MCF-06B/MCF-06C, MCF-08B/AA-08 (Western Hook), and MCF-09B/AA-09

The final calculations showed the following well pairs have a downward vertical gradient:

- Deep/Shallow well pair MCF-06A/MCF-06C and Middle/Shallow Zone well pair MCF-12C/MCF-12B (both well pairs on the Eastside Main)

The final calculations also showed that Eastside Main Deep/Shallow Zone well pair MCF-07/AA-07 and Middle/Shallow Zone MCF-01B/AA-01 had a temporally variable gradient (both

upward and downward). Historical aerial photographs show that Eastside Main well pair MCF-06A/MCF-06C is adjacent to a former gravel mine where most of the Qal had been removed at one time to expose the UMCf at that location.

This section summarizes the available data regarding the presence of vertical gradients but does not address groundwater flow between hydrostratigraphic units at the Site. Other work at the Site has identified that the UMCf has a very low permeability as compared to the overlying alluvial materials with a much higher permeability. Further, water-bearing units encountered in the Deep and Middle Zones do not represent regional aquifer features. Rather, these water-bearing lenses of unknown connectivity are sporadically encountered within the larger UMCf sequence, and are typically characterized by a relatively small increase in the sand content compared with surrounding finer-textured sediments. As a result, these slightly coarser sediment lenses bear water, though at very low rates (as evidenced by well recovery rates of approximately 0.5 to 2.0 gpm), that can be sampled with a monitoring well screened over a discrete interval. As a result of the sporadic spatial distribution and unknown lens connectivity, wells completed in the Middle and Deep Zones have water with piezometric heads that vary spatially over the scale of the Site. This, in turn, results in both upward and downward calculated vertical gradients.

2.8 Water-Bearing Zone Connectivity Report

DBS&A conducted sampling and analysis of tritium (radioactive isotope of hydrogen) and stable isotopes (oxygen and hydrogen) to address the hydrogeologic connectivity between the three water-bearing zones on the Eastside Properties: the Shallow Zone, the Middle Zone, and the Deep Zone. DBS&A submitted a report dated April 21, 2010 (DBS&A, 2010b) (“isotope report”) to present the sampling data and interpretations regarding zone connectivity.

2.8.1 Methods

Because atmospheric tritium has been decaying over the last few decades to almost its low, natural levels, tritium is now less useful as a hydrological tracer than it once was years ago (IAEA, 2009). While tritium was chemically analyzed and evaluated for Site and vicinity

monitoring wells sampled, the evaluation is qualitative and based on the absence or presence of tritium. Nonetheless, it provides an additional useful line of evidence in the interpretation of the source and fate and transport of chemicals at the Site.

Stable isotopes of oxygen and hydrogen were sampled as an alternative means of evaluating the connectivity between the three water-bearing zones and to potentially gain insight as to the origin of the water in the individual zones. The chemical and some physical properties of the isotopes of one element are not exactly equal, resulting from mass differences of the atomic nuclei. In general, heavier isotopic molecules have lower mobility caused by lower diffusion velocity and lower frequency of collision with other molecules. The heavier isotopic molecules can also have higher binding energy which, for example, can result in a lower vapor pressure and thus a lower tendency to evaporate from a liquid phase and a higher tendency to condense from the vapor phase (Mook, 2006).

Considering this isotopic mass difference at the molecular level, the two stable, or non-radioactive, isotopes of hydrogen—^{1}H (protium [H]) and ^{2}H (deuterium [D])—and the three stable isotopes of oxygen—^{16}O, ^{17}O, and ^{18}O—form part of the water molecule. Forces that drive the hydrologic cycle will tend to impart measureable differences in the abundance of stable isotopes in water at different locations and different times. Thus, analyses of their concentrations in groundwater can be used to trace movement of water in the subsurface.

It is well established that the isotopic composition of precipitation at a particular location will vary seasonally and with individual storms (Mook, 2006). The isotopic composition of precipitation will also vary among locations depending upon climate and elevation. Nevertheless, the composition of all precipitation generally falls on a straight line plot of $\delta^{2}H$ versus $\delta^{18}O$. This line is called the global meteoric water line (GMWL). The GMWL is defined by the annual average stable isotope composition of precipitation at locations around the globe.

Evaporation of soil water or evaporation from a free water surface leads to an increase in the concentration of the stable isotopes ^{2}H and ^{18}O in the residual water, as the lighter isotopes ^{1}H and ^{16}O are preferentially lost during evaporation as vapor. This physical process is known as fractionation. When water evaporates, the heavier atoms or molecules tend to remain behind in

the liquid phase, thus leading to enrichment in the concentration (fractionation) of the heavier isotopes in the residual liquid, as the lighter isotopes preferentially fractionate into the vapor phase.

During the fifth quarterly groundwater monitoring and sampling performed during April through July 2008, groundwater samples collected from the three Eastside water-bearing zones were analyzed for tritium and stable isotopes. During the groundwater monitoring and sampling performed in August and September 2009 at the Eastside Properties, additional samples were collected from the Deep Zone. No additional samples were collected for tritium analysis during this event. The results of the laboratory analyses were used to determine if the isotopic character of the water in the three water-bearing zones could be differentiated on the basis of their isotopic signature and to assess the connectivity between the three site water-bearing zones.

Between April 22 and July 18, 2008, groundwater samples were collected by Converse and analyzed as part of a groundwater monitoring event conducted by MWH. MWH (2008) reported those data in a report entitled, *Fifth Round Groundwater Monitoring Report (April - July 2008), BMI Common Areas (Eastside), Clark County, Nevada.* Samples were collected and analyzed for the following constituents:

- $\delta^{18}O$ (reported as the ratio of stable isotopes of oxygen [^{18}O to ^{16}O] relative to the Vienna standard mean ocean water [VSMOW] ratio)
- $\delta^{2}H$ (reported as the ratio of stable isotopes of hydrogen (^{2}H [deuterium] to ^{1}H [protium]) relative to the VSMOW ratio)
- Tritium (^{3}H) (radioactive isotope of hydrogen)

The samples were collected from the following Eastside Properties monitoring wells:

- *Northern Site area (near Las Vegas Wash):* Wells AA-08 (Shallow Zone, Western Hook), MCF-08B-R (Middle Zone, Western Hook), and MCF-17A (Deep Zone, Western Hook)

- *Northern Site area (upgradient of the Northern rapid infiltration basins [RIBs]):* Wells MCF-05 (Middle Zone) and MCF-20A (Deep Zone) (Shallow Zone Well DM-5 was proposed but not sampled due to lack of water.)

- *Central Site area:* Wells MCF-16C (Shallow Zone), MCF-16B (Middle Zone), and MCF-16A (Deep Zone)

- *Southern Site area (near plants sites):* Wells AA-01 (Shallow Zone), MCF-02B (Middle Zone), and MCF-01A (Deep Zone)

Between August 21 and September 29, 2009, additional groundwater samples were collected by Converse and analyzed for stable isotopes. This sampling event focused on Deep Zone wells:

- *MCF-02A:* Located at the southern end of the Site, approximately 1,830 feet north-northwest of the intersection of Boulder Highway and Lake Mead Drive

- *MCF-06A-R:* Located at the north-central edge of the Site, on the boundary with the Weston Hill property

- *MCF-18A (Western Hook):* Located approximately 390 feet west-northwest of the northwest corner of the City of Henderson Northern RIBs

- *MCF-18A (FD):* Field duplicate collected from monitoring well MCF-18A

- *MCF-29A:* Located at the northwestern corner of the Weston Hills property, immediately south of Las Vegas Wash

- *MCF-31A:* Located adjacent to the north-central boundary of the Tuscany Village property

- *MCF-30A:* Located approximately 460 feet east of the northwest corner of the Tuscany Village property, south of the C channel

2.8.2 Results

The results of the stable isotope and tritium laboratory analyses are summarized in Table 1 of DBS&A (2019). The analytical results of stable isotope sampling (δ^2H versus δ^{18}O) are also plotted in Figure 9 (DBS&A, 2019), along with results of the tritium (^{3}H) sample analyses and the GMWL. Tritium was detected in Shallow Zone wells AA-08 (5.18 Tritium units [TU]) and AA-01 (9.88 TU). Tritium was not detected in Middle or Deep Zone groundwater samples. Well AA-08 is in the Western Hook area.

The range of δ^2H values measured in the Eastside Properties samples generally fell within the range of expected δ^2H VSMOW values for temperate zone precipitation: –60 to –95 per mil (‰) (Mook, 2006). Likewise, the range of δ^{18}O values measured in the Site samples generally fell within the range of expected δ^{18}O VSMOW values for temperate zone precipitation: –2 to –15‰ (Mook, 2006). The stable isotope concentrations in most of the Deep Zone wells are relatively high and indicate a source of water that has been strongly fractionated, based on values plotting to the right of the GMWL by shifts in δ^{18}O of approximately 6 to 11‰ and the clustering of the values along a line with a slope of approximately 3.3.

2.8.3 Conclusions

Analysis of tritium samples indicated that the water in the Shallow Zone (Qal) is younger than water in the Middle or Deep Zones that has been isolated at depth and has not been exposed to atmospheric tritium. Stable isotope analyses further indicated that Deep Zone groundwater is relatively fractioned (enriched in heavier isotopes) and is not sourced at the surface. This is consistent with vertical hydraulic gradient data that show a predominant upward gradient between the Shallow and Deep Zones at the Site (Section 2.7). Though no data are available to assess historical vertical gradients, it is expected that similar gradient conditions would have existed in the past, based on the Eastside Properties location as a pressure zone in a mixed alluvial fan and lacustrine depositional environment (Section 3.6).

Groundwater quality in the Shallow Zone is interpreted to be independent of groundwater in the underlying Deep Zone. Only relatively limited or incidental connectivity exists between the three

water-bearing zones at the Eastside. It is interpreted that the Shallow Zone and the Deep Zone are largely isolated from one another. There could be limited and incidental connection between the Shallow Zone and the Deep Zone via the Middle Zone. The large depth interval and generally low permeability of the Middle Zone together serve to greatly modulate and buffer hydraulic variation and groundwater flow between the Shallow and the Deep Zones.

2.9 Groundwater Flow Modeling

In 2009, DBS&A finalized development of a regional groundwater flow model for the Eastside Properties (Figure 10). The groundwater flow model was developed sequentially through completion of the following tasks:

- Mounding evaluation of groundwater mounding that may have occurred in the past beneath the ponds and described in Westphal and Nork (1972)
- Flow modeling work plan development (DBS&A, 2006a; DBS&A, 2006b)
- Water balance development (DBS&A, 2008b)
- Flow model calibration (DBS&A, 2008a; DBS&A, 2008b; DBS&A, 2008c)

Detailed discussion of the sequential development of the Eastside groundwater flow model is described in DBS&A (2019). After NDEP review, comment, and subsequent revision by DBS&A, the updated groundwater flow model served as the basis for solute transport modeling as proposed in the solute transport modeling work plan (DBS&A, 2009d).

2.10 Groundwater Solute Transport Modeling

DBS&A prepared a final work plan with NDEP input dated October 2, 2009 for solute transport modeling at the Eastside Properties (DBS&A, 2009d). The Eastside solute transport model was based on the final groundwater flow model with some modifications to recharge, including appropriate updates or revisions based on the simulation results of the groundwater flow model. Detailed discussion of the development and implementation of groundwater solute transport modeling for the Eastside is described in DBS&A (2019).

The solute transport modeling was completed to evaluate the current and future transport and discharge of dissolved contaminants in groundwater from the site to the Las Vegas Wash, either directly or indirectly. This also included evaluation of the potential effects that a rising water table may have on future contaminant transport, including remobilization of contaminants that potentially exist in the vadose zone beneath source areas.

The results of the predictive transport simulations were presented in a final DBS&A technical memorandum dated May 28, 2010 (DBS&A, 2010d). NDEP comments from earlier report drafts and discussions are incorporated into the final report. A series of predictive solute transport simulations were conducted for perchlorate, arsenic, hexavalent chromium, and selenium.

Simulation results indicate that perchlorate, a chemical with little retardation, is readily flushed from the Qal within a period of 10 to 20 years, depending on the hydraulic conductivity value for Qal. However, perchlorate in the UMCf that exists under current observed conditions or that enters the lower-permeability UMCf during the predictive simulation period is less easily flushed and serves as a long-term continuing source of perchlorate mass transfer to the Qal. For this reason, long-term simulated concentrations of perchlorate are lowest in the Qal, and increase with depth through the upper UMCf. In addition, the geographic distribution of simulated future perchlorate concentration in the Qal is closely correlated with regions of significant perchlorate concentration in the UMCf.

Predicted solute concentrations for arsenic, hexavalent chromium, and selenium are influenced more by the initial concentration than by the assumed boundary conditions. Due to retardation processes, simulated changes in these constituents through time are much slower (take more time) as compared to perchlorate. Even with the effects of retardation, however, trends in simulated concentrations for these constituents are observed over time periods of 40 to 50 years. Selenium is of concern due to potential loading to Las Vegas Wash. The simulation results indicate that the selenium loading to the wash is about 0.02 pounds per day (lb/d). As noted in the report, the retardation factors for each of these constituents (arsenic, hexavalent chromium, and selenium) were selected on the conservatively low end of possible values based on the literature; therefore, in reality the migration of these constituents may be significantly slower than simulated.

In addition to providing some insights about potential future constituent concentrations and solute transport behavior, the simulation results have significant implications regarding the Eastside CSM, for both the Eastside Main and the Western Hook. Specifically, the simulation results indicate that the magnitude and extent of current observed solute concentrations in the aquifer system beneath the Eastside Properties are likely a highly complex result of historical source locations and strengths, historical groundwater flow conditions, and the degree of hydraulic communication between the Qal and the upper UMCf. For example, the observed distribution of various constituents in the UMCf at many locations is likely a product of historical groundwater flowpaths in the Qal, rather than the direct migration of constituents from a given source area along groundwater flowpaths within the UMCf itself.

Finally, it should be noted that observed constituent concentrations from UMCf monitoring wells with limited screen lengths (generally 20 feet, all of which may not be saturated) were used to estimate initial solute concentrations across the entire simulated thickness of UMCf in the model of 50 feet. This approach likely increases the assumed mass of a given constituent within the simulated portion of the UMCf, since observed data indicate that the concentrations of solutes in the UMCf generally decrease with increasing depth. Consequently, simulated mass in the UMCf for the constituents considered in this report is likely greater than that which actually exists.

In addition to the base case simulations summarized above, a series of worst-case source area leaching scenarios were considered for perchlorate, arsenic, and hexavalent chromium. In these model runs, the entire estimated mass of the given constituent in each source area was assumed to enter groundwater in the Qal over a 3.5-year period at the beginning of the predictive simulation. For source areas that have not yet been characterized, constituent mass was estimated based on the soil concentrations measured for adjacent areas. For arsenic and hexavalent chromium, it is likely that a significant portion of the mass in soil will never reach groundwater. For perchlorate, it is likely that the mass that leaches to groundwater will do so over an extended period of time much longer than 3.5 years.

The results of these Eastside Properties simulations indicated that for perchlorate, elevated solute concentrations are concentrated along the northern site boundary of the Upper Ponds

area, in the former City of Henderson (COH) Northern RIBs area, and west of Tuscany Village. As noted for previous perchlorate simulations, simulated concentrations are lowest in the Qal and increase with depth through the UMCf. For arsenic and hexavalent chromium, the greatest simulated long-term concentrations in groundwater occur in the Upper Ponds area and beneath the former COH Northern RIBs (there is a paleochannel that passes beneath the former RIBs area).

In the vertical dimension, the simulated long-term concentrations are significantly different than those of perchlorate in that there is less mass (lower concentrations) in the top of the UMCf, and almost no constituent mass that reaches the base of the UMCf that is simulated in the model (depth of 50 feet). This result is due to the significant retardation factors applied for these constituents, which tends to limit vertical migration (as compared to perchlorate) due to the smaller magnitude of advection and hydrodynamic dispersion, which is velocity dependent.

The groundwater flow and solute transport model was later used to evaluate groundwater flow paths (particle tracks) originating in upgradient wells along the southern, southeastern, and southwestern flow model boundary (DBS&A, 2010e). The particle tracking confirmed that paleochannels incised into the UMCf (Section 3.5) are primary transport pathways due to relatively elevated hydraulic conductivity. In the 100-year simulation, particles released (in the model) in upgradient wells transported overall north-northeasterly across the model domain about 2.8 miles horizontally in the alluvium to the Las Vegas Wash (Figure 11). Groundwater flow and solute transport in the UMCf is relatively limited due to reduced hydraulic conductivity, and is directed northwesterly for only a relatively short distance (extending horizontally up to 0.5 mile) compared to particle tracks in the alluvium.

2.11 Groundwater Monitoring

Since 2006, BRC has completed and reported numerous groundwater monitoring events at the Eastside Properties (i.e., MWH, 2006a; MWH, 2008; DBS&A, 2009f, 2010a, 2014, and 2018):

- First quarter 2006 event completed April to June 2006
- Second quarter 2006 event completed July and August 2006

- Third quarter 2006 event completed October and November 2006
- Fourth quarter 2006 event completed January to March 2007
- Fifth quarterly event completed April to July 2008
- Sixth quarterly event (2009 event) completed August to October 2009
- 2014 monitoring event completed December 2014
- 2015 monitoring event completed between May and June 2015
- 2016 monitoring event completed September 2016

The groundwater monitoring events were performed to collect groundwater data to further characterize Site groundwater quality and hydrogeology. Sampling was also completed to provide additional data to improve the understanding of the Site CSM, to evaluate groundwater conditions, to ensure that public health and the environment are protected, and to establish baseline conditions in areas where these conditions have not been established. The following activities were performed during the groundwater monitoring events:

- Inspected wellheads, including surface completion and well security
- Measured depth to groundwater in wells relative to top of casing (TOC)
- Measured total depth of well relative to TOC in wells without dedicated pumps in place
- Collected photoionization detector (PID) readings at wellheads
- Collected groundwater samples for laboratory chemical analysis using both micro-purge and net-purge sampling techniques
- Evaluated hydrogeology and chemical analytical results for water quality
- Evaluated data for trends based on previous data and project-specific screening levels

As discussed in Section 2.1.3, groundwater monitoring program samples were analyzed for a short list of analytes with NDEP approval:

- General chemistry (cations and anions)
- Metals
- Organochlorine pesticides

- Perchlorate
- Radionuclides
- VOCs
- Water quality parameters (pH, conductivity, TDS, alkalinity, hardness)

The BRC well location map was combined with NERT well location data to create a regional well location map. Combined with NERT water level data, the BRC water level data from each event were used to generate a regional groundwater flow map (Figure 12). Western Hook flow maps were also prepared using all available Layer 1 and Layer 2 Shallow Zone data (Figure 13) and data for only Layer 1 (Figure 14) and Layer 2 (Figure 15) of the Shallow Zone, respectively.

Electronic laboratory data from each event were compiled into the master analytical database maintained by BRC for all groundwater data (Section 4.1). The database was used to generate time-series plots of selected parameters (Section 4.2) (Appendix B), as well as plume maps (Section 4.3) posting data results for selected wells or events. Groundwater quality statistics such as detection frequency, non-detect frequency, minimum, maximum, and average concentration values, as well as values exceeding federal maximum contaminant levels (MCLs) or Basic Cleanup Levels (BCLs) for BRC groundwater data were also generated for reference (Table 2).

2.12 POU3 Area Investigations

Chloroform detected in soil vapor and shallow groundwater in the well POU3 area was further characterized as described in BRC technical memoranda and submittals dated 2016, 2018, and 2020 (BRC, 2016b, 2018, and 2020).

Shallow soil vapor probes were installed and sampled in a grid pattern near well POU3. Additional shallow zone wells DS-5, ES-2, ES-3, and ES-4 were later installed by BRC and NERT the POU3 area. Chloroform was detected at concentrations up to 4,700 micrograms per liter (µg/L) in soil vapor (probe SV-POU3-14 in 2016) and up to 1,100 µg/L in shallow groundwater from POU3 sampled in 2016 (BRC, 2018). Lower chloroform concentrations were detected in both soil vapor and groundwater in 2018 samples (3,700 µg/L in SV-POU3-14 vapor

and 340 µg/L in POU3 groundwater). Additional recent chloroform data from TIMET indicate that POU3 area impacts are sourced to the southwest upgradient in the plants area (BRC, 2020).

3. Physical Setting

3.1 Climate

The Las Vegas Valley climate consists of hot summers, mild winters, and wide fluctuations in the approximately 4.5-inch annual rainfall. Precipitation generally occurs during two periods: December through March (winter months) and July through September (summer months). Summer temperatures above 105°F are normal and winter temperatures below freezing are common. The average daily minimum and maximum temperatures during winter months are about 35°F and 60°F, respectively. During the summer nights, minimum temperatures average 70°F to 75°F. The frost-free period averages about 241 days per year (G&M, 1993).

Evaporation is high in the Las Vegas Valley, partly due to the high annual average temperature, but also due to wind and the prevalent low humidity. The average relative humidity is about 20 percent, and summer readings less than 10 percent are common. Measurements of free-water evaporation at Boulder City and Lake Mead indicate an annual loss of about 6.5 feet of water, three-fourths of which occurs during the six warmer months. Winds frequently blow from the southwest or northwest and are strongly influenced by the mountain topography. The mean annual wind velocity is 9 miles per hour (mph); velocities in excess of 50 mph are known to occur.

3.2 Topography

Las Vegas Valley is a northwest-southeast trending, rectangular-shaped alluvial valley that extends 50 miles from Indian Springs, approximately 43 miles northwest of the city of Las Vegas, to the Las Vegas Wash, the main catchment basin in the Las Vegas Valley. The highest elevations in the mountains surrounding the Las Vegas Valley reach 12,000 feet msl. Alluvial surfaces range from 9,000 feet msl in the Spring Mountains, west of Henderson and Las Vegas, to 1,300 feet msl where Las Vegas Wash enters Lake Mead.

The CSM study area is located along alluvial fan deposits derived principally from the River Mountains located to the east and the McCullough Range located to the south-southwest. The

ground surface gently slopes mainly to the north toward the Las Vegas Wash. Due to the orientation of the alluvial fans, the BMI Industrial Area and the Western Hook area slope to the northeast and the Eastside-Main area slopes mainly to the northwest. Elevations across the Eastside study area range from 2,000 to 1,520 feet msl at an average gradient of 0.02 foot per foot (ft/ft). In general, the slope is relative constant; however, north of the Sunset Road, the land surface flattens and the average gradient decreases to approximately 0.011 ft/ft from south to northeast. Some developed areas have been graded to accommodate new facilities, operational areas, stormwater control, and commercial developments.

3.3 Soils

The River Mountains and McCullough Range consist of dacite in the River Mountains and andesite in the McCullough Range (Bingler, 1977; Bell and Smith, 1980). These volcanic rocks are the implied source area for the Site Quaternary alluvial sediments (Qal) deposited between the mountains and the Las Vegas Wash. Soils that formed subsequently from pedogenic processes in the Qal have been identified and mapped by the NRCS in *Soils Survey of Las Vegas Valley Area, Nevada* (USDA, 1985) (hereinafter referred to as NRCS Soils Survey).

The NRCS Soils Survey also presents values for pH, cation exchange capacity, electrical conductivity of the saturated extract, and total organic matter content that characterize the general chemical characteristics of individual soil map units in the depth interval between 0 and 5 feet bgs. The NRCS Soils Survey presents a map of the following naturally occurring soils in the vicinity of the Site:

- *Caliza (map units 184 and 187)*: This soil type represents the dominant soil type in the immediate vicinity of the Site. Map unit 184 is described as very gravelly sandy loam; a very deep soil formed from different types of rock; forms in alluvium; generally forms on slopes of 2 to 8 percent. Map unit 187 is found in two main areas: (1) west of the map unit 184 occurrences to the west of the Site, along the western boundary of the Site and transecting the Lower Ponds, and (2) south of the BMI Common Areas and southeast of the BMI Complex. It is similar to the description above, except that it is “extremely cobbly” sandy loam. Unit 184 is primarily located in the area downgradient of both the

River Mountains and the McCullough Range, while unit 187 is located north of the McCullough Range and also in the areas east-northeast of the McCullough Range and west of the River Mountains. Data listed in the Chemical Soil Properties Table and Physical Soil Properties Table for soil map units 184 and 187 are similar. Both units have characteristic pH that ranges from 7.9 to 8.4. In the depth interval nominally 1 to 5 feet bgs (the only interval for which data are available), map unit 184 has a characteristic cation exchange capacity of 2.0 to 6.0 milliequivalents per 100 grams (meq/100 g) of soil and map unit 187 has a characteristic cation exchange capacity of 1.0 to 6.0 meq/100 g of soil. Characteristic salinity in both map units ranges from 0.0 to 2.0 millimhos per centimeter (mmhos/cm). Organic matter content for both units ranges from 0.0 to 0.5 percent by weight.

- *Caliza-Pittman-Arizo (map unit 182)*: This soil type is located in a thick band east of the BMI Common Areas and Complex and transects the southeastern most corner of the Upper Ponds. This soil type also occurs south and adjacent to an area of unit 184 found along the southern boundary of the BMI Complex. This soil consists of approximately 60 percent Caliza, 20 percent Pittman, and 15 percent Arizo. Caliza description: a very deep soil formed from different types of rocks; formed on erosional fan remnants. Pittman description: a moderately deep soil formed from different types of rock; forms on exposed remnants of alluvial fan deposits. Arizo description: a very deep soil formed from different types of rock; forms in channels. This complex forms on slopes of 0 to 8 percent. Unit 182 is located in areas northeast and east of the McCullough Range, as well as in areas west of the River Mountains. Map unit 182 has a characteristic pH that ranges from 7.9 to 8.4. In the depth interval nominally 1 to 5 feet bgs (the only interval for which data are available), map unit 182 has a characteristic cation exchange capacity of 1.0 to 6.0 meq/100 g of soil. Characteristic salinity in this map unit ranges from 0.0 to 2.0 mmhos/cm. Organic matter content for the map unit ranges from 0.0 to 0.5 percent by weight.

- *Arizo (map units 112 and 117)*: These soils are in localized areas south and east of the BMI Common Areas and Complex, and extend east of the Upper Ponds. They transect the Upper Ponds east of the Beta Ditch. They are very gravelly loamy sand/very gravelly

fine sandy loam. These very deep soils formed on recent alluvium and in channels are formed from various types of rock; they generally form on slopes of 0 to 8 percent. Data listed in the Chemical Soil Properties Table and Physical Soil Properties Table for soil map units 112 and 117 are similar. Map unit 112 has a characteristic pH that ranges from 7.4 to 9.0, while map unit 117 has characteristic pH range of 7.4 to 8.4. In the depth interval nominally 1 to 5 feet bgs (the only interval for which data are available), map unit 112 has a characteristic cation exchange capacity of 0.8 to 4.7 meq/100 g of soil and map unit 117 has a characteristic cation exchange capacity of 1.0 to 5.0 meq/100 g of soil. Characteristic salinity in both map units ranges from 0.0 to 2.0 mmhos/cm. Organic matter content for both units ranges from 0.0 to 0.5 percent by weight.

Based on the published soil chemical data for the soil map units (USDA, 1985), small differences in the soil chemical and physical characteristics of the soil map units exist. Based on the locations of the soil units relative to the McCullough Range and the River Mountains, the topographic slope, and the dendritic geomorphology of the soil units, it is likely that the alluvium in which these soils formed was derived from the weathered volcanic rocks of the McCullough Range and/or the River Mountains. Mineral assemblages in these source rocks would be the primary contributor to concentrations of metals and radionuclides in the native soils. The primary parent materials for soils formed beneath the BMI Common Areas and Complex are presumed to be the following:

- Soil map units 112 and 117 source material: McCullough Range and/or River Mountains (location-specific)
- Soil map unit 182 source material: McCullough Range and/or River Mountains (location-specific)
- Soil map units 184 and 187 source material: Combination of weathered rocks from both the McCullough Range and River Mountains

The McCullough Range is the primary source of materials upslope of the BMI Complex and the Western Hook, formerly known as the Lower Ponds area. Both the River Mountains and the McCullough Range are primary sources of materials upslope of the Upper Ponds. Beneath

near-surface soils, there are two geologic formations encountered at the Western Hook. The uppermost unit is composed of approximately 50 to 65 feet of Qal, which in turn is underlain by more than 2,000 feet of Tertiary age lacustrine sediments of the Muddy Creek formation (UMCf) (Section 3.5).

3.4 Hydrology

Surface water flow occurs for brief periods of time during periodic precipitation events and drains to the Las Vegas Wash near the northern border of the Eastside Properties.

The City of Henderson Wastewater Facility treats wastewater to meet water quality standards and uses the product to irrigate golf courses and highway medians. A portion of the treated wastewater is also discharged into the Las Vegas Wash and Lake Mead. The ponds represent the third largest surface water body in Southern Nevada (City of Henderson, 2020). As an unintended byproduct of the facility operations, native and migratory birds found a desirable and plentiful water source. As a result, the City of Henderson Bird Viewing Preserve was officially dedicated in 1998. The preserve is located south of the southern border of the Western Hook.

North and downgradient of the Western Hook, the Las Vegas Wash flows from east to west and is a critical water resource element of the Las Vegas Valley. The Las Vegas Wash is the primary outlet for water flows from the metropolitan Las Vegas Valley, and provides about 2 percent of the total water inflow to nearby Lake Mead. The Las Vegas Wash flows are variably composed of stormwater, treated wastewater, landscape and surface street runoff, and discharging shallow groundwater. Typically, the largest flow component is treated wastewater, but the Las Vegas Wash flow is periodically overwhelmed by runoff from storm events. These massive runoff events create flows that have historically resulted in erosion, headcutting, and loss of habitat and infrastructure (Las Vegas Wash Coordinating Committee, 2000). Las Vegas Wash dry weather flows are about 240 cubic feet per second (cfs), whereas storm flows can range up between 500 to greater than 10,000 cfs. The Las Vegas Wash Coordination Committee (LVWCC) was established to address and manage the issues posed by the Las Vegas Wash. BMI, the parent company of BRC, is an active participating member of the LVWCC.

A Wetlands Park Study Team (a task subgroup of the LVWCC) recommended implementing the master plan for the Clark County Wetlands Park, which was completed in 1995. The Clark County Wetlands Park encompasses 2,900 acres along the Las Vegas Wash (Figure 16) and abuts the northern boundary of the Western Hook. A significant focus of the park is to develop wildlife habitat and recreational opportunities. As a result, the intent of ecological restoration along the Wash is to correct the disequilibrium that has been caused by erosion (Southern Nevada Water Authority et al., 2008). In addition to wetlands created in the Wash channel by installation of erosion control structures, the LVWCC also determined in its report entitled *Las Vegas Wash Comprehensive Adaptive Management Plan (CAMP)* that stabilization of the Wash would require establishment and management of wetland areas on a large scale off stream and out of the Wash channel (LVWCC, 2000).

Groundwater seeps have historically been observed at various locations in the northern portions of the Western Hook close to the Las Vegas Wash and at nearby locations. In recent years, the observed seeps have been restricted to wetland areas described above. An evaluation of historical aerial photographs indicates that seeps have appeared in association with past effluent conveyance into the ponds and with infiltration of nearby municipal wastewater at RIBs.

Surface water currently flows largely unmanaged from south to north-northeasterly across the Western Hook. A drainage channel from the southeastern perimeter of the adjacent community (South Valley Ranch) crosses under Wiesner Way and over the western boundary of the Western Hook property. The channel distributes its flow into an unpaved, riprap lined, channel on Site that is oriented north then northeasterly and bifurcates toward Las Vegas Wash.

3.5 Geology

The logs of more than 1,500 borings installed at the Eastside and vicinity were reviewed to evaluate the lithology and stratigraphy of the primary geologic units in the Site area. More than 15 miles of geophysical transects have been shot across the 3.6-square-mile Eastside Properties to support the geologic evaluation (Section 2.2). With a review of geologic literature, these data have yielded a good understanding of the depositional environments of the various

strata that control the flow of groundwater and distribution of chemicals that are found in Eastside Properties soils and groundwater.

The Western Hook is located on alluvial fan sediments with a surface that slopes to the north-northeast toward the Las Vegas Wash. These alluvial sediments were deposited within the last 2 million years, and are of Quaternary age (Bingler, 1977; Bell and Smith, 1980). The alluvial fan deposits that originated from various nearby mountains tend to coalesce in the Las Vegas Valley, with the regional drainage being to the east. A regional surficial geologic map is presented as Figure 17 and a local surficial geologic map is provided as Figure 18. The associated geologic maps legends are provided as Figures 19 and 20, respectively. As discussed in Section 2.2, the Site Quaternary alluvial sediments are collectively referenced as the "Qal" in this report.

The Qal overlies Tertiary-aged lacustrine sediments known as the Muddy Creek Formation, which is approximately 2,000 feet thick. The upper 400 feet (approximately) is referred to as the Upper Muddy Creek Formation (UMCf).

3.5.1 Quaternary Alluvium

The uppermost strata beneath the Eastside consist primarily of alluvial sands and gravels derived from a volcanic source. These deposits are of Quaternary age (less than 2 million years before present), and are thus mapped and collectively referred to as Qal. The Qal is typically on the order of 50 feet thick, with a maximum thickness of 65 feet noted southwest of the Southern RIBs. The Qal is not present in localized areas of the northernmost portion of the Eastside because it has been removed as a result of gravel mining and residential development operations. Some areas where excavation has occurred, such as the Weston Hills area, have since been backfilled to allow for development. The variations of the thickness of the Qal are, in part, a result of the non-uniform contact between the Qal and the underlying UMCf.

Whereas the original surface of the Qal was a nominally planar surface that, as a whole, dips gently to the north at a gradient of approximately 0.02 ft/ft, the contact between the Qal and the underlying UMCf is not a planar surface. Broad surface water channels were incised into the

UMCf surface and filled with the relatively coarse-grained sediments, resulting in the development of southwest-to-northeast trending paleochannels. Plate 1 is a structure contour map of the top of the UMCf based on the evaluation of geophysical surveys and logs of more than 500 borings.

3.5.2 Upper Muddy Creek Formation

The UMCf underlies the Qal. The Muddy Creek Formation, of which the UMCf is the uppermost part, underlies much of the Las Vegas Valley and is more than 2,000 feet thick in places. At the Eastern Properties, the depth to the top of the UMCf ranges from approximately 25 feet bgs to a depth of approximately 65 feet bgs near the southwestern Site boundary. The UMCf at the Site was encountered to the maximum explored depth of 430 feet bgs.

The lithology of the UMCf underlying the Western Hook is typically fine-grained (sandy silt and clayey silt), although layers with increased sand content are also sporadically encountered. These materials have typically low permeability, with hydraulic conductivities on the order of 10^{-6} cm/s, or approximately 7.5 feet per year (ft/yr) (Section 2.6). A coarse-grained facies of the UMCf occurs to the south, closer to the McCullough Range mountain front, with the proportion of coarse-grained sediments in the upper portion of the UMCf decreasing to the north. One ramification of these coarser UMCf sediments being present near the southwestern border of the Eastside Properties is that they likely serve as a pathway for off-site chemicals to migrate into the UMCf. While caliche is occasionally encountered in the UMCf, laterally continuous cementation is not encountered within the 400 feet of geologic profile explored beneath the surface of the Eastside Properties.

3.6 Hydrogeology

The uppermost water-bearing zone in the Western Hook is identified as the Shallow Zone. Shallow Zone groundwater is unconfined and occurs in both the Qal and the uppermost portion of the UMCf. In the eastern portion of the Eastside Main, the Qal is dry and Shallow Zone groundwater is first encountered in the UMCf.

Groundwater flow maps were generated with water level data from Eastside wells, Plants Area wells, and wells downgradient of the Eastside area (Section 4.1). Shallow Zone groundwater generally flows in a north-northeasterly direction toward Las Vegas Wash (Figures 12 through 15). Groundwater flow direction at the Plants Area is generally north to northwesterly, whereas in the Western Hook, the direction changes to north-northeast. This generally uniform flow pattern may be modified locally by several factors including:

- Subsurface alluvial channels cut into the underlying UMCf
- NERT and TIMET barrier walls
- Localized recharge areas from on-site storm water retention basins
- Recharge from the COH Bird Viewing Ponds
- Groundwater extraction from NERT Interceptor Well Field (IWF), the Athens Road Well Field (AWF), and the Seep Well Field (SWF)
- Groundwater extraction conducted by OSSM, TIMET, and AMPAC/Endeavour (Ramboll, 2018)

Ramboll (2018) reports that during the reporting period of July 2017 to June 2018, shallow groundwater was generally encountered in NERT site wells between approximately 20 and 60 feet bgs, and is generally deepest in the southern portion of the NERT site. North of the NERT site, shallow groundwater was generally encountered between approximately 4 and 40 feet bgs, becoming shallower as it approaches Las Vegas Wash.

To distinguish between unconfined groundwater occurring in the two lithologies, the Shallow Zone is further divided into Layer 1 (Qal only) and Layer 2 (UMCf only). Shallow Zone groundwater is continuous across the Site, but there are areas where some Shallow Zone Layer 1 or Layer 2 wells are dry. The important hydrologic difference between the two layers is that Layer 2 is fine-textured, and has a significantly lower permeability than Layer 1. As discussed below, this permeability contrast results in important differences in the fate and transport characteristics of SRCs in the respective layers.

Below the Shallow Zone, deeper groundwater occurs in sporadically encountered lenses in the Middle Zone, designated between approximately 90 and 270 feet bgs. Deep Zone groundwater is generally continuous across the Eastside and is characterized with wells screened below 270 feet bgs to a maximum nominal depth of 400 feet bgs. Groundwater elevation data show that Deep Zone groundwater is confined, and that the potentiometric surface of Deep Zone groundwater is oriented generally north toward Las Vegas Wash.

BRC defined the rationale behind the definitions of the Shallow, Middle, and Deep Zones at BRC Eastside and adjacent properties, and NDEP concurred (NDEP, 2009). Figures 21 and 22 illustrate the relationship between the hydrogeologic zones at the property.

It is important to the understanding of Eastside groundwater flow, chemical transport, monitoring, and any contemplated remediation efforts that there is a significant contrast in hydraulic conductivity between the Qal (Layer 1) and the uppermost UMCf (Layer 2). The Shallow Zone is the unconfined, uppermost water-bearing zone, and occurs in both Qal (Layer 1) and underlying upper UMCf (Layer 2). On the eastern Eastside (also known as the Eastside Main), the Qal is predominantly dry. Over the past several years, the Plants Area and associated wastewater disposal ditches and ponds have ceased operation. Likewise, the Eastside Spray Wheel and both the Southern and Northern RIBs have ceased operation. As a result of the reduction in percolating waters across the Eastside Properties and vicinity, recharge and water levels in the Qal have declined. The Eastside Layer 1 (Qal) is dry over a large area, presumably similar to the condition it was in before the plants/ponds were constructed. Where the Qal is dry, Shallow Zone groundwater is first encountered in the uppermost portion of the UMCf.

Multiple cross sections of the Eastside area (A-A' through K-K') were created for hydrogeologic evaluation. A north-southeast (A-A') section, including a segment that runs through the eastern portion of the Western Hook, is presented as Figure 23. A north-south section (B-B'), also with a segment that runs through the eastern portion of the Western Hook, is presented as Figure 24, with groundwater arsenic data posted from 2009.

Additional cross sections are provided as Figures 25 and 26 for reference. As shown in cross section A-A', groundwater is first encountered in Layer 2 at well AA-UW4 in the eastern Eastside area where Layer 1 is dry. Groundwater is primarily first encountered in Layer 1 farther north-northeast along section A-A' at well PC-2. As shown in section B-B', groundwater is first encountered in Layer 2 at well MW-3 at the Plants Area. Also evident from Section B-B' is the fact that the Plants Area land surface is topographically higher than the Eastside Properties. West of Pabco Road and the Eastside Area, groundwater is first encountered in the relatively high permeability Layer 1 much farther to the south, in the vicinity of monitoring wells TIMETMW-4 and CMT-303.

Plate 1 shows where paleochannels have been incised into the surface of the UMCf before the Qal was deposited. Paleochannels have been demonstrated with particle tracking to be preferred groundwater flow and solute transport pathways in Shallow groundwater (Section 2.10).

Pumping test data (Section 2.6) indicate that the hydraulic conductivity of the tested Qal wells ranged from 18.5 to 1,140 ft/d (6.5×10^{-3} to 4.02×10^{-1} cm/s) with an average of 399 ft/d (1.41×10^{-1} cm/s). Slug testing in the lower hydraulic conductivity Middle and Deep Zones indicated that hydraulic conductivity ranged from 0.02 to 0.08 ft/d (7.06×10^{-6} to 2.82×10^{-5} cm/s) for the tested Middle Zone wells, and that the average hydraulic conductivity for the Middle Zone was 0.038 ft/d (1.24×10^{-5} cm/s). The average hydraulic conductivity for the Deep Zone wells was 0.041 ft/d (1.45×10^{-5} cm/s). Hydraulic conductivity ranged from 0.004 to 0.10 ft/d (1.41×10^{-6} to 3.3×10^{-5} cm/s) for the Deep Zone slug-tested wells.

Shallow groundwater is first encountered in the UMCf in some eastern portions of the Eastside Properties and in the adjacent off-site areas where the Qal is dry. Where the Qal is dry, there is no opportunity to install functional Layer 1 (Qal) monitoring wells. As a result, upgradient wells in the eastern Eastside area are installed in the UMCf (Layer 2) where Shallow Zone groundwater is first encountered. Due to the low hydraulic conductivity of Layer 2 (UMCf), solute transport is so slow to be nearly non-existent in the short-term (decades) in the UMCf in this area and across the Site. Furthermore, the Shallow Zone groundwater has been shown with isotope data to be isolated from the Deep Zone (Section 2.8). This conclusion is consistent

with the low hydraulic conductivity and vertical gradient data, as well as groundwater quality data showing no Deep Zone impacts (MWH, 2008).

3.7 Historical and Ongoing Remediation Programs

Remediation programs have been historically implemented in the BRC Commons Area, Plants Area, AMPAC facility, and surrounding vicinity. These programs have generally involved pump-and-treat systems, groundwater barrier walls, and in-situ methods. In the cases where groundwater has been extracted, it has been treated to various degrees and either reinjected into the aquifer by means of injection trench or discharged to the Las Vegas Wash via pipeline. The following subsections provide more detailed descriptions, organized by responsible party, of the relevant remediation systems that have the potential to impact groundwater flow and water quality.

3.7.1 NERT Groundwater Extraction and Treatment System

NERT operates a groundwater extraction and treatment system (GWETS) on the NERT Site, located within the BMI Complex, and off-site. The primary infrastructure of the GWETS was completed by KMC in the early 2000s in accordance with an Order issued by NDEP. The GWETS currently operates as a removal action designed to capture the highest concentrations of perchlorate and hexavalent chromium present in groundwater.

As the term is used by NERT, GWETS refers to the entirety of all systems and components of the groundwater extraction and treatment systems owned by NERT, both on-site and off-site. The GWETS does not include the ion exchange (IX) treatment system treating perchlorate from Southern Nevada Water Authority's (SNWA) Sunrise Mountain Weir and Historic Lateral Weir (Ramboll, 2018). Much of the description of the GWETS that follows in this section is excerpted and/or summarized from Ramboll (2018).

The GWETS uses three groundwater capture well fields (Figure 12): the IWF, the AWF, and the SWF. The IWF, coupled with the on-site bentonite-slurry groundwater barrier wall (the "barrier wall"), provides capture of the highest concentrations of perchlorate and chromium and

significantly reduces the amount of perchlorate and chromium in downgradient groundwater. The off-site AWF, located approximately 8,200 feet downgradient of the IWF, captures moderate concentrations of both perchlorate and chromium (compared to groundwater captured by the IWF), but operates at higher extraction rates than the IWF, resulting in significant contributions to overall perchlorate mass removal from the environment and reduction of perchlorate mass flux. The SWF, located in close proximity to Las Vegas Wash, operates at the highest extraction rate of the three well fields, but captures groundwater containing significantly lower perchlorate concentrations than both the IWF and AWF.

The AP Area Soil Flushing Treatability Study, located approximately 300 feet south of the IWF just west of AP-5, was implemented in 2016 and operated independently of the IWF. Following completion of the treatability study in early 2018, the AP Area extraction wells continued operating as part of the GWETS.

For the reporting period July 2017 through June 2018, the combined average discharge rate was 61.3 gpm for the IWF extraction wells, 463.1 gpm for the AWF, and 757.5 gpm for the SWF. Total combined discharge from the AP Area extraction wells averaged 10.1 gpm during the reporting period (Ramboll, 2018).

Treatment of chromium-contaminated groundwater extracted at the IWF and the AP Area occurs via the on-site Groundwater Treatment Plant (GWTP), which chemically reduces hexavalent chromium and removes total chromium via chemical precipitation. Treatment of perchlorate-contaminated groundwater extracted at the IWF, AWF, SWF, or AP Area occurs via either (1) the on-site FBRs, which biologically remove perchlorate, as well as chlorate, nitrate, and trace concentrations of residual chromium or (2) an IX treatment system (Ramboll, 2018).

The FBR and IX systems discharge treated water to Las Vegas Wash from a combined effluent pipe that discharges to a side channel of Las Vegas Wash located immediately west of the Pabco Road erosion control structure under authority of NPDES Permit NV0023060 (Ramboll, 2018).

3.7.2 Olin/Stauffer/Syngenta/Montrose (OSSM) Groundwater Remediation Operations

Stauffer operated its chemical manufacturing plant from 1945 to 1988 on the western portion of the Plants Area (NDEP, 2019a). In 1988, Stauffer ceased its operations after it was purchased by Pioneer. Pioneer was subsequently purchased by Olin Corporation in 2007, and is now doing business as Olin Chlor Alkali Products. In 1983, the State of Nevada, Stauffer, and Montrose entered into Consent Order for the installation and operation of a groundwater treatment system north of the Stauffer chemical plant to prevent the downgradient migration of groundwater that was discovered to be contaminated (Section 1.4.1). The GWTS is still active and is collectively operated by Pioneer Americas, LLC d/b/a Olin Chlor Alkali Products, Stauffer, Syngenta, and Montrose (OSSM).

In the second half of 2017, the system treated over 34 million gallons of groundwater and removed approximately 6,000 pounds of dissolved VOCs. Since its startup in November 1983, the system has removed approximately 1,000 tons of VOCs (NDEP, 2019a). NDEP (2019a) stated that routine groundwater monitoring and analysis currently demonstrates that the OSSM GWTS effectively contains contaminants on the industrial site and the OSSM GWTS operations continue to meet Consent Order requirements.

The OSSM GWTS consists of groundwater extraction wells, groundwater treatment by air stripping in a low-profile air stripper, and carbon adsorption in two liquid granular activated carbon (LGAC) vessels (de maximis, 2019). Treated water is returned to the alluvial aquifer by discharge to three recharge trenches. During the period July 1 through December 31, 2018, the OSSM GWTS processed 35,716,630 gallons at an average process flow rate of 139 gpm. The OSSM GWTS was on line 97 percent of the time during that period. The average total VOC influent concentration was 15,378 µg/L, and the average total VOC effluent concentration was 1.0 µg/L (de maximis, 2019).

Based on a review of contoured groundwater elevations in the second half of 2018, significant perturbations to groundwater flow can be observed in wells up to about 200 feet downgradient of the recharge trenches. In other words, groundwater is returned to the water table aquifer

through the injection trenches after treatment, and the groundwater flow gradient returns to normal after a relatively short distance.

3.7.3 AMPAC/Endeavour LLC Groundwater Remediation Operations

In 1982, PEPCON was acquired by AMPAC (Section 1.4.4). NDEP investigated the destroyed manufacturing site from 1988 to 1995 for the presence of contaminants in soil and groundwater. Perchlorate was discovered in the groundwater beyond the boundaries of the former PEPCON plant site. In June 2006, subsequent to a pilot test conducted in 2002-2003, AMPAC began operation of an in-situ bioremediation system designed to treat the perchlorate-impacted groundwater at the northern end of the discovered perchlorate plume and prevent perchlorate migration into the Las Vegas Wash. In 2012, AMPAC abandoned the in-situ bioremediation system and began operation of a new and larger ex-situ bioremediation system consisting of FBRs and additional extraction wells located closer to the former PEPCON plant. NDEP (2019b) reported that this change in approach, subsequent to an extensive groundwater modeling effort that began in 2008, was designed to speed up the remediation process timeline significantly. Daily perchlorate mass reduction rates have been more than 40 times the rates observed using the in-situ system from 2006-2012. In 2015, Endeavour, LLC was formed to continue operation of the treatment facility, now known as the Athens Groundwater Treatment System (AGTS), and the ongoing perchlorate remediation effort. Endeavour LLC now has remediation responsibilities previously undertaken by AMPAC in the June 2013 Administrative Order on Consent with NDEP.

During the first half of 2019, Endeavour's FBR-based groundwater treatment system treated approximately 188 million gallons of perchlorate-impacted groundwater, from which more than 166,000 pounds of perchlorate were successfully removed. Since its inception in 2012, the FBR system has removed more than 2.6 million pounds of perchlorate from the groundwater. Operation and maintenance of the system is ongoing (NDEP, 2019b).

Endeavor (2019) reported that the AGTS operation is based at a 9,000-square-foot building located within a 1.77-acre site at 900 Wiesner Way in Henderson, Nevada, which is northeast of Boulder Highway and Sunset Road. The operational controls, offices, chemical storage, and

analytical laboratory are located there. The FBR system began operation in late September 2012, and is designed to remove perchlorate from groundwater extracted from the Valley Auto Mall area near the source area close to the former PEPCON facility. Groundwater is also extracted from the shallow groundwater-bearing zone along Galleria Drive and from the Athens Pen area (the Leading Edge) before it enters the Las Vegas Wash to the north.

Endeavor (2019) reports that the treatment system consists of 14 extraction wells, a water handling and FBR treatment plant, and a discharge system. A total of 5 Auto Mall extraction wells (AMEWs) are located within the Valley Auto Mall area of Henderson. A total of 6 Athens Road extraction wells (AREWs) are located along the north side of Galleria Drive (formerly Athens Road) west of Wiesner Way. A total of 3 Athens Pen extraction wells (APEWs) are located east of Wiesner Way along the driveway to the treatment plant.

The target system contaminant is perchlorate (ClO_4^-). During the process, chlorate (ClO_3^-), nitrate (NO_3^-), and dissolved oxygen (DO) are also reduced in biologically mediated redox reactions. As described by Endeavor (2019), groundwater containing perchlorate is extracted through a series of extraction wells as described above. The primary function of the AMEWs is to extract a higher volume of perchlorate-contaminated groundwater near the former PEPCON manufacturing site area, principally groundwater from the deep water-bearing zone (Deep WBZ), thus reducing the overall duration of the remediation project. The purpose of the AREWs is to intercept groundwater containing perchlorate from the shallow water-bearing zone (Shallow WBZ), lowering the groundwater elevation broadly before it can enter (seep into) the Athens Drainage Channel (ADC) and thereby become surface water. The other function of the AREWs is to reduce the flux of perchlorate moving in the aquifer below the ADC that moves downgradient toward the Las Vegas Wash.

Treated water is pumped from the effluent tank to the Las Vegas Wash via one or two 8-inch HDPE pipelines. Dual 8-inch HDPE pipelines extend out from the mixing vault approximately 6,200 feet to the discharge point within the Las Vegas Wash where those lines recombine to one line immediately prior to discharge. Discharge into the Las Vegas Wash is subject to a NPDES permit (NV0024112, dated December 29, 2011) and quarterly discharge monitoring reports (DMRs) are submitted to NDEP under this permit.

3.7.4 TIMET Groundwater Remediation Operations

GEI (2019) states that historical operations/practices at the TIMET plant site have resulted in impacts to groundwater in the first water-bearing zone. TIMET-derived contaminants consist of inorganic chemicals (metals, chloride, sulfate) and VOCs, including chloroform, tetrachloroethene (PCE) and its degradation products. PCE concentrations measured in TIMET groundwater monitoring wells have been generally less than 100 µg/L; mass loading of chloroform is an approximate order of magnitude greater than PCE. No nonaqueous-phase liquid (NAPL) has been observed in any site monitoring or extraction well. Measured aqueous concentrations are sufficiently low that GEI (2019) concluded that the presence of NAPL in site groundwater cannot be inferred. GEI (2019) further states that groundwater at the TIMET facility has potentially been impacted by contamination migrating from other sites in the BMI Complex. In particular, GEI (2019) stated that perchlorate and chloroform appear to have migrated to TIMET from the west.

The TIMET GWETS is designed to extract groundwater from extraction wells spaced along the north (downgradient) border of the TIMET property (17 wells along the south side of the slurry wall, 3 wells east of the slurry wall and 1 well north of the slurry wall). Groundwater is conveyed in piping from the extraction wells to a lift station located at the western end of the wall near Extraction Well EwQal-1. Extraction well water is collected in the lift station and pumped approximately 1,300 feet southeast to an air stripper for treatment. VOCs, including chloroform, are removed from the waste stream by the air stripper. GEI (2019) states that water is then gravity-discharged from the air stripper to the six injection trenches located parallel to and north (downgradient) of the slurry wall. Water thus discharged into the subsurface then flows as groundwater in a northerly direction onto the BRC Eastside property. Construction of the system was completed in March 2014, and the TIMET GWETS was brought on-line March 12, 2014 (GEI, 2019).

GEI conducted an investigation of groundwater capture along the east side of the TIMET GWETS in November/December 2017. Based on this investigation, which included new piezometer installations and hydraulic testing, two additional extraction wells were installed. The new extraction wells, EWQal-20 (near the southeastern end of the extraction well field) and

EWQal-21 (located southwest of well POU3 on the BRC property), became operational on February 22, 2019.

4. Groundwater Impacts

4.1 Dataset Development

To develop updated regional and Eastside plume maps showing analyte concentrations in Shallow Zone groundwater, DBS&A identified and downloaded numerous off-site reports and Plants Area documents from various sources to gather well construction information, water levels for various dates, and the results of analytical sampling from historical and recent sampling events. Each document was reviewed to determine if sampling data and/or well construction summary data were available for plume map generation.

Water level data for the generation of Eastside and regional potentiometric surface maps (groundwater flow maps) were also downloaded. In addition to water level data, the documents were searched for historical and recent sampling data for chemical parameters with a range of relevant physiochemical properties: arsenic, beta-BHC, chloroform, and radium 226+228. The off-site data were combined with the BRC historical groundwater monitoring database. The sequence of steps for data sorting consisted of:

1. Water level and well construction data was gathered for each well (such as status, well ID, owner, casing elevation, grade elevation, survey coordinates (Northing and Easting), depth and elevation of top and bottom of the screen, depth and elevation of Qal/UMCf contact, water-bearing zone, and screen lithology). Due to a lack of data or unreliable data, numerous wells required further data searching and/or boring log search and review.
    - The wells were classified by water-bearing zone (Shallow, Middle and Deep) using NDEP guidance. Several wells are cross-screened and were treated separately. Wells screened only in the Qal were classified as Layer 1 and wells screened only in the UMCf were classified as Layer 2. When depth-to-contact data were missing, wells were identified according to logged lithology at the well screen, if available.

- Cross-screened wells were classified by water level data. If the water level was above the Qal/UMCf contact, the well was assigned to Layer 1. If the water level was below the contact, the well was assigned to Layer 2.
- If the well was dry, the screen interval alone was used to classify the wells as Layer 1 or Layer 2. If a dry well is cross-screened, it was classified as Layer 1. If the well was not cross-screened, the well was either Layer 1 or 2 based on the unit in which the well was screened.

2. Not all of the chemical parameters were sampled in only one event; multiple sampling events were completed off-site over the previous years. Documents were searched for the most recent sampling data for each well for each parameter that corresponded with a useable water level data point that matched the date of the most recent sampling event.

3. The off-site data were compiled into master Excel files for each parameter, and by off-site area (TIMET, Tronox, AMPAC, POSSM, Montrose, Stauffer, NERT).

Plume maps were completed in 2010 using the database developed from all sampling data available at that time (DBS&A, 2019). A second round of off-site data downloads was completed in 2018 and 2019 to develop time-series plots and updated plume maps for arsenic, beta-BHC, chloroform, and radium 226+228. The chloroform map was updated again in 2019 and 2020 (BRC, 2020). The NERT database currently includes groundwater sampling data up to 2020 and was most recently accessed to download offsite data in May 2020.

BRC maintains a database for groundwater monitoring results separate from the NERT database for events completed by BRC. Data from the recent BRC sampling events were integrated with the off-site NERT data to create plume map datasets. Sampling results from the BRC database were used to generate statistics for the representative chemical parameters (DBS&A, 2019). Duplicate samples were utilized in the same manner as field samples. Data may also be posted with standard data qualifiers such as “J” (estimated value).

4.2 Time-Series Plots

Thousands of data points were compiled and reviewed for generation of time-series analyte plots for the representative chemical parameters showing analyte concentrations over time for each sampled well in the dataset. Time-series plots were constructed to provide a historical reference as needed for the evaluation of analyte concentrations over time at individual Eastside locations and in individual Western Hook Shallow Zone monitoring wells. The discussion of analyte occurrence and distribution provided in Section 4.3 is based on plume maps prepared from the most recent data in the time-series plot dataset for each analyte (thus a systematic description of each of the individual time-series plots is not provided). The period of the time series plots presented in Appendix B extend beyond the data summaries in Table 2 and Table 3 (i.e. beyond 2004-2016 sampling events). Times-series plots for the Western Hook area include recent data while Table 2, for Eastside data, is presented for context in Section 2.11 describing Eastside groundwater monitoring. Non-detect values are plotted as an open symbol at the reporting limit for the sample.

4.3 Plume Maps

Regional plume maps were generated for the four representative chemical parameters using data from over 500 well results. The data for each plume map were posted, checked, and contoured to show regional distribution of impacts, impact sources, and regional trends. The maps were refined until final through quality control checks to reassign wells by layer, if needed, according to newly received well construction data.

Updated plume maps were constructed for the four representative chemical parameters (arsenic, beta-BHC, chloroform, and radium 226+228) extending from source(s) in the Plants Area northward to Western Hook and Eastside Main areas and further downgradient toward the Las Vegas Wash. Indicator parameter selection (DBS&A, 2011) is summarized in Table 3.

The updated plume maps are provided as Figures 27 through 30. Each map is divided into Layer 1 (higher permeability Quaternary alluvium) and Layer 2 (lower permeability Tertiary

Muddy Creek formation) for further characterization. Plume maps from 2010 for arsenic, beta-BHC, chloroform, and radium 226+228 are provided in Appendix C for reference.

4.3.1 Arsenic

Arsenic is the most widely detected metal (metalloid) within the BMI Complex (Plants Areas and Eastside) and is also a naturally occurring constituent in soil and groundwater. In 2010, Western Hook arsenic soil, and groundwater data were reviewed along with historical and more current Western Hook soil, groundwater, and geologic conditions to determine whether the Western Hook arsenic detections are anthropogenic or naturally occurring (DBS&A, 2010f). Tamarix (salt cedar) leaf samples were also collected and analyzed. The following tasks were completed:

- Geology was evaluated and summarized (including pedogenic, hydrogeologic and geochemical site conditions).
- Western Hook Subarea use history was evaluated and summarized (including potential natural and anthropogenic sources, and potential arsenic mobilization and/or accumulation mechanisms).
- Supplementary laboratory analyses were completed.

The report evaluated the potential for natural sources of arsenic, and concluded that the McCullough Mountains, the River Mountains, alluvial deposits derived therefrom, and the tertiary UMCf were all potential contributing natural sources of arsenic.

In a review of arsenic geochemistry, EPA (Melamed, 2004) reported that the main species of arsenic found in the environment are the As (III) and As (V) oxyacids. In aqueous solutions, arsenic forms the ox-anions arsenite, $H_3As^{3+}O_3$ [or commonly written $As^{3+}(OH)_3$], and arsenate, $H_3As^{5+}O_4$ (O'Day, 2006). In many environments, the As (V) is often deprotonated as an As (V) or arsenate anion. In contrast, the As (III) oxyacid remains in its neutral form as arsenite. In contaminated soils, inorganic arsenate is the predominant species (Melamed, 2004). In general, the arsenate and other As (V) species are immobilized on geologically available surfaces, usually iron oxides. The redox potential of arsenic ox-anions is such that arsenite is

expected to be the stable aqueous form under moderately reducing conditions, roughly from oxidation potentials (Eh) of about +300 millivolts (mV) at pH 4 to –200 mV at pH 9, while arsenate is stable in oxidized aqueous solutions (O'Day, 2006). As (III) commonly partitions to the aqueous phase in anoxic environments, and would be more mobile. As (V) usually remains bound to minerals, such as ferrihydrite and alumina, limiting its mobility and bioavailability (U.S. Department of Health and Human Services, 2007).

DBS&A (2010f) presented the results of field sampling conducted to speciate arsenic and evaluate the predominant form in which arsenic is present in soil. Sample collection points were distributed from the southern end of the Western Hook Subarea to the north in an attempt to sample the range of conditions that might impact the speciation of arsenic. In both the Western Hook Subarea surface and subsurface soils, the predominant species of arsenic present was As (V). In both surface and subsurface soil samples, the organic forms of arsenic, dimethylarsinic acid (DMA) and methylarsenate (MMA), were nondetect for all soil samples. The data indicate that, under the present redox conditions, the less-mobile and less toxic (U.S. Department of Health and Human Services, 2007) As (V) is the predominant form of arsenic present in the Western Hook.

A map of regional detections of arsenic in shallow groundwater was constructed using BRC data from the 2006 groundwater sampling event and historical data from sampling in the upgradient Plants Area (Olin, Montrose, Stauffer, Syngenta, Tronox, and TIMET) and AMPAC wells. BRC's 2006 data were roughly contemporaneous with the off-site data available at the time. A plot of the arsenic groundwater plume showed that the highest arsenic detection in the region was located in the Plants Area at well EC-09 (1,000 µg/L). Wells near EC-09 were also impacted with relatively high arsenic ranging up to 530 µg/L (at well EC-06). An arsenic contour line of 200 µg/L delineated the elevated arsenic detections around the approximate center of the Plants Area. Contour lines for 150 µg/L and 100 µg/L extended from the Plants Area to the north-northeast into the Pittman residential area. The 50 µg/L contour was broader and extended north and northeast from the Plants Area to the Las Vegas Wash. The DBS&A (2010f) report concluded that the data indicate a significant groundwater source concentration of total arsenic in groundwater beneath the Plants Area feeds an arsenic groundwater plume that is moving northward toward the Western Hook and Las Vegas Wash.

Soil along the historical Western and Northwestern drainage ditches that fed surface water into the Western Hook were sampled in to evaluate potential arsenic occurrence. The soil sampling data showed that historical effluent from the ditches was not a likely source of arsenic transport to the Western Hook (DBS&A, 2010f).

Though terrestrial plants may accumulate arsenic by root uptake, total arsenic was not detected in live tamarisk leaf samples from any of the Western Hook stand locations and only at relatively low concentrations in the leaf litter samples. Arsenic was detected, however, in the soil samples collected at the tamarisk stand locations from 3.8 to 29.8 milligrams per kilogram (mg/kg).

At the time of the writing of DBS&A (2010f), subsurface water was draining from the South Valley Ranch residential development immediately west of the Western Hook (Section 3.4). French drains were removing the subsurface water, and that water mixed with surface storm drain water and flowed in a channelized ditch that traversed the Western Hook on its way northward to Las Vegas Wash. Before it reached the wash, the channel broadened and the drainage water flowed across open ground. Samples collected from the French drain outlets indicated that groundwater beneath the residential area is likely impacted by arsenic at concentrations above the MCL and that the drainage water arsenic concentrations were consistent with those observed in the regional arsenic groundwater plume.

The Shallow Zone plume maps for arsenic show a significant arsenic source in the Plants Area, where the highest posted value is 1,500 µg/L. Arsenic in Shallow Zone groundwater trends to the north-northeast, consistent with Shallow Zone groundwater flow direction (DBS&A, 2013). The maximum concentration detected in Western Hook area groundwater posted on the 2010 maps was 250 µg/L near the property boundary between the Western Hook and the western margin of the City of Henderson wastewater treatment plant in well MW-S; an arsenic concentration of 112 µg/L was detected in well PC-108. Detected concentrations in Western Hook Shallow Zone posted on the 2010 maps groundwater ranged from <11 µg/L to 250 µg/L.

The updated Shallow Zone plume maps for arsenic (Figures 27A/B) also show a significant off-site arsenic source in the Plants Area propagating in a north-northeasterly trend, consistent with

the Shallow Zone groundwater flow direction toward the Western Hook and the Las Vegas Wash.

4.3.2 Beta-BHC

The 2010 Shallow Zone plume maps for beta-BHC also show a significant off-site source in the Plants Area, where the highest posted value is 160 µg/L in well AA-BW-08B. Beta-BHC in Shallow Zone groundwater trends north-northeasterly with the Shallow Zone groundwater flow direction. The maximum concentration detected in Western Hook groundwater posted on the 2010 maps was in well PC-77 at 1.1 µg/L. Beta-BHC was also detected at 0.88 J (AA-08) µg/L and at 0.63 µg/L (PC-108) in Western Hook Shallow Zone groundwater.

The updated beta-BHC plume maps (Figures 28A/B) also show that the highest detections are located in the Plants Area propagating in a northerly trend, generally consistent with the Shallow Zone groundwater flow direction toward the Western Hook and the Las Vegas Wash.

4.3.3 Chloroform

Like arsenic and beta-BHC, the 2010 Shallow Zone plume maps for chloroform show a significant off-site source in the Plants Area where the highest posted value is 65,000 µg/L in Shallow Zone Layer 2 well MC-MW-10. The maximum concentration in Shallow Zone Layer 1 is also in the Plants Area at a concentration of 21,000 in well AA-MW-07. Chloroform in Shallow Zone groundwater trends generally north-northeasterly with the Shallow Zone groundwater flow direction. The maximum concentration detected in Western Hook groundwater posted on the 2010 maps was 100 J µg/L in well PC-4 in the eastern arm of the Western Hook. Chloroform was also detected at concentrations of 50 µg/L and 41 µg/L in wells DBMW-19 and PC-94, respectively—other wells located in the eastern arm of the Western Hook. Chloroform was detected at concentrations of 4.1 µg/L and 2.1 µg/L in wells AA-10 and SB-2-7, respectively, located in the western arm of the Western Hook. Concentrations generally declined to non-detect at the north end of the Western Hook. Chloroform was detected at concentrations of 440 J µg/L in well POU3 and 220 µg/L in well MCF-16C. Isoconcentration plots indicate a chloroform source area in the Plants Area in Shallow Zone groundwater with a chloroform

plume propagating in a north-northeasterly trend, consistent with the Shallow Zone groundwater flow direction toward the Western Hook.

NERT produced an updated chloroform map for the Shallow water-bearing zone in 2017. This map also shows a significant source in the Plants Area, where the highest posted chloroform value is 110,000 µg/L at well MW-02. In Western Hook area groundwater, the chloroform detections were posted at 670 µg/L in well PC-53 (north and downgradient of the Athens Road Well Field), 100 µg/L in well PC-4 (west of the eastern arm of the Western Hook), and 46 J+ and 46 J+ µg/L in wells DBMW-3 and AA-20, respectively (at the southern end of the eastern arm of the Western Hook). Measured concentrations were lower on the western arm of the Western Hook, with a concentration of 2.0 µg/L in well PC-110. The 2017 NERT map shows a chloroform source in the Plants Area with a plume trending north-northeasterly in Shallow Zone groundwater, consistent with the BRC 2010 plume maps.

The updated chloroform plume maps (Figure 29A/B1/B2) also show a significant source in the Plants Area trending north-northeasterly from the Plants Area in Shallow Zone groundwater consistent with the 2010 and 2017 NERT plume maps. In Western Hook area groundwater, chloroform was detected at a concentration of 630 µg/L in well PC-53 and 100 µg/L in well PC-04, downgradient of the Athens Road Well Field.

The data indicate that the chloroform plume is migrating from the Plants Area source in Shallow Zone groundwater north-northeasterly primarily toward the eastern side of the Western Hook. Although the data density is lower on the west side, the western side of the Western Hook appears to be less impacted by chloroform in groundwater.

4.3.4 Radium 226+228

The 2010 plume maps for radium 226+228 in Shallow Zone groundwater show that the highest detected activity in the Plants Area was 12.6 picocuries per liter (pCi/L) in Shallow Zone Layer 1 well AA-BW-09A. Radium 226+228 was also detected in Western Hook wells at activities ranging from non-detect in well PC-86 (<0.51 pCi/L) to 4.86 pCi/L (PC-80). The activities were distributed generally across the entire Western Hook with an activity in well AA-10, in the

western arm of the Western Hook, of 2.12 pCi/L. The 2010 maps generally show radium 226+228 plume migration trending with Shallow Zone groundwater flow direction north-northeasterly away from a significant Plants Area source. There is a break in the plume, with activities non-detect in wells located along Boulder Highway, though with relatively high laboratory detection levels. All of the radium activities in groundwater north of the Boulder Highway, west of Pabco Road, and including all of the Western Hook, have groundwater activities for radium 226+228 below the federal MCL of 5 pCi/L. Well DBMW-3, at the south end of the eastern arm of the Western Hook, had a sampled activity of 7.04 pCi/L.

The updated radium 226+228 plume maps (Figures 30A/B) show that the highest detection in the Plants Area was 0.92 pCi/L with more elevated activities in Eastside groundwater. The maximum detected activity in Eastside groundwater was 7.15 pCi/L in well AA-UW6. Consistent with the 2010 data, most of the radium 226+228 activities in groundwater are below the federal MCL of 5 pCi/L.

5. Conceptual Site Model

5.1 Site History

Conceptual diagrams have been prepared to illustrate the changes in operations and conditions that have occurred over time in the Western Hook area. A conceptual diagram of former Western Hook area operations and conditions that existed in 1943 is presented as Figure 31. An operational diagram for 1968 is presented as Figure 32, and a diagram for 1976 is presented as Figure 33. More recent diagrams are presented for 1992 as Figure 34 and for 2005 as Figure 35.

These diagrams illustrate the changes in Western Hook operations that have occurred over time. By spring 1943, the Upper and Lower Ponds were constructed to aid in the disposal of wastewater as BMI's Trade Effluent Ponds, west of present-day Boulder Highway, reached capacity. Wastewater was conveyed to the unlined Upper and Lower Ponds Areas via a series of ditches. The Western Ditch and Northwest Ditch were located to the north of the BMI Complex and both conveyed water to the Lower Ponds. Once wastewater entered the Alpha or Beta Ditches, it was transferred to the east for management in the Upper Ponds via the Beta Ditch or to the north for management in the Lower Ponds via the Alpha Ditch.

The Upper Ponds were constructed first, and were followed by the Lower Ponds to the north shortly thereafter. The ponds were designed in a cascade fashion such that as the nearer ponds were filled, the next row would fill. Evaporation in the Las Vegas Valley is high (pan evaporation greater than 84 inches per year [in/yr]), and this high rate of evaporation left evaporative sediments and non-volatile chemicals in the pond cells. During the period of time until 1976, when wastewater was conveyed to the ponds via the Alpha and Beta Ditches, residual effluent liquids (not evaporated) leached from pond and ditch bottoms through the Site soils to the underlying alluvial groundwater. Rainwater is presumed to have also created a leaching mechanism for dried sediment.

In 1976, the Upper and Lower Ponds were permanently removed from service. Although more than 100 ponds were built in 1942-43 and have been identified on plans and aerial photographs,

there is no documentary, photographic, or visual indication that more than the first 10 rows of the Upper Ponds were ever directly in service (i.e., filled with effluent). It appears from the documentary evidence that the decision to construct a large number of ponds resulted from an erroneous assumption made in 1941 or early 1942 when trying to rectify an earlier miscalculation of the evaporative area needed for the magnesium plant's effluent (BRC et al., 2007). The assumption neglected to account for percolation (thus assuming that only evaporation would occur) when considering the fate of effluent discharged to the ponds. As a subsequent result, a lesser number of ponds were directly used and filled with effluent than was originally envisioned when the ponds were designed and constructed. The Lower Ponds were in service between 1943 and 1970. TIMET operated its lined ponds in the Upper Ponds area between 1976 and 2005.

5.2 Contaminant Sources

As evidenced by the current distribution of arsenic, chloroform, beta-BHC, and radium 226+228 in groundwater, the predominant historical source of these constituents in groundwater is the Plants Area. Groundwater impacts in Eastside and Western Hook wells are recognized to be due mostly to these Plants Area sources (DBS&A, 2010c).

Lesser sources of contaminant mass at the Western Hook include percolation from the ditch conveyances, percolation from the historical evaporation ponds while in operation, and natural sources (of arsenic).

5.3 Hydrogeologic Setting and Contaminant Distribution

As discussed in Section 3.6, the hydraulic conductivity of Shallow Zone Layer 1 (Qal only) is relatively high and hydraulic conductivity in Layer 2 (UMCf only) is relatively low. Groundwater occurs in both Qal and underlying UMCf. Layer 1 (Qal) is dry over a large area of the Eastside Main, presumably similar to the condition it was in before the plants/ponds were constructed. Where the Qal is dry, Shallow Zone groundwater is first encountered in the uppermost UMCf.

The distribution of chemicals in Shallow Zone groundwater beneath the Western Hook is consistent with transport from off-site sources in the Plants Area and subsequent advective transport and dispersion in Shallow Zone groundwater. Historically, Plants Area releases and releases from the Lower Ponds saturated the previously predominantly dry Layer 1 (Qal). At relatively low water elevations in the Qal, the groundwater flowed preferentially in UMCf paleochannels in a northerly direction. When recharge was increased and the elevation of groundwater rose above the paleochannel banks, the groundwater flow was increasingly controlled by the regional hydraulic gradient to the northeast. Over time, dissolved chemicals migrated north-northeasterly in the direction of groundwater flow. Mounding associated with the releases helped spread the impacts laterally.

Historical operation of the Southern and Northern RIBs resulted in localized mounding on the Eastside property and on the eastern side of the Western Hook, and also contributed to the lateral spread of groundwater and dissolved chemical impacts. A downward vertical component of groundwater flow and chemical migration also occurred and impacted the underlying and lower permeability UMCf (Layer 2). The marked decline observed in concentrations of chemicals with depth in the Middle and Deep Zones indicates that minimal leaching has occurred from the Shallow Zone to the Deep Zone or Middle Zone.

5.4 Solute Fate and Transport

The Layer 2 isoconcentration map for arsenic (2010, Appendix C) represents the best single, contemporary indicator of the residual artifacts from the historical flow regime that was driving multiple contaminants. In solute transport simulations (Section 2.10), arsenic was used to represent the behavior of a chemical that is subject to retardation. Thus, while other chemicals (such as perchlorate) may be more mobile and travel farther over a given time period, the “imprint” of arsenic on the UMCf provides a reasonable indication of the historical lateral spreading of groundwater and most retarded chemicals under previous flow regimes.

The solute transport simulations (DBS&A, 2010d) provided the basis to conclude that the magnitude and extent of current observed solute concentrations in the aquifer system beneath the Western Hook are likely a highly complex result of historical source locations and strengths,

historical groundwater flow conditions, remediation efforts, and the degree of hydraulic communication between the Qal and the UMCf. For example, the observed distribution of various constituents in the UMCf at many locations is likely a product of historical groundwater flowpaths in the Qal, rather than the direct migration of constituents from a given source area along groundwater flowpaths within the UMCf itself. Particle tracking (DBS&A, 2010d) confirmed that paleochannels are primary transport pathways in the alluvium, while transport in the UMCf is limited.

The results of the arsenic modeling are interpreted to also broadly represent other retarded groundwater constituents at the Western Hook, such as beta-BHC and radium 226+228, where these compounds are detected. Chloroform fate and transport is typical of a VOC solute migrating with groundwater advection and dispersion from off-site sources. Chloroform also partitions from groundwater to soil vapor.

In summary, Western Hook groundwater quality is the result of a highly complex combination of multiple historical chemical source locations and strengths that have impacted groundwater whose even presence has been strongly affected by variable historical anthropogenic recharge sources and strengths. Understanding of the system has been further complicated by resultant groundwater flow and chemical transport through a hydrogeologic regime characterized by the presence of preferential pathways (paleochannels) and vertical permeability and chemical retardation contrasts. Lastly, the chemical distribution in Western Hook groundwater has been impacted by ongoing remediation programs being conducted along the migration pathway.

5.5 Impact of Remediation Programs

As discussed in detail in Section 3.7.1, the NERT GWETS consists of three groundwater capture well fields (IWF, AWF, and SWF). Once captured, treated water is discharged to the Las Vegas Wash from a combined effluent pipe that discharges to a side channel of Las Vegas Wash. Though the operation of these well fields results in local perturbation of groundwater elevations and flow paths, at a larger regional scale, the NERT GWETS well fields do not change the general direction of groundwater flow from the primary source area in the Plants Area north-northeasterly beneath the Western Hook and to the Las Vegas Wash. The NERT

GWETS provides capture and treatment of perchlorate and chromium, as described in Section 3.7.1, and significantly reduces the amount of perchlorate and chromium in downgradient groundwater. The NERT GWETS is not specifically designed to capture and treat VOCs such as chloroform.

The OSSM GWTS consists of groundwater extraction wells and groundwater treatment by air stripping followed by carbon adsorption (Section 3.7.2). Treated water is returned to the alluvial aquifer by discharge to three recharge trenches. Groundwater elevations are locally affected by mounding caused by injection in the recharge trenches. At a larger regional scale, there is little impact to the direction or flux of groundwater that flows from the Plants Area source area north-northeasterly beneath the Western Hook area and to the Las Vegas Wash. As discussed in Section 3.7.2, the OSSM GWTS removes VOCs. As of 2019, the system had removed approximately 1,000 tons of VOCs from groundwater flowing toward the Western Hook.

Endeavor's AGTS operation consists of 14 extraction wells along the flow paths of groundwater that potentially flows beneath the Western Hook, a water handling and FBR treatment plant, and a discharge system in three locations (described in detail in Section 3.7.3). Since it began operation in 2012, the FBR system has removed more than 2.6 million pounds of perchlorate from the groundwater. The AGTS is not specifically designed to treat VOCs. Treated water is pumped via pipeline from the effluent tank to the Las Vegas Wash. Though the operation of these well fields results in local perturbation of groundwater elevations and flow paths, at a larger regional scale, the Endeavor AGTS well field does not change the general direction of groundwater flow from the primary source area in the Plants Area north-northeasterly beneath the Western Hook and to the Las Vegas Wash.

The TIMET GWETS extracts groundwater from extraction wells spaced along the north (downgradient) border of the TIMET property from 17 wells along the south side of a slurry wall, 3 wells east of the slurry wall, and 1 well north of the slurry wall. VOCs are removed from the extracted effluent stream by air stripping; the water is then discharged into six injection trenches north of the slurry wall. The discharge water becomes groundwater that flows in a northerly direction onto the BRC Eastside property and northward toward the eastern side of the Western Hook.

VOCs, including chloroform, are being captured and treated in the OSSM GWTS and in the TIMET GWETS. The NERT GWETS and the Endeavor AGTS are not designed to capture and treat VOCs. The OSSM GWTS and TIMET GWETS are capturing and treating the highest concentration areas of the chloroform plume. However, an apparent gap remains where plume chloroform concentrations in the 100 to 500 µg/L range are not being captured in the area around the northern property limit of the Plants Area to Boulder Highway. Chloroform concentrations exceeding 1,000 µg/L also extend from TIMET to the western Eastside area at BRC well POU-3.

The NERT AWF is capturing groundwater, treating for perchlorate and chromium but not chloroform, and then discharging into the Las Vegas Wash such that the chloroform impact to groundwater is somewhat reduced incidentally before groundwater flows beneath the Western Hook. Similarly, Endeavor extracts groundwater upgradient of the Western Hook, treats the extracted water to reduce perchlorate but not chloroform, and then discharges the treated water to the Las Vegas Wash. Chloroform impacts in groundwater beneath the Western Hook are thus incidentally reduced. Based on current monitoring data, chloroform concentrations in groundwater flowing from the Western Hook into the Las Vegas Wash are non-detect (<0.25 µg/L) and very close to the NDEP BCL (0.22 µg/L).

Beta-BHC is primarily sourced at the OSSM site within the Plants Area. The OSSM GWTS appears to be effective in capturing, treating, and significantly reducing beta-BHC concentrations in groundwater to below the NDEP BCL of 2 µg/L. Monitored beta-BHC concentrations beneath the Western Hook, and thus flowing into the Las Vegas Wash, are less than one-half the NDEP BCL.

Relatively high concentrations of arsenic are sourced on the OSSM and TIMET sites of the Plants Area, with concentrations on the OSSM site ranging from approximately 50 to 1,000 µg/L and concentrations on the TIMET site ranging from approximately 50 to over 100 µg/L. The OSSM GWTS and the TIMET GWETS employ air strippers to remove VOCs (and not inorganics such as arsenic). Groundwater treatment being conducted with the NERT GWETS is apparently having the collateral effect of reducing arsenic concentrations. Arsenic concentrations in groundwater downgradient (north) of Boulder Highway are generally below

200 µg/L, and arsenic concentrations decrease as the plume propagates northward toward the Las Vegas Wash. Groundwater entering the Las Vegas Wash generally has a concentration in the 50 to 85 µg/L range. The federal MCL and the NDEP BCL are both 10 µg/L.

Seven wells (DBMW-1, DBMS-3, PC-58, PC-86, PC-88, PC-90, and PC-94) have sufficient data to represent multiple years (10 years), from 2001 to 2006 leading up to the present (2016 to 2019). These 7 wells are located on the eastern half of the Western Hook area, where the concentrations are higher than on the west. Of these 7 wells, 4 had arsenic concentration trends that declined over the period, 2 had arsenic concentrations that were variable but relatively stable, and 1 had an arsenic concentration trend that increased over the period. With the exception of the very southeastern portion of the Western Hook, the groundwater treatment systems in place appear to be having a positive incidental effect on arsenic plume control and concentration reduction.

6. Remedial Alternatives

As discussed in detail in Section 1.4, the Plants Area is a significant source of shallow groundwater impacts in the Western Hook and other downgradient properties. Contaminant transport is consistently directed north-northeasterly from the source areas toward Las Vegas Wash and the Hook area. Multiple remedial efforts have been completed and are ongoing in the Plants Area including groundwater extraction, containment, and in-situ treatment. Additional site investigation is also ongoing to address areas needing further characterization to support future remedial actions. There are no current or historical contaminant source areas on the Western Hook.

Impacted Western Hook groundwater quality reflects Plants Area releases over the decades of chemical manufacturing completed upgradient. Ongoing and future remedial actions addressing Plants Area sources will also improve groundwater quality in the downgradient properties as well including the Hook area. Remedial action in the Western Hook area would not be effective until the continual loading from upgradient Plants Area shallow groundwater is mitigated. Thus, Western Hook remedial alternatives will be evaluated by BRC in the future once Plants Area cleanup efforts are nearing completion and downgradient constituent loading has ceased.

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Figures

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 1
Site Location Map

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
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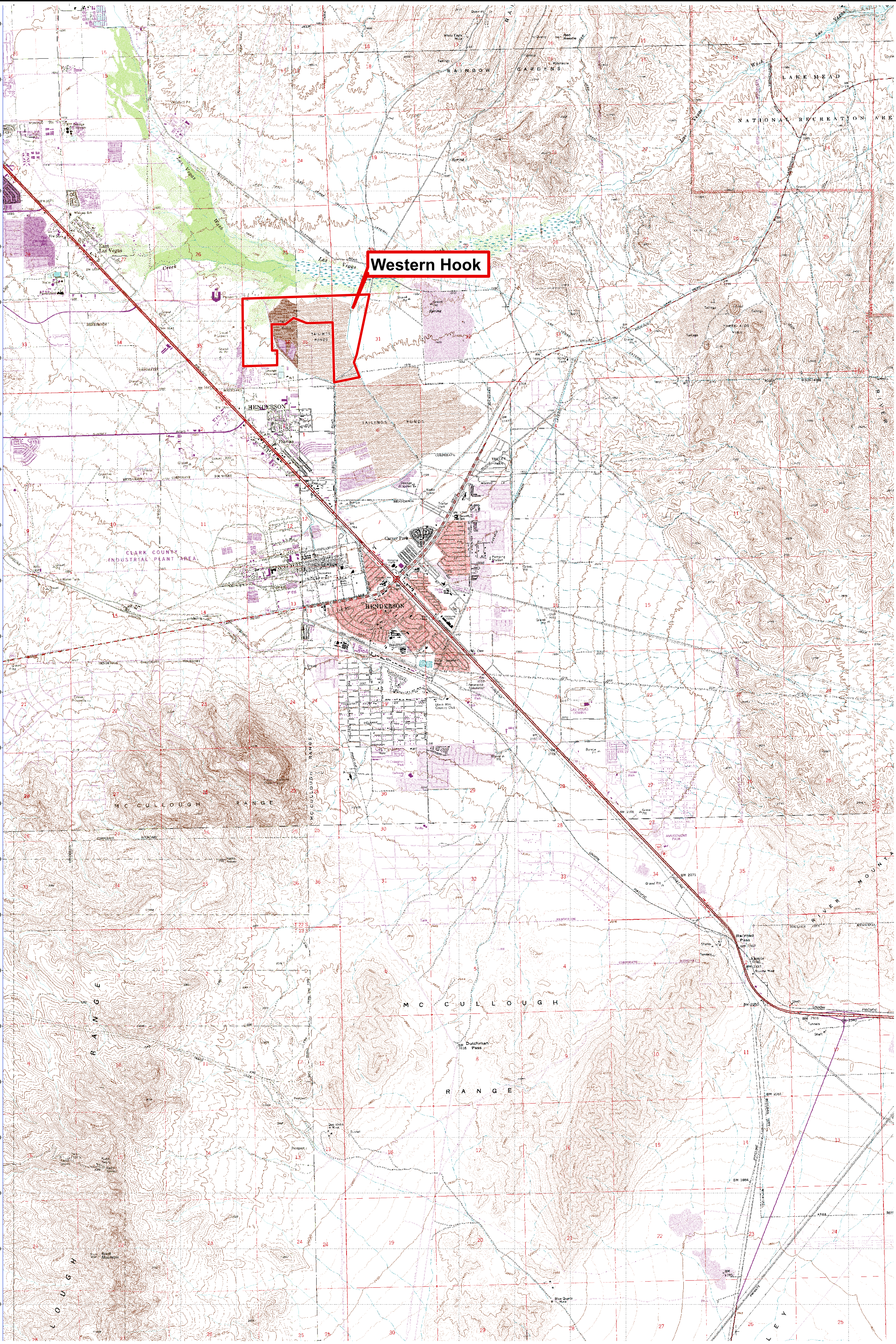

N

0 0.5 1 Miles

Explanation

Western Hook area

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 2
Regional Site Location and Topography

Daniel B. Stephens & Associates, Inc.

Basic Remediation Company

Prepared by: DBS&A AFM

Date 10/24/2019

S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG02_REGIONAL_SITE_LOCATION_AND_TOPOGRAPHY.MXD

Las Vegas Wash
CITY OF HENDERSON LANDFILL
Lower Ponds
CITY OF HENDERSON BIRD VIEWING PRESERVE
Western Ditch
CITY OF HENDERSON WATER RECLAMATION FACILITY
CITY OF HENDERSON NORTHERN RIB PONDS
WESTON HILLS PROPERTY
TUSCANY HILLS PROPERTY
Parcel 3
Parcel 4B
SUNSET ROAD
Upper Ponds
Former TIMET Spray Wheel Area
PITTMAN
Boulder Highway
Beta Ditch
Parcel 4B
Former TIMET Active Ponds
Alpha Ditch
CITY OF HENDERSON SOUTHERN RIB PONDS
Lake Mead Parkway
Parcel 5/6
Northwestern Ditch
CAMU
Inactive Landfill
Parcel 9
BMI Siphon
Parcel 4A
Slit Trenches
Inactive Landfill
Borrow Area
Beta Ditch
Alpha Ditch
Western Ditch
BMI Industrial Area
N
2,000 1,000 0 2,000
Feet

S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG03_ BMI_COMMON_AREAS.MXD

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 3
BMI Common Areas

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DBS&A AFM	10/24/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG03_ BMI_COMMON_AREAS.MXD

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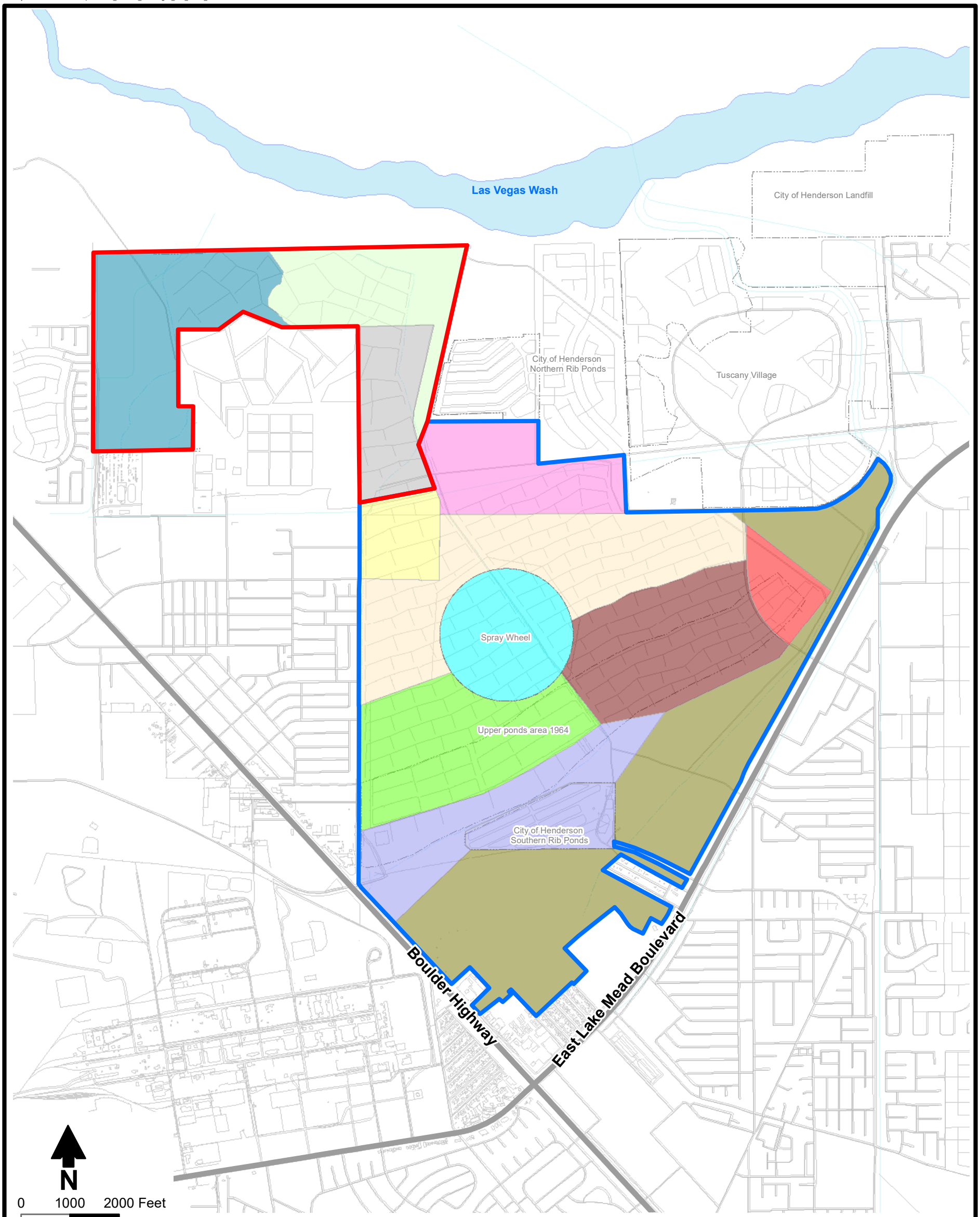

Explanation

- Western Hook
- Eastside Main area

Sub area

- First Eight Rows
- Galleria North
- Mohawk
- No Build
- Sunset North Commercial
- Southern RIBs
- Spray Wheel
- TIMET Ponds
- Upper Ponds
- Western Hook
- NFA Areas
- CoH WRF

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 4

Eastside Sub-Areas

Daniel B. Stephens & Associates, Inc.

Basic Remediation Company

Prepared by: DBS&A CRS

Date 10/24/2019

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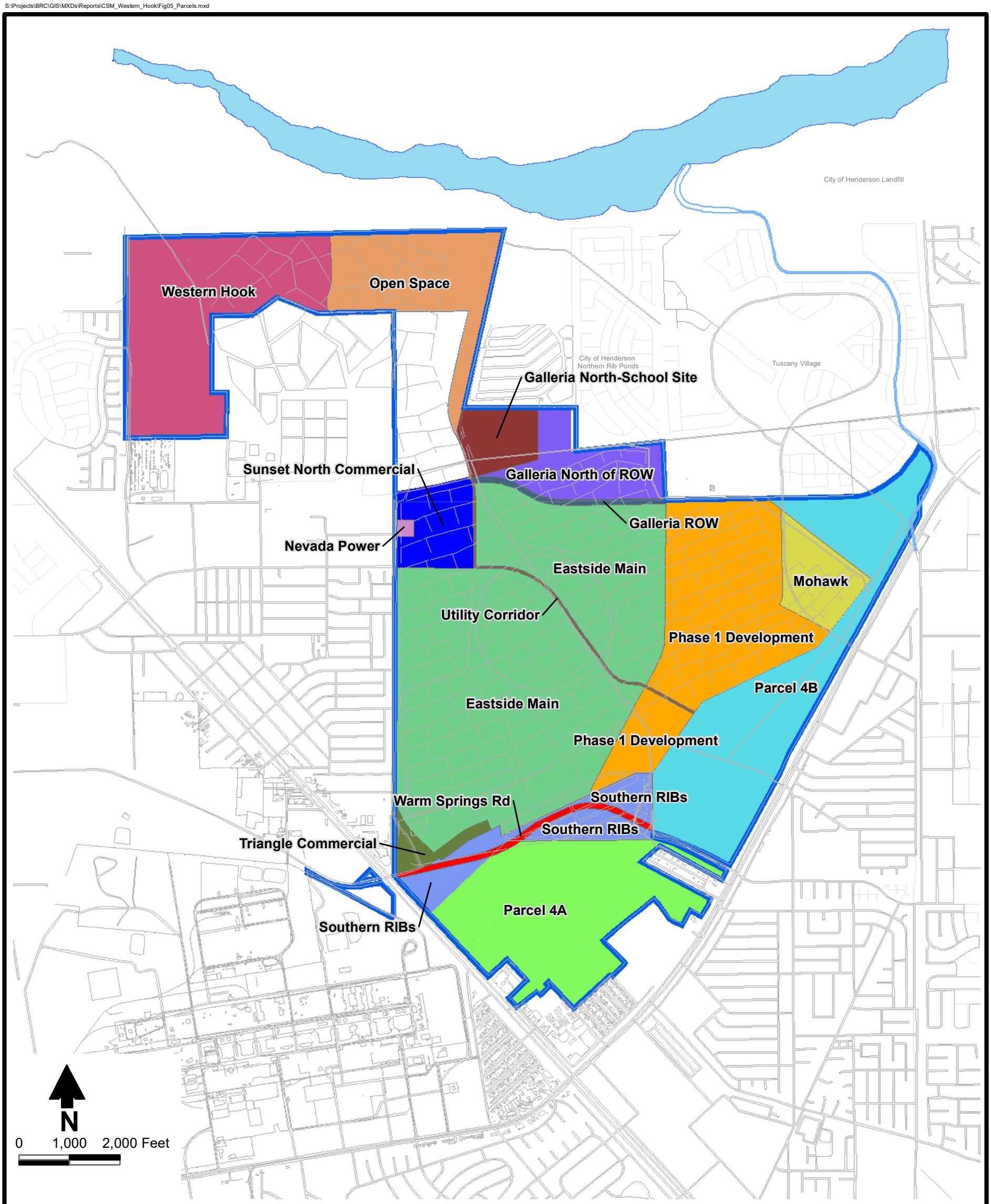

Explanation

Site AOC3 boundary

Sub-area

- Eastside Main
- Galleria North of ROW
- Galleria North-School Site
- Galleria ROW
- Mohawk
- Nevada Power
- Open Space
- Parcel 4A
- Parcel 4B
- Phase 1 Development
- Southern RIBs
- Sunset North Commercial
- Triangle Commercial
- Utility Corridor
- Warm Springs Rd
- Western Hook

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 5

Western Parcels

Daniel B. Stephens & Associates, Inc.

Basic Remediation Company

Prepared by:	Date	
DBS&A AFM	10/24/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG05_PARCELS.MXD

COH-1A
WMW5.58SS WMW5.58SD
WMW5.58SI
AA-21
PC-76
COH-2A
AA-30
TWI
PC-95
HMW-09
HMW-08
AA-08
PC-81
PC-83
PC-84
PC-86
PC-89
PC-90
PC-79
PC-80
PC-82
PC-88
PC-92
PC-94
PC-62
PC-56
PC-58
AA-23
AA-23-R
PC-108
AA-22
PC-105
DBMW-19
PC-104
PC-106
PC-103
PC-1
PC-2
PC-4
AA-10
DBMW-4
DBMW-5
PC-107
DBMW-7
DBMW-8
MCF-06B
DBMW-6
DM-5
MCF-06C
HMW-16
PC-19
PC-12
DBMW-2
DM-4
DBMW-3
AA-20
DBMW-1

N
0 450 900 Feet

Explanation

Shallow Zone well
Western Hook area

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 6
Western Hook Parcel
Shallow Zone Monitoring Wells

Daniel B. Stephens & Associates, Inc.
Basic Remediation COMPANY

Prepared by:	Date
DBS&A AFM	11/1/2019

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig07_WH_Shallow_MWs

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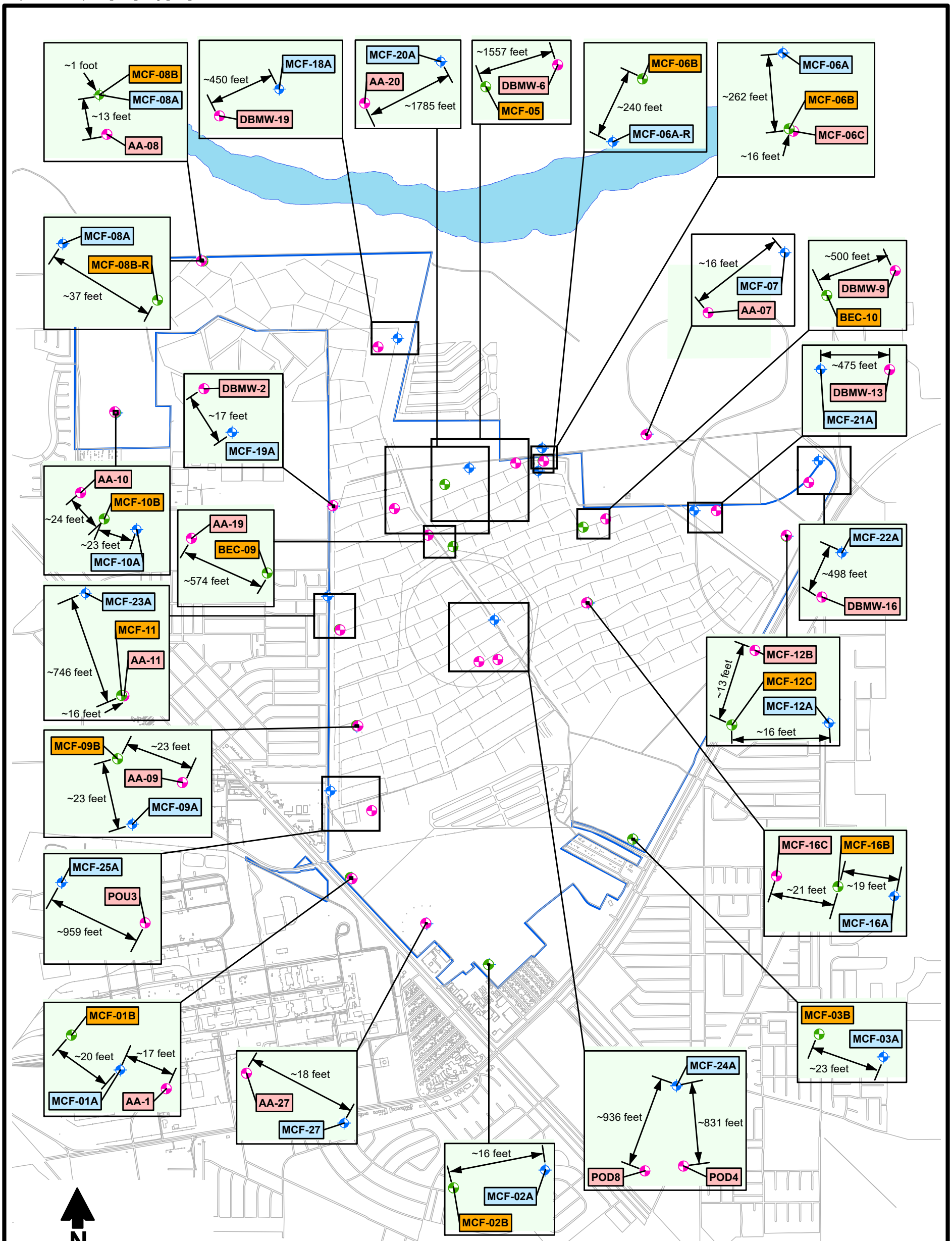


Explanation

- MCF-16C — Shallow zone well
- MCF-16B — Intermediate zone well
- MCF-16A — Deep zone well
- Site AOC3 boundary

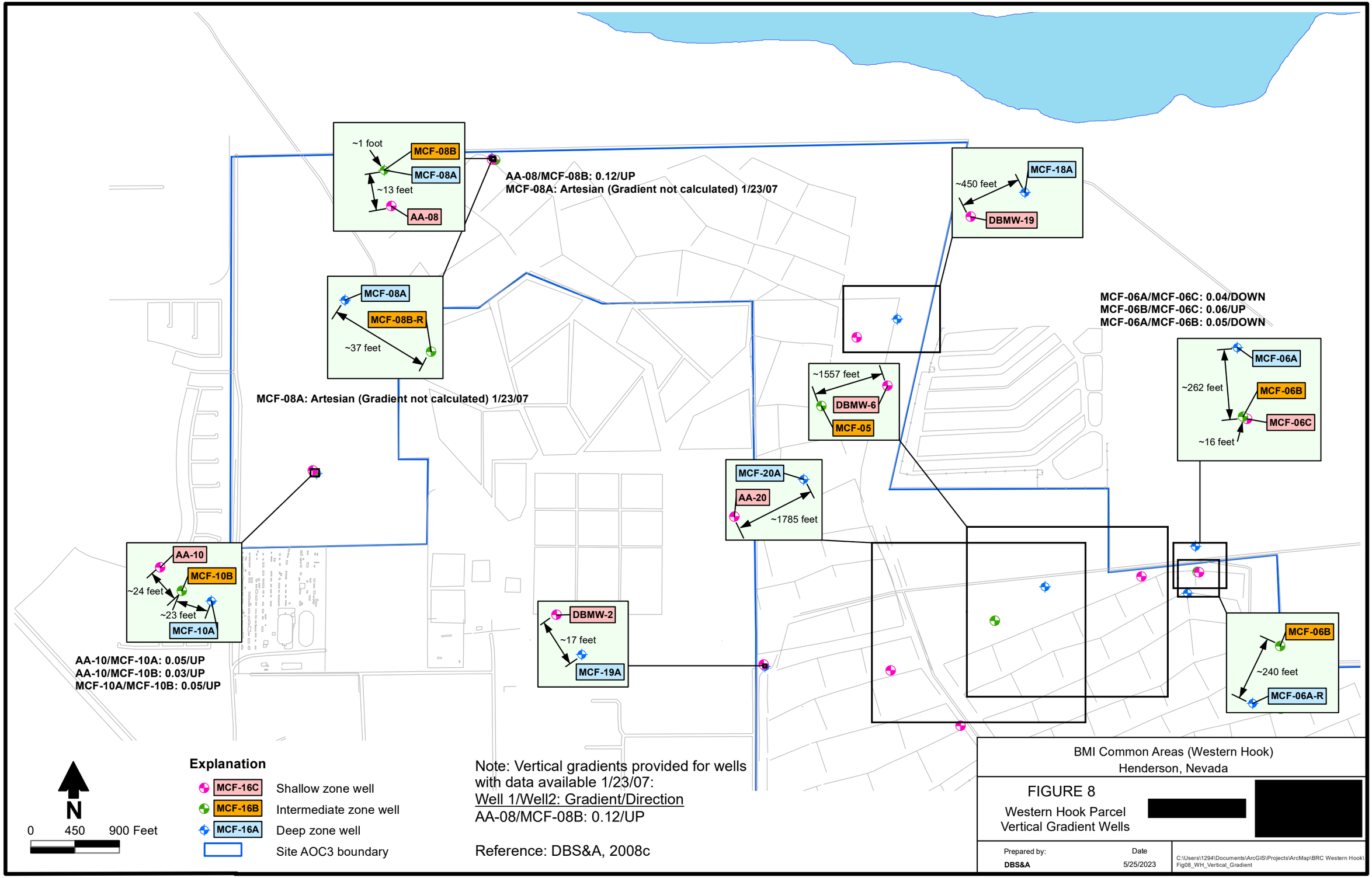
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 7
Eastside Area Vertical Gradient Wells

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A CRS	10/24/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG07_VERTICAL_GRADIENT.MXD


~1 foot
MCF-08B
MCF-08A
~13 feet
AA-08
AA-08/MCF-08B: 0.12/UP
MCF-08A: Artesian (Gradient not calculated) 1/23/07
MCF-18A
~450 feet
DBMW-19
MCF-08A
MCF-08B-R
~37 feet
MCF-08A: Artesian (Gradient not calculated) 1/23/07
MCF-06A/MCF-06C: 0.04/DOWN
MCF-06B/MCF-06C: 0.06/UP
MCF-06A/MCF-06B: 0.05/DOWN
~1557 feet
DBMW-6
MCF-05
MCF-06A
~262 feet
MCF-06B
MCF-06C
~16 feet
MCF-20A
AA-20
~1785 feet
AA-10
MCF-10B
~24 feet
~23 feet
MCF-10A
AA-10/MCF-10A: 0.05/UP
AA-10/MCF-10B: 0.03/UP
MCF-10A/MCF-10B: 0.05/UP
DBMW-2
~17 feet
MCF-19A
MCF-06B
~240 feet
MCF-06A-R
N
0
450
900 Feet
Explanation
MCF-16C
Shallow zone well
MCF-16B
Intermediate zone well
MCF-16A
Deep zone well
Site AOC3 boundary
Note: Vertical gradients provided for wells with data available 1/23/07:
Well 1/Well2: Gradient/Direction
AA-08/MCF-08B: 0.12/UP
Reference: DBS&A, 2008c
BMI Common Areas (Western Hook)
Henderson, Nevada
FIGURE 8
Western Hook Parcel
Vertical Gradient Wells
[redacted]
[redacted]
Prepared by:
DBS&A
Date
5/25/2023
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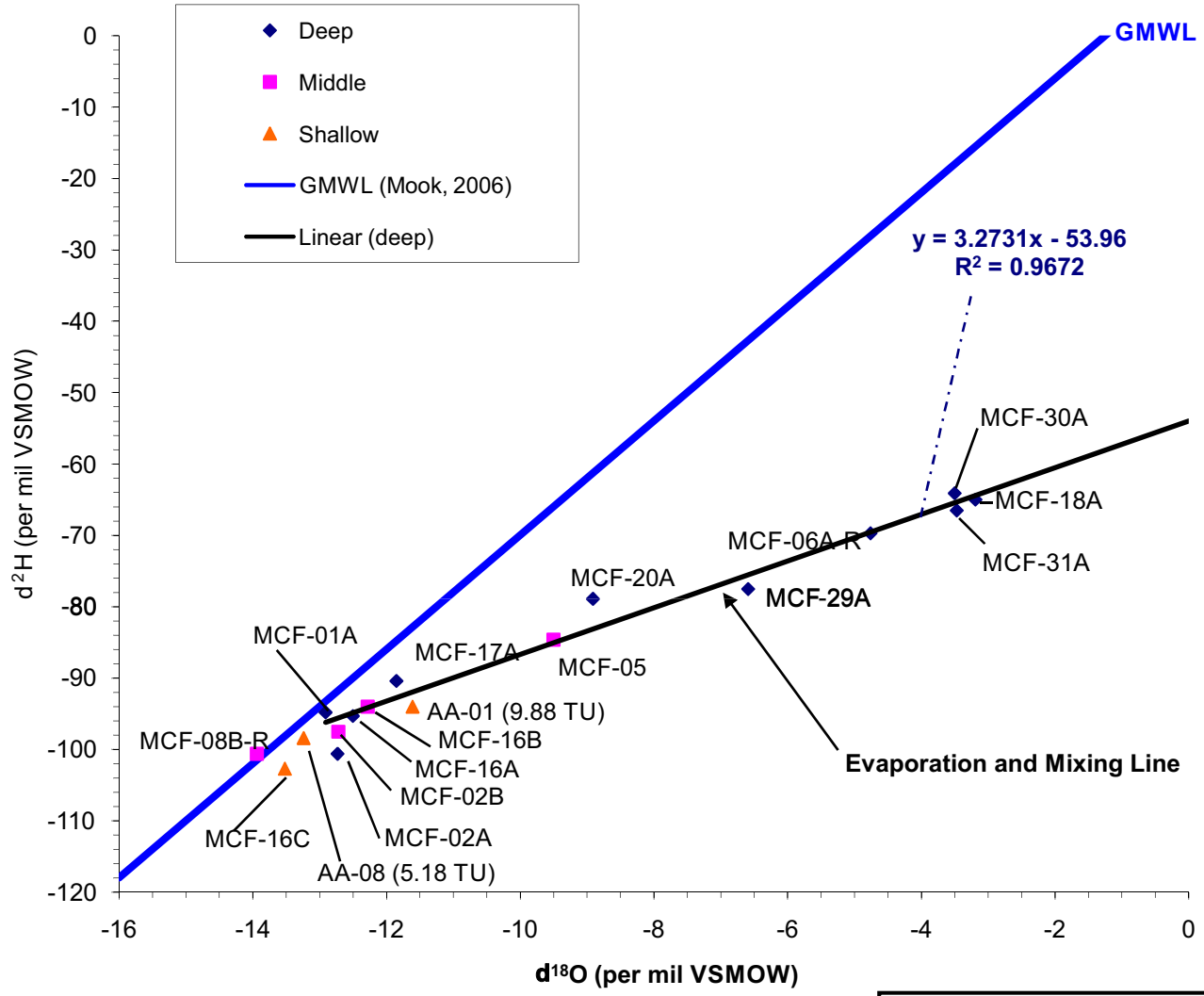

Note: 1. GMWL = Global meteoric water line
2. VSMOW = Vienna Standard Mean Ocean Water
3. Data from groundwater samples collected April and July 2008 and August and September 2009

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 9
Groundwater Stable Isotope Data

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 03-06-19

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG24_GW_ISOTOPE_ANALYTIC_RESULTS.CDR

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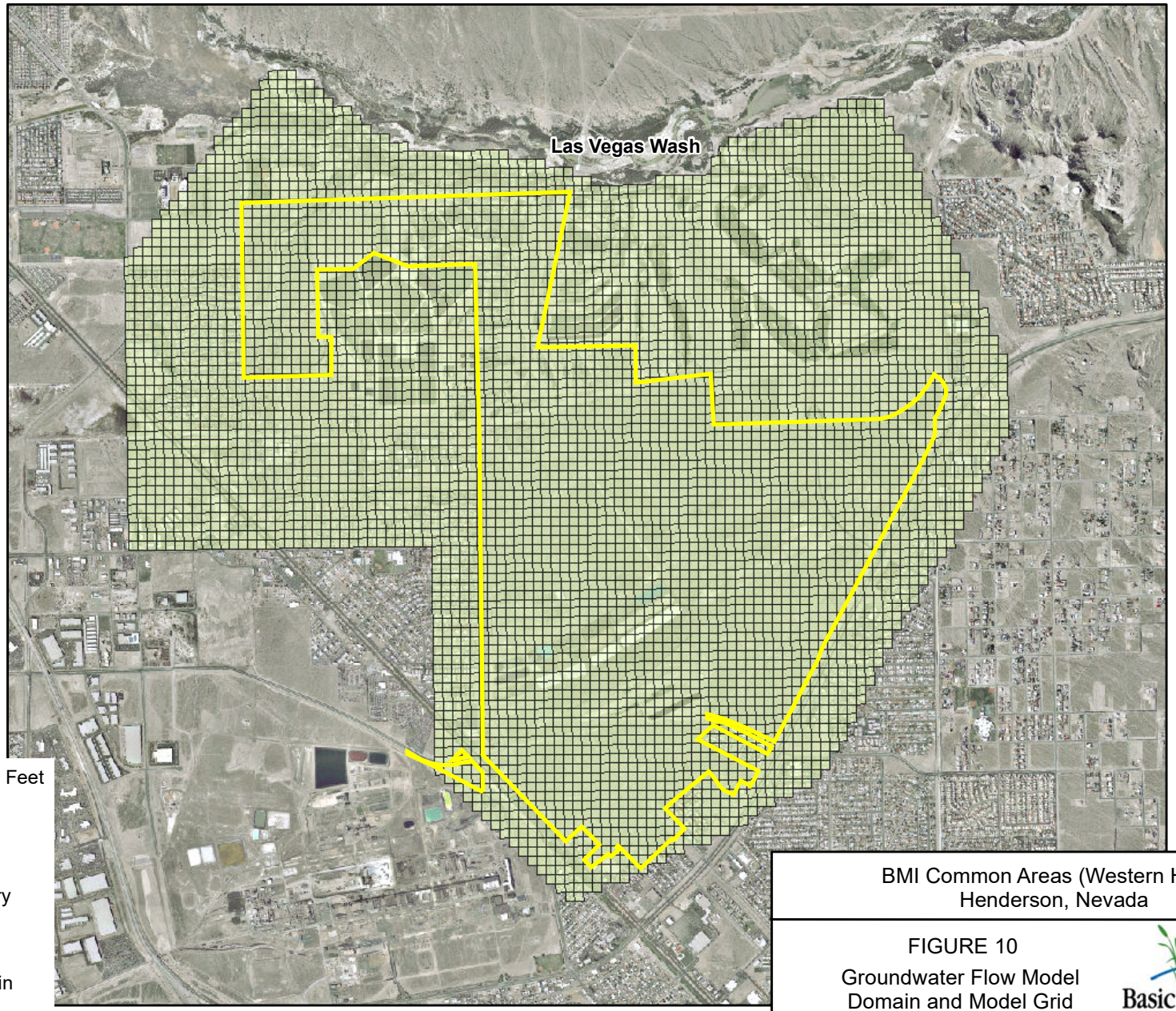

N

0 1750 3500 Feet

Explanation

- Site boundary
- Model grid
- Model domain

Source: Aerial photograph, April 2004

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 10

Groundwater Flow Model
Domain and Model Grid

Basic Remediation COMPANY

Prepared by:		Date	
DBS&A	GJ	10/24/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG09_MODEL_DOMAIN_AND_MODEL_GRID.MXD

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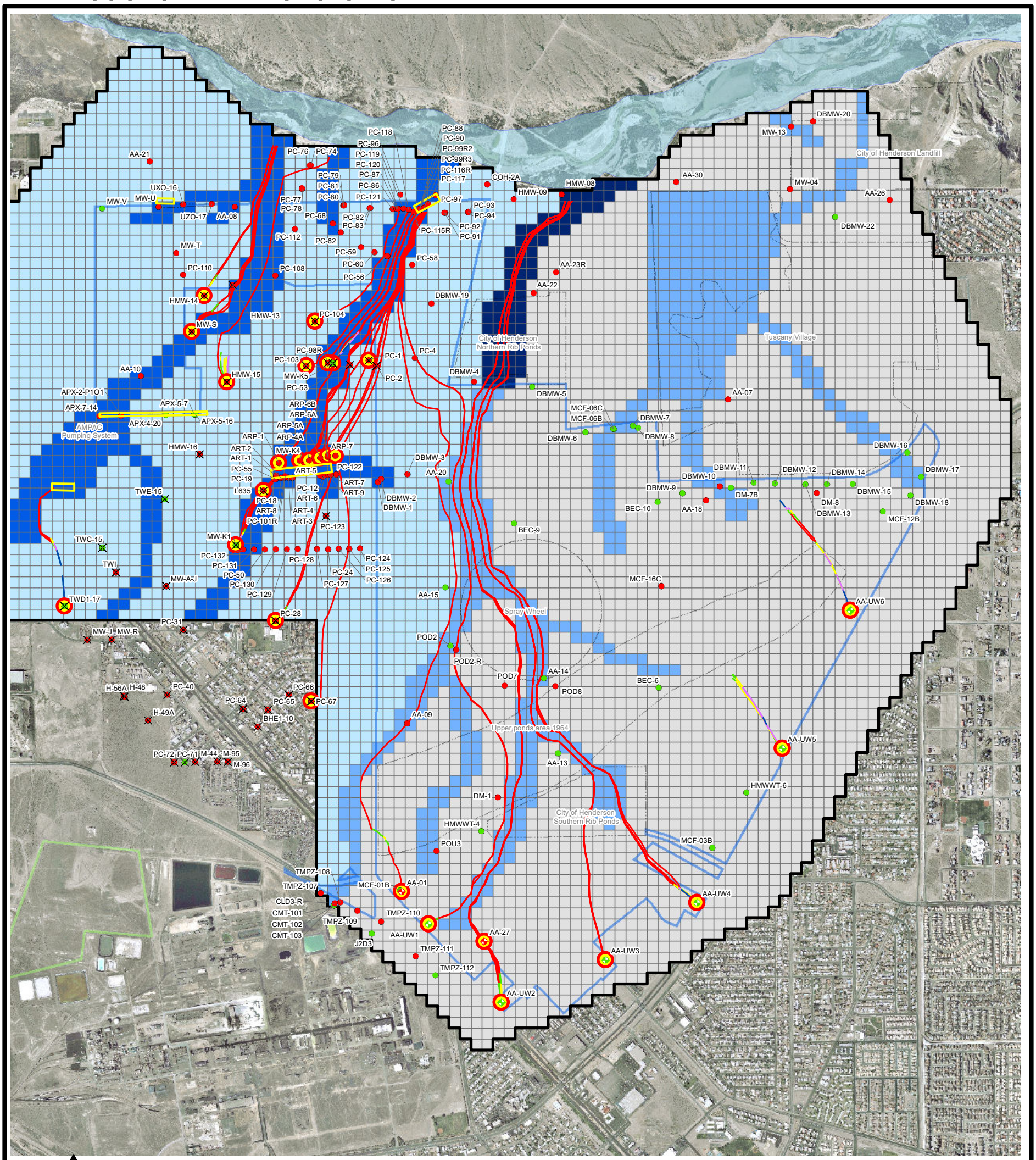

Explanation

- Upgradient well layer 1 – Eastside-Main
- Upgradient well layer 2 – Eastside-Main
- Upgradient Wells – Eastside-Hook
- Shallow Zone monitoring well layer 1
- Shallow Zone monitoring well layer 2
- Particle release wells
- Particle tracks layer 1
- Particle tracks layer 2
- Particle tracks layer 3
- Particle tracks layer 4
- Particle tracks layer 5
- Groundwater extraction well fields
- Flow model domain
- Site boundary
- Las Vegas Wash
- Site AOC3 boundary

Horizontal hydraulic conductivity (ft/day)

- 10
- 30
- 100
- 300
- 360

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 11

Particle Tracks from Upgradient Wells

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:		Date	
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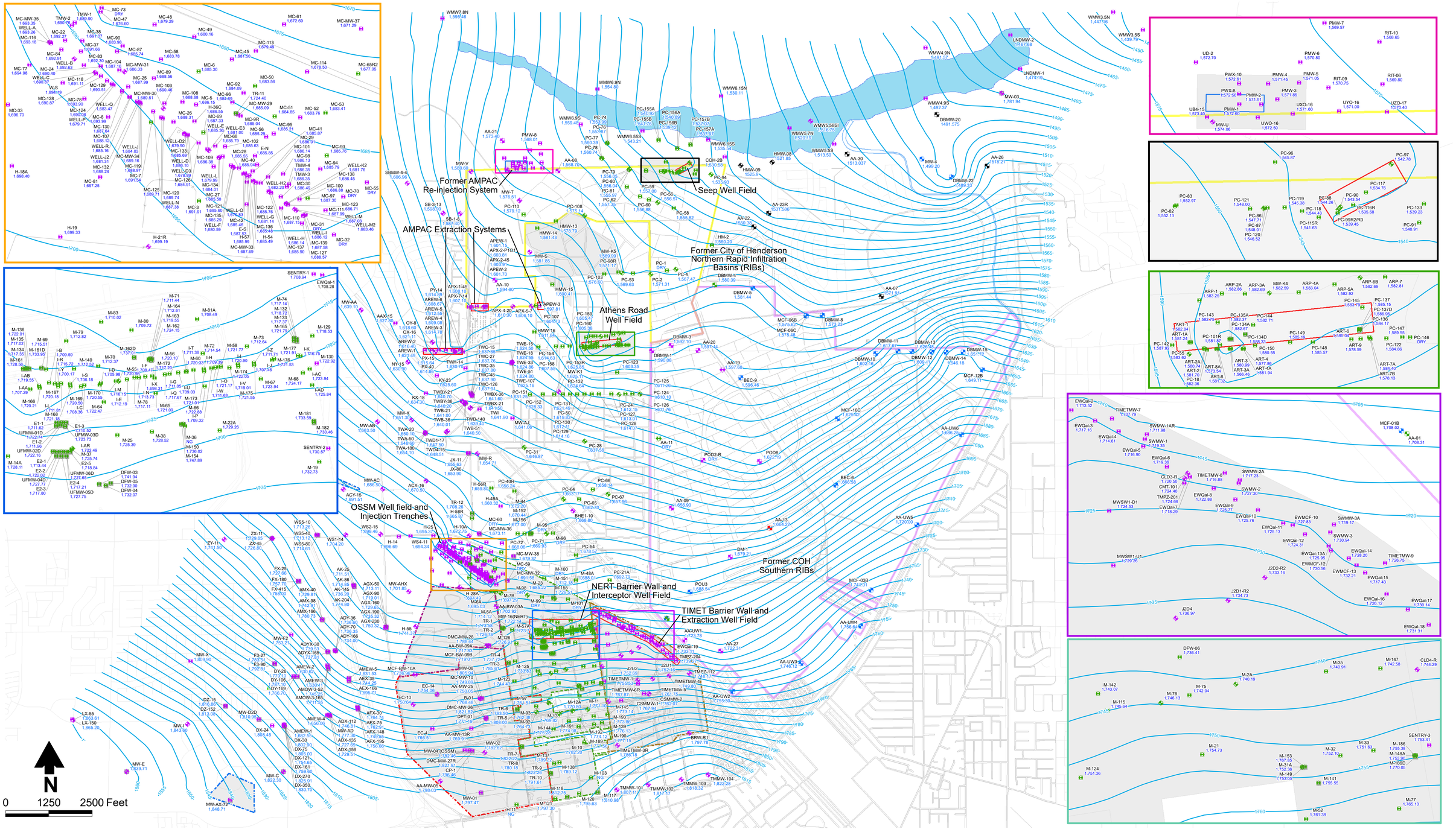

Explanation

- Well gaged in 2009
- Well gaged in 2014
- Well gaged in 2015
- Well gaged in 2017
- Well gaged in 2018

BRC well
- Layer 1 or layer 2
- Layer 1
- Layer 2

Offsite well
- Layer 1 or layer 2
- Layer 1
- Layer 2

- Well not used for contouring
- Groundwater elevation contour (ft msl)
- Eastside Hook area
- Eastside Main area

- Extraction well field
- Injection well field
- External features

- Canal
- Street
- Las Vegas Wash

- City of Henderson Bird Viewing Preserve
- AMPAC/Endeavour Auto Mall Extraction Wells (Deeper Water Bearing Zone)
- BRC CAMU

- Former PEPCON Site
- NERT Site
- Olin Corporation
- TIMET

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 12
Regional Shallow Zone Groundwater Potentiometric Surface

Daniel B. Stephens & Associates, Inc.

Basic Remediation Company

Prepared by: DBS&A

Date: AFM 11/1/2019

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig12_Regional_Shallow_Potentiometric_Map.mxd

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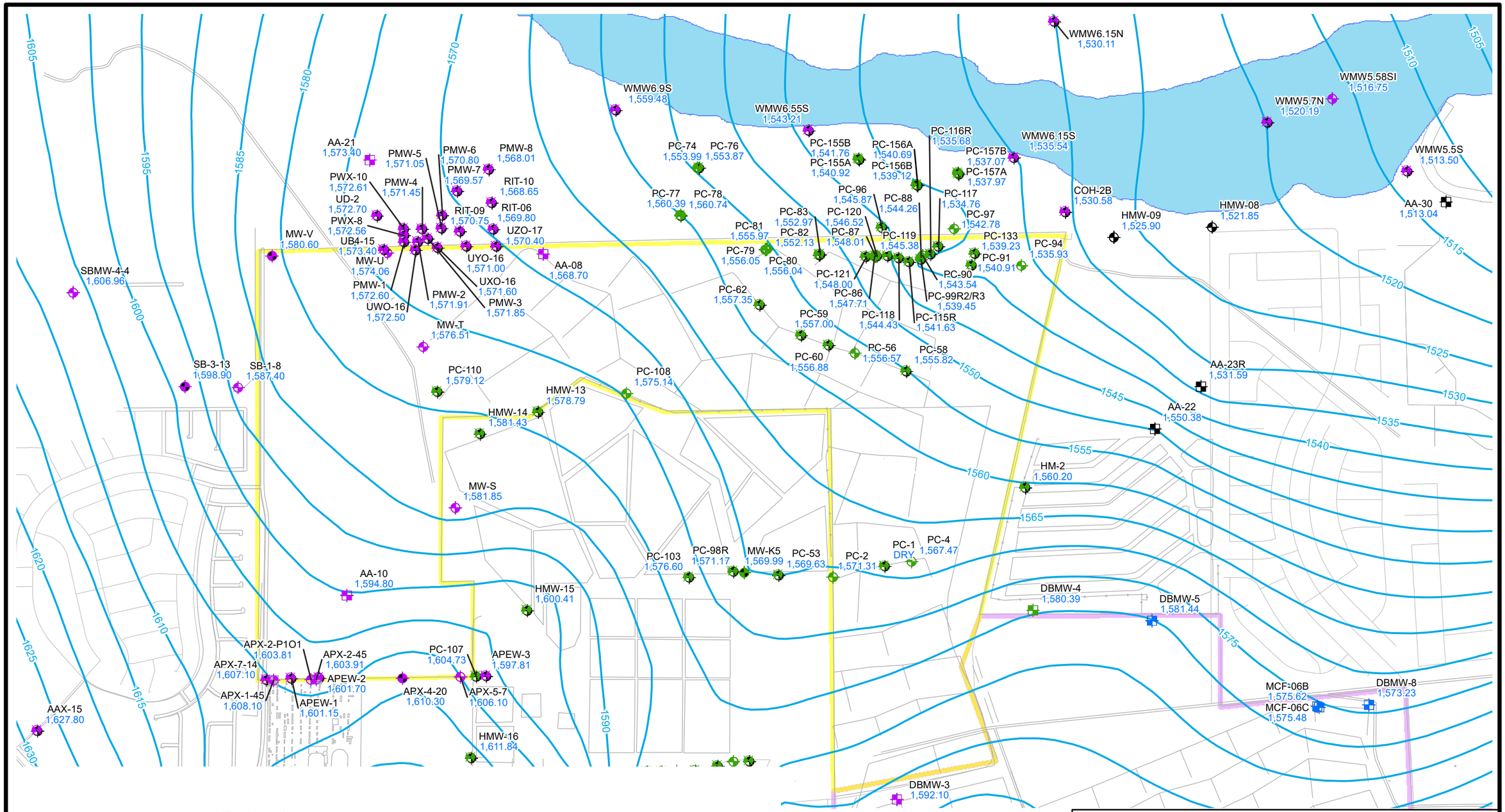


Explanation

- Well gaged in 2009
- Well gaged in 2014
- Well gaged in 2015
- Well gaged in 2017
- Well gaged in 2018

Offsite well

- Layer 1 or layer 2
- Layer 1
- Layer 2

- Groundwater elevation contour (ft msl)
- Western Hook area
- Eastside Main area

BMI Common Areas (Western Hook)
Henderson, Nevada

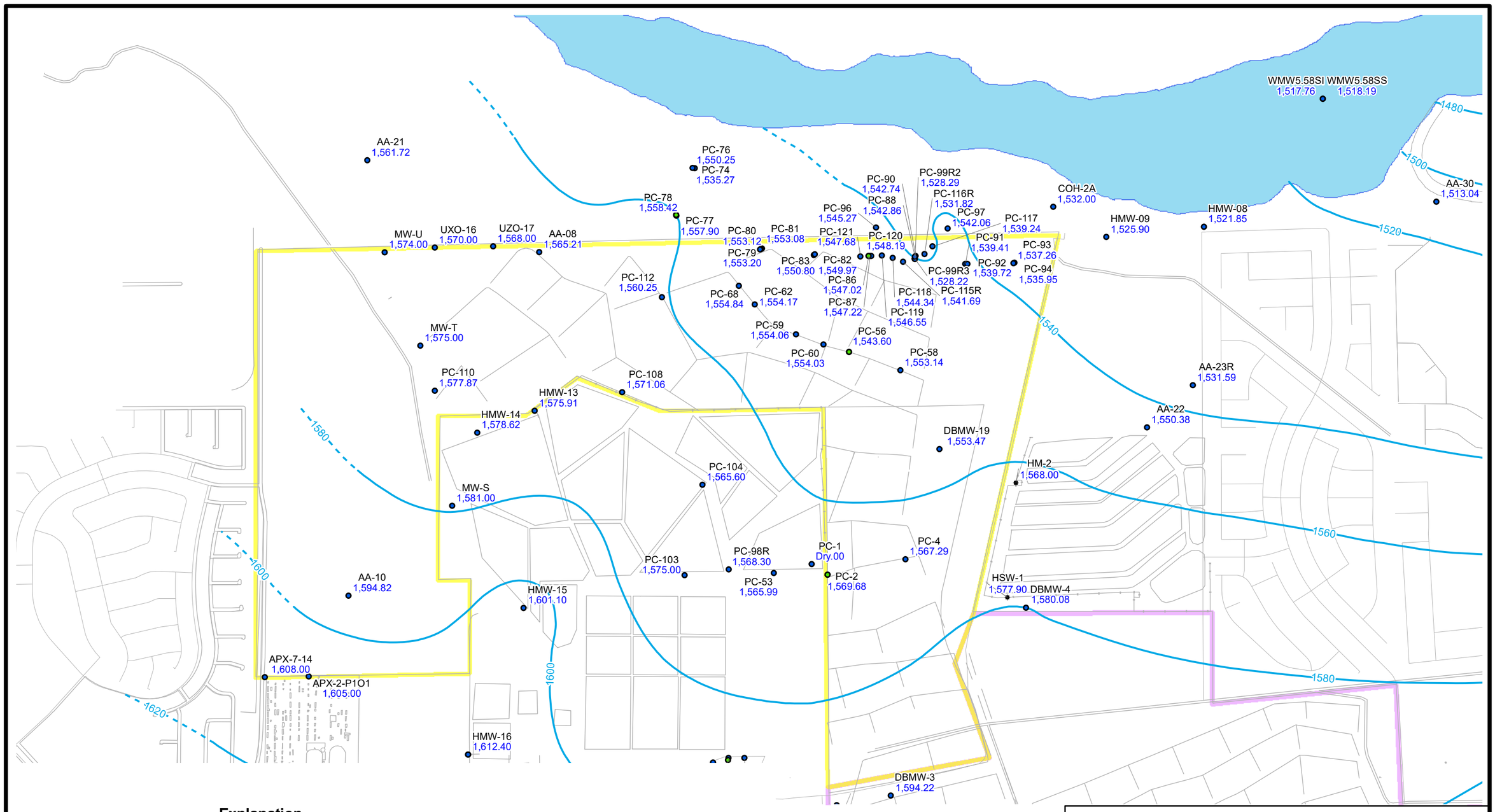
FIGURE 13
Western Hook Parcel
Shallow Zone Groundwater
Potentiometric Surface

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date
DBS&A AFM	11/1/2019

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig13_WH_Shallow_Potentiometric_Map



Explanation

Well Date
- 2007
- 2008
- 2009

Groundwater elevation contour (ft msl)

Western Hook area

Eastside Main area

N

0 450 900 Feet

BMI Common Areas (Western Hook)
Henderson, Nevada

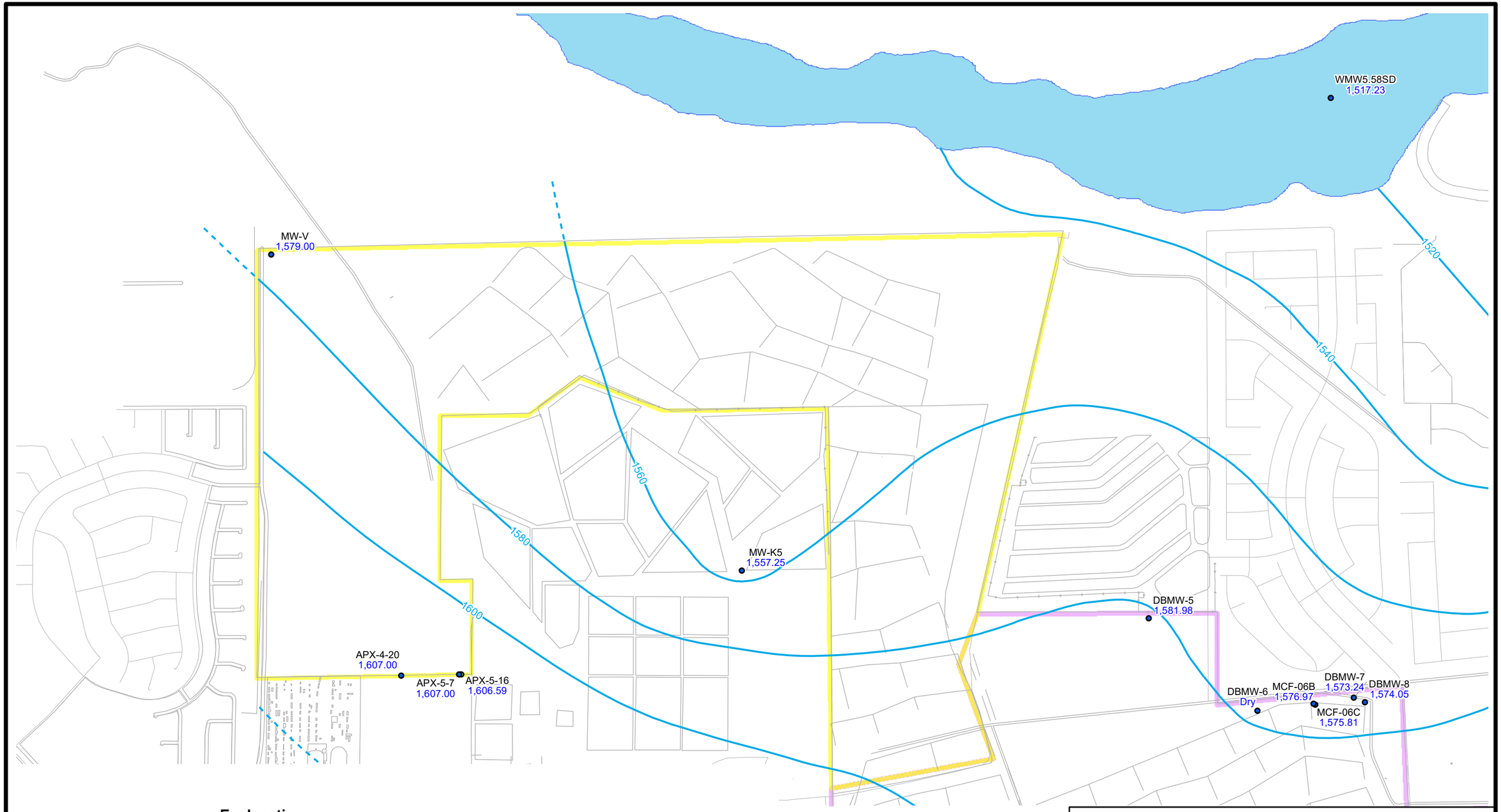
FIGURE 14
Western Hook Parcel
Shallow Zone Groundwater
Potentiometric Surface Layer 1

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date
DBS&A AFM	11/1/2019

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig14_WH_Shallow_Potentiometric_Map_Layer1



N

0 450 900 Feet

Explanation

Well Date
- 2007
- 2008
- 2009

Groundwater elevation contour (ft msl)

Western Hook area

Eastside Main area

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 15
Western Hook Parcel
Shallow Zone Groundwater
Potentiometric Surface Layer 2

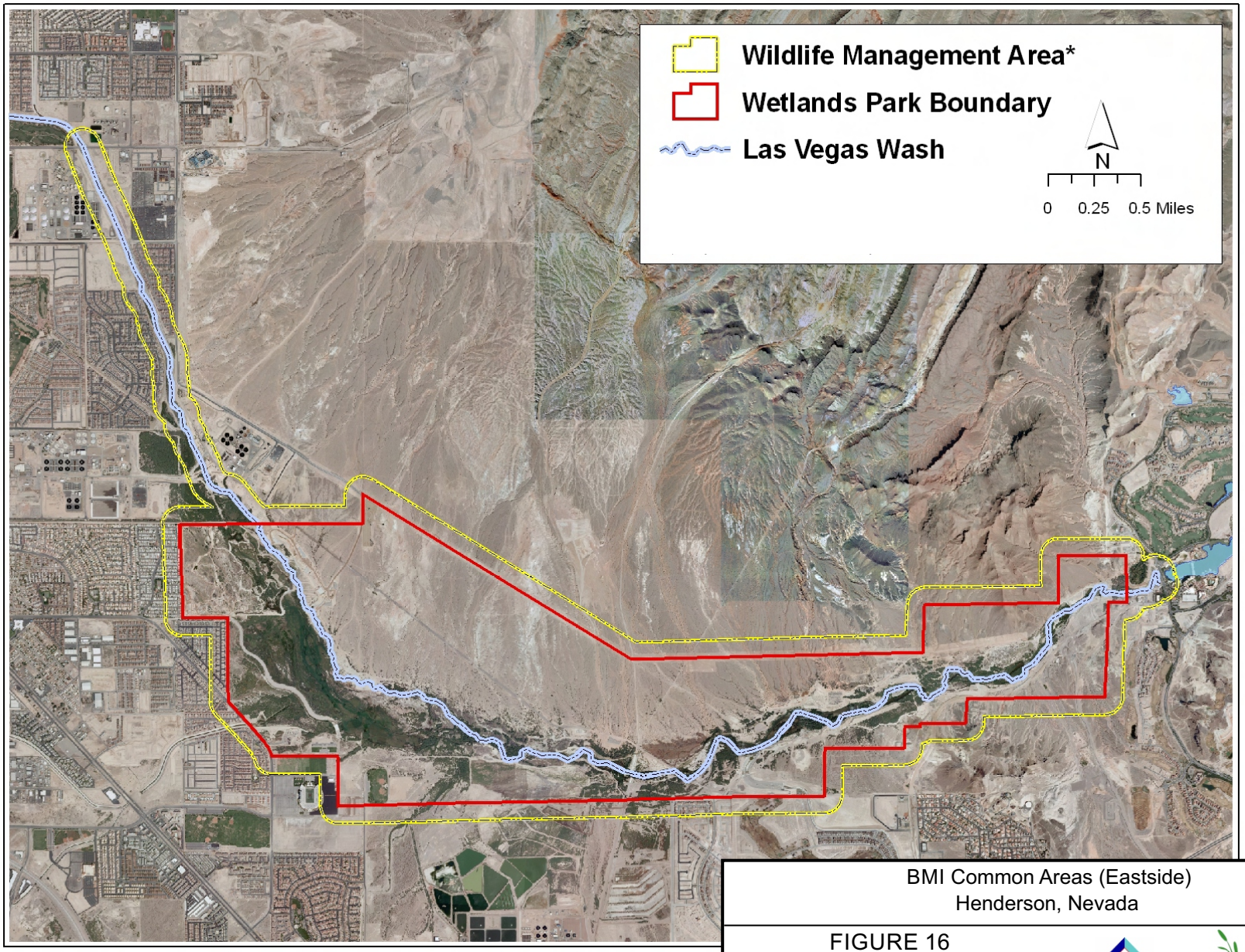
Daniel B. Stephens & Associates, Inc.

Basic Remediation Company

Prepared by: DBS&A AFM

Date 11/2/2019

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig15_WH_Shallow_Potentiometric_Map_Layer2



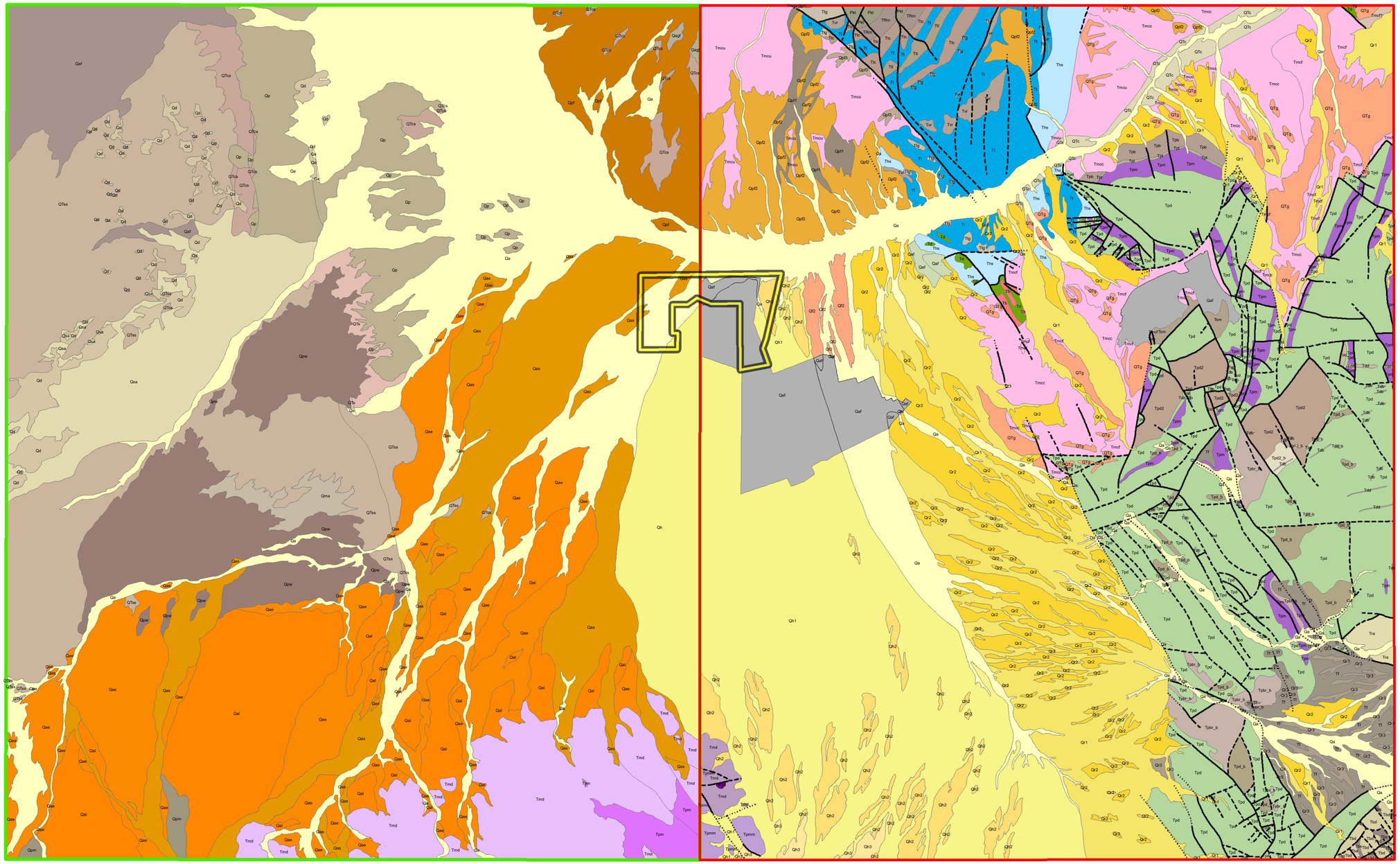
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 16
General Boundary
Wildlife Management Area

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A AFM	05-14-20	S:\PROJECTS\BRC\GIS\VR_DRAWINGS\DB20.1099\FIG16_WILDLIFE_MANAGEMENT_AREA.CDR



N

0 0.5 1 Miles

Explanation

Western Hook area

Quadrangle

Henderson (Bell, J.W. and Smith, 1980)

Las Vegas SE (Binger, J.W., 1977)

Fault

Concealed

Inferred

Known

Sources:

1. Geology from Bell, J.W. and Smith, 1980. Geology Map of the Henderson Quadrangle, Nevada. Nevada Bureau of Mines and Geology, Map 67.
2. Geology from Binger, J.W., 1977. Geology Map of the Las Vegas SE Quadrangle, Nevada. Nevada Bureau of Mines and Geology.

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 17
Regional Geologic Map

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A AFM

Date 10/31/2019

S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG16_REGIONAL_GEOLOGIC_MAP.MXD

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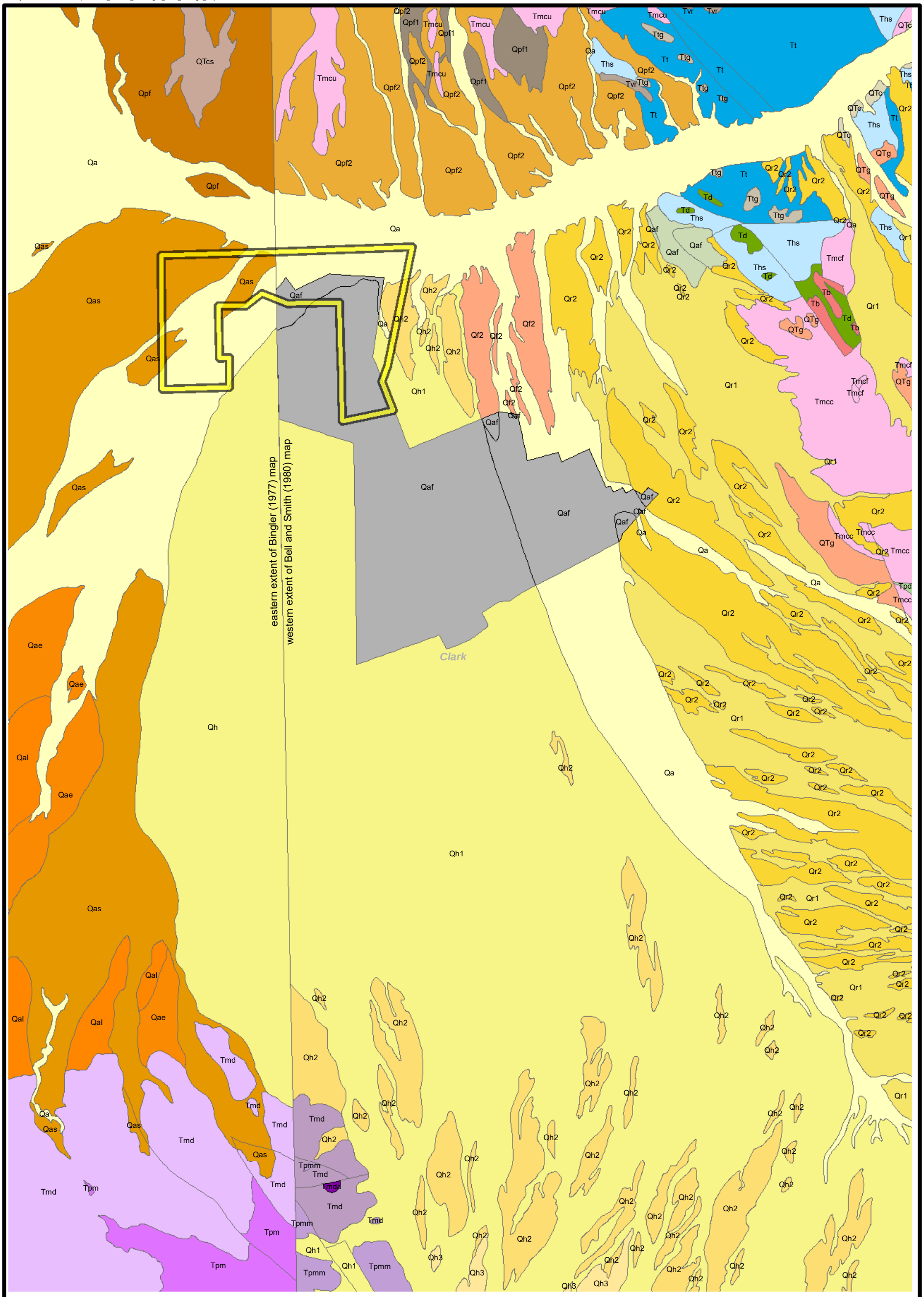


Explanation

Western Hook area

Sources:

1. Geology from Bell, J.W. and Smith, 1980. Geology Map of the Henderson Quadrangle, Nevada. Nevada Bureau of Mines and Geology, Map 67.
2. Geology from Binger, J.W., 1977. Geology Map of the Las Vegas SE Quadrangle, Nevada. Nevada Bureau of Mines and Geology.

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 18
Local Geologic Map

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A AFM	10/31/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG17_LOCAL_GEOLOGIC_MAP.MXD

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig18_Geologic_Legend_Bell_and_Smith.mxd

Explanation

Geologic Unit, Description

- Pkt, Kaibab and Toroweap Formations
- QTc, Conglomerate of Las Vegas Wash
- QTg, Older alluvial-fan deposits
- Qa, Modern wash deposits
- Qaf, Artificial fill
- Qf2, Pediment and fan deposits, undifferentiated
- Qh1, Pediment and fan deposits of Henderson
- Qh2, Pediment and fan deposits of Henderson
- Qh3, Pediment and fan deposits of Henderson
- Qpf1, Pediment and fan deposits of Frenchman Mountain
- Qpf2, Pediment and fan deposits of Frenchman Mountain
- Qpf3, Pediment and fan deposits of Frenchman Mountain
- Qr1, Pediment and fan deposits of the River Mountains
- Qr2, Pediment and fan deposits of the River Mountains
- Qr3, Pediment and fan deposits of the River Mountains
- TRm, Moenkopi Formation
- Tb, Volcanic rocks north of Lake Mead Drive
- Tba, Volcanic rocks of Bootleg Wash
- Tbd, Volcanic rocks of Bootleg Wash
- Tbs, Volcanic rocks of Bootleg Wash
- Td, Volcanic rocks north of Lake Mead Drive
- Tdb, Dikes
- Tdd, Dikes
- Tf, Fanglomerate of the Interior Valley
- Ths, Horse Spring Formation
- Tmcc, Muddy Creek Formation
- Tmcf, Muddy Creek Formation
- Tmcf?, Muddy Creek Formation
- Tmcu, Muddy Creek Formation
- Tmd, Volcanic rocks of the McCullough Range
- Tmda, Volcanic rocks of the McCullough Range
- Tpb, Volcanic rocks of Powerline Road
- Tpbr_b, Volcanic rocks of Powerline Road Brecciated
- Tpd, Volcanic rocks of Powerline Road
- Tpd2, Volcanic rocks of Powerline Road
- Tpd2_b, Volcanic rocks of Powerline Road Brecciated
- Tpd_b, Volcanic rocks of Powerline Road Brecciated
- Tpm, Volcanic rocks of Powerline Road
- Tpmm, Volcanic rocks of the McCullough Range
- Tpt, Volcanic rocks of Powerline Road
- Tra, Volcanic rocks of the River Mountains
- Trma, Volcanic rocks of Red Mountain
- Tsm, Manganiferous sedimentary rocks of the Three Kids
- Tt, Thumb Formation
- Ttc, Thumb Formation
- Ttg, Thumb Formation
- Ttl, Thumb Formation
- Tvr, Volcanic rocks of Rainbow Gardens

Source:

Geology from Bell, J.W. and Smith, 1980. Geology Map of the Henderson Quadrangle, Nevada. Nevada Bureau of Mines and Geology, Map 67.

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 19
Geologic Map Legend
(Bell and Smith,1980)

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A AFM	10/31/2019	S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG18_GEOLOGIC_LEGEND_BELL_AND_SMITH.MXD

S:\Projects\BRC\GIS\MXDs\Reports\CSM_Western_Hook\Fig19_Geologic_Legend_Bingler.mxd

Explanation

Geologic Unit, Description

- QTcs, Plio-Pleistocene silty sand
- QTs, Plio-Pleistocene silty sand
- QTss, Plio-Pleistocene silty sand
- Qa, Alluvium
- Qae, Alluvial deposits of Eastern Avenue
- Qaf, Alluvium of Flamingo Wash
- Qagf, Alluvial gravel of Frenchman Mountain
- Qal, Alluvial deposits of Lamb Boulevard
- Qas, Alluvial deposits of Sunset Road
- Qd, Sand dunes
- Qh, Henderson fan deposits
- Qma, Mesa alluvium
- Qp, Pediment deposits of east Las Vegas
- Qpf, Pediment gravel of Frenchman Mountain
- Qpm, Pediment gravel of the McCullough Range
- Qpw, Pediment deposits of Whitney Mesa
- Qsa, Sandy alluvium of Paradise Valley
- Tmd, Mount Davis Volcanics
- Tpm, Patsy Mine Volcanics

Source:

Geology from Bingler, J.W., 1977. Geology Map of the Las Vegas SE Quadrangle, Nevada. Nevada Bureau of Mines and Geology.

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 20
Geologic Map Legend
(Bingler, 1977)

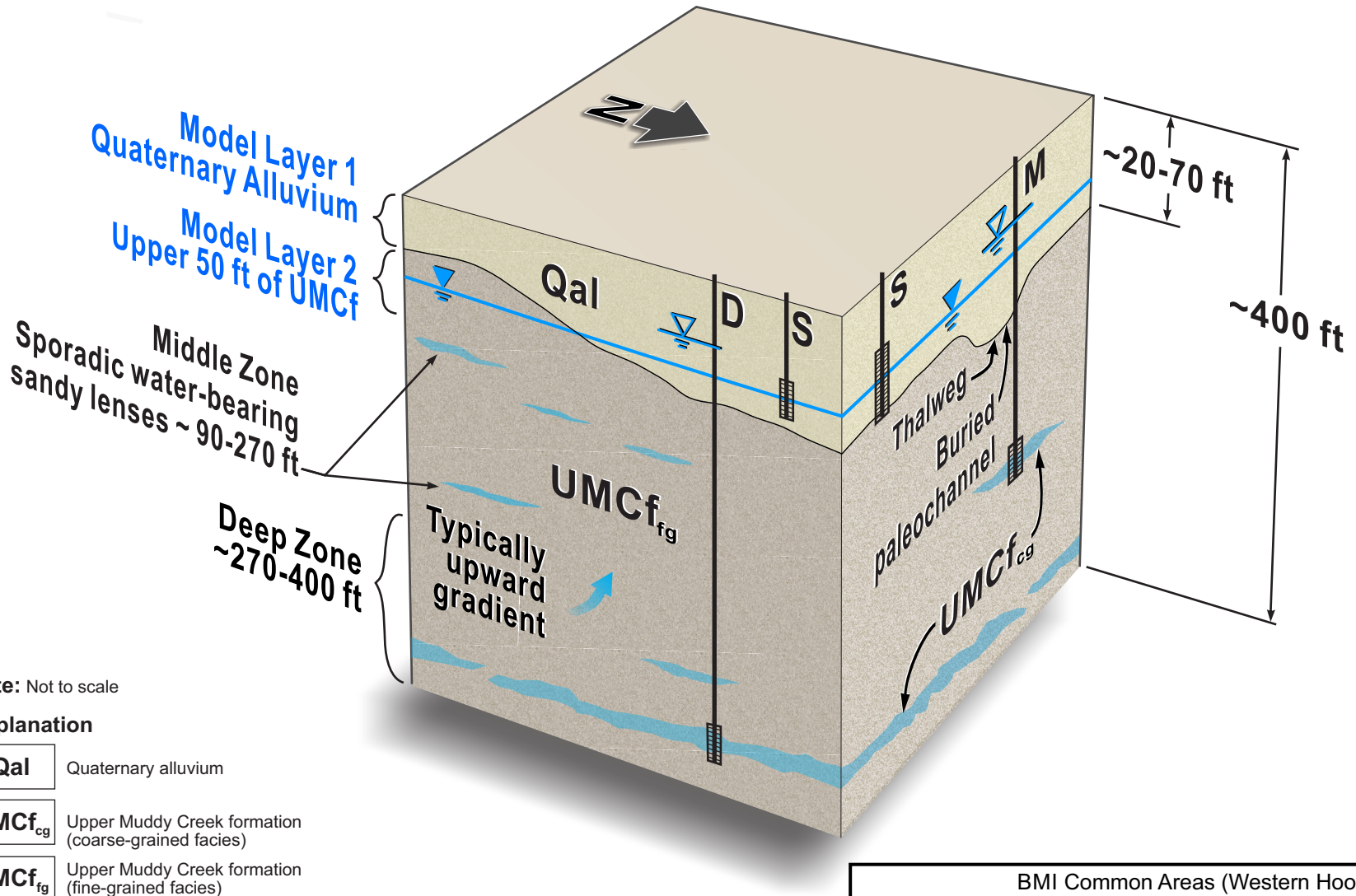
Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A AFM

Date 10/31/2019

S:\PROJECTS\BRC\GIS\MXDS\REPORTS\CSM_WESTERN_HOOK\FIG19_GEOLOGIC_LEGEND_BINGLER.MXD



Note: Not to scale

Explanation

Qal	Quaternary alluvium
$UMCf_{cg}$	Upper Muddy Creek formation (coarse-grained facies)
$UMCf_{fg}$	Upper Muddy Creek formation (fine-grained facies)
	Example well and screen **S** = Shallow Zone well **M** = Middle Zone well **D** = Deep Zone well
	Deep or Middle Zone groundwater level
	Shallow Zone groundwater level

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 21 Schematic Diagram of Water-Bearing Zones and Model Layers

Daniel B. Stephens & Associates, Inc.

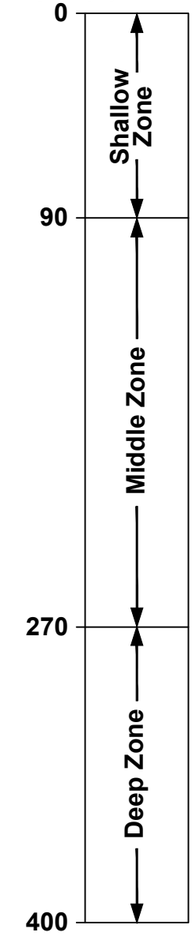
Basic Remediation COMPANY

Prepared by: DBS&A CRS

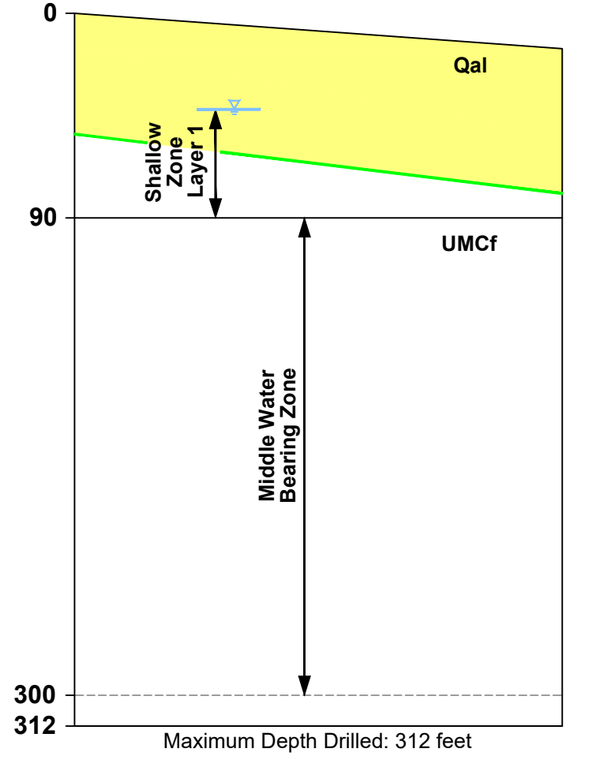
Date 10-25-19

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\CSM_WESTERN_HOOK\FIG20_SCHEM_DIAG_WATER-BEARING_ZONES_MODEL_LAYERS.CDR

NDEP

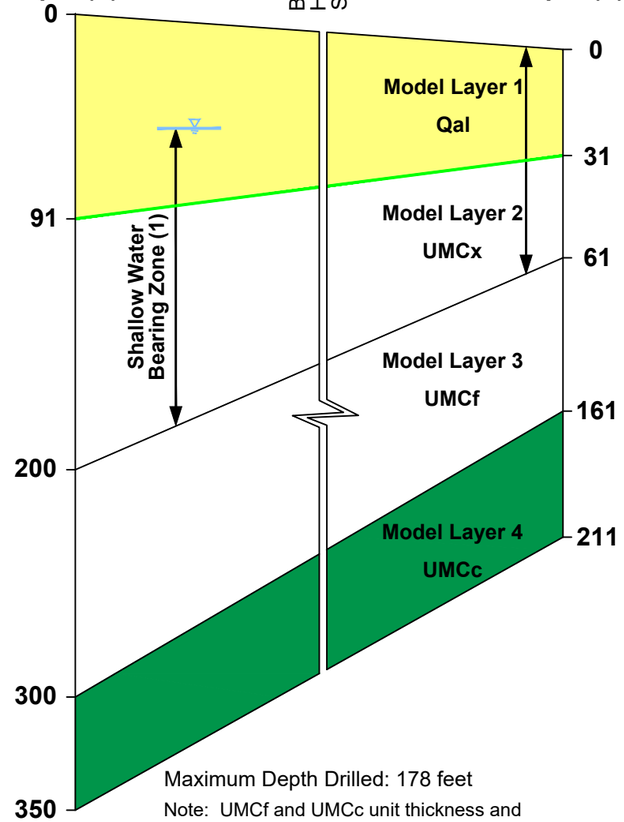


TRONOX



Maximum Depth Drilled: 312 feet

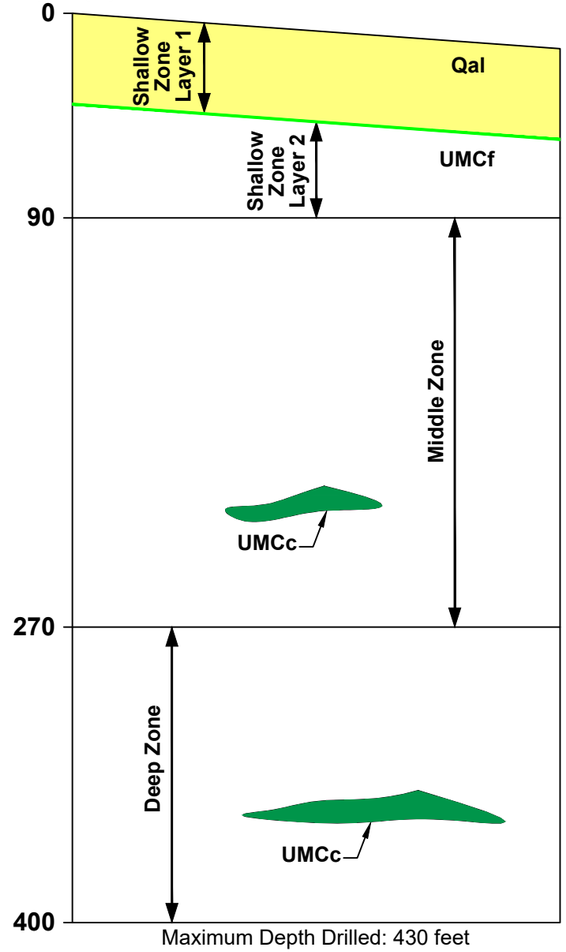
TIMET



Maximum Depth Drilled: 178 feet

Note: UMCf and UMCc unit thickness and extent assumed by Timet to be uniform as shown for Timet flow model construction

BRC



Maximum Depth Drilled: 430 feet

Notes:

1. Timet Shallow Water-bearing Zone also termed "water-table aquifer, first water-bearing zone, and near-surface aquifer" (Timet, 2008)
2. Not to scale
3. Not a cross-sectional diagram, schematic only
4. Qal may extend beyond 90 ft below grade at some locations
5. Qal – Quaternary alluvium
6. UMC – Tertiary Upper Muddy Creek Formation
7. UMCc – Tertiary Upper Muddy Creek Formation (coarse-grained facies)
8. UMCf – Tertiary Upper Muddy Creek Formation (fine-grained facies)
9. UMCx – Tertiary Upper Muddy Creek Formation (transitional zone)

Sources:

1. Revised Remedial Design for the First Water Bearing Zone, Titanium Metals Corporation Facility, Henderson, Nevada, October 14, 2009, Technical Addendum, Capture Zone Modeling – October, 2009, Attachment A - Groundwater Modeling Report
2. (Tronox)Tronox reference: Interim Groundwater Capture Evaluation and Vertical Delineation Report 2010

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 22
Schematic Diagram of Zones and Layers

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A SJR

Date 09-12-19

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South-Southwest
A

North-Northeast
A'

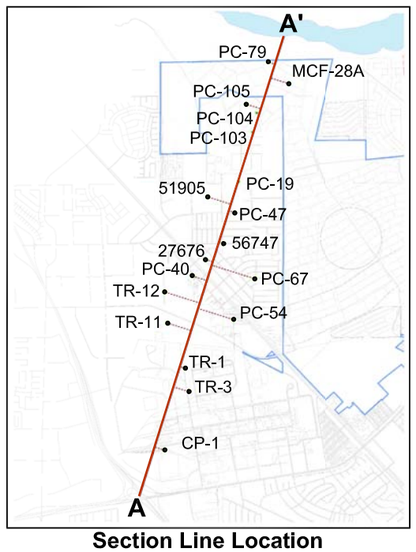
Plants Area | CAMU | Tronox | City of Henderson WRF | Pittman | Eastside - Hook Area | LVW

Elevation (ft msl)

2000
1850
1700
1550
1400
1250

Qal
TMC
Ash
E

CP-1 (438ft) 4/07 129'
TR-3 (684ft) 6/09 251.5'
TR-1 (212ft) 6/09 312'
TR-11 (1,086ft) 6/09 252'
PC-54 (1,610ft) 8/09 40'
TR-12 (1,622ft) 6/09 293'
PC-40 (691ft) 8/09 60'
PC-67 (1,946ft) 8/09 39'
56747 ** (74ft) 175'
PC-50 (244ft) 8/09 44'
51905 * (1,070ft) 800' 850' 910'
PC-19 (18ft) 8/09 60'
PC-103 (52ft) 12/09 30'
PC-104 (146ft) 8/09 36'
PC-105 (688ft) 64'
MCF-28A (813ft) 8/09 397'
PC-79 (292ft) 8/09 73'



Section Line Location

Vertical Scale: 1" = 150'
Horizontal Scale: 1" = 1500'
Vertical exaggeration = 10x

0 1500 ft

Explanation

- Well
- Water level (date measured)
- Well screen interval
- Contact between Qal and TMC
- Cemented
- Sand zone
- Evaporite zone (E)

MCF-28A (813ft) — Well Designation
397' — Total Depth
Projection Distance
Well
Break in Scale

Notes:

Qal	=	Quaternary Alluvium (Qal)
TMC	=	Tertiary Muddy Creek Formation
msl	=	Mean sea level
CAMU	=	Corrective Action Managment Unit
WRF	=	Water Reclamation Facility
LVW	=	Las Vegas Wash
*	=	Supply well, drilled by cable tool, 1942
**	=	Supply well installed 1953

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 23
CROSS SECTION
A-A'

Daniel B. Stephens & Associates, Inc.
Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-29-10

S:\Projects\BRC\ES09.0281_BRC_WH_and_Pre-CSM_Tasks\VR_Drawings\ES09_281_03CS_cross_section_AAbend.dwg

S:\Projects\BRC\ES10.0136_BRC_Misc_Eastside_Tasks\VR_Drawings\ES10_0136_cross_section_A-A'.dwg

South-Southeast B — Eastside - Main — Eastside - Hook Area — North-Northeast B'

Elevation (ft msl): 2000, 1850, 1700, 1550, 1400, 1250

Qal

TMC

AA-UW4 — 8/09 — 80' — 90.4 J (8/09)

AA-13 (586ft) — 8/09 — 98.5' — 57 (8/09)

AA-14 — 8/09 — 108.5' — 67.8 (9/09)

POD-8 (246ft) — 8/09 — 74'

MCF-24A (999ft) — 375'

AA-15 (589ft) — 8/09 — 78.5' — 77.8 (8/09)

BEC-9 (1,155ft) — 8/09 — 60.3'

AA-19 (857ft) — Dry — 8/09 — 98.5' — 107 (9/09)

AA-20 (584ft) — Dry — 8/09 — 77.5' — 98.6 (9/09)

Bend in Section

DM-4 (203ft) — DBMW-3 — 26' — 40'

PC-2 (1,105ft) — DBMW-4 (750ft) — PC-4 (444ft) — 8/09 — 35' — 40' — 45' — 103 (8/09) — 96.9 J (9/09) — 64 (8/09)

DBMW-19 (423ft) — 8/09 — 40' — 52.1 J (9/09)

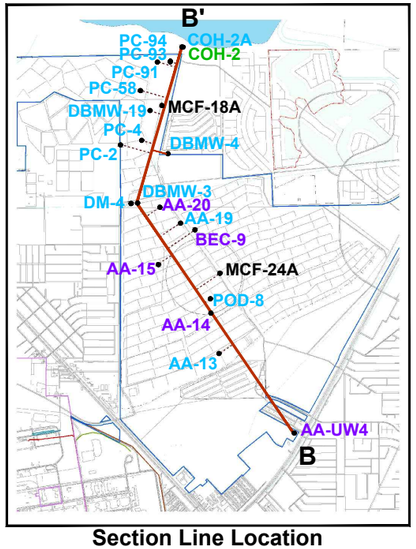
MCF-18A (109ft) — PC-58 (976ft) — 8/09 — 36' — 402.5'

PC-91 (666ft) — PC-93 (236ft) — PC-94 (236ft) — 5/09 — 8/09 — 12/09 — 8/09 — 45' — 38' — 25' — 65.5 (9/09) — 33.8 J (8/09)

COH-2 — COH-2A (310ft) — 8/09 — 50' — 170.1' — 51.9 (9/09)

Vertical Scale: 1" = 150'
Horizontal Scale: 1" = 1500'
Vertical exaggeration = 10x

0 1500 ft



Section Line Location

Explanation

- Well or boring
- Shallow Zone groundwater elevation (date measured)
- Middle Zone groundwater elevation (date measured)
- Well screen interval
- Contact between Qal and TMC
- 25.3 (9/09) — Arsenic result (ug/L) (date measured)
- AA-09 — Shallow Zone Monitoring well (layer 1)
- MW-3 — Shallow Zone Monitoring well (layer 2)
- MCF-01B — Middle Zone Monitoring well
- MCF-01A — Deep Zone Monitoring well

MCF-18A (109ft) — Well or boring Designation
Projection Distance
Well or boring
402.5' — Total Depth

Notes:

Qal = Quaternary Alluvium (Qal)
TMC = Tertiary Muddy Creek Formation
msl = Mean sea level
LVW = Las Vegas Wash

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 24
Cross Section
B-B'

Daniel B. Stephens & Associates, Inc.
Basic Remediation Company

Prepared by: DBS&A SJR
Date 11-12-19

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South C

City of Henderson

Tronox

City of Henderson WRF

Eastside - Hook Area

North C'

DBSA1 (90.5')

DBSA2 (529ft) (80')

DBSA4 (505ft) (160')

DBSA9 (335ft) (160')

TR-9 (315ft) (250.5')

TR-7 (797ft) (292')

TR-5 (506ft) (253')

TR-3 (226ft) (251.5')

TR-1 (312')

Bend in Section

TR-11 (743ft) (252')

TR-12 (877ft) (293')

PC-40 (314ft) (60')

51909 (385ft) (805')

51905 * (1,004ft) (860')

MCF-10A (219ft) (400')

MCF-17A (297ft) (392')

AA-21 (45')

Qal

TMC

Ash

Elevation (ft msl)

2150
2000
1850
1700
1550
1400
1250
1100

5/09
6/09
8/09
8/09 Artesian

E

Continued this sheet

Vertical Scale: 1" = 150'
Horizontal Scale: 1" = 1500'
Vertical exaggeration = 10x

0 1500 ft

Explanation

- Well
- Water level (date measured)
- Well screen interval
- Contact between Qal and TMC
- Cemented
- Sand zone
- Evaporite zone (E)

MCF-10A (219ft) 400'

- Projection Distance
- Well Designation
- Well
- Break in Scale
- Total Depth

Notes:

Qal = Quaternary Alluvium (Qal)
TMC = Tertiary Muddy Creek Formation
msl = Mean sea level
WRF = Water Reclamation Facility
* = Supply well, drilled by cable tool, 1942

C' AA-21 MCF-17A MCF-10A 51905 51909 PC-40 TR-12 TR-11 TR-1 TR-3 TR-5 TR-7 TR-9 DBSA9 DBSA4 DBSA2 DBSA1 C

Section Line Location

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 25
CROSS SECTION
C-C'

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A SJR

Date 11-8-19

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West

D

East

D'

AA-21

AA-08

MCF-08B-R

MCF-28B (449ft)

DBMW-19

Average Alluvium thickness = 43 feet

CITY OF HENDERSON, NEVADA TREATED WASTEWATER INFILTRATION PONDS (ESTIMATED DEPTH)

Qal

Qal

Qal

TMC

TMC

TMC

45'

37'

137.5'

397'

40'

Elevation (ft msl)

1600

1550

1500

1450

1400

Feet Below Grade

0

-50

-100

-150

-200

Vertical Scale: 1" = 50'
Horizontal Scale: 1" = 500'
Vertical exaggeration = 10x

0 500 ft

Explanation

- Well
- Water level July 2009
- Well screen interval
- Contact between Qal and TMC
- Shallow Groundwater Potentiometric Surface

MCF-28B (449ft)

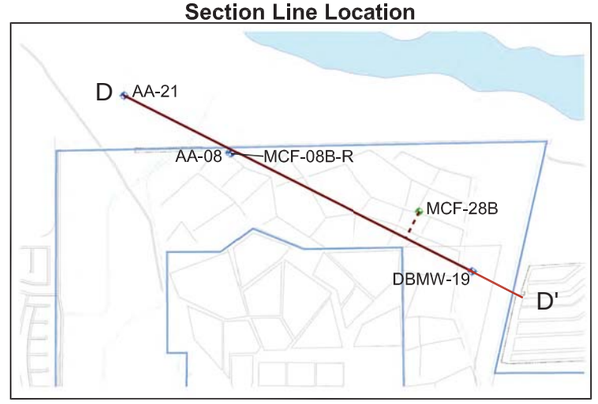
397'

- Projection Distance
- Well Designation
- Well
- Break in Scale
- Total Depth

Notes:

Qal = Quaternary Alluvium (Qal)
TMC = Tertiary Muddy Creek Formation
msl = Mean sea level

Section Line Location



BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 26
CROSS SECTION
D-D'

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A KDB	04-12-10	S:Projects/BRC\ES09.0281_BRC_WH_and_Pre-CSM_Tasks\VR_Drawings\ES09_281_03CS_cross_section_AAbend.dwg

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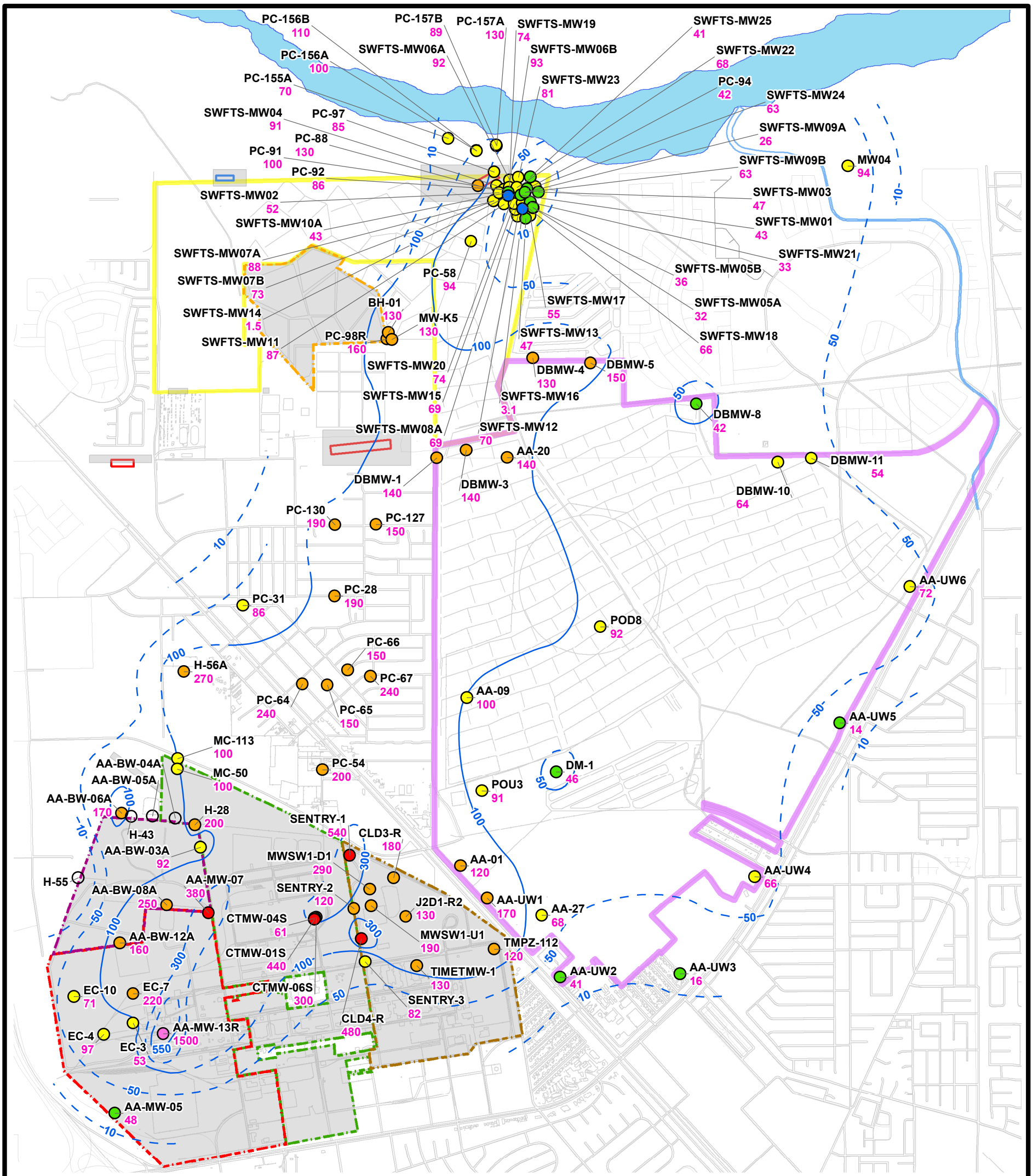


Explanation

Arsenic layer 1 result

- ND
- ≤ 10
- 11 - 50
- 51 - 100
- 101 - 300
- 301 - 550
- > 550

EC-4 Well name
97 Result

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Quaternary alluvium (Qal) wells.
2. Layer 1 = Shallow Zone Qal wells
3. Detection limits range from 0.5 to 200 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Arsenic, inorganic: 10.0 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015, 2018, 2020 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

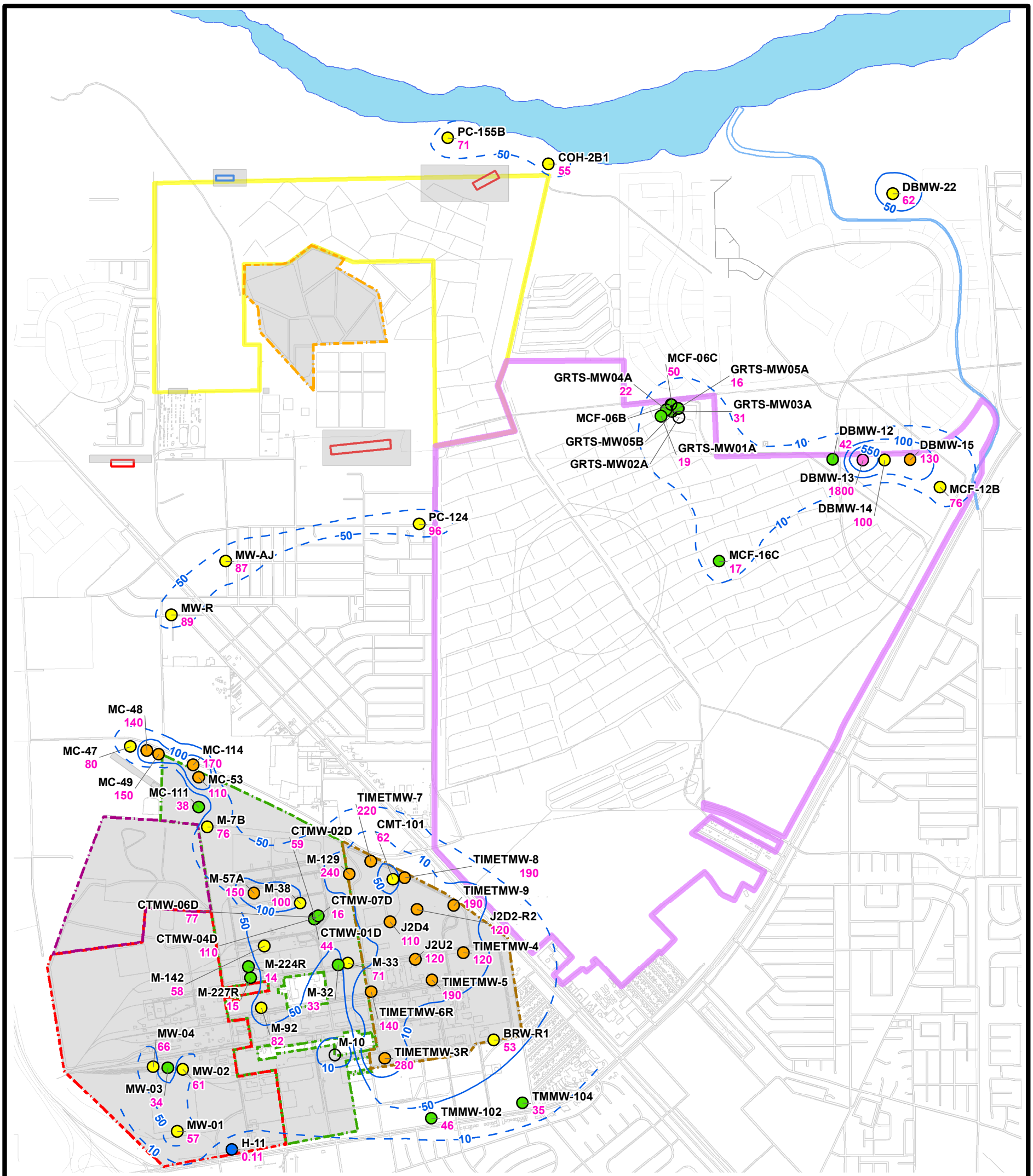
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 27A
Arsenic Map
Layer 1

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig27a_BRC_Arsenic_Layer1_Anno



Explanation

Arsenic layer 2 result

- ND
- ≤ 10
- 11 - 50
- 51 - 100
- 101 - 300
- 301 - 550
- > 550

H-11 Well name
0.11 Result

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Upper Muddy Creek Formation (UMCf) wells, transitional Muddy Creek Formation (xMCF) wells, and Quaternary alluvium (Qal) wells with UMCf/xMCF.
2. Layer 2 = Shallow Zone UMCf, xMCF, and Qal/UMCf/xMCF wells
3. Detection limits range from 0.5 to 200 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Arsenic, inorganic: 10.0 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015, 2018, 2020 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

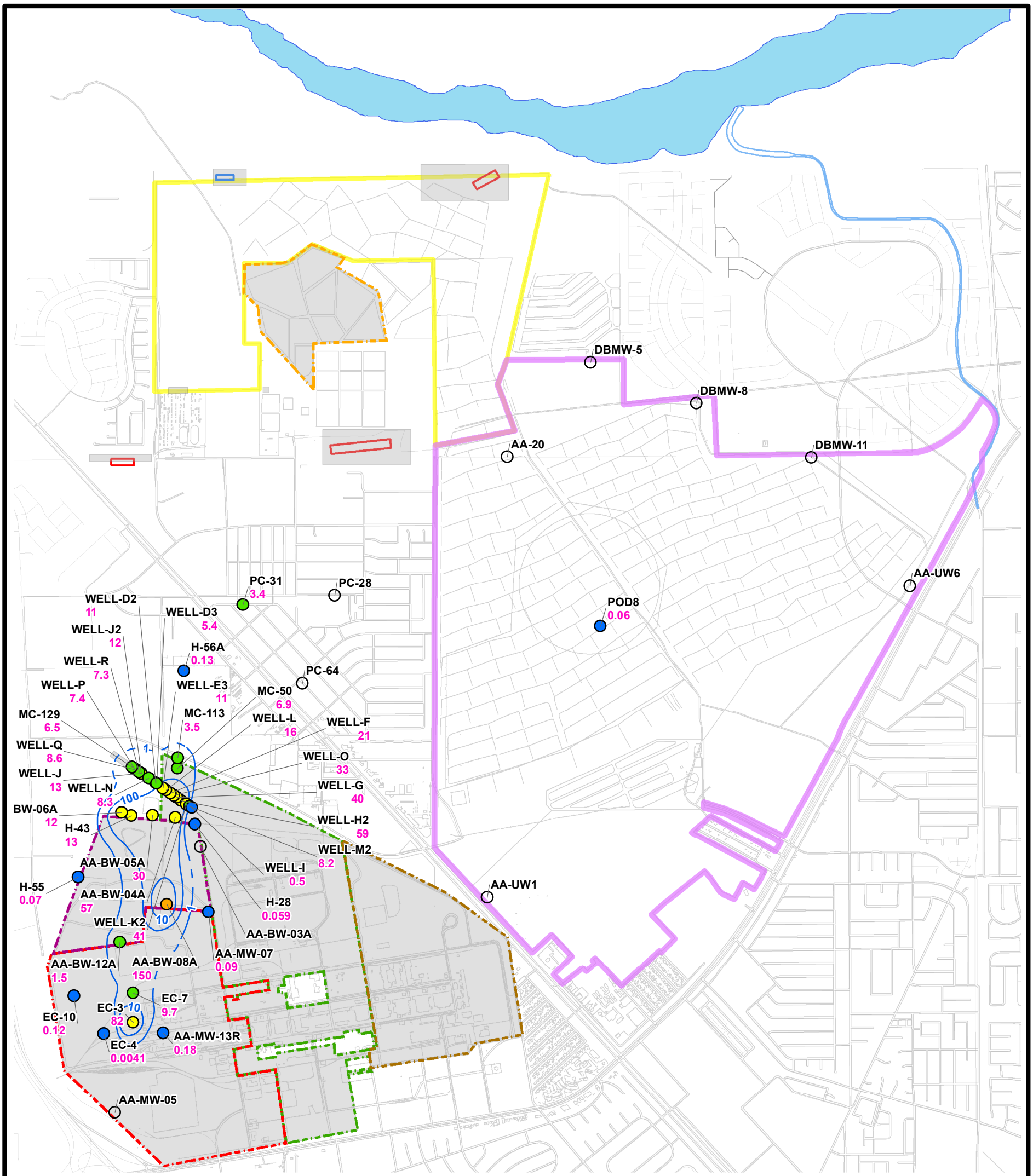
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 27B
Arsenic Map
Layer 2

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig27b_BRC_Arsenic_Layer2_Anno



Explanation

Beta-BHC layer 1 result

- ND
- ≤ 1
- 2 - 10
- 11 - 100
- > 100

EC-3 Well name
82 Result

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Quaternary alluvium (Qal) wells.
2. Layer 1 = Shallow Zone Qal wells
3. Detection limits range from 0.0038 to 0.014 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Hexachlorocyclohexane, beta (bBHC): 2.00 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015 and 2020 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

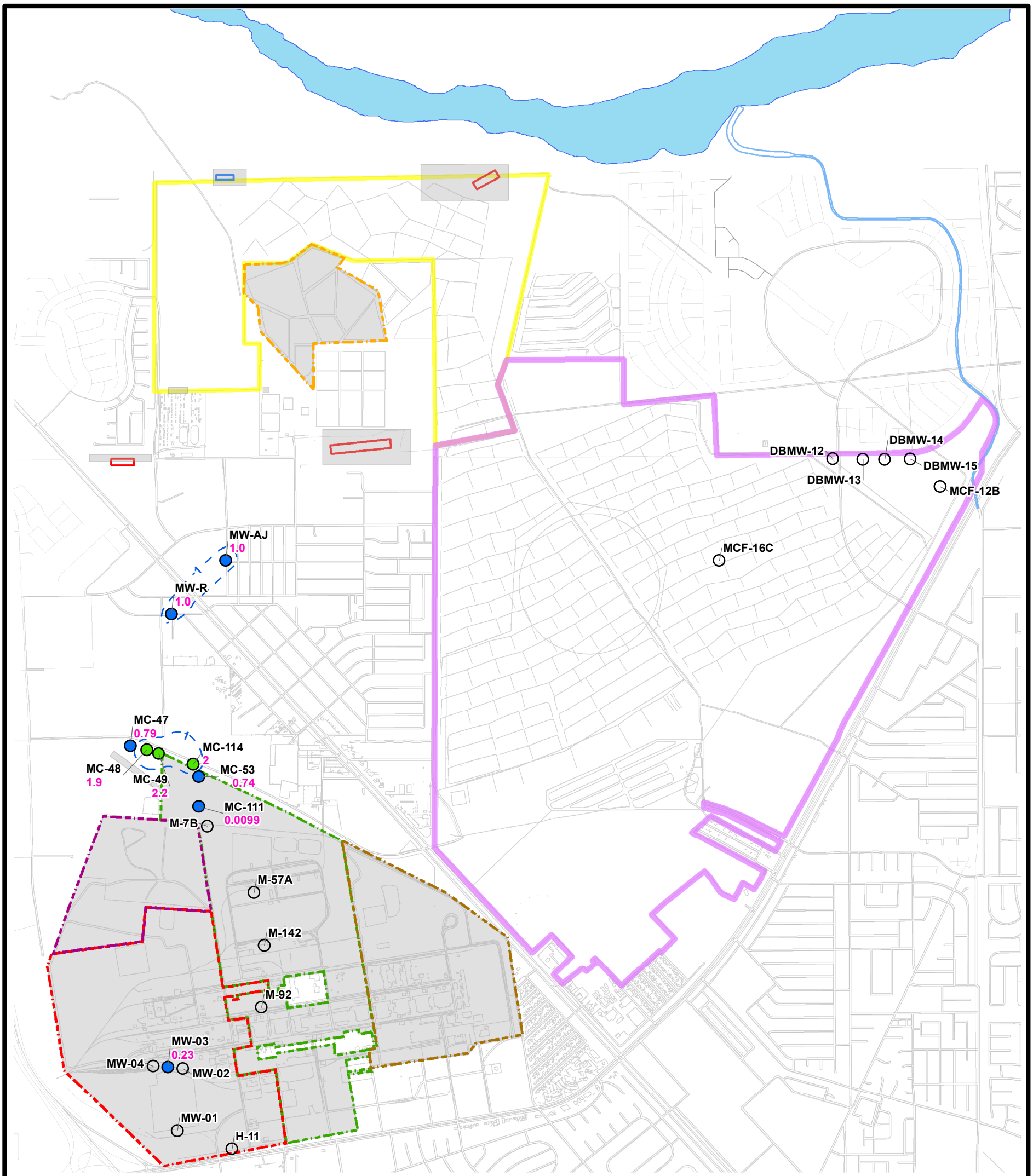
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 28A
Beta-BHC Map
Layer 1

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig28a_BRC_bBHC_Layer1_Anno



Explanation

Beta-BHC layer 2 result

- ND
- ≤ 1
- 2 - 10
- 11 - 100
- > 100

MW-R Well name
1.0 Result

- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Upper Muddy Creek Formation (UMCf) wells, transitional Muddy Creek Formation (xMCF) wells, and Quaternary alluvium (Qal) wells with UMCf/xMCF.
2. Layer 2 = Shallow Zone UMCf, xMCF, and Qal/UMCf/xMCF wells
3. Detection limits range from 0.0038 to 0.014 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Hexachlorocyclohexane, beta (bBHC): 2.00 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015 and 2020 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

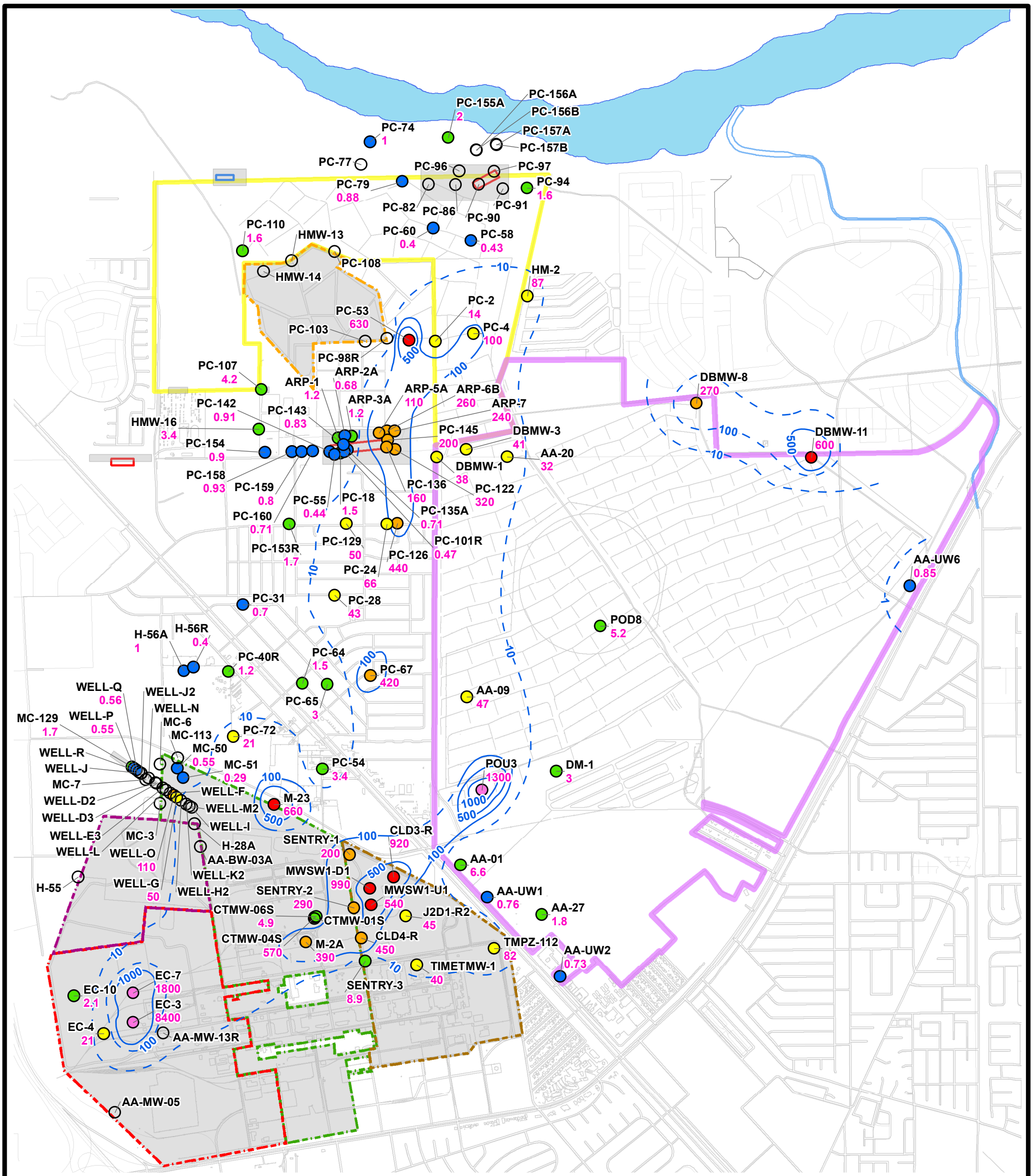
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 28B
Beta-BHC Map
Layer 2

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig28b_BRC_bBHC_Layer2_Anno



Explanation

Chloroform layer 1 result

- ND
- ≤ 1
- 2 - 10
- 11 - 100
- 101 - 500
- 501 - 1000
- > 1000

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

EC-4 Well name
21 Result

N

0 1250 2500 Feet

Notes:
1. Data posted for Shallow Zone Quaternary alluvium (Qal) wells.
2. Layer 1 = Shallow Zone Qal wells
3. Detection limits range from 0.23 to 50 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Chloroform: 70.0 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015, 2018, 2019 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

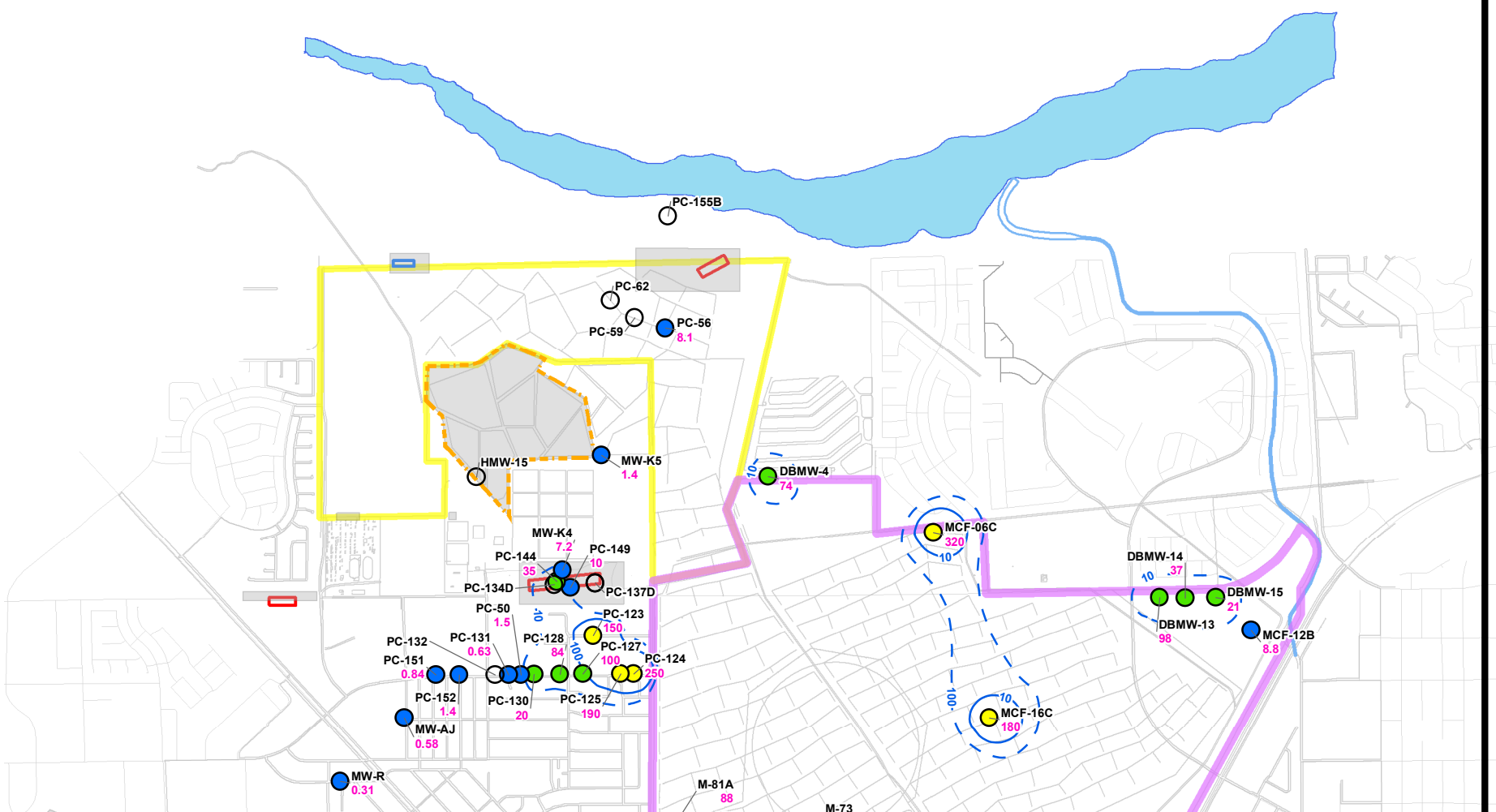
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 29A
Chloroform Map
Layer 1

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig29a_Chloroform_Layer1_Anno



Explanation

Chloroform layer 2 result

- ND
- ≤ 10
- 11 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 - 15,000
- > 15,000

TR-6 Well name
750 Result

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Upper Muddy Creek Formation (UMCf) wells, transitional Muddy Creek Formation (xMCF) wells, and Quaternary alluvium (Qal) wells with UMCf/xMCF.
2. Layer 2 = Shallow Zone UMCf, xMCF, and Qal/UMCf/xMCF wells.
3. Detection limits range from 0.23 to 1.2 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Chloroform: 70.0 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015, 2018, 2019 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 29B (1)
Chloroform Map
(Labeled) Layer 2

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by: DBS&A

Date 5/25/2023

C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig29b_Chloroform_Layer2_1_Anno

Explanation

Chloroform layer 2 result

- ND
- ≤ 10
- 11 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 - 15,000
- > 15,000

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area

- Extraction well field
- Injection well field
- Las Vegas Wash
- External features

- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Upper Muddy Creek Formation (UMCf) wells, transitional Muddy Creek Formation (xMCF) wells, and Quaternary alluvium (Qal) wells with UMCf/xMCF.
2. Layer 2 = Shallow Zone UMCf, xMCF, and Qal/UMCf/xMCF wells.
3. Detection limits range from 0.23 to 1.2 ug/L
4. ug/L = micrograms per liter
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Chloroform: 70.0 ug/L (residential water)
6. Data downloaded from Neptune BMI database for 2015, 2018, 2019 sampling events.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

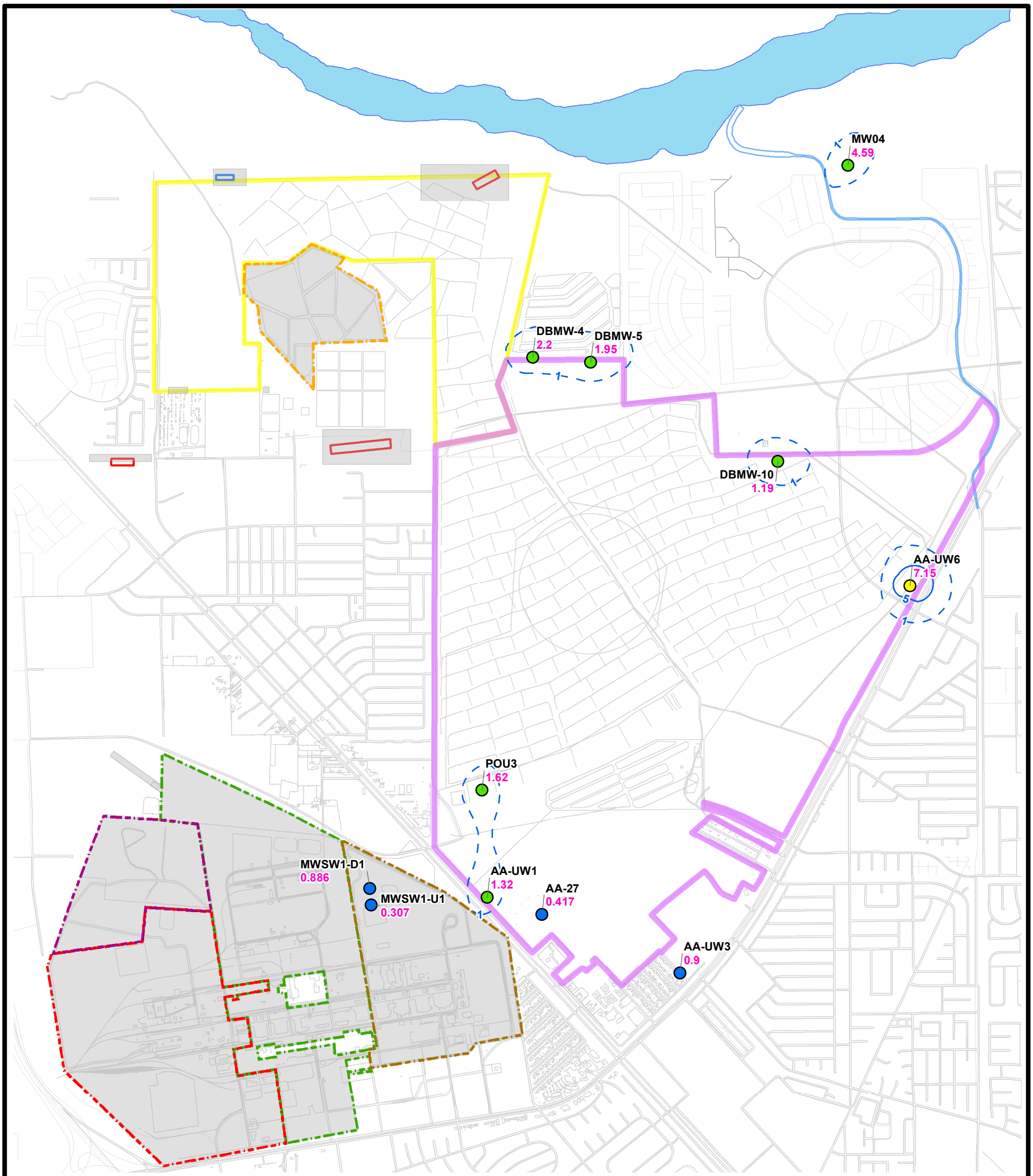
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 29B (2)
Chloroform Map
(Unlabeled) Layer 2

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/25/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig29b_Chloroform_Layer2_2_Anno



Explanation

Radium layer 1 result

- ND
- ≤ 1
- 2 - 5
- 6 - 10
- > 10

M-10 Well name
0.149 Result

- Contour
- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Quaternary alluvium (Qal) wells.
2. Layer 1 = Shallow Zone Qal wells
3. pCi/L = picocuries per liter
4. Radium = Radium 226 + Radium 228
5. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Radium: not listed.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

Draft

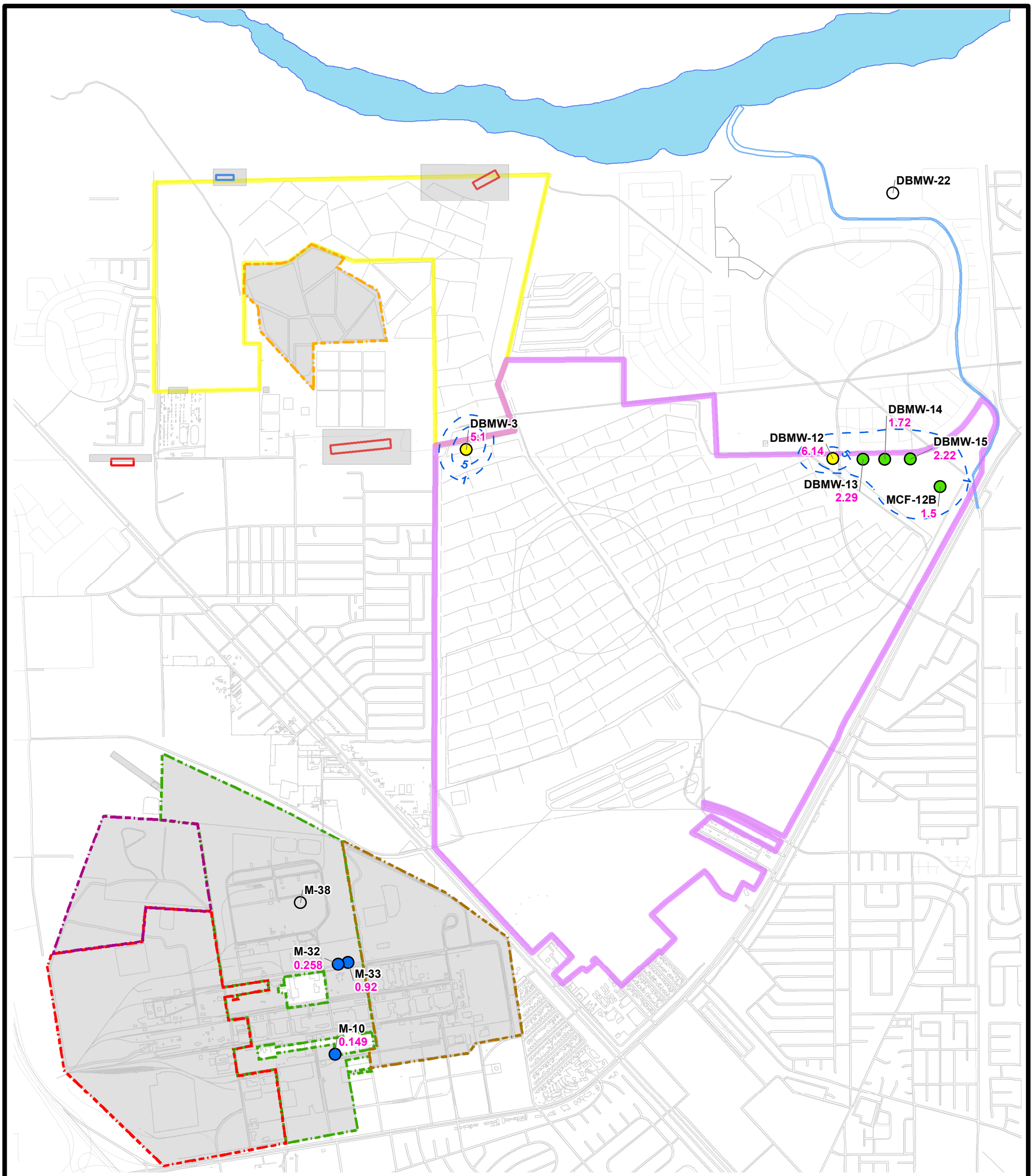
BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 30A
Radium Map
Layer 1

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/17/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig30a_BRC_Ra226_Layer1_Anno



Explanation

Radium layer 2 result

- ND
- ≤ 1
- 2 - 5
- 6 - 10
- > 10

M-10 Well name
0.149 Result

- Contour (inferred)
- Eastside Hook area
- Eastside Main area
- Extraction well field
- Injection well field
- Las Vegas Wash
- External features
- BRC CAMU
- City of Henderson Bird Viewing Preserve
- NERT Site
- Olin Corporation
- TIMET

Notes:
1. Data posted for Shallow Zone Upper Muddy Creek Formation (UMCf) wells, transitional Muddy Creek Formation (xMCF) wells, and Quaternary alluvium (Qal) wells with UMCf/xMCF.
2. Layer 2 = Shallow Zone UMCf, xMCF, and Qal/UMCf/xMCF wells
3. Detection limits range from 0.2302 to 1.617 pCi/L
4. pCi/L = picocuries per liter
5. Radium = Radium 226 + Radium 228
6. Nevada Department of Environmental Protection (NDEP) Basic Comparison Level (BCL) for Radium: not listed.

Source:
1. https://ndep.nv.gov/resources/risk-assessment-and-toxicology-basic-comparison-levels

N

0 1250 2500 Feet

Draft

BMI Common Areas (Western Hook)
Henderson, Nevada

FIGURE 30B
Radium Map
Layer 2

DBS&A a Geo-Logic Company

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A	5/17/2023	C:\Users\1294\Documents\ArcGIS\Projects\ArcMap\BRC Western Hook\Fig30b_BRC_Ra226_Layer2_Anno

Highlands Precipitation

Airborne Dispersion

McCullough and River Mtn. Ranges

Runoff and Recharge

BMI Complex

Western Ditch

Active Trade Effluent Ponds

Northwest Ditch

Kerr McGee Seep

Western Hook

Waste

Boulder Hwy.

Pabco Rd.

Beta Ditch

Alpha Ditch

Surface Runoff

Surface Runoff

Lower Ponds

Wastewater Pond

Upper Ponds

Lake Mead Drive

Beta Ditch

Direction of Upper Zone Groundwater Flow

Qa

TMCf

Downward Gradient

Groundwater mounding

Infiltration

Las Vegas Wash sediments

Las Vegas Wash

~400 ft

Inferred Direction of Deep Zone Groundwater Flow

Upward Gradient

Alluvial Aquifer

Sporadic water-bearing sandy lenses (under pressure)

Deep Zone Aquifer

Explanation

- Water movement
- Chemical waste movement
- Water and chemical seep
- Water and chemical infiltration
- Pond evaporation
- Airborne dispersion
- Primary area of effluent disposal
- Las Vegas Wash impacted by chemicals
- Residential and related development

Notes:

- Features represented are conceptual and not exact as to scale or precise location
- Construction of the BMI Upper and Lower Ponds, Alpha and Beta Ditches, and Pabco Road (under construction) was completed during the end of 1942, beginning 1943 time frame.
- Historic aerial photos indicate that effluent disposal was confined primarily to the first eight rows of the Upper Ponds area, the Lower Ponds area, and seepage adjacent to the Beta Ditch along its length.
- Residential development in the Site vicinity increased between circa 1943 and circa 1968. Historical aerial photos indicate that some mobile home parks were removed while permanent housing increased.
- During this period, effluent disposal was transferred from Grade Effluent Ponds to Upper and Lower Ponds.

BMI Common Areas (Eastside)
Henderson, Nevada

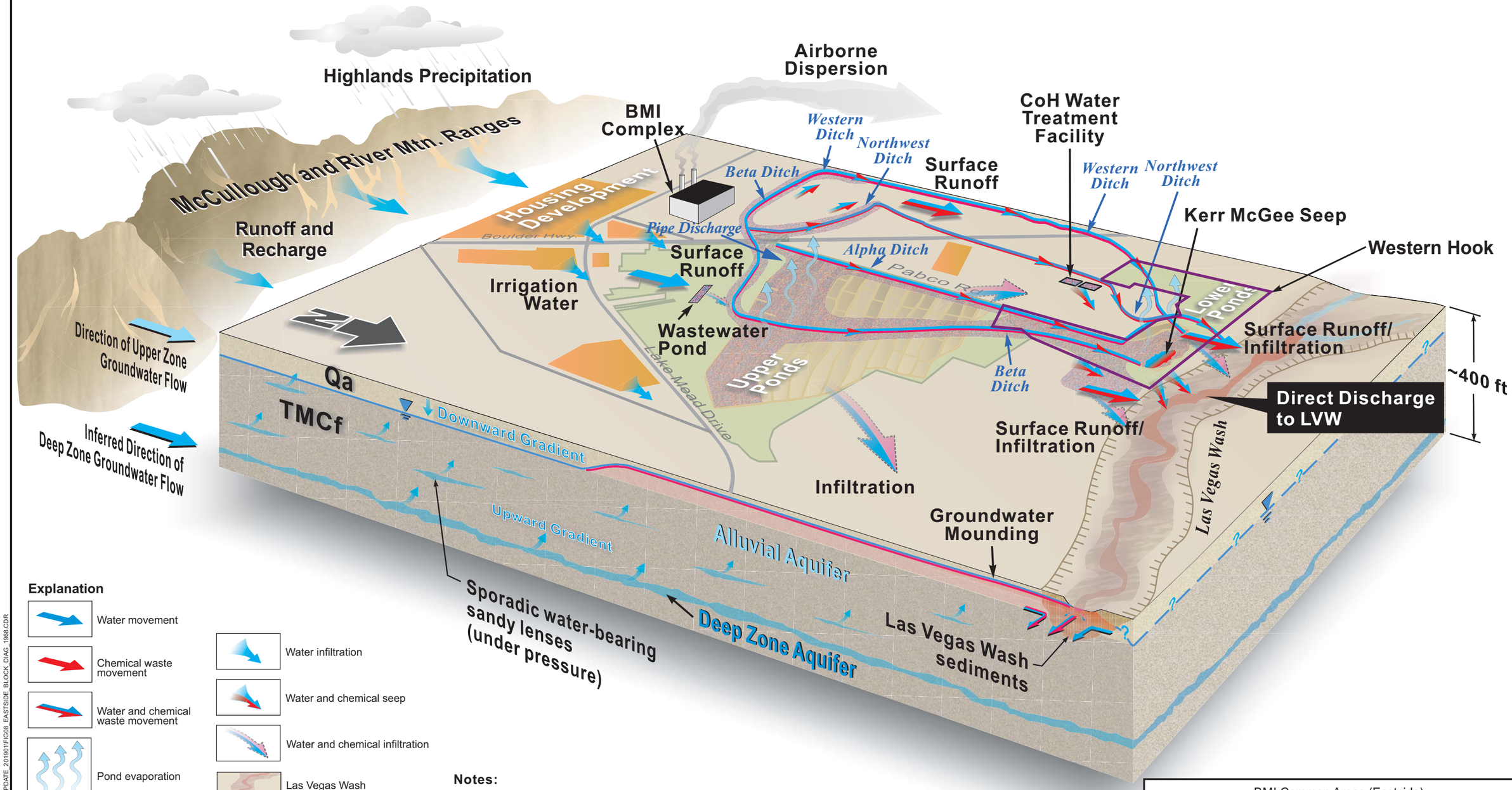
FIGURE 31
Conceptual Diagram
Western Hook Area Circa 1943

Daniel B. Stephens & Associates, Inc.
Basic Remediation COMPANY

Prepared by: DBS&A DCC
Date 11-07-19

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG07_EASTSIDE_BLOCK_DIAG_1943.CDR

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG07_EASTSIDE_BLOCK_DIAG_1943.CDR



Explanation

- Water movement
- Chemical waste movement
- Water and chemical waste movement
- Pond evaporation
- Airborne dispersion
- Water infiltration
- Water and chemical seep
- Water and chemical infiltration
- Las Vegas Wash impacted by chemicals
- Residential and related development

Notes:

- Features represented are conceptual and not exact as to scale or precise location
- Historic aerial photos indicate that effluent disposal was confined primarily to the first eight rows of the Upper Ponds area, the Lower Ponds area, and seepage adjacent to the Alpha and Beta Ditches along their length.
- Preliminary analytic modeling indicates that mounding of the water table aquifer would have occurred as the result of infiltration beneath evaporation and wastewater ponds. This groundwater mounding would have similarly occurred beneath infiltrating ponds throughout the BMI Complex.

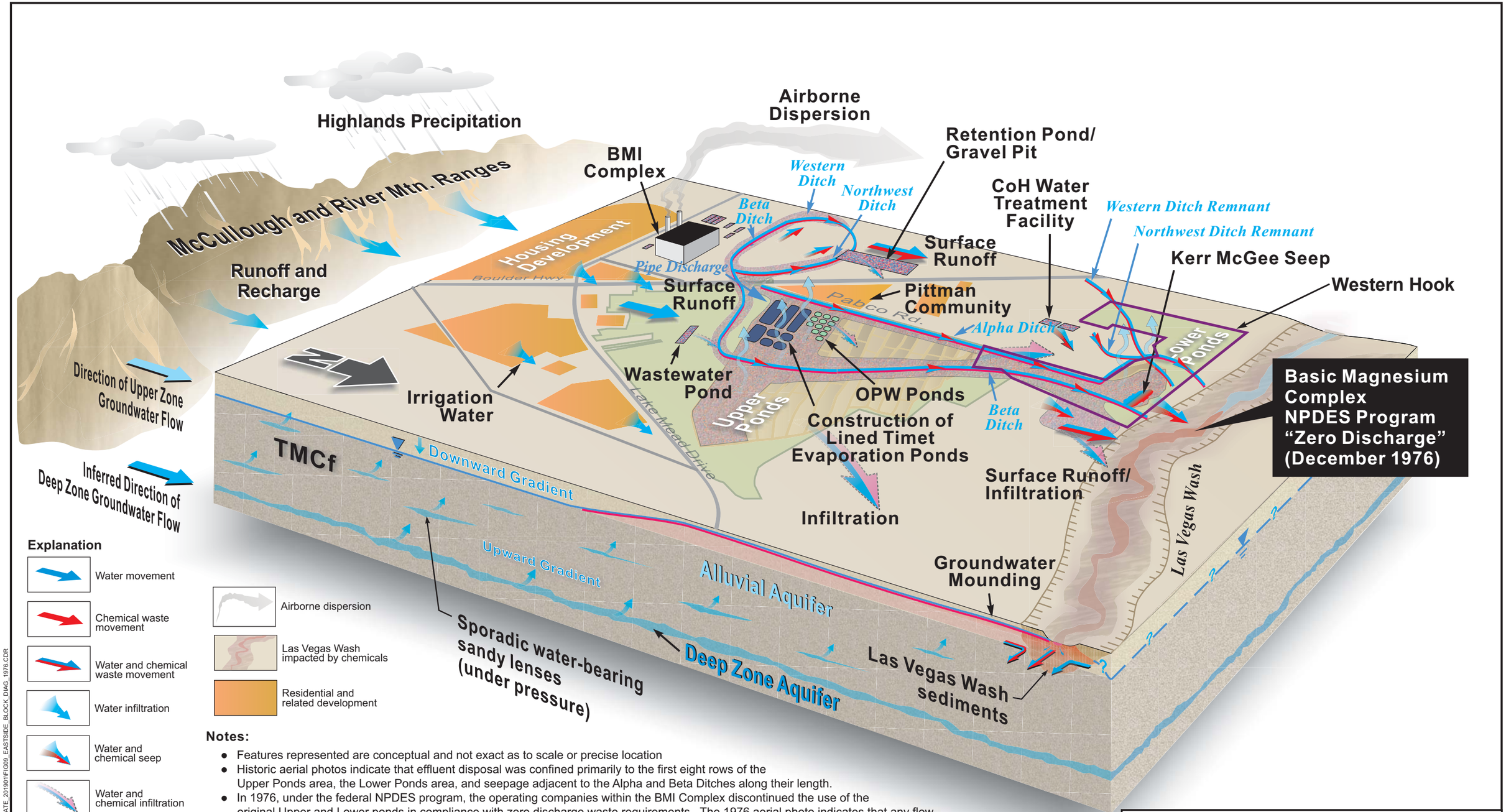
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 32
Conceptual Diagram
Western Hook Area Circa 1968

Daniel B. Stephens & Associates, Inc.
Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 03-08-19

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG08_EASTSIDE_BLOCK_DIAG_1968.CDR



Notes:

- Features represented are conceptual and not exact as to scale or precise location
- Historic aerial photos indicate that effluent disposal was confined primarily to the first eight rows of the Upper Ponds area, the Lower Ponds area, and seepage adjacent to the Alpha and Beta Ditches along their length.
- In 1976, under the federal NPDES program, the operating companies within the BMI Complex discontinued the use of the original Upper and Lower ponds in compliance with zero discharge waste requirements. The 1976 aerial photo indicates that any flow in the Western and Northwestern Ditches were intercepted by a feature that appears to be a gravel pit and/or retention basin.
- TIMET began construction of a set of lined evaporation ponds in 1976. By 1980, nine evaporation ponds were constructed and in use. They were taken out of service in May, 2005.
- The "OPW" ponds were installed by TIMET around the mid-1970s and in use by 1980. These were reportedly unlined ponds. They were all formally taken out of service in 2005.
- Preliminary analytic modeling indicates that mounding of the water table aquifer would have occurred as the result of infiltration beneath the evaporation and wastewater ponds. This groundwater mounding would have similarly occurred beneath infiltrating ponds throughout the BMI Complex.
- All operating effluent ponds and ditches lined in accordance with NPDES Permit.

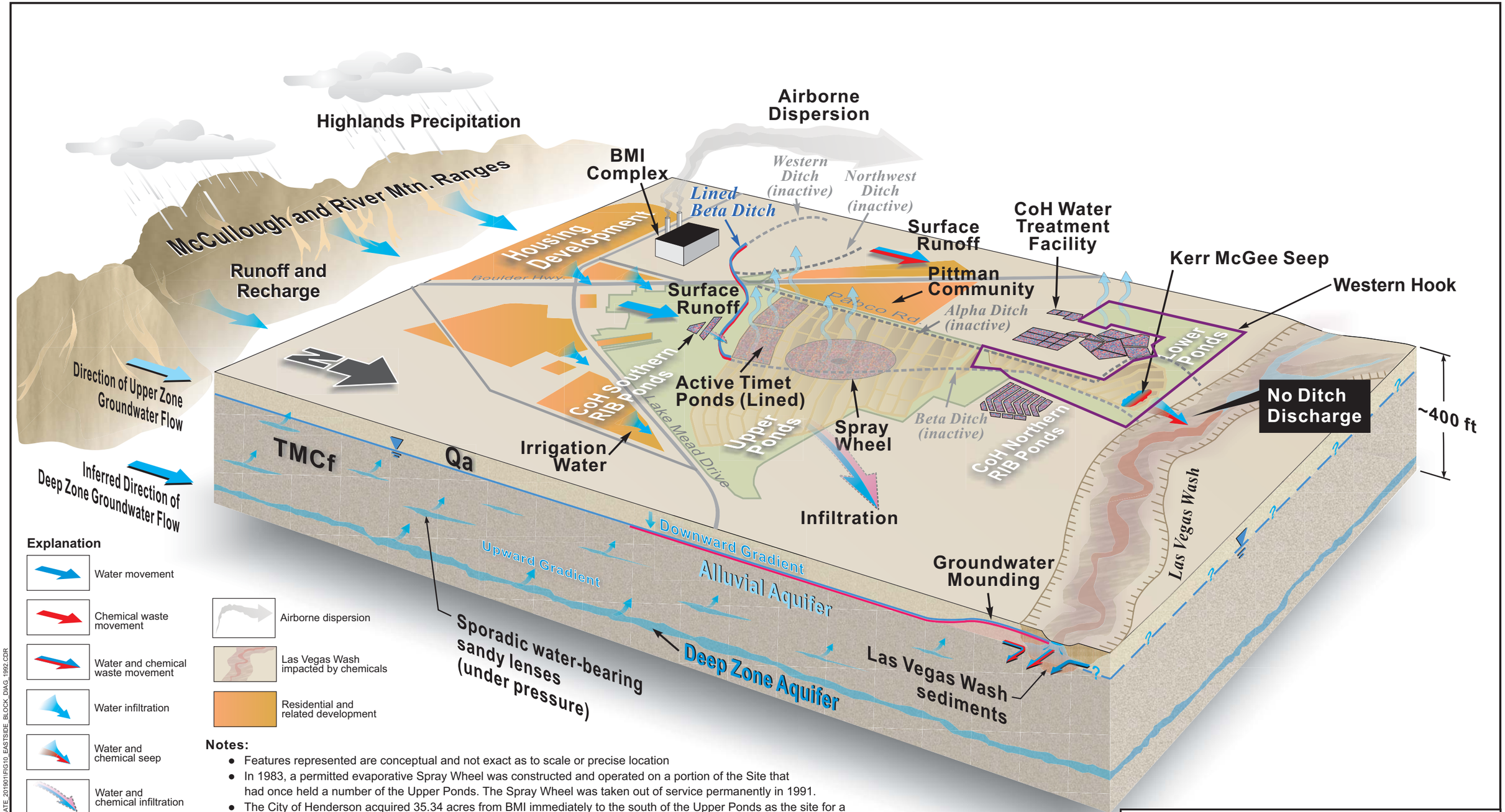
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 33
Conceptual Diagram
Western Hook Area Circa 1976

Daniel B. Stephens & Associates, Inc.
Basic Remediation COMPANY

Prepared by:	Date	
DBS&A DCC	11-07-19	S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG09_EASTSIDE_BLOCK_DIAG_1976.CDR

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG09_EASTSIDE_BLOCK_DIAG_1976.CDR



Explanation

- Water movement
- Chemical waste movement
- Water and chemical waste movement
- Water infiltration
- Water and chemical seep
- Water and chemical infiltration
- Pond evaporation
- Airborne dispersion
- Las Vegas Wash impacted by chemicals
- Residential and related development

Notes:

- Features represented are conceptual and not exact as to scale or precise location
- In 1983, a permitted evaporative Spray Wheel was constructed and operated on a portion of the Site that had once held a number of the Upper Ponds. The Spray Wheel was taken out of service permanently in 1991.
- The City of Henderson acquired 35.34 acres from BMI immediately to the south of the Upper Ponds as the site for a municipal wastewater injection facility (the Rapid Infiltration Basins [RIBs]), which was in operation from 1992 to at least 2002. The Northern RIBs first appear on the aerial photos in 1987.
- On October 6, 2003, as a part of a land exchange, the City of Henderson acquired approximately 101.6 acres generally located adjacent and southwest of the Lower Ponds from BMI for the construction of a wastewater treatment facility (WRF).
- Preliminary analytic modeling indicates that mounding of the water table aquifer would have occurred as the result of infiltration beneath the Rapid Infiltration Basins (RIBs). This groundwater mounding would have similarly occurred beneath infiltrating ponds (and possibly beneath the spray wheel) throughout the BMI Complex.
- All operating effluent ponds and ditches lined in accordance with NPDES Permit.

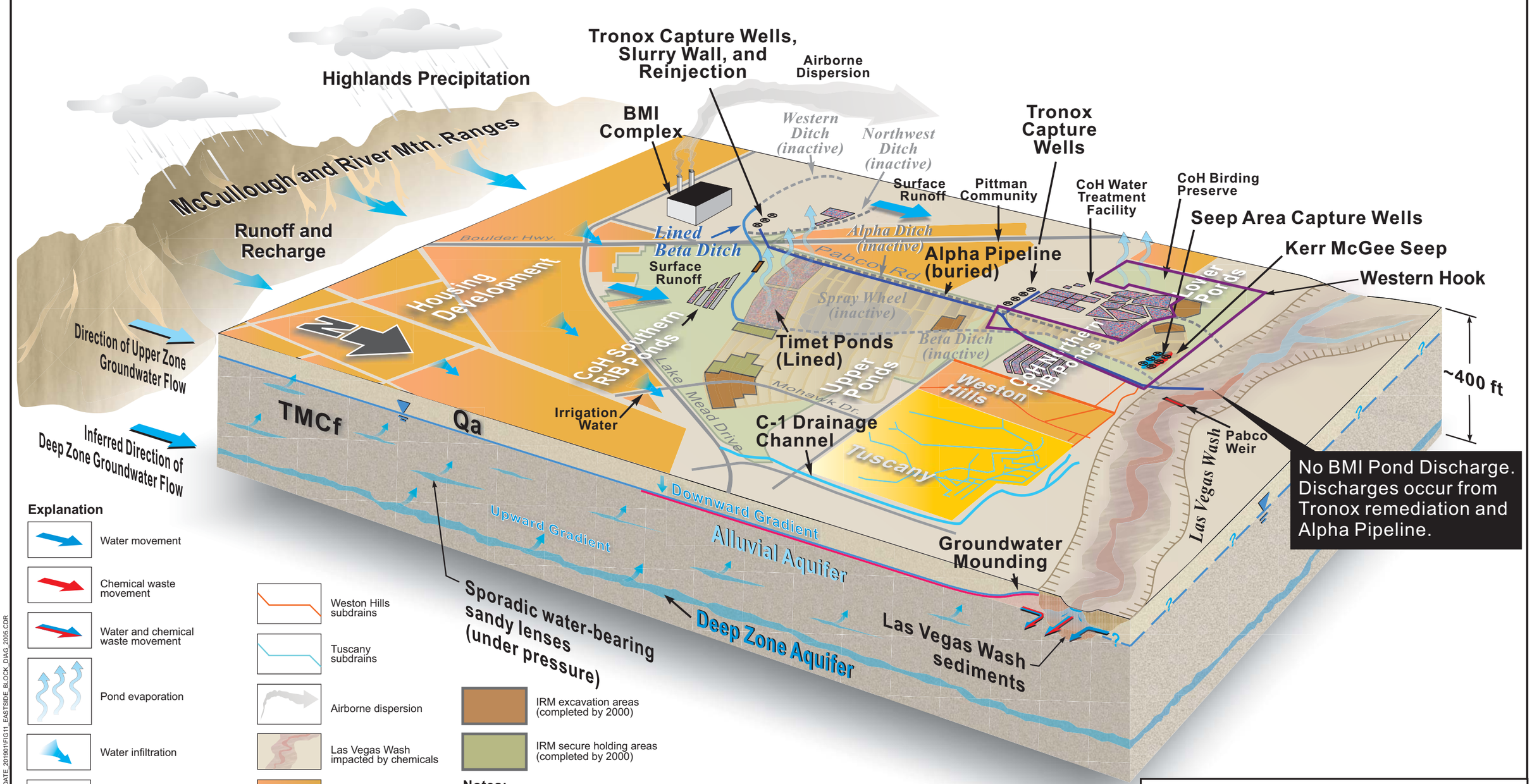
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 34
Conceptual Diagram
Western Hook Area Circa 1992

Daniel B. Stephens & Associates, Inc. | Basic Remediation COMPANY

Prepared by: DBS&A DCC | Date 11-07-19 | S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG10_EASTSIDE_BLOCK_DIAG_1992.CDR

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG10_EASTSIDE_BLOCK_DIAG_1992.CDR



Explanation

- Water movement
- Chemical waste movement
- Water and chemical waste movement
- Pond evaporation
- Water infiltration
- Water and chemical seep
- Water and chemical infiltration
- Weston Hills subdrains
- Tuscany subdrains
- Airborne dispersion
- Las Vegas Wash impacted by chemicals
- Residential and related development
- Residential and golf course
- IRM excavation areas (completed by 2000)
- IRM secure holding areas (completed by 2000)

Notes:

- Features represented are conceptual and not exact as to scale or precise location
- By 1980, nine TIMET lined evaporation ponds were in use. They were taken out of service in May, 2005.
- Subdrains are located beneath the Tuscany and Weston Hills Residential Developments
- Tronox Chrome Treatment Line (CTL) wells began operation January, 1999; Tronox Plant slurry wall was installed October, 2001; Tronox Athens Road wells and Alpha Pipeline became fully operational October, 2002; Tronox Seep capture began November, 1999.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 35
Conceptual Diagram
Western Hook Area Circa 2005

Daniel B. Stephens & Associates, Inc. | Basic Remediation Company

Prepared by:	Date	
DBS&A DCC	11-07-19	S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG07_EASTSIDE_BLOCK_DIAG_1943.CDR

S:\PROJECTS\BRC\GIS\VR_DRAWINGS\UPDATE_201901\FIG11_EASTSIDE_BLOCK_DIAG_2005.CDR

Tables

Table 1. Isotopic Data Results Summary
BMI Common Areas Groundwater Sampling
April–July 2008 and August–September 2009

Location	Well	Water Bearing Zone	Screen Interval (ft bgs)		Date	δ^2D [a] (‰)	$\delta^{18}O$ [b] (‰)	Tritium (TU)
			Top	Bottom				
Western Hook	AA-08	Shallow	5	35	5/16/2008	–98.4	–13.24	5.18
	MCF-08B-R	Middle	116.5	136.5	7/23/2008	–100.6	–13.94	<1
	MCF-17A	Deep	367	387	7/21/2008	–90.4	–11.85	<1
East of Spray Wheel	MCF-16C	Shallow	53	73	5/19/2008	–102.7	–13.52	<1
	MCF-16B	Middle	283.7	313.7	5/19/2008	–94	–12.28	<1
	MCF-16A	Deep	364.5	384.5	5/19/2008	–95.3	–12.5	<1
Near Pittman lateral	MCF-05	Middle	221	231	4/30/2008	–84.6	–9.5	<1
	MCF-20A	Deep	360	380	7/18/2008	–78.9	–8.91	<1
Southwestern Site boundary	AA-01	Shallow	29	49	4/22/2008	–94	–11.61	9.88
Southern Site boundary	MCF-02B	Middle	215	235	4/24/2008	–97.5	–12.72	<1
Southwestern Site boundary	MCF-01A	Deep	335	355	4/28/2008	–94.8	–12.91	<1
Southern Site boundary	MCF-02A	Deep	360	380	8/25/2009	–100.6	–12.73	NA
North Central Site boundary	MCF-06A-R	Deep	353	373	9/25/2009	–69.7	–4.76	NA
390 feet W-NW of COH RIBs	MCF-18A	Deep	380	400	9/25/2009	–65.0	–3.19	NA
390 feet W-NW of COH RIBs	MCF-18A (FD)	Deep	380	400	9/25/2009	–65.9	–3.52	NA
NW corner, Weston Hills property	MCF-29A	Deep	259.5	379.5	10/1/2009	–77.5	–6.59	NA
North central boundary of Tuscany	MCF-31A	Deep	361	381	10/1/2009	–66.5	–3.47	NA
NW corner of the Tuscany Village	MCF-30A	Deep	350	370	10/8/2009	–64.1	–3.50	NA
NW corner of the Tuscany Village	MCF-30A (ms/msd)	Deep	350	370	10/8/2009	–65.6	–3.59	NA

[a] δ^2H – Stable isotopes of Hydrogen (Deuterium [^2H] to Protium [^1H])
[b] $\delta^{18}O$ – Stable isotopes of oxygen ($^{18}O/^{16}O$)

ft bgs = Feet below ground surface
‰ = Per mil relative to VSMOW
TU = Tritium unit (1 TU is equivalent to approximately 3.19 picocuries per liter)
< = Analyte detected below indicated reporting limit
NA = Not analyzed

Table 2. Statistical Summary of BRC Groundwater Analytical Data, Eastside Main and Downgradient Wells, Monitoring Events Completed 2004–2016

								Non-Detect Data								Detected Data								
Layer	Class	Analyte	Units	MCL	BCL	Total Analyses	Detect Frequency	Count	Min.	Q1	Median	Mean	Q3	Max.[a]	GT_MCL	GT_BCL	Count	Min.	Q1	Median	Mean	Q3	Max.	GT_MCL	GT_BCL
L1	Metals	Arsenic	µg/L	10	10	146	72%	41	1.9	39	40	51	64	150	39	39	105	5.6	37	57	62	85	150	104	104
L2	Metals	Arsenic	µg/L	10	10	158	74%	41	5.9	39	50	200	99	3,900	37	37	117	7.8	45	68	79	100	653	116	116
L1/L2	Metals	Arsenic	µg/L	10	10	304	73%	82	1.9	39	48	120	82	3,900	76	76	222	5.6	40	61	71	91	653	220	220
L1	Metals	Lithium	µg/L	—	67	146	77%	33	8.7	44	96	110	190	190	—	19	113	74.2	160	220	320	300	1800	—	113
L2	Metals	Lithium	µg/L	—	67	158	80%	32	8.7	13	96	110	190	480	—	17	126	50.9	200	350	1400	620	24,500	—	125
L1/L2	Metals	Lithium	µg/L	—	67	304	79%	65	8.7	29	96	110	190	480	—	36	239	50.9	190	280	910	450	24,500	—	238
L1	Metals	Manganese	µg/L	—	800	150	55%	67	0.31	3.4	6.8	9.6	12	50	—	0	83	0.58	6.5	17	130	56	1,730	—	6
L2	Metals	Manganese	µg/L	—	800	163	61%	64	0.88	4.4	8.5	36	17	1,200	—	1	99	2.2	8.7	21	140	85	3,800	—	3
L1/L2	Metals	Manganese	µg/L	—	800	313	58%	131	0.31	3.4	6.8	23	12	1,200	—	1	182	0.58	7.5	18	140	65	3,800	—	9
L1	Metals	Molybdenum	µg/L	—	167	146	97%	4	1.4	3.6	16	14	22	22	—	0	142	7.5	19	40	130	91	2,800	—	17
L2	Metals	Molybdenum	µg/L	—	167	158	97%	4	1.4	2.2	4.5	230	680	900	—	1	154	2.1	42	75	220	140	2,800	—	30
L1/L2	Metals	Molybdenum	µg/L	—	167	304	97%	8	1.4	2.2	7.3	120	22	900	—	1	296	2.1	29	59	180	110	2,800	—	47
L1	Metals	Selenium	µg/L	50	167	146	41%	86	0.48	8	10	13	20	50	0	0	60	3.4	9.2	20	34	33	230	12	2
L2	Metals	Selenium	µg/L	50	167	158	49%	81	3.5	7	9.6	37	20	960	8	5	77	1.4	13	21	29	30	160	10	0
L1/L2	Metals	Selenium	µg/L	50	167	304	45%	167	0.48	8	10	25	20	960	8	5	137	1.4	11	21	31	31	230	22	2
L1	Metals	Uranium	µg/L	30	100	146	97%	5	0.1	0.55	10	6.2	10	10	0	0	141	4.4	11	25	31	48	93.5	62	0
L2	Metals	Uranium	µg/L	30	100	158	81%	30	0.1	0.95	7.6	34	21	420	6	3	128	1.3	11	19	24	29	130	30	3
L1/L2	Metals	Uranium	µg/L	30	100	304	88%	35	0.1	1	10	30	21	420	6	3	269	1.3	11	20	28	36	130	92	3
L1	Metals	Vanadium	µg/L	—	170	144	53%	68	2.1	16	32	41	42	170	—	0	76	4.9	16	27	33	40	150	—	0
L2	Metals	Vanadium	µg/L	—	170	158	58%	66	1.4	32	42	140	84	4,200	—	6	92	2.1	16	23	31	36	181	—	1
L1/L2	Metals	Vanadium	µg/L	—	170	302	56%	134	1.4	21	40	91	59	4,200	—	6	168	2.1	16	24	32	36	181	—	1
L1	OCPs	beta-BHC	µg/L	—	0.037	114	15%	97	0.0065	0.0072	0.0072	0.013	0.01	0.05	—	9	17	0.015	0.054	0.063	0.068	0.079	0.12	—	16
L2	OCPs	beta-BHC	µg/L	—	0.037	132	8%	122	0.0065	0.0072	0.01	0.012	0.013	0.05	—	6	10	0.026	0.032	0.057	0.057	0.078	0.099	—	7
L1/L2	OCPs	beta-BHC	µg/L	—	0.037	246	11%	219	0.0065	0.0072	0.01	0.013	0.013	0.05	—	15	27	0.015	0.049	0.062	0.064	0.078	0.12	—	23
L1	OCPs	gamma-BHC (Lindane)	µg/L	0.2	0.061	114	1%	113	0.0025	0.003	0.0032	0.0081	0.0067	0.05	0	0	1	0.02	—	0.02	0.02	—	0.02	0	0
L2	OCPs	gamma-BHC (Lindane)	µg/L	0.2	0.061	132	3%	128	0.0025	0.003	0.0032	0.0072	0.0087	0.05	0	0	4	0.0096	0.012	0.021	0.019	0.024	0.025	0	0
L1/L2	OCPs	gamma-BHC (Lindane)	µg/L	0.2	0.061	246	2%	241	0.0025	0.003	0.0032	0.0077	0.0067	0.05	0	0	5	0.0096	0.015	0.02	0.019	0.023	0.025	0	0

Note: NERT database sampling data for Eastside wells not included in statistical summaries (i.e., MW-03 and others). Supplemental BRC data from 2018 in POU3 area also not included.
[a] Elevated arsenic detection limits reduced below Basic cleanup level (BCL)/maximum contaminant level (MCL) in subsequent analyses.
Q1 = First quartile
Q3 = Third quartile
GT_MCL = Number of samples with detections or detection limits exceeding the MCL
GT_BCL = Number of samples with detections or detection limits exceeding the BCL
L1 = Layer 1 well
L2 = Layer 2 well
L1/L2 = Layer 1 or Layer 2 well
µg/L = Micrograms per liter
pCi/L = Picocuries per liter

Table 2. Statistical Summary of BRC Groundwater Analytical Data, Eastside Main and Downgradient Wells, Monitoring Events Completed 2004–2016

								Non-Detect Data									Detected Data								
Layer	Class	Analyte	Units	MCL	BCL	Total Analyses	Detect Frequency	Count	Min.	Q1	Median	Mean	Q3	Max.[a]	GT_MCL	GT_BCL	Count	Min.	Q1	Median	Mean	Q3	Max.	GT_MCL	GT_BCL
L1	Rads	Radium-226/228	pCi/L	5	—	131	100%	0	—	—	—	—	—	—	—	—	131	–0.332	0.81	1.8	2.1	3.1	7.04	8	—
L2	Rads	Radium-226/228	pCi/L	5	—	130	100%	0	—	—	—	—	—	—	—	—	130	0.159	1.8	2.9	3.9	4.1	22.66	27	—
L1/L2	Rads	Radium-226/228	pCi/L	5	—	261	100%	0	—	—	—	—	—	—	—	—	261	–0.332	1.2	2.3	3	3.7	22.66	35	—
L1	GenChem	Nitrate	mg/L	10	53	167	96%	6	0.004	0.031	2	1.3	2	2	0	0	161	0.018	10	15	52	22	5670	123	2
L2	GenChem	Nitrate	mg/L	10	53	181	93%	12	0.005	0.14	0.5	1	2	2	0	0	169	0.015	6.6	15	19	26	64.8	115	1
L1/L2	GenChem	Nitrate	mg/L	10	53	348	95%	18	0.004	0.036	1.3	1.1	2	2	0	0	330	0.015	9.5	15	35	24	5670	238	3
L1	VOCs	Chloroform	µg/L	—	0.22	140	92%	11	0.048	0.048	0.067	0.25	0.19	1	—	2	129	0.11	1.5	7.5	110	66	1,400	—	124
L2	VOCs	Chloroform	µg/L	—	0.22	137	94%	8	0.048	0.067	0.074	0.2	0.16	1	—	1	129	0.11	2.5	37	120	220	900	—	128
L1/L2	VOCs	Chloroform	µg/L	—	0.22	277	93%	19	0.048	0.048	0.067	0.23	0.19	1	—	3	258	0.11	1.9	19	120	98	1,400	—	252
L1	VOCs	1,4-Dichloro-benzene	µg/L	75	12	122	8%	112	0.047	0.1	0.11	0.2	0.2	1	0	0	10	0.11	0.31	1.2	1.4	2	4.5	0	0
L2	VOCs	1,4-Dichloro-benzene	µg/L	75	12	109	4%	105	0.047	0.1	0.11	0.17	0.2	1	0	0	4	0.14	0.18	0.44	0.53	0.97	1.1	0	0
L1/L2	VOCs	1,4-Dichloro-benzene	µg/L	75	12	231	6%	217	0.047	0.1	0.11	0.18	0.2	1	0	0	14	0.11	0.25	0.84	1.1	1.8	4.5	0	0

Note: NERT database sampling data for Eastside wells not included in statistical summaries (i.e., MW-03 and others). Supplemental BRC data from 2018 in POU3 area also not included.
[a] Elevated arsenic detection limits reduced below Basic cleanup level (BCL)/maximum contaminant level (MCL) in subsequent analyses.

Q1 = First quartile
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GT_MCL = Number of samples with detections or detection limits exceeding the MCL
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L1 = Layer 1 well
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Table 3. Indicator Parameter Selection Summary
Page 1 of 3

Layer	Analyte	Units	MCL	BCL	Total Analyses	Detect Frequency	Detected Data						Notes	Retained in CSM/RAS?
							Count	Min.	Mean	Max.	>MCL	>BCL		
Metals														
L1/L2	Arsenic	µg/L	10	10	304	73.0%	222	5.6	71	653	220	220	• Modeling with low K_d confirms limited mobility. • Highest detections in low permeability UMCf. • Significant plants area source.	Retained
L1					146	71.9%	105	5.6	62	150	104	104		
L2					158	74.1%	117	7.8	79	653	116	116		
L1/L2	Lithium	µg/L	—	67	304	78.6%	239	50.9	910	24,500	—	238	• Less mobile than arsenic. • Highest detections in low permeability UMCf. • Fate and transport represented by arsenic. • Highly sorptive; limited mobility. • Significant plants area source.	Eliminated
L1					146	77.4%	113	74.2	320	1,800	—	113		
L2					158	79.7%	126	50.9	1400	24,500	—	125		
L1/L2	Manganese	µg/L	—	800	313	58.1%	182	0.58	140	3,800	—	9	• Less mobile than arsenic. • Few detections exceed BCL. • Fate and transport represented by arsenic. • Highest detections in low permeability UMCf. • Significant plants area source.	Eliminated
L1					150	55.3%	83	0.58	130	1,730	—	6		
L2					163	60.7%	99	2.2	140	3,800	—	3		
L1/L2	Molybdenum	µg/L	—	167	304	97.4%	296	2.1	180	2,800	—	47	• Mostly limited to northwestern Site area. • Fate and transport represented by arsenic. • Additional sampling planned for 2019. • Significant plants area source.	Eliminated
L1					146	97.3%	142	7.5	130	2,800	—	17		
L2					158	97.5%	154	2.1	220	2,800	—	30		
L1/L2	Selenium	µg/L	50	167	304	45.1%	137	1.4	31	230	22	2	• Only two detections exceed BCL. • Fate and transport represented by arsenic.	Eliminated
L1					146	41.1%	60	3.4	34	230	12	2		
L2					158	48.7%	77	1.4	29	160	10	0		

MCL = Maximum contaminant level
BCL = Basic cleanup level
L/kg = Liters per kilogram

L1 = Layer 1 well
L2 = Layer 2 well
L1/L2 = Layer 1 or Layer 2 well

µg/L = Micrograms per liter
mg/L = Milligrams per liter
pCi/L = Picocuries per liter

Table 3. Indicator Parameter Selection Summary
Page 2 of 3

Layer	Analyte	Units	MCL	BCL	Total Analyses	Detect Frequency	Detected Data						Notes	Retained in CSM/RAS?
							Count	Min.	Mean	Max.	>MCL	>BCL		
Metals (cont.)														
L1/L2	Uranium	µg/L	30	100	304	88.5%	269	1.3	28	130	92	3	• Less mobile than arsenic. • Highly sorptive; limited mobility. • Fate and transport represented by arsenic. • Few detections exceed BCL. • Significant plants area source.	Eliminated
L1					146	96.6%	141	4.4	31	93.5	62	0		
L2					158	81.0%	128	1.3	24	130	30	3		
L1/L2	Vanadium	µg/L	—	170	302	55.6%	168	2.1	32	181	—	1	• One detection >BCL.	Eliminated
L1					144	52.8%	76	4.9	33	150	—	0	• Fate and transport represented by arsenic.	
L2					158	58.2%	92	2.1	31	181	—	1	• Highly sorptive; limited mobility. • Less mobile than arsenic.	
Volatile Organic Compounds (VOCs)														
L1/L2	Chloroform	µg/L	—	0.22	277	93.1%	258	0.11	120	1,400	—	252		Retained
L1					140	92.1%	129	0.11	110	1,400	—	124		
L2					137	94.2%	129	0.11	120	900	—	128		
L1/L2	1,4-Dichloro-benzene	µg/L	75	12	231	6.1%	14	0.11	1.1	4.5	0	0	• Low detection frequency • No detections >BCL	Eliminated
L1					122	8.2%	10	0.11	1.4	4.5	0	0		
L2					109	3.7%	4	0.14	0.53	1.1	0	0		
Organochlorine Pesticides (OCPs)														
L1/L2	beta-BHC	µg/L	—	0.037	246	11.0%	27	0.015	0.064	0.12	—	23		Retained
L1					114	14.9%	17	0.015	0.068	0.12	—	16		
L2					132	7.6%	10	0.026	0.057	0.099	—	7		
L1/L2	gamma-BHC (Lindane)	µg/L	0.2	0.061	246	2.0%	5	0.0096	0.019	0.025	0	0	• Low detection frequency • No detections >BCL • Fate and transport represented by beta-BHC.	Eliminated
L1					114	0.9%	1	0.02	0.02	0.02	0	0		
L2					132	3.0%	4	0.0096	0.019	0.025	0	0		
General Chemistry														
L1/L2	Nitrate	mg/L	10	53	348	94.8%	330	0.015	35	5,670	238	3	• Few detections >BCL • Fate and transport represented by perchlorate	Eliminated
L1					167	96.4%	161	0.018	52	5,670	123	2		
L2					181	93.4%	169	0.015	19	64.8	115	1		

MCL = Maximum contaminant level
BCL = Basic cleanup level
L/kg = Liters per kilogram

L1 = Layer 1 well
L2 = Layer 2 well
L1/L2 = Layer 1 or Layer 2 well

µg/L = Micrograms per liter
mg/L = Milligrams per liter
pCi/L = Picocuries per liter

Table 3. Indicator Parameter Selection Summary
Page 3 of 3

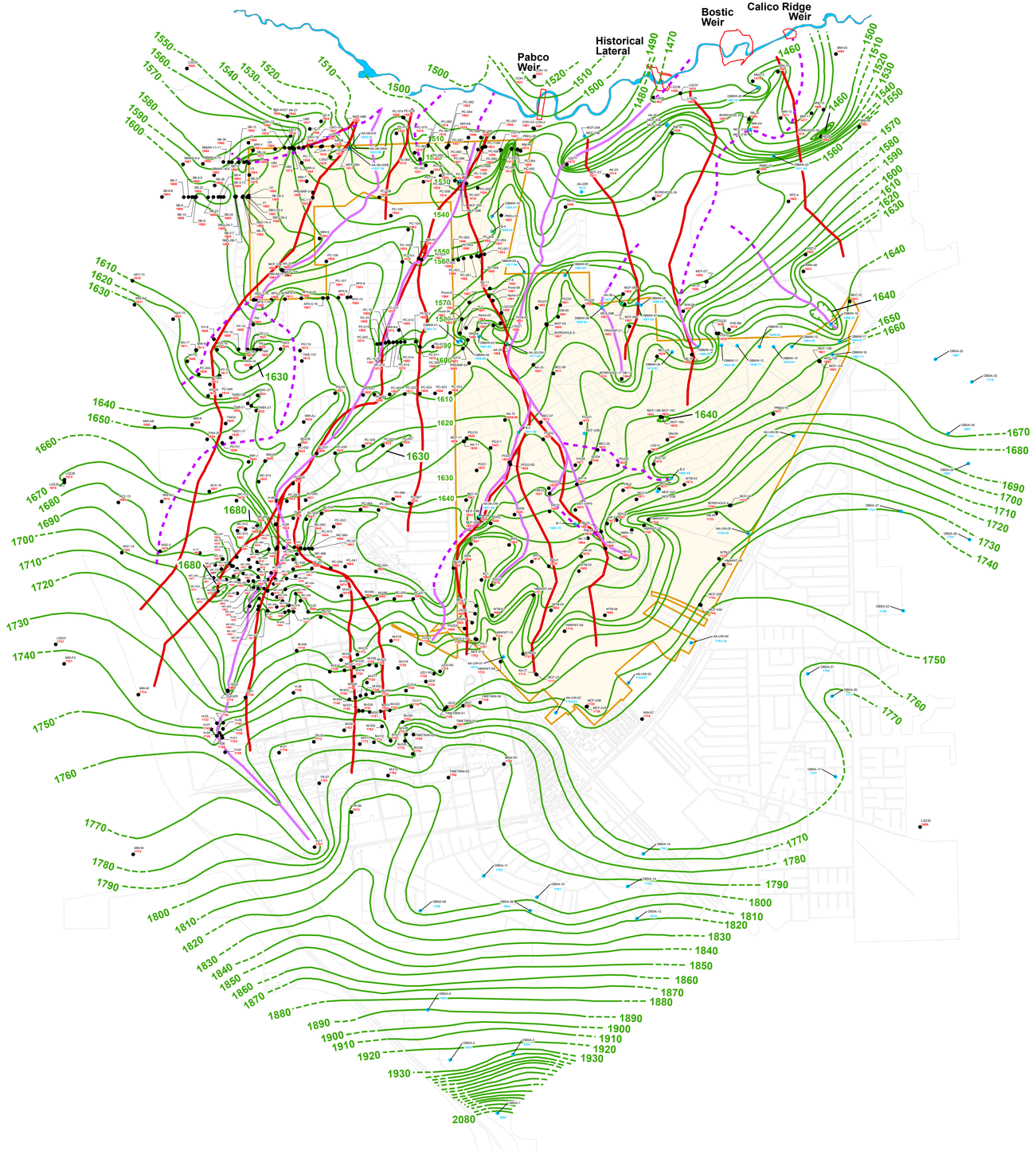
Layer	Analyte	Units	MCL	BCL	Total Analyses	Detect Frequency	Detected Data						Notes	Retained in CSM/RAS?
							Count	Min.	Mean	Max.	>MCL	>BCL		
Radiological														
L1/L2	Radium-226/228	pCi/L	5	—	261	100.0%	261	–0.332	3	22.66	35	—		Retained
L1					131	100.0%	131	–0.332	2.1	7.04	8	—		
L2					130	100.0%	130	0.159	3.9	22.66	27	—		

MCL = Maximum contaminant level
BCL = Basic cleanup level
L/kg = Liters per kilogram

L1 = Layer 1 well
L2 = Layer 2 well
L1/L2 = Layer 1 or Layer 2 well

µg/L = Micrograms per liter
mg/L = Milligrams per liter
pCi/L = Picocuries per liter

Plate



Note:
Although work is ongoing to further delineate the paleochannels, the channels depicted are based on currently available data.

N

0 1,500 3,000 Feet

Explanation

- New data point used in contouring (2008)
- Data point used in contouring (2006)
- Site boundary
- Top of Muddy Creek Formation contour (ft msl)
- Paleochannels – BRC
- Paleochannels – Ramboll (2018)

Daniel B. Stephens & Associates, Inc.

BMI Common Areas (Eastside)
Henderson, Nevada

PLATE 1
TOPOGRAPHIC SURFACE OF THE MUDDY CREEK FORMATION

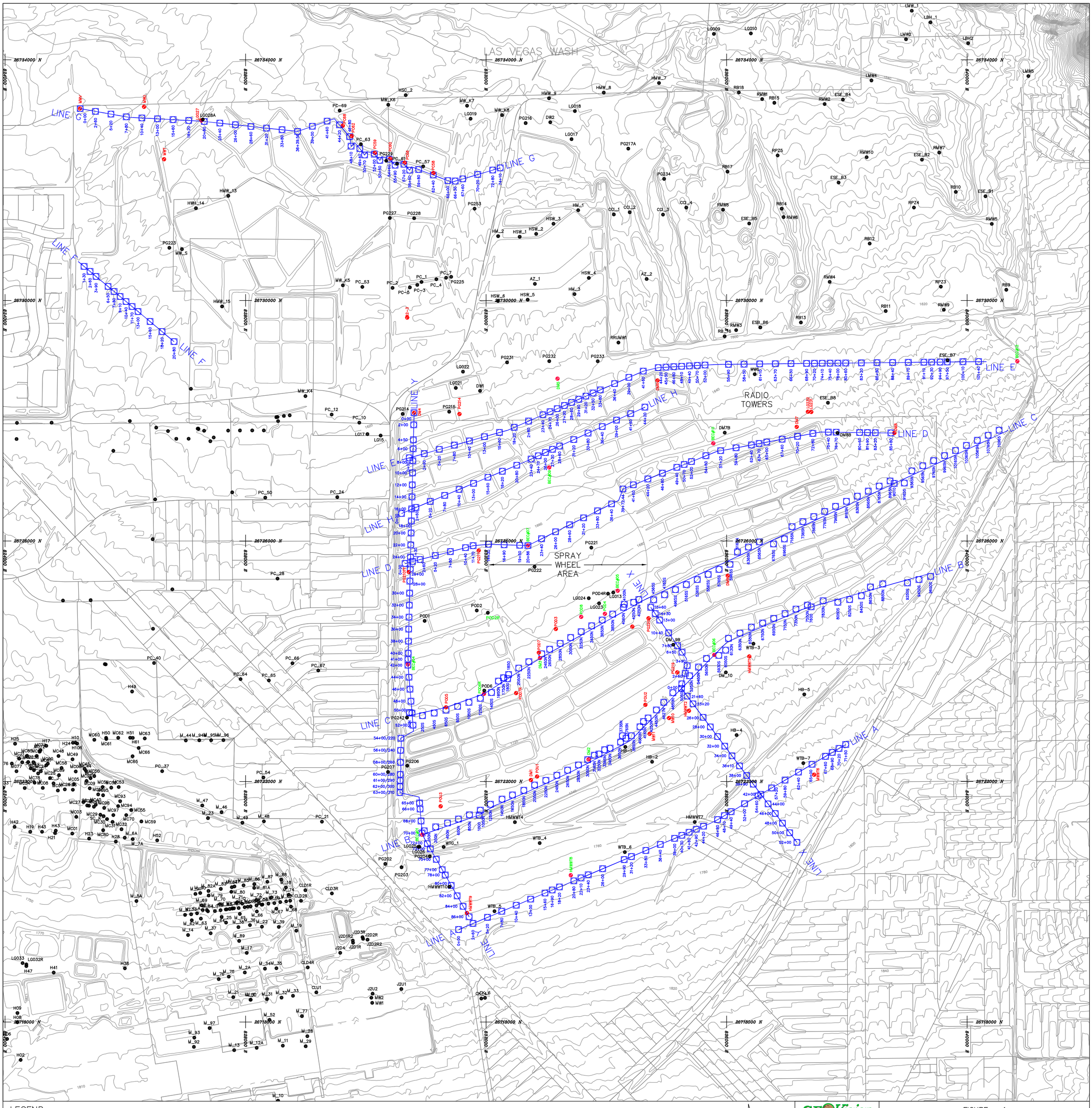
Basic Remediation Company

Prepared by: AFM (DBS&A) Date: 7/29/2019

S:\PROJECTS\BRC\GIS\MXDS\REPORTS\UPDATE 2019 PALEOCHANNELS\TOP_MUDDY_CREEK_07-29-19_D-SIZE.MXD

Appendix A

Geophysical Survey Maps



LEGEND

- NEVADA STATE PLANE COORDINATE SYSTEM (NAD 83 EASTERN ZONE)
- TDEM SOUNDING LOCATION
- GEONICS EM31/34 TRAVERSE
- MONITORING WELL / SOIL BORING
- MONITORING WELL (SURVEYED DURING THIS INVESTIGATION)
- MONITORING WELL WITH EM INDUCTION LOG

0 400 800 1200 (feet)

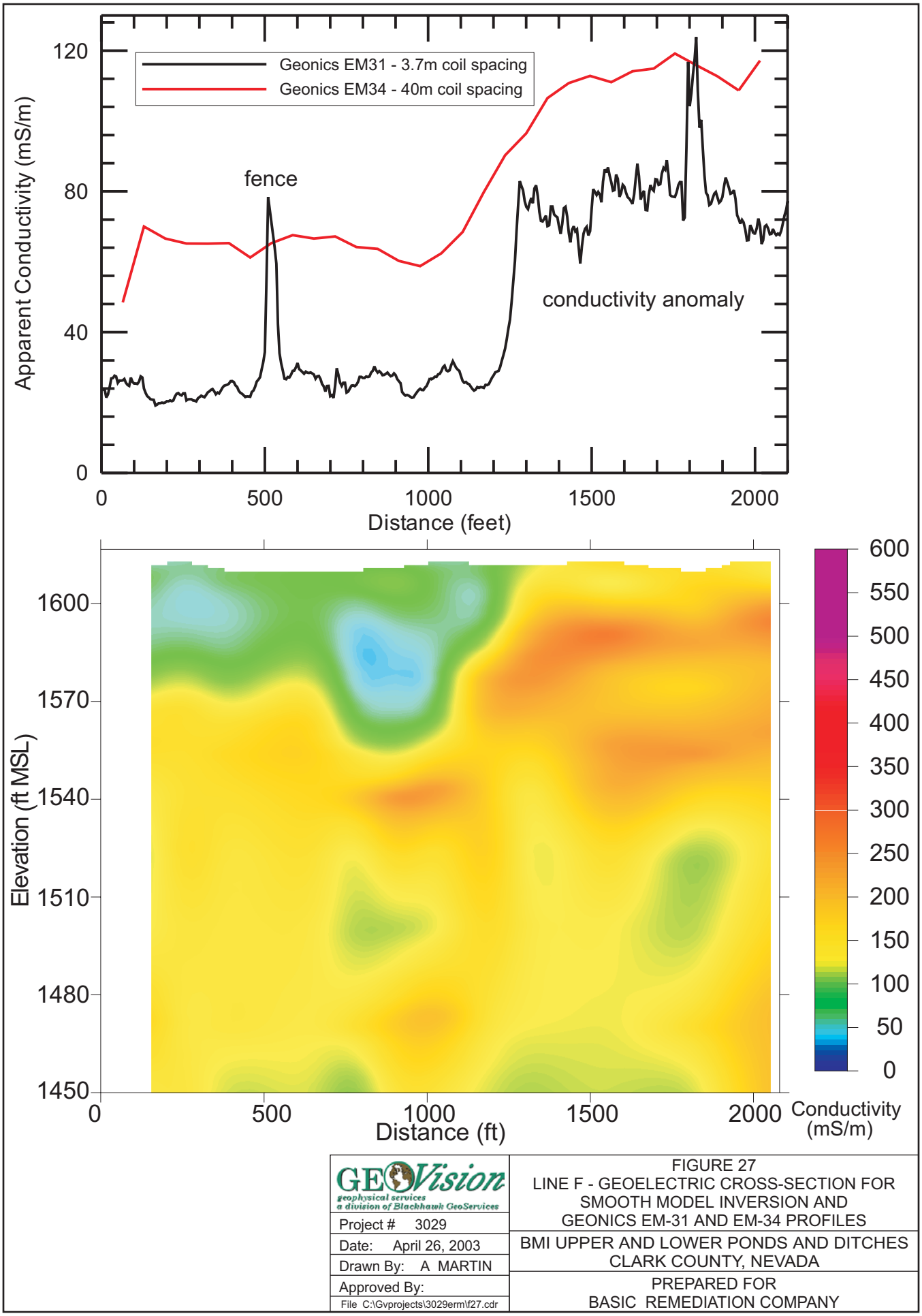
GEOVision Geological Services

Project #	3029
Date	May 01,2003
Developed by	A MARTIN
Drawn by	T RODRIGUEZ
Approved by	
File	Z:\3029\3029-1.DWG

FIGURE – 1
SITE MAP

BMI UPPER AND LOWER PONDS AND DITCHES
CLARK COUNTY, NEVADA

PREPARED FOR
ENVIRONMENTAL RESOURCES MANAGEMENT, INC.



GEOVision geophysical services a division of Blackhawk GeoServices

Project # 3029

Date: April 26, 2003

Drawn By: A MARTIN

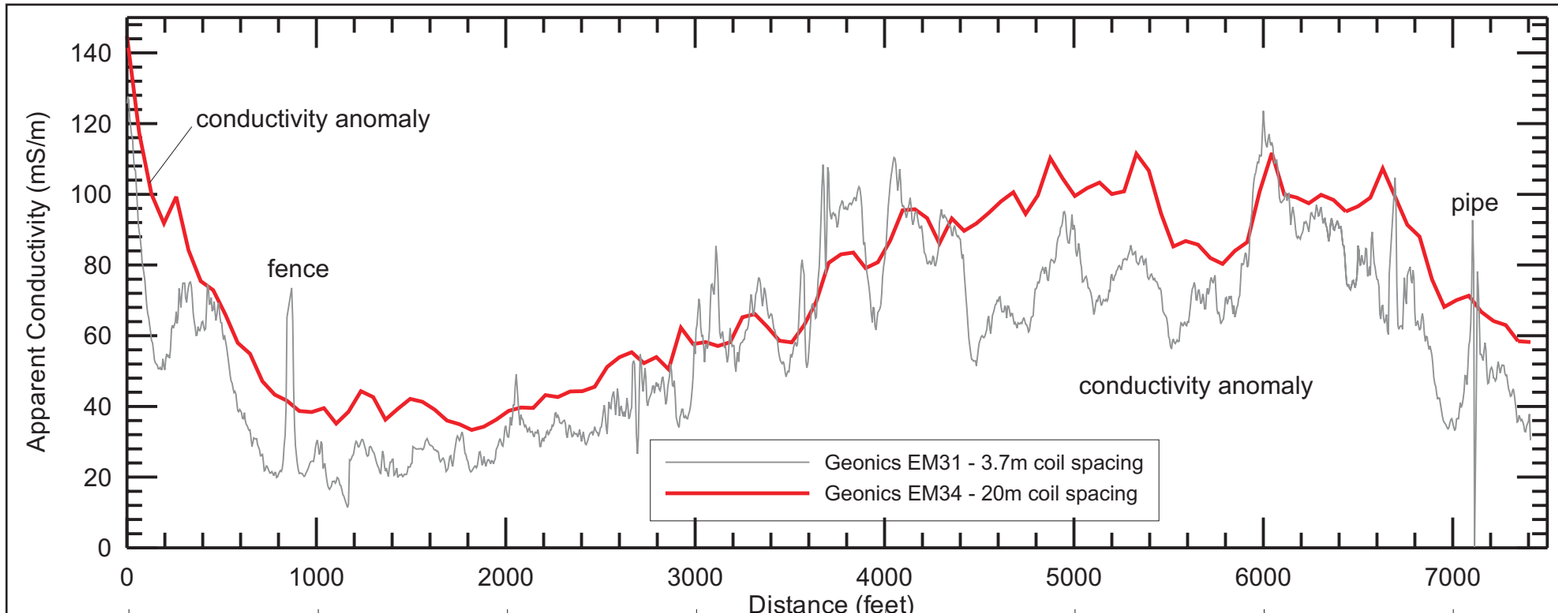
Approved By:

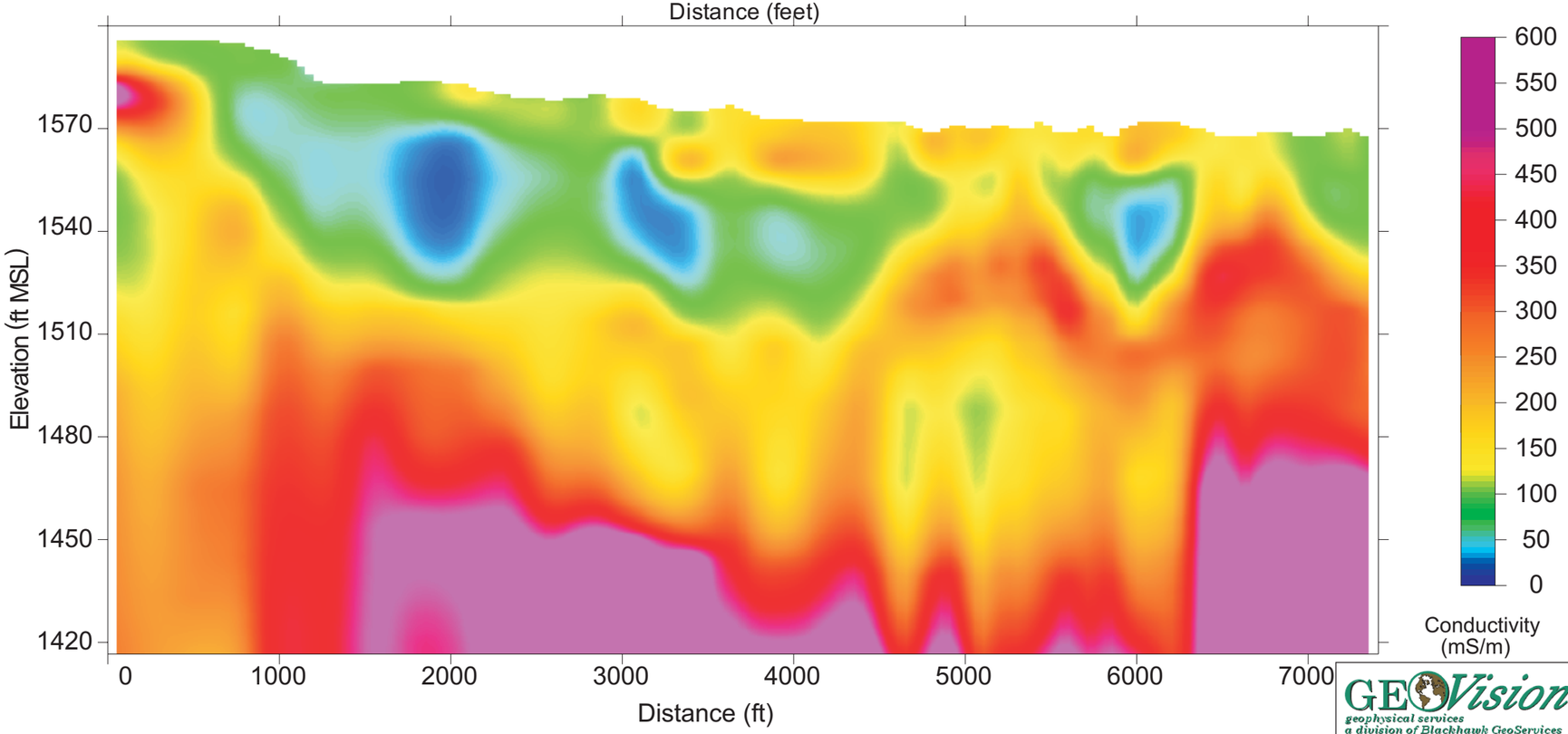
File C:\Gvprojects\3029erm\f27.cdr

FIGURE 27
LINE F - GEOELECTRIC CROSS-SECTION FOR SMOOTH MODEL INVERSION AND GEONICS EM-31 AND EM-34 PROFILES

BMI UPPER AND LOWER PONDS AND DITCHES
CLARK COUNTY, NEVADA

PREPARED FOR
BASIC REMEDIATION COMPANY





GEOVision
geophysical services
a division of Blackhawk GeoServices

Project # 3029
Date: April 29, 2003
Drawn By: A MARTIN
Approved By:
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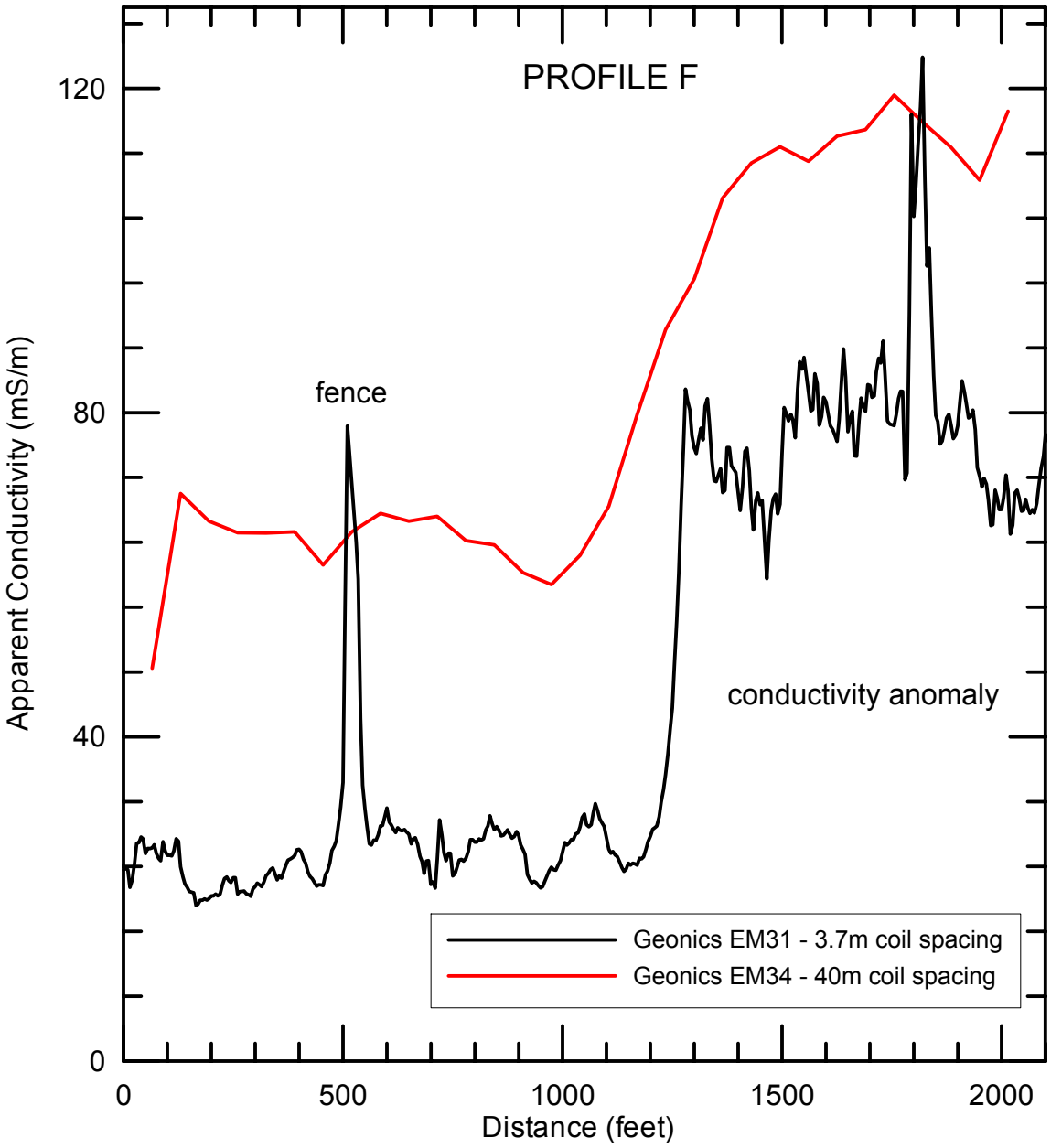
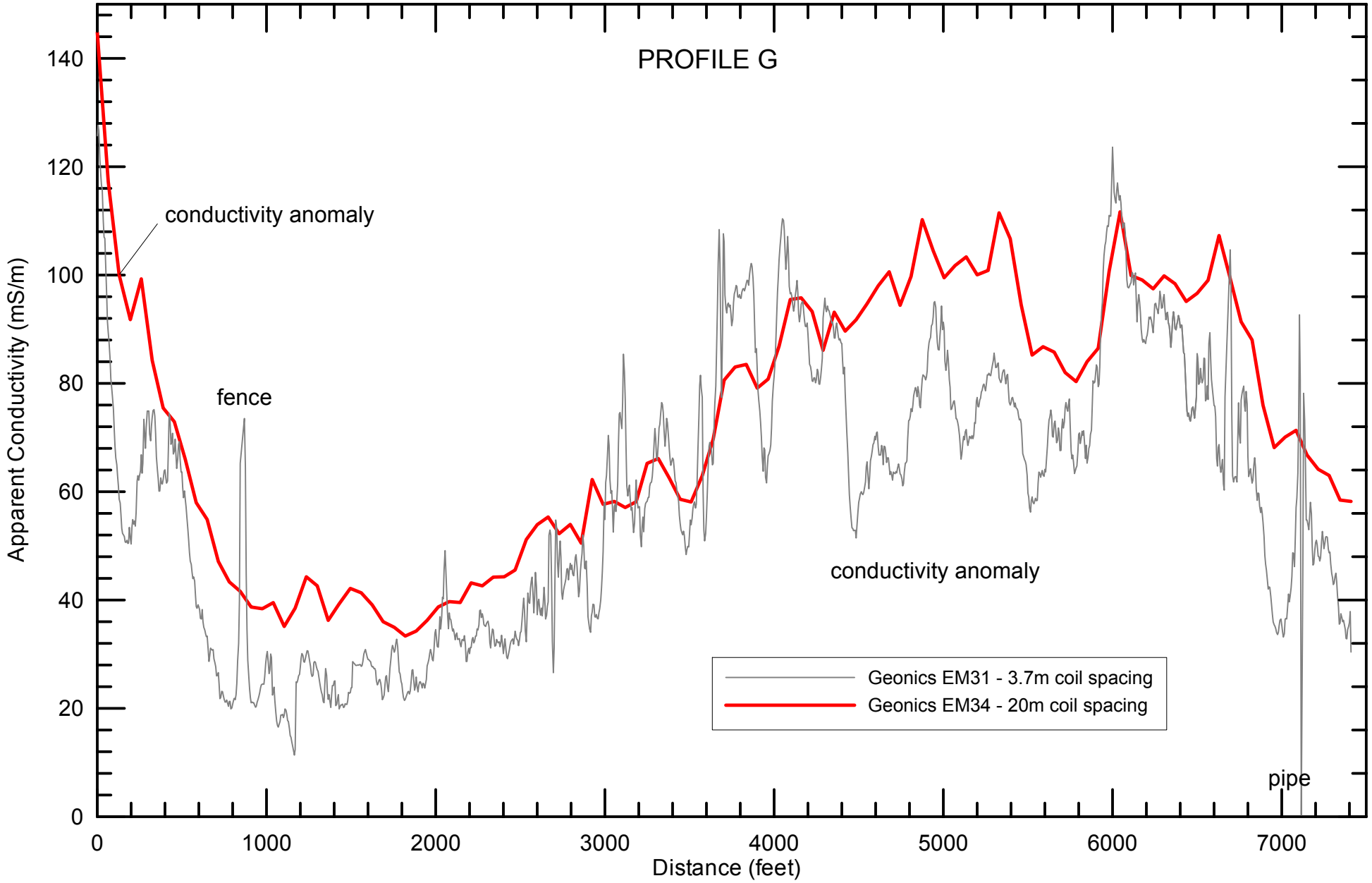
FIGURE 28
LINE G - GEOELECTRIC CROSS-SECTION FOR
SMOOTH MODEL INVERSION AND
GEONICS EM-31 AND EM-34 PROFILES

BMI UPPER AND LOWER PONDS AND DITCHES
CLARK COUNTY, NEVADA

PREPARED FOR
BASIC REMEDIATION COMPANY


PROFILE F
120
80
40
0
Apparent Conductivity (mS/m)
fence
conductivity anomaly
Geonics EM31 - 3.7m coil spacing
Geonics EM34 - 40m coil spacing
0
500
1000
1500
2000
Distance (feet)

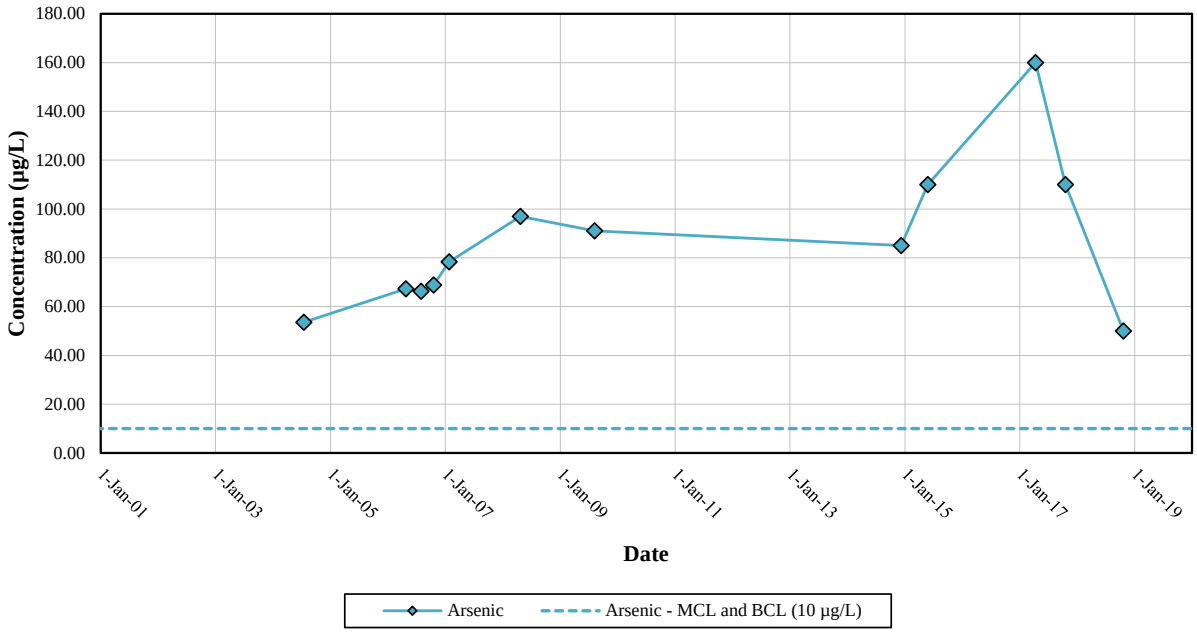

PROFILE G
Apparent Conductivity (mS/m)
Distance (feet)
0
20
40
60
80
100
120
140
0
1000
2000
3000
4000
5000
6000
7000
conductivity anomaly
fence
conductivity anomaly
pipe
Geonics EM31 - 3.7m coil spacing
Geonics EM34 - 20m coil spacing

Appendix B

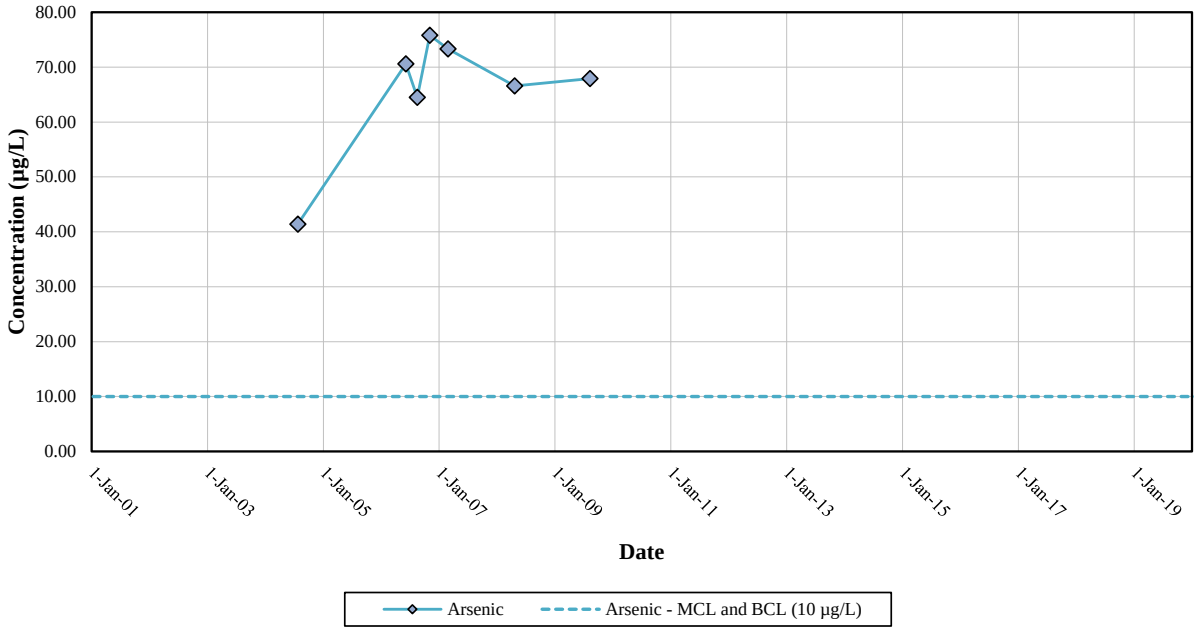
Time-Series Plots

Time Series Plots
Eastside Shallow

Well AA-01
Arsenic Concentrations vs. Time



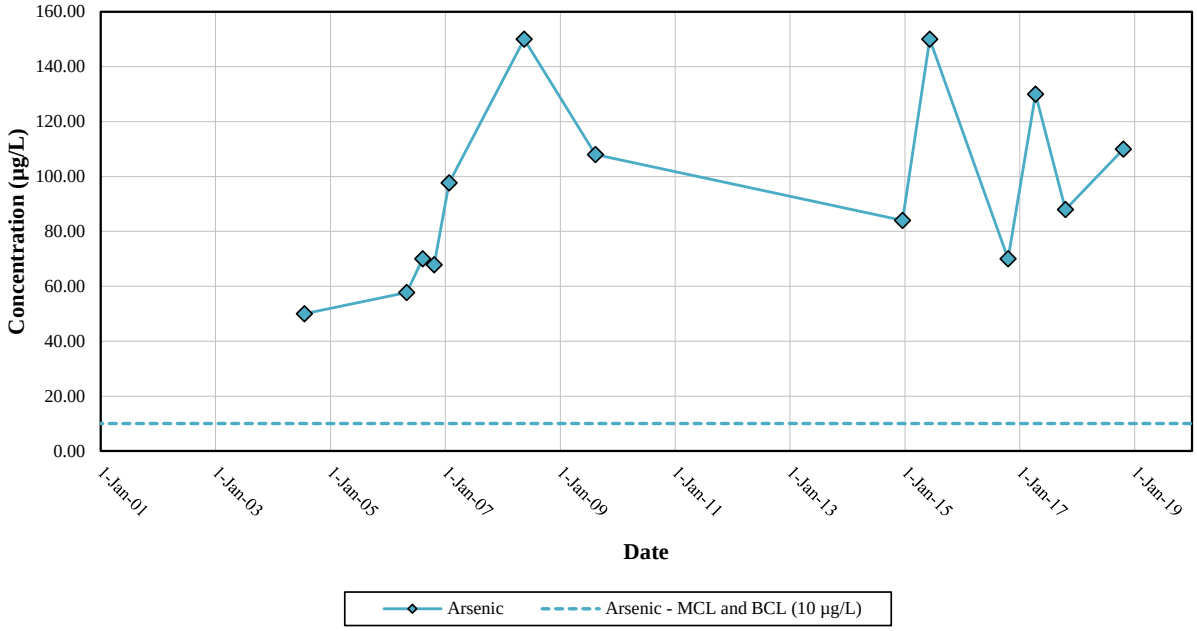
Well AA-07
Arsenic Concentrations vs. Time



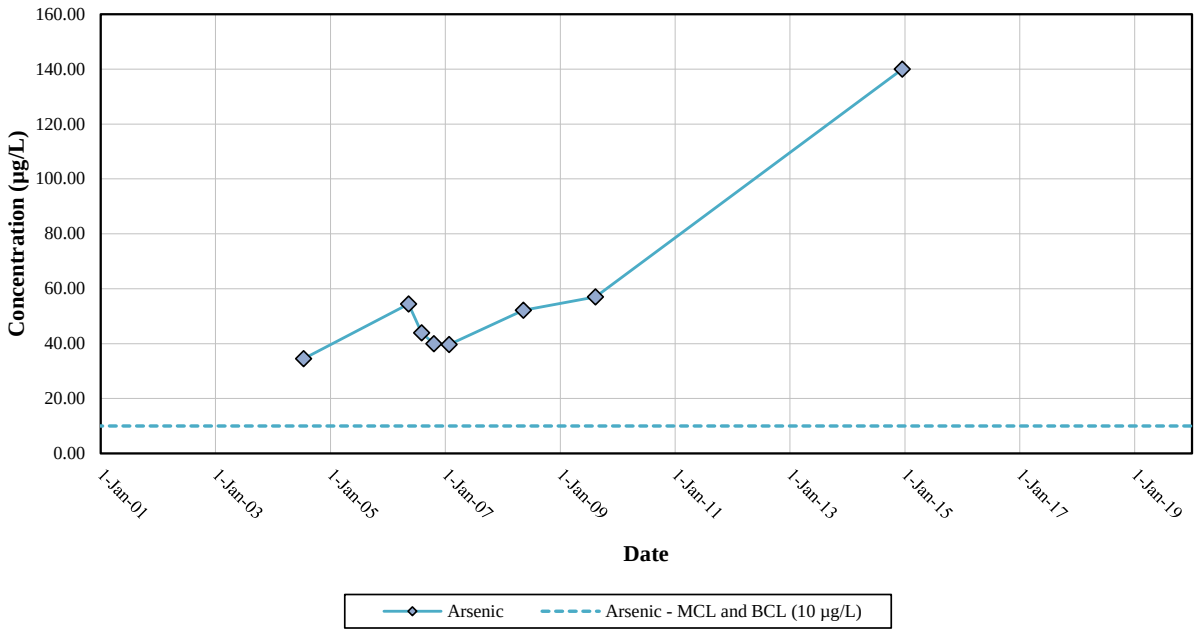
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-09
Arsenic Concentrations vs. Time



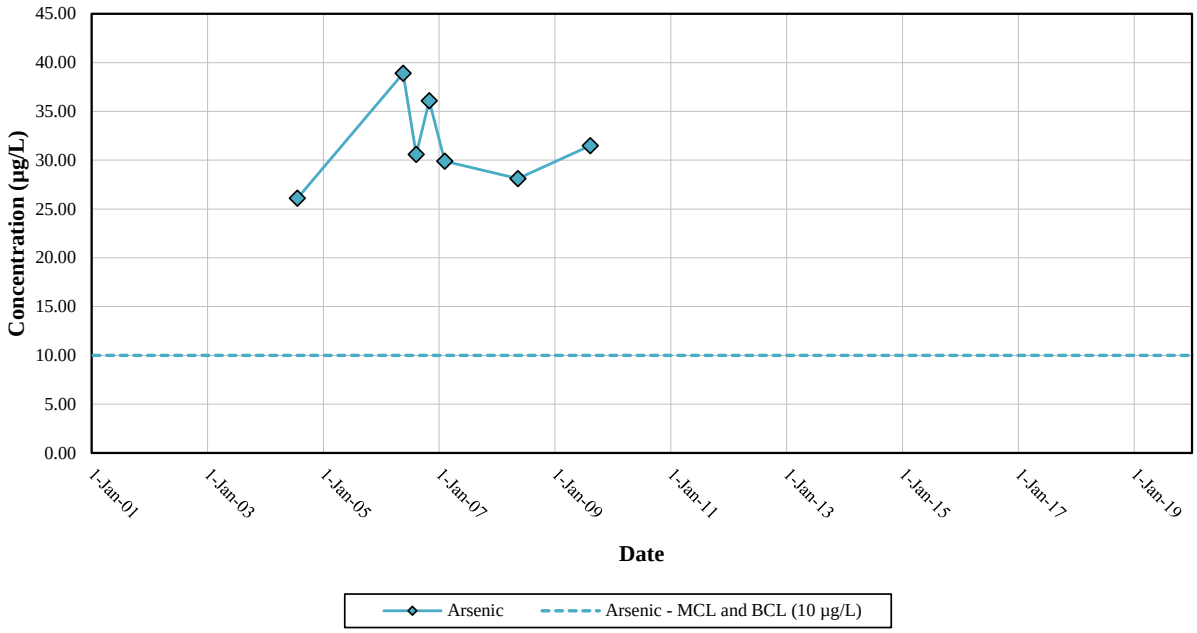
Well AA-13
Arsenic Concentrations vs. Time



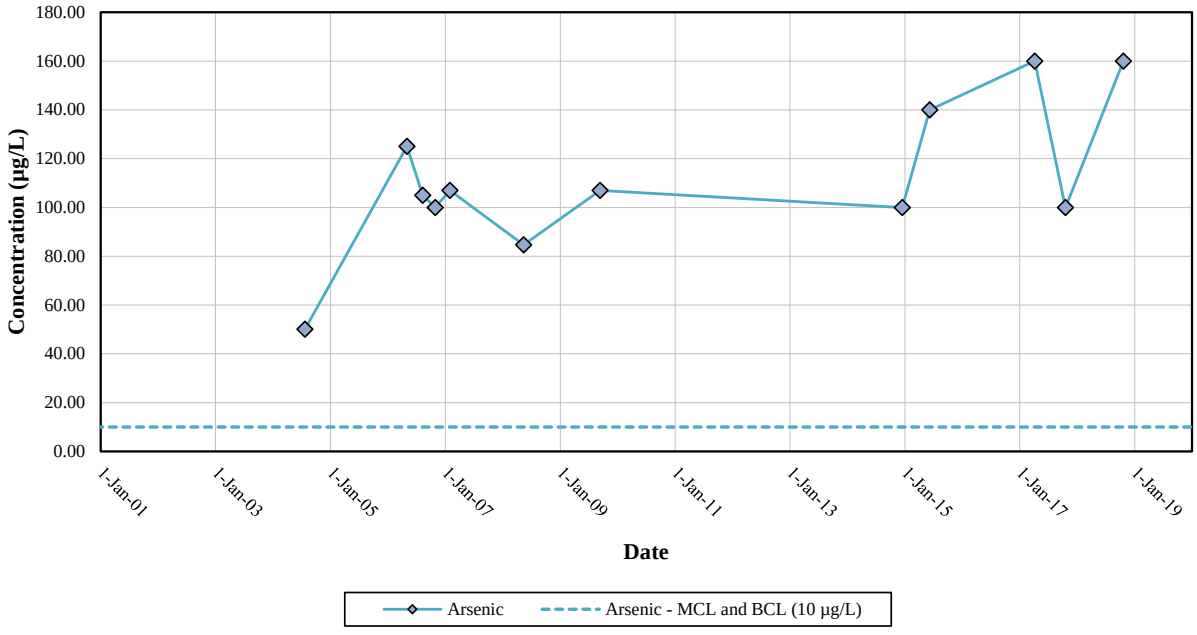
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-18
Arsenic Concentrations vs. Time



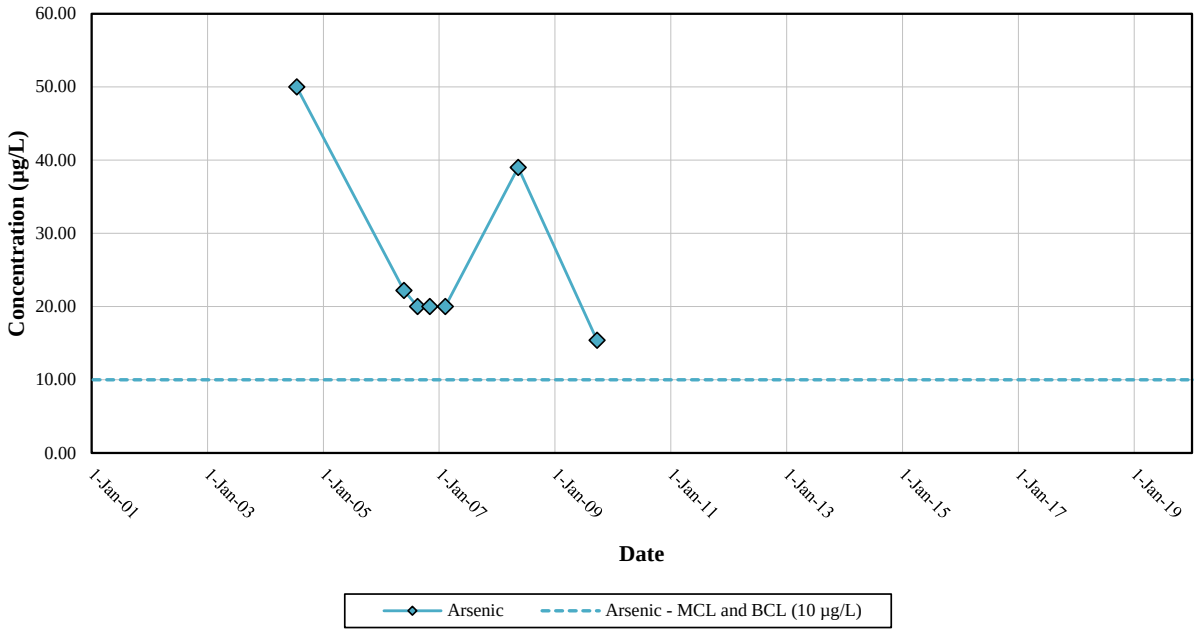
Well AA-20
Arsenic Concentrations vs. Time



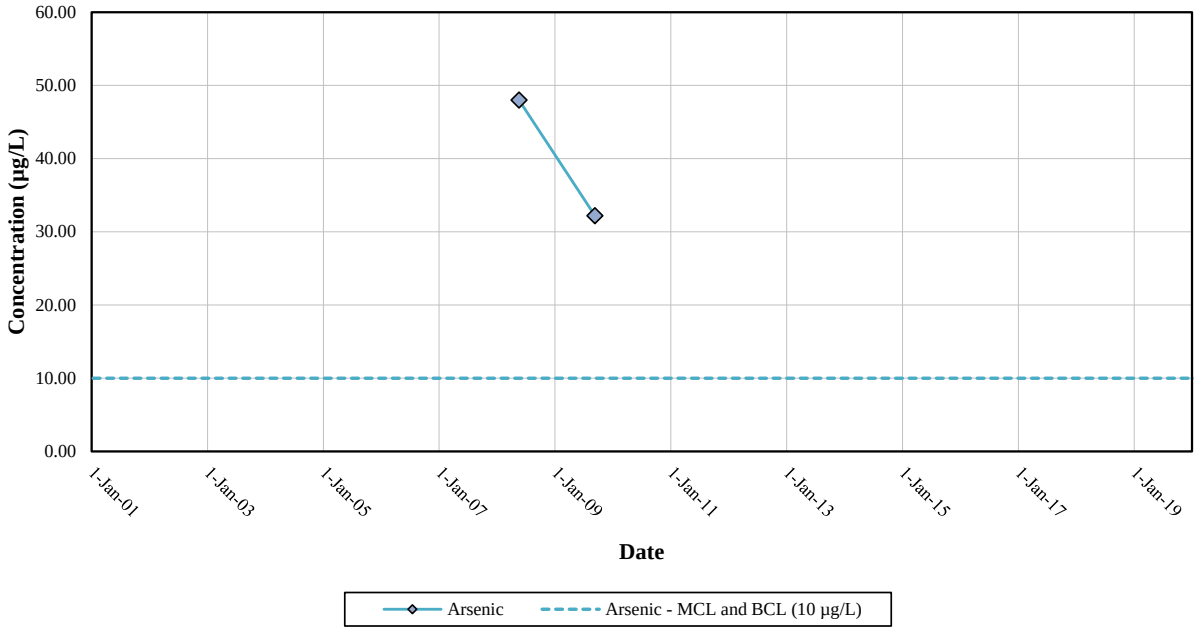
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-22
Arsenic Concentrations vs. Time



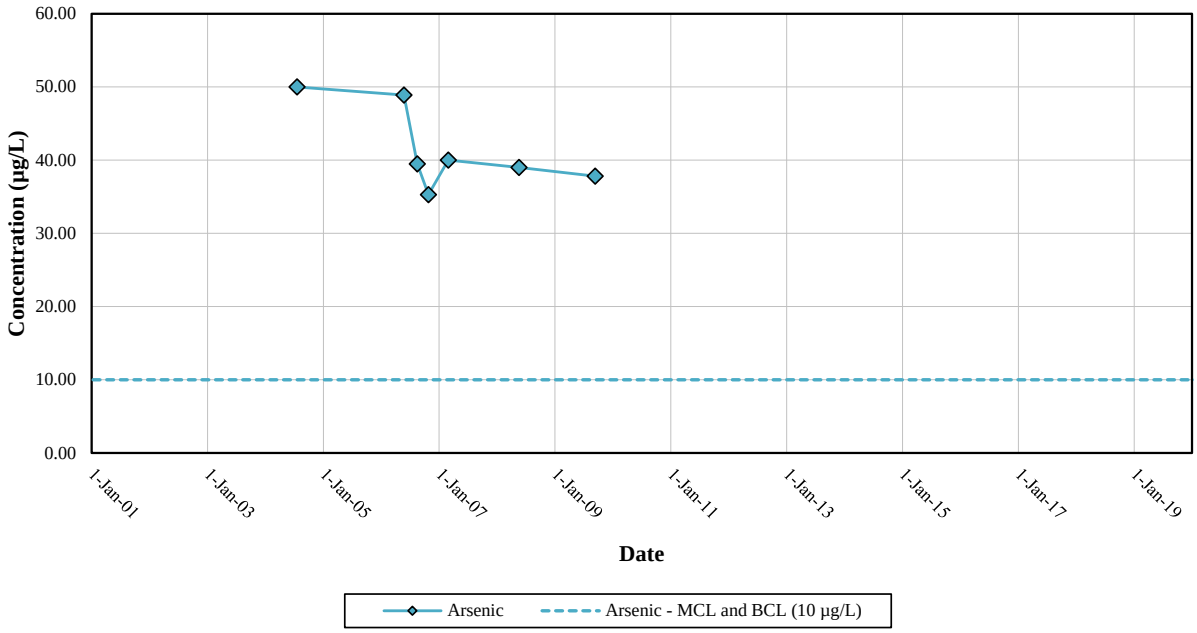
Well AA-23R
Arsenic Concentrations vs. Time



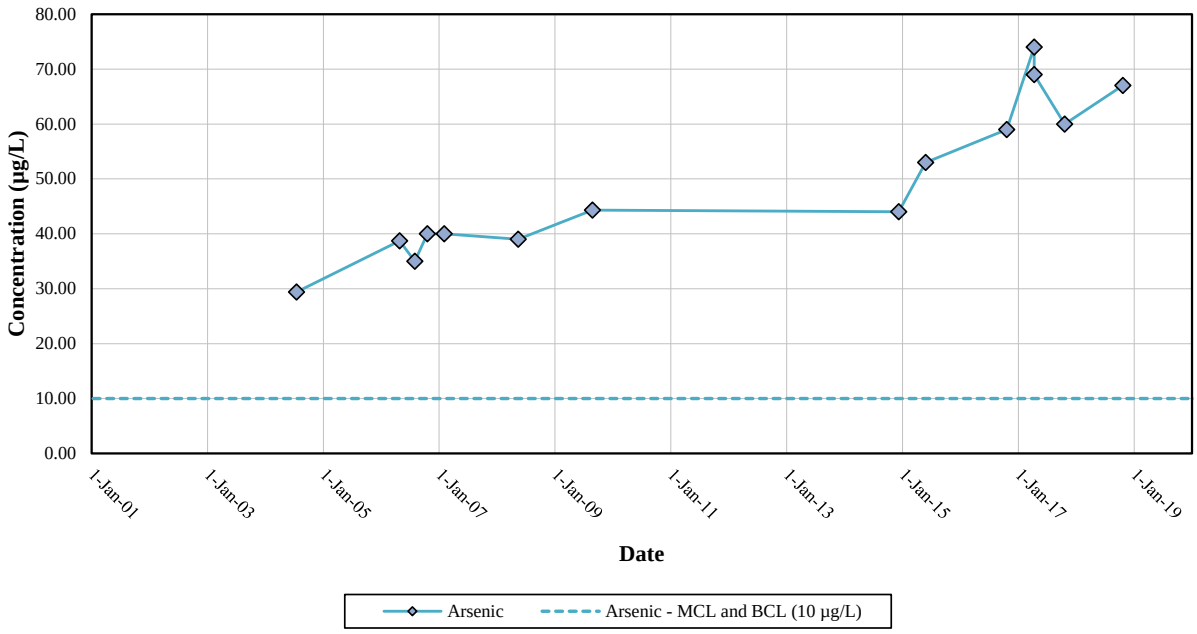
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-26
Arsenic Concentrations vs. Time



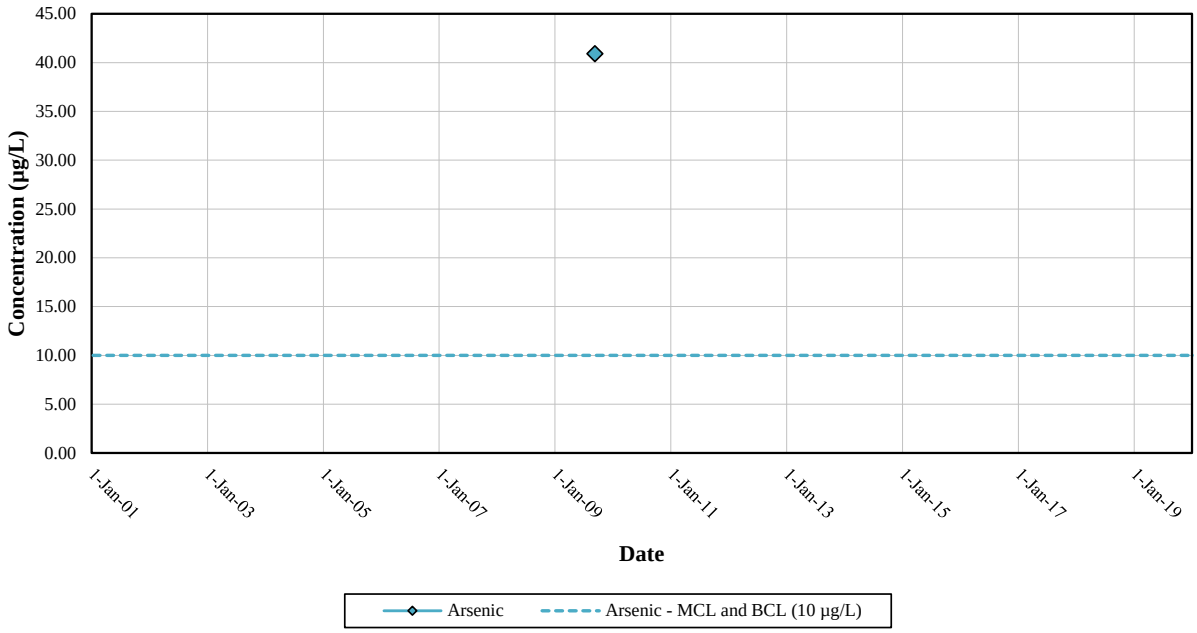
Well AA-27
Arsenic Concentrations vs. Time



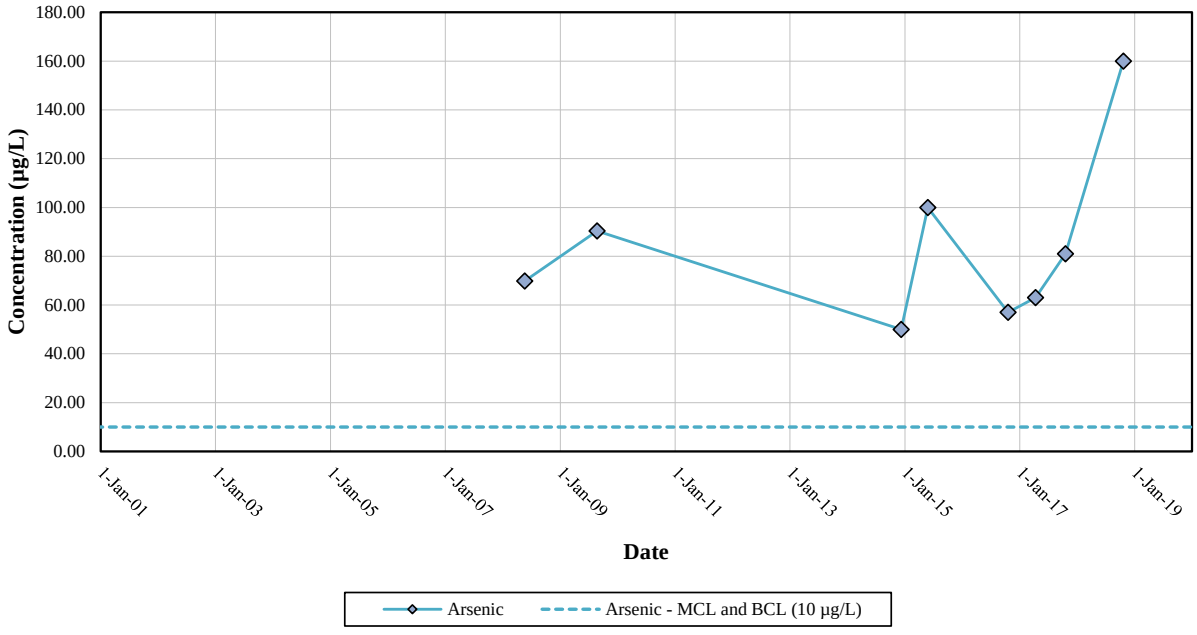
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-30
Arsenic Concentrations vs. Time



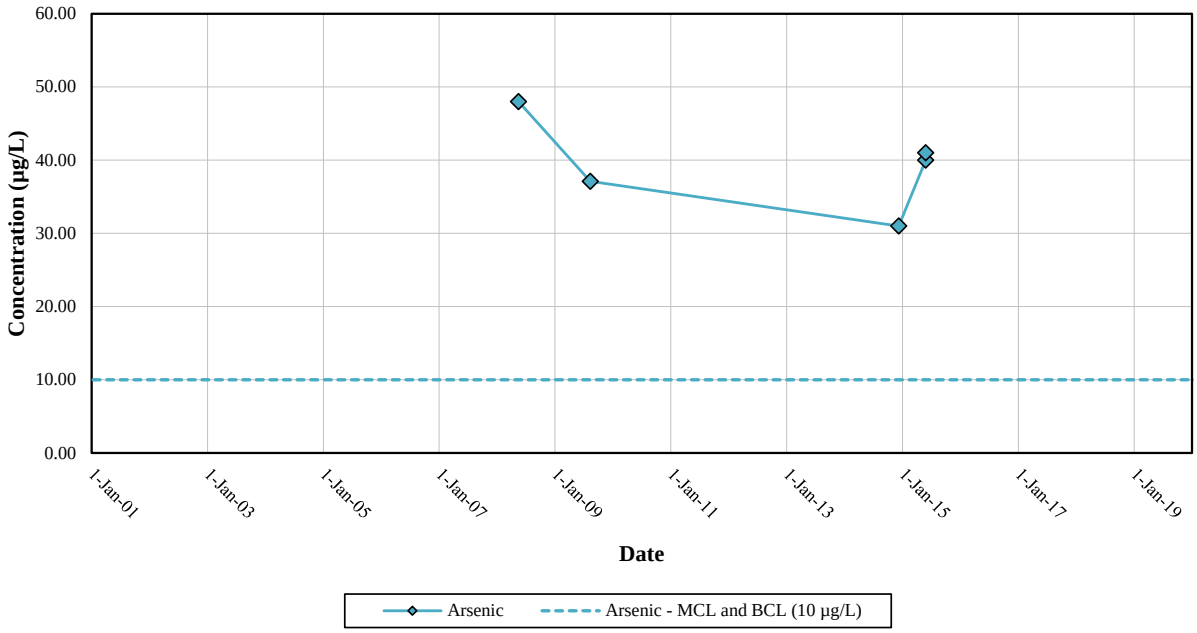
Well AA-UW1
Arsenic Concentrations vs. Time



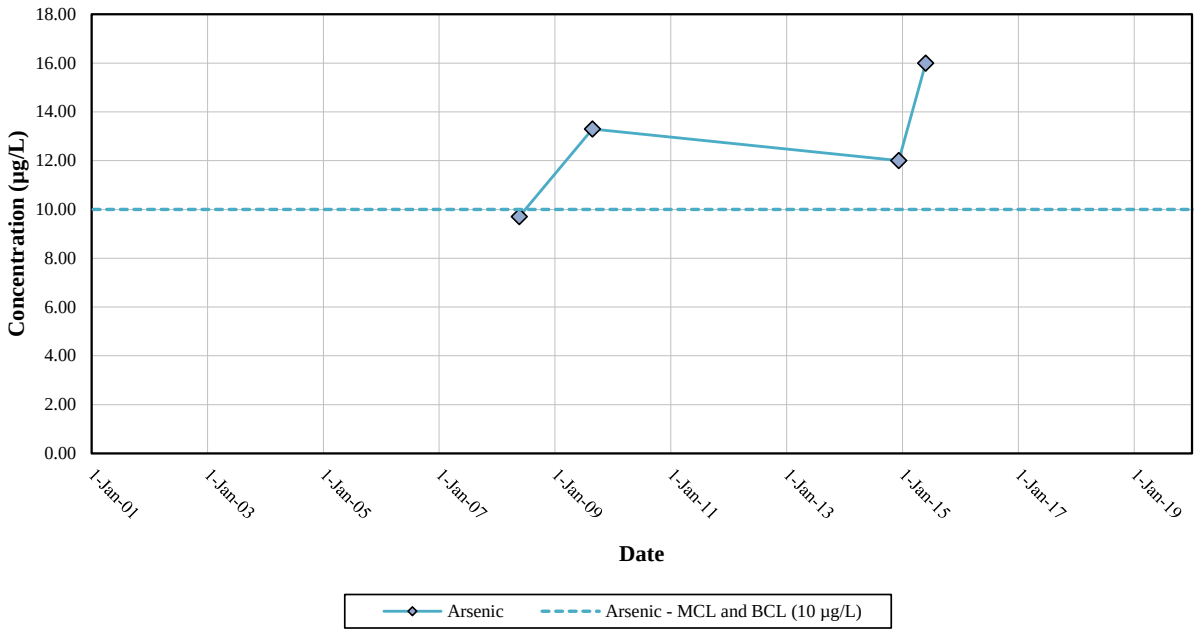
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-UW2
Arsenic Concentrations vs. Time



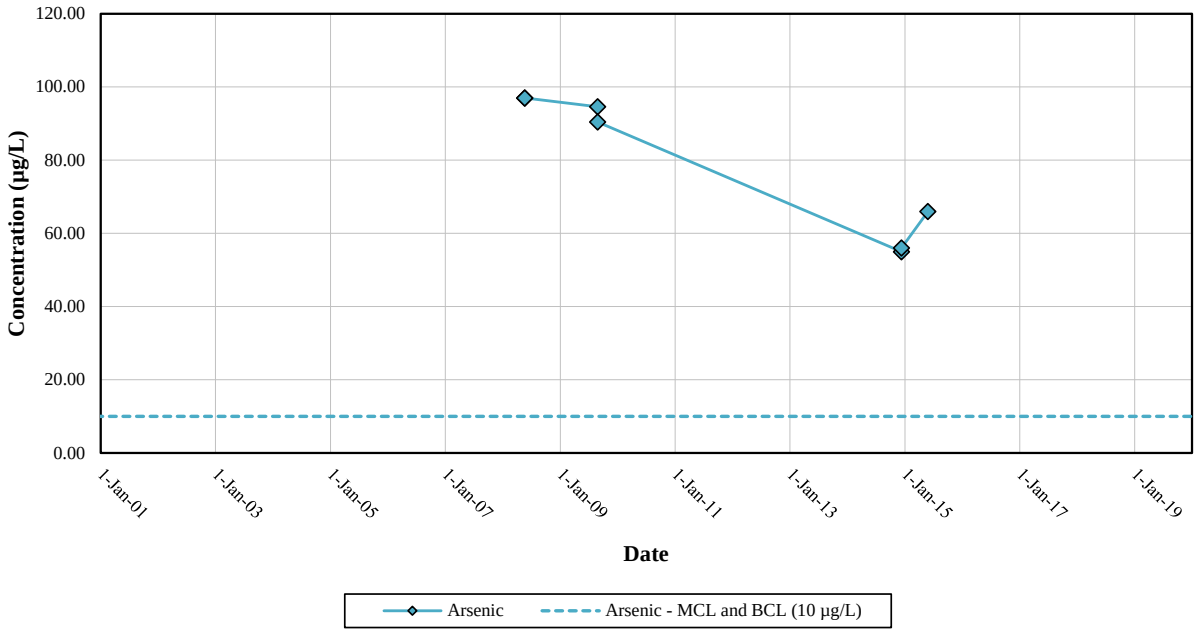
Well AA-UW3
Arsenic Concentrations vs. Time



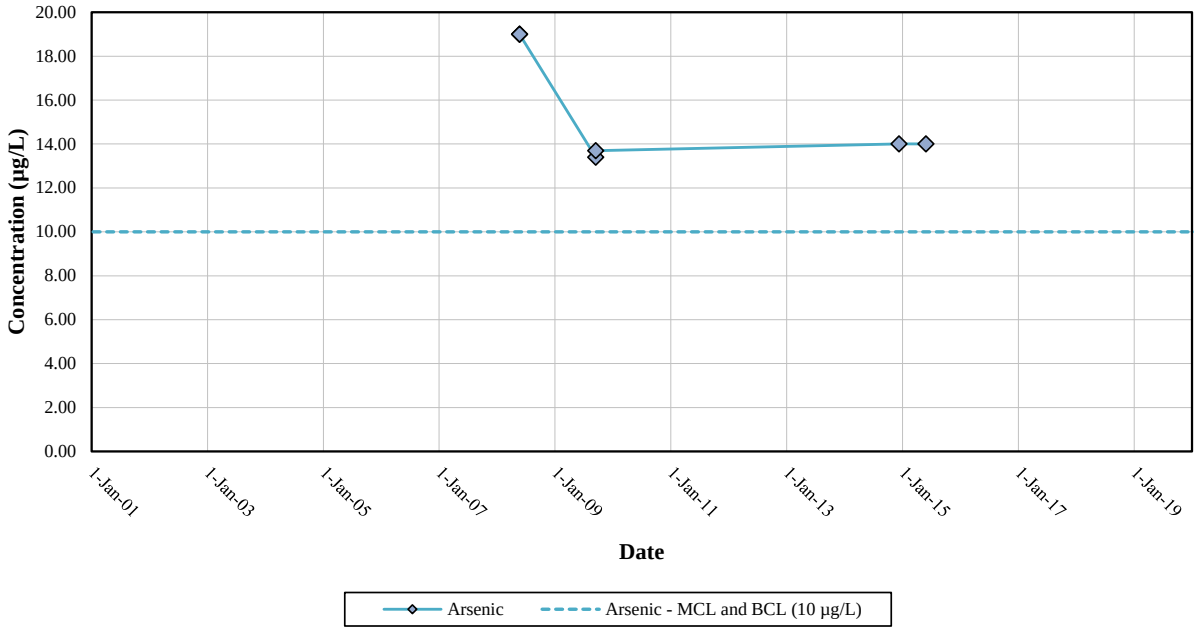
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-UW4
Arsenic Concentrations vs. Time



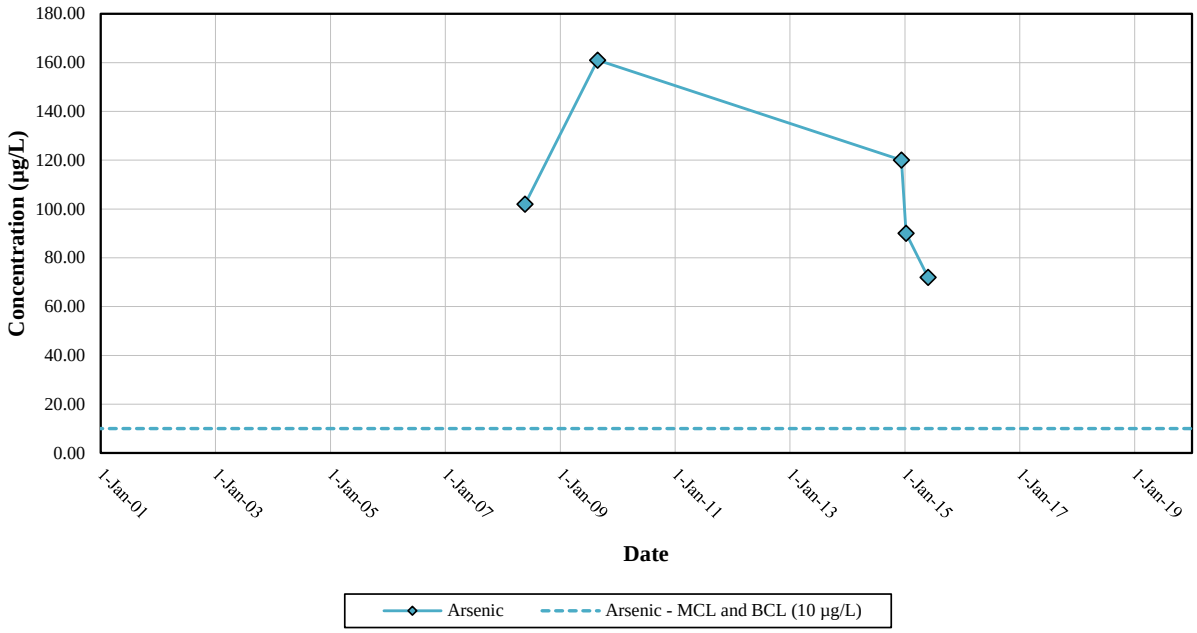
Well AA-UW5
Arsenic Concentrations vs. Time



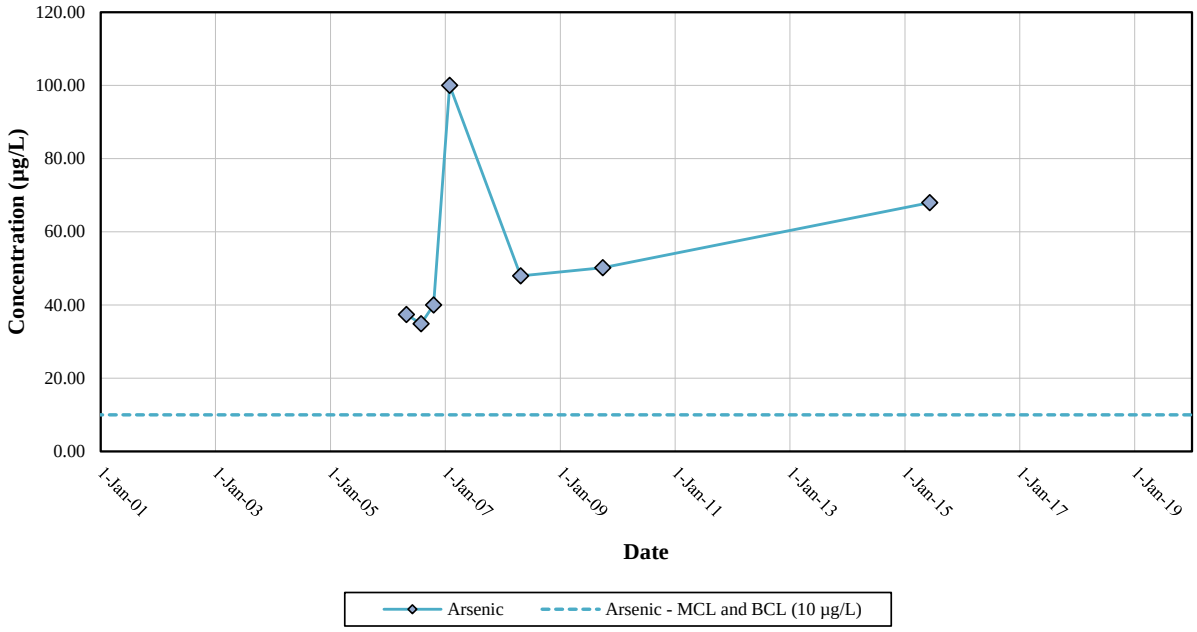
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-UW6
Arsenic Concentrations vs. Time



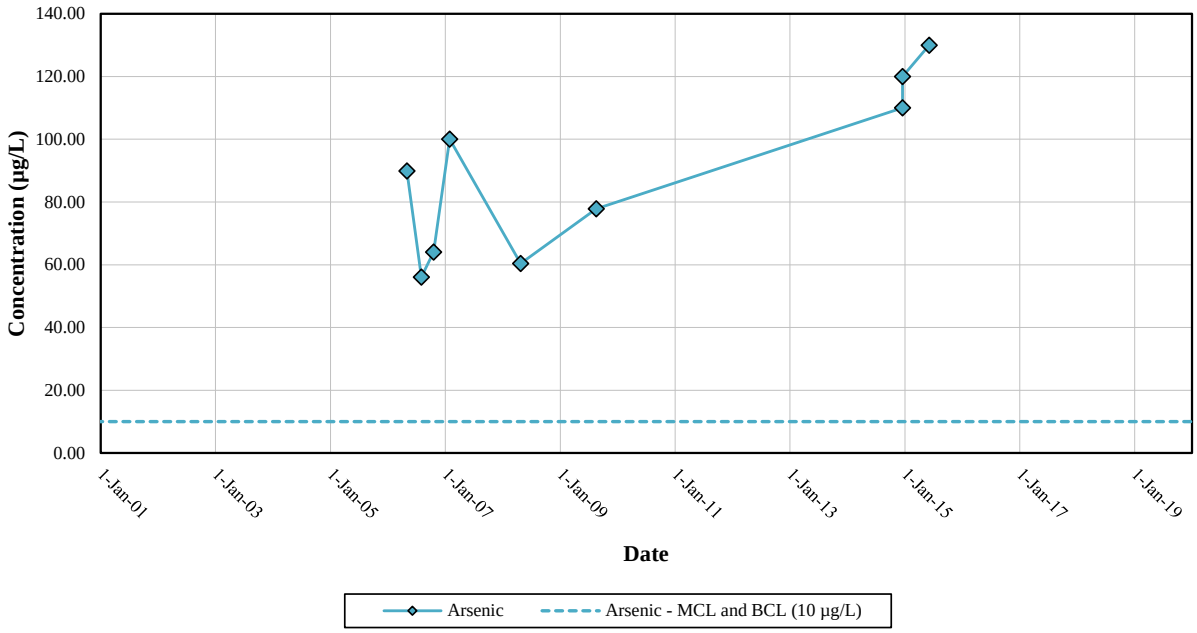
Well BEC-6
Arsenic Concentrations vs. Time



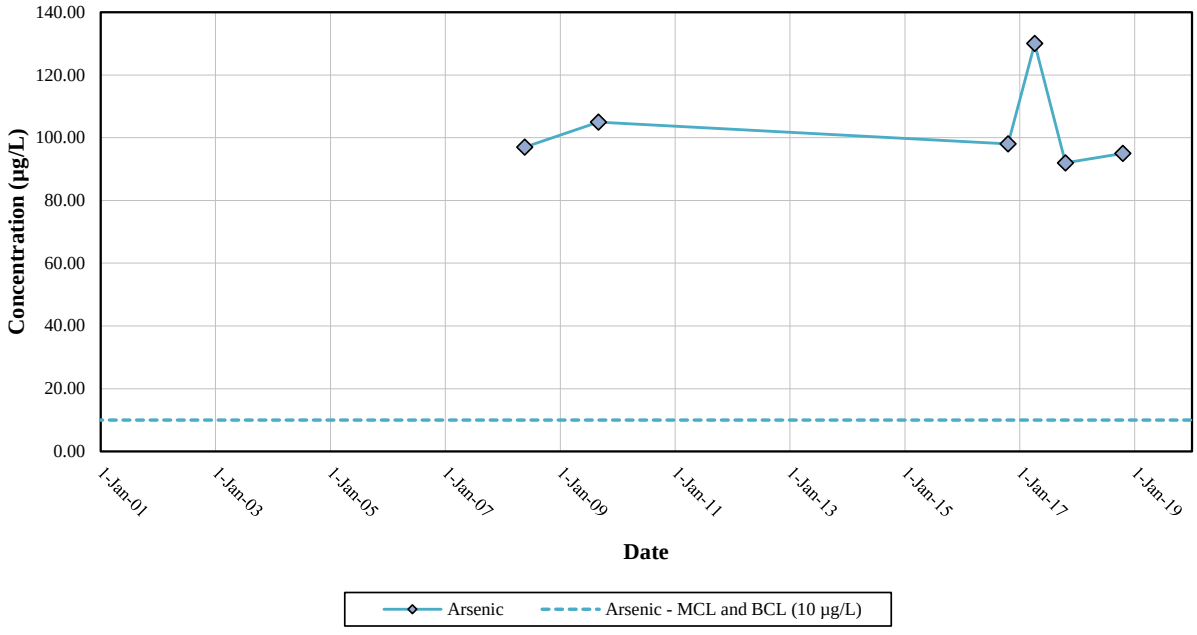
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well BEC-9
Arsenic Concentrations vs. Time



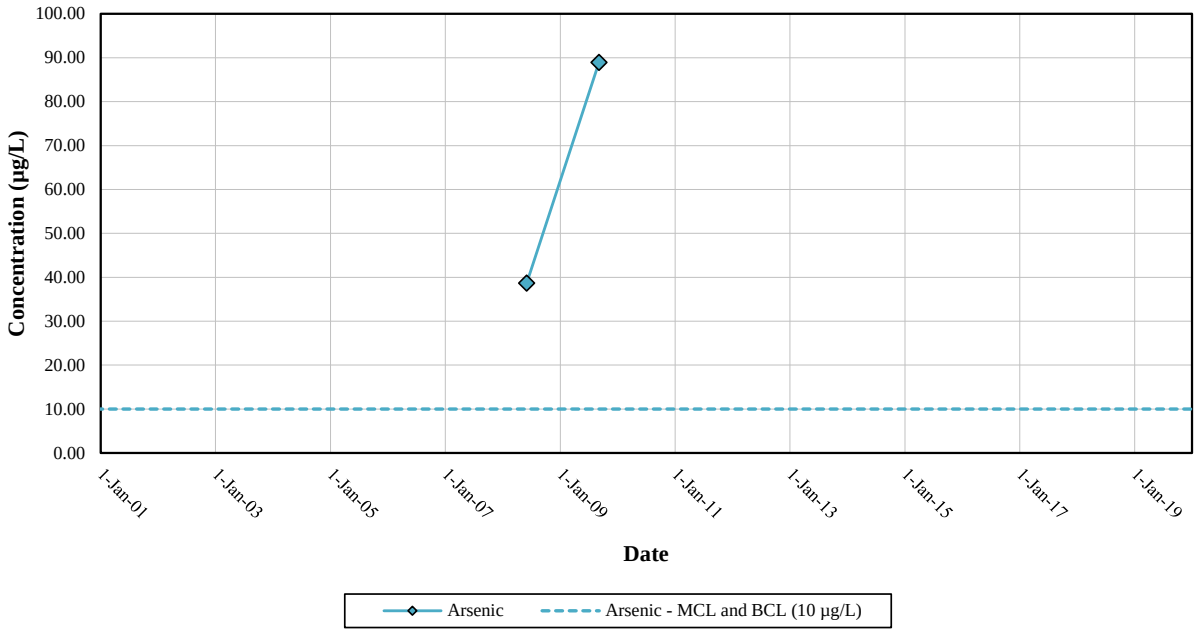
Well DBMW-1
Arsenic Concentrations vs. Time



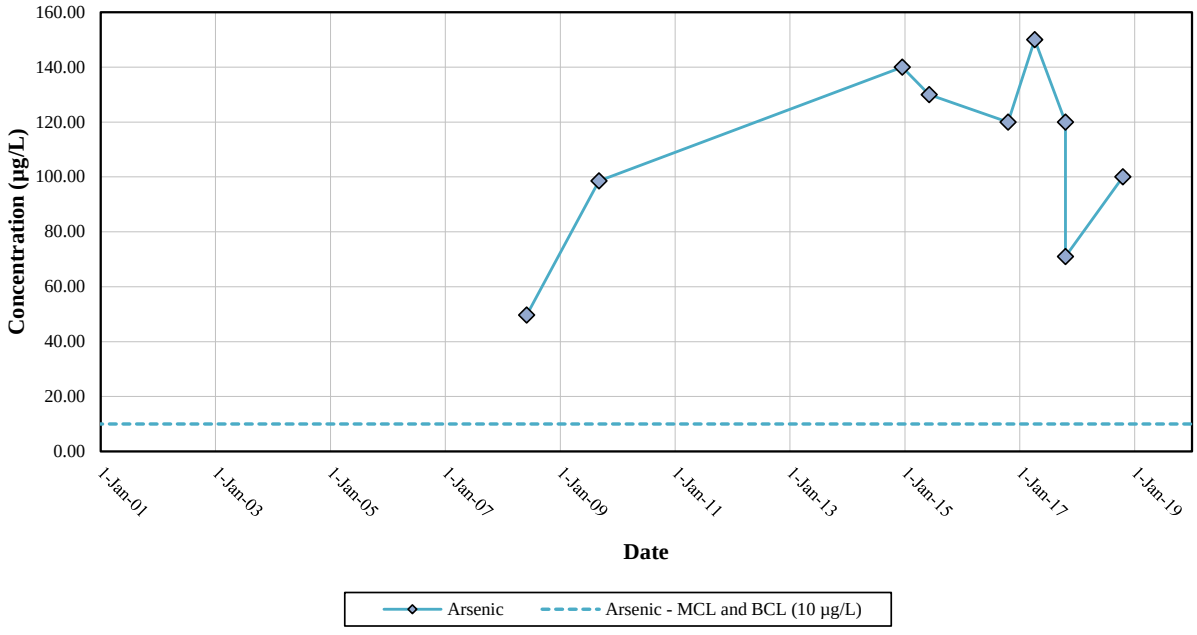
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-2
Arsenic Concentrations vs. Time



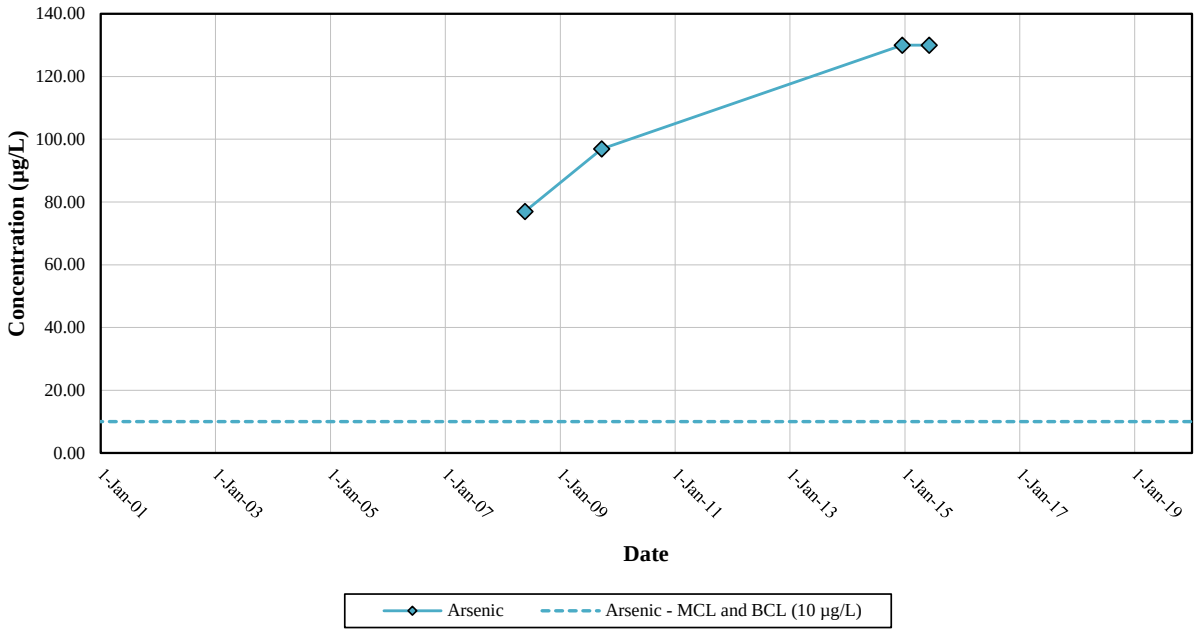
Well DBMW-3
Arsenic Concentrations vs. Time



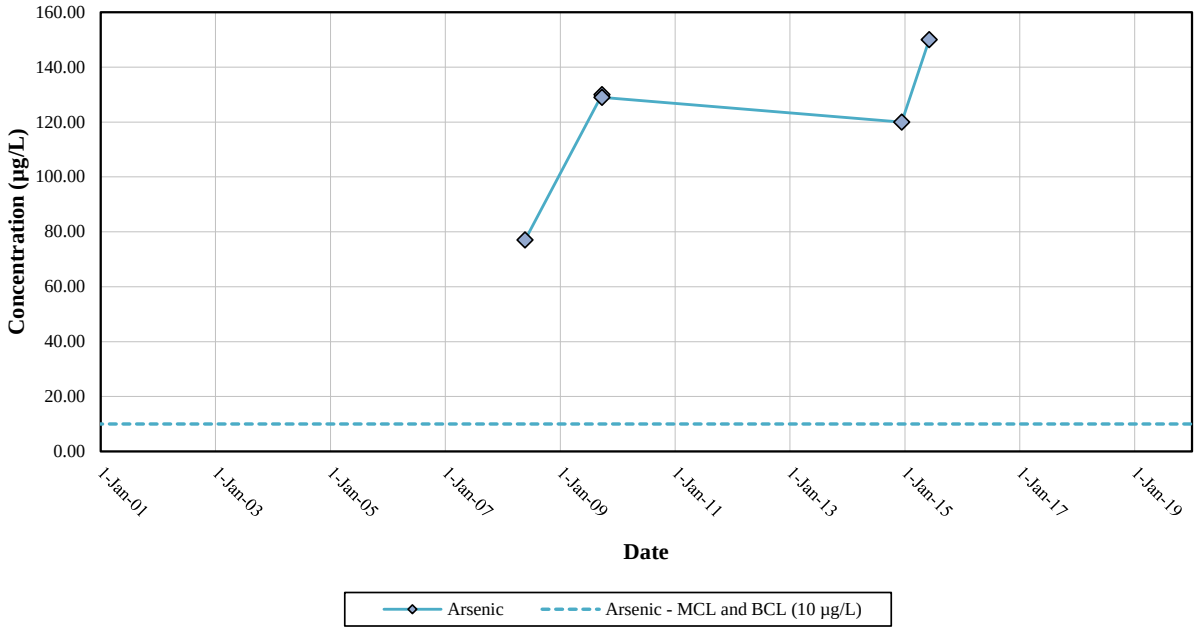
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-4
Arsenic Concentrations vs. Time



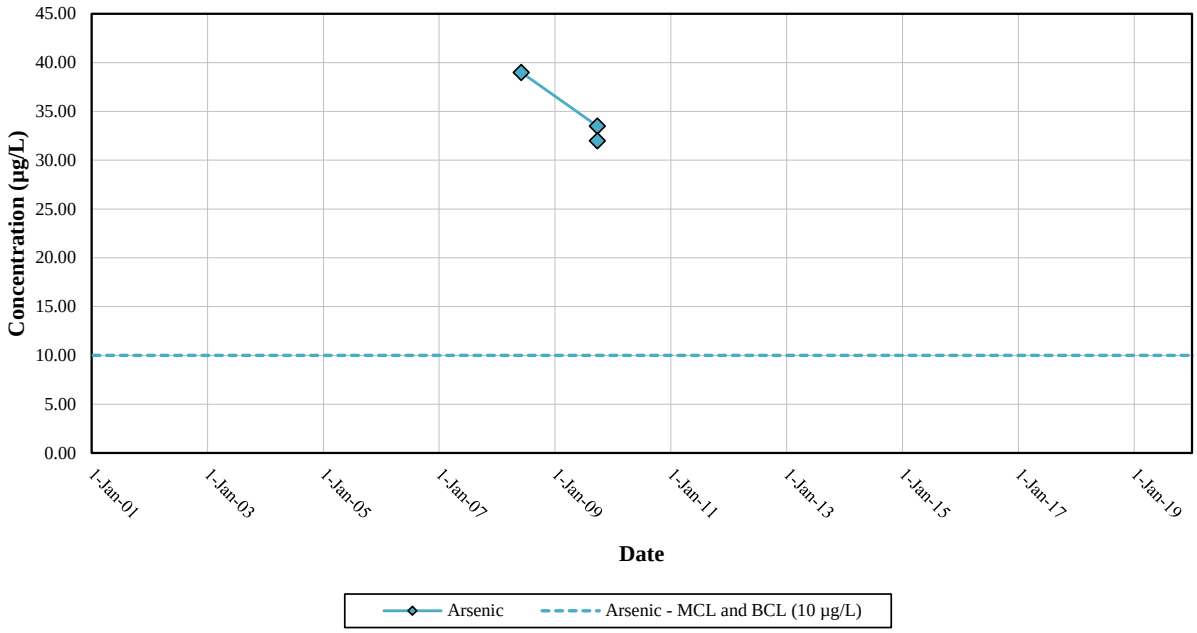
Well DBMW-5
Arsenic Concentrations vs. Time



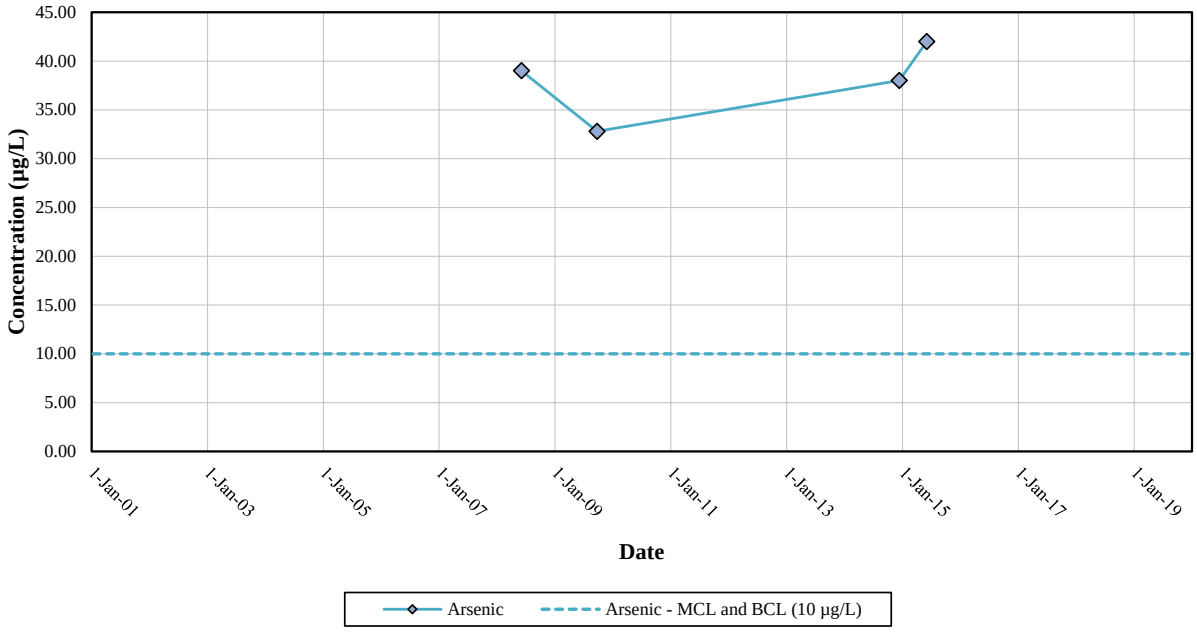
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-7
Arsenic Concentrations vs. Time



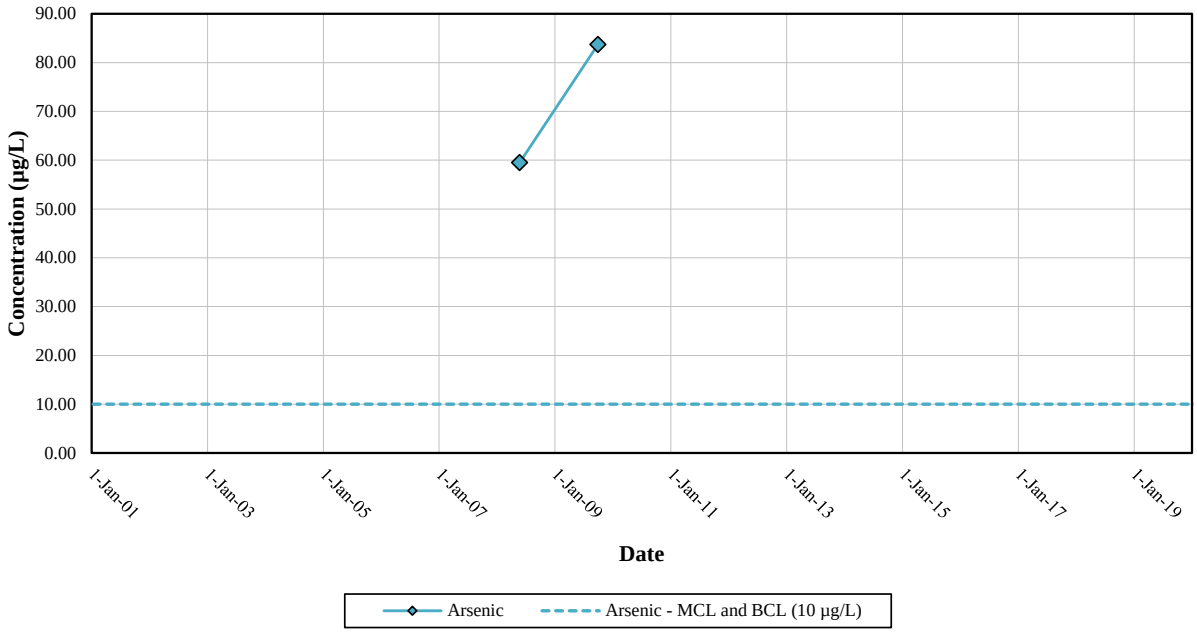
Well DBMW-8
Arsenic Concentrations vs. Time



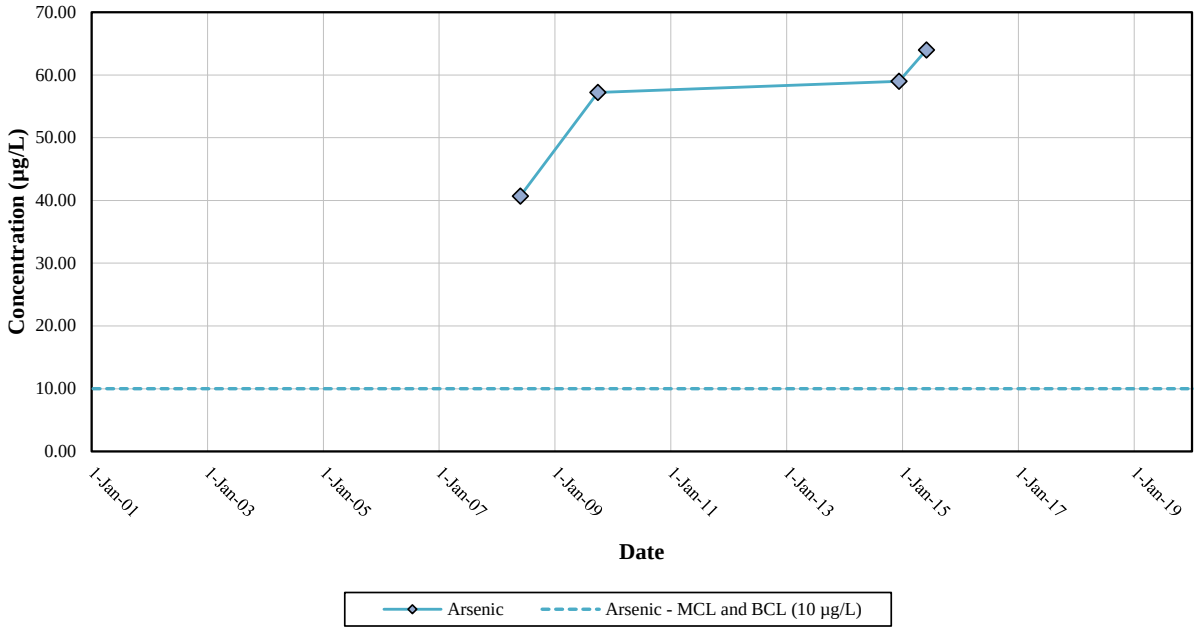
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-9
Arsenic Concentrations vs. Time



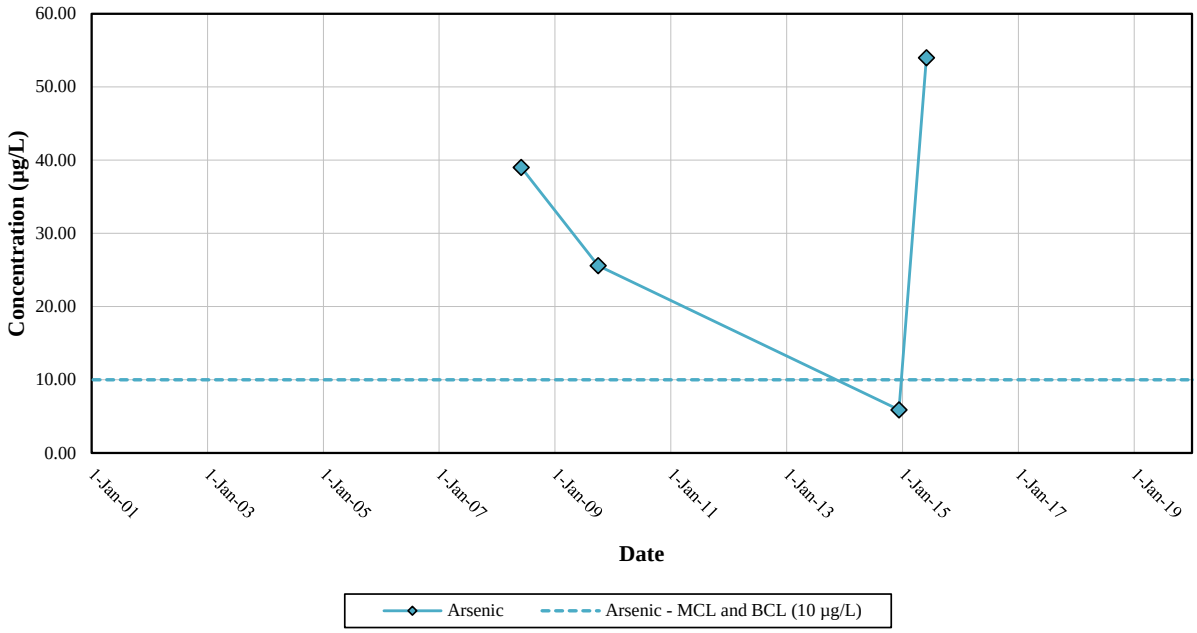
Well DBMW-10
Arsenic Concentrations vs. Time



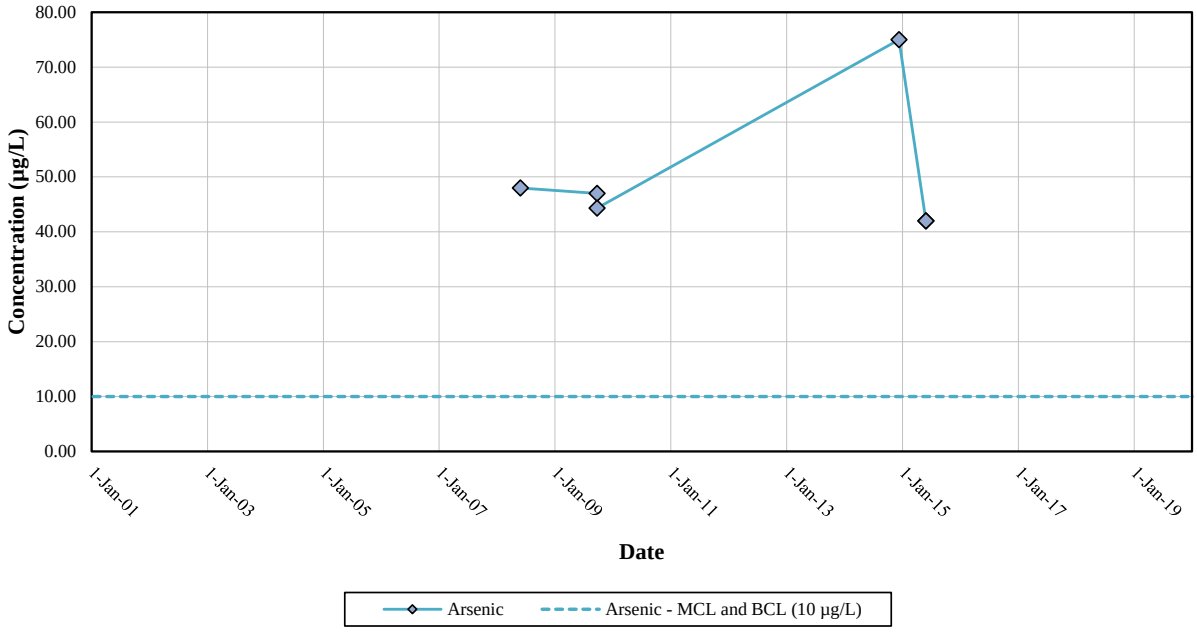
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-11
Arsenic Concentrations vs. Time



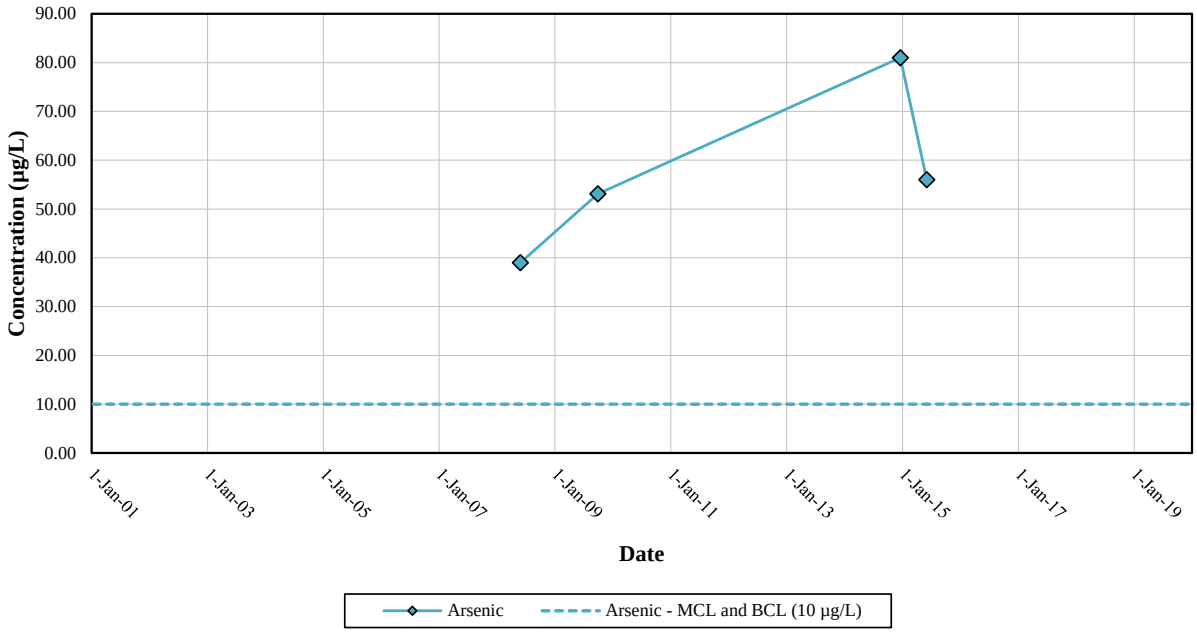
Well DBMW-12
Arsenic Concentrations vs. Time



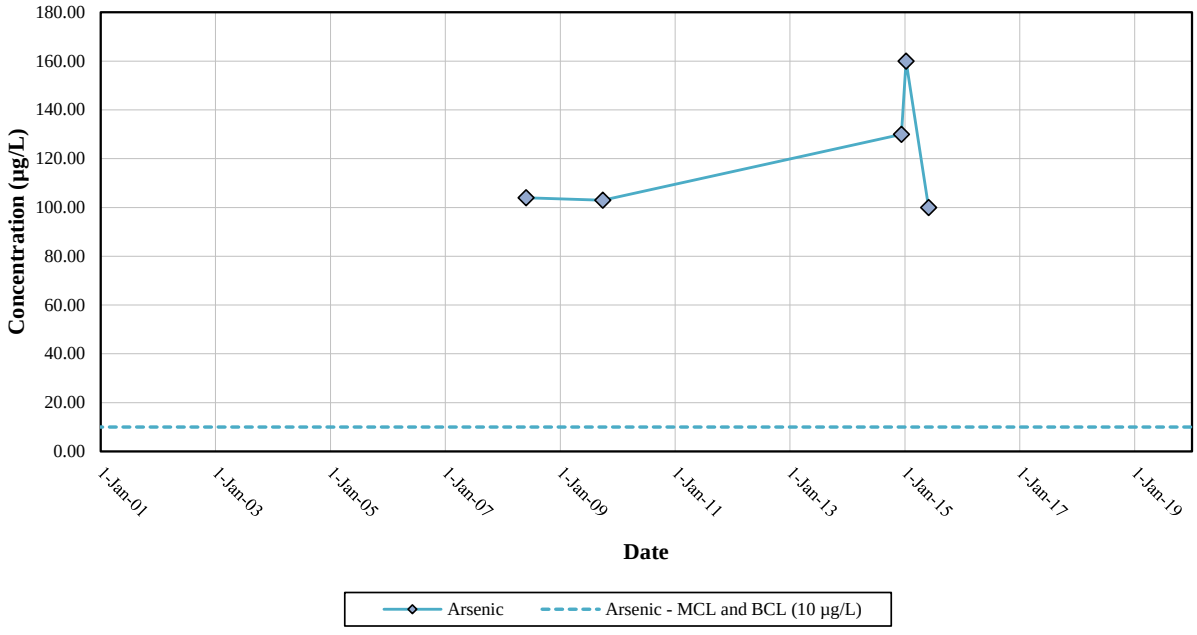
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-13
Arsenic Concentrations vs. Time



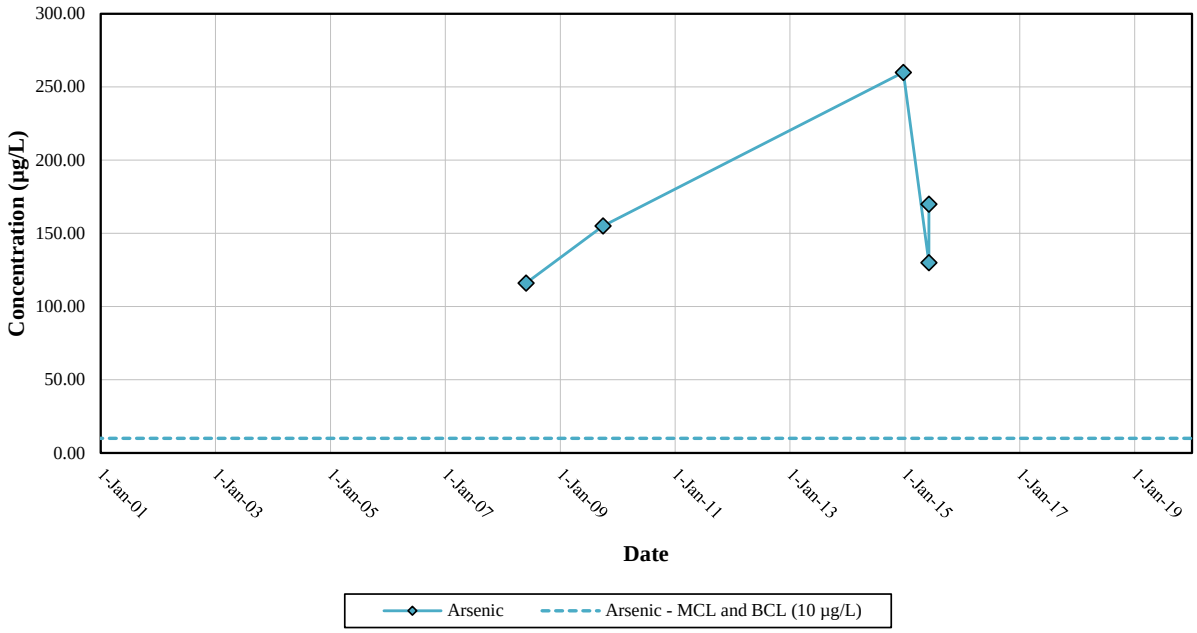
Well DBMW-14
Arsenic Concentrations vs. Time



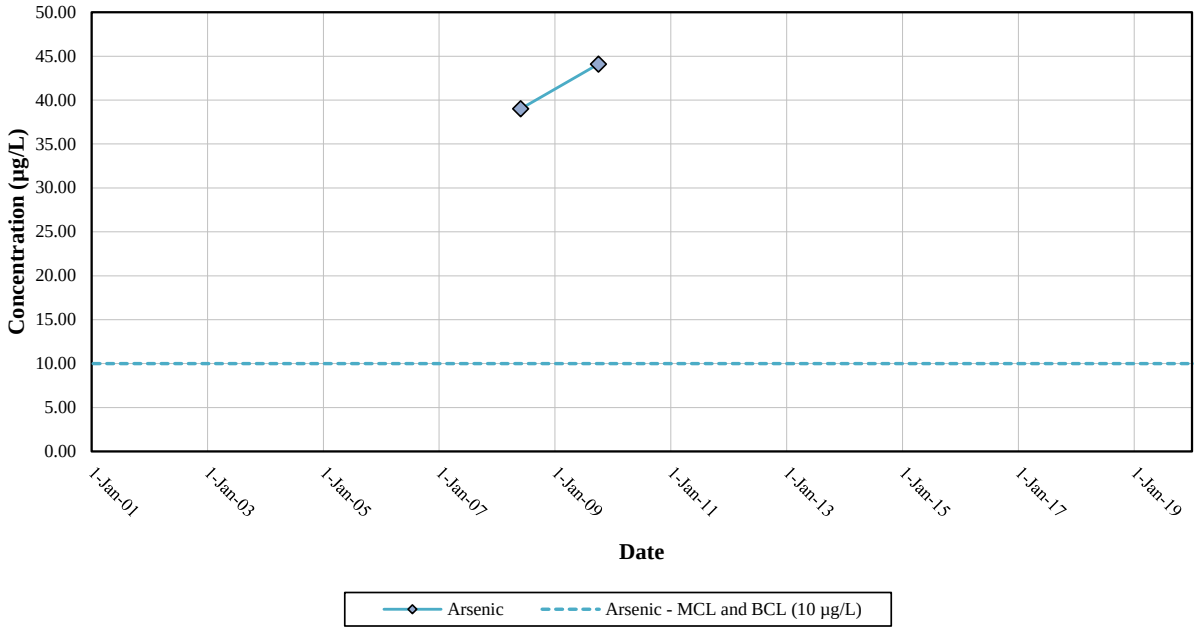
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-15
Arsenic Concentrations vs. Time

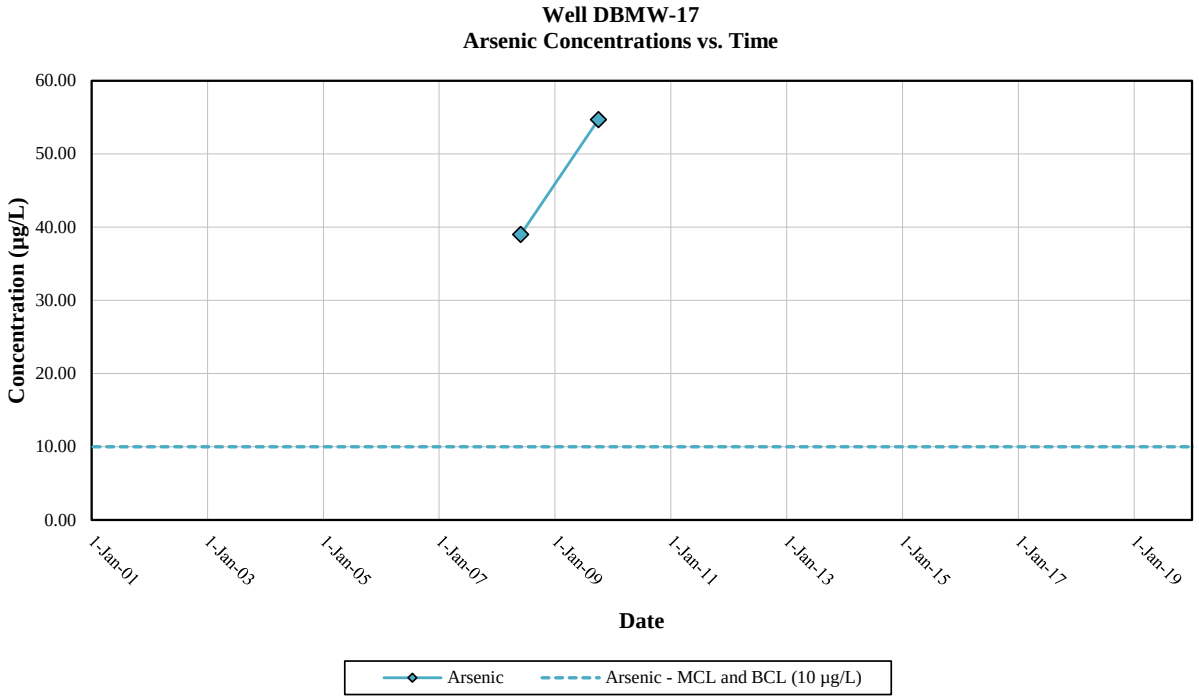


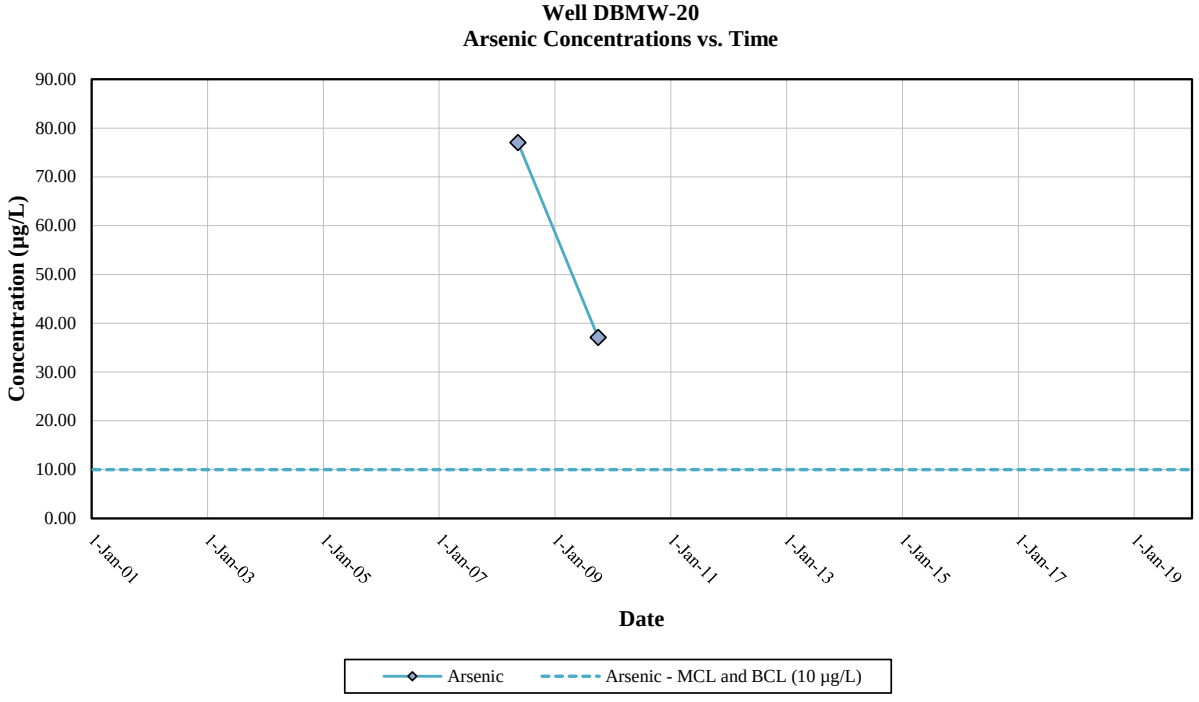
Well DBMW-16
Arsenic Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

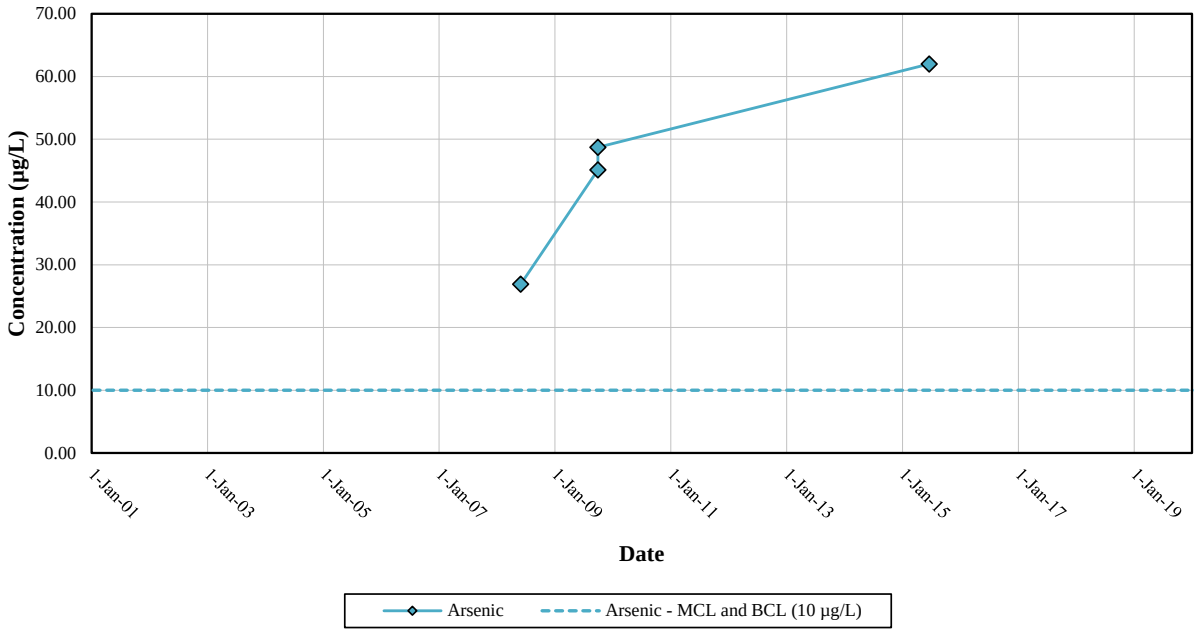




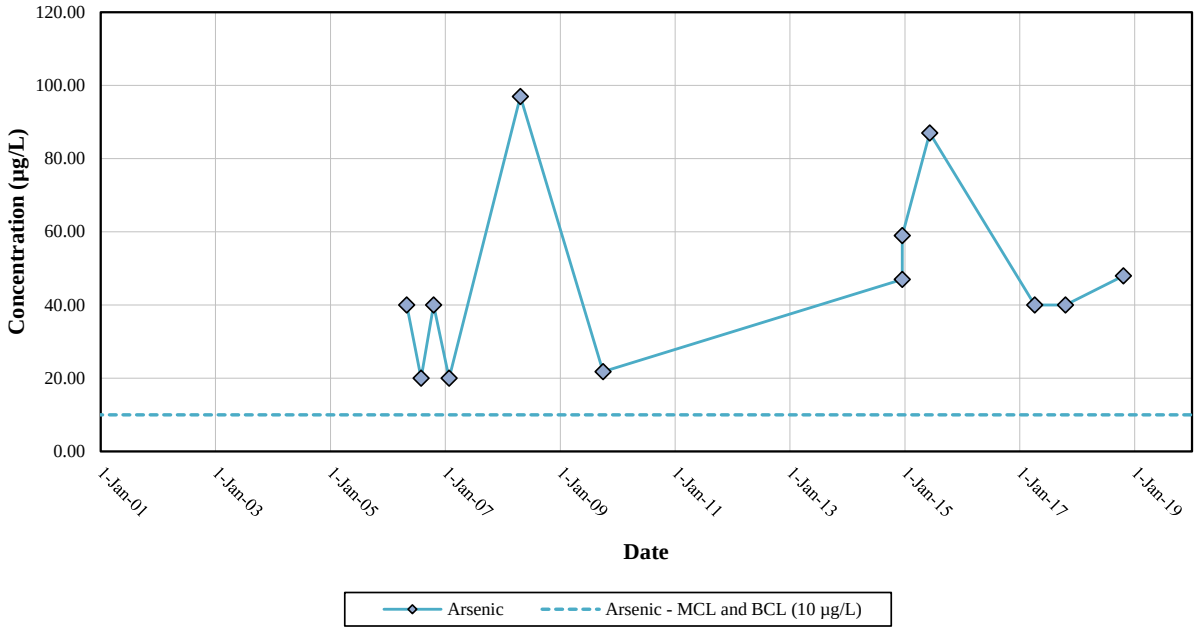
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-22
Arsenic Concentrations vs. Time



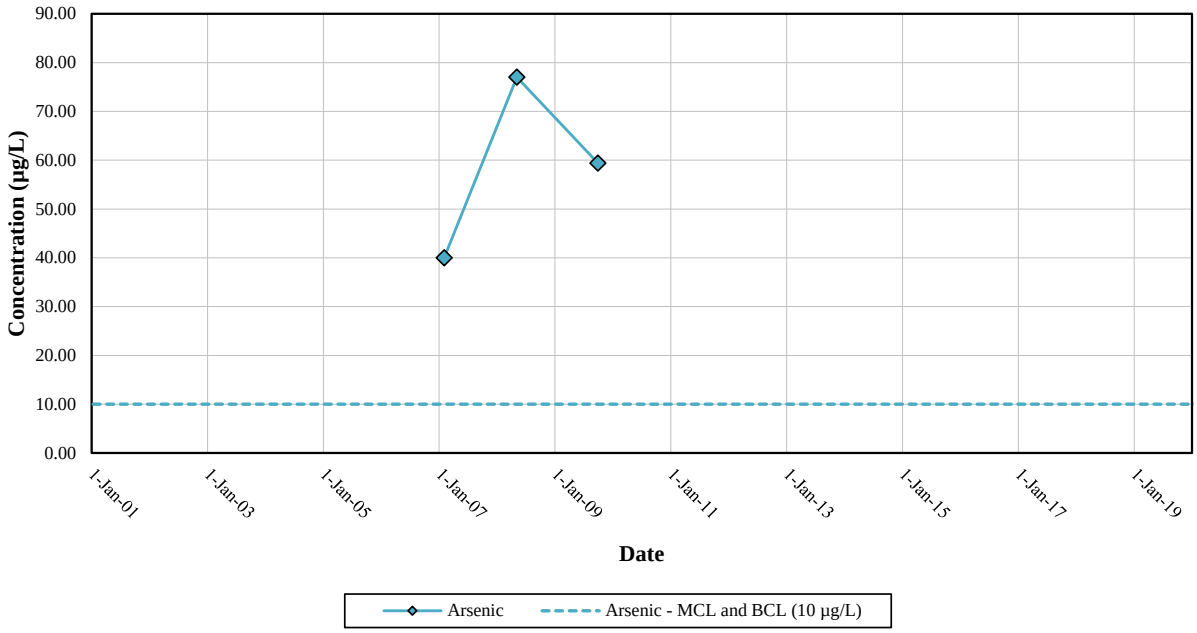
Well DM-1
Arsenic Concentrations vs. Time



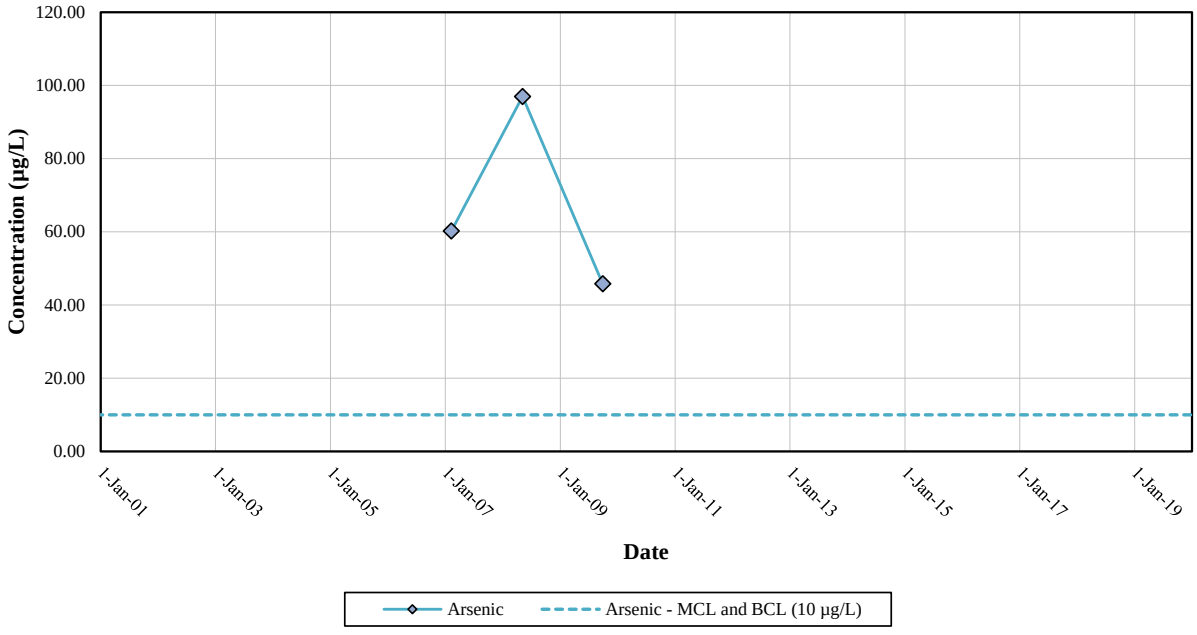
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well HMW-08
Arsenic Concentrations vs. Time



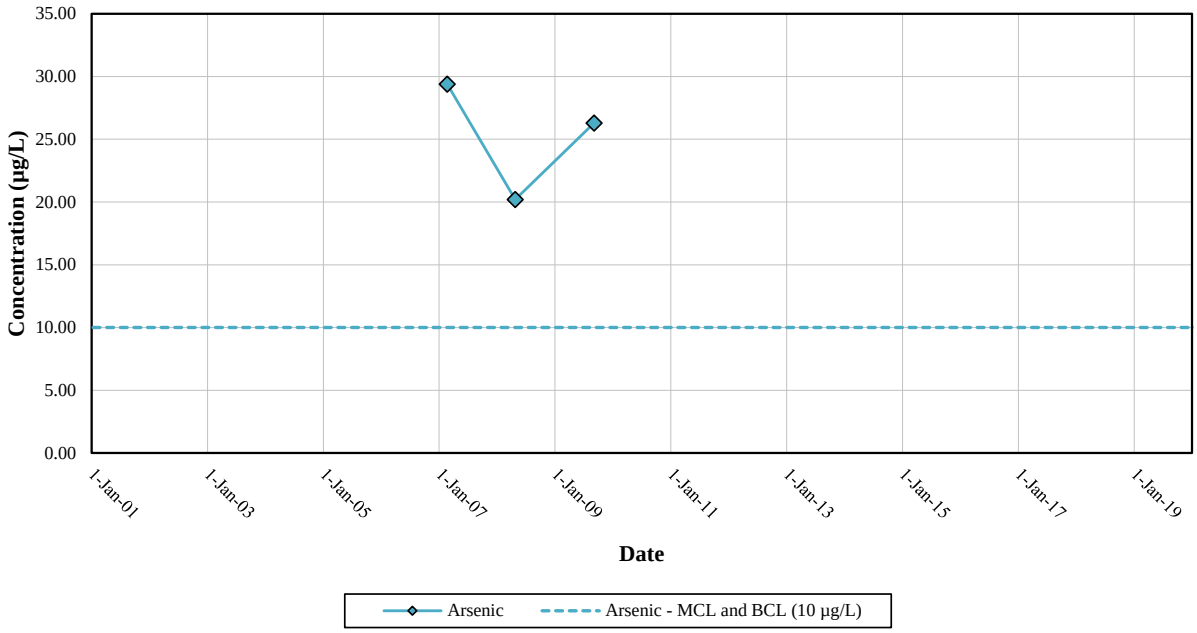
Well HMW-09
Arsenic Concentrations vs. Time



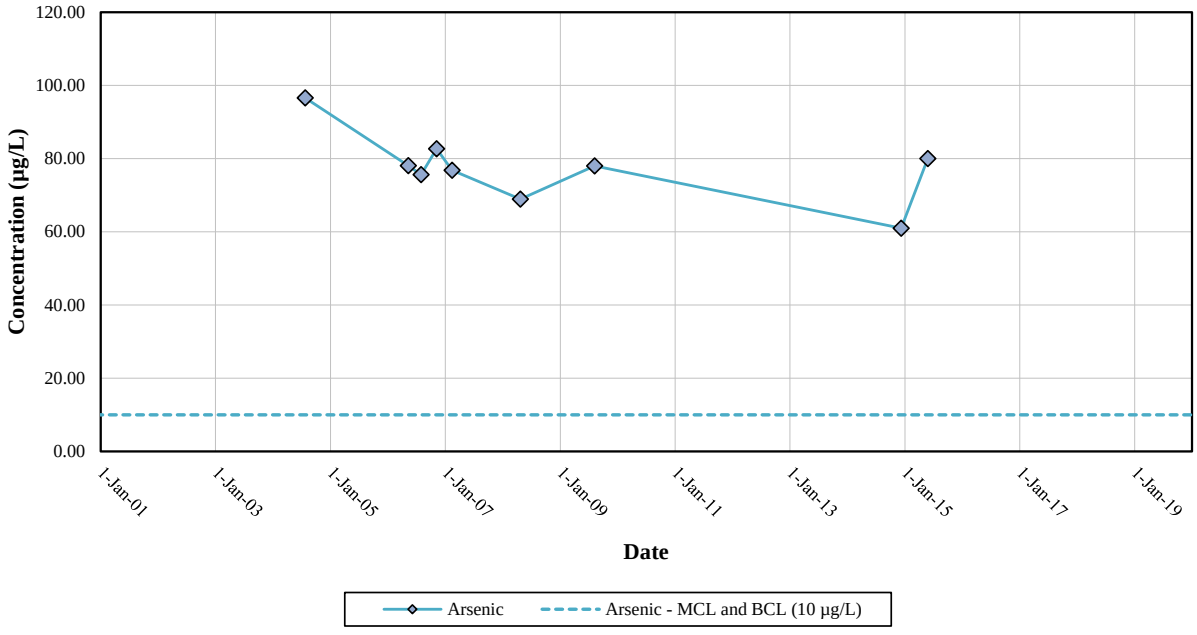
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well HMWWT-6
Arsenic Concentrations vs. Time



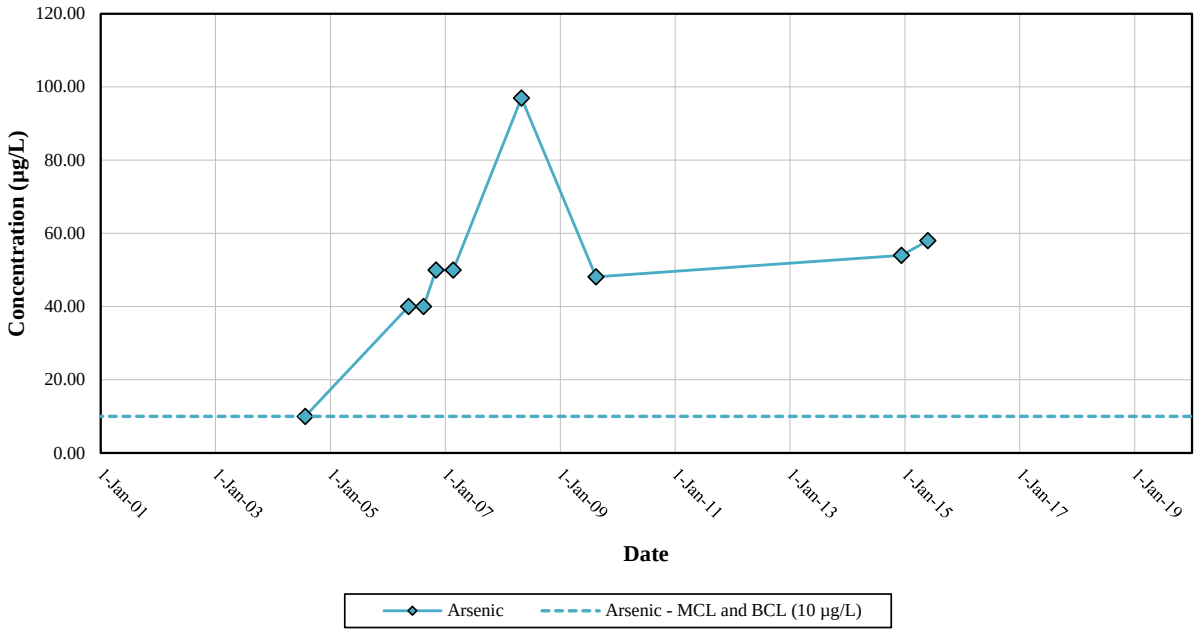
Well MCF-01B
Arsenic Concentrations vs. Time



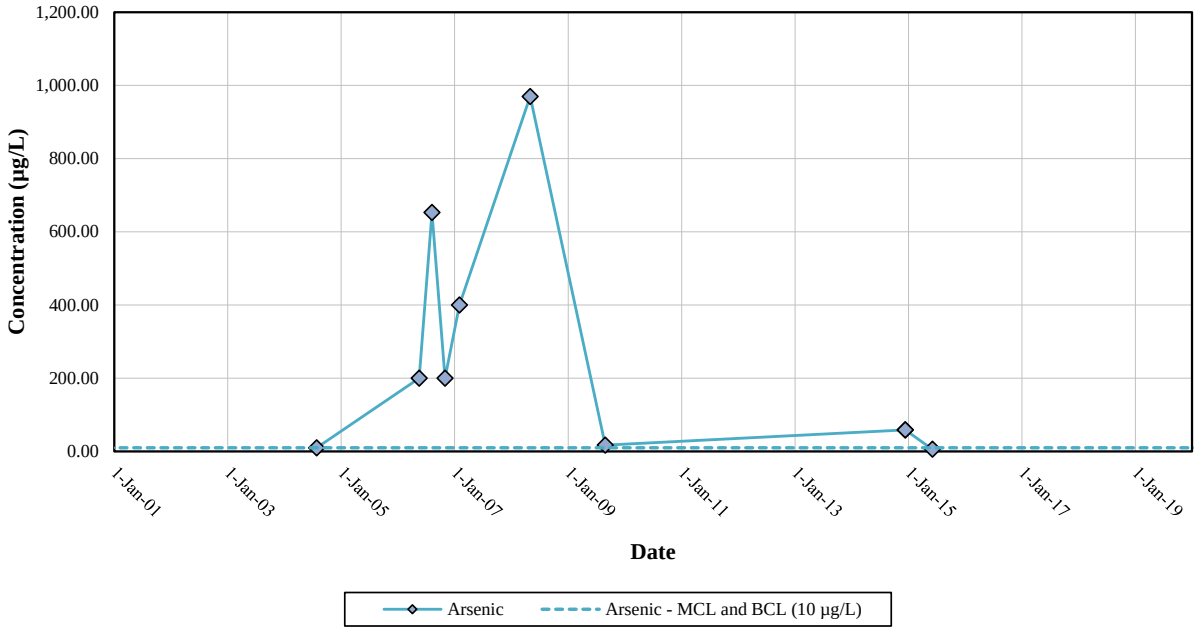
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-03B
Arsenic Concentrations vs. Time



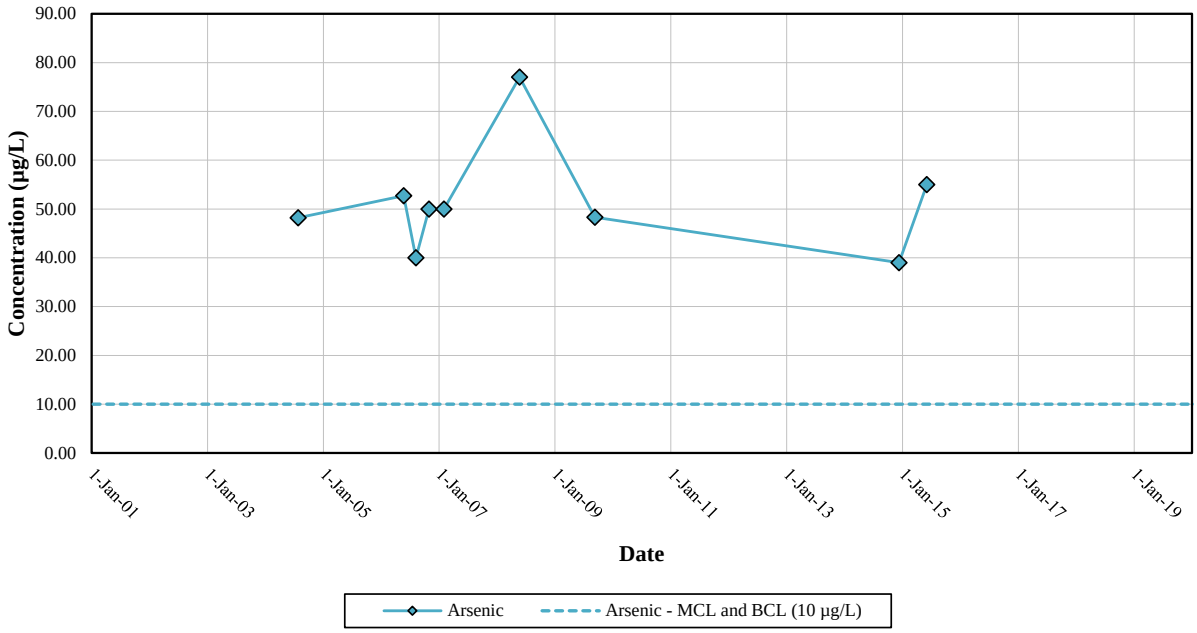
Well MCF-06B
Arsenic Concentrations vs. Time



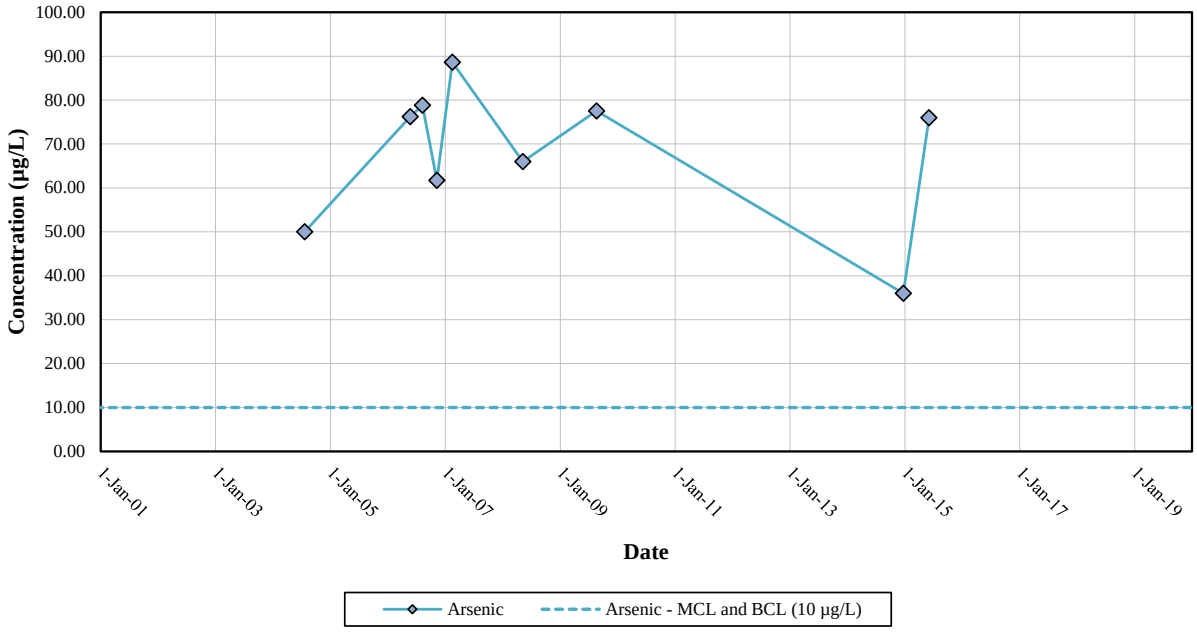
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-06C
Arsenic Concentrations vs. Time



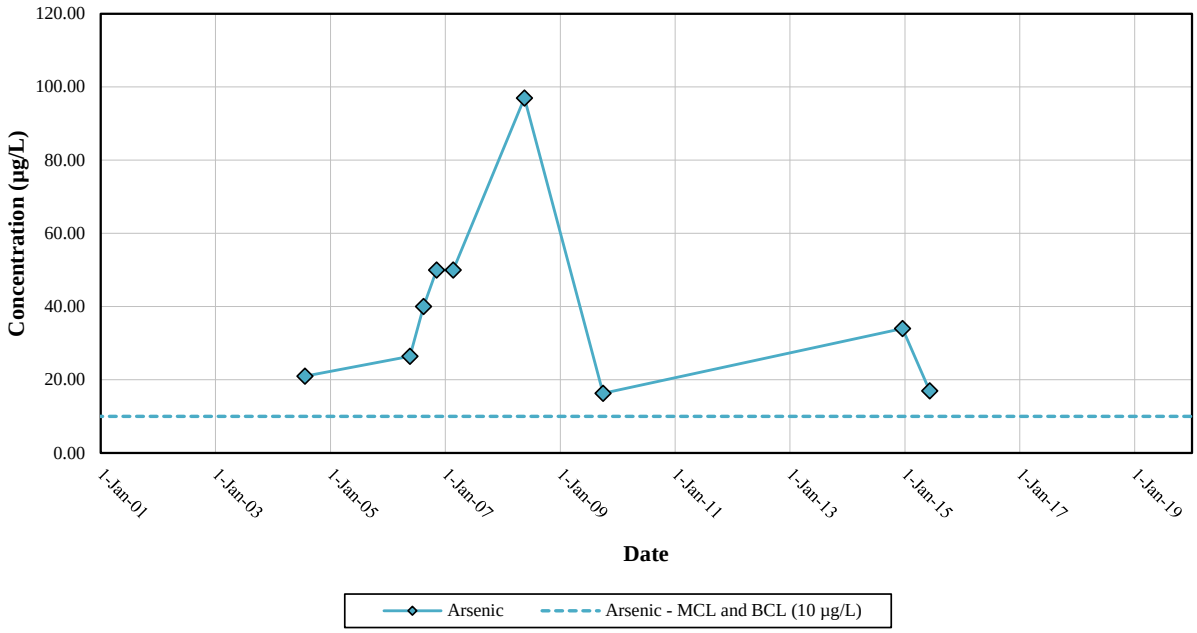
Well MCF-12B
Arsenic Concentrations vs. Time



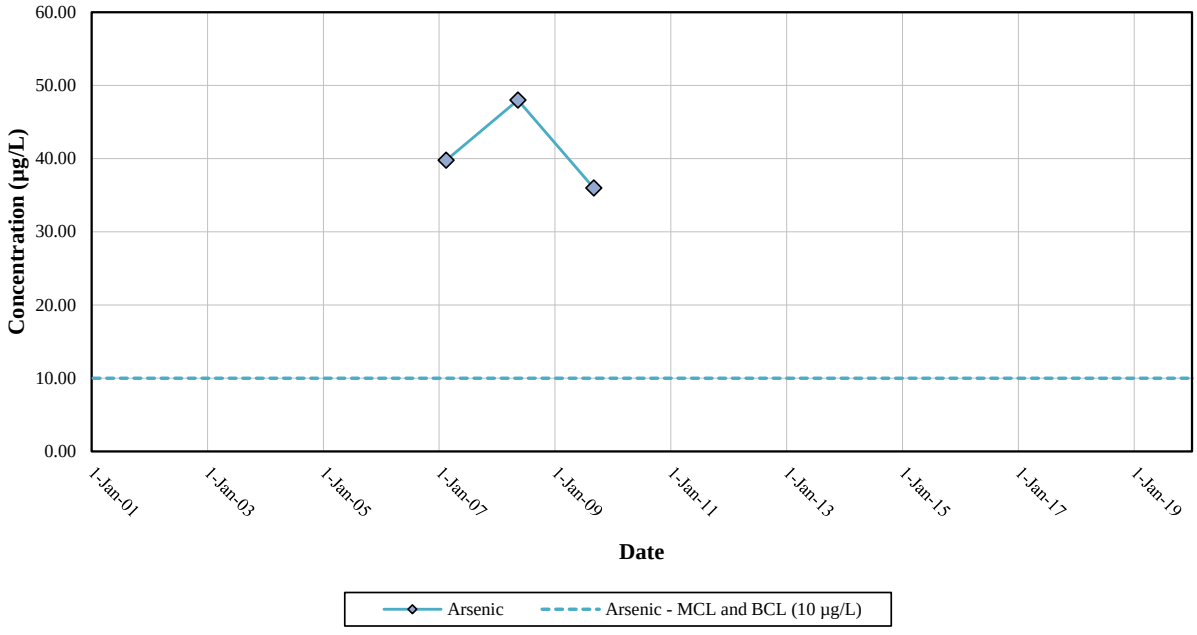
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-16C
Arsenic Concentrations vs. Time



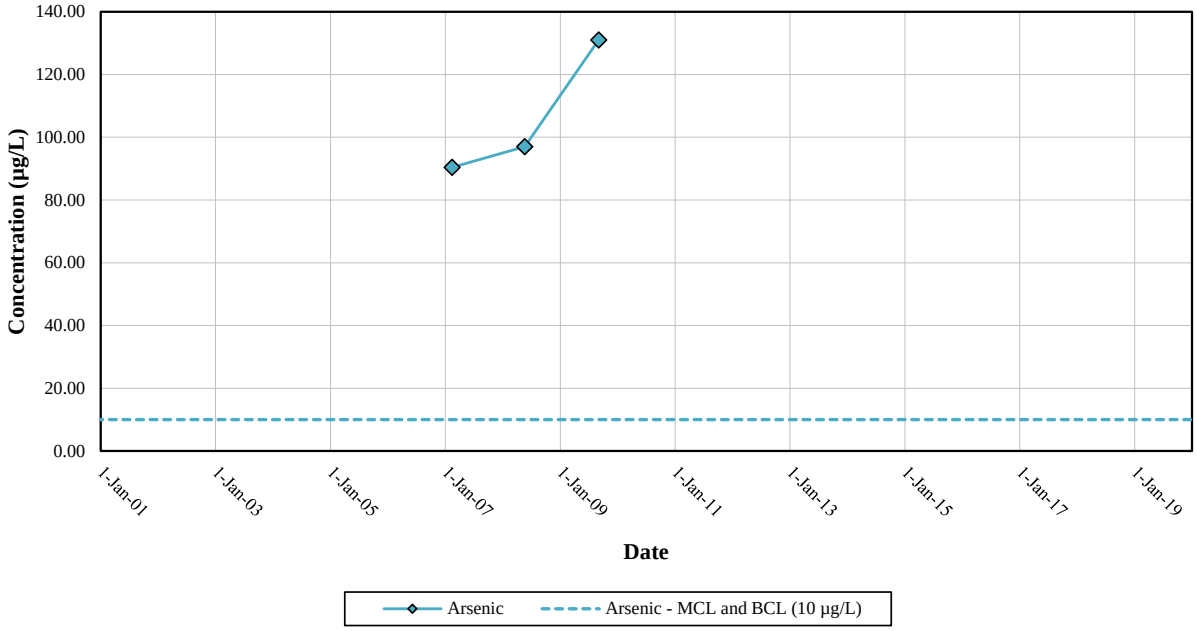
Well MW-13
Arsenic Concentrations vs. Time



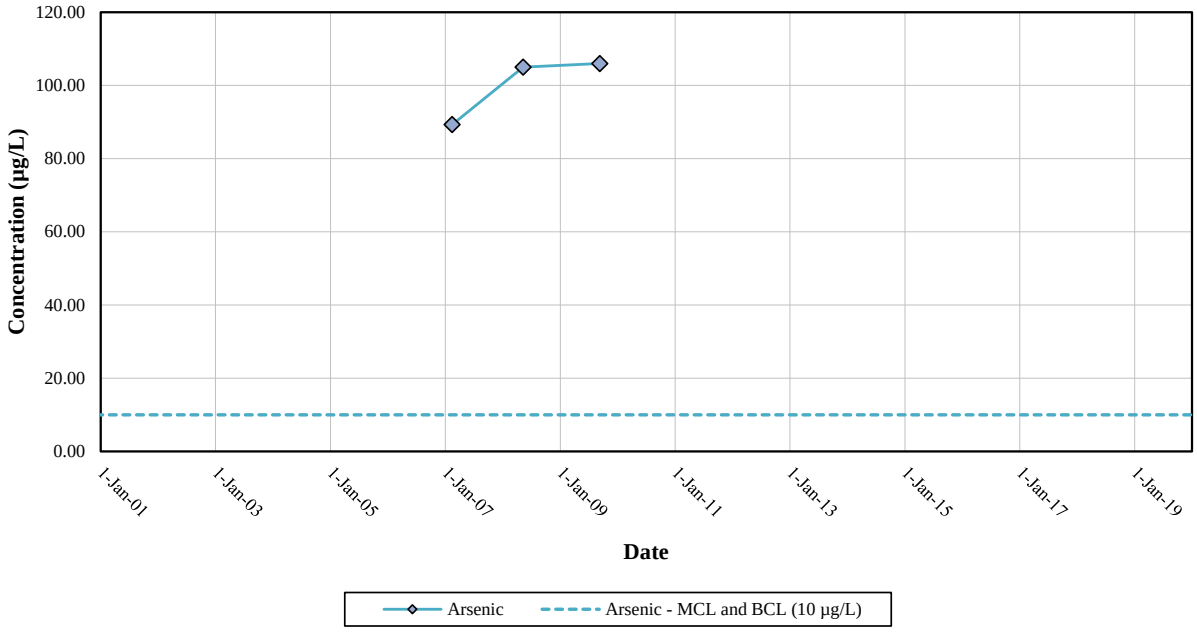
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MW-15
Arsenic Concentrations vs. Time



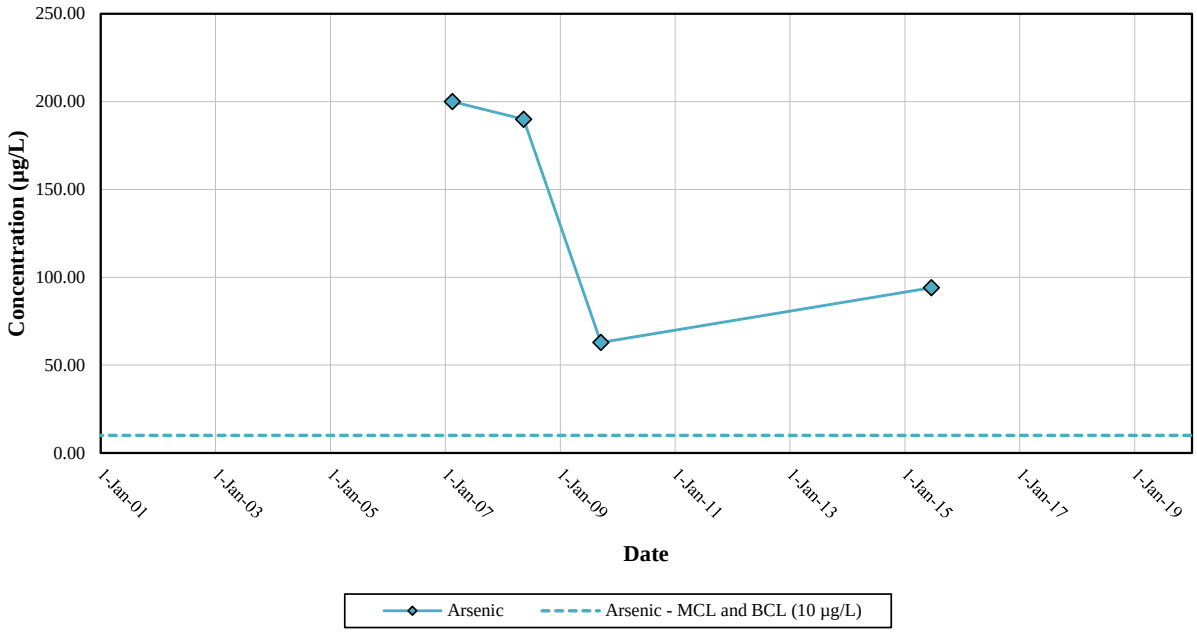
Well MW-3
Arsenic Concentrations vs. Time



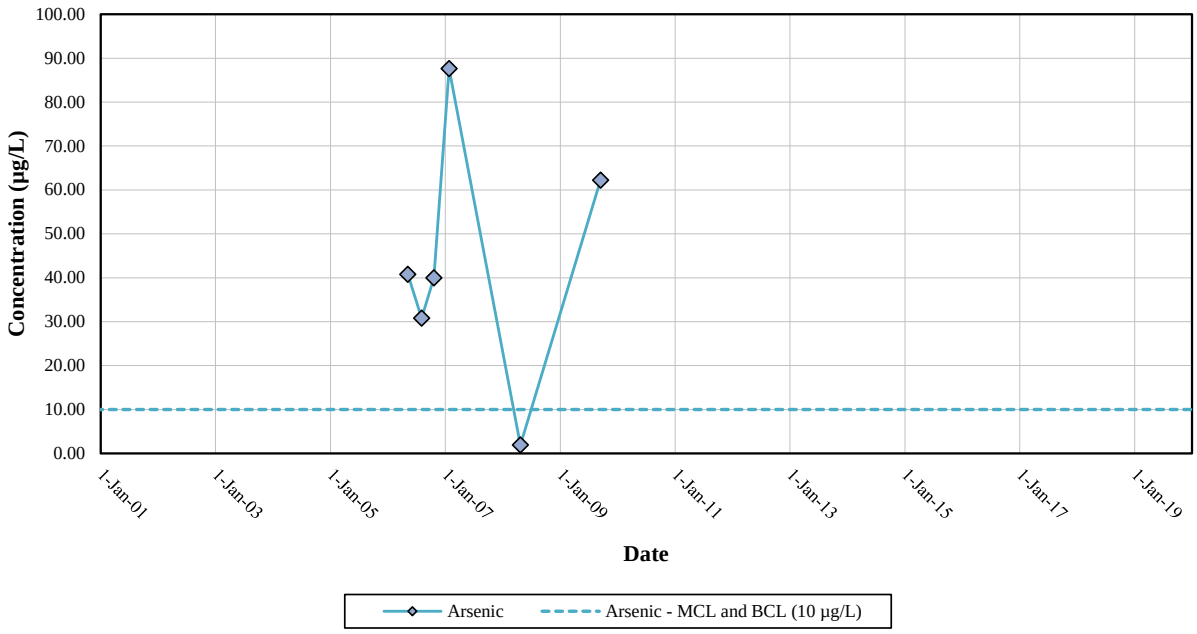
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MW-4
Arsenic Concentrations vs. Time



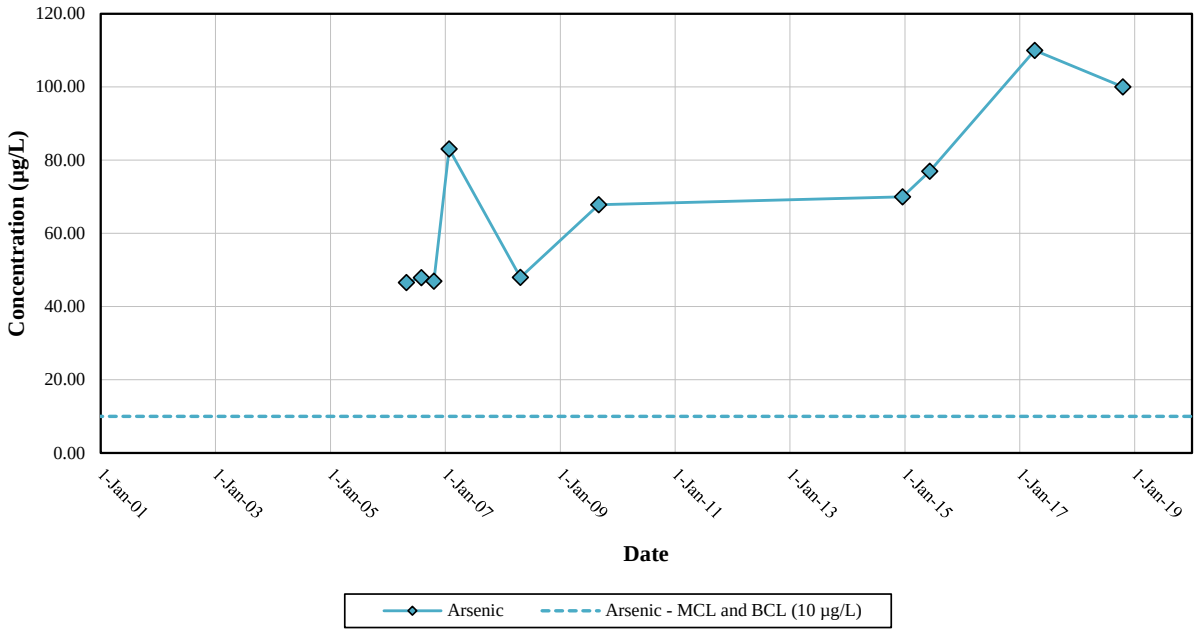
Well POD2-R
Arsenic Concentrations vs. Time



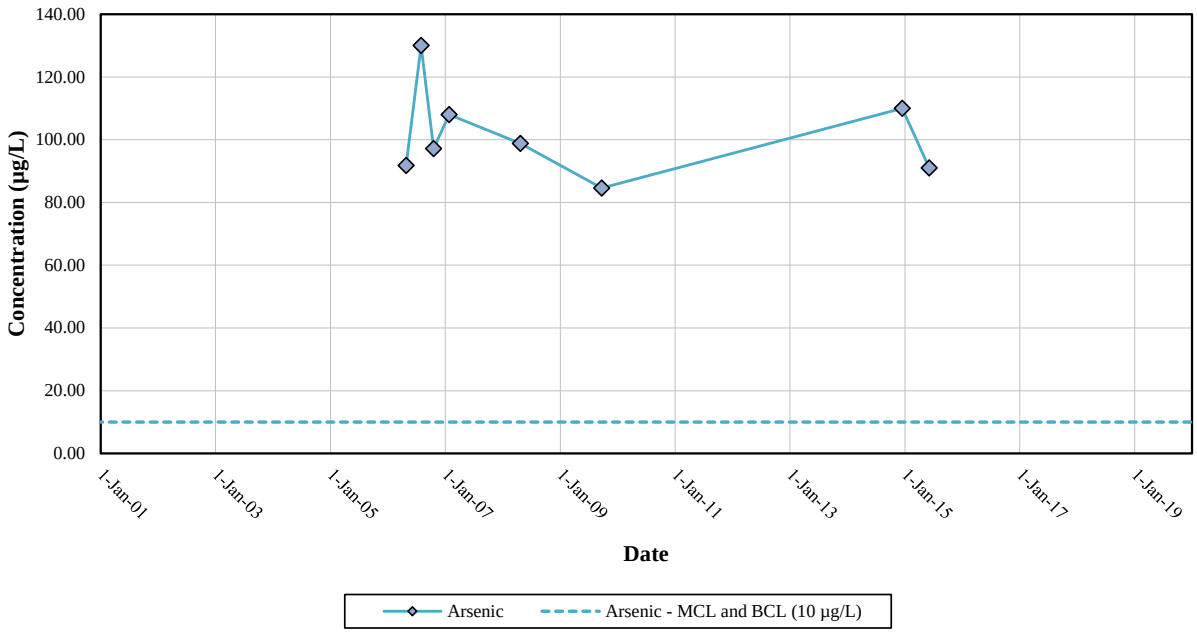
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well POD8
Arsenic Concentrations vs. Time



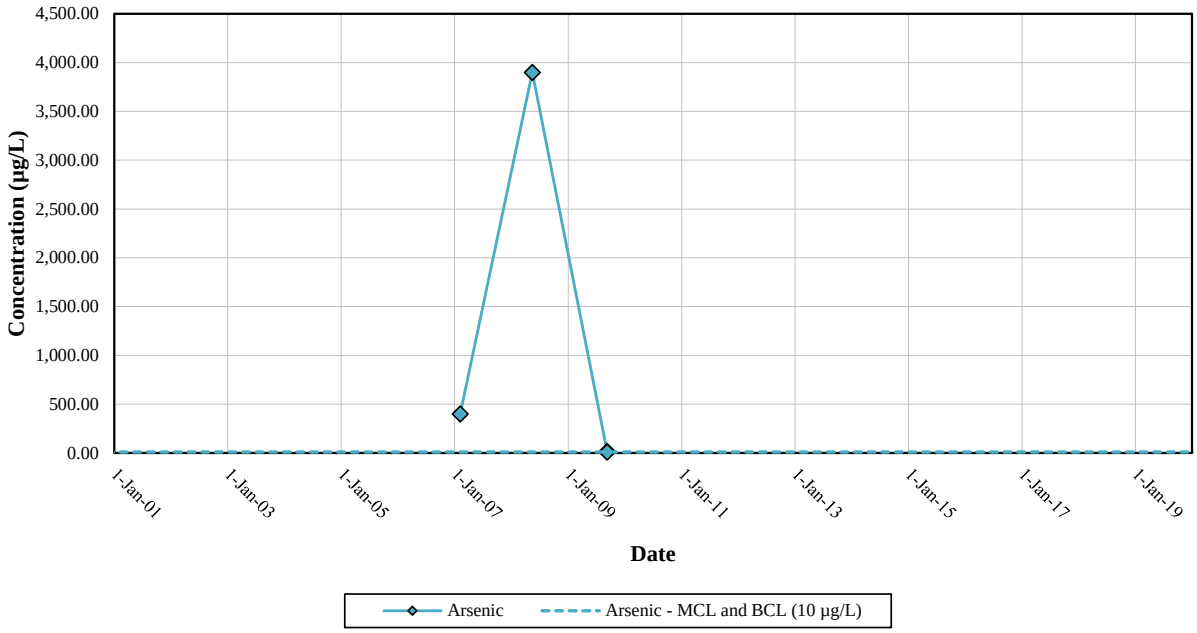
Well POU3
Arsenic Concentrations vs. Time



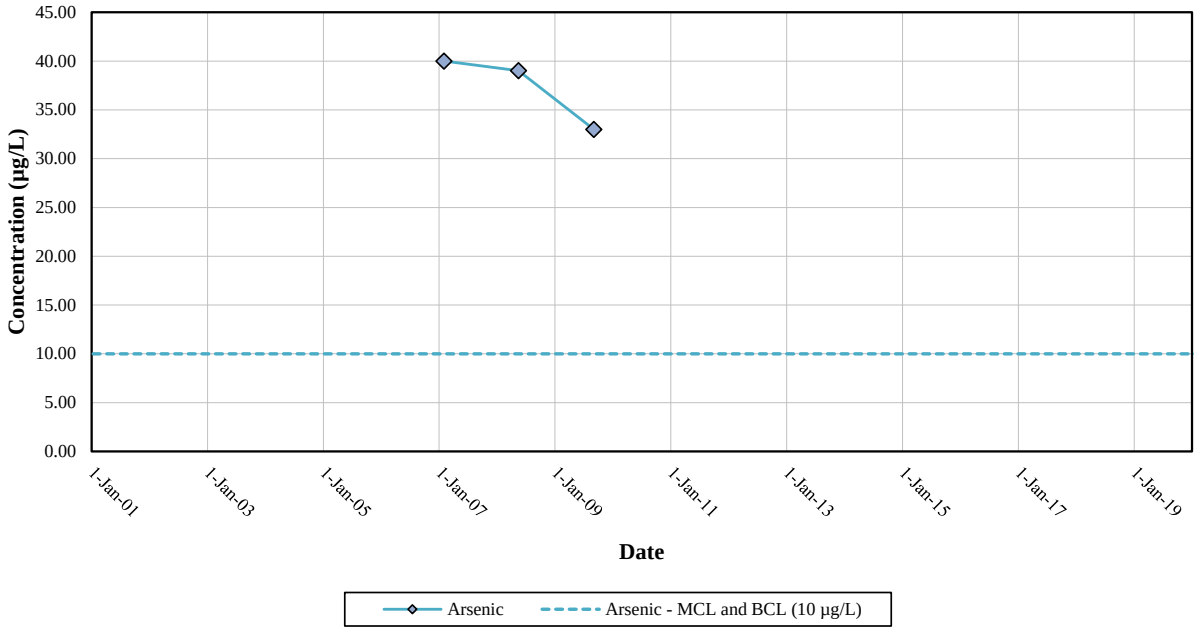
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well WMW5.58SD
Arsenic Concentrations vs. Time



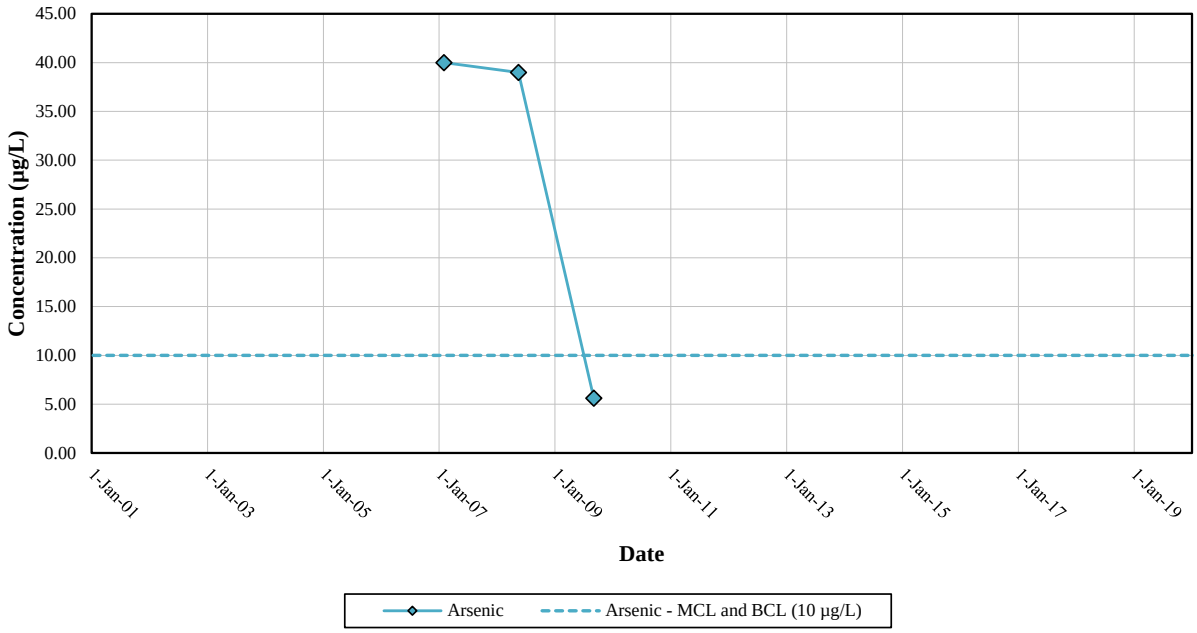
Well WMW5.58SI
Arsenic Concentrations vs. Time



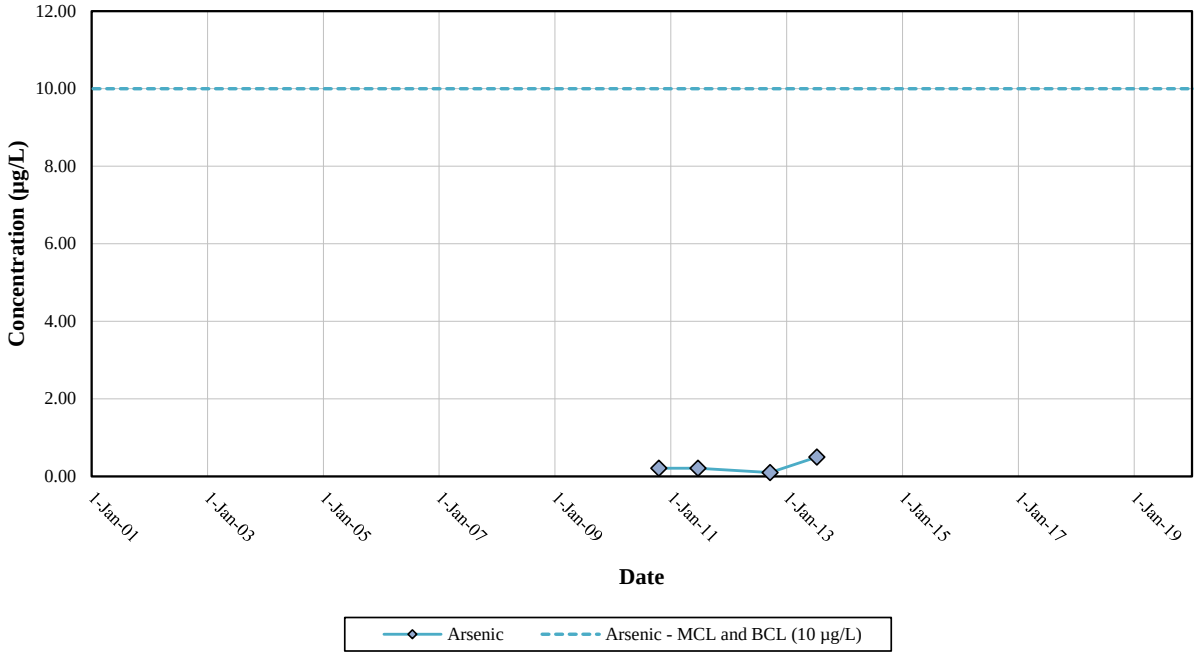
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well WMW5.58SS
Arsenic Concentrations vs. Time



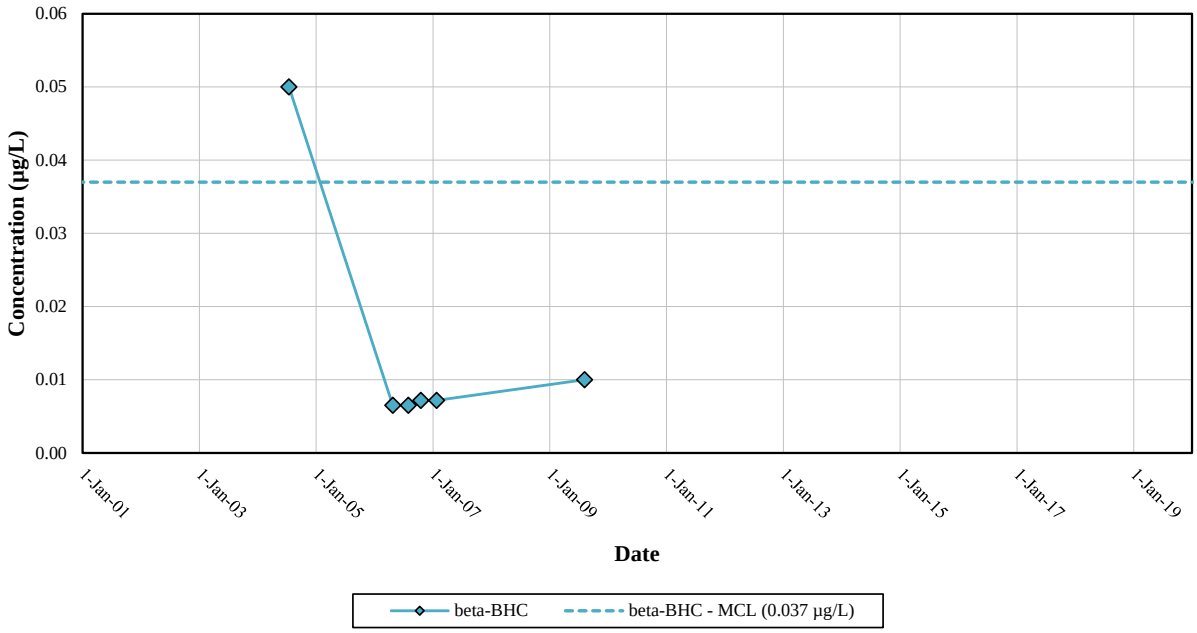
Arsenic Concentrations vs. Time



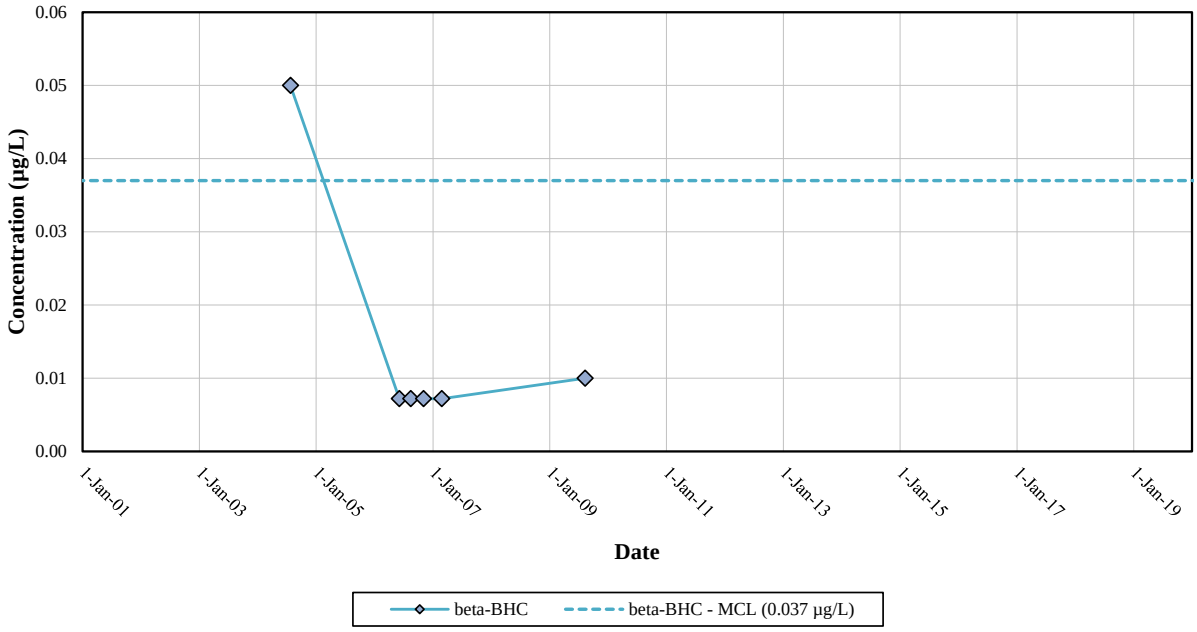
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-01
beta-BHC Concentrations vs. Time



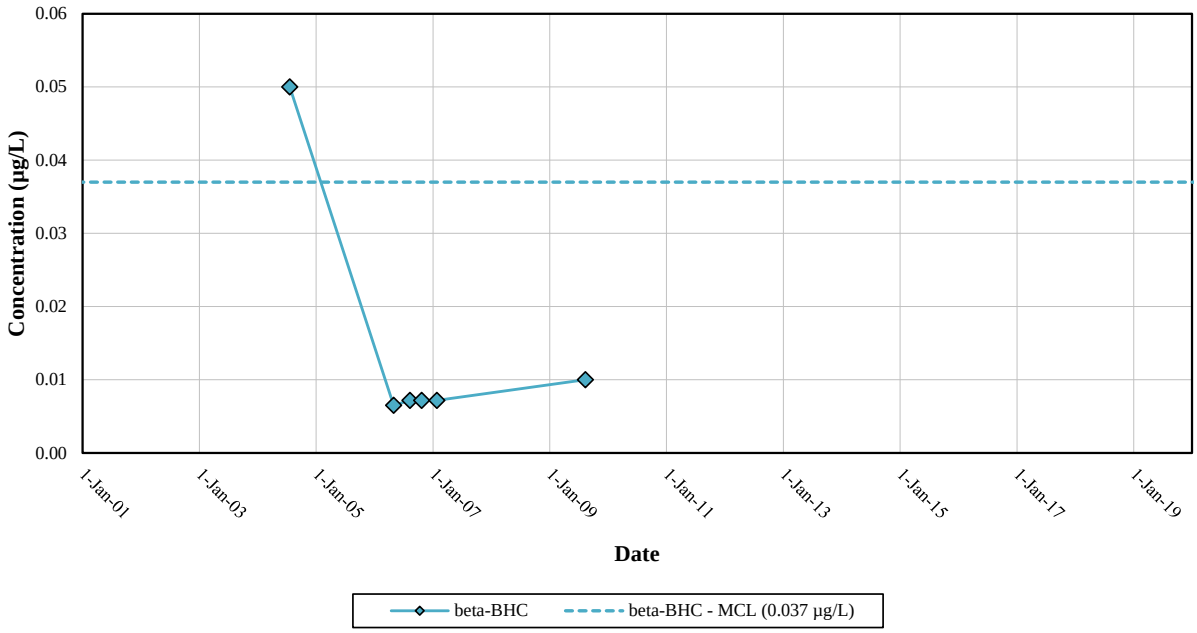
Well AA-07
beta-BHC Concentrations vs. Time



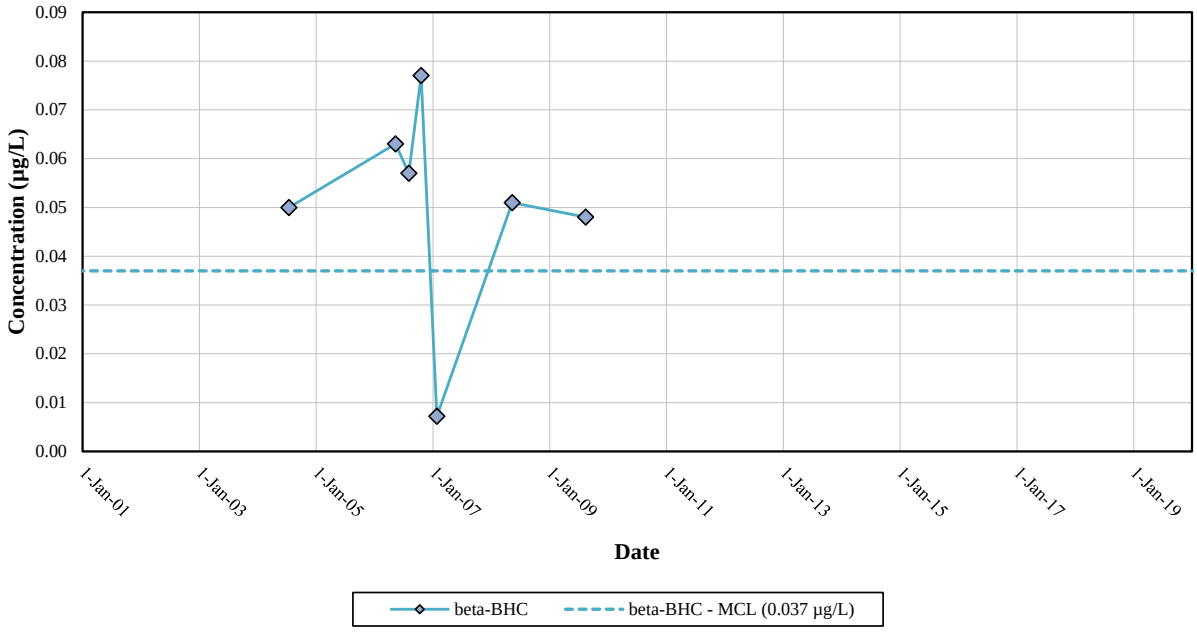
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-09
beta-BHC Concentrations vs. Time



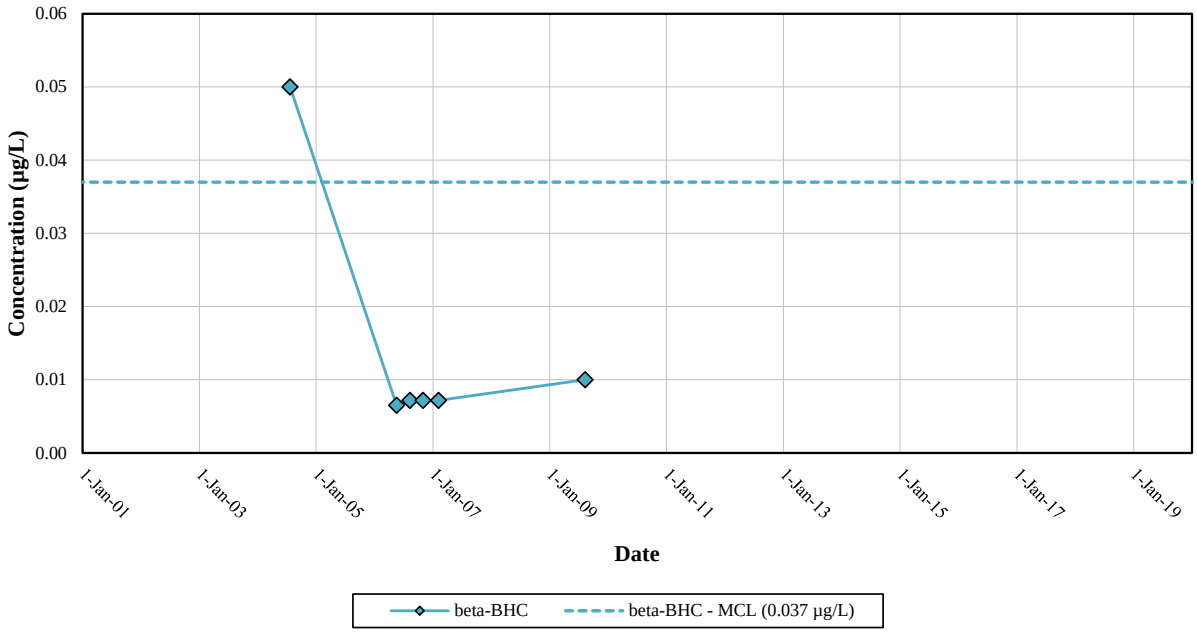
Well AA-13
beta-BHC Concentrations vs. Time



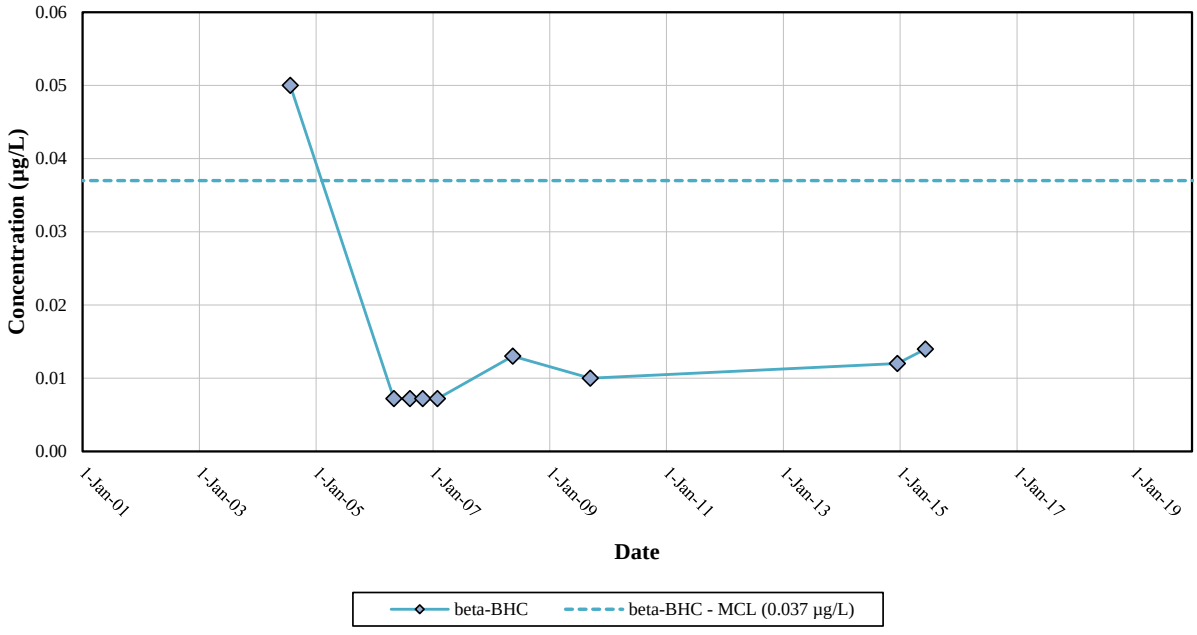
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-18
beta-BHC Concentrations vs. Time



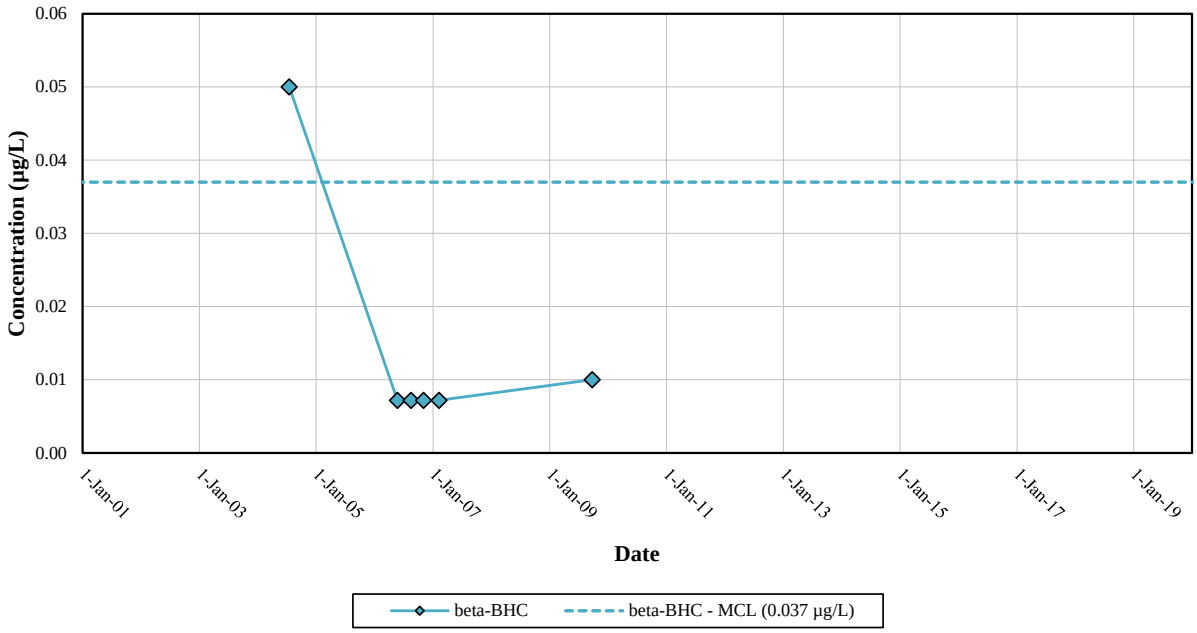
Well AA-20
beta-BHC Concentrations vs. Time



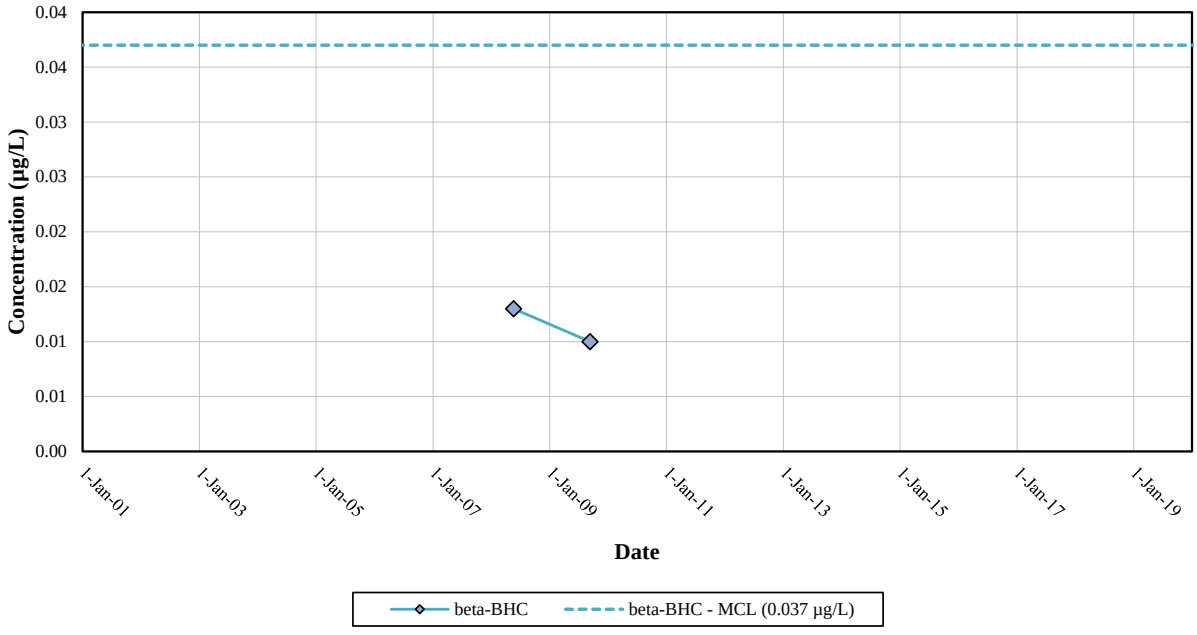
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-22
beta-BHC Concentrations vs. Time



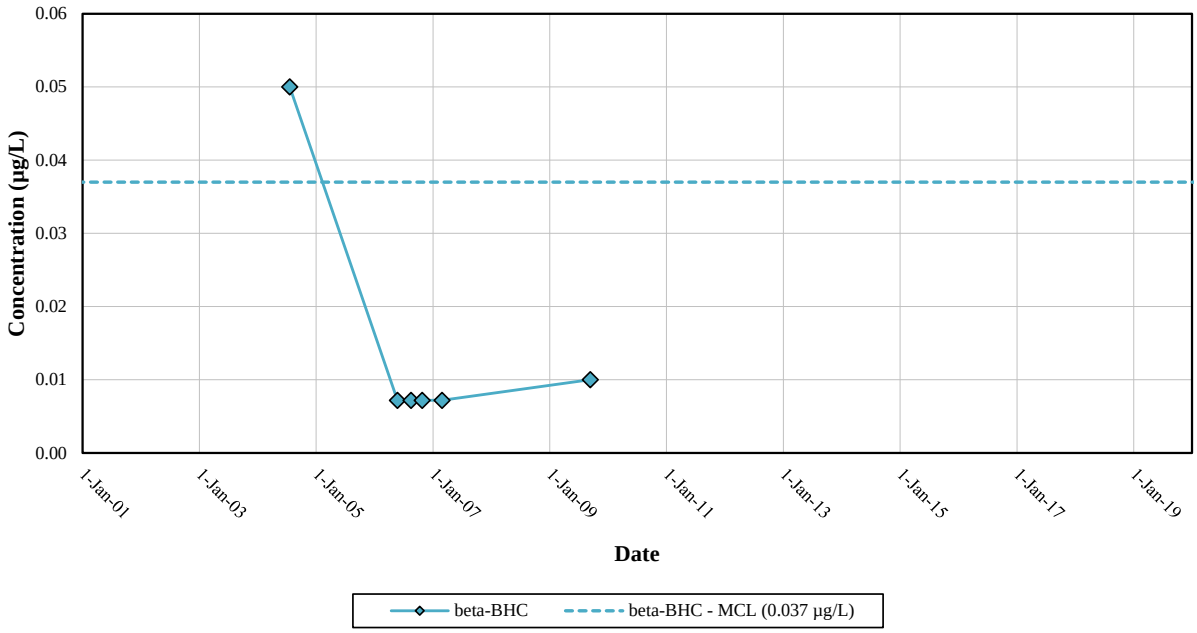
Well AA-23-R
beta-BHC Concentrations vs. Time



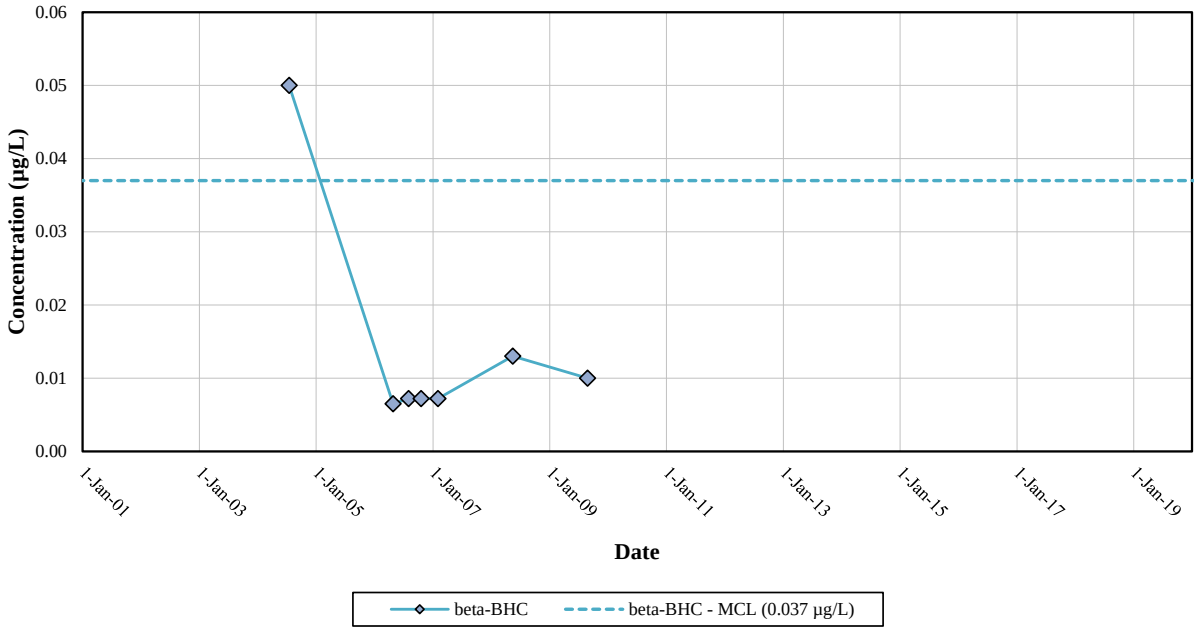
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-26
beta-BHC Concentrations vs. Time



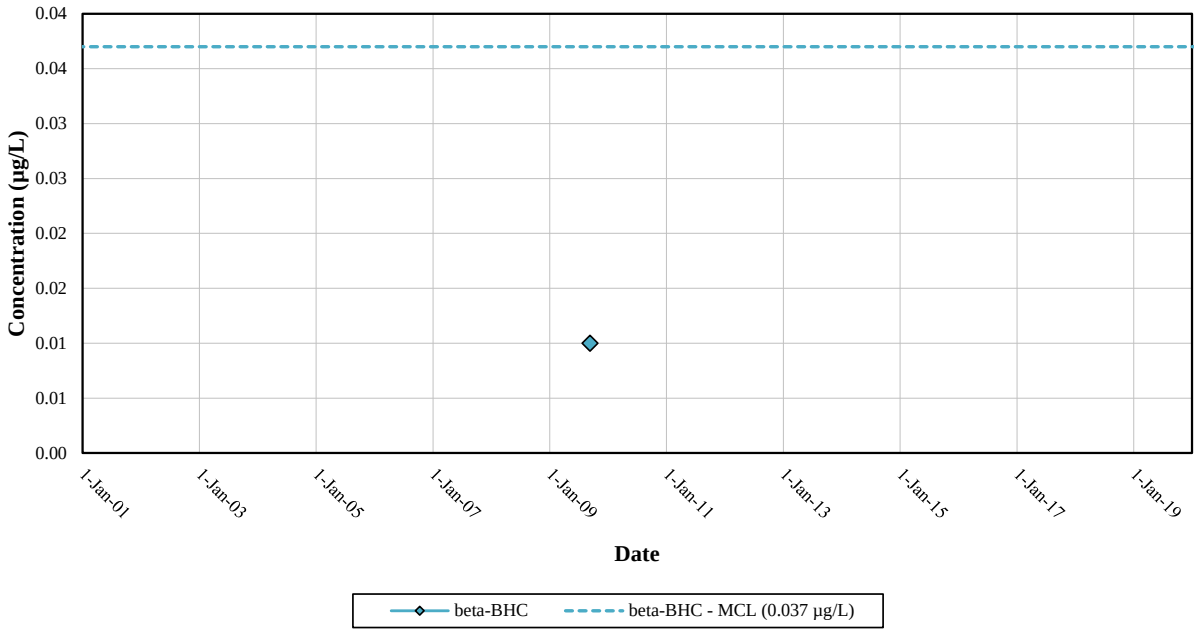
Well AA-27
beta-BHC Concentrations vs. Time



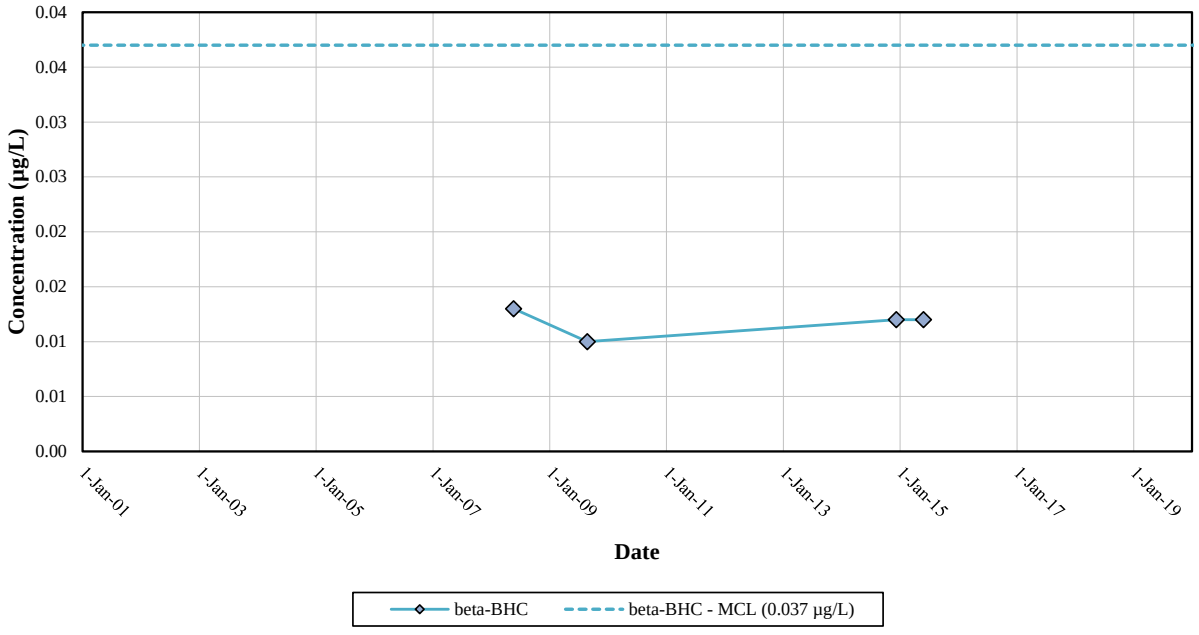
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-30
beta-BHC Concentrations vs. Time



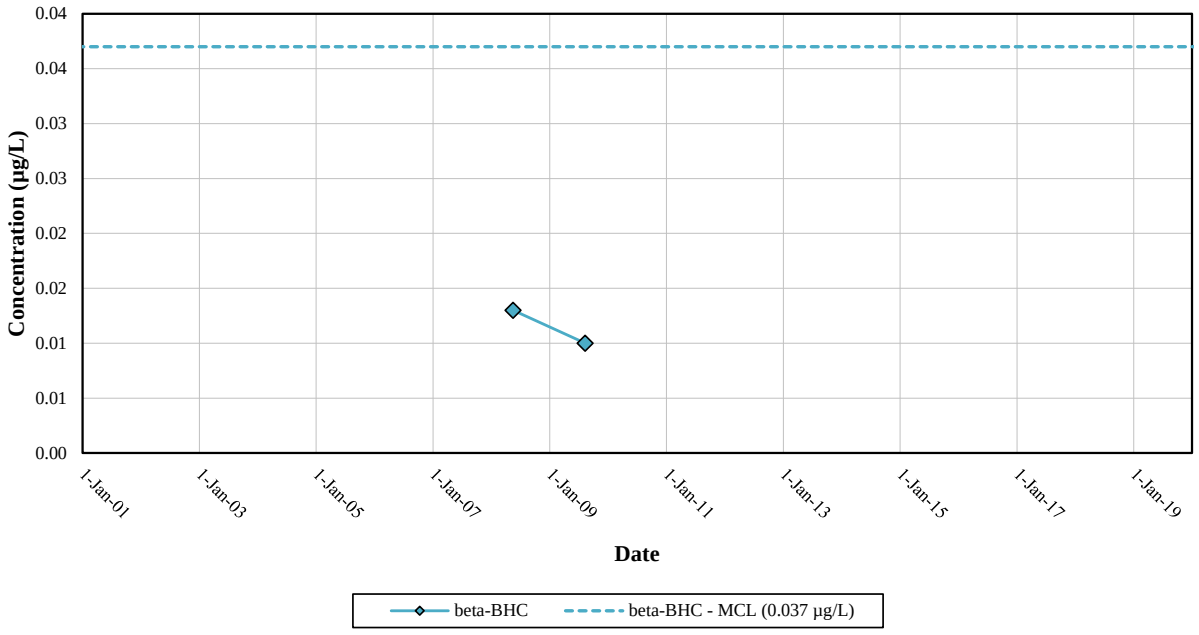
Well AA-UW1
beta-BHC Concentrations vs. Time



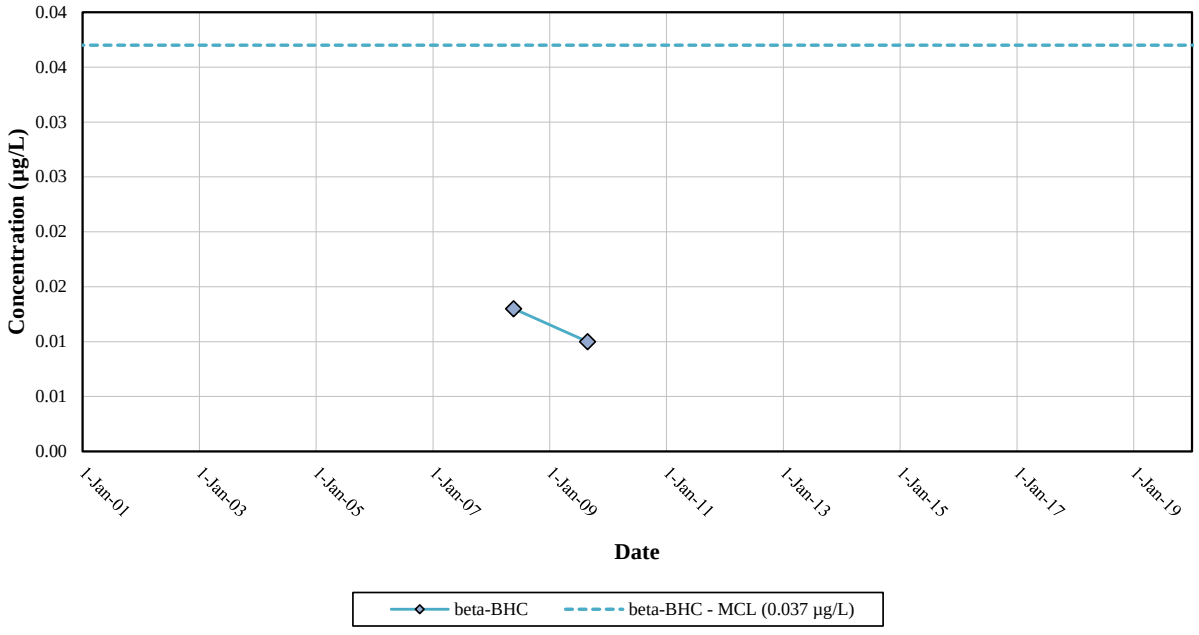
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW2
beta-BHC Concentrations vs. Time



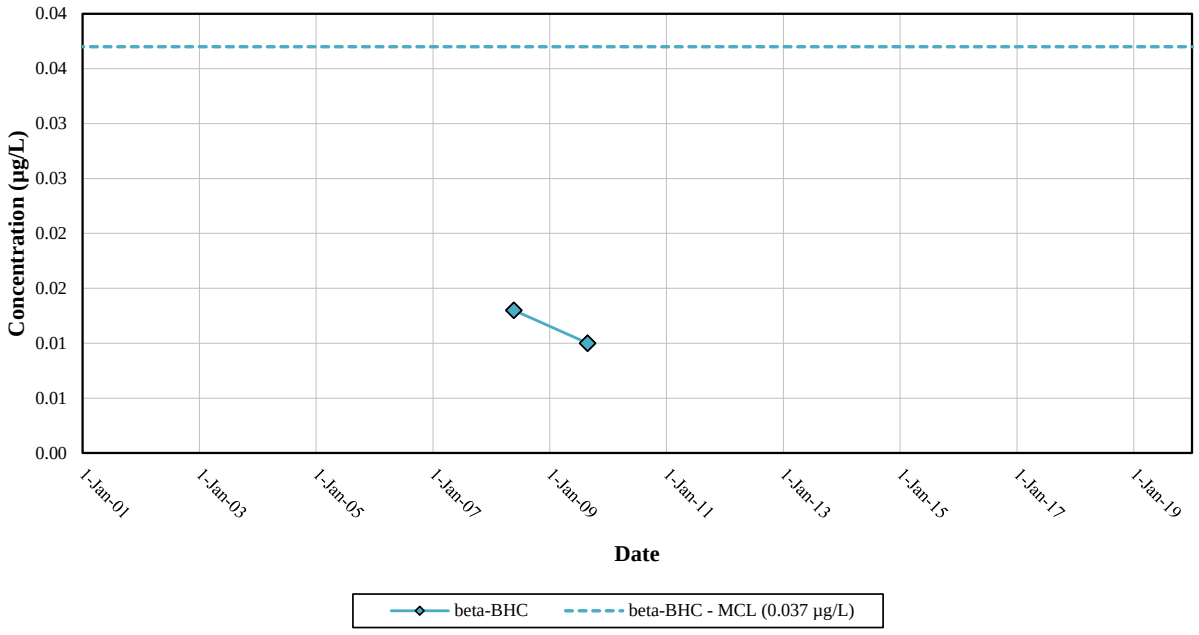
Well AA-UW3
beta-BHC Concentrations vs. Time



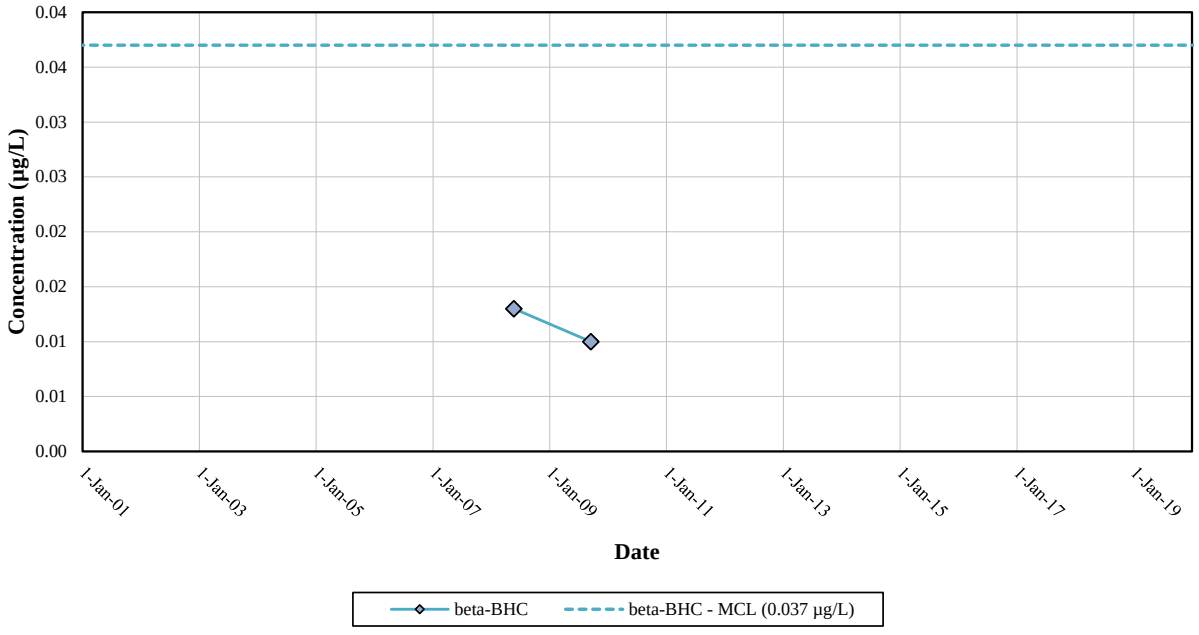
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW4
beta-BHC Concentrations vs. Time



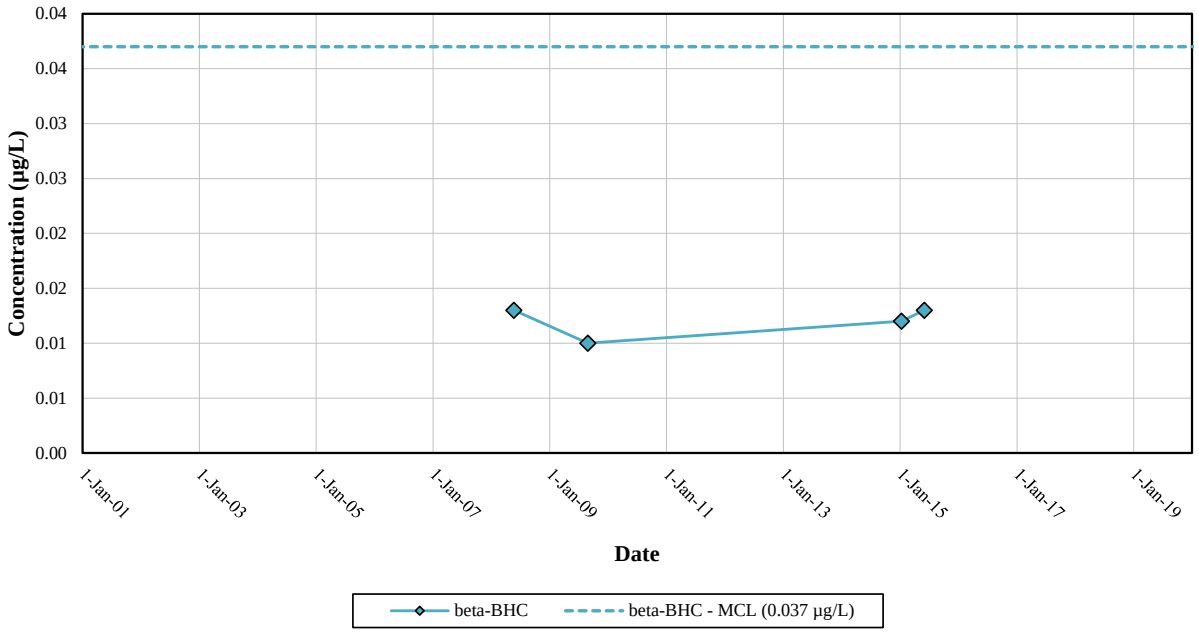
Well AA-UW5
beta-BHC Concentrations vs. Time



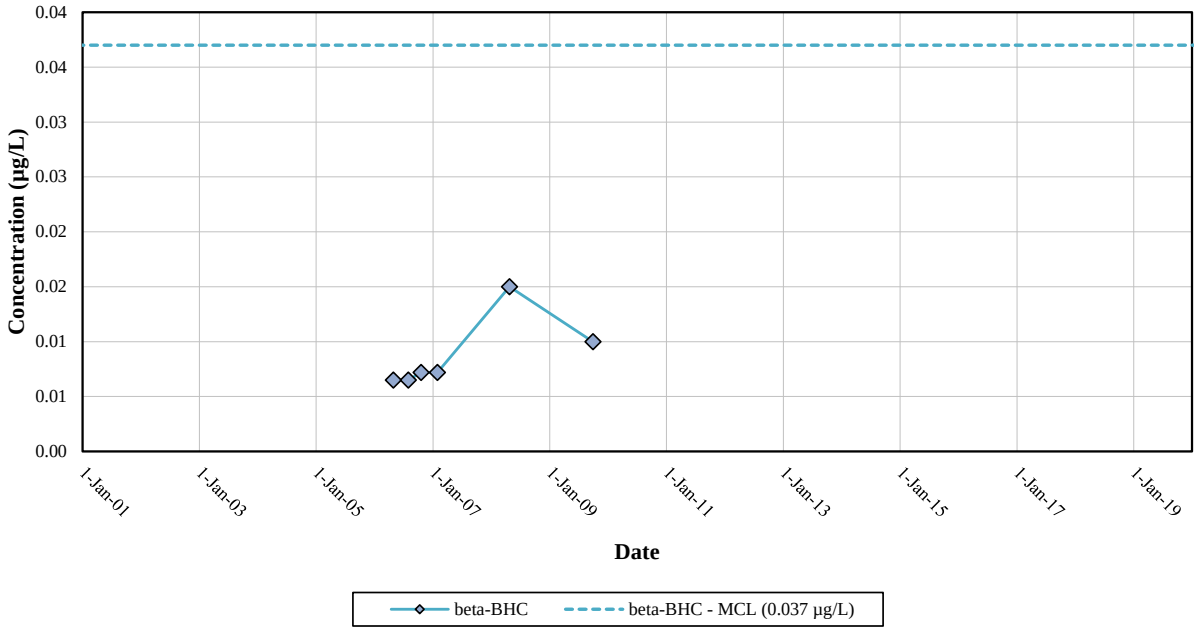
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW6
beta-BHC Concentrations vs. Time



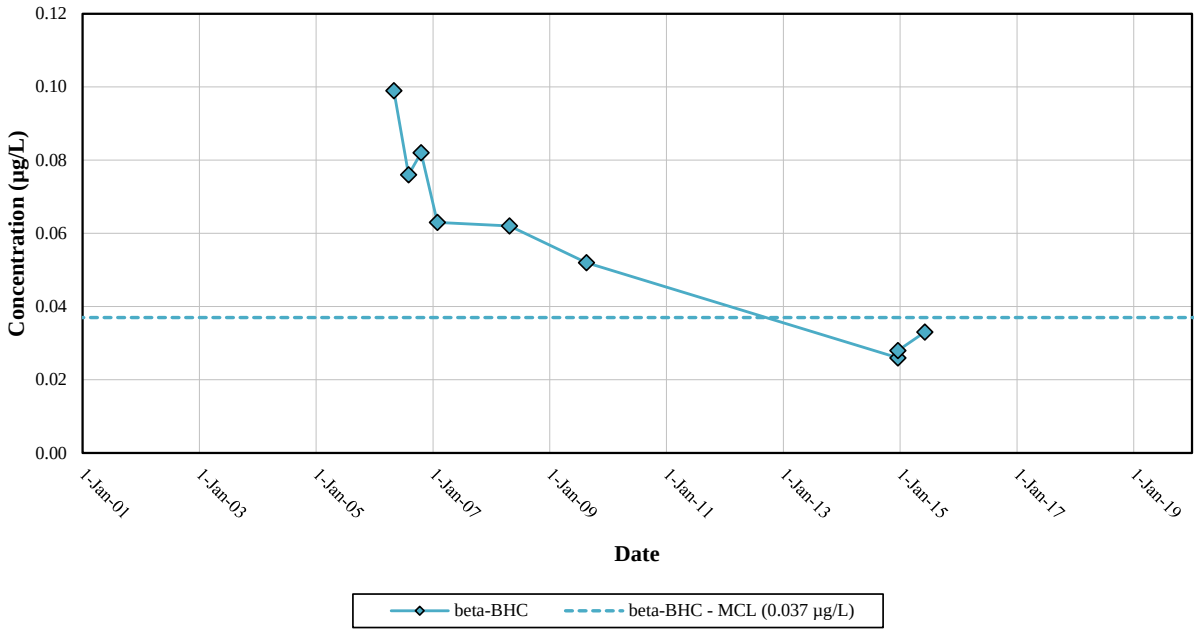
Well BEC-6
beta-BHC Concentrations vs. Time



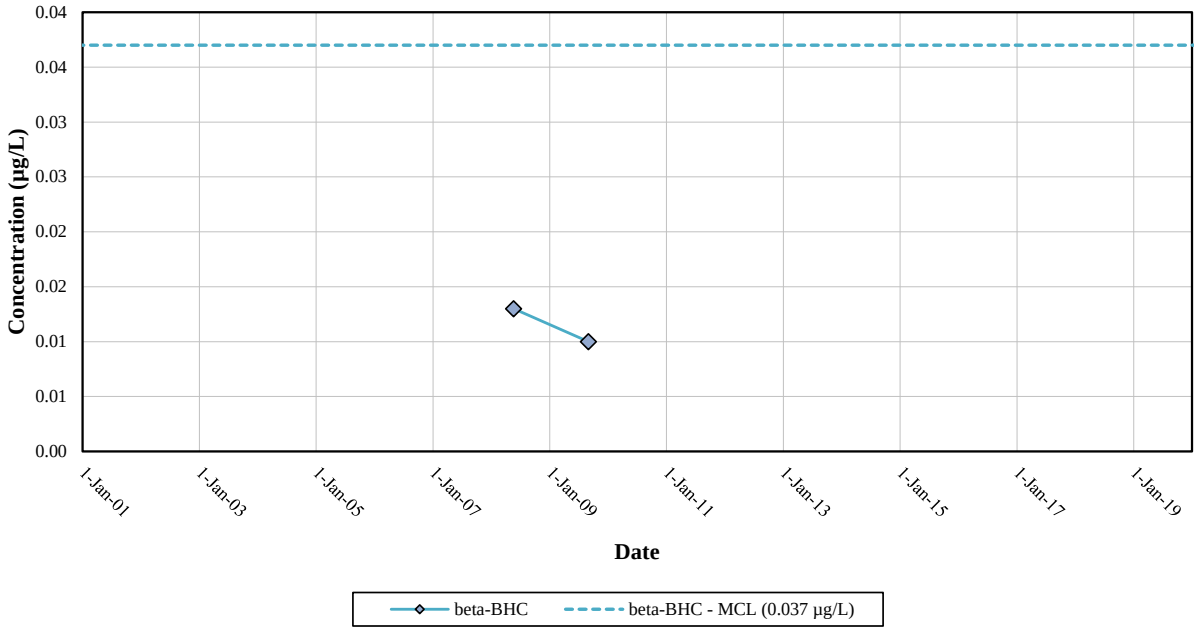
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well BEC-9
beta-BHC Concentrations vs. Time



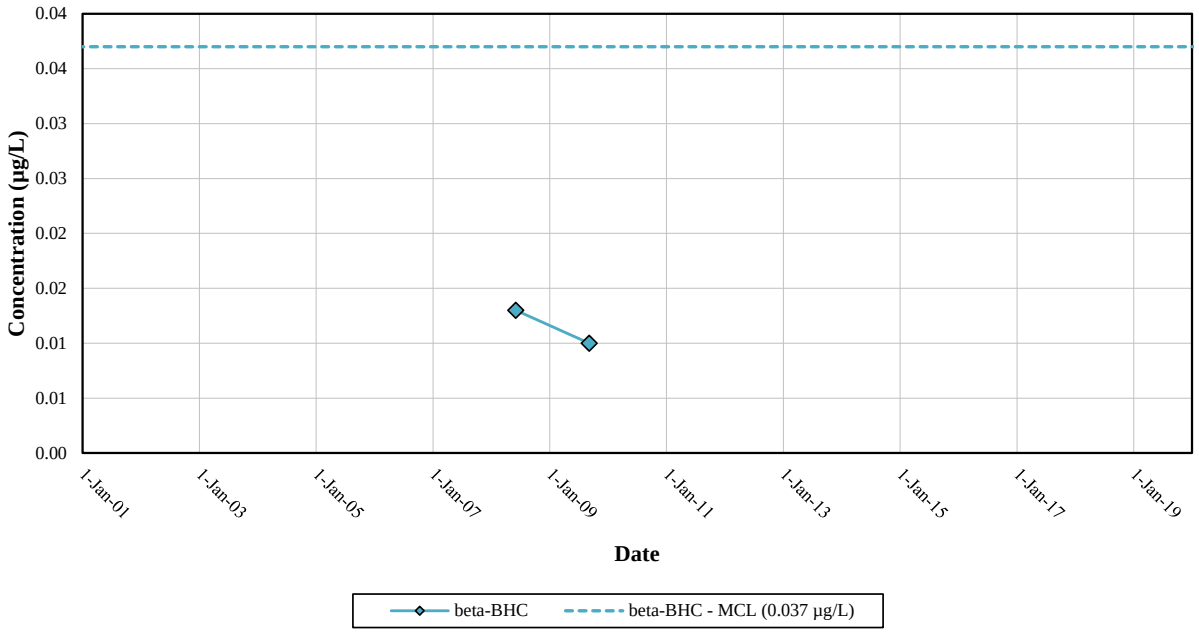
Well DBMW-1
beta-BHC Concentrations vs. Time



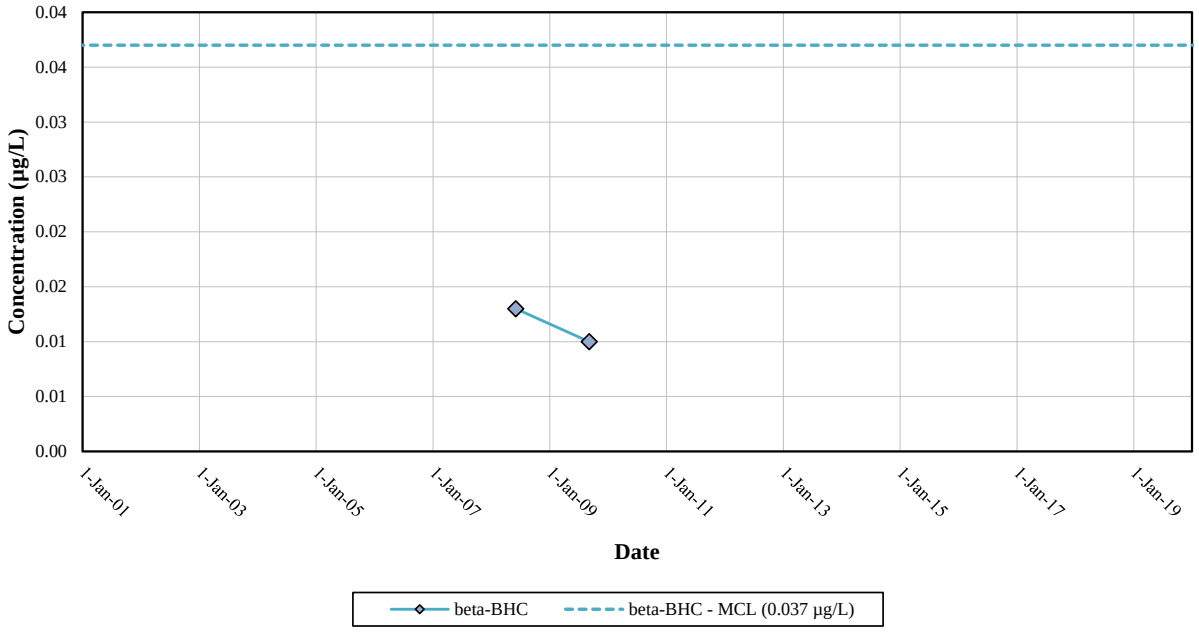
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-2
beta-BHC Concentrations vs. Time



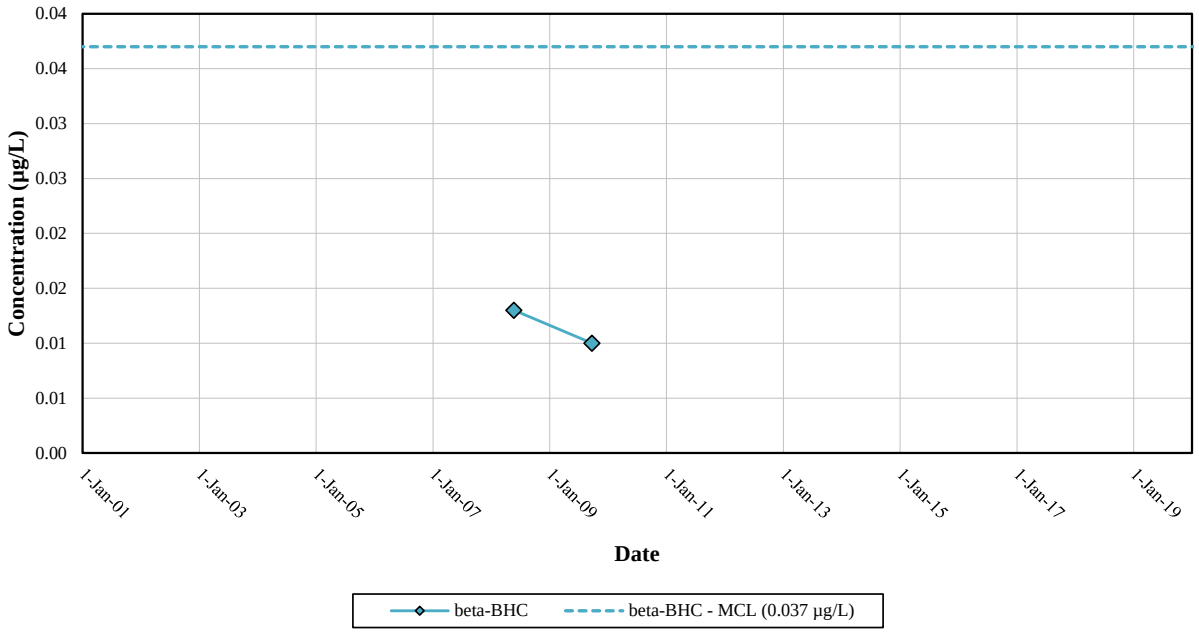
Well DBMW-3
beta-BHC Concentrations vs. Time



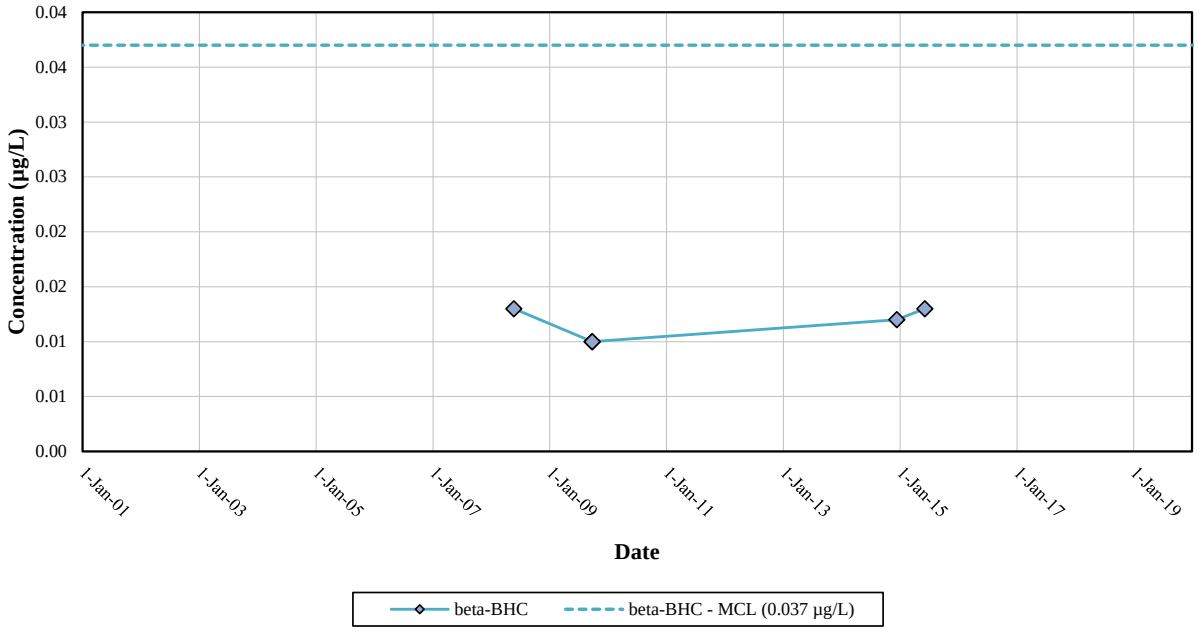
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-4
beta-BHC Concentrations vs. Time



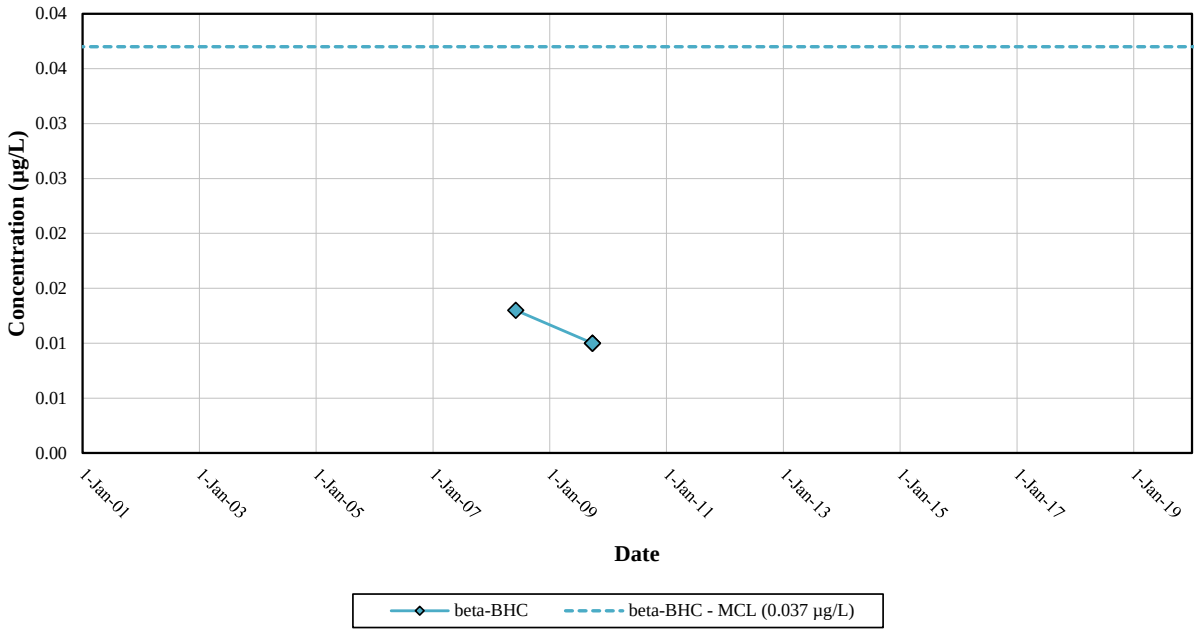
Well DBMW-5
beta-BHC Concentrations vs. Time



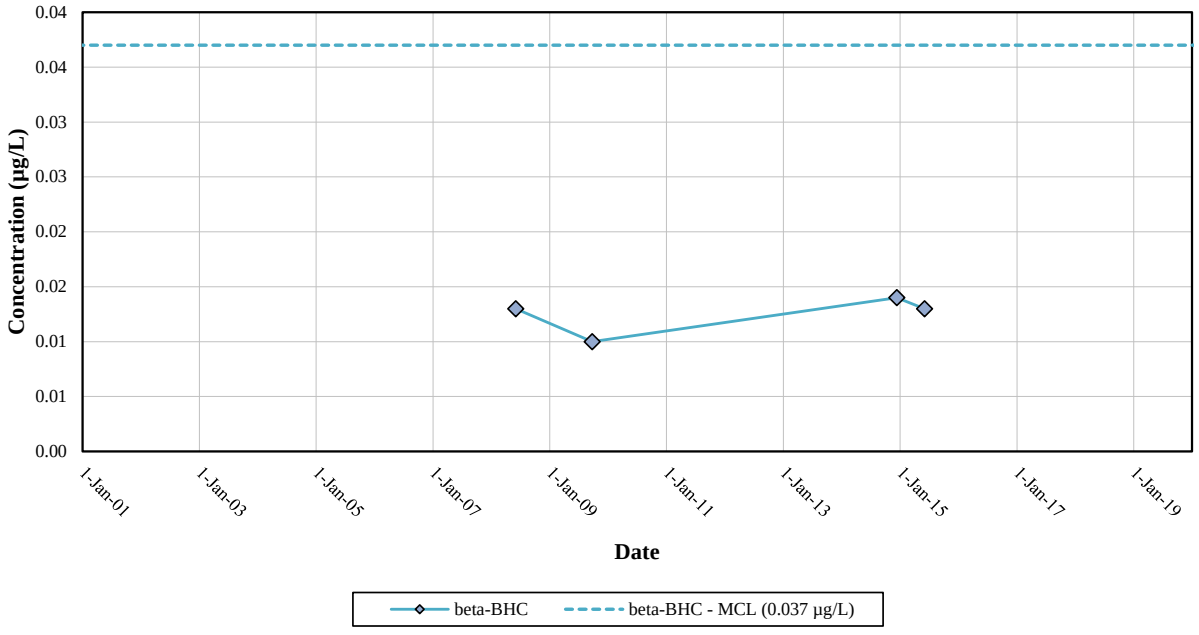
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-7
beta-BHC Concentrations vs. Time



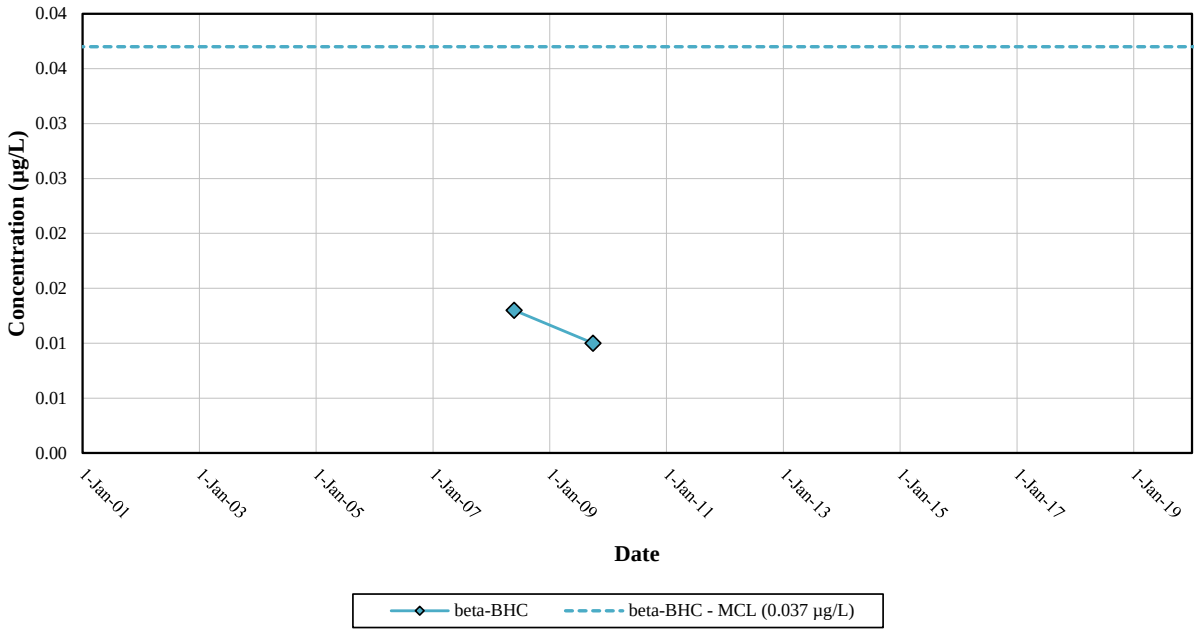
Well DBMW-8
beta-BHC Concentrations vs. Time



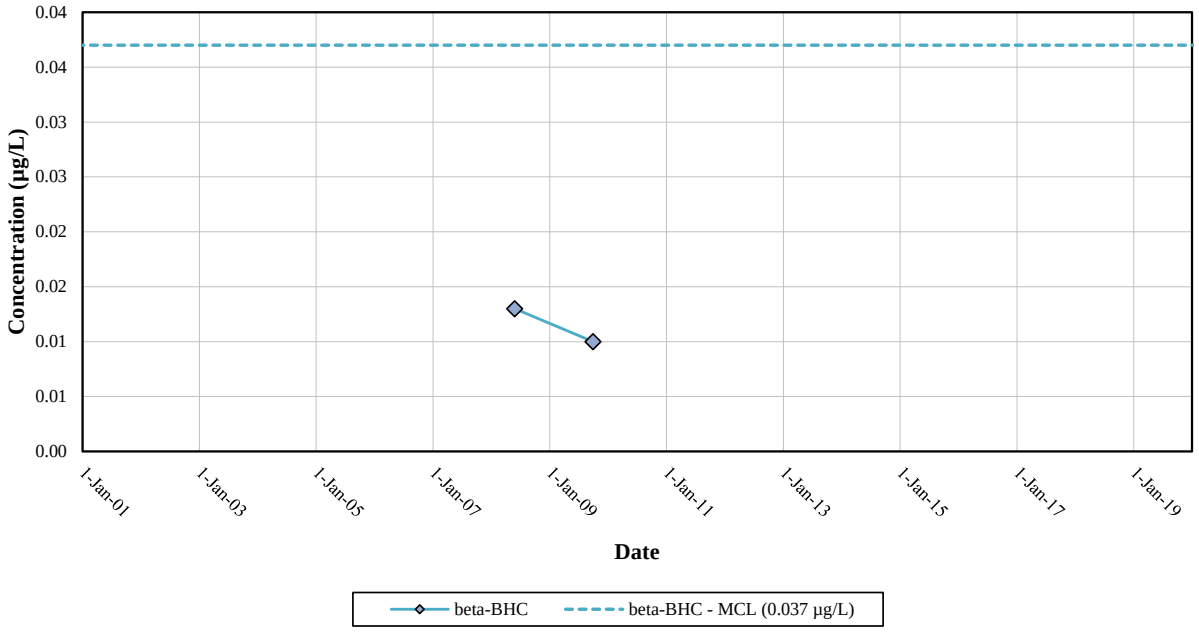
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-9
beta-BHC Concentrations vs. Time



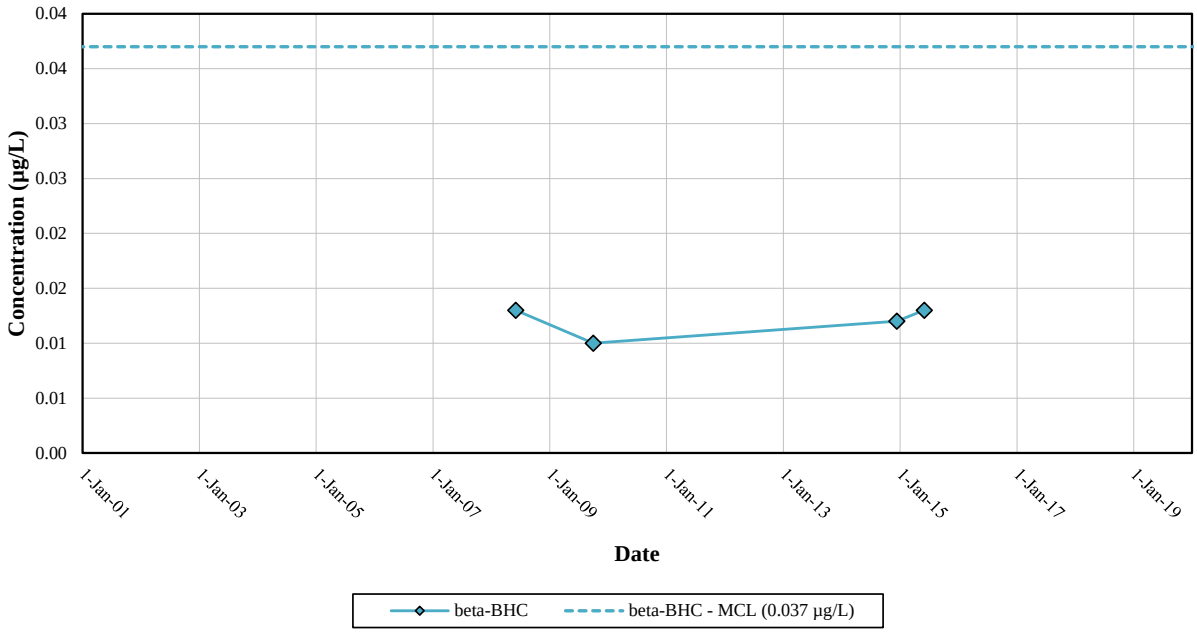
Well DBMW-10
beta-BHC Concentrations vs. Time



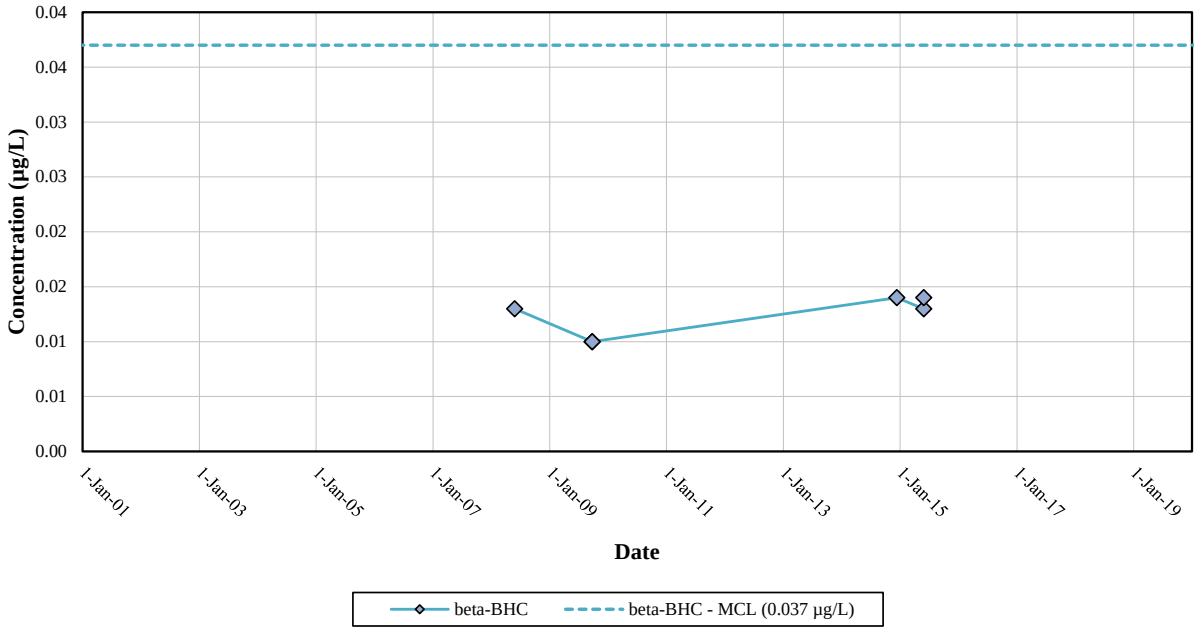
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-11
beta-BHC Concentrations vs. Time



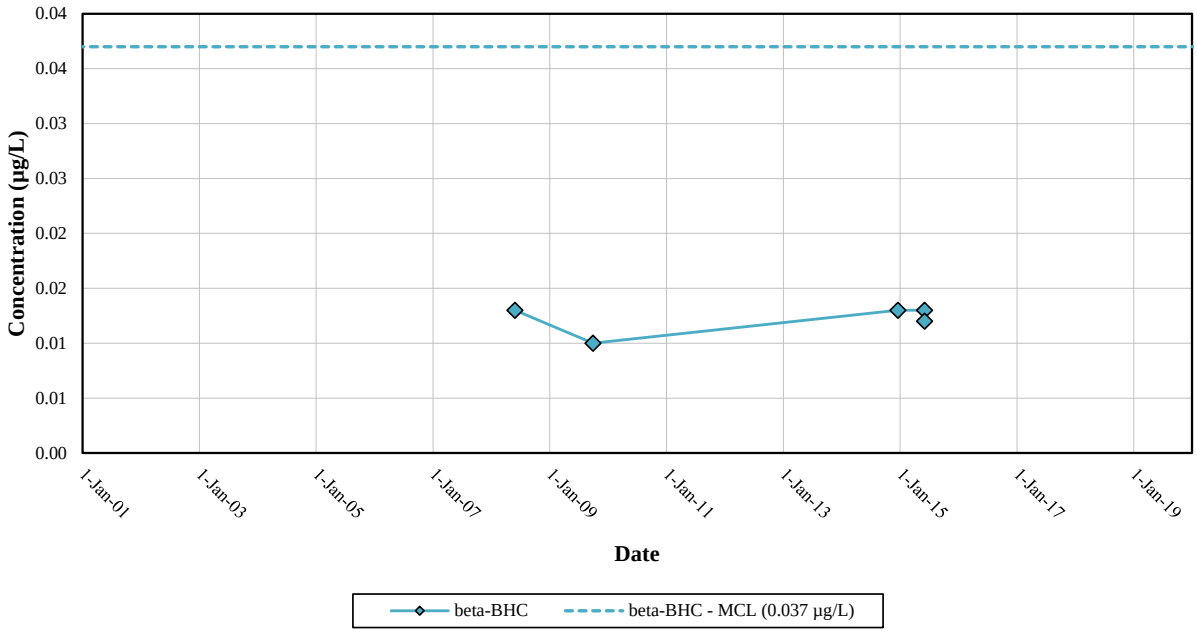
Well DBMW-12
beta-BHC Concentrations vs. Time



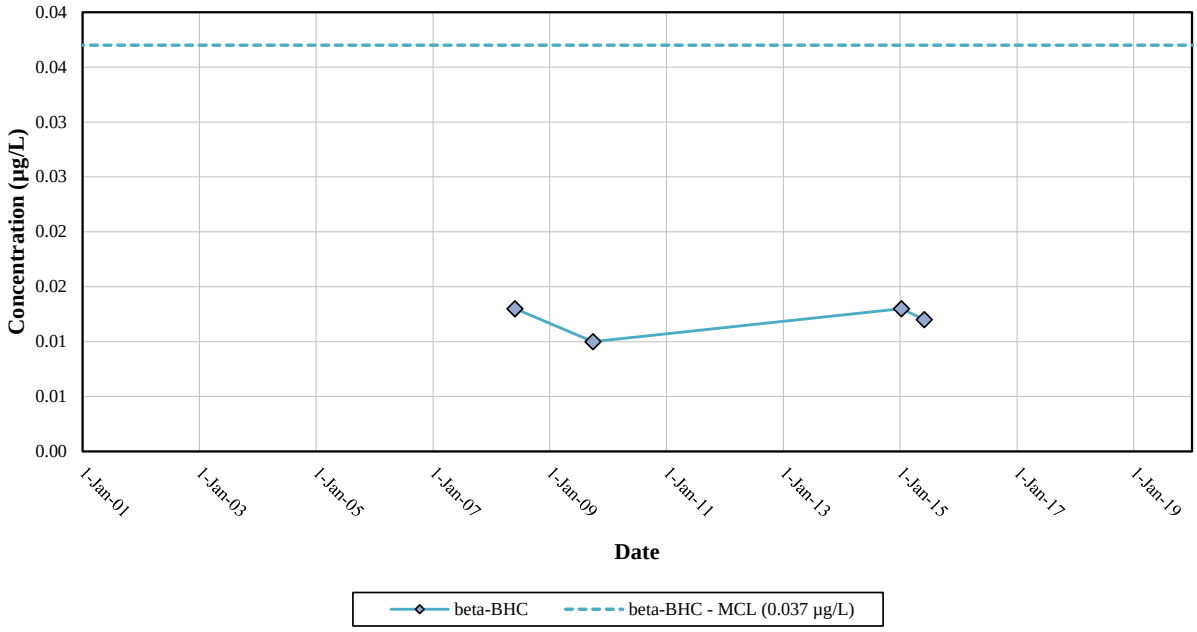
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-13
beta-BHC Concentrations vs. Time



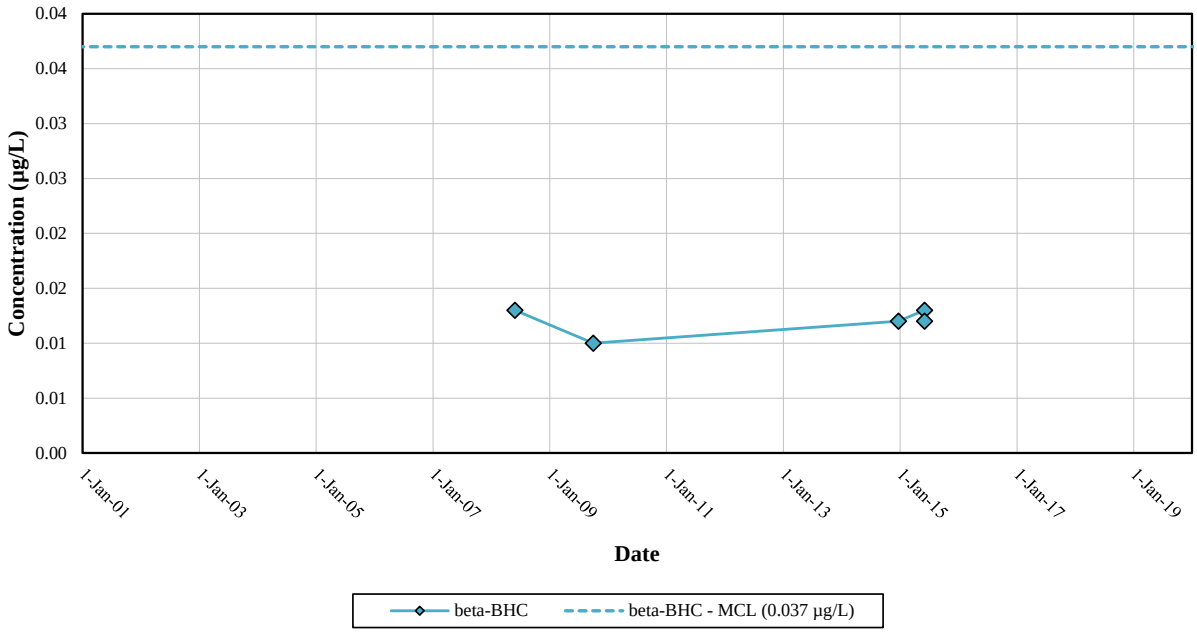
Well DBMW-14
beta-BHC Concentrations vs. Time



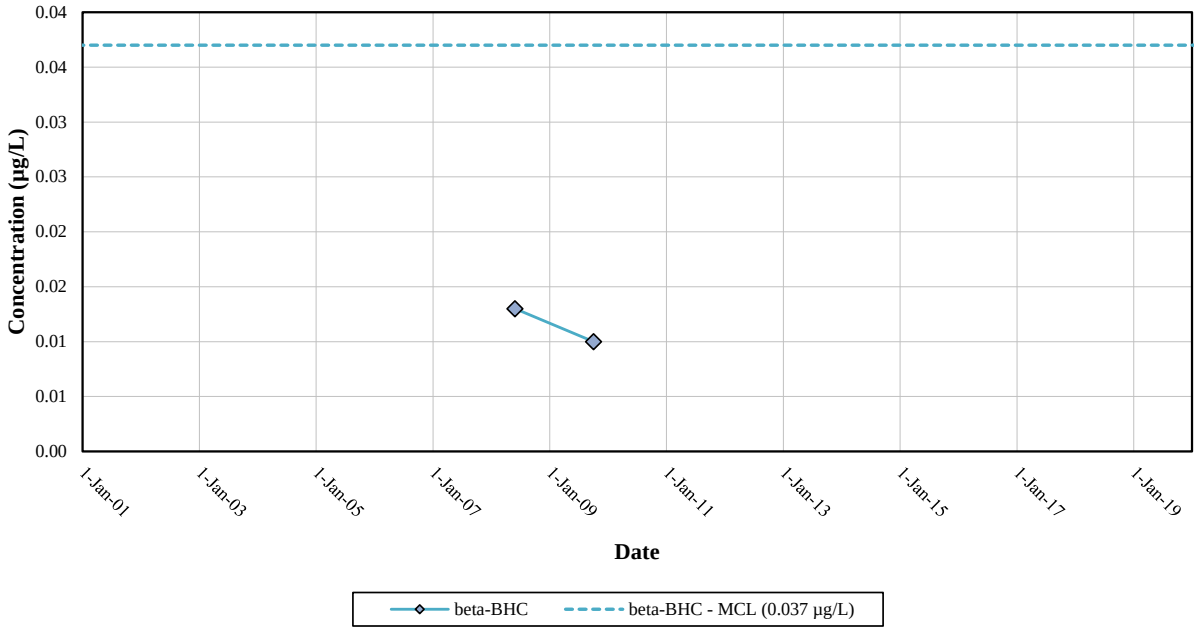
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-15
beta-BHC Concentrations vs. Time



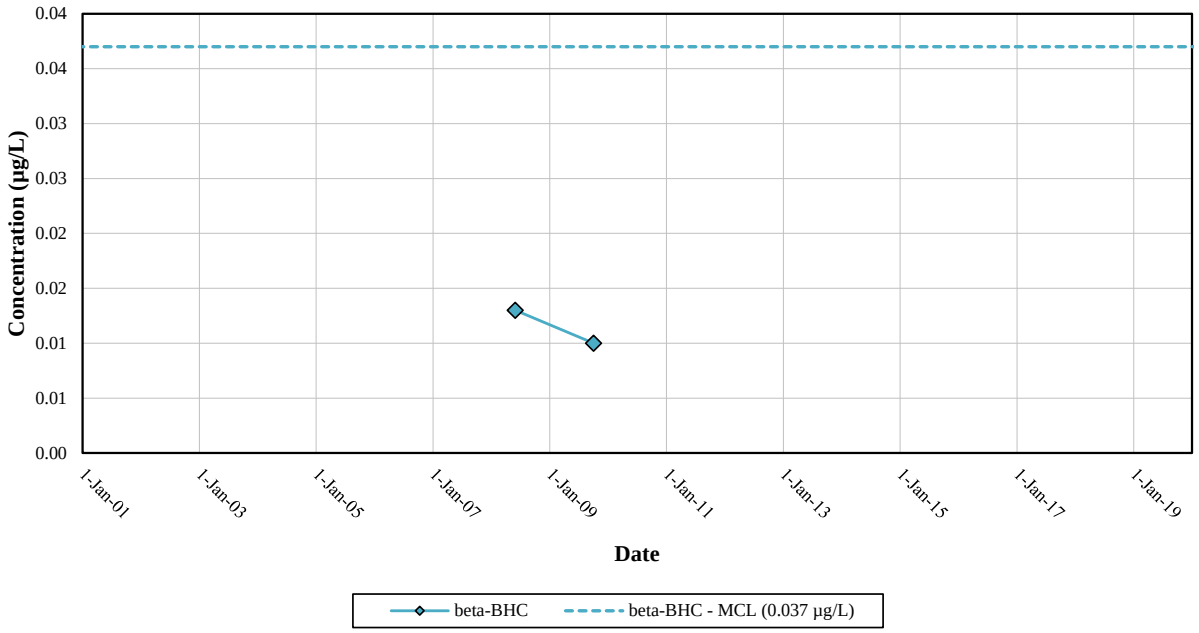
Well DBMW-16
beta-BHC Concentrations vs. Time



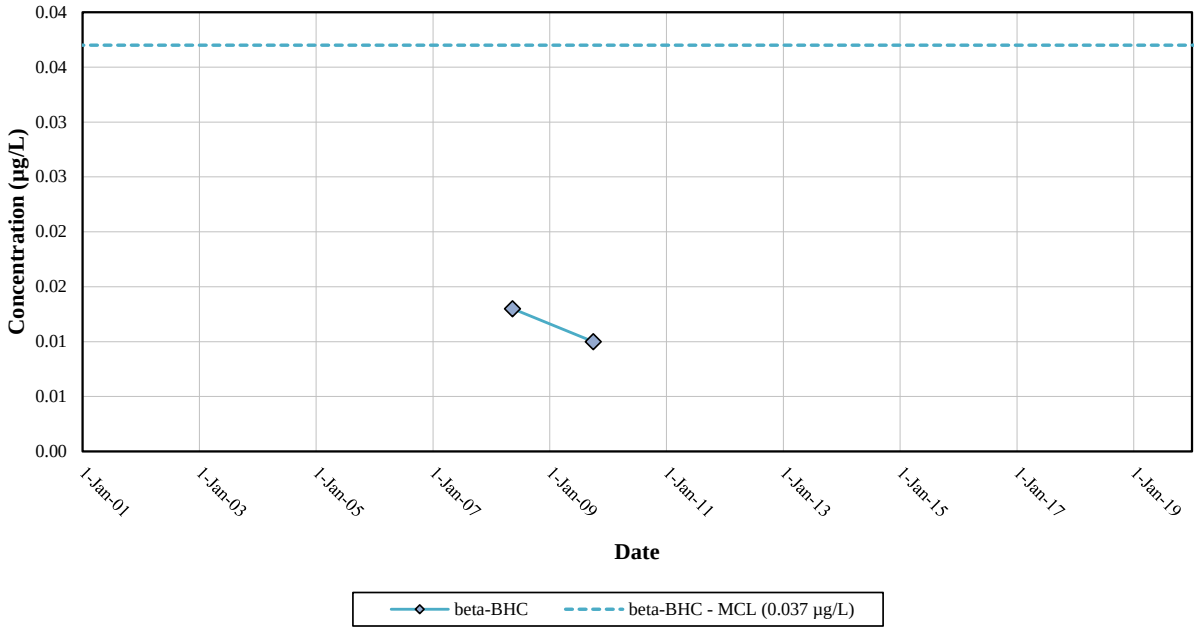
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-17
beta-BHC Concentrations vs. Time



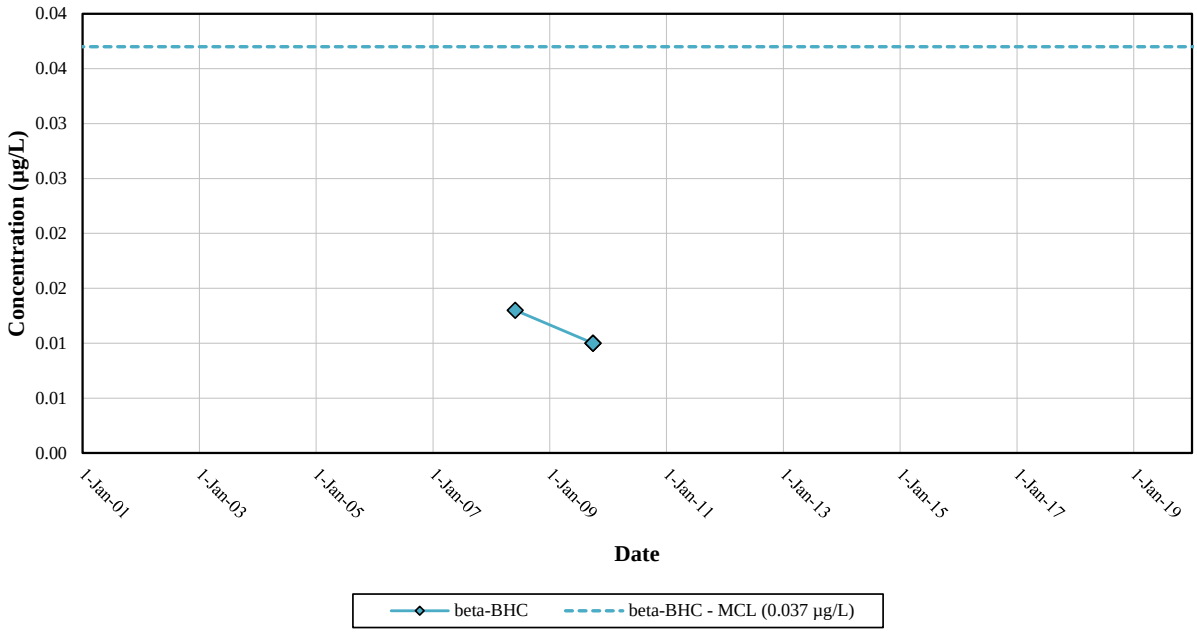
Well DBMW-20
beta-BHC Concentrations vs. Time



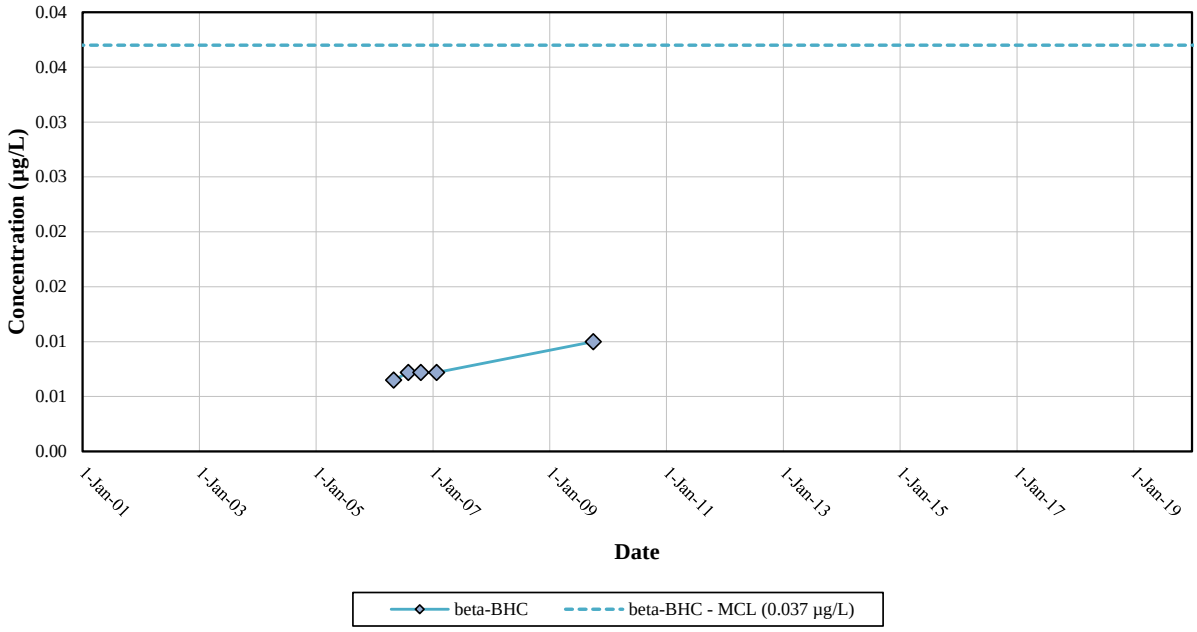
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-22
beta-BHC Concentrations vs. Time



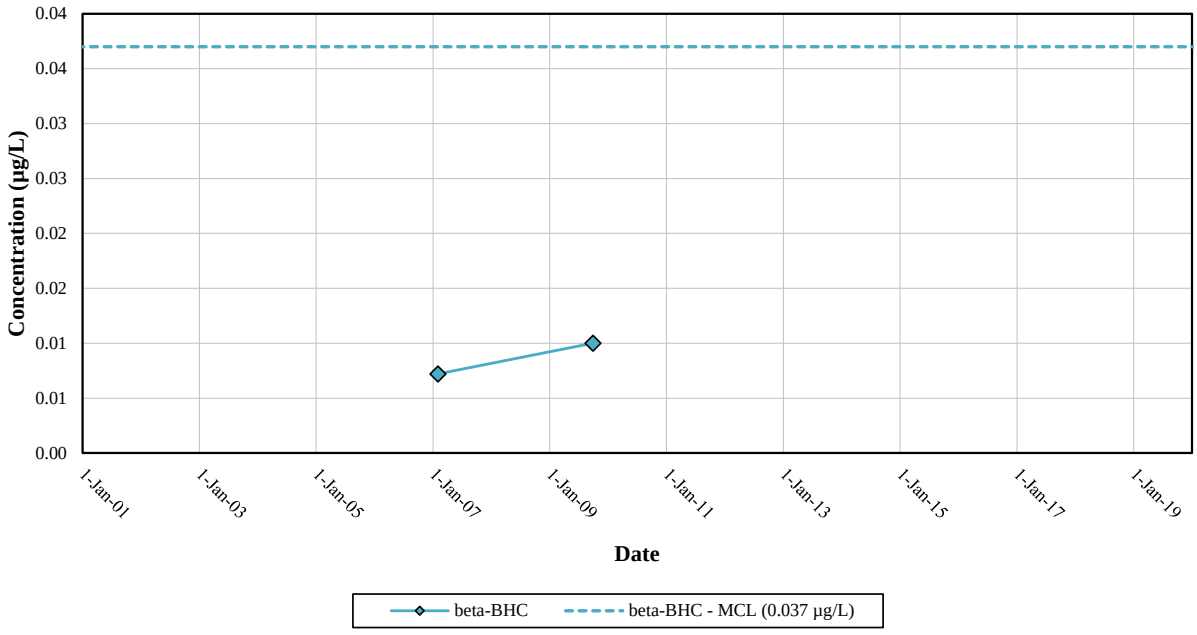
Well DM-1
beta-BHC Concentrations vs. Time



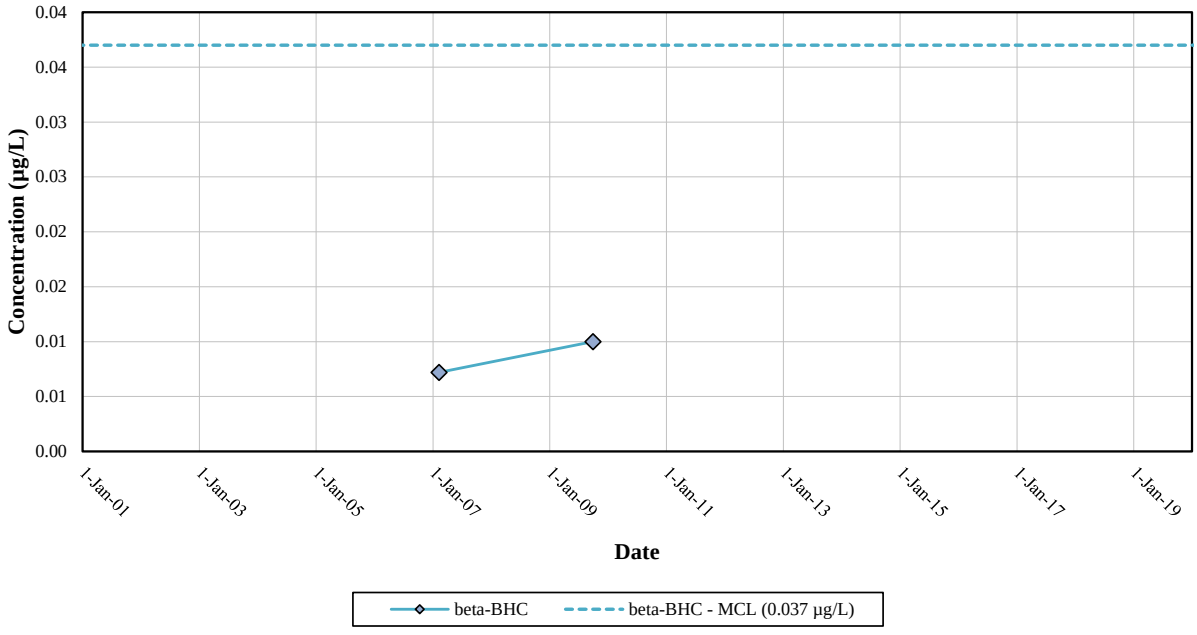
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well HMW-08
beta-BHC Concentrations vs. Time



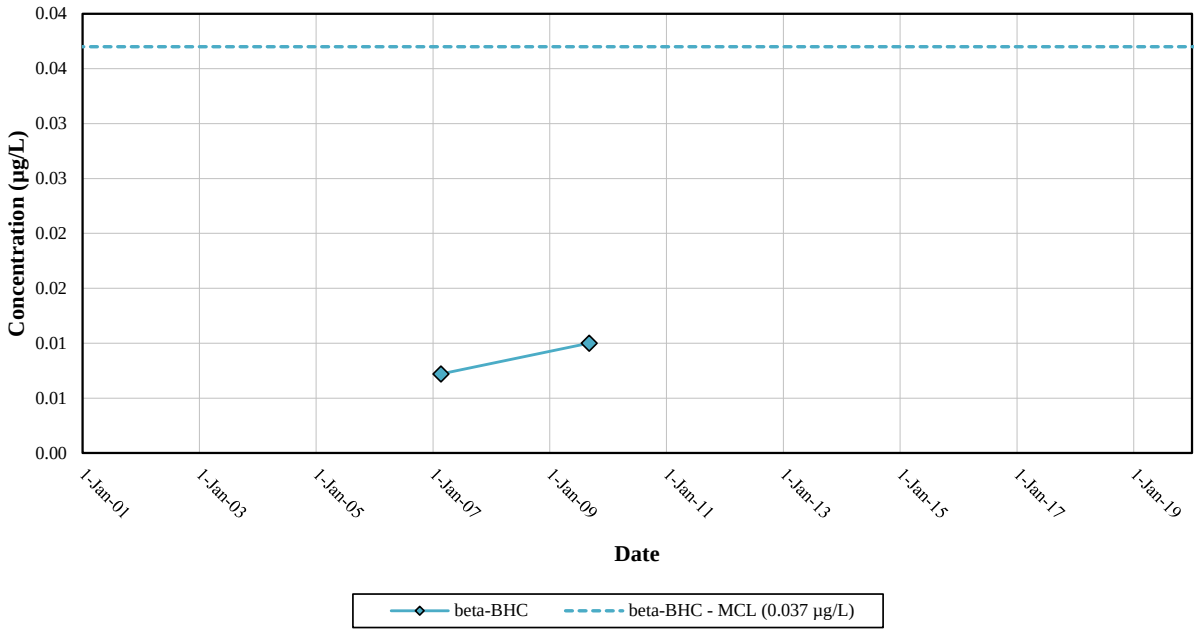
Well HMW-09
beta-BHC Concentrations vs. Time



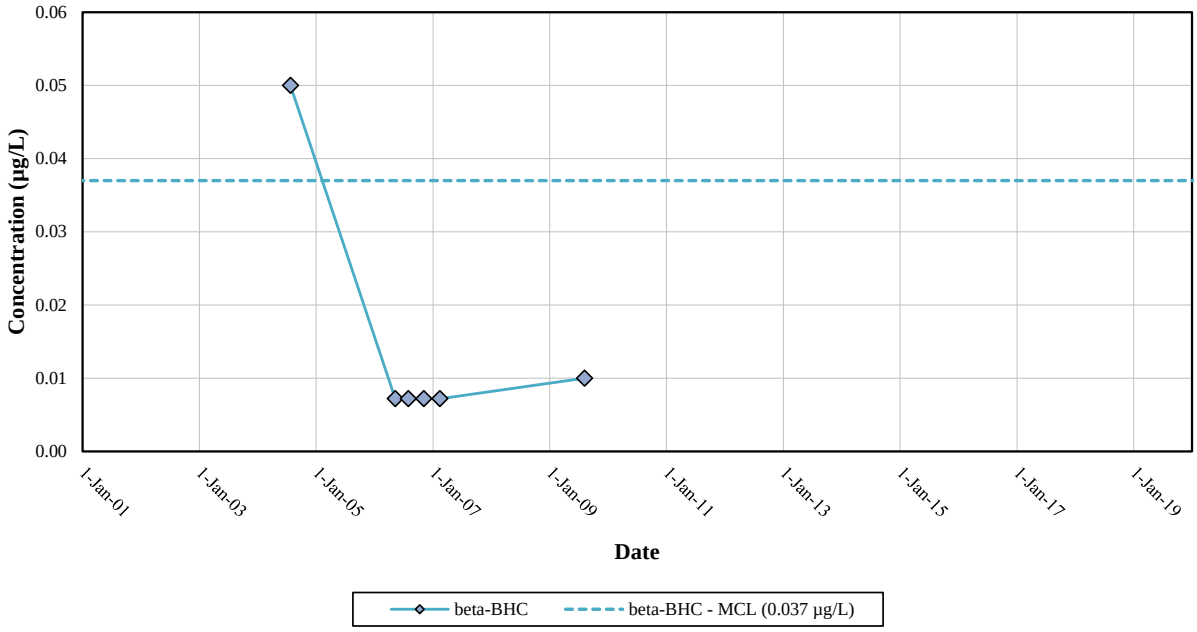
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well HMWWT-6
beta-BHC Concentrations vs. Time



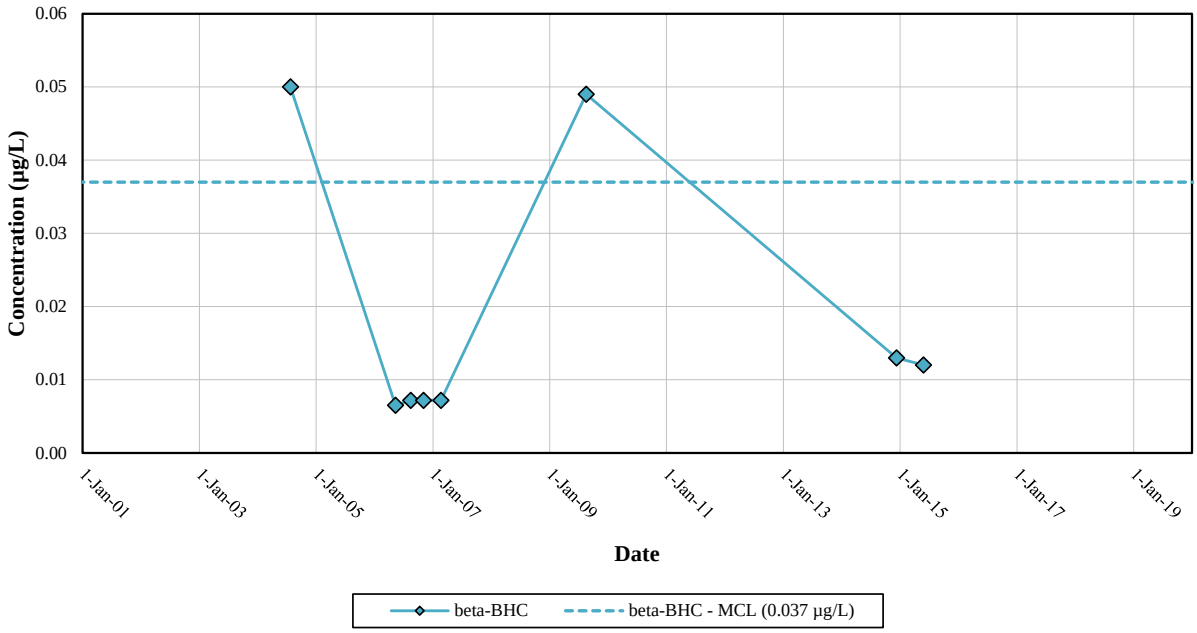
Well MCF-01B
beta-BHC Concentrations vs. Time



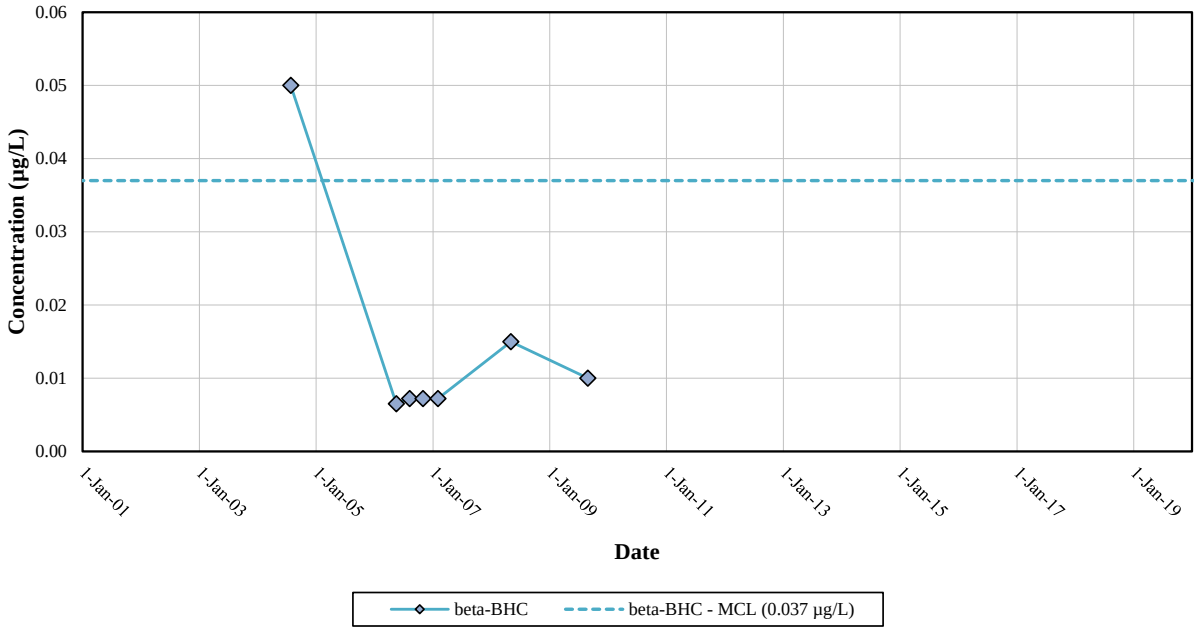
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well MCF-03B
beta-BHC Concentrations vs. Time



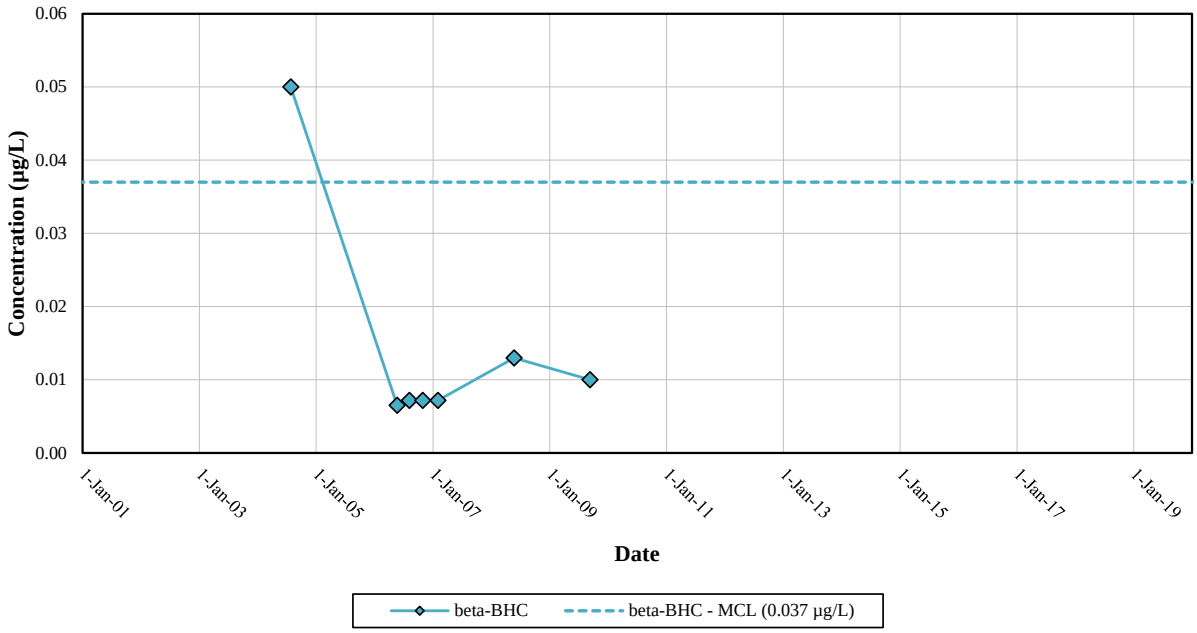
Well MCF-06B
beta-BHC Concentrations vs. Time



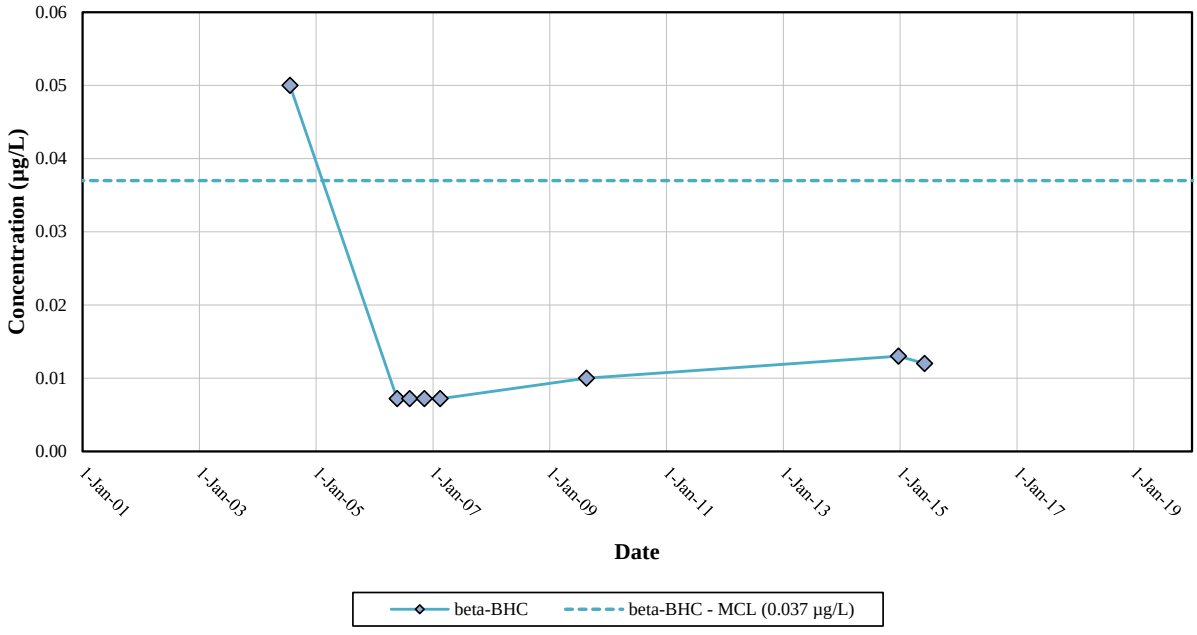
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well MCF-06C
beta-BHC Concentrations vs. Time



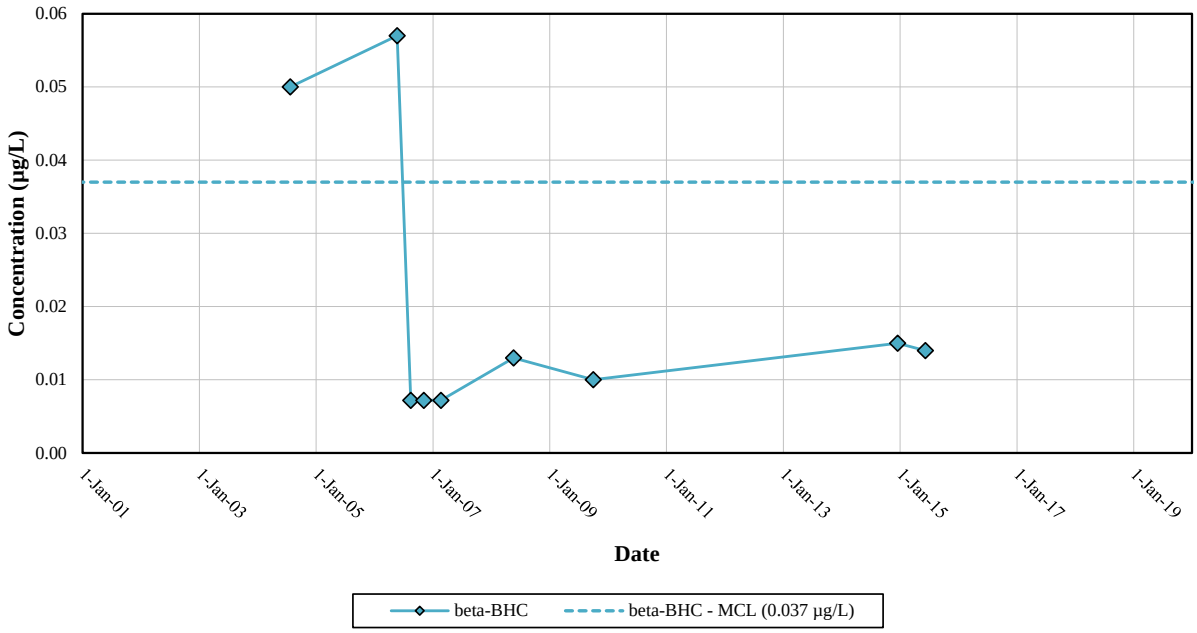
Well MCF-12B
beta-BHC Concentrations vs. Time



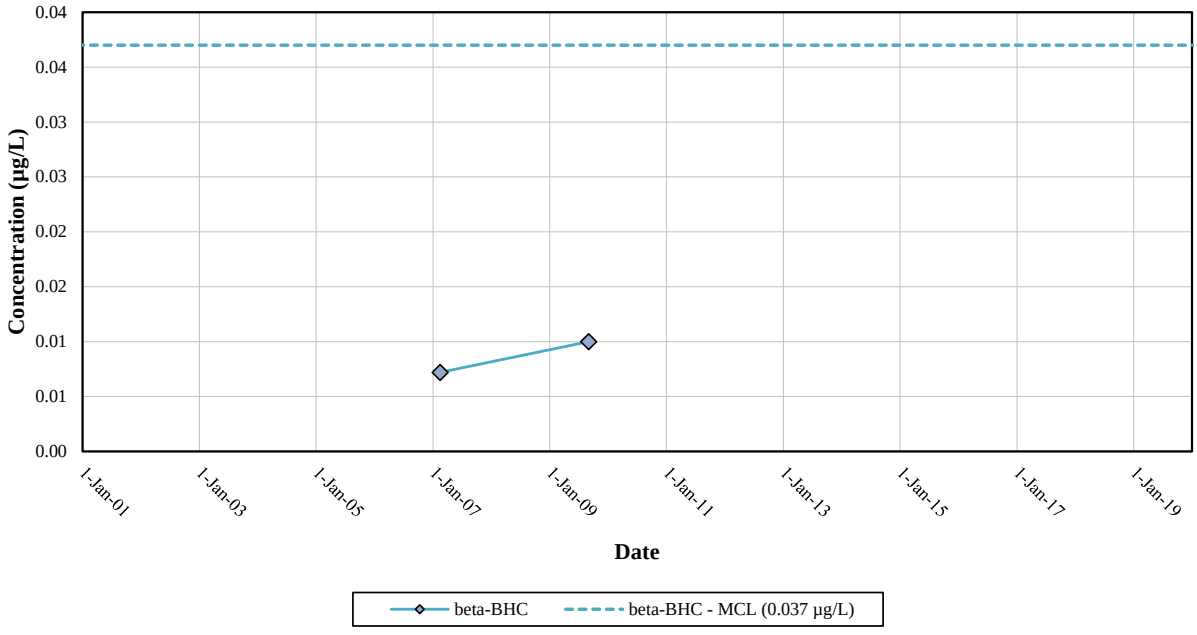
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well MCF-16C
beta-BHC Concentrations vs. Time



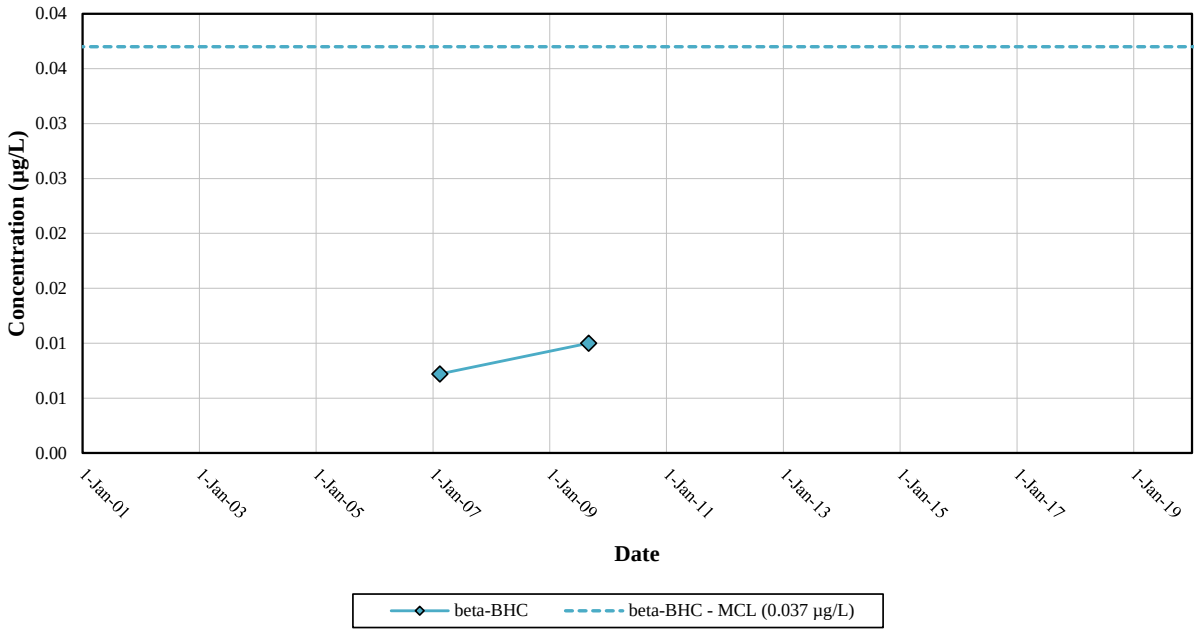
Well MW-13
beta-BHC Concentrations vs. Time



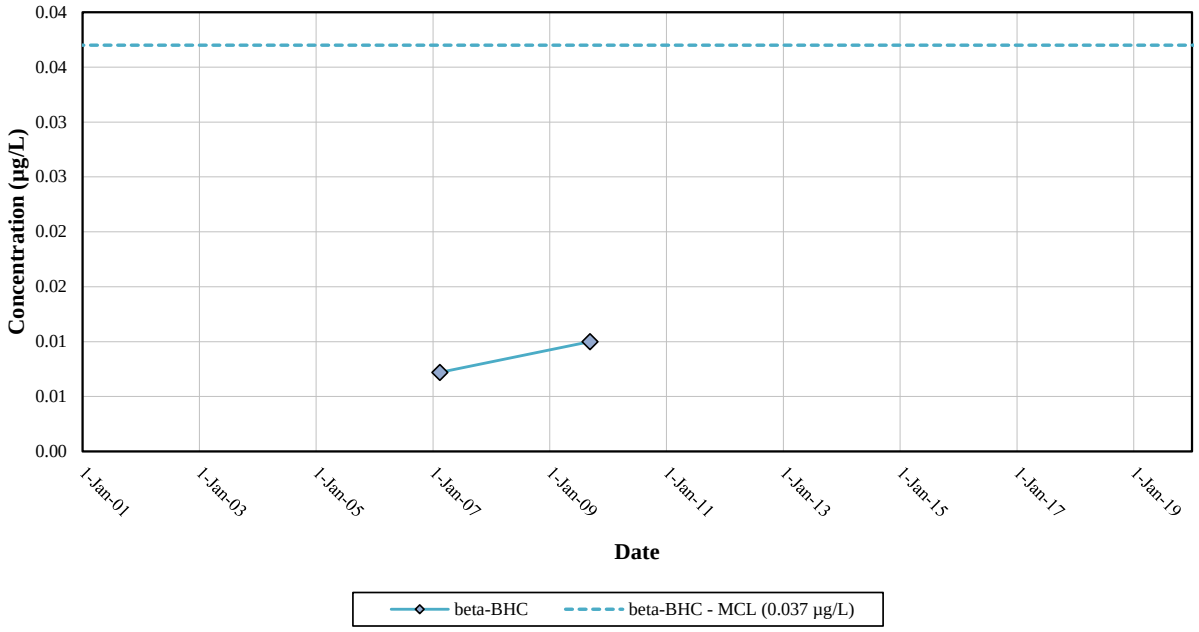
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well MW-15
beta-BHC Concentrations vs. Time



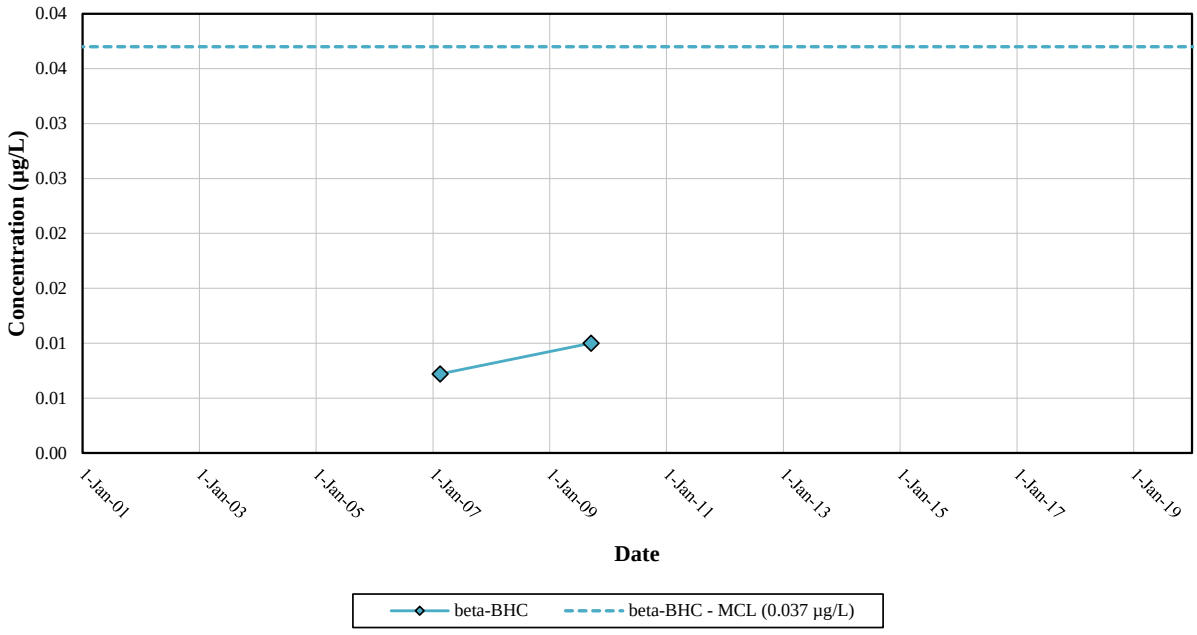
Well MW-3
beta-BHC Concentrations vs. Time



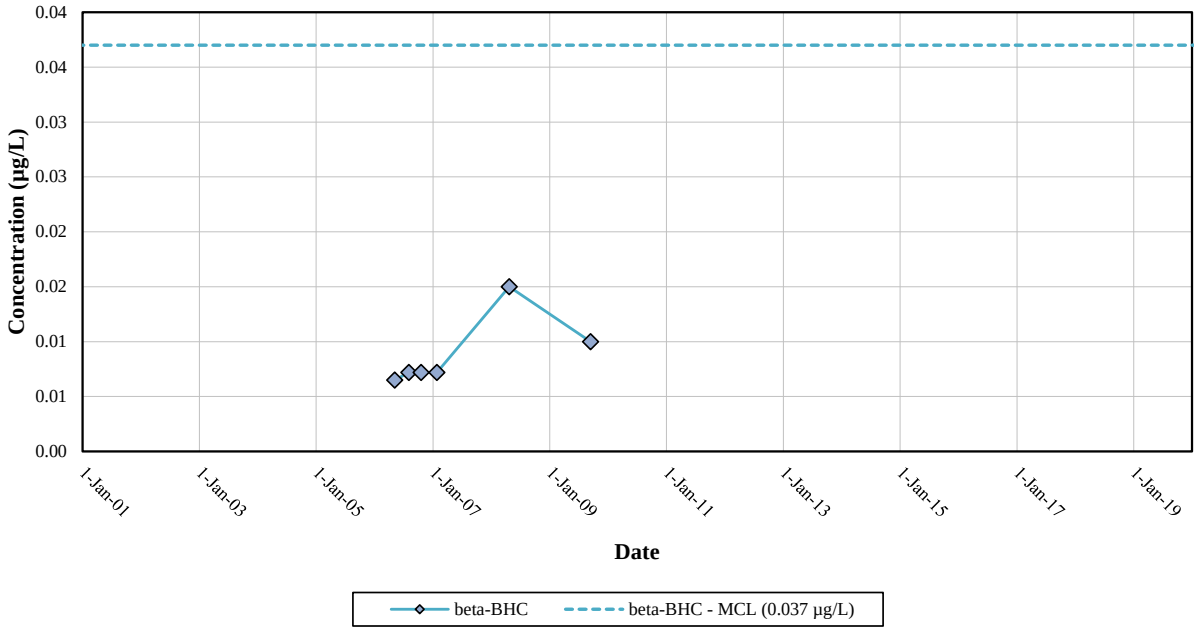
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well MW-4
beta-BHC Concentrations vs. Time



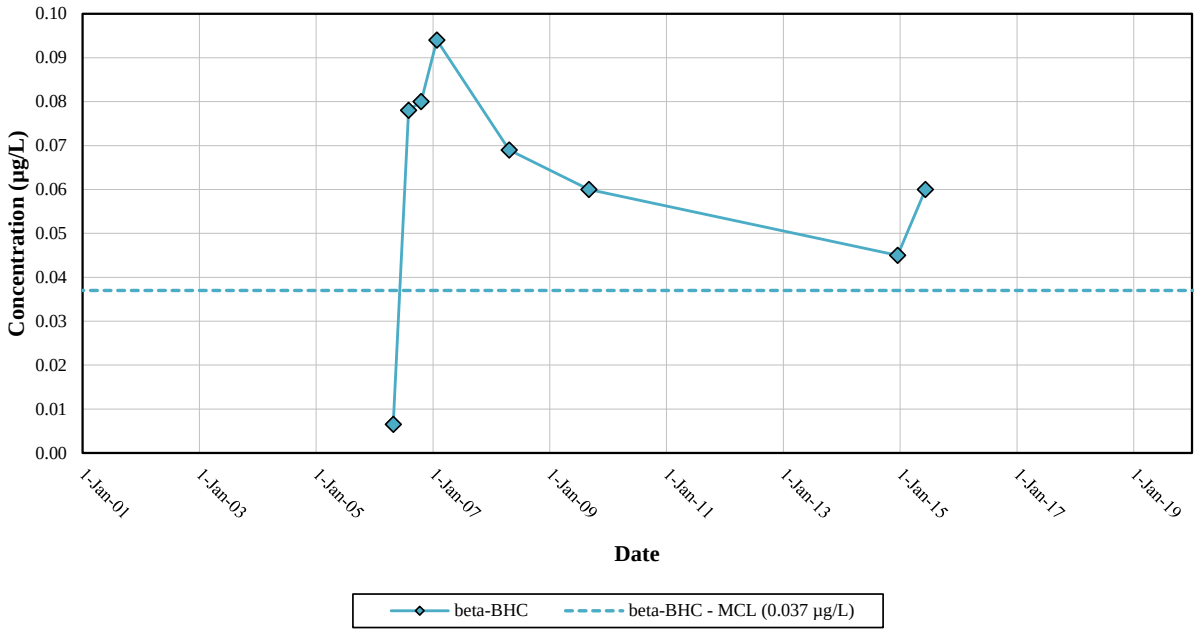
Well POD2-R
beta-BHC Concentrations vs. Time



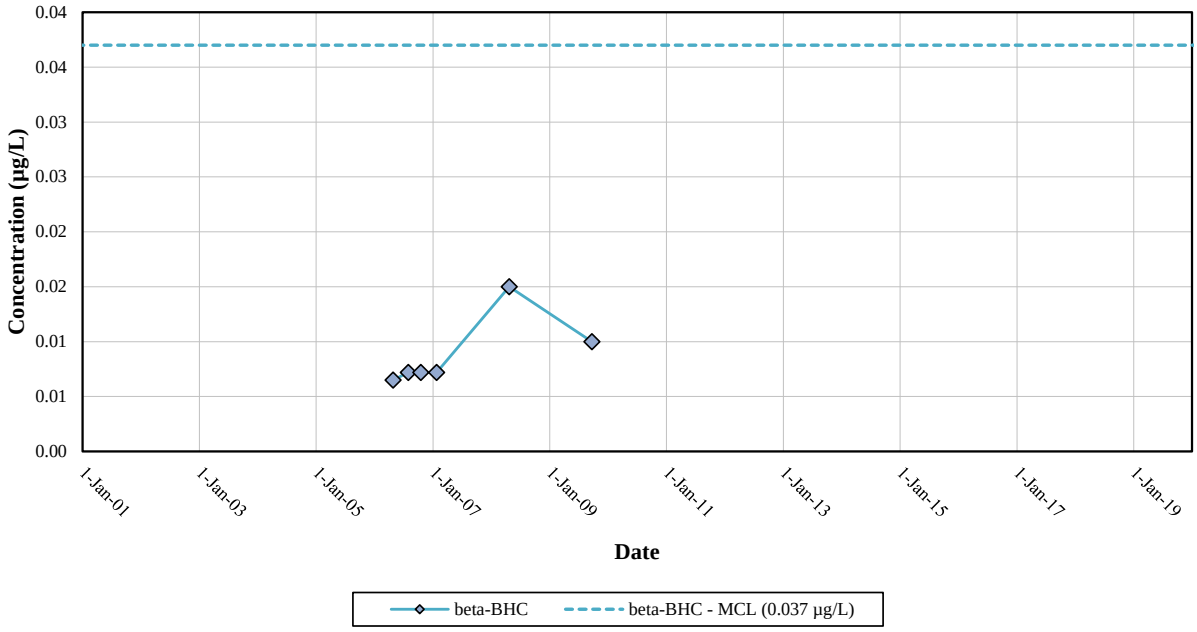
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well POD8
beta-BHC Concentrations vs. Time



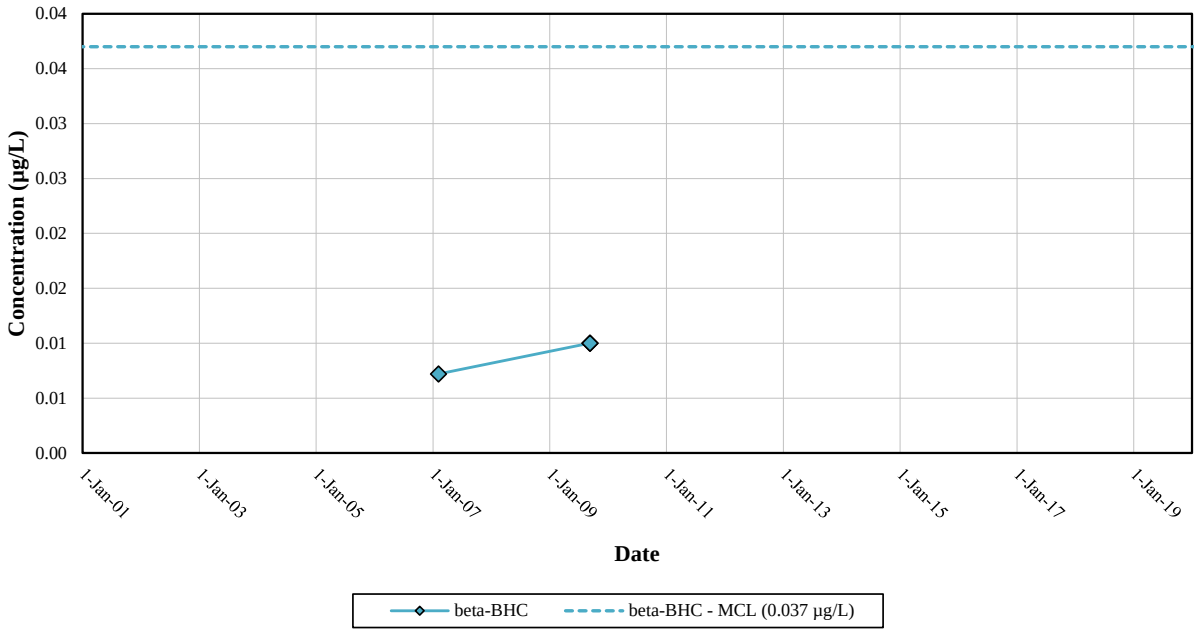
Well POU3
beta-BHC Concentrations vs. Time



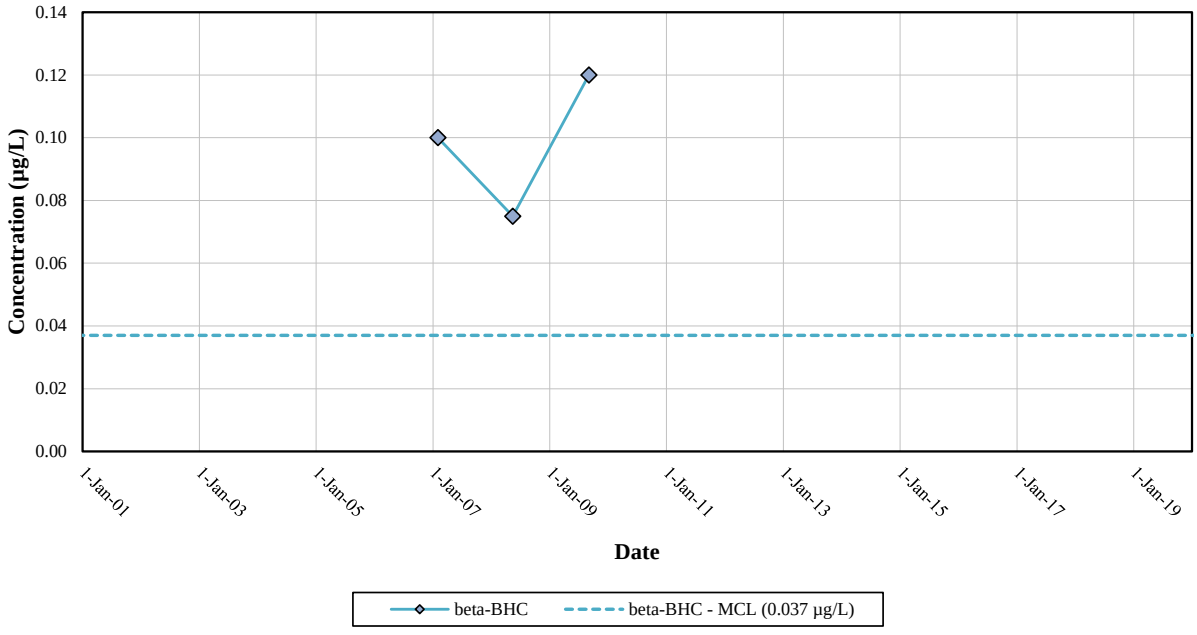
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well WMW5.58SD
beta-BHC Concentrations vs. Time

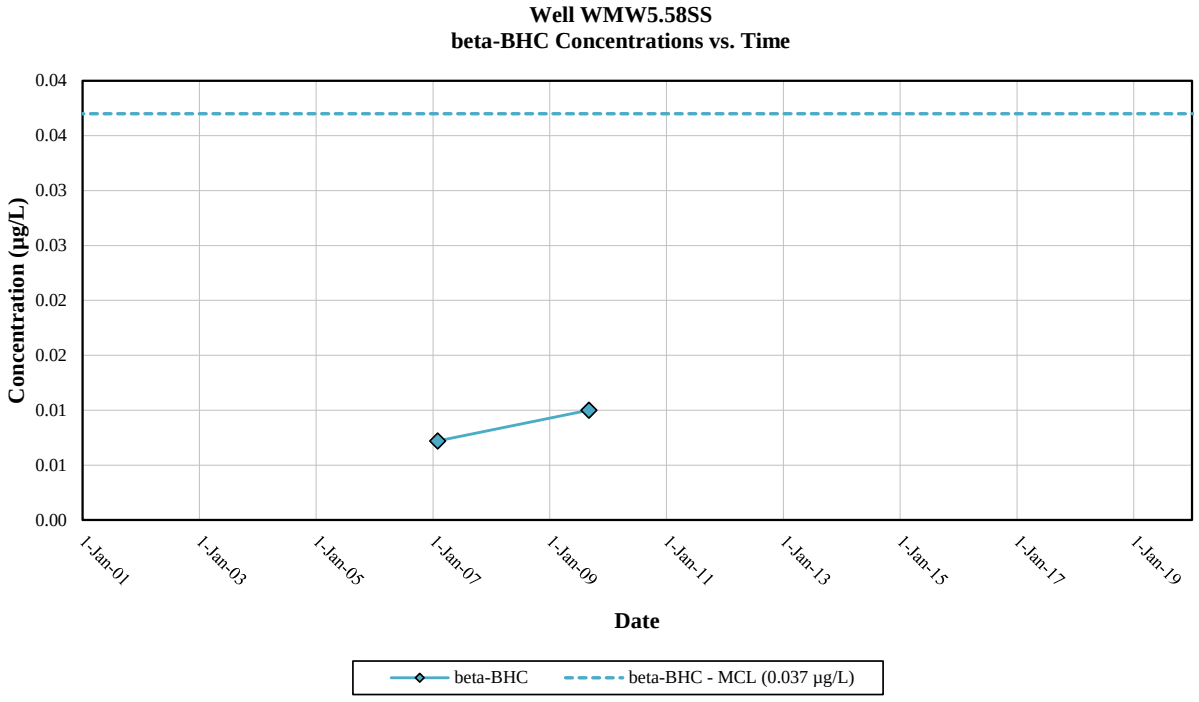


Well WMW5.58SI
beta-BHC Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

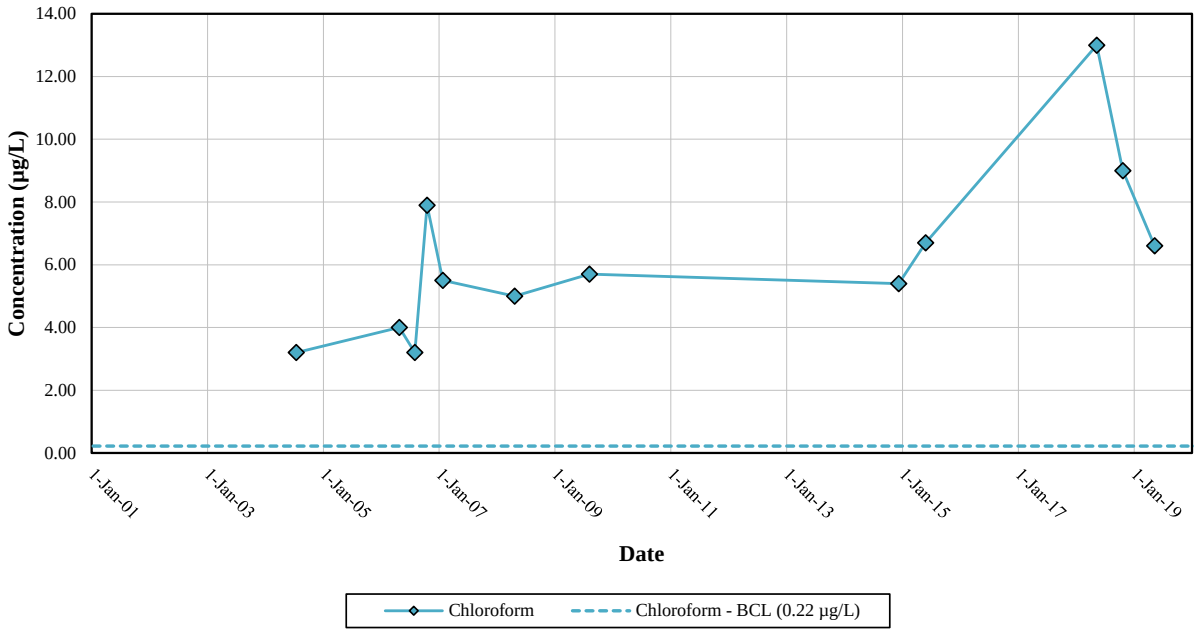
Appendix A
Time Series Plots
Eastside Shallow



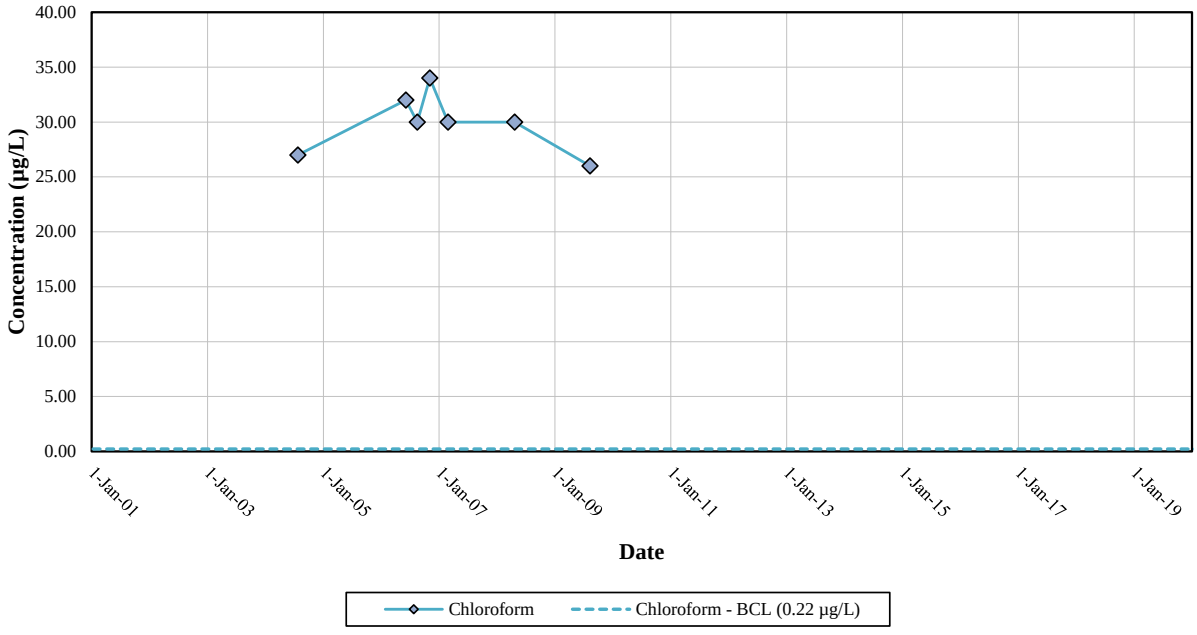
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-01
Chloroform Concentrations vs. Time



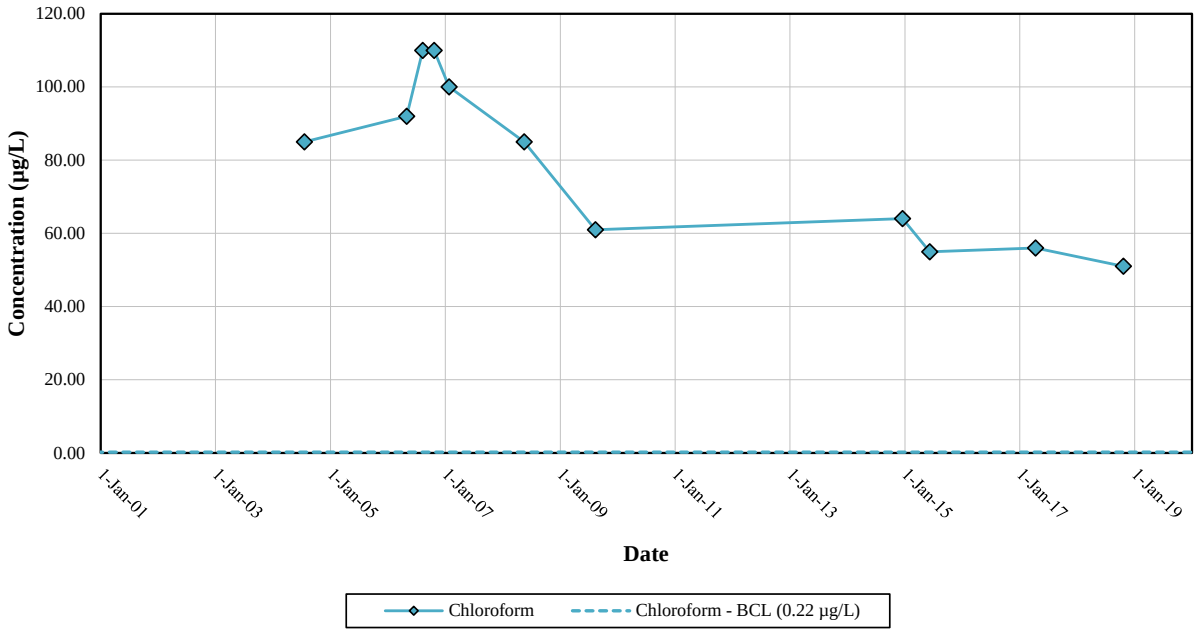
Well AA-07
Chloroform Concentrations vs. Time



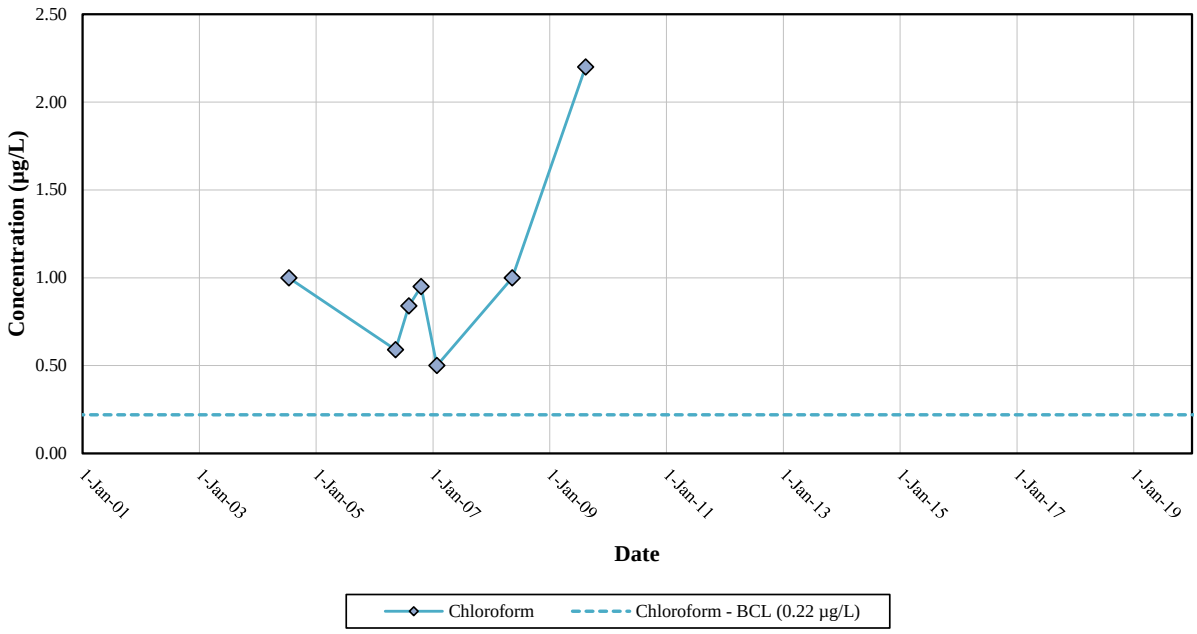
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-09
Chloroform Concentrations vs. Time



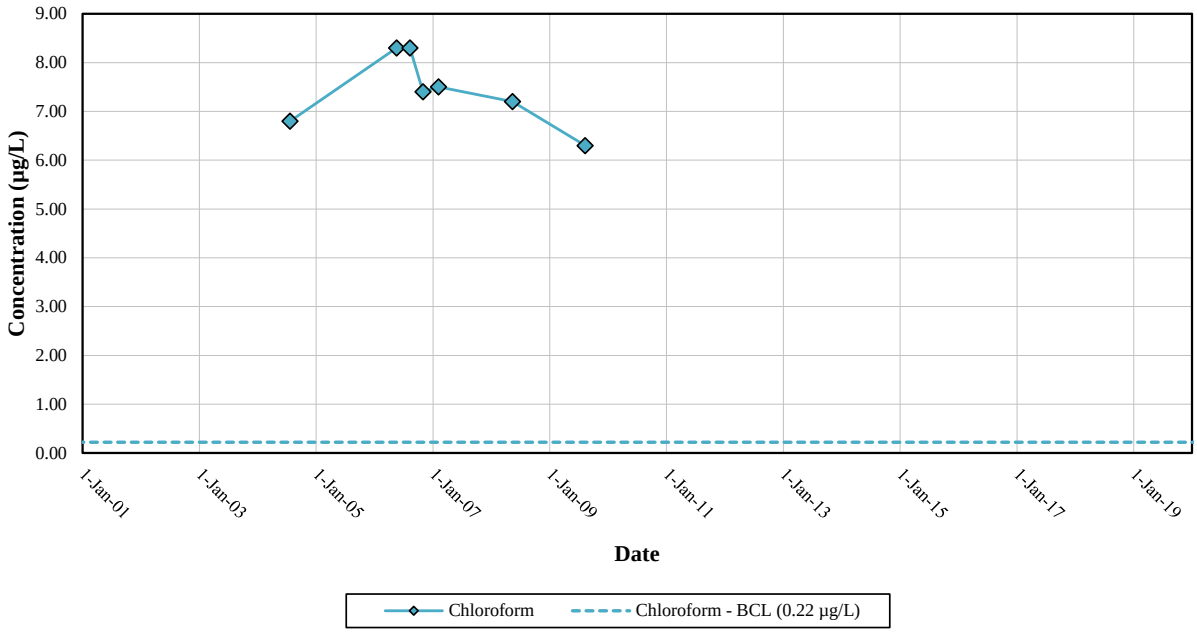
Well AA-13
Chloroform Concentrations vs. Time



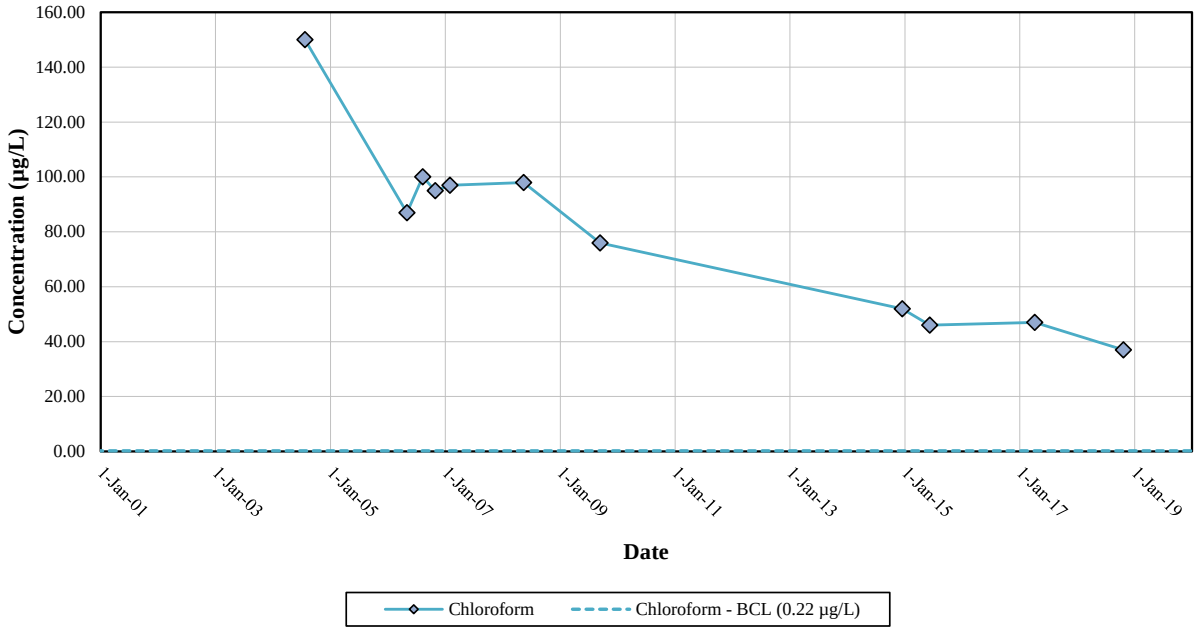
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-18
Chloroform Concentrations vs. Time



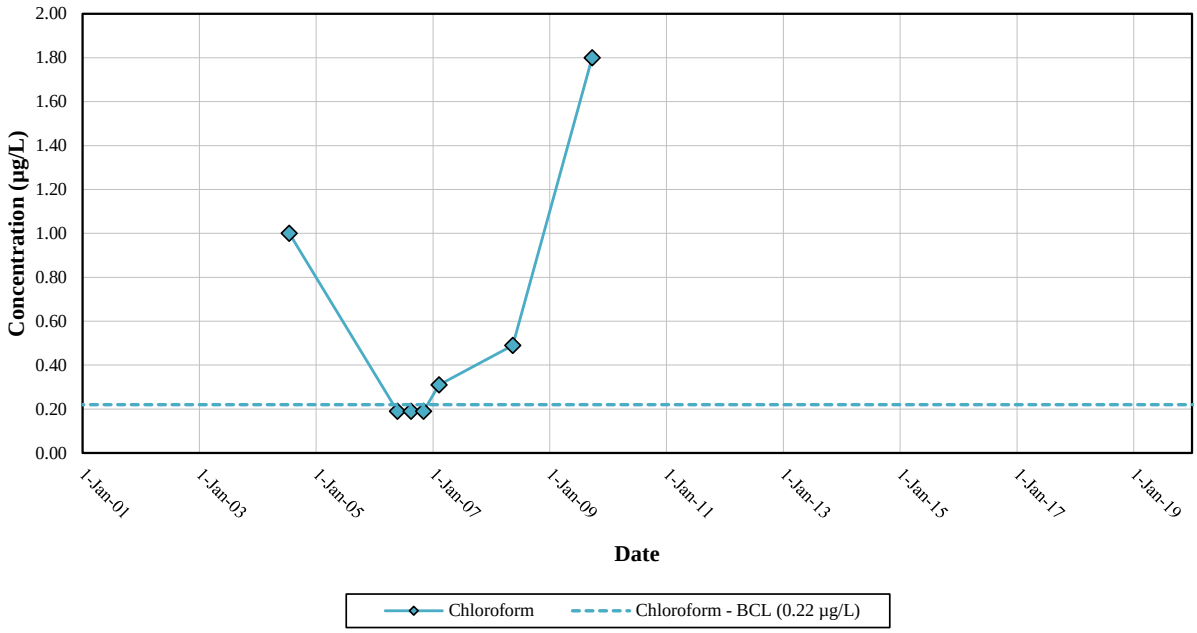
Well AA-20
Chloroform Concentrations vs. Time



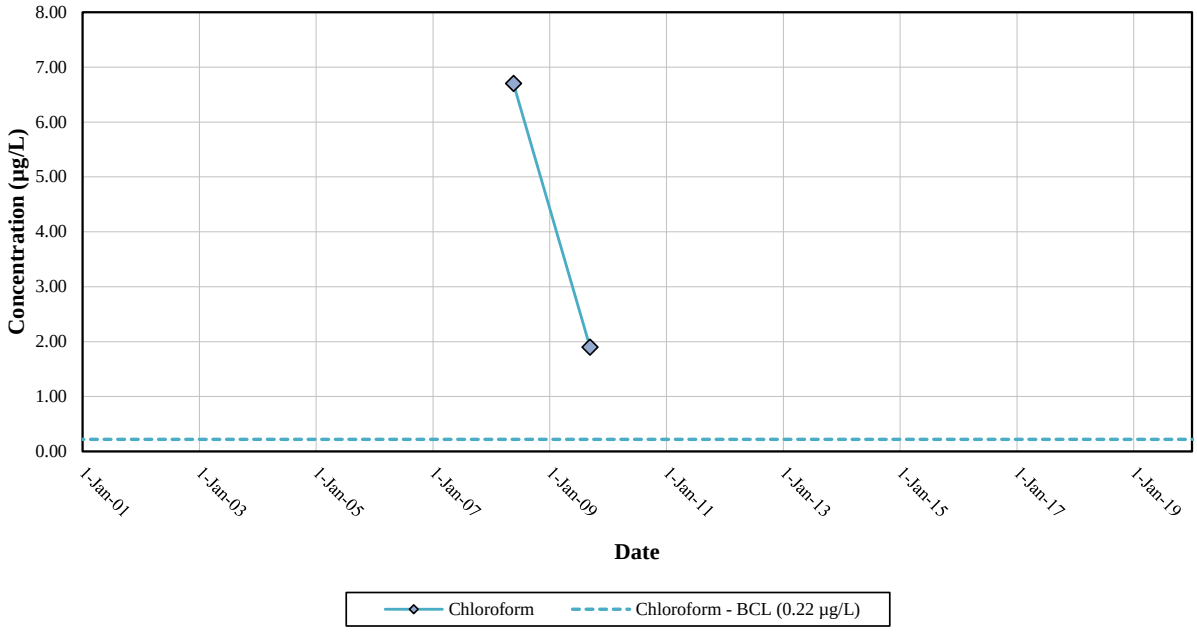
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-22
Chloroform Concentrations vs. Time



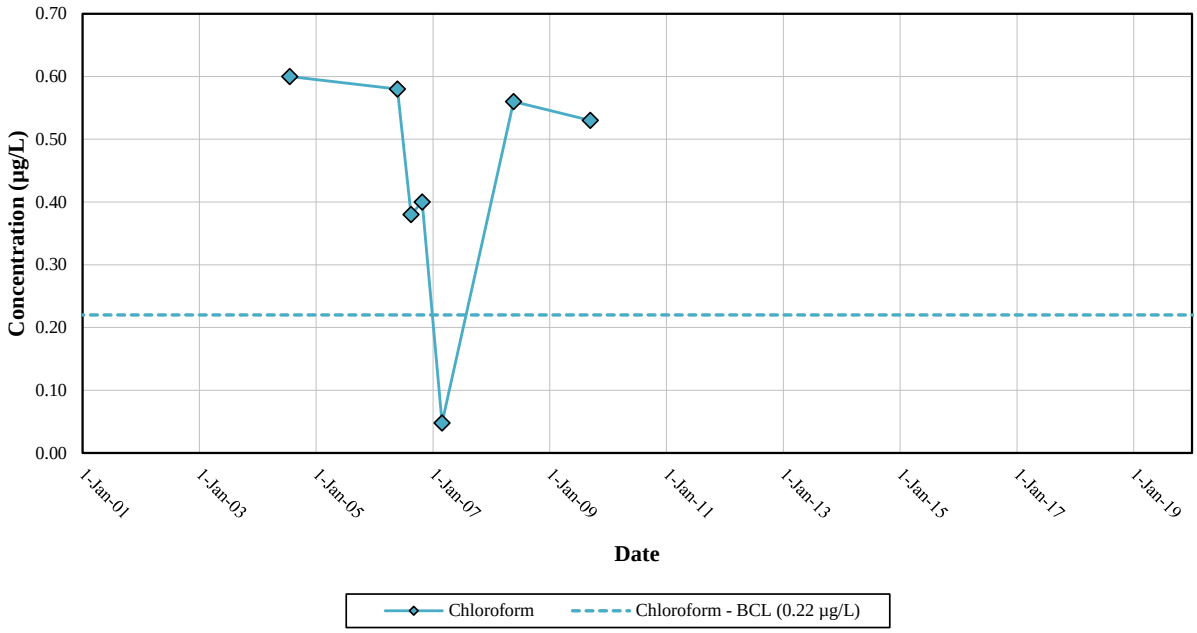
Well AA-23-R
Chloroform Concentrations vs. Time



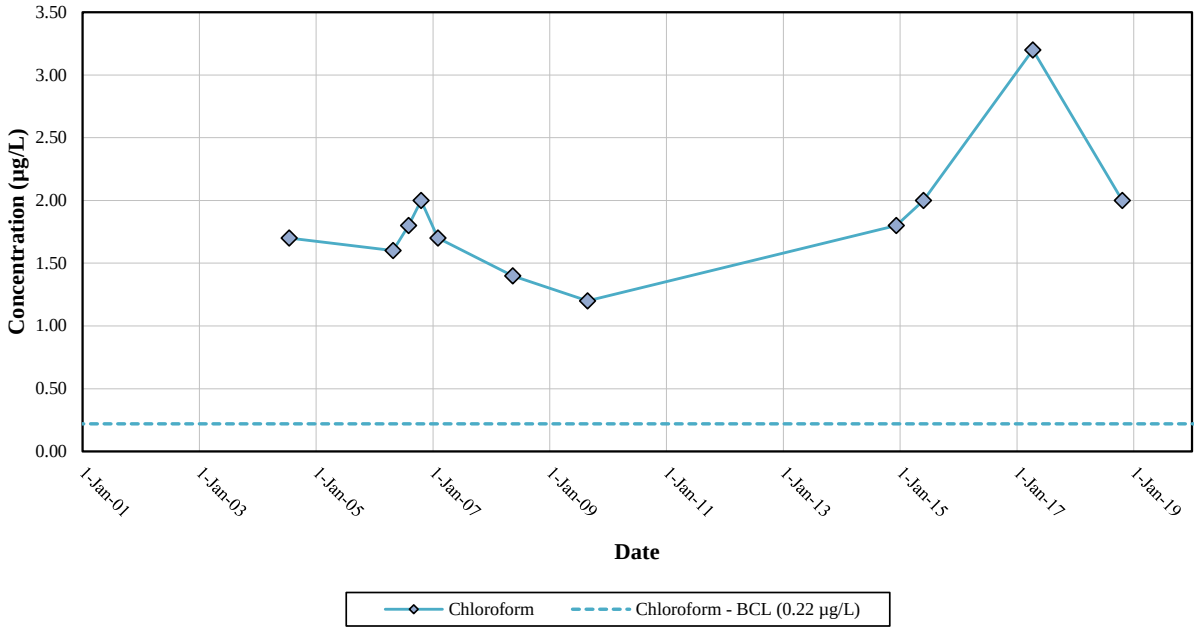
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-26
Chloroform Concentrations vs. Time



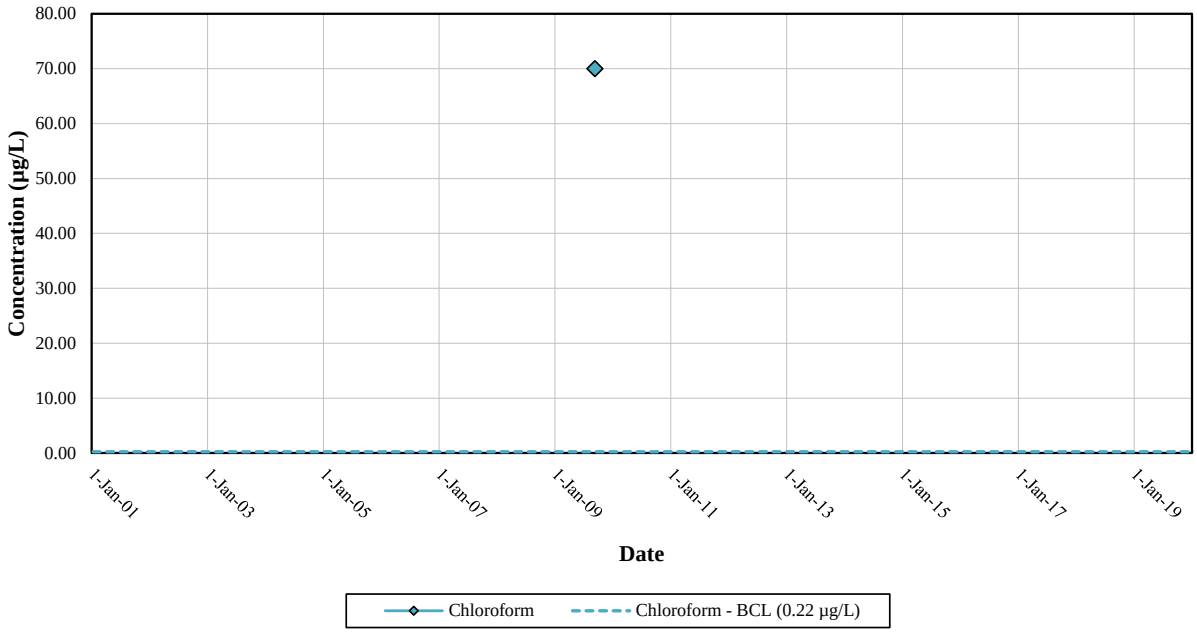
Well AA-27
Chloroform Concentrations vs. Time



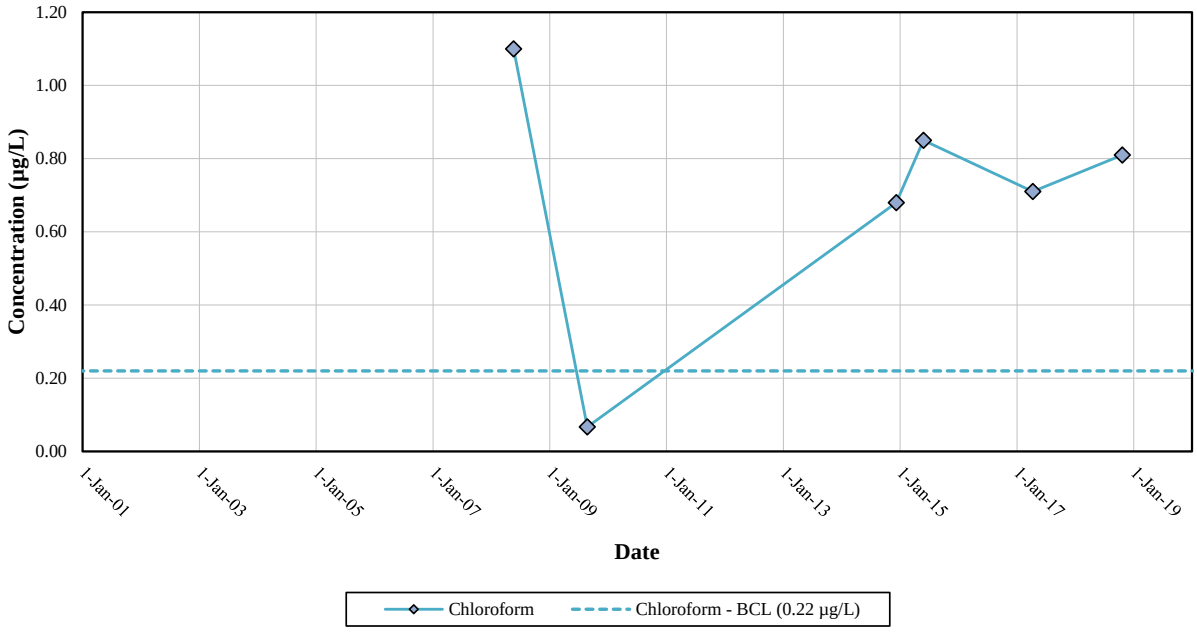
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-30
Chloroform Concentrations vs. Time



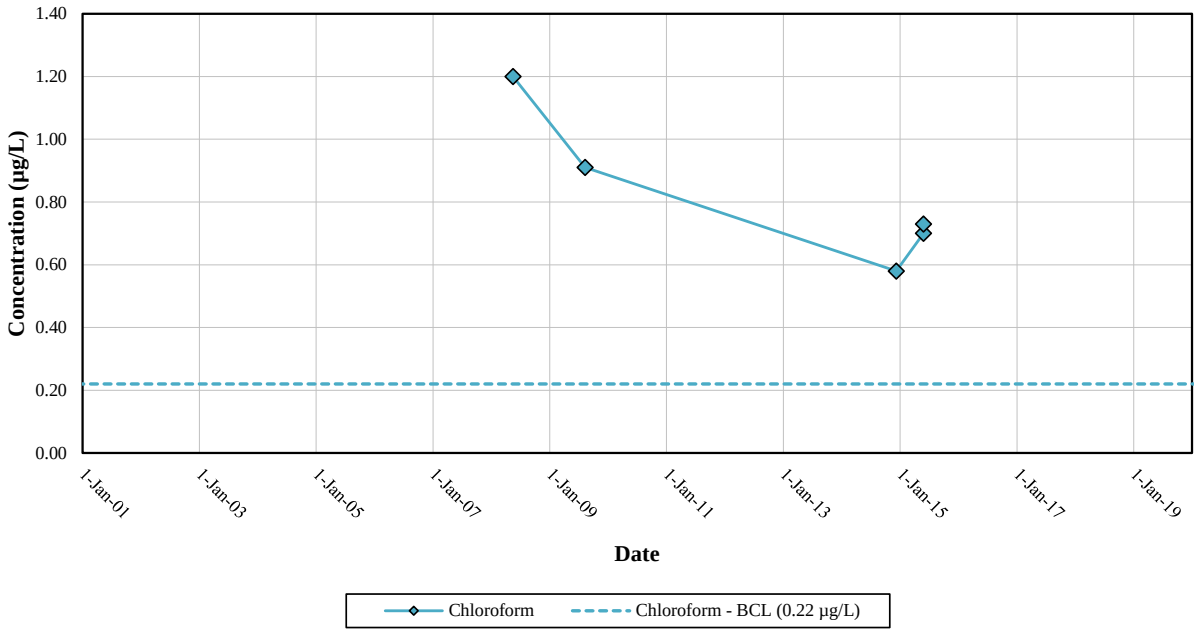
Well AA-UW1
Chloroform Concentrations vs. Time



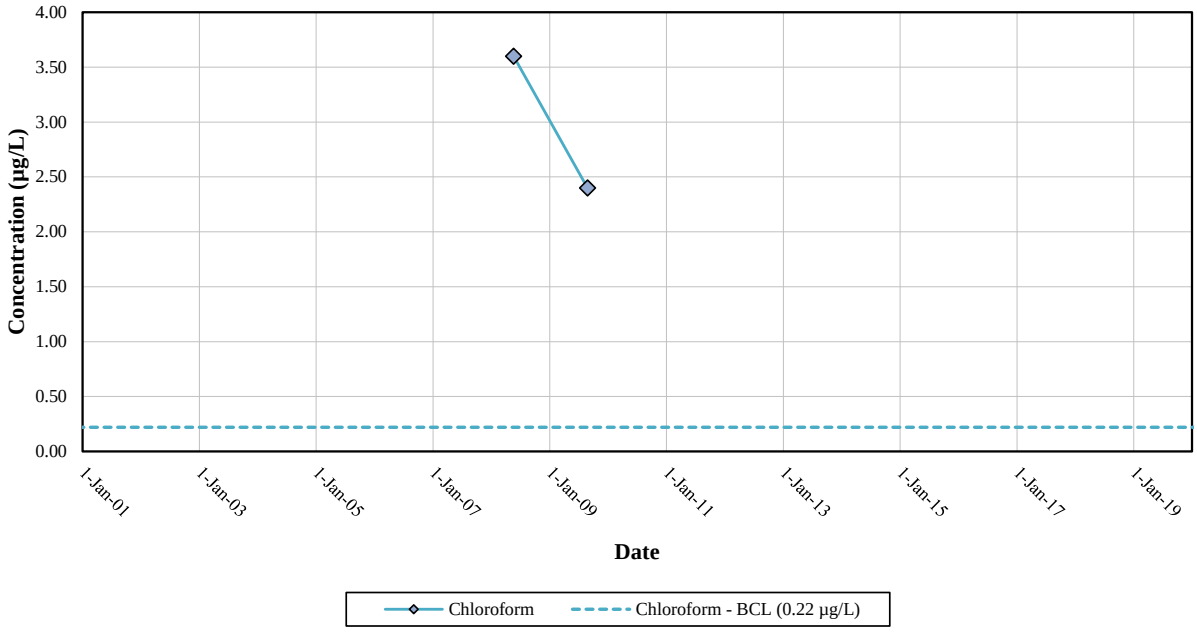
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-UW2
Chloroform Concentrations vs. Time



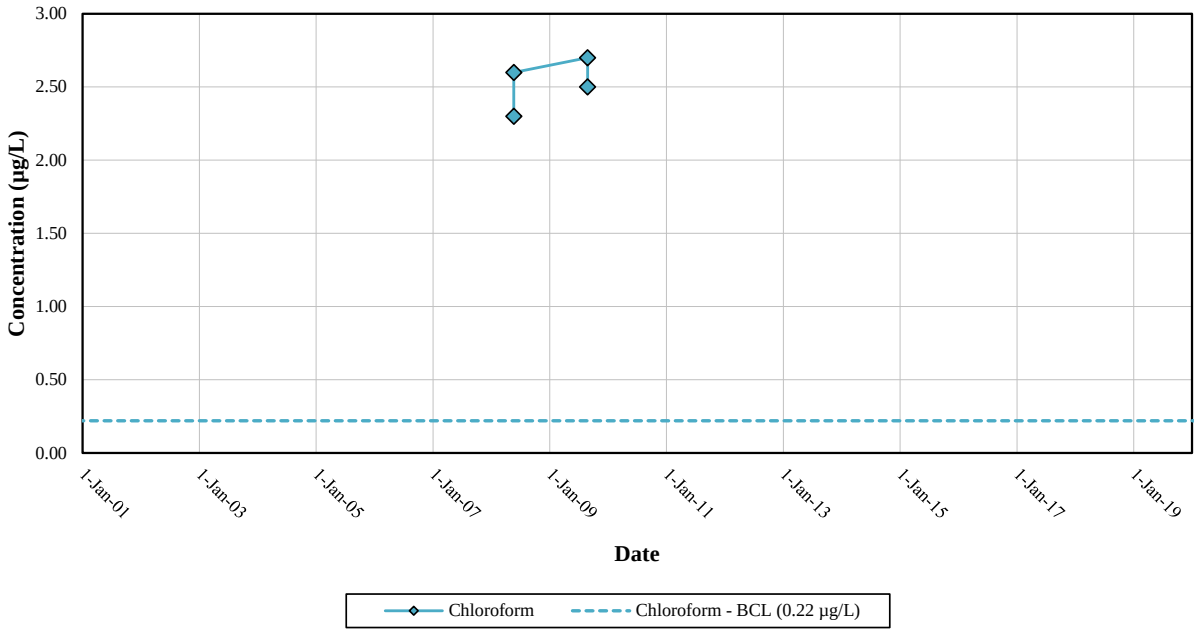
Well AA-UW3
Chloroform Concentrations vs. Time



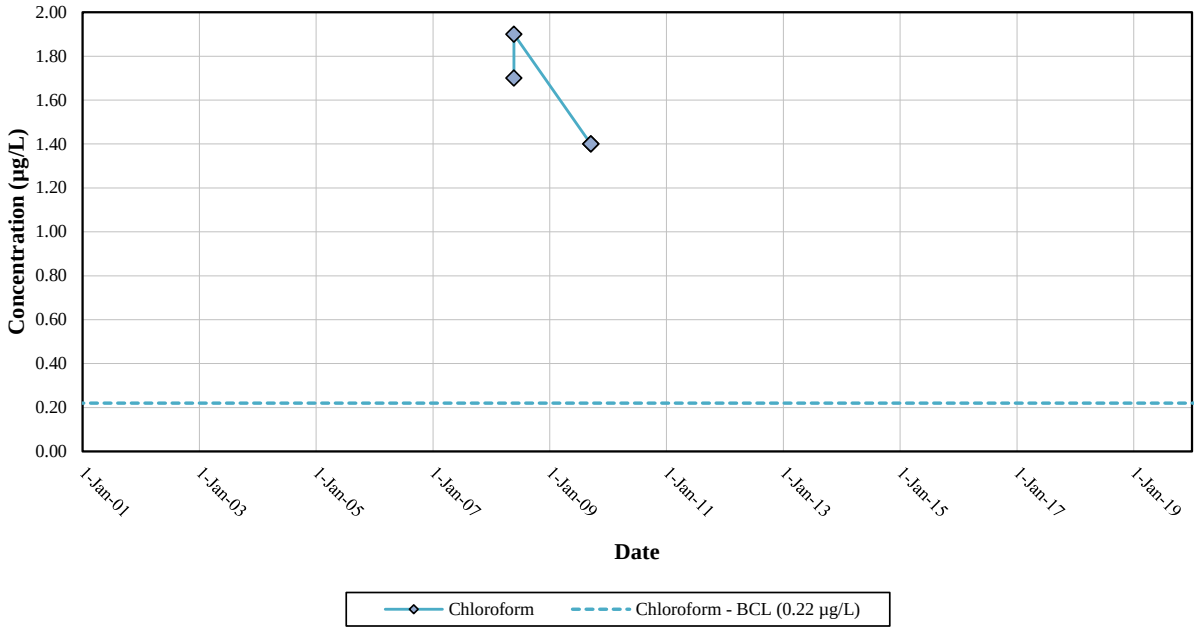
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well AA-UW4
Chloroform Concentrations vs. Time

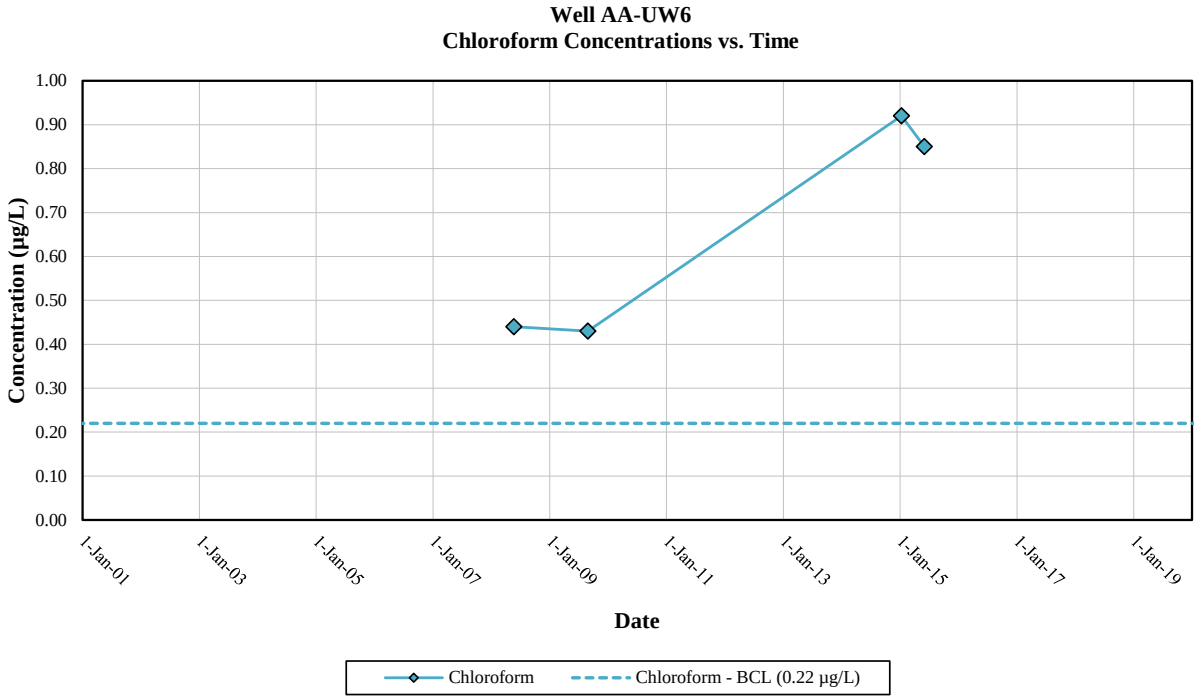


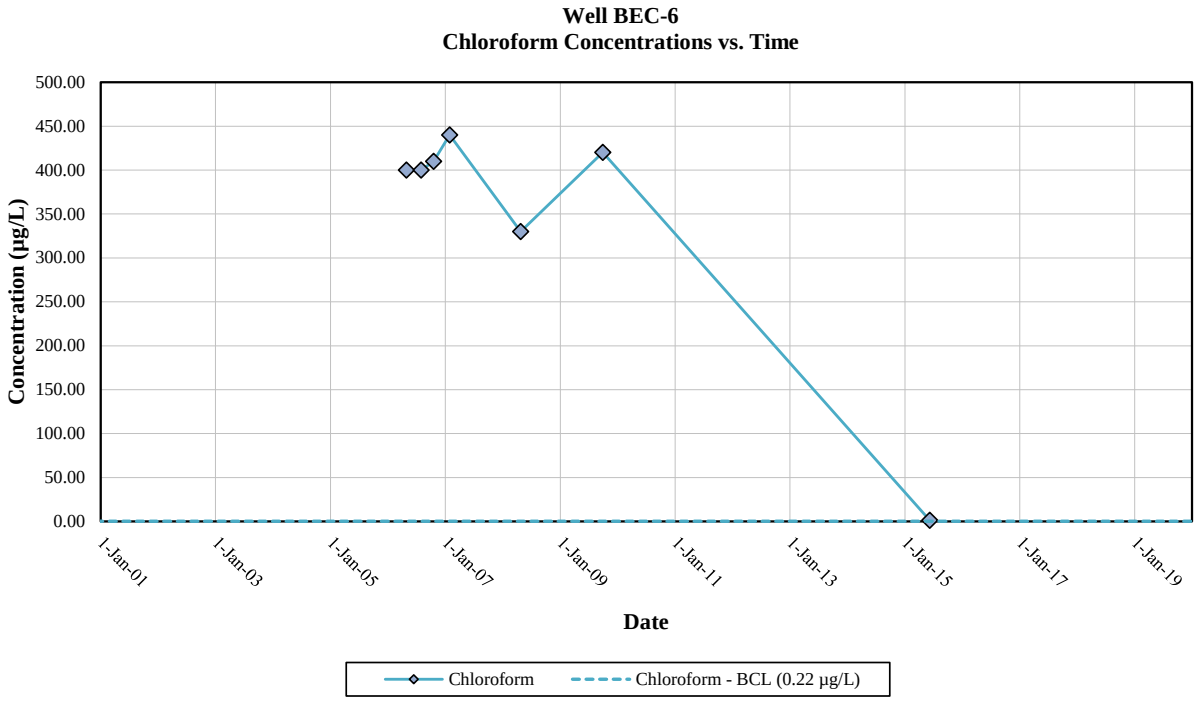
Well AA-UW5
Chloroform Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

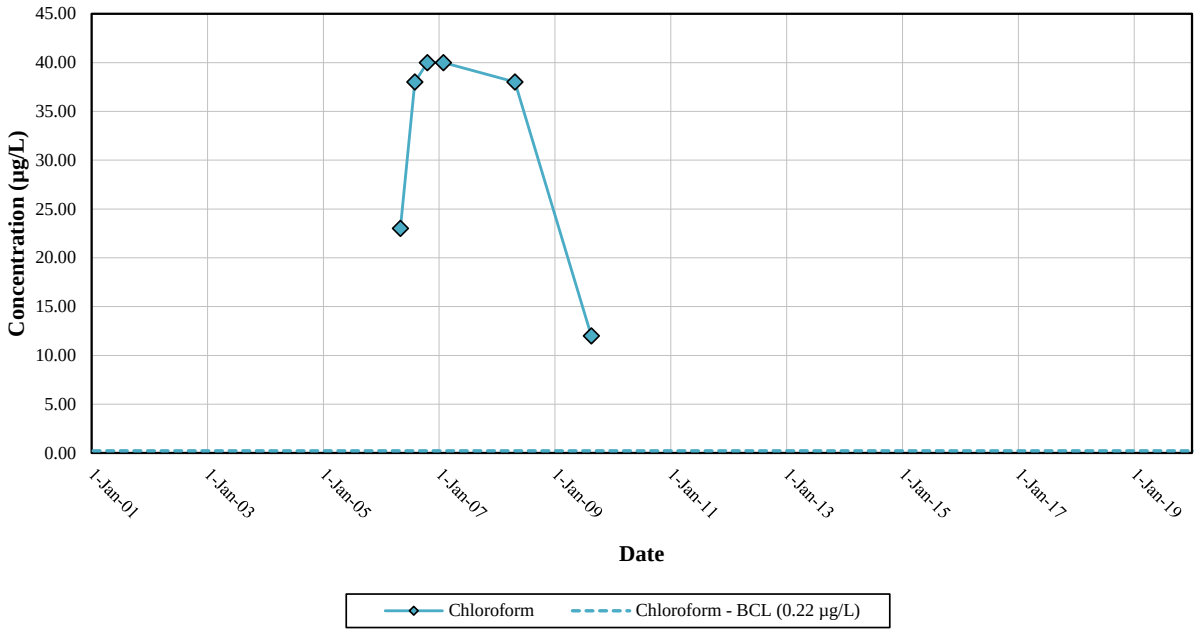




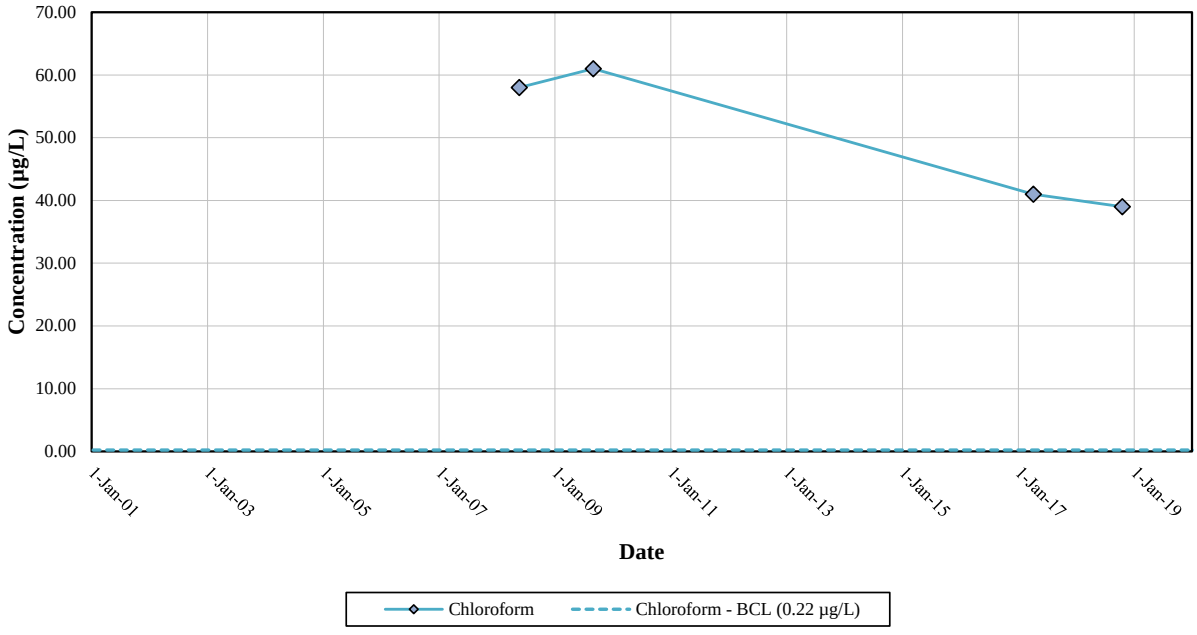
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well BEC-9
Chloroform Concentrations vs. Time



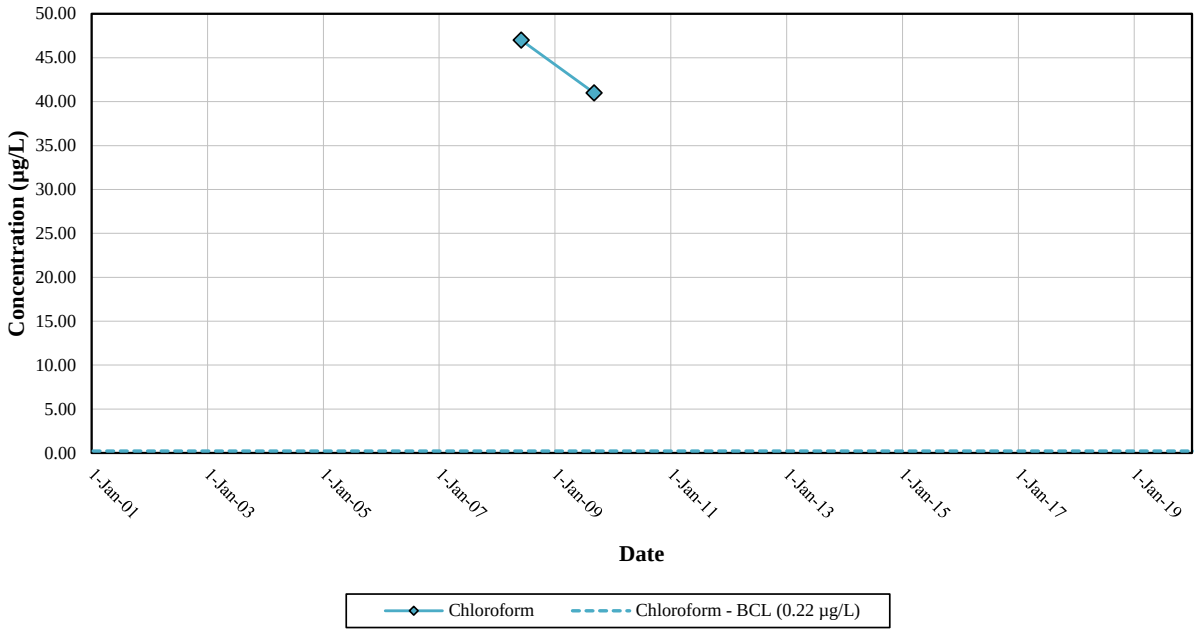
Well DBMW-1
Chloroform Concentrations vs. Time



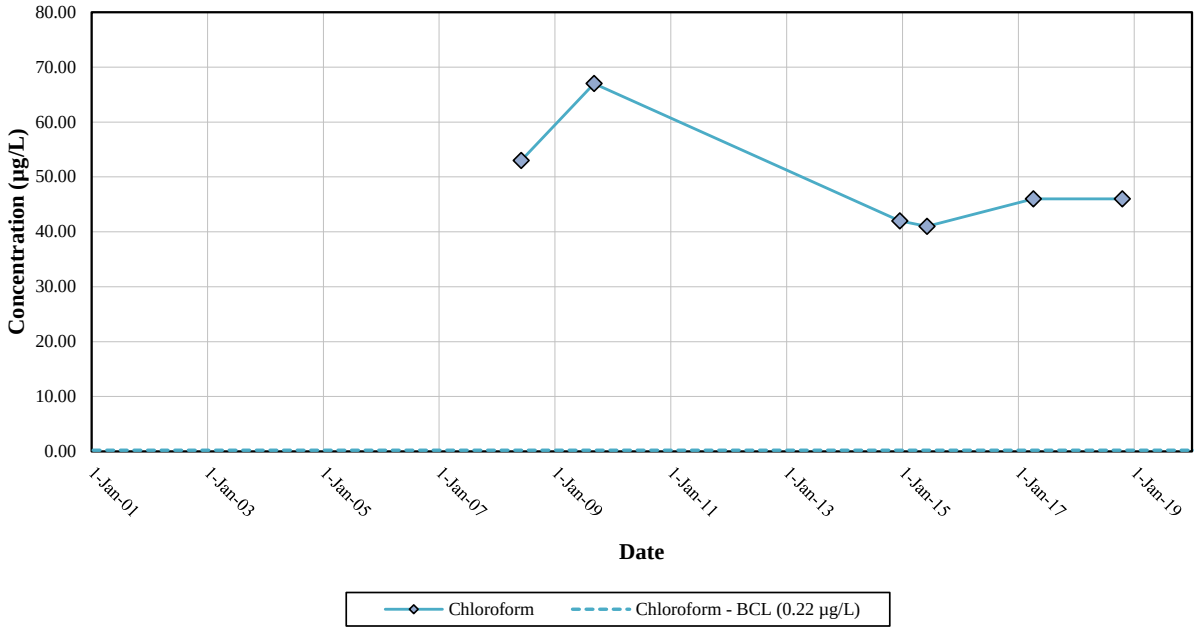
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-2
Chloroform Concentrations vs. Time



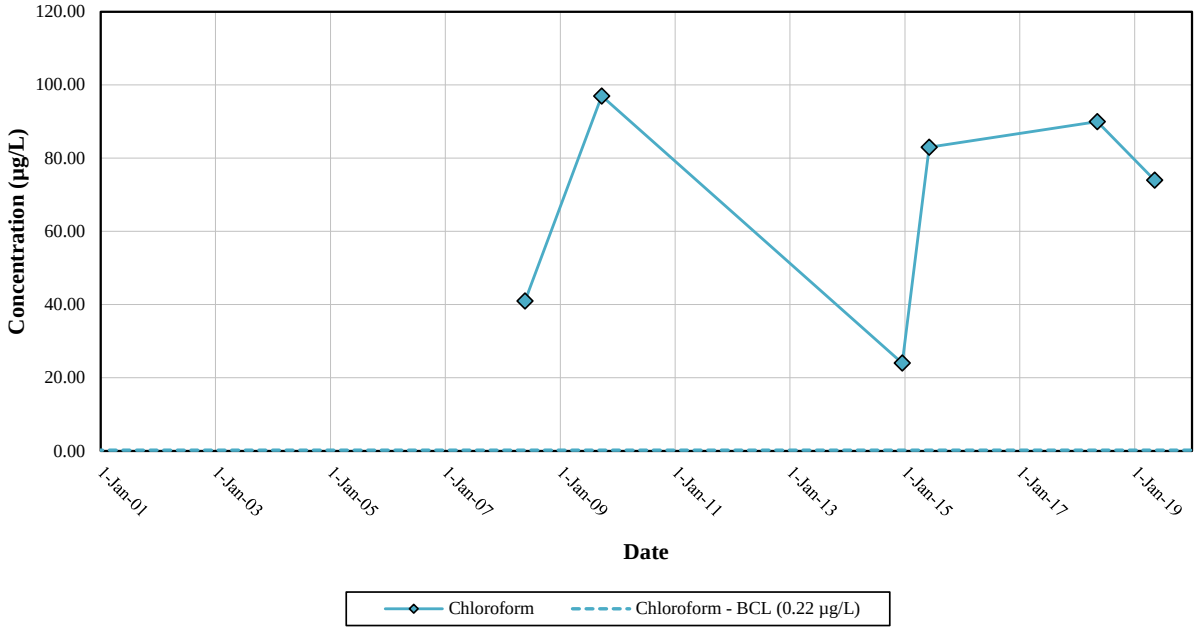
Well DBMW-3
Chloroform Concentrations vs. Time



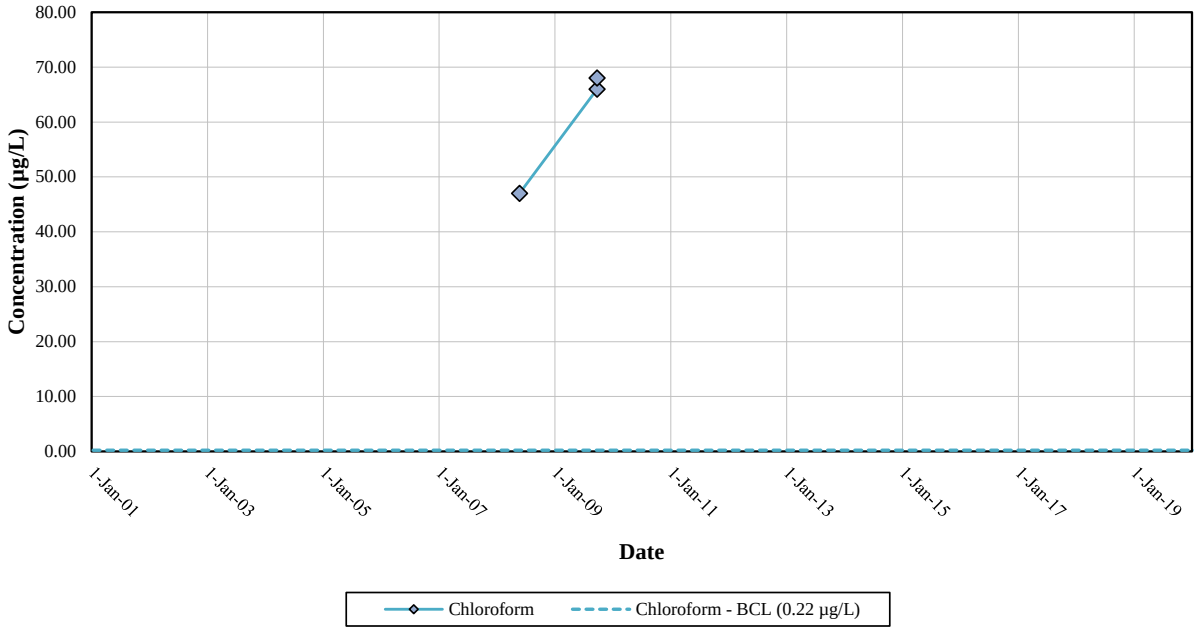
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-4
Chloroform Concentrations vs. Time



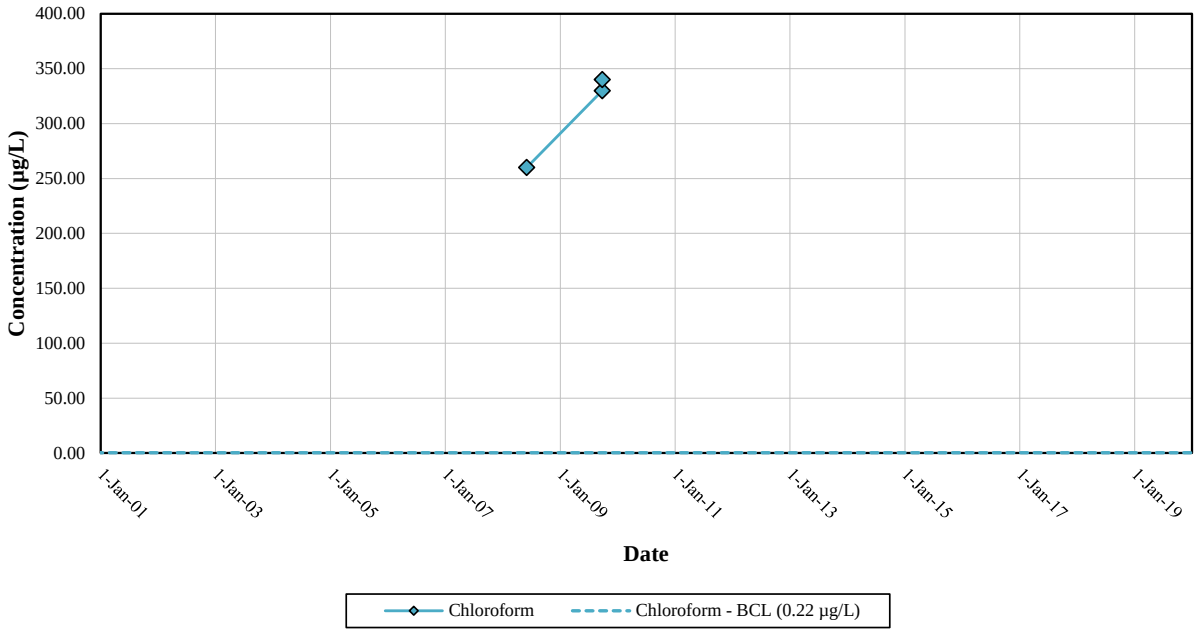
Well DBMW-5
Chloroform Concentrations vs. Time



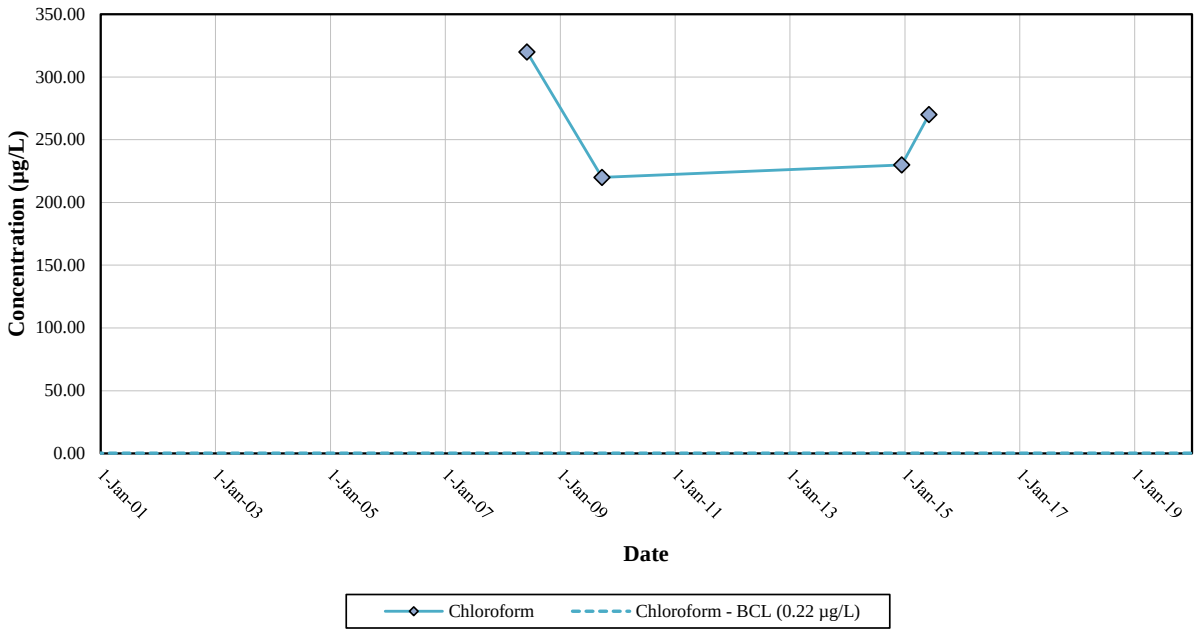
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-7
Chloroform Concentrations vs. Time

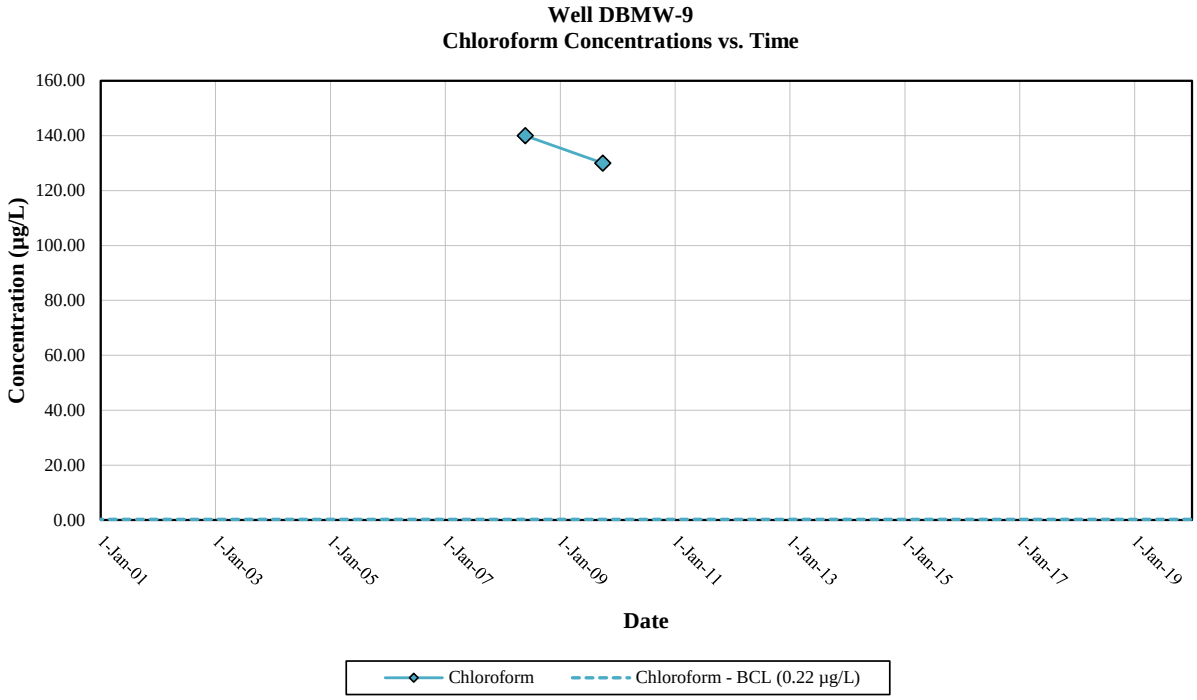


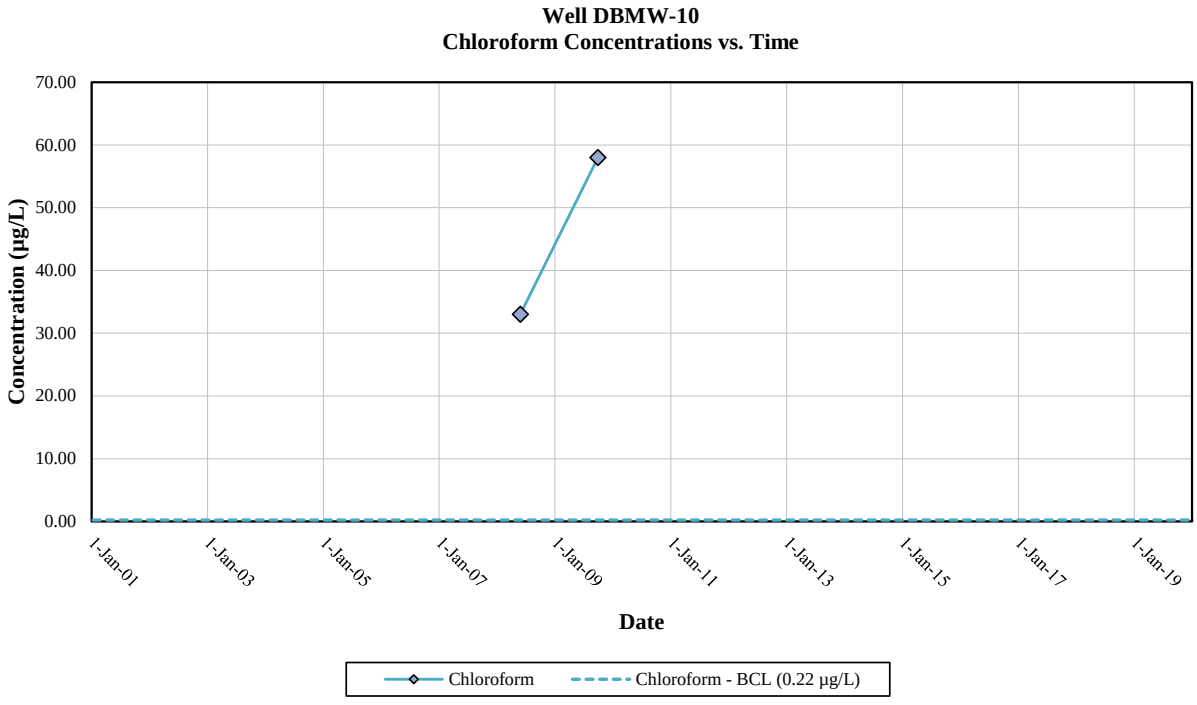
Well DBMW-8
Chloroform Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

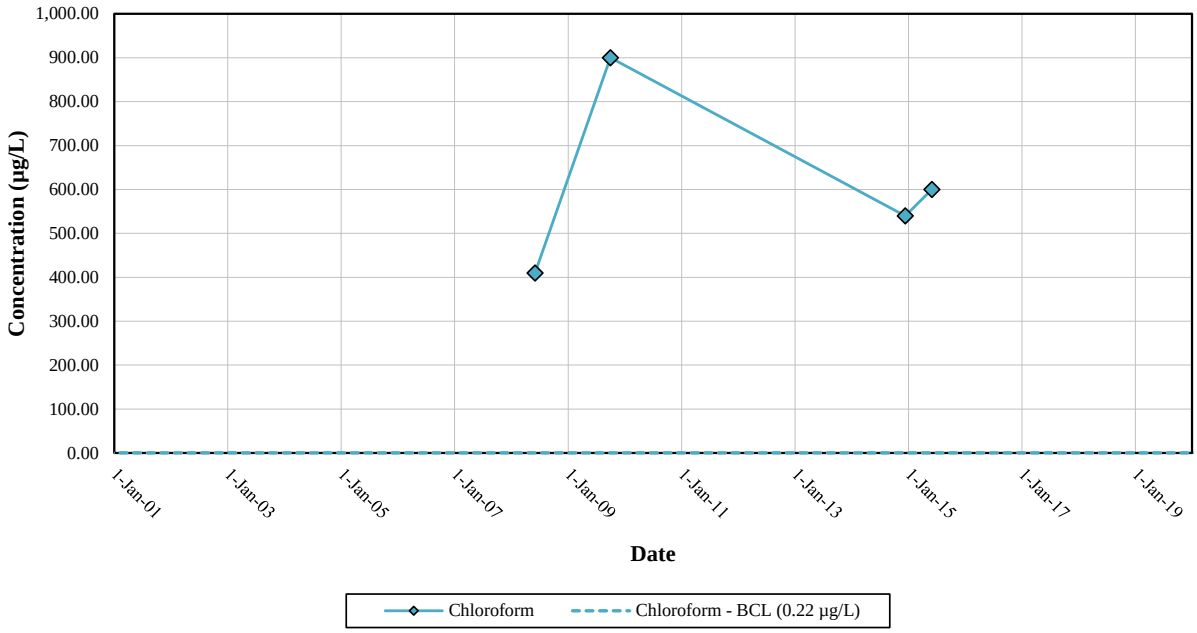




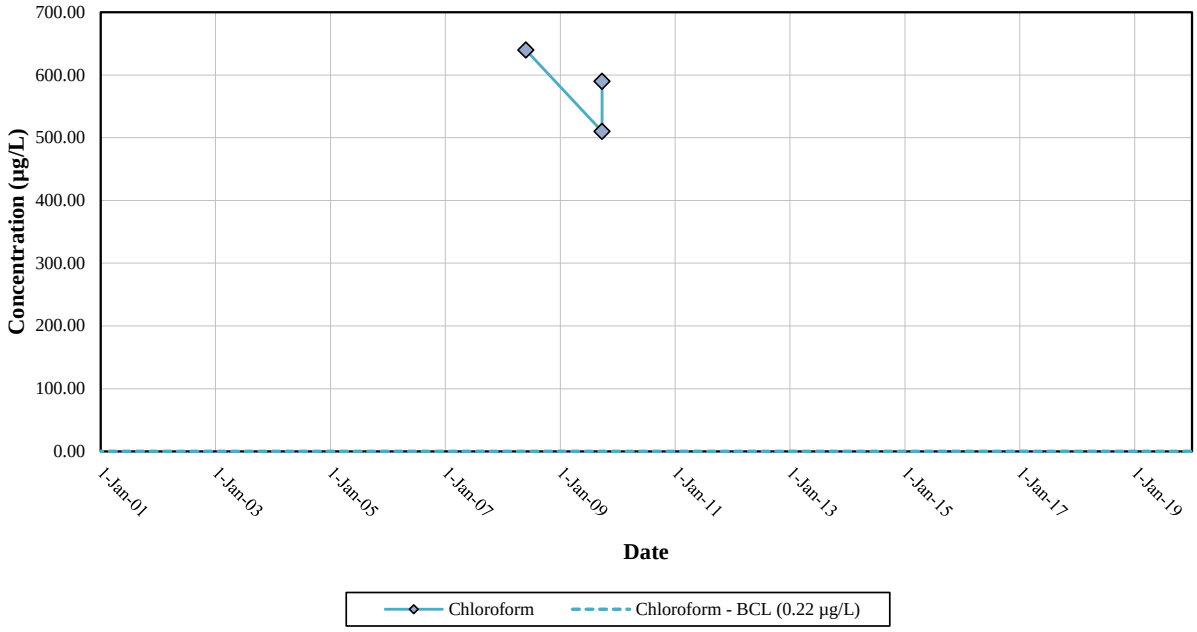
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-11
Chloroform Concentrations vs. Time



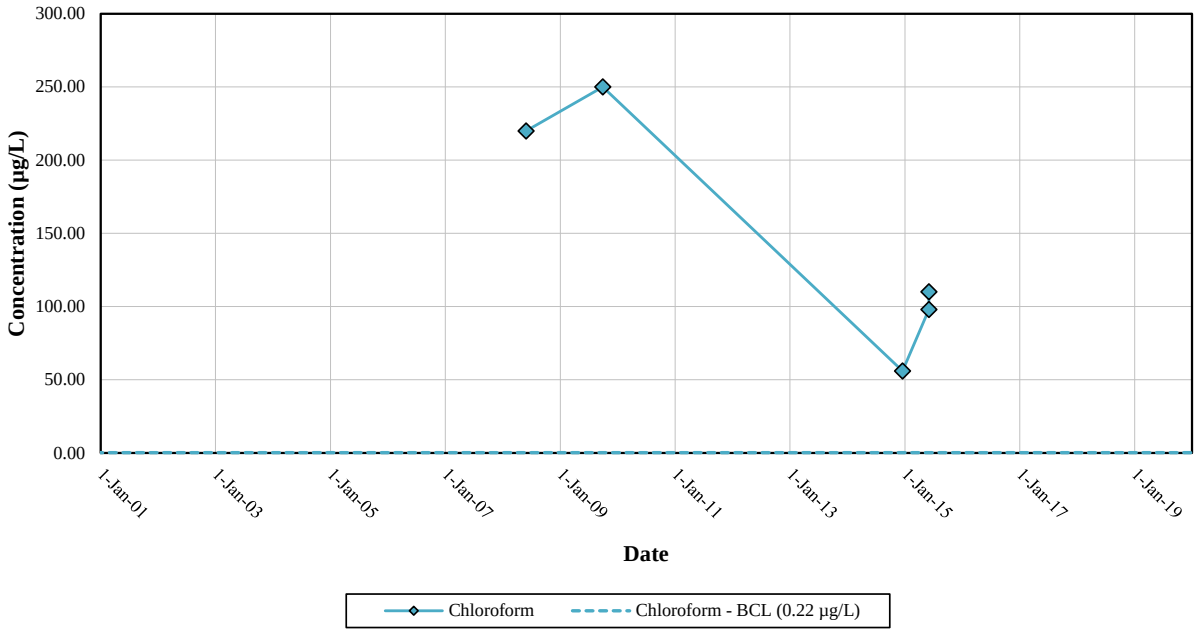
Well DBMW-12
Chloroform Concentrations vs. Time



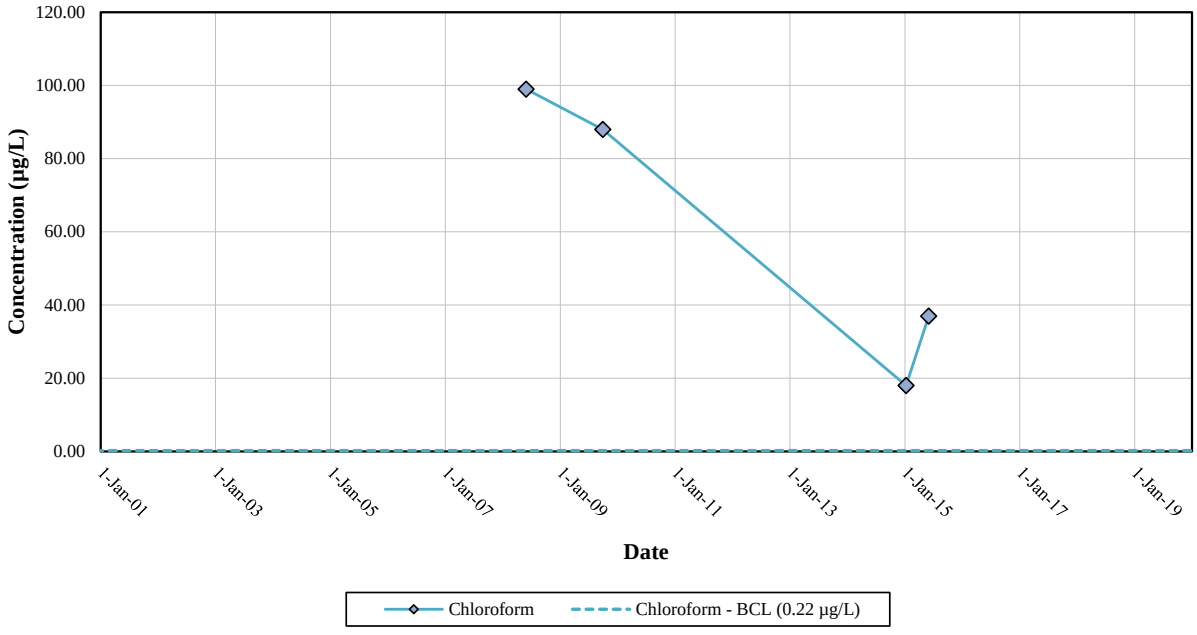
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-13
Chloroform Concentrations vs. Time



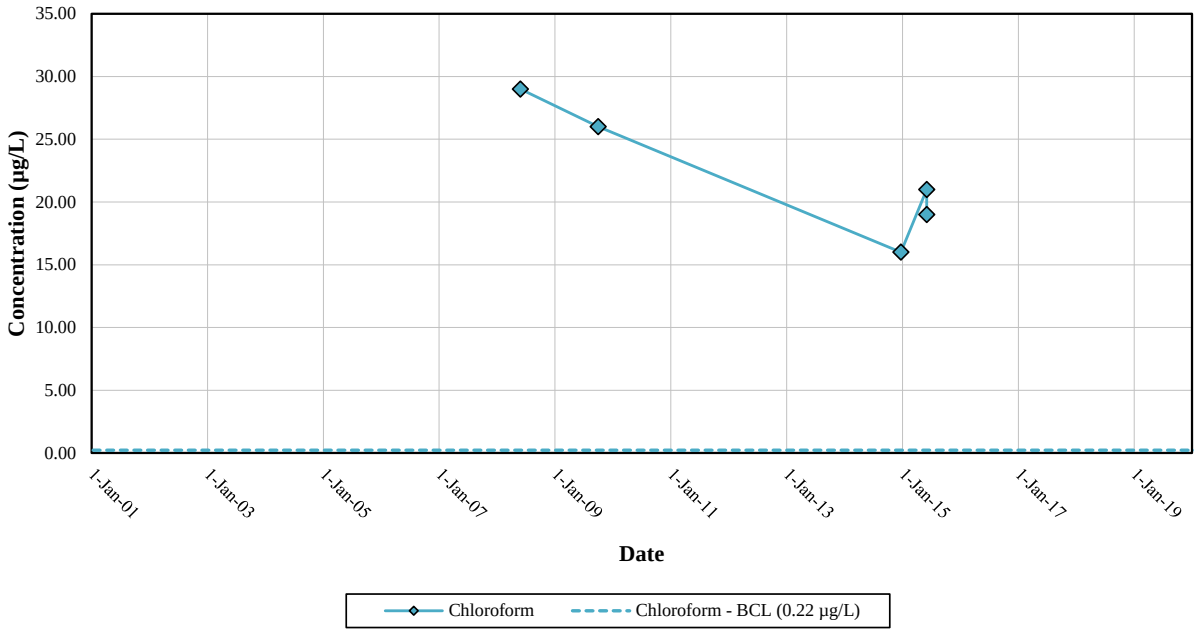
Well DBMW-14
Chloroform Concentrations vs. Time



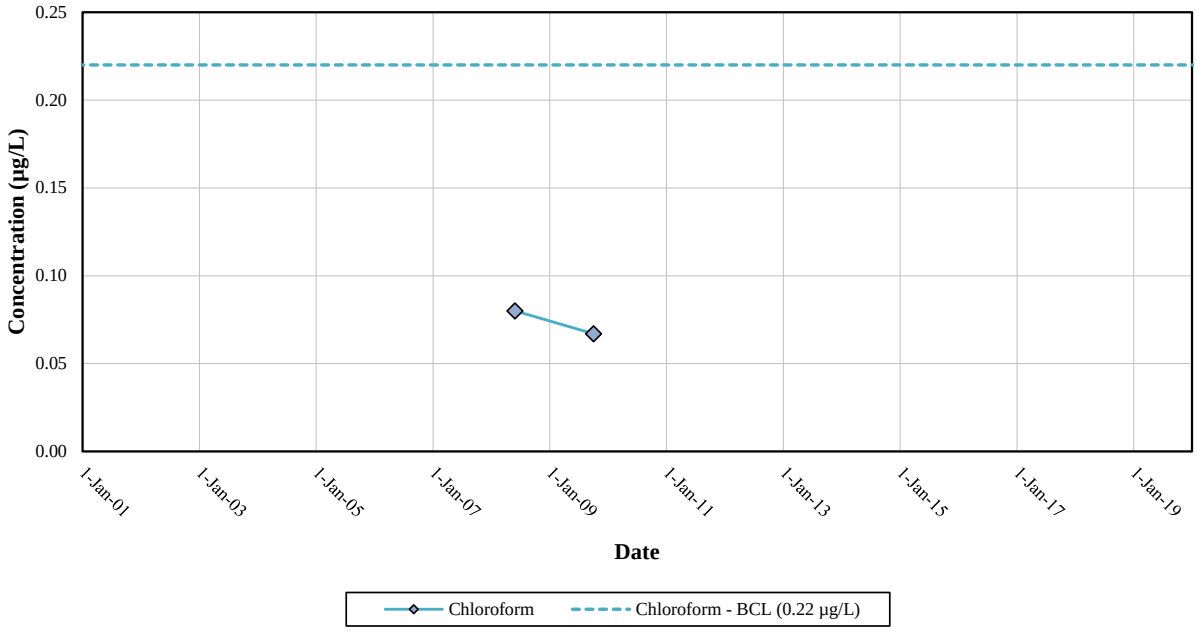
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-15
Chloroform Concentrations vs. Time

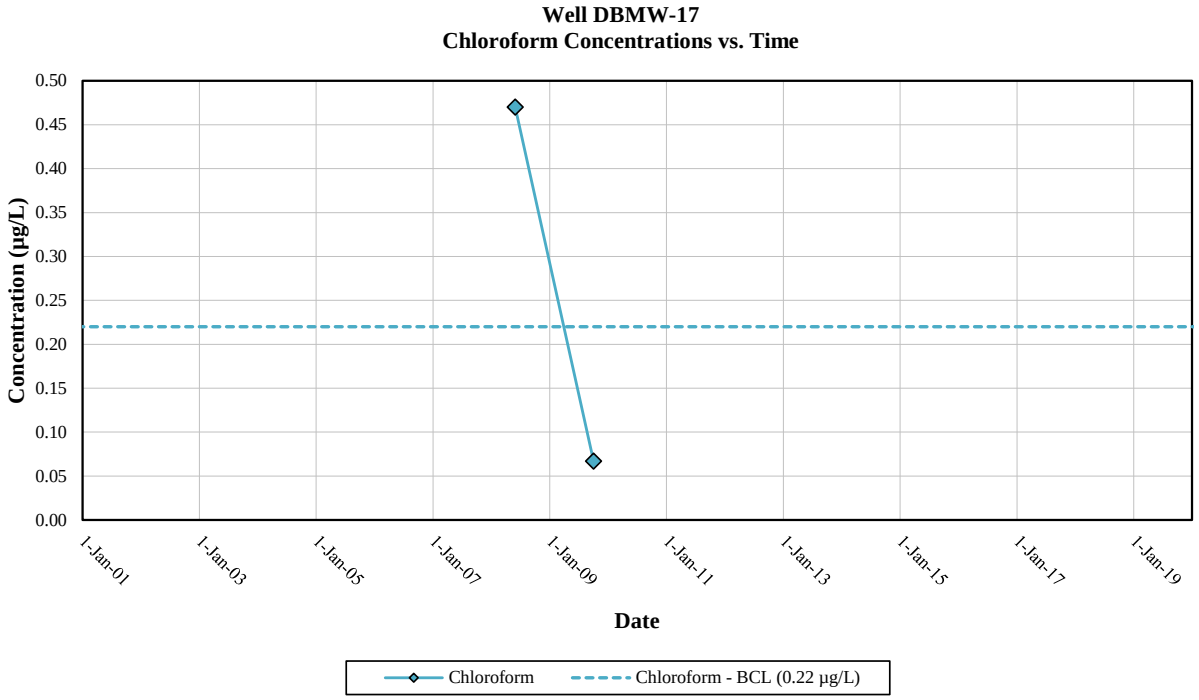


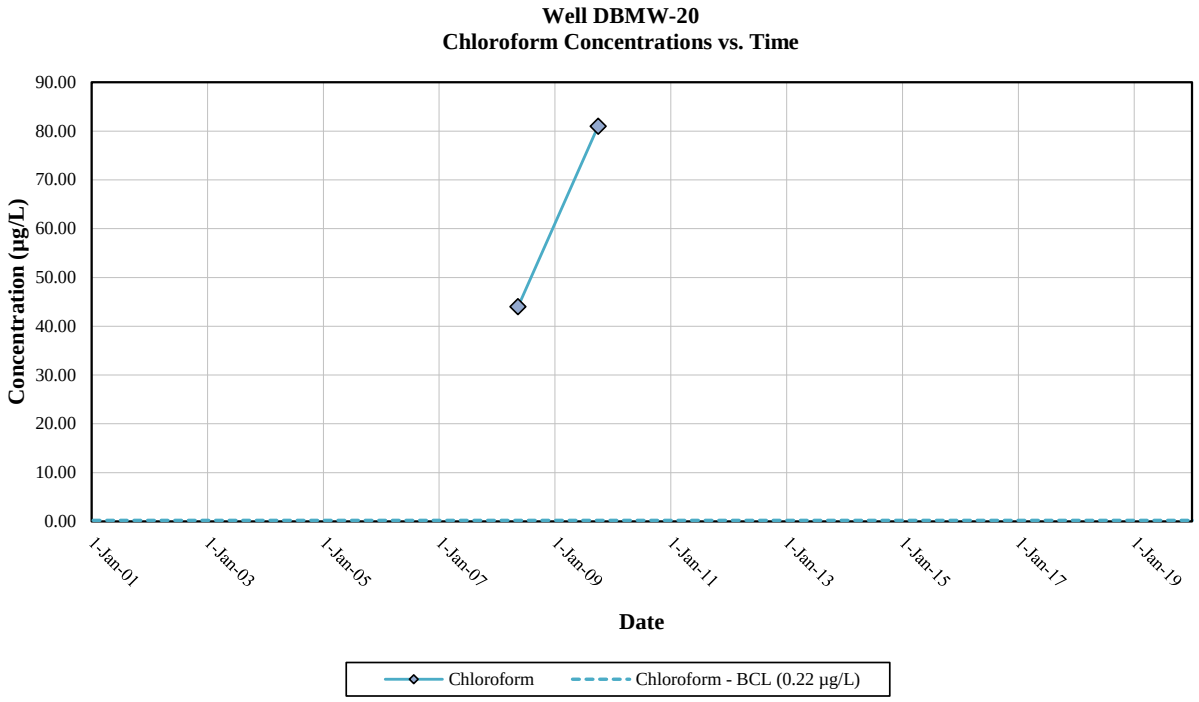
Well DBMW-16
Chloroform Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

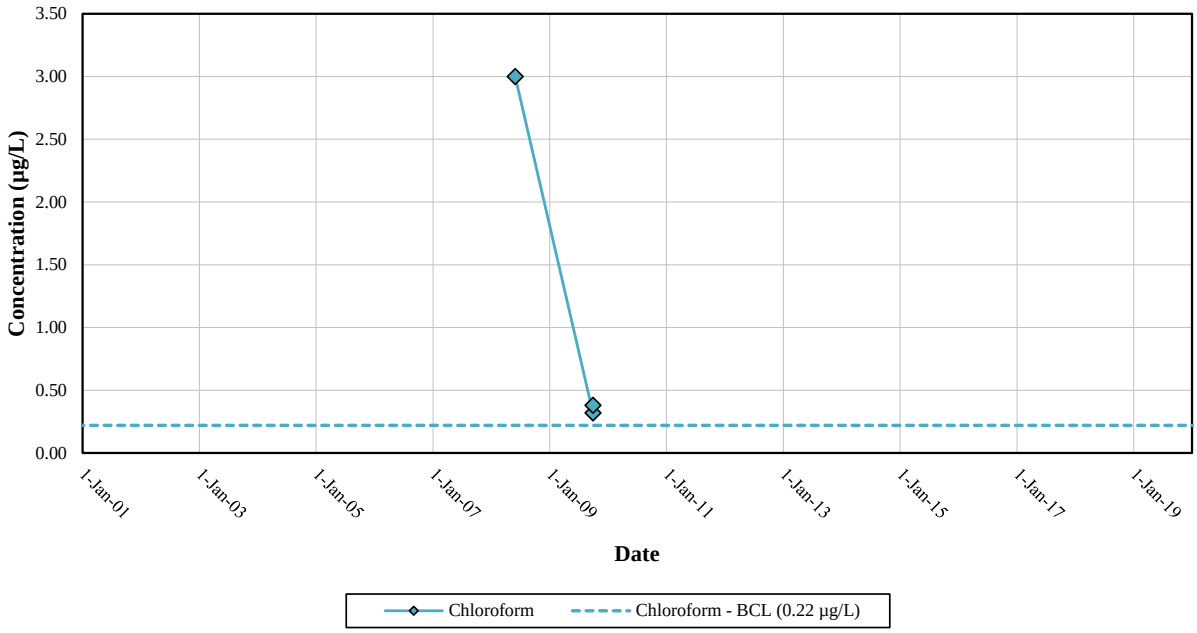




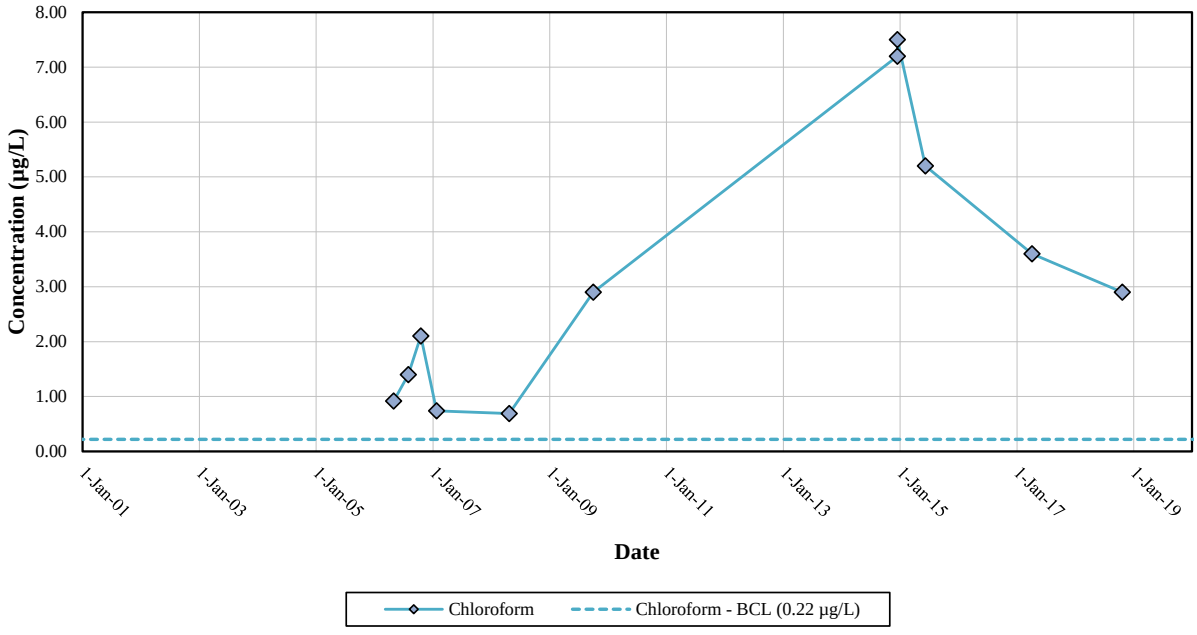
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well DBMW-22
Chloroform Concentrations vs. Time



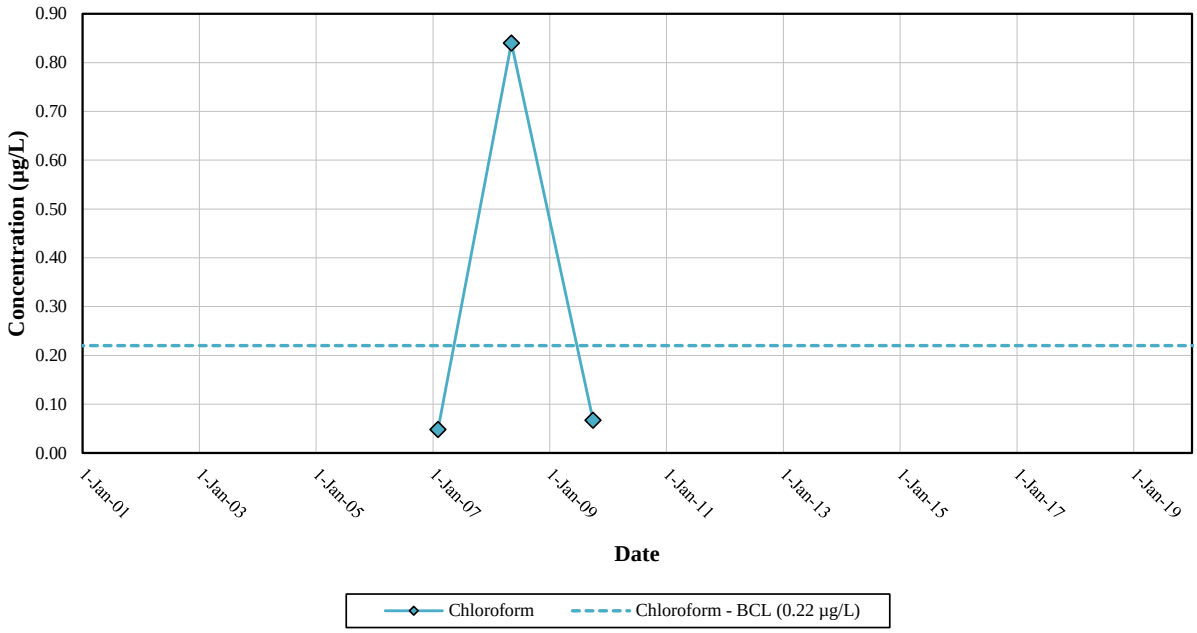
Well DM-1
Chloroform Concentrations vs. Time



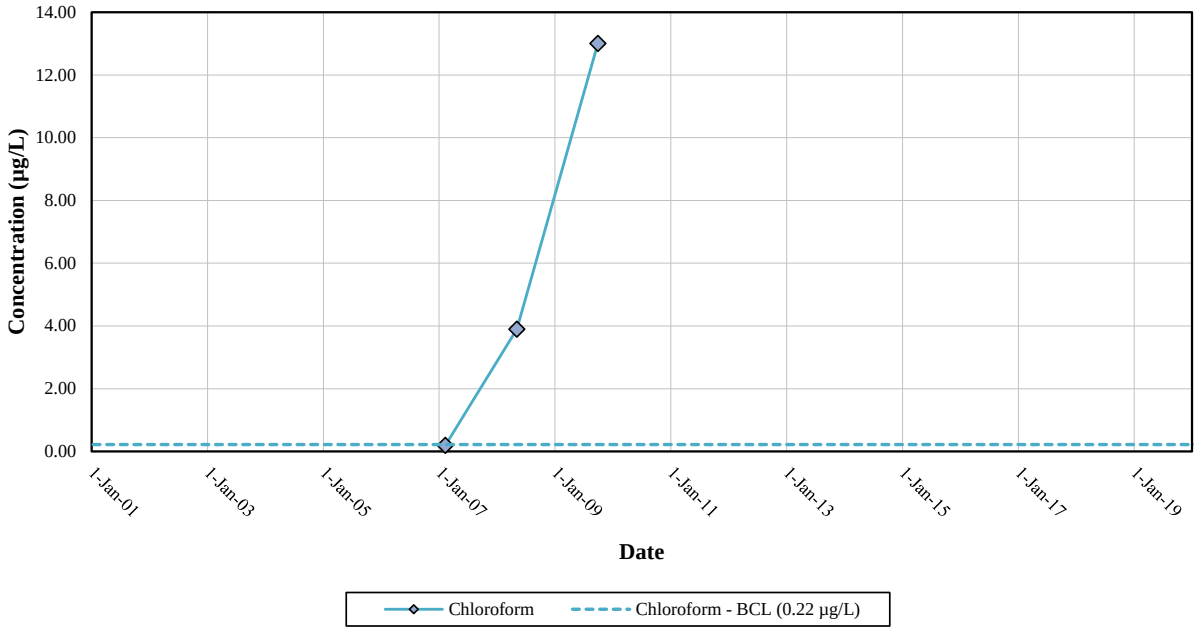
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well HMW-08
Chloroform Concentrations vs. Time



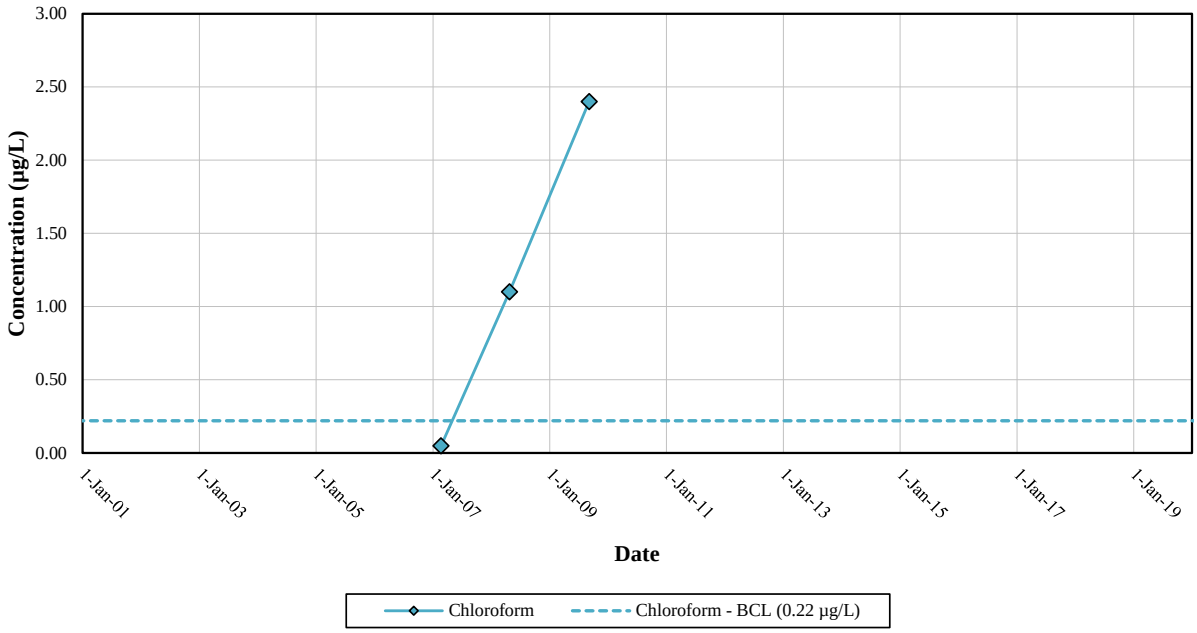
Well HMW-09
Chloroform Concentrations vs. Time



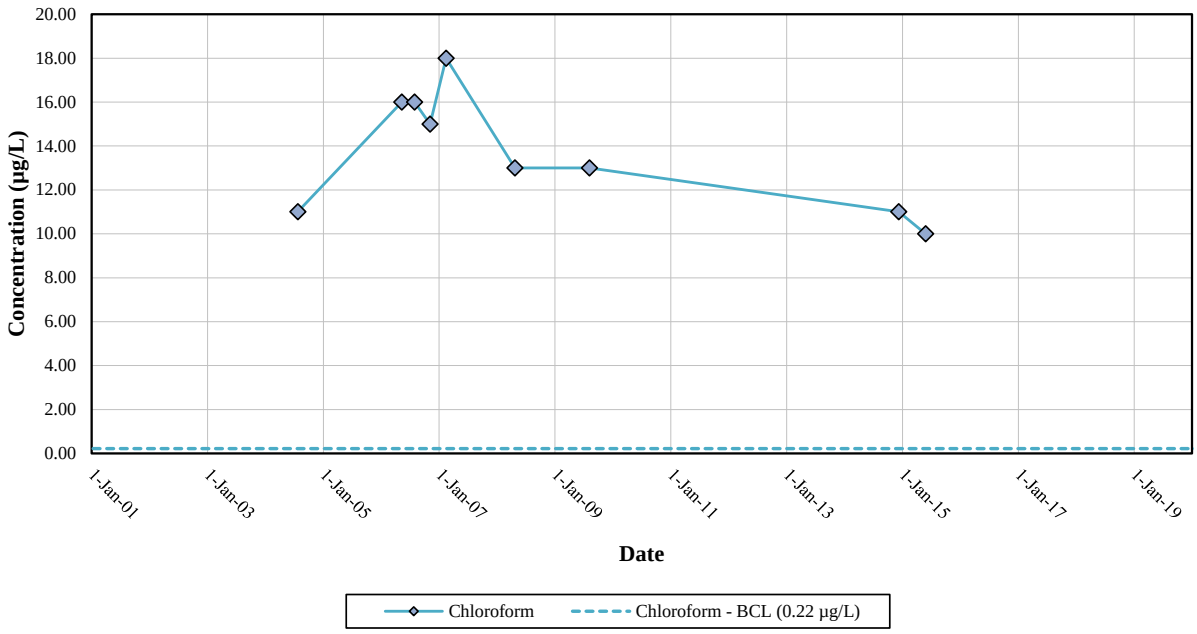
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well HMWWT-6
Chloroform Concentrations vs. Time



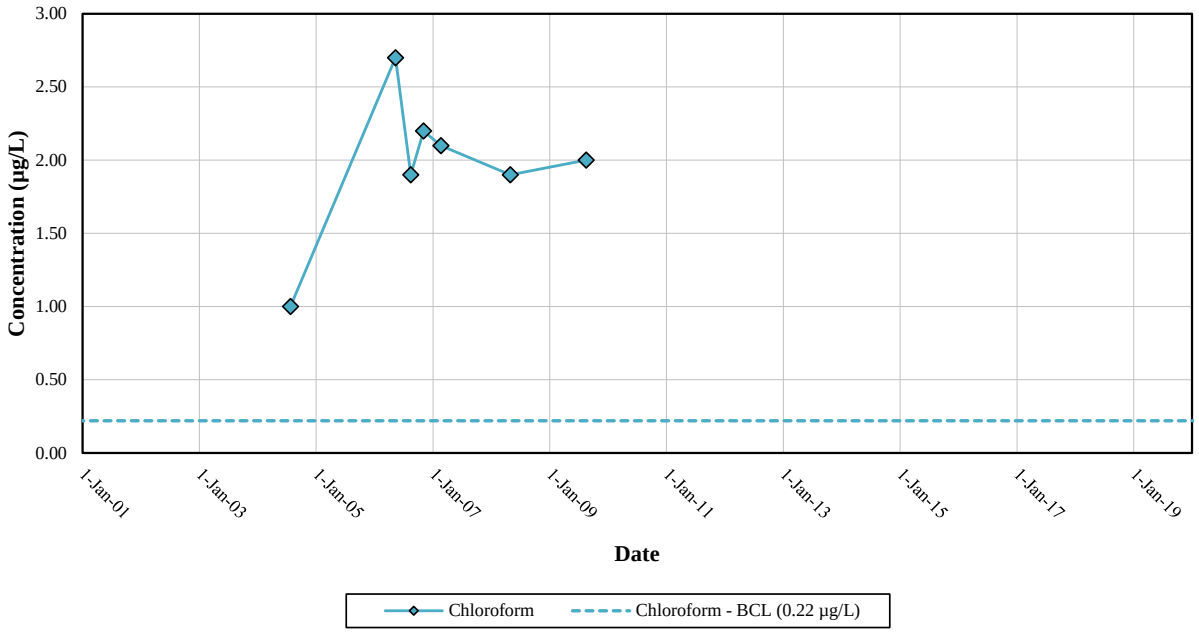
Well MCF-01B
Chloroform Concentrations vs. Time



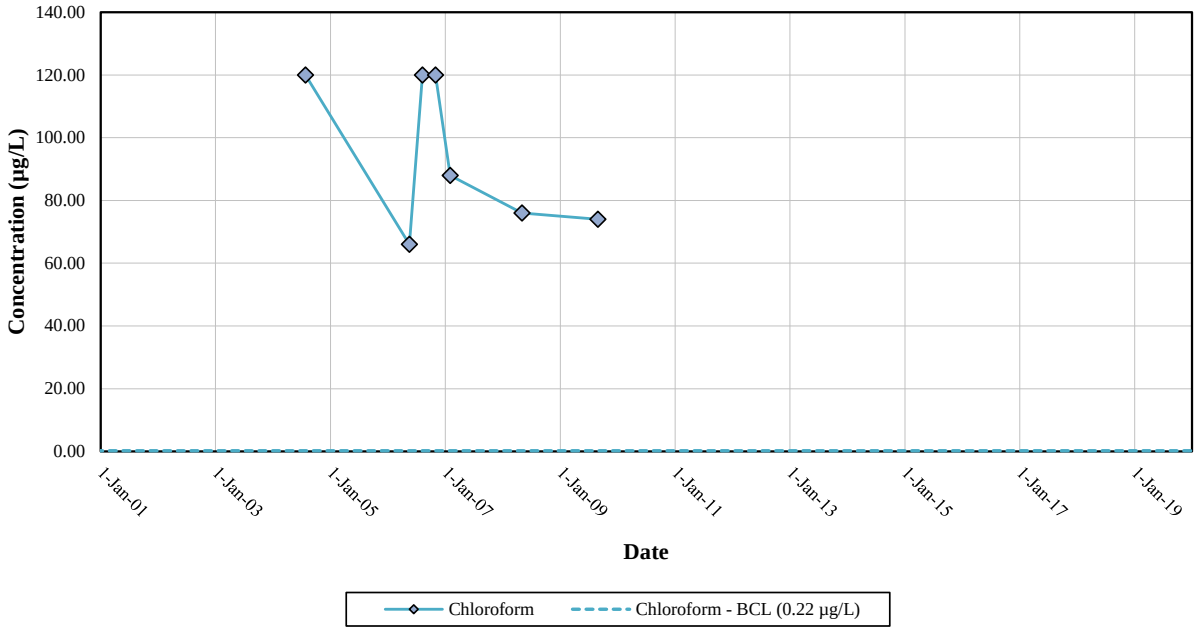
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-03B
Chloroform Concentrations vs. Time



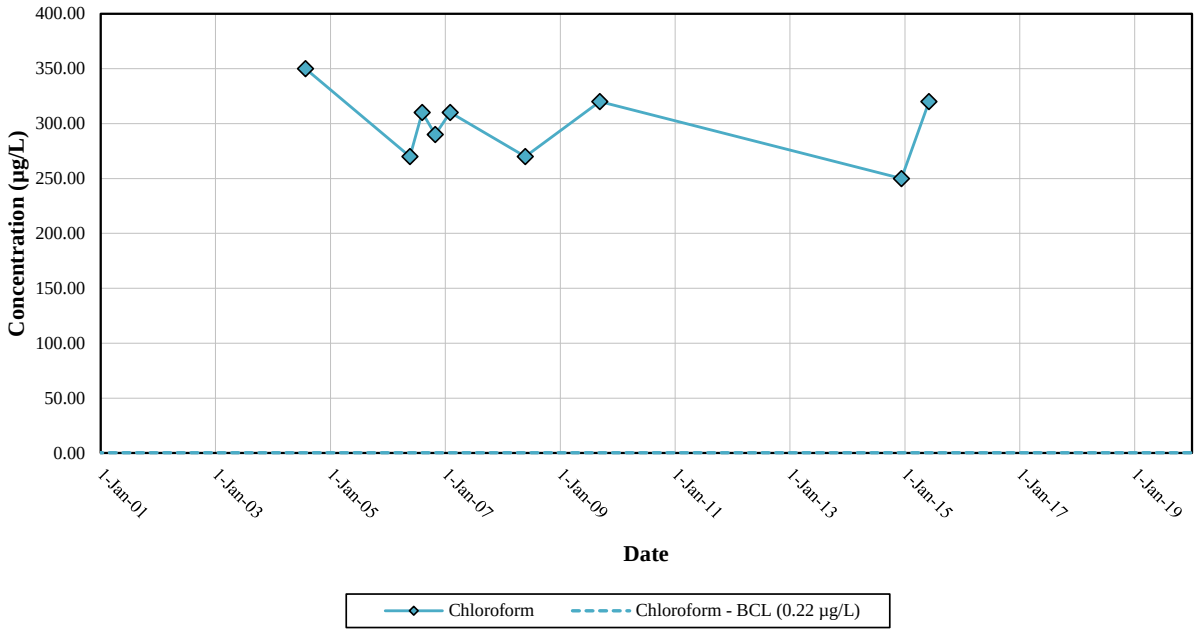
Well MCF-06B
Chloroform Concentrations vs. Time



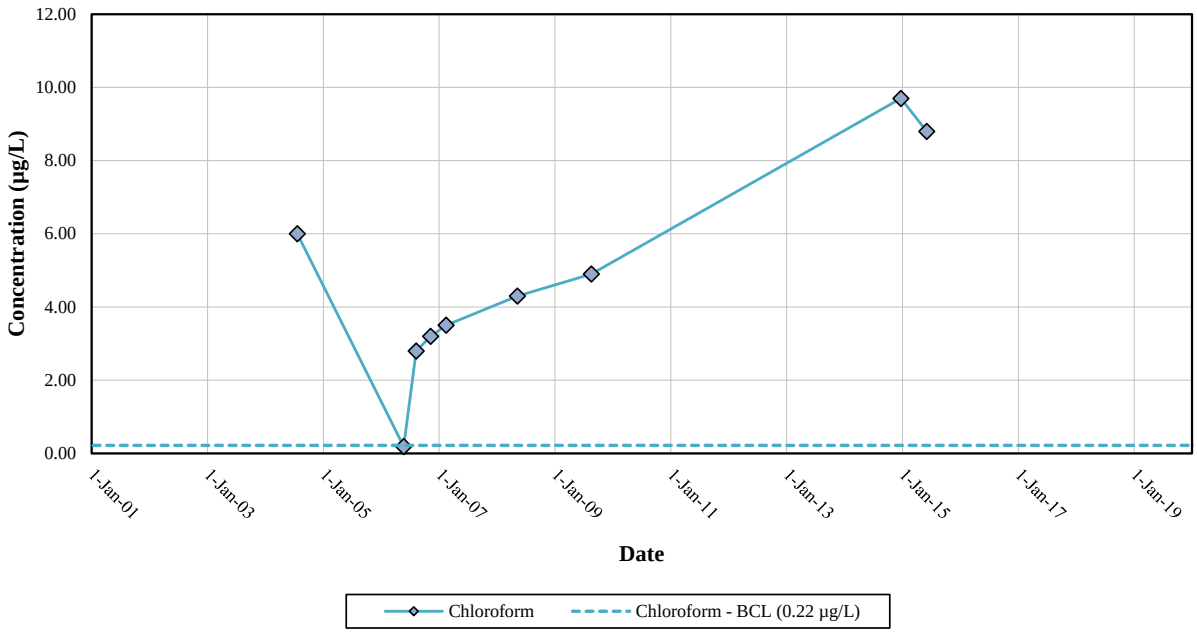
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-06C
Chloroform Concentrations vs. Time



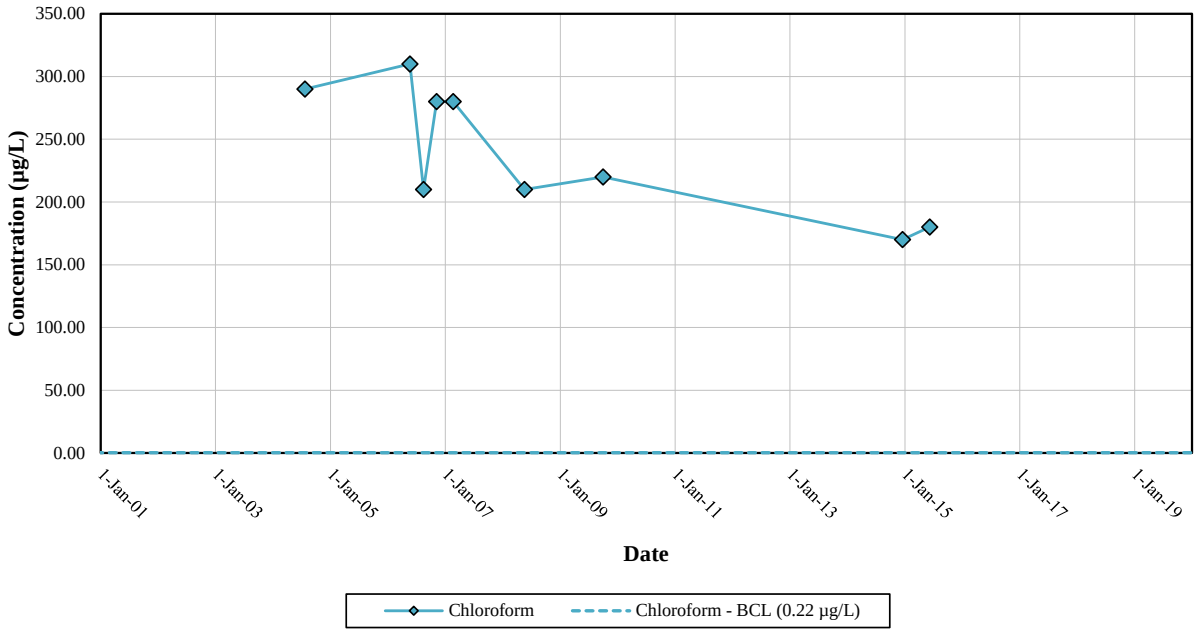
Well MCF-12B
Chloroform Concentrations vs. Time



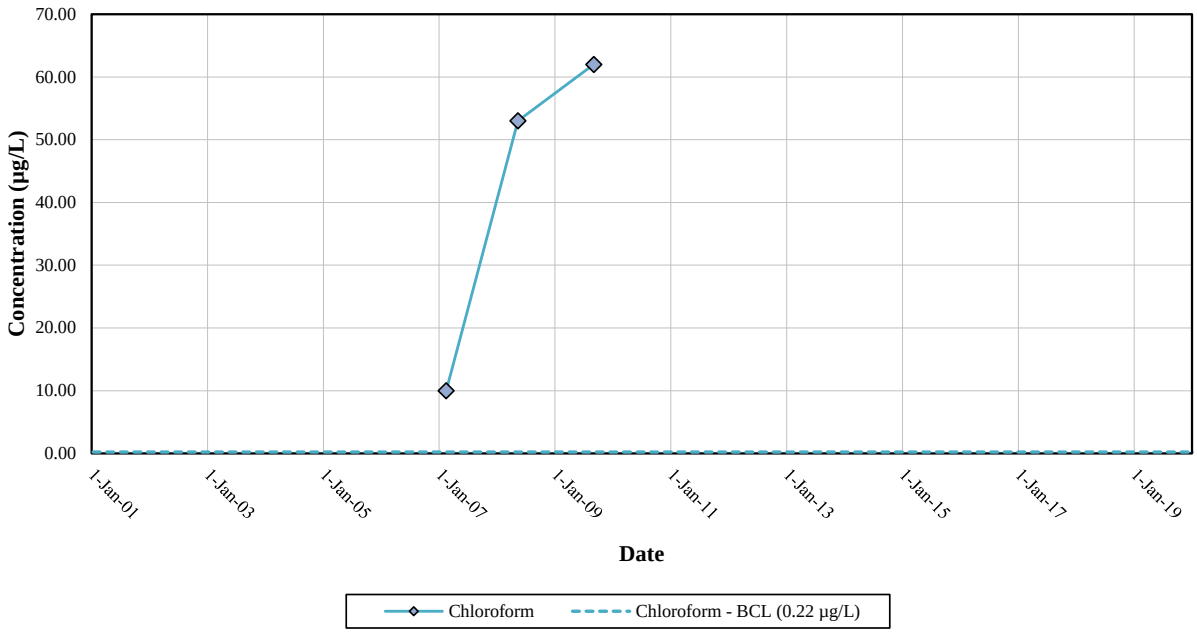
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MCF-16C
Chloroform Concentrations vs. Time

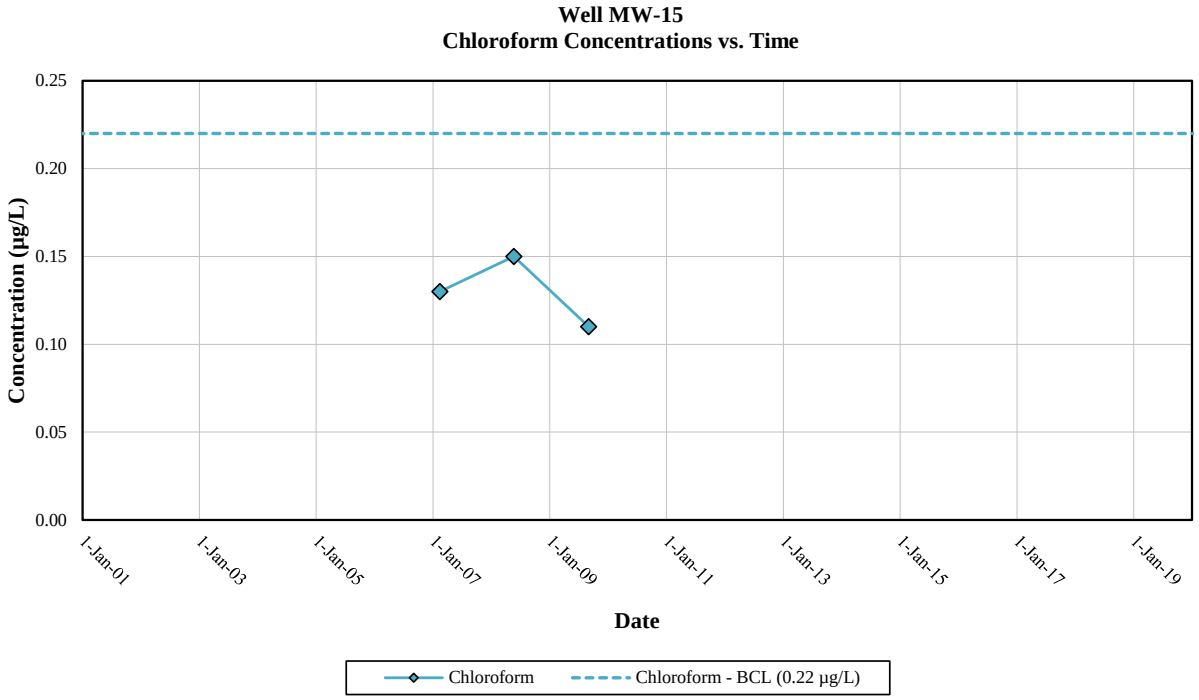


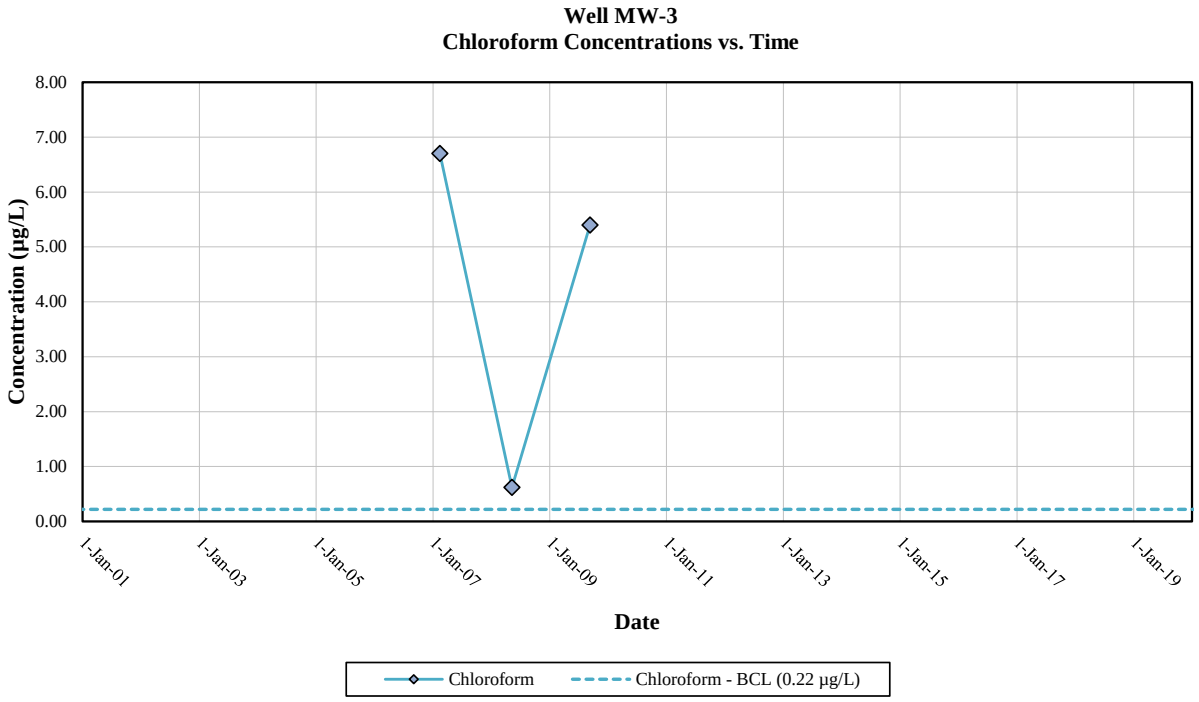
Well MW-13
Chloroform Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

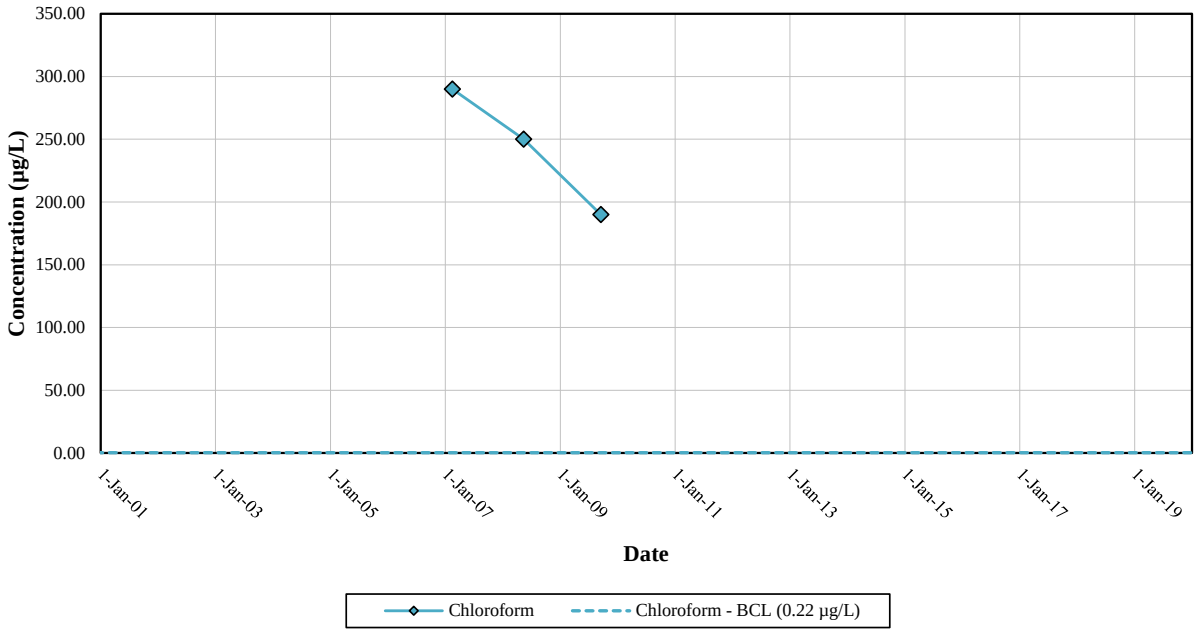




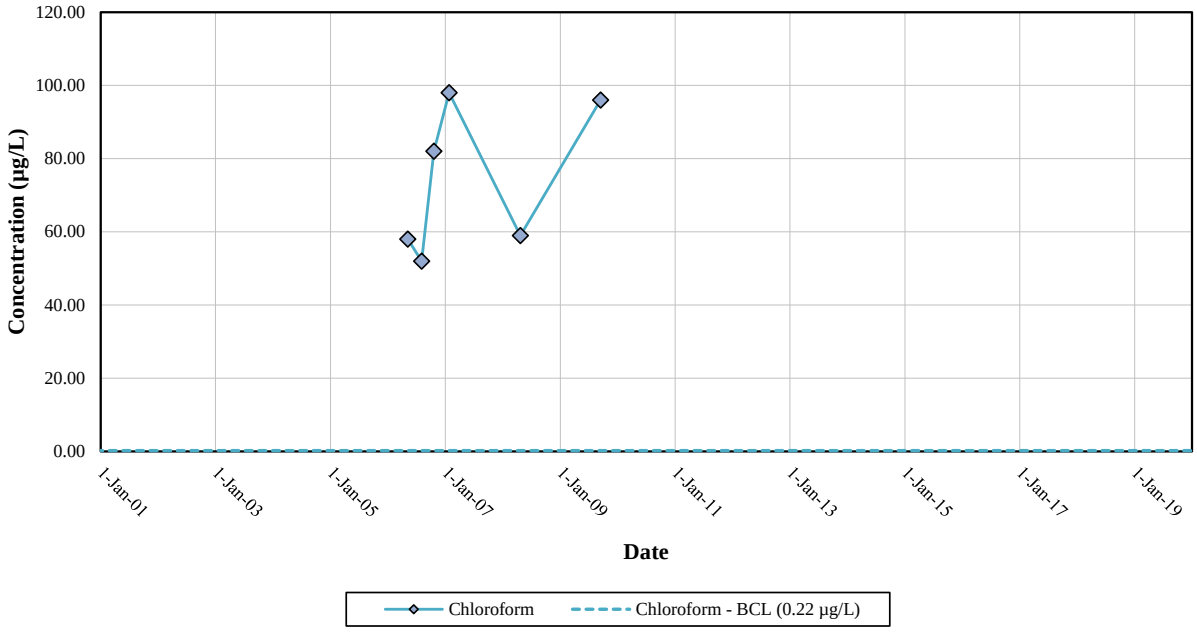
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well MW-4
Chloroform Concentrations vs. Time



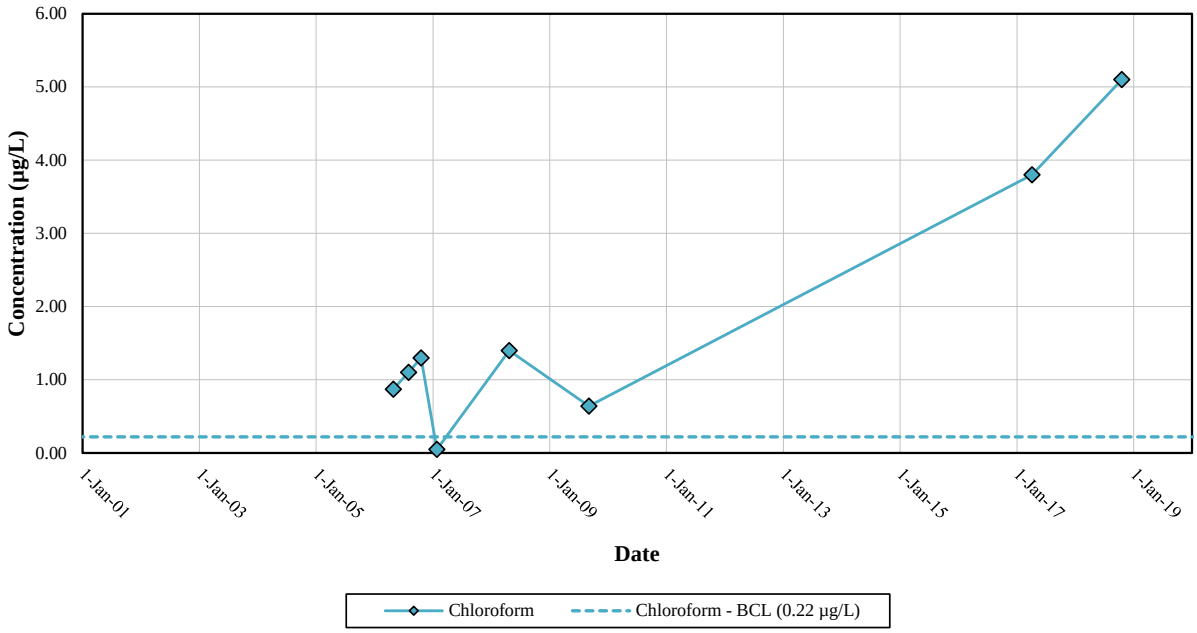
Well POD2-R
Chloroform Concentrations vs. Time



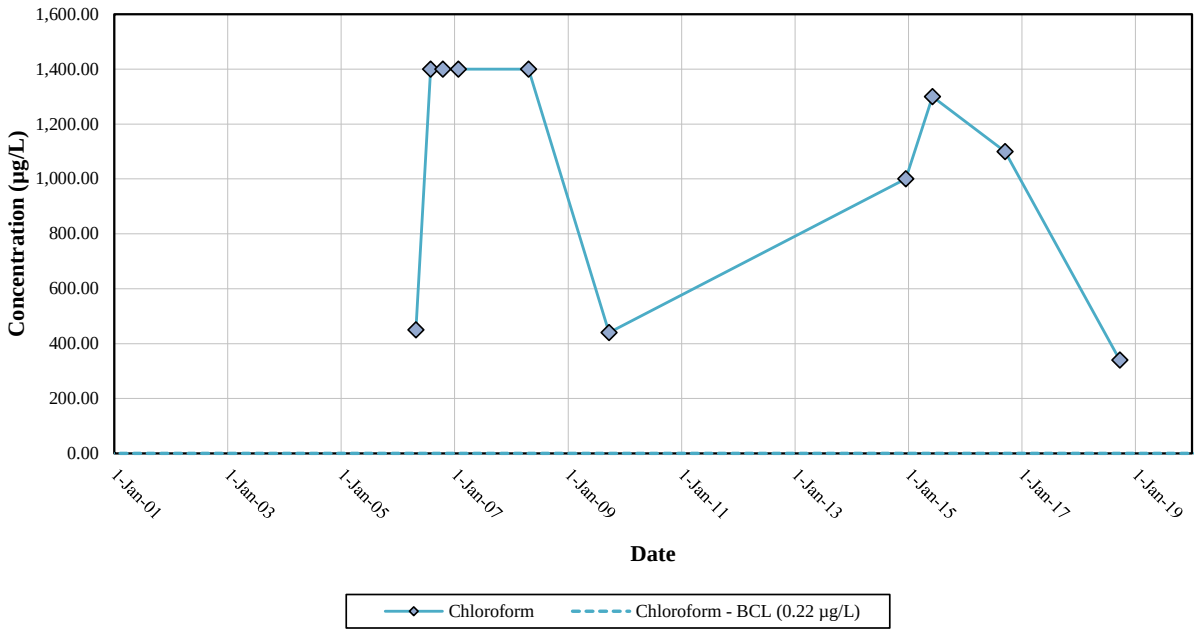
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well POD8
Chloroform Concentrations vs. Time



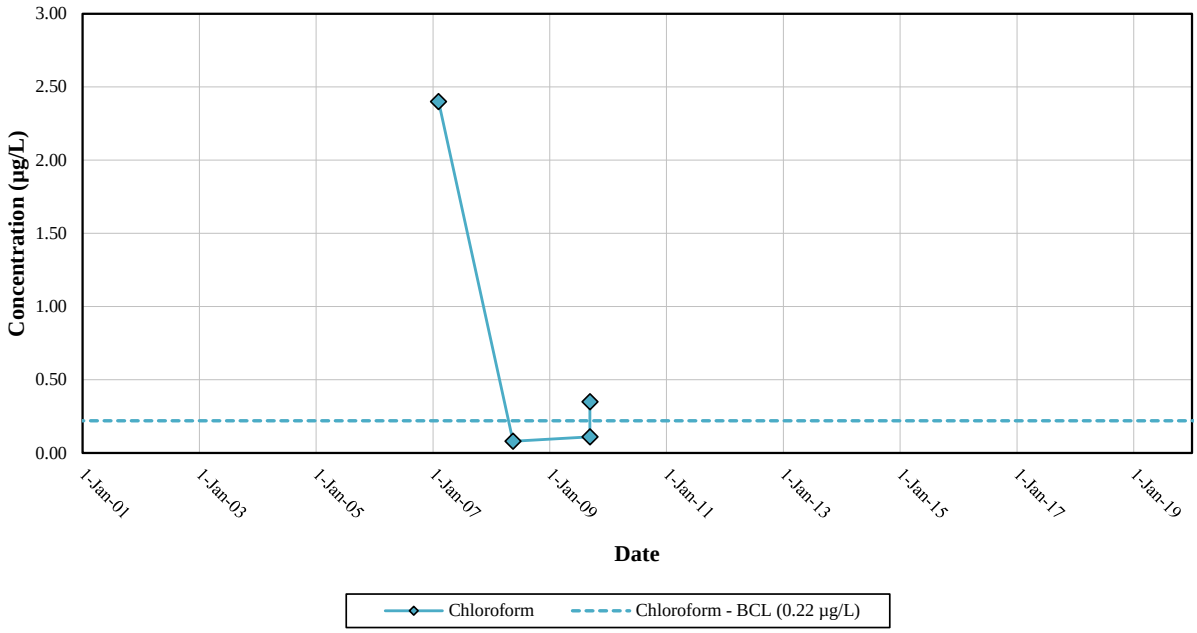
Well POU3
Chloroform Concentrations vs. Time



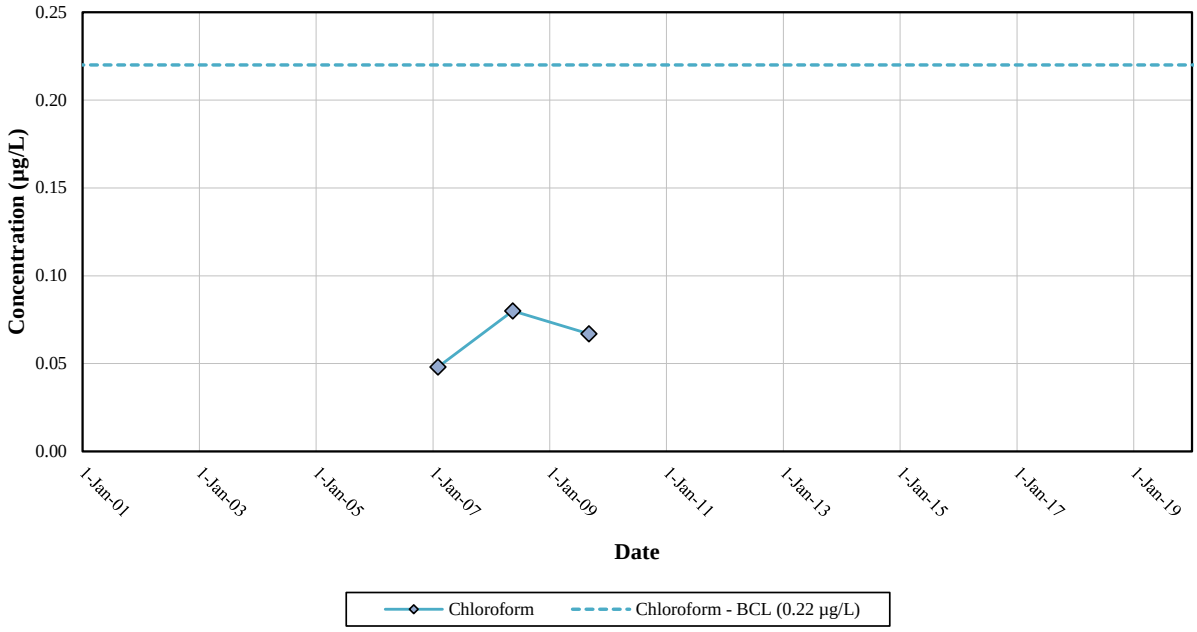
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Time Series Plots
Eastside Shallow

Well WMW5.58SD
Chloroform Concentrations vs. Time

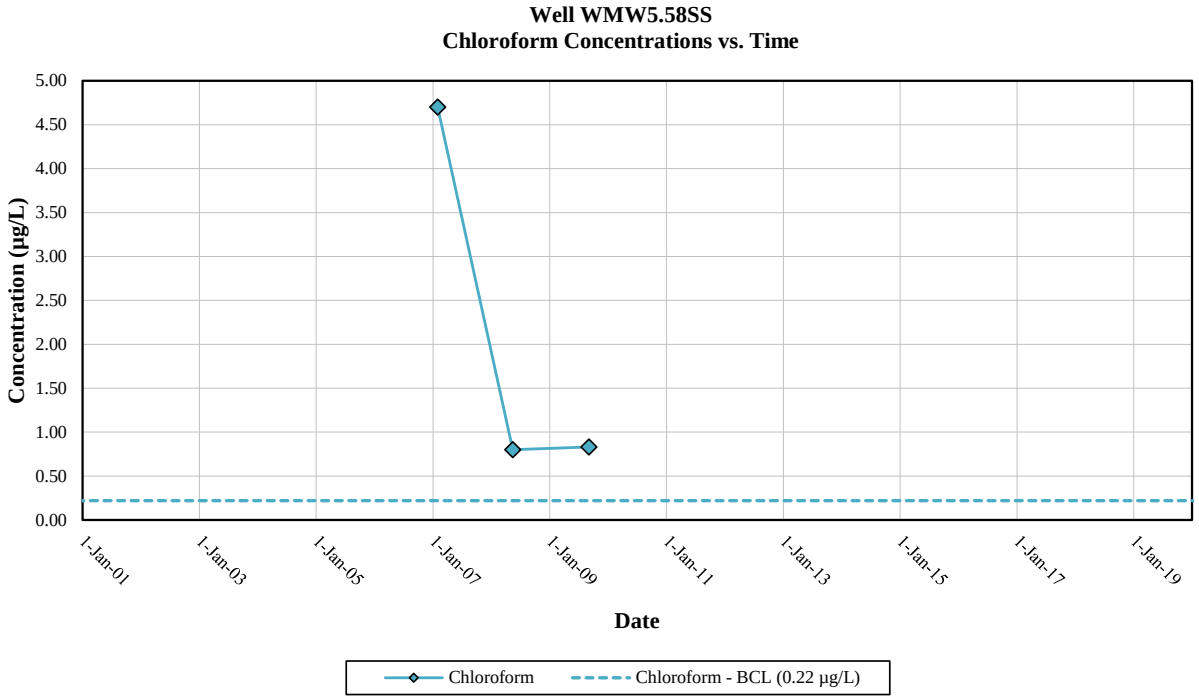


Well WMW5.58SI
Chloroform Concentrations vs. Time



Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

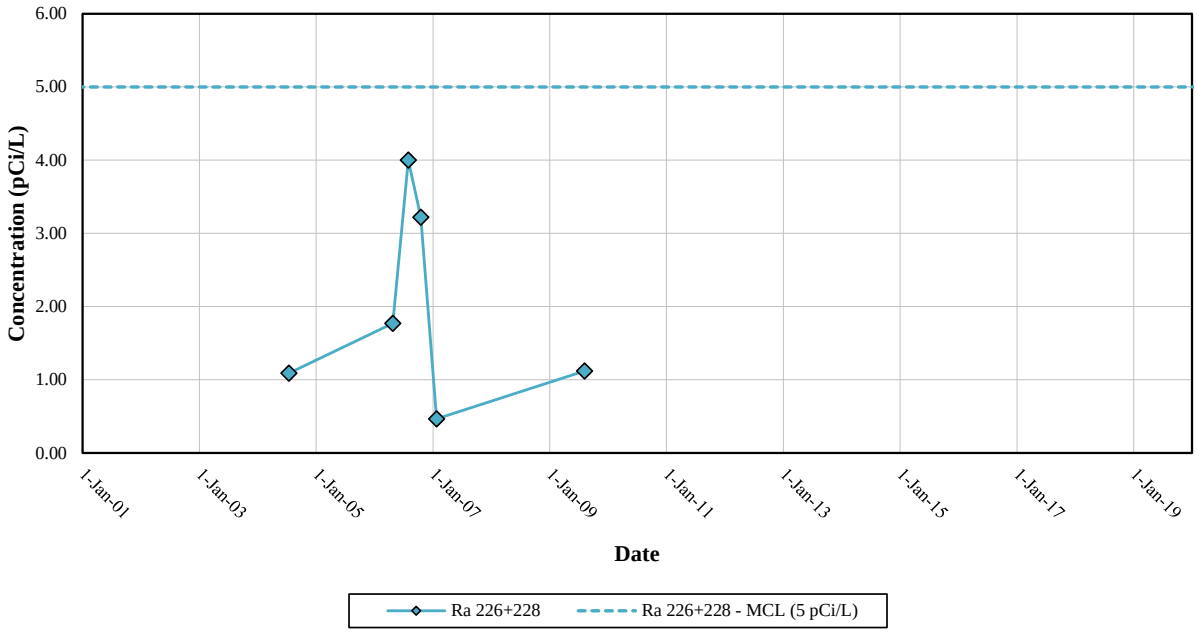
Time Series Plots
Eastside Shallow



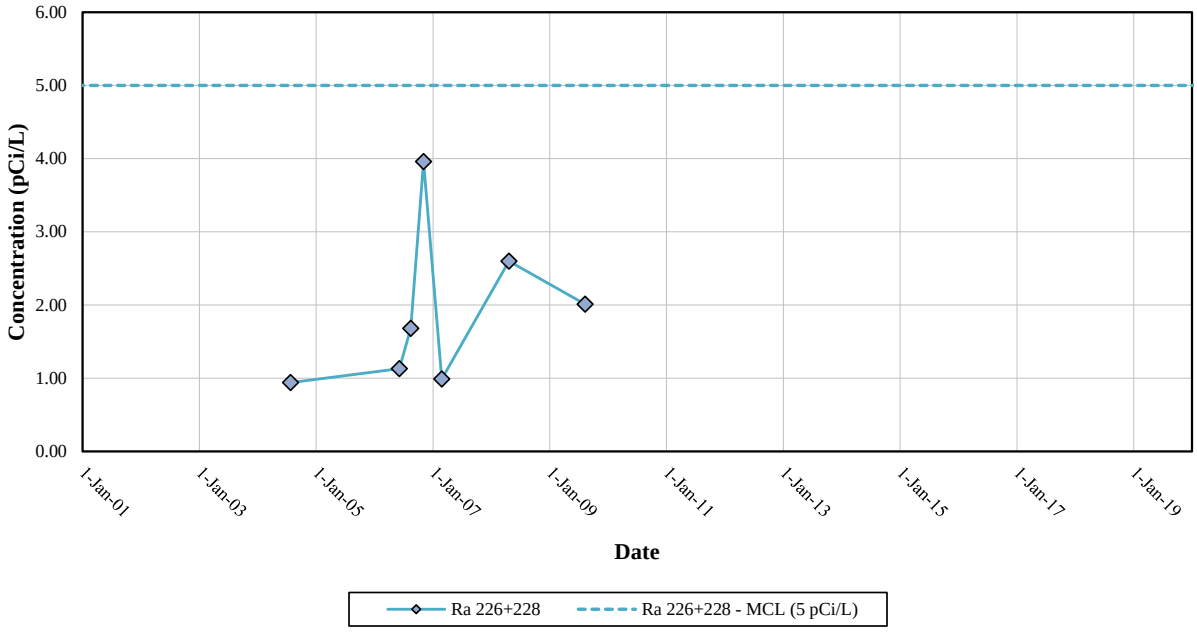
Notes: All non-detect values are plotted as an open symbol at the Reporting Limit for the sample.

Appendix A
Time Series Plots
Eastside Shallow

Well AA-01
Ra 226+228 Concentrations vs. Time

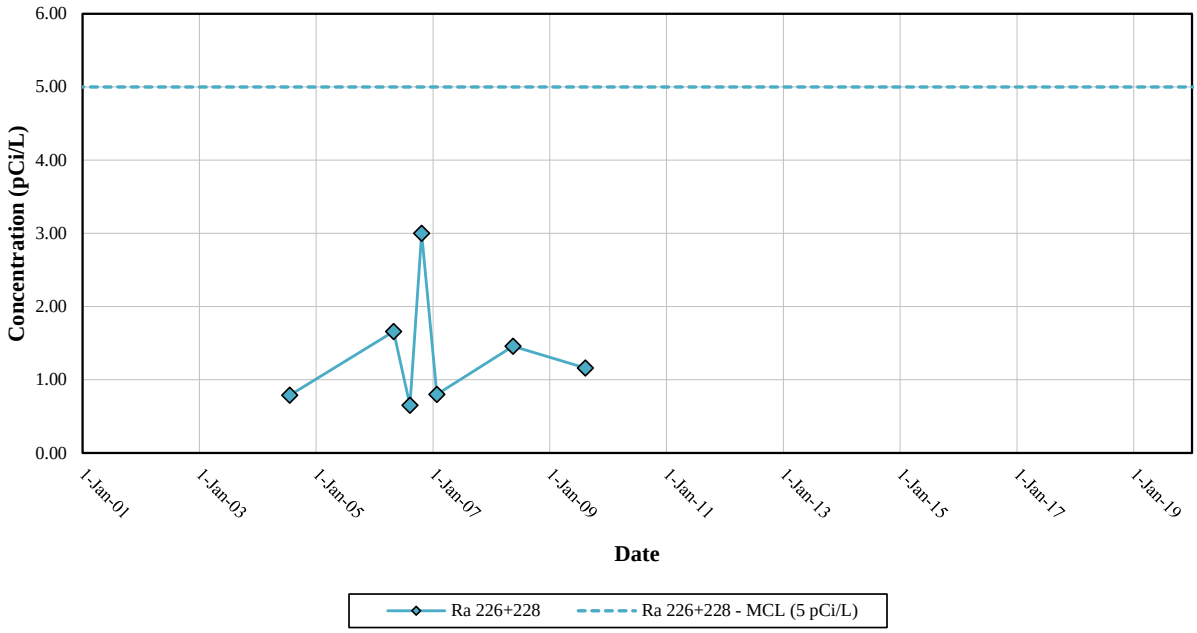


Well AA-07
Ra 226+228 Concentrations vs. Time

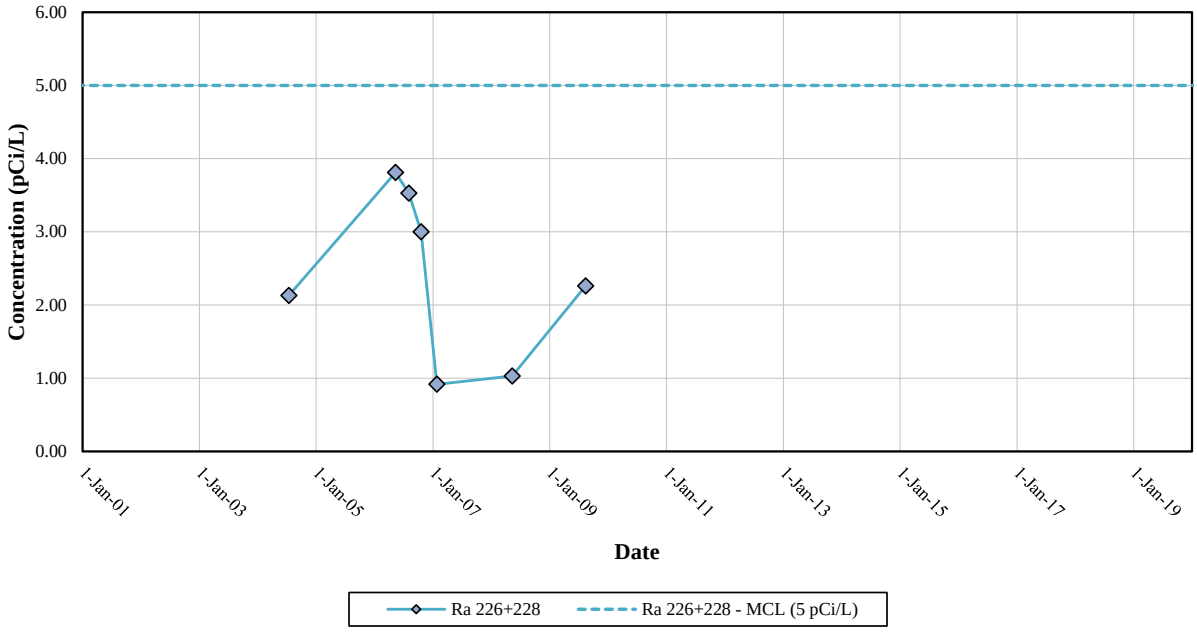


Appendix A
Time Series Plots
Eastside Shallow

Well AA-09
Ra 226+228 Concentrations vs. Time

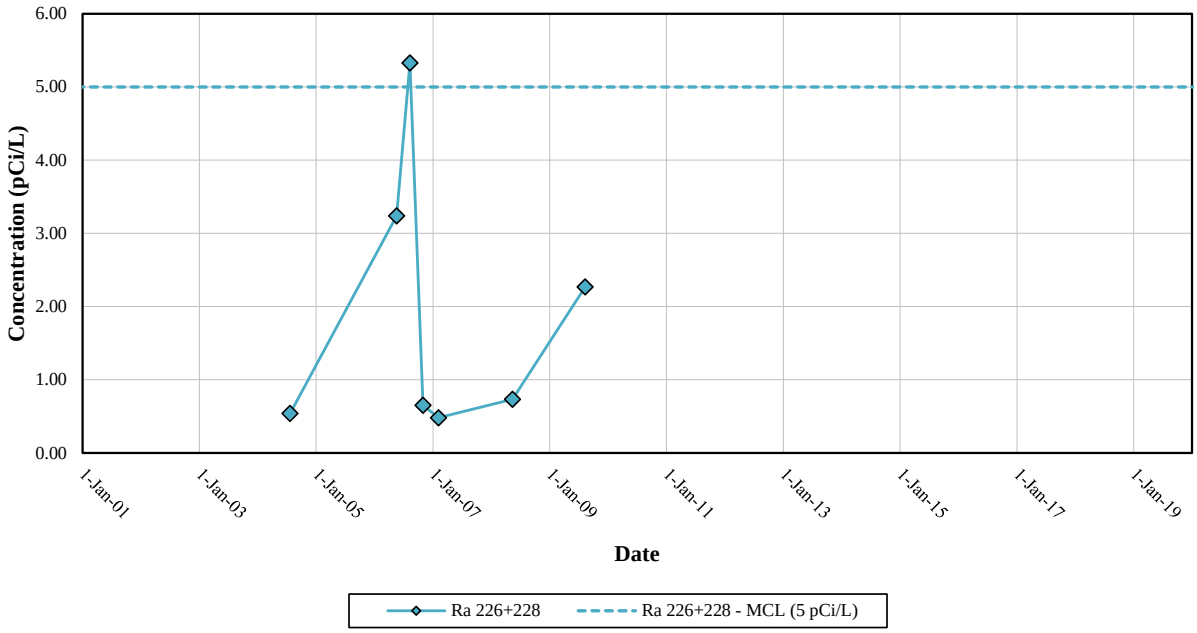


Well AA-13
Ra 226+228 Concentrations vs. Time

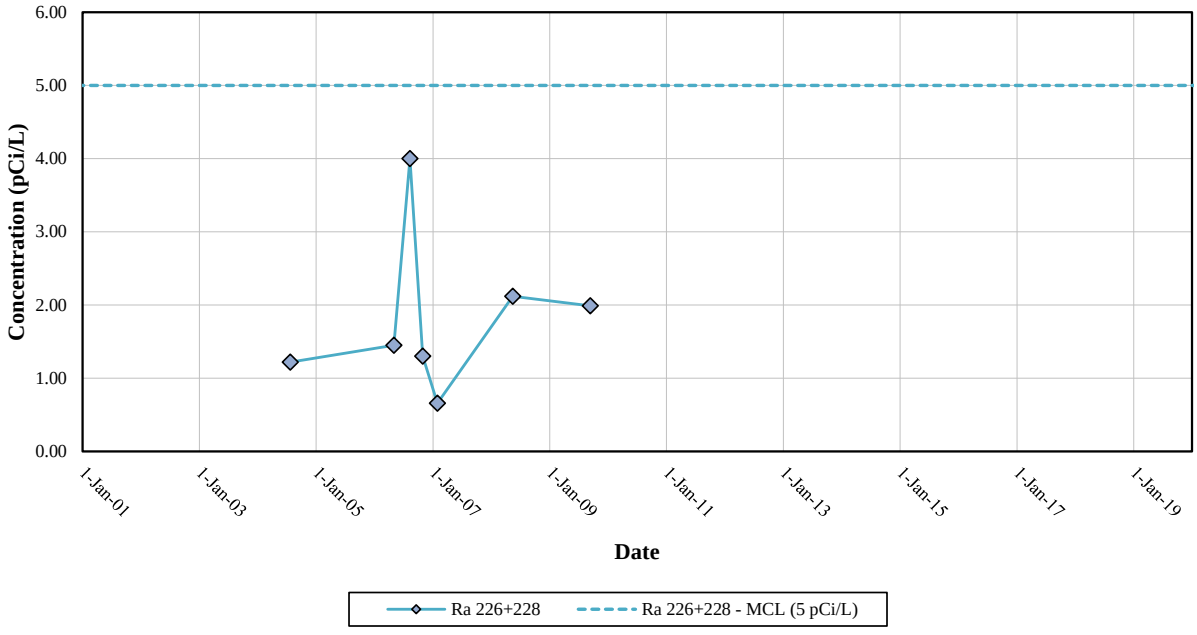


Appendix A
Time Series Plots
Eastside Shallow

Well AA-18
Ra 226+228 Concentrations vs. Time

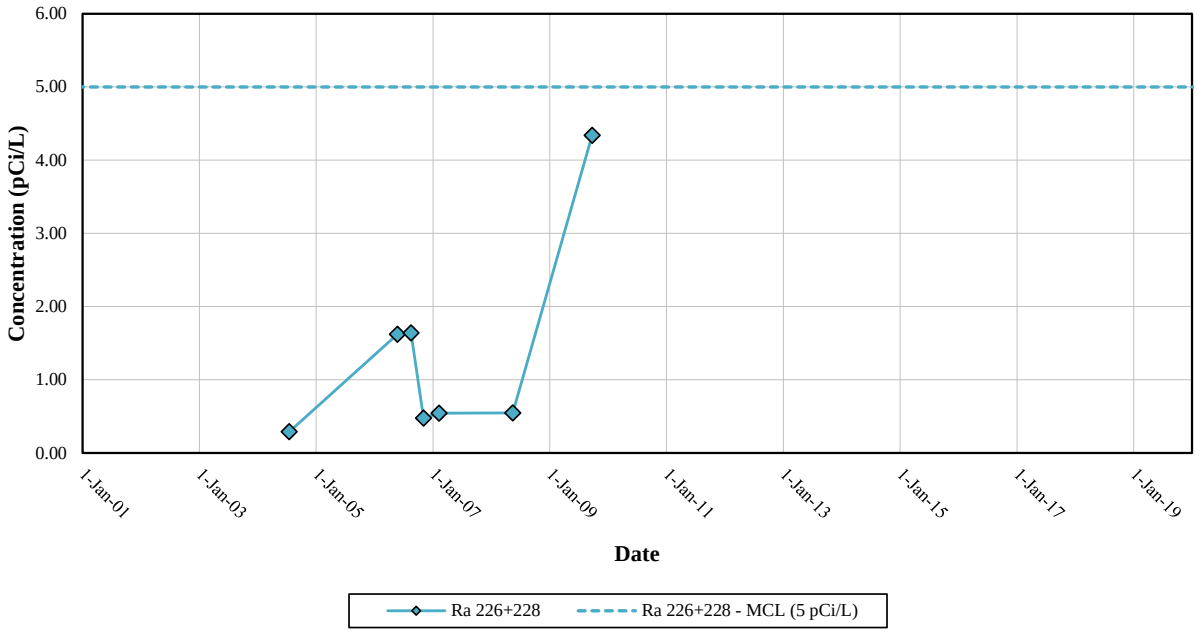


Well AA-20
Ra 226+228 Concentrations vs. Time

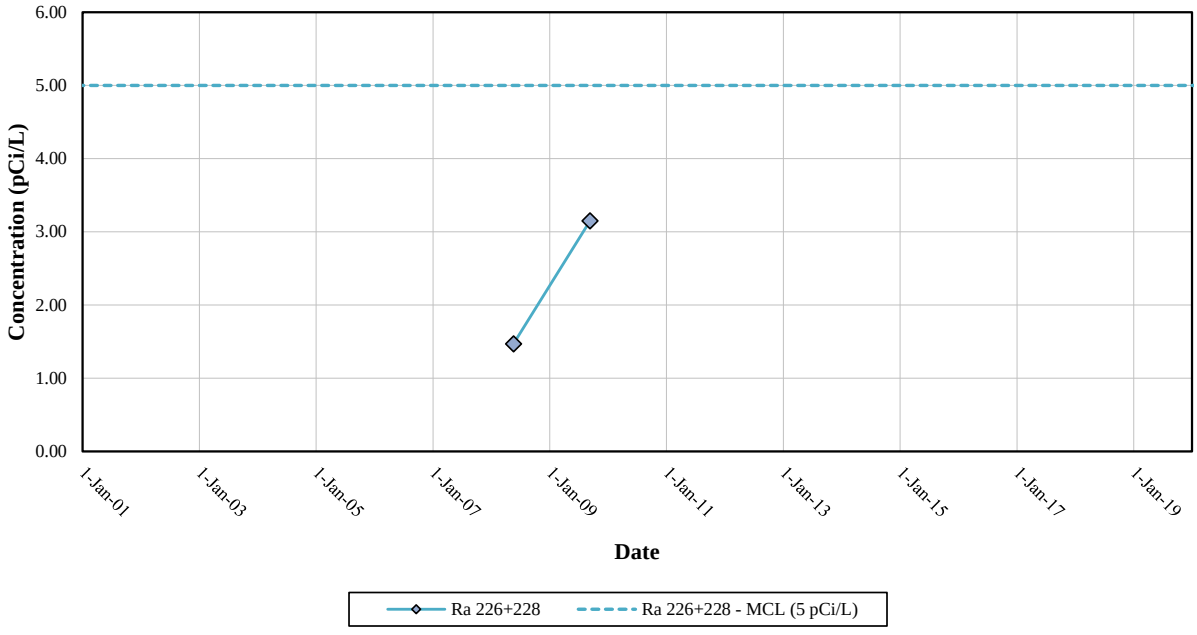


Appendix A
Time Series Plots
Eastside Shallow

Well AA-22
Ra 226+228 Concentrations vs. Time

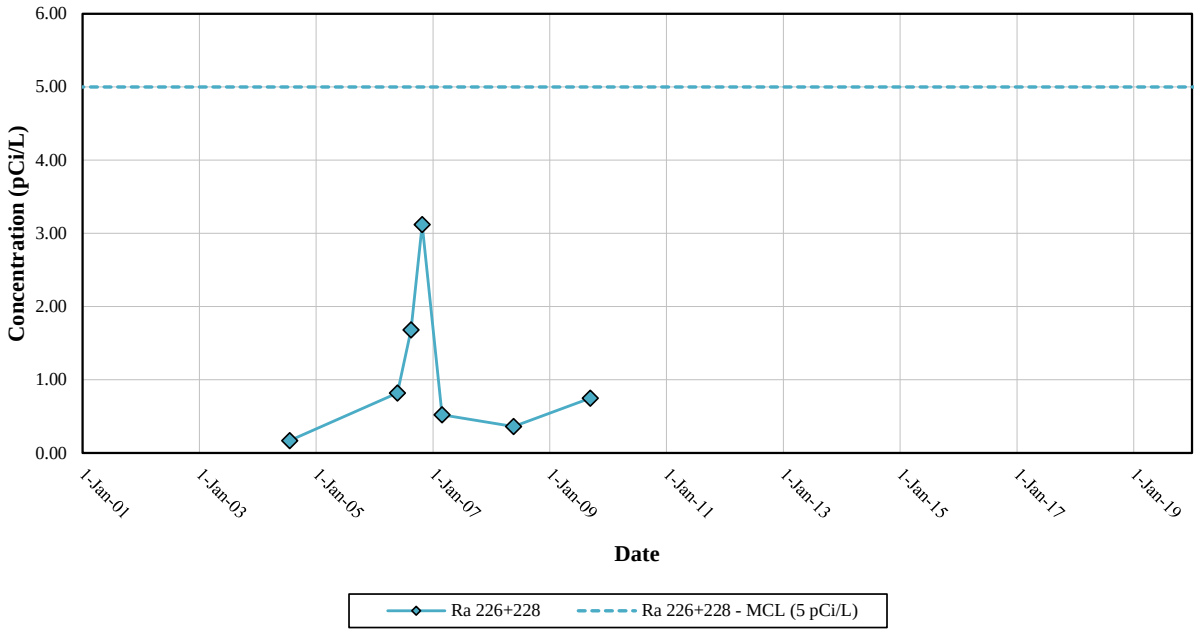


Well AA-23-R
Ra 226+228 Concentrations vs. Time

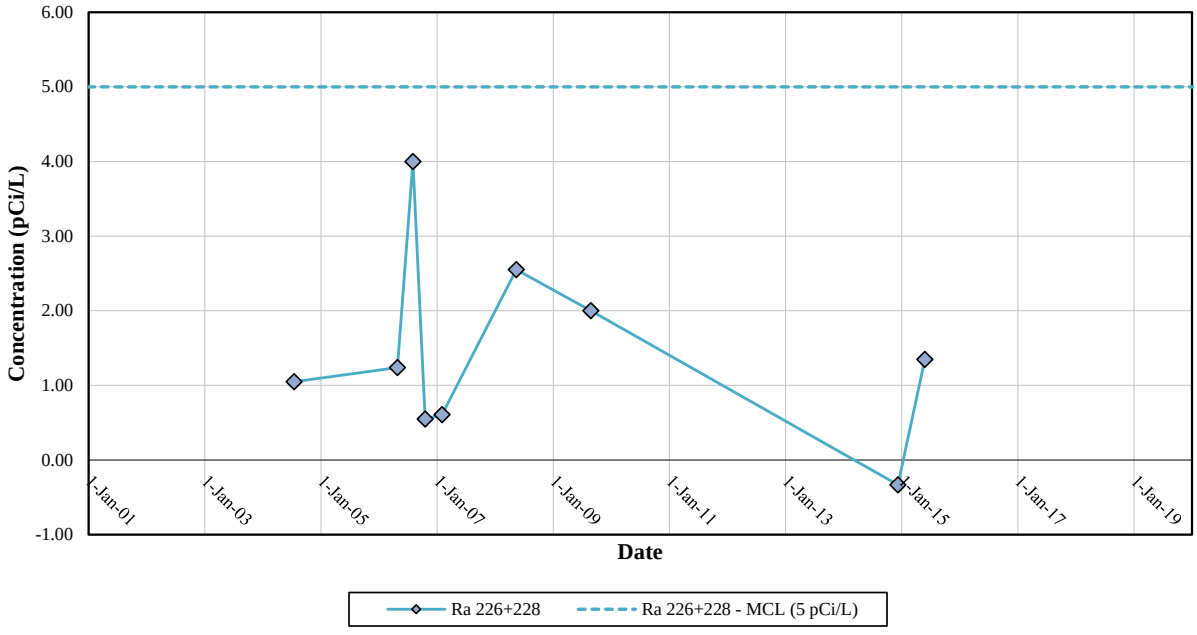


Appendix A
Time Series Plots
Eastside Shallow

Well AA-26
Ra 226+228 Concentrations vs. Time

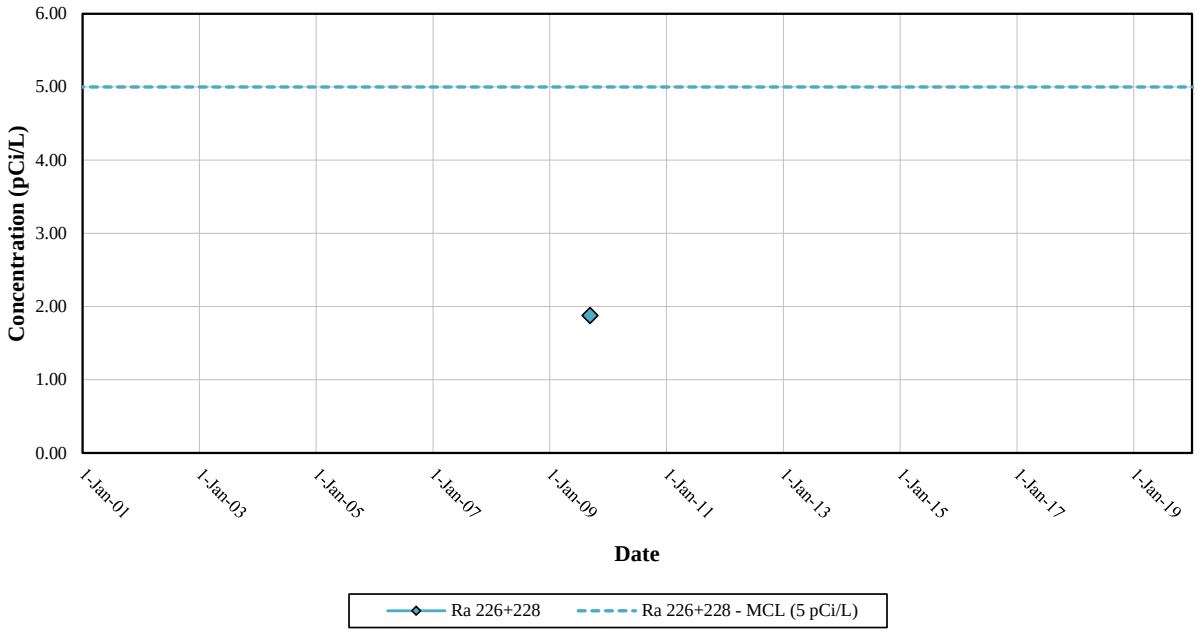


Well AA-27
Ra 226+228 Concentrations vs. Time

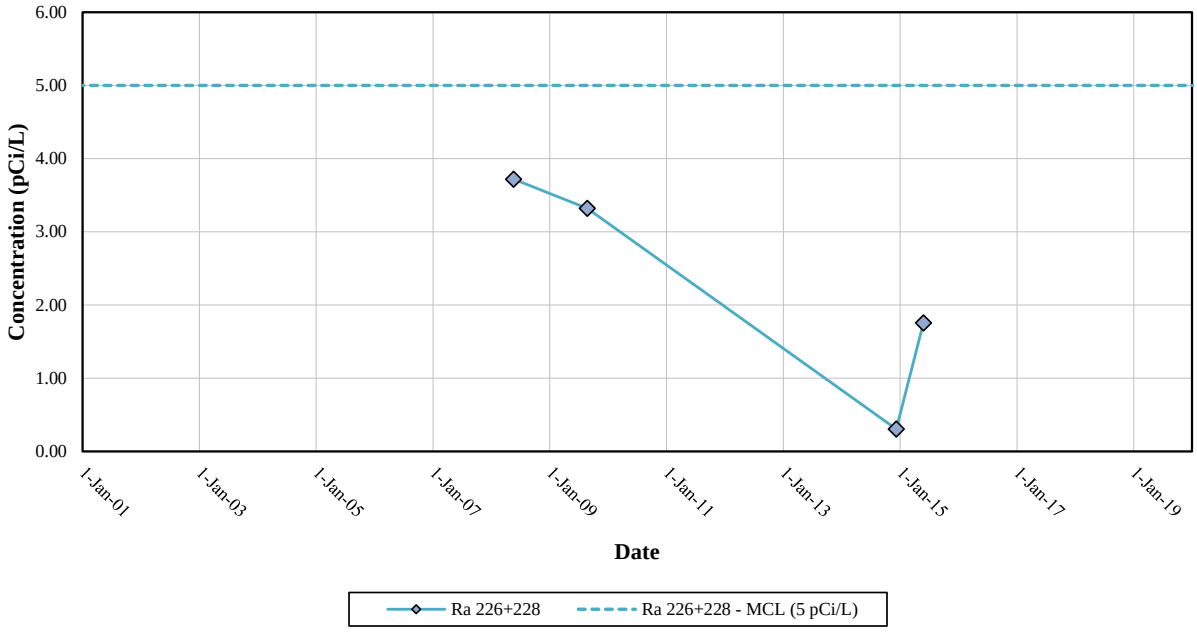


Appendix A
Time Series Plots
Eastside Shallow

Well AA-30
Ra 226+228 Concentrations vs. Time

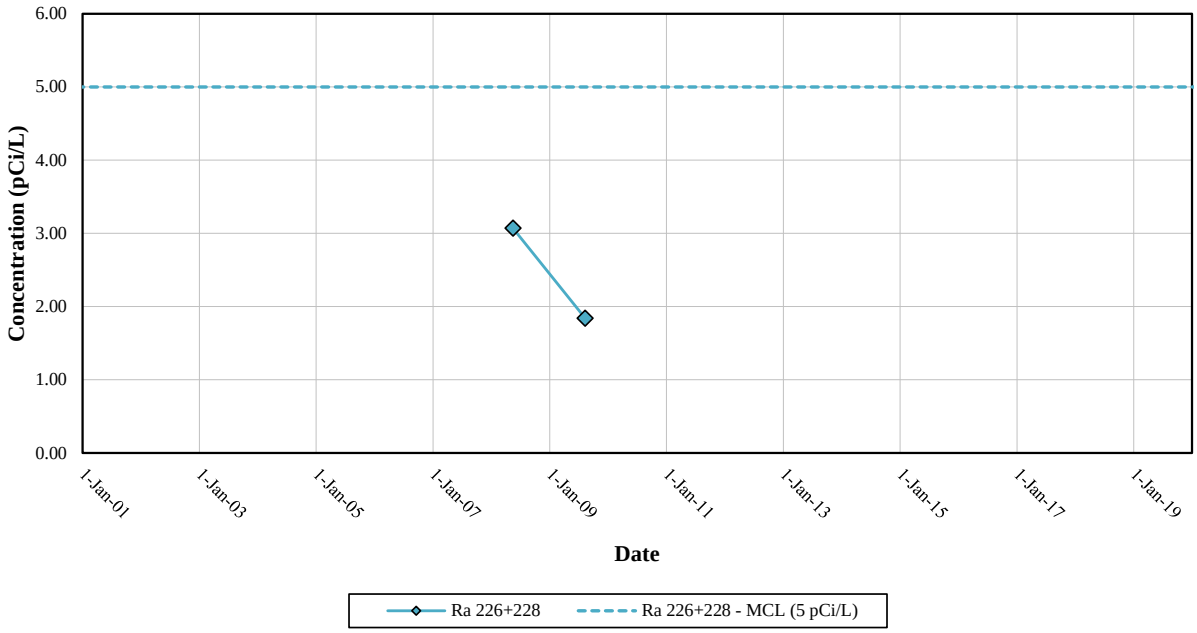


Well AA-UW1
Ra 226+228 Concentrations vs. Time

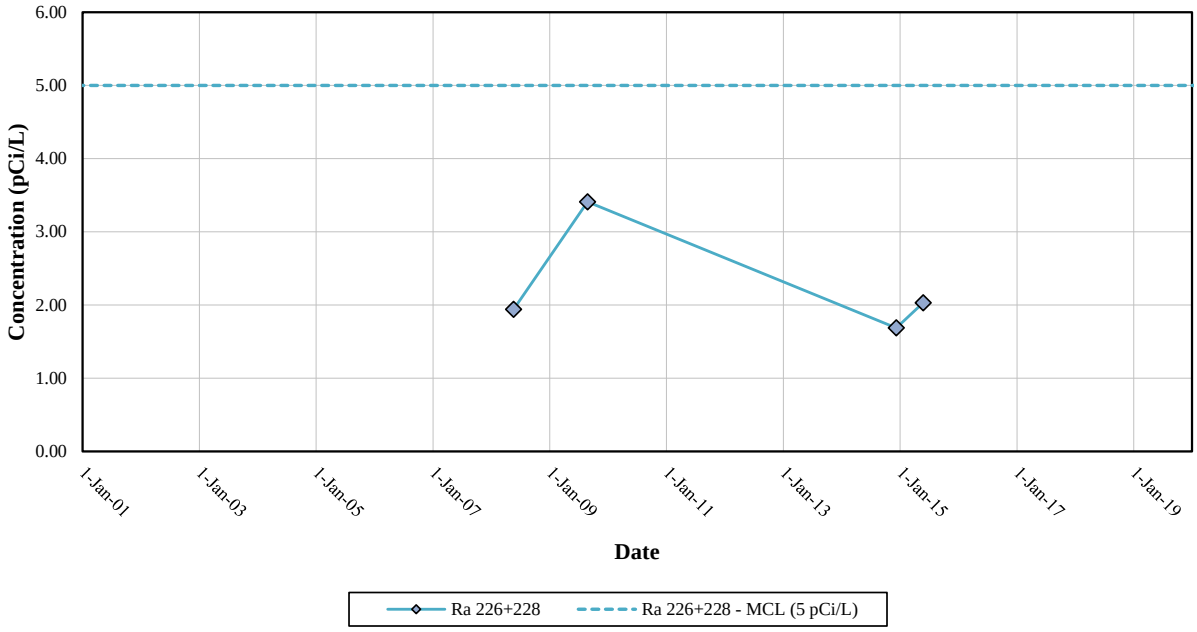


Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW2
Ra 226+228 Concentrations vs. Time

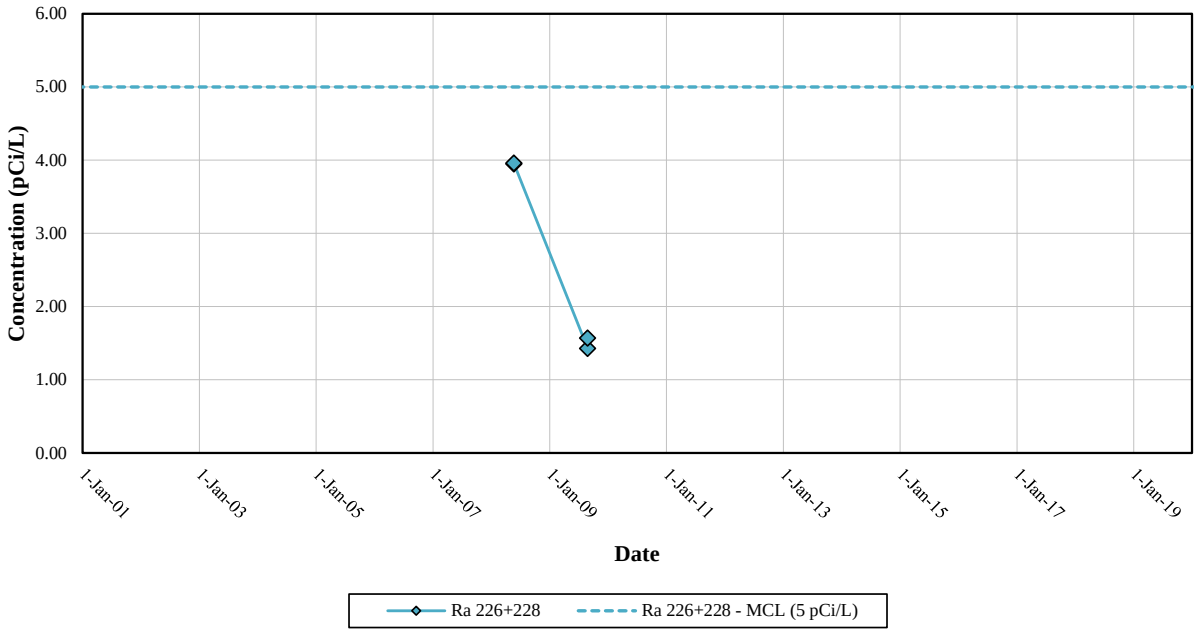


Well AA-UW3
Ra 226+228 Concentrations vs. Time

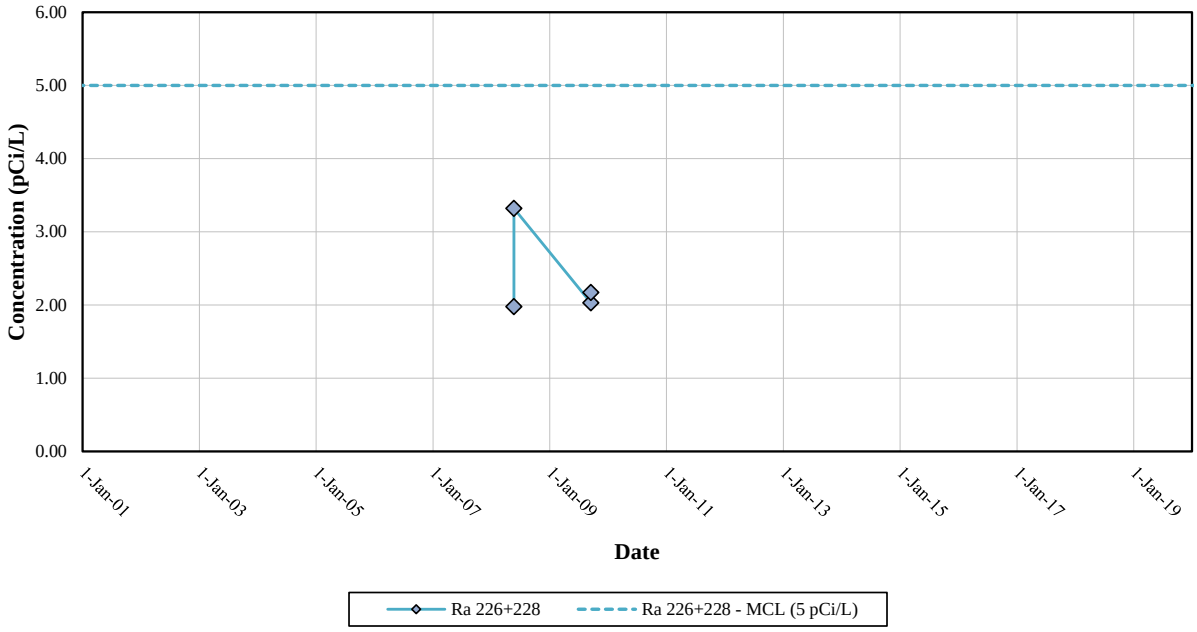


Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW4
Ra 226+228 Concentrations vs. Time

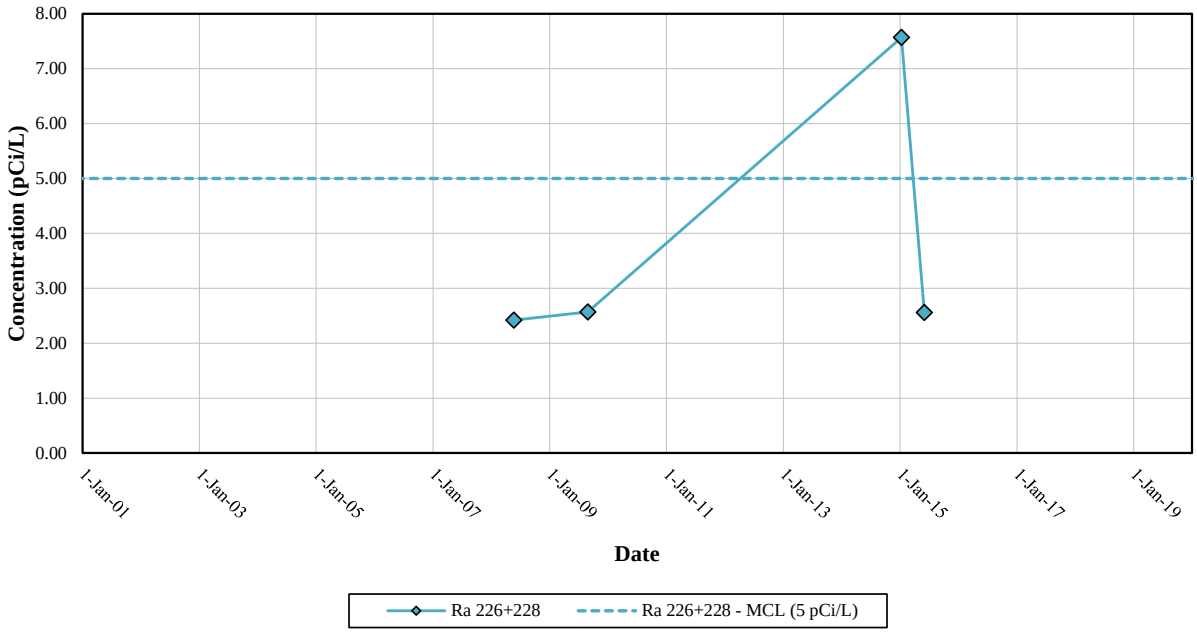


Well AA-UW5
Ra 226+228 Concentrations vs. Time

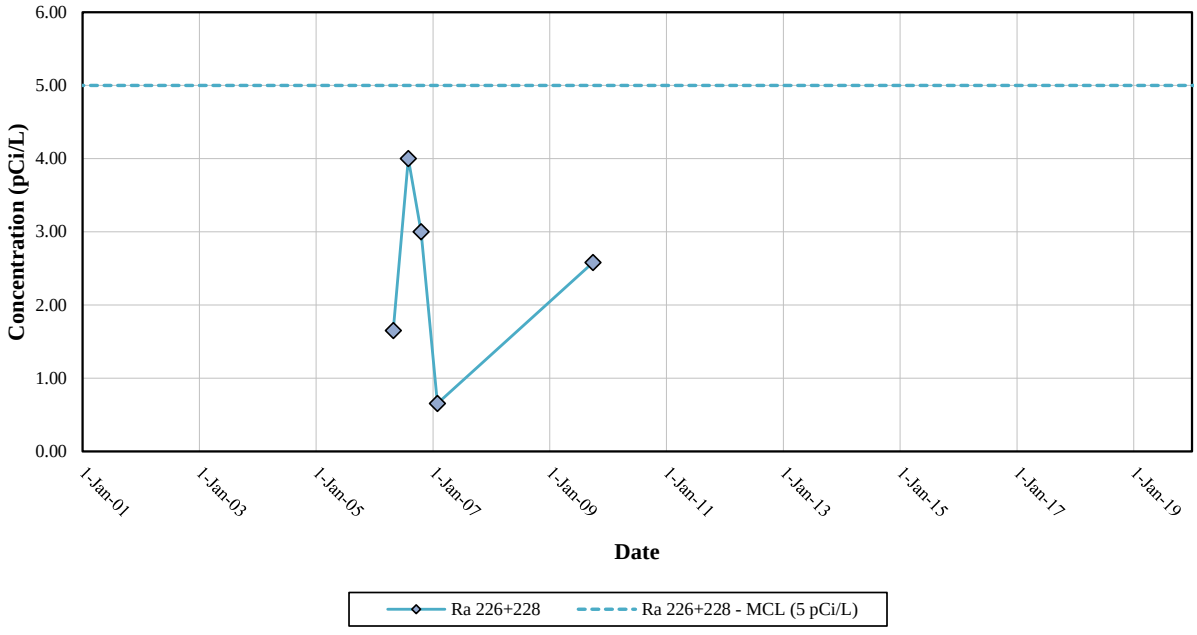


Appendix A
Time Series Plots
Eastside Shallow

Well AA-UW6
Ra 226+228 Concentrations vs. Time

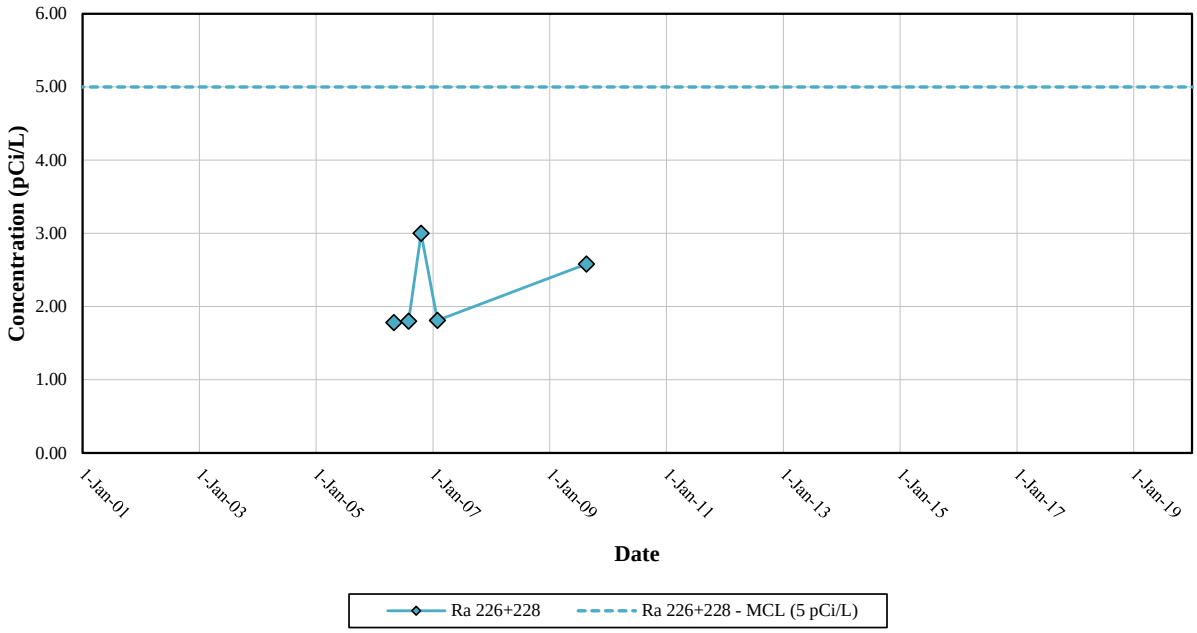


Well BEC-6
Ra 226+228 Concentrations vs. Time

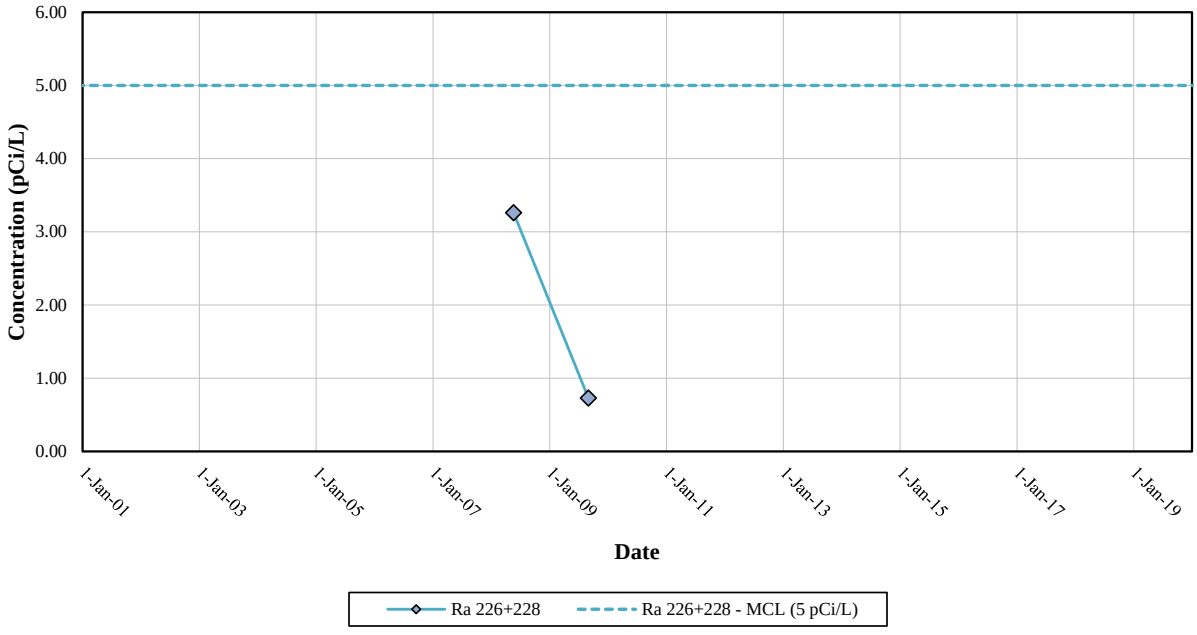


Appendix A
Time Series Plots
Eastside Shallow

Well BEC-9
Ra 226+228 Concentrations vs. Time

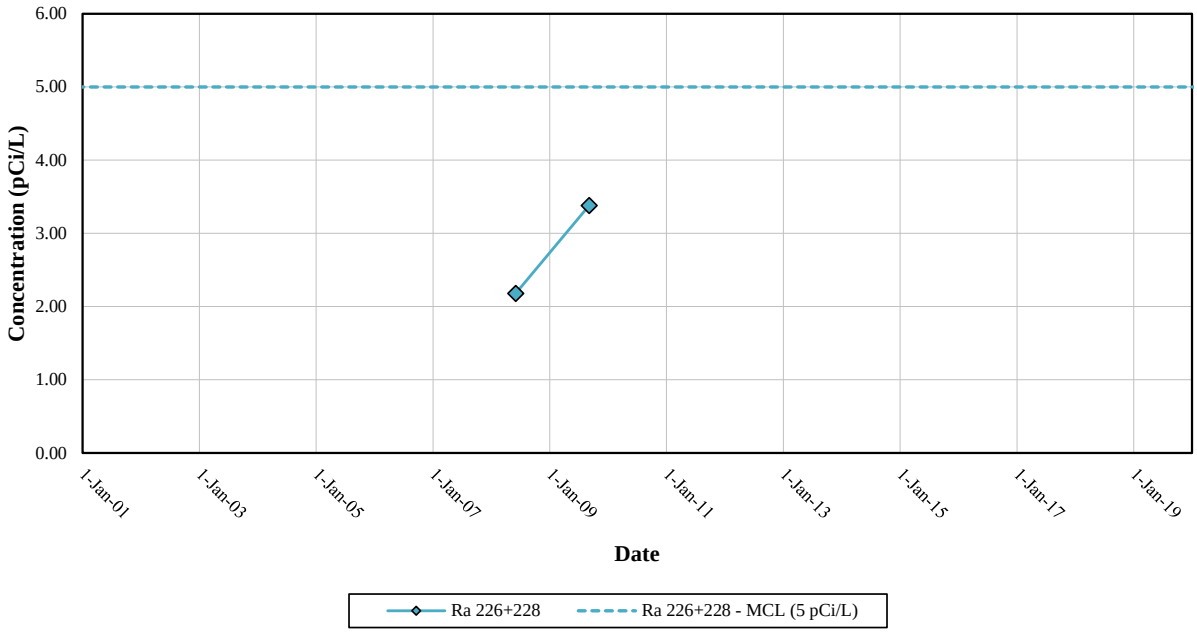


Well DBMW-1
Ra 226+228 Concentrations vs. Time

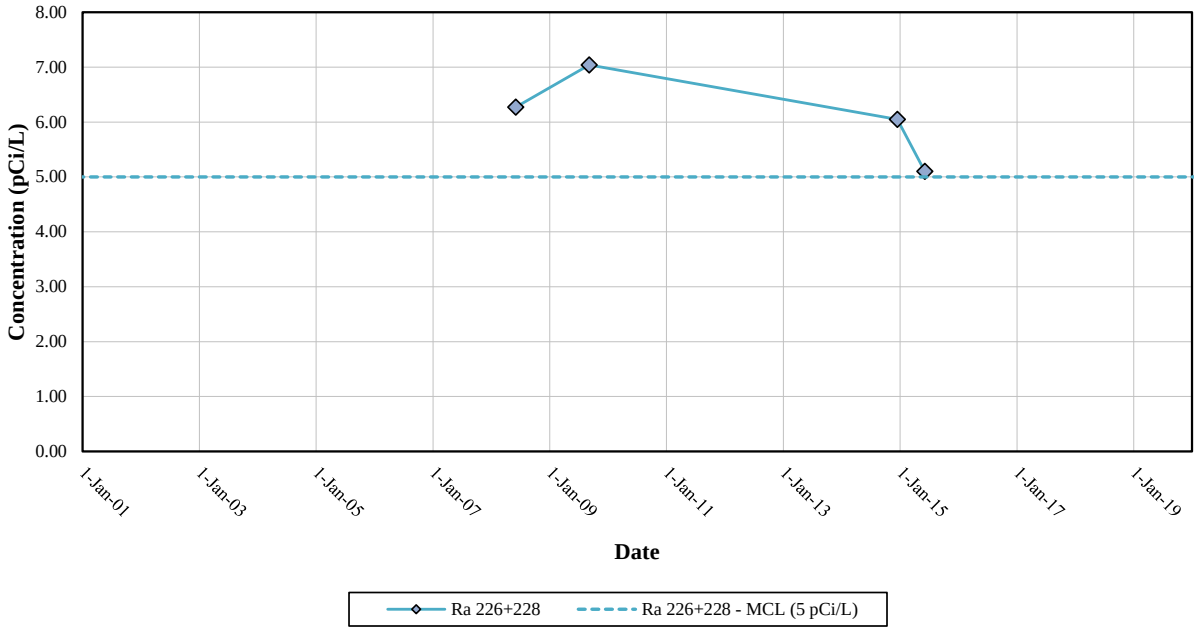


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-2
Ra 226+228 Concentrations vs. Time

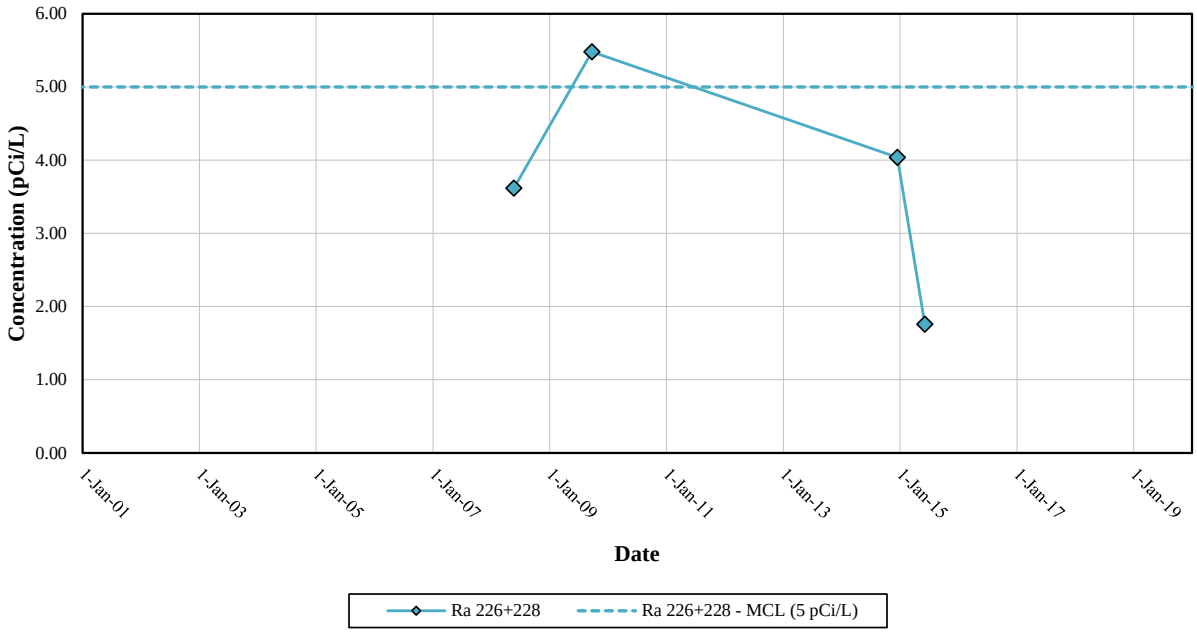


Well DBMW-3
Ra 226+228 Concentrations vs. Time

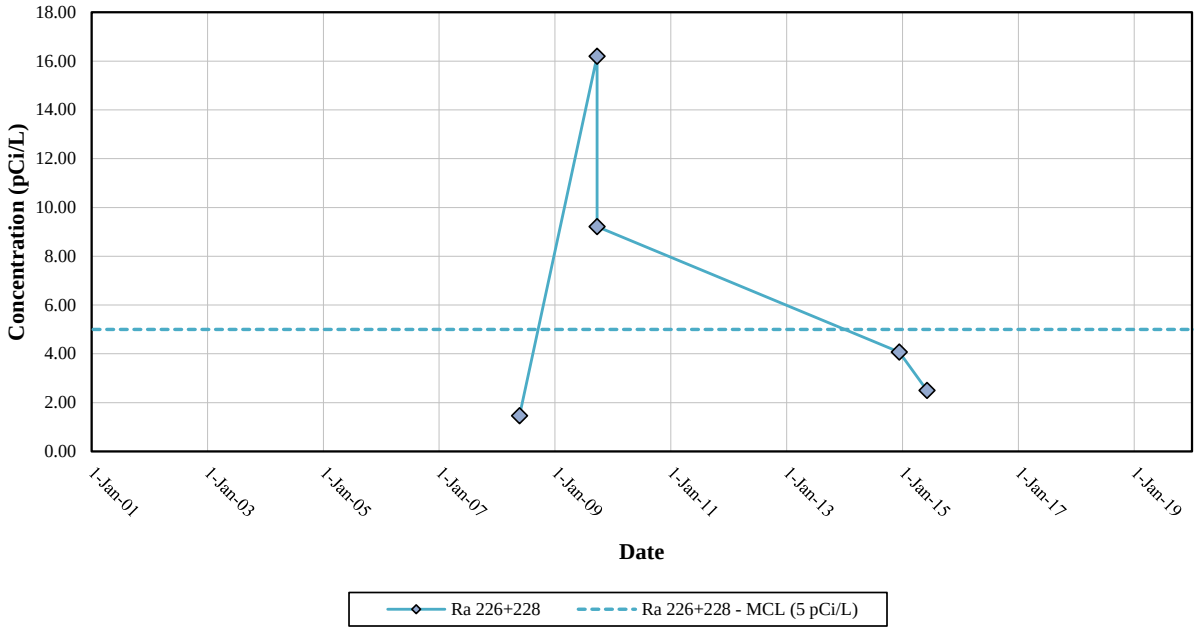


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-4
Ra 226+228 Concentrations vs. Time

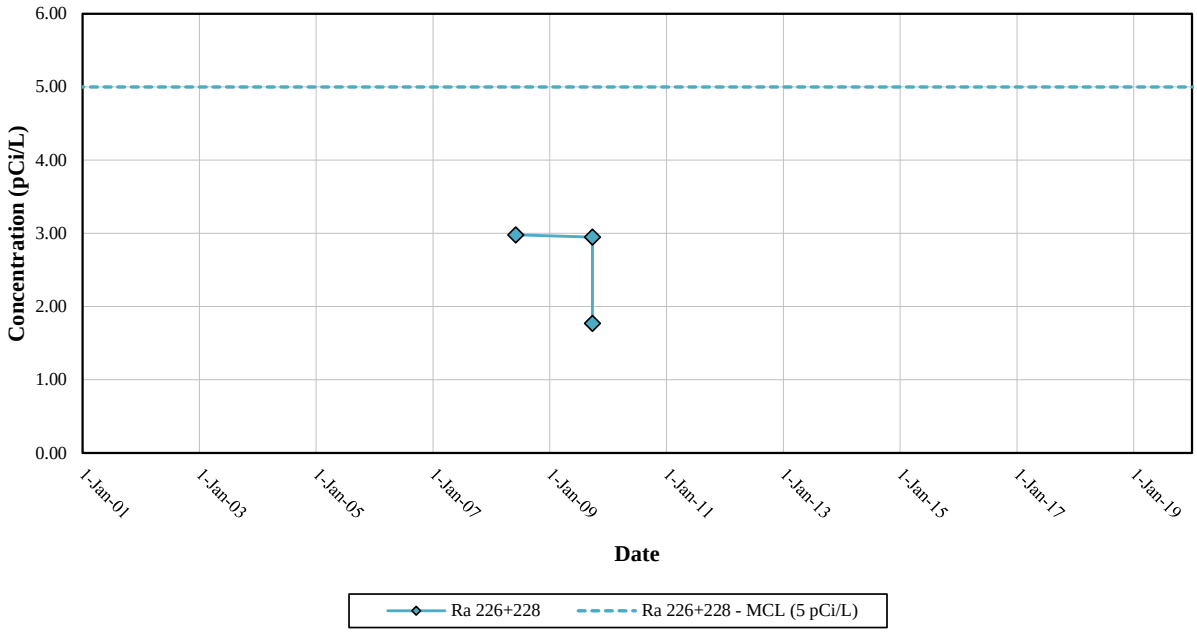


Well DBMW-5
Ra 226+228 Concentrations vs. Time

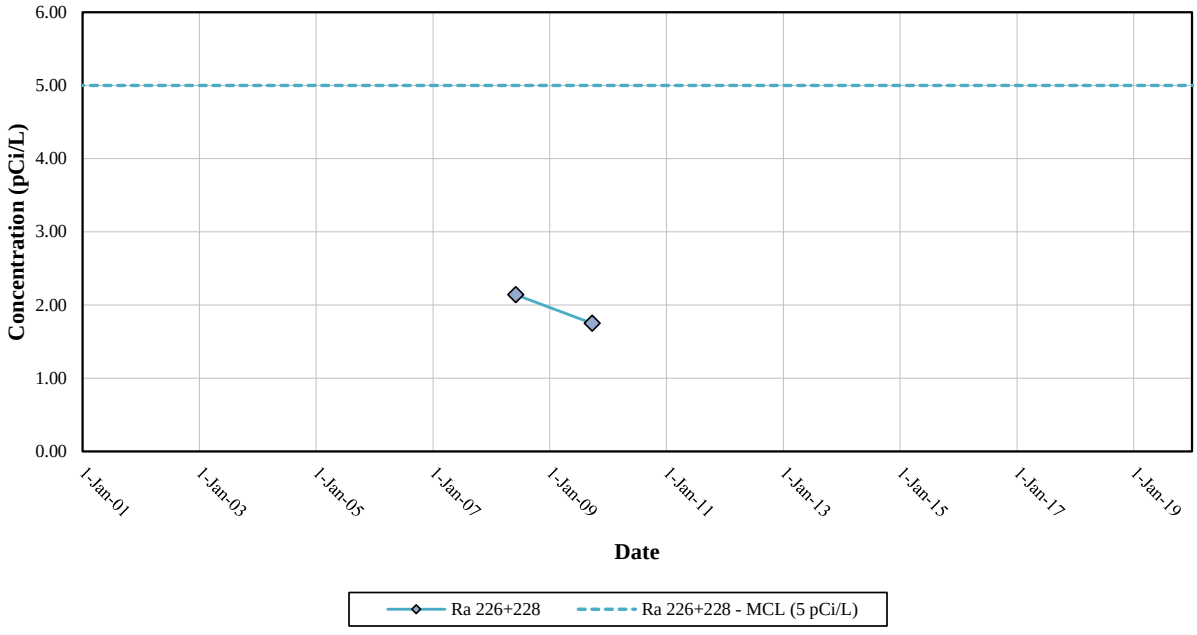


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-7
Ra 226+228 Concentrations vs. Time

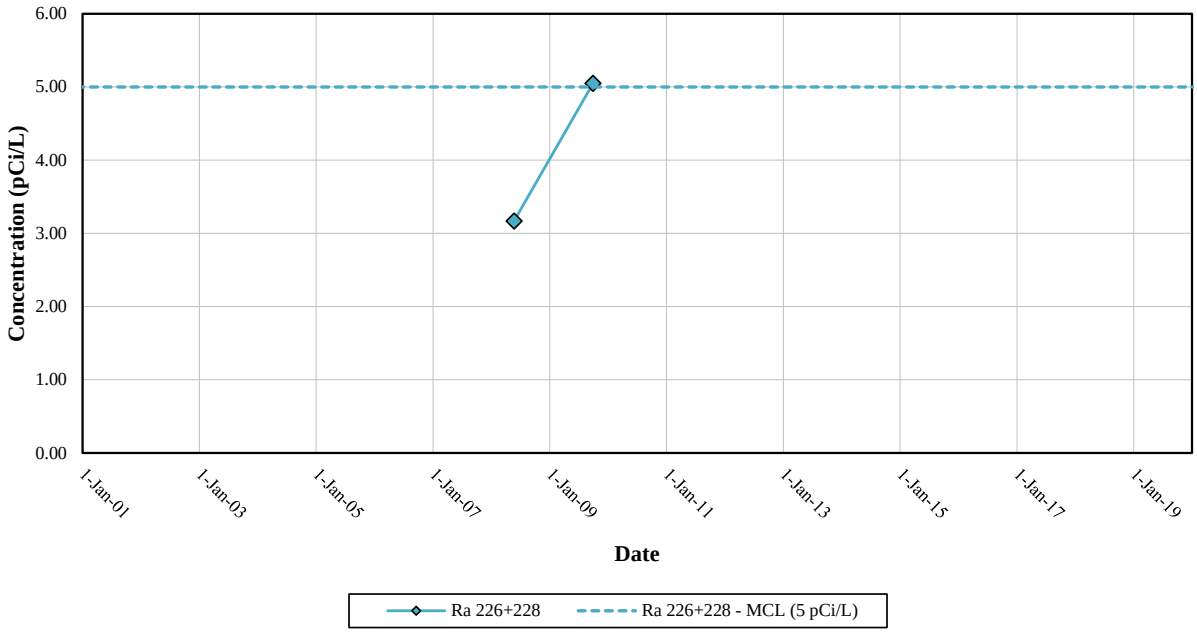


Well DBMW-8
Ra 226+228 Concentrations vs. Time

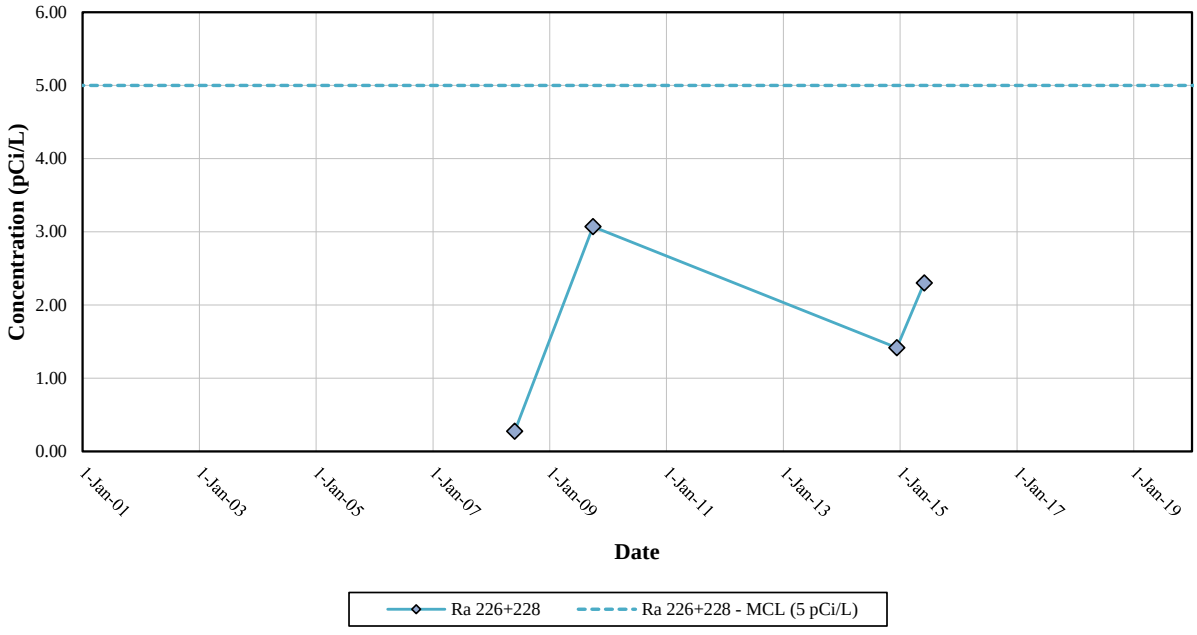


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-9
Ra 226+228 Concentrations vs. Time

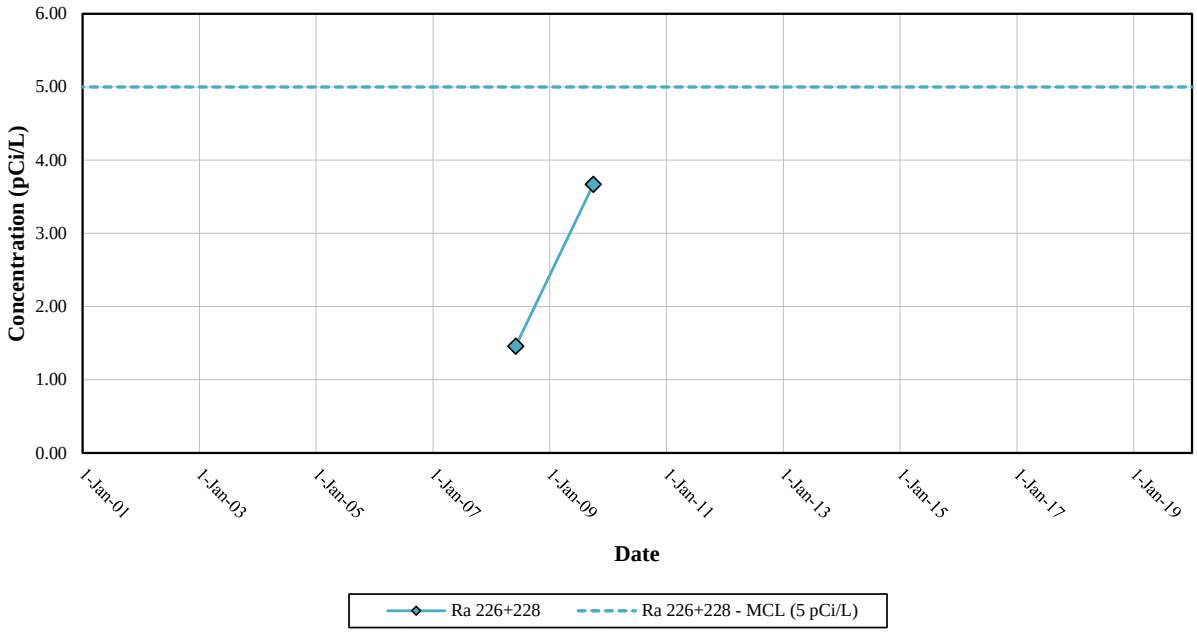


Well DBMW-10
Ra 226+228 Concentrations vs. Time

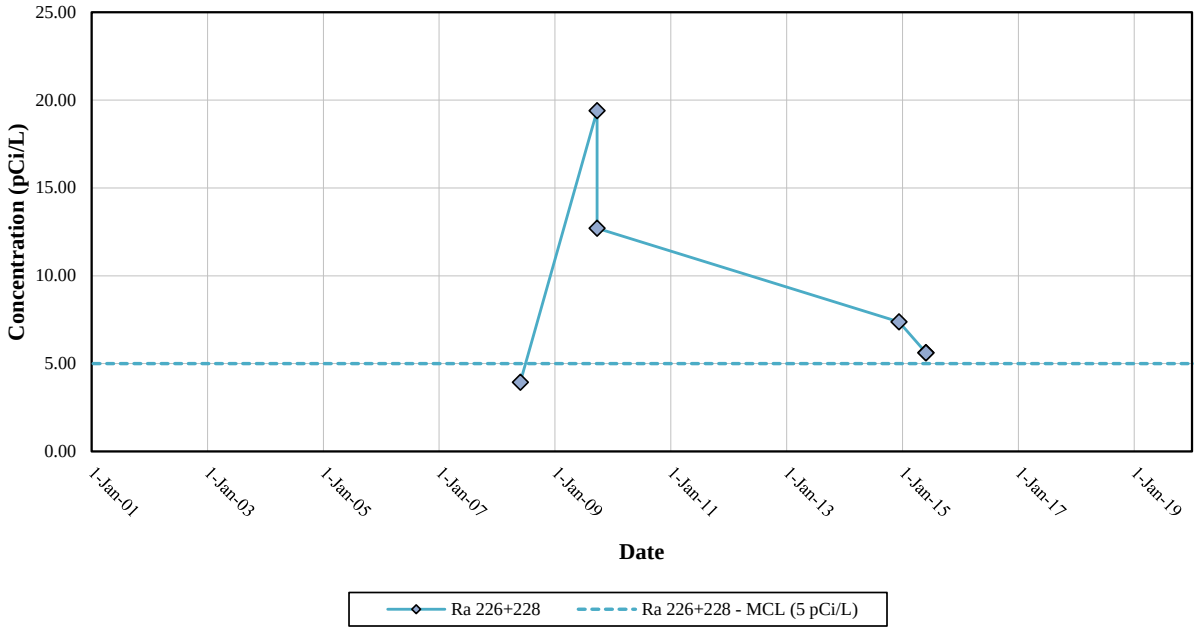


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-11
Ra 226+228 Concentrations vs. Time

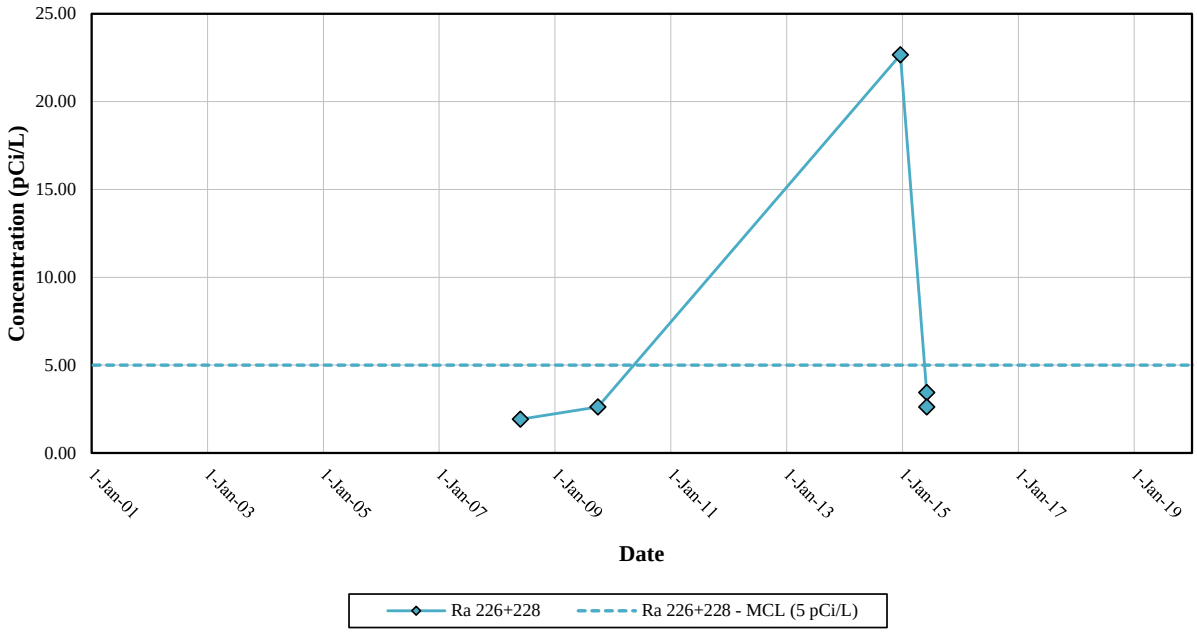


Well DBMW-12
Ra 226+228 Concentrations vs. Time

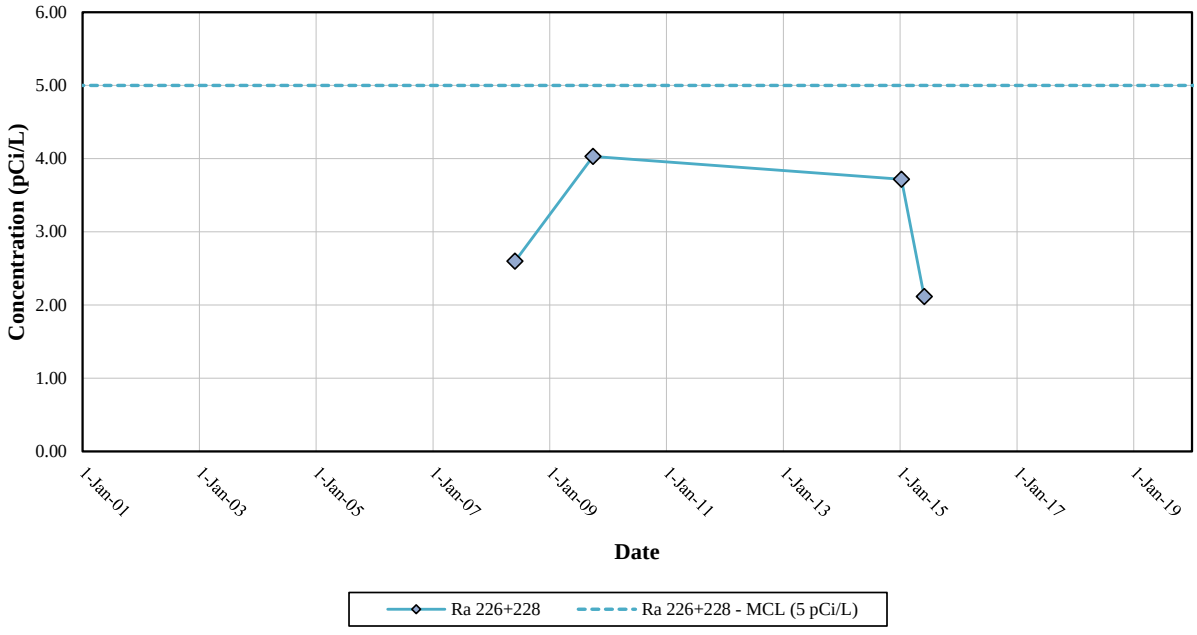


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-13
Ra 226+228 Concentrations vs. Time

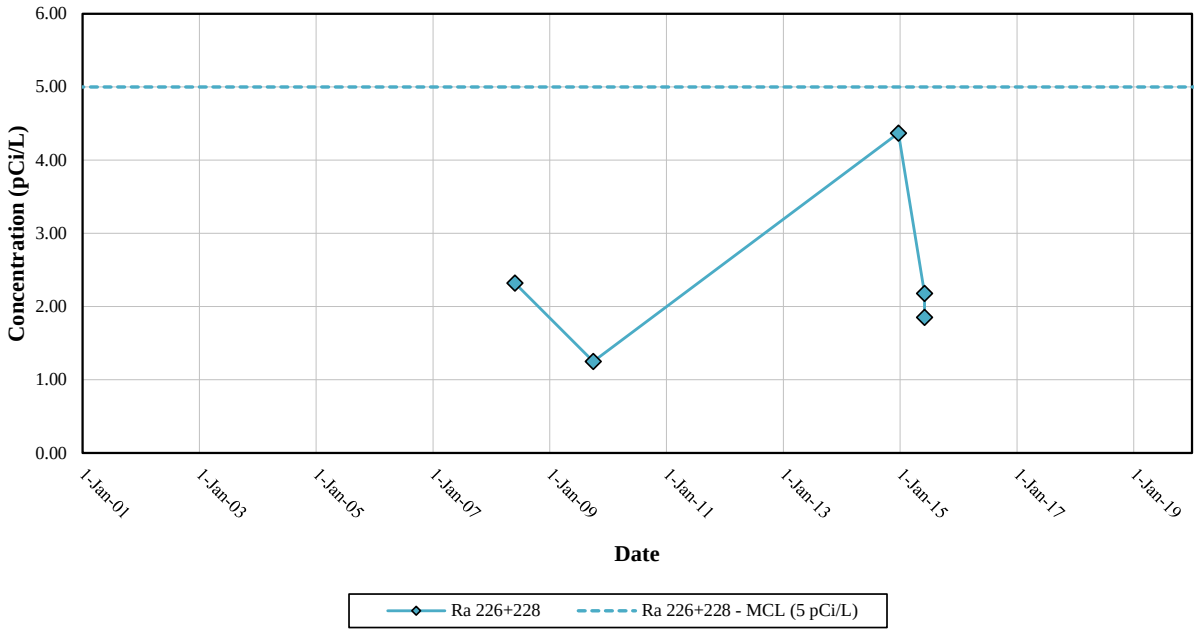


Well DBMW-14
Ra 226+228 Concentrations vs. Time

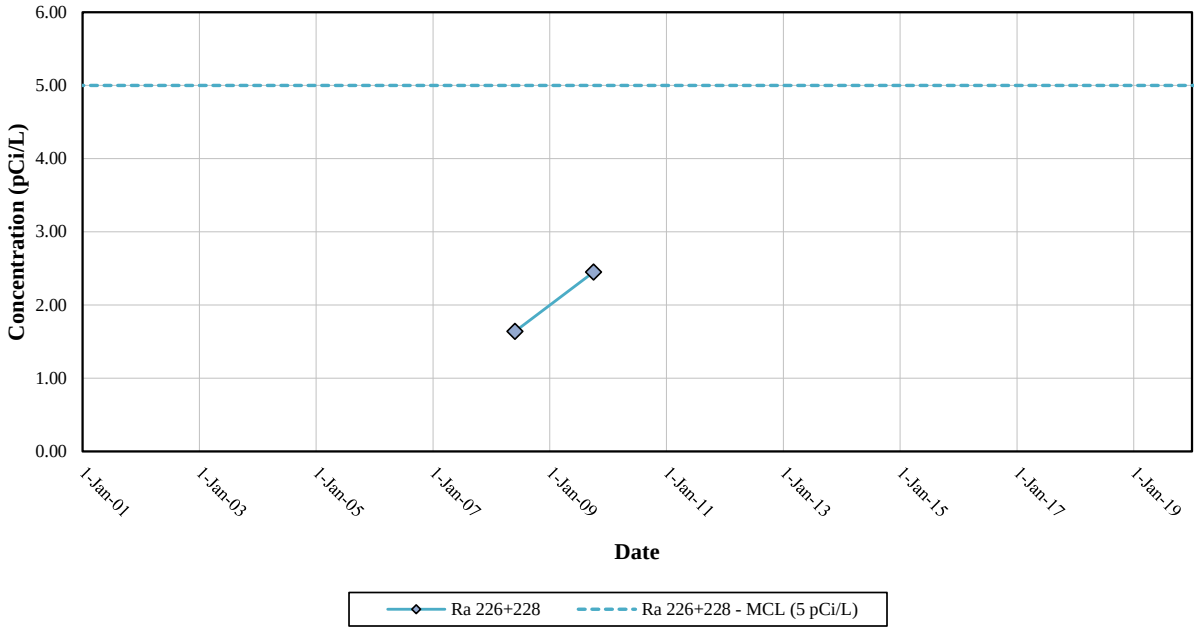


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-15
Ra 226+228 Concentrations vs. Time

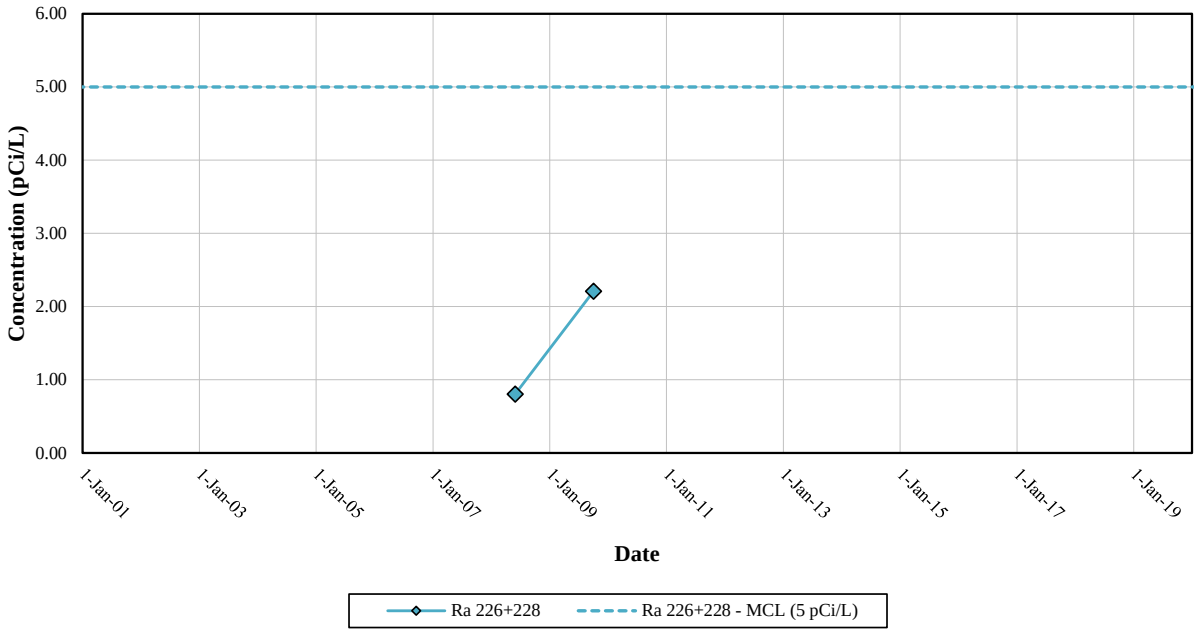


Well DBMW-16
Ra 226+228 Concentrations vs. Time

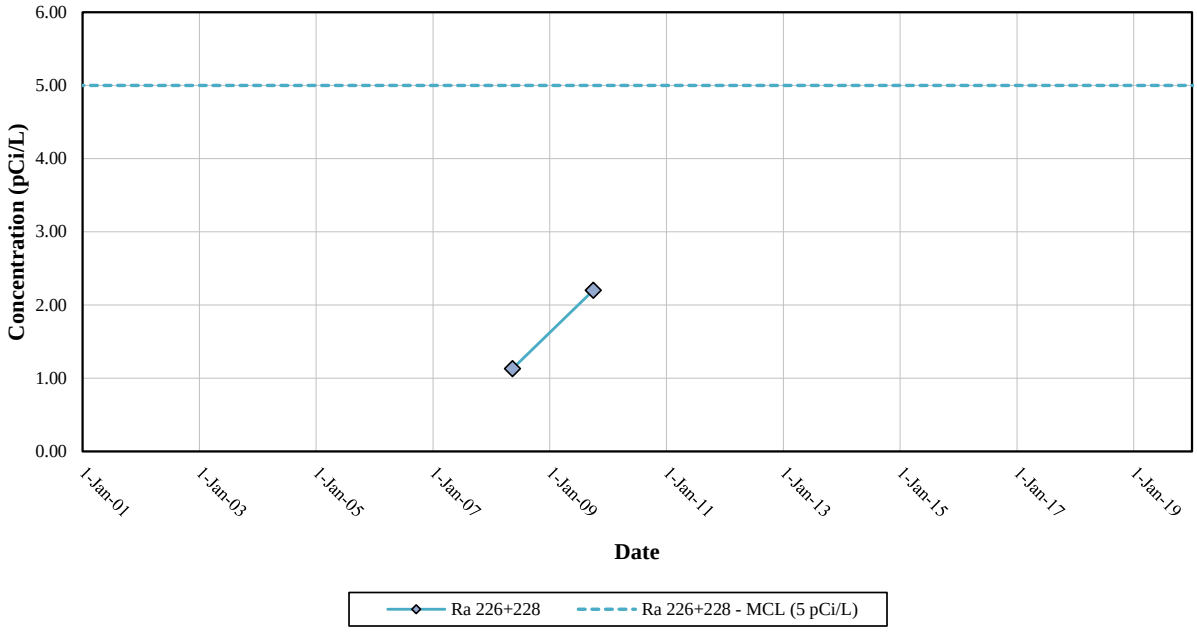


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-17
Ra 226+228 Concentrations vs. Time

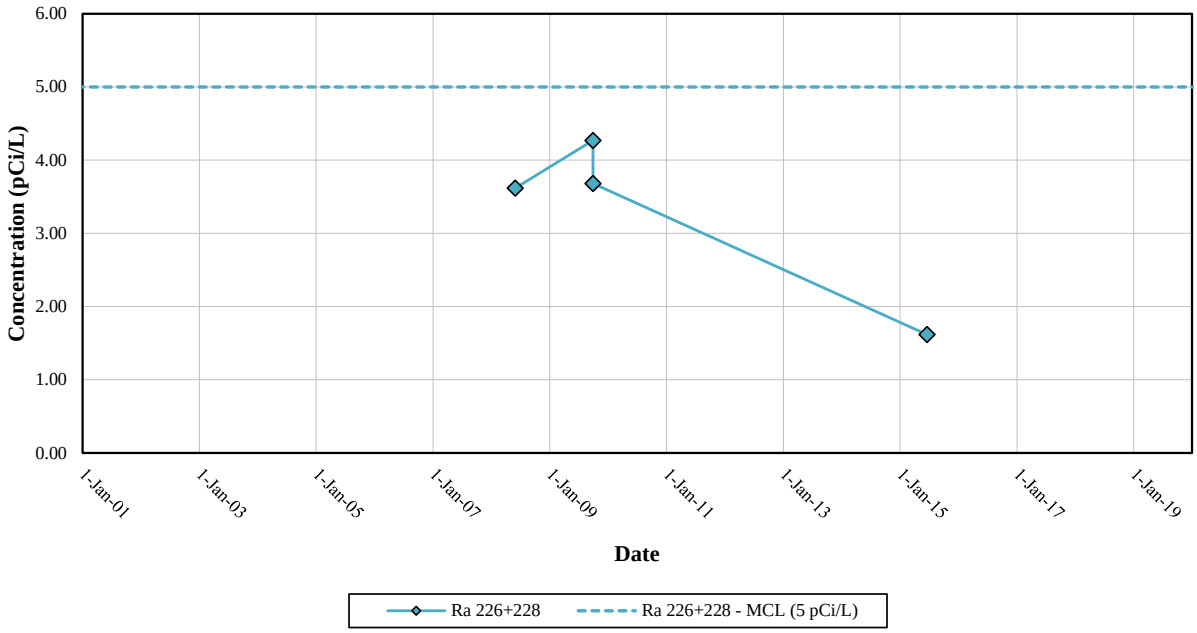


Well DBMW-20
Ra 226+228 Concentrations vs. Time

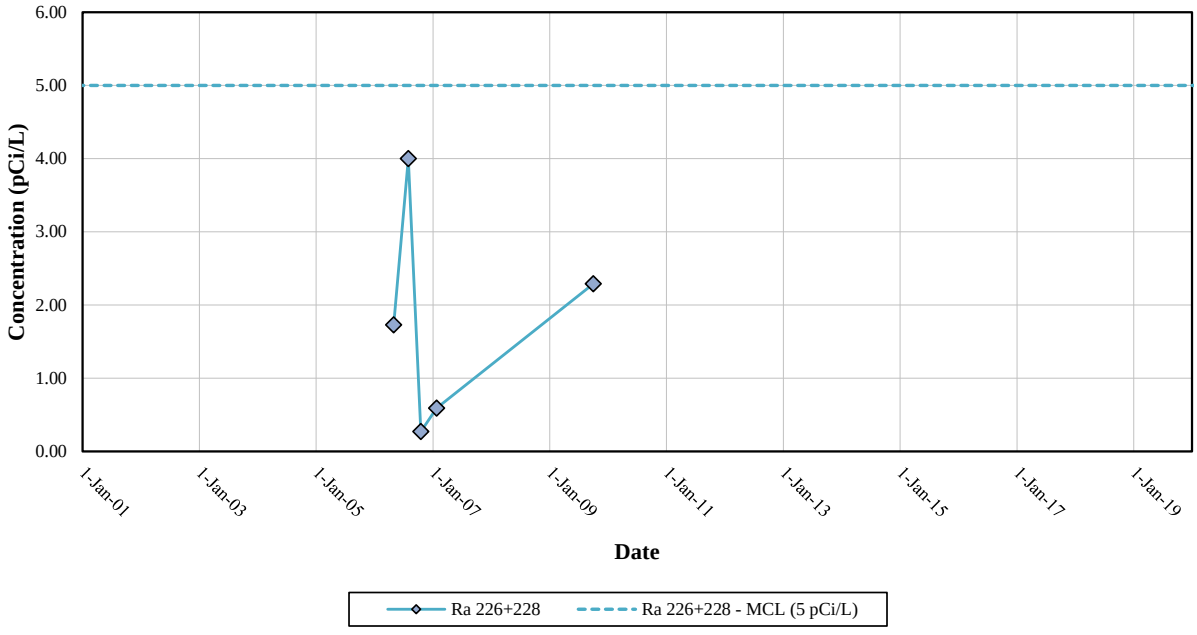


Appendix A
Time Series Plots
Eastside Shallow

Well DBMW-22
Ra 226+228 Concentrations vs. Time

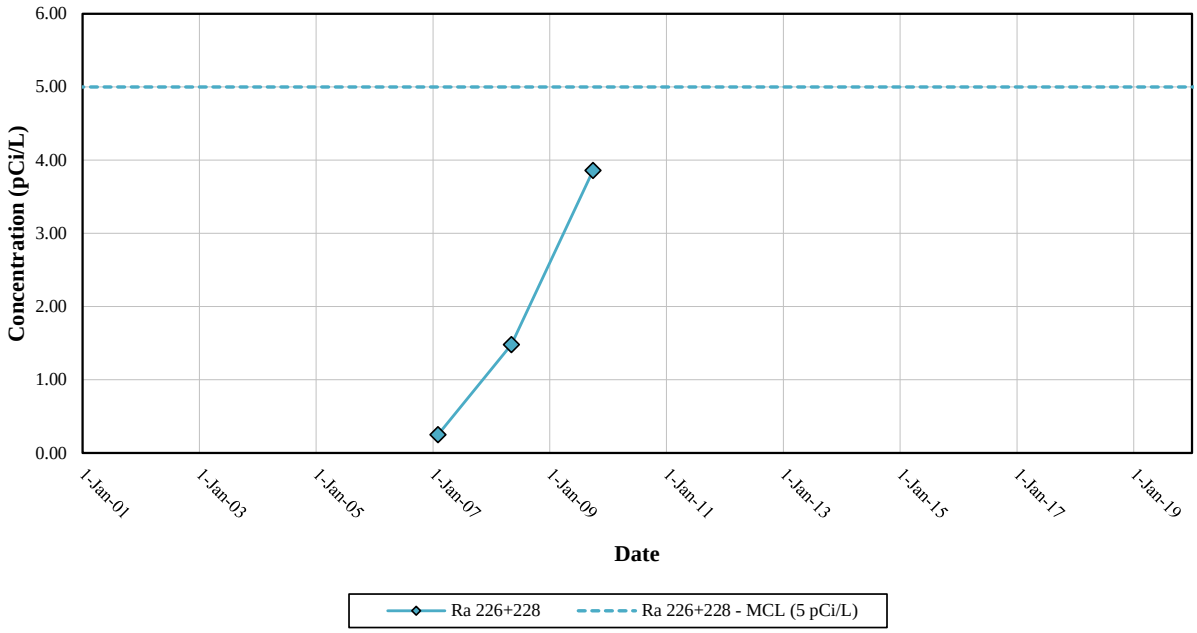


Well DM-1
Ra 226+228 Concentrations vs. Time

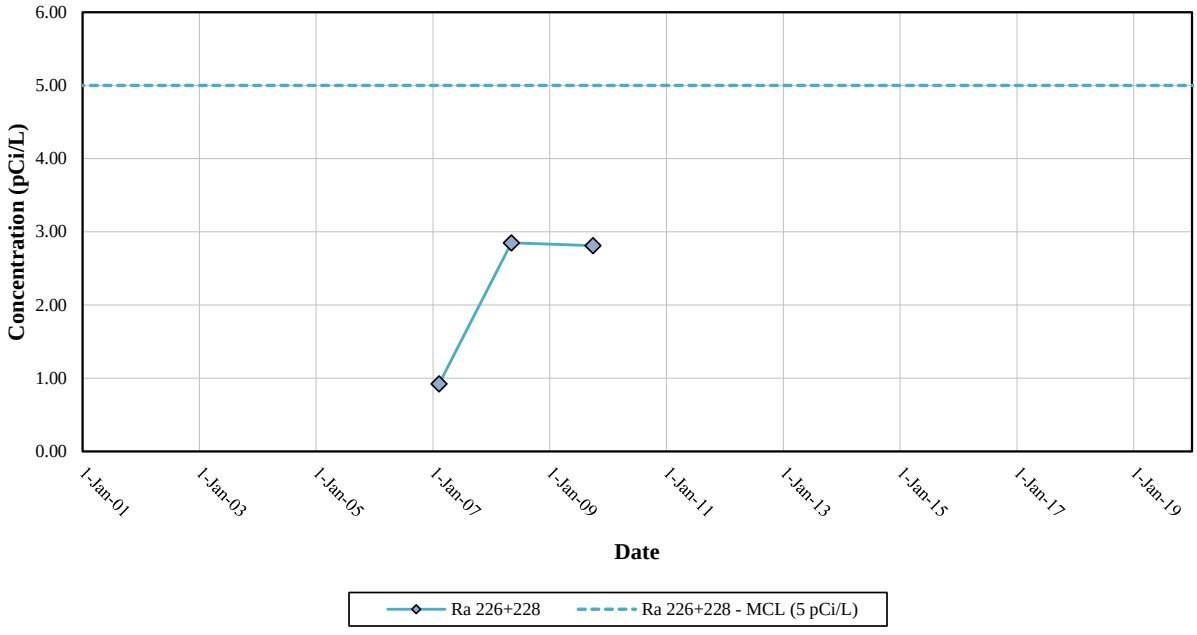


Appendix A
Time Series Plots
Eastside Shallow

Well HMW-08
Ra 226+228 Concentrations vs. Time

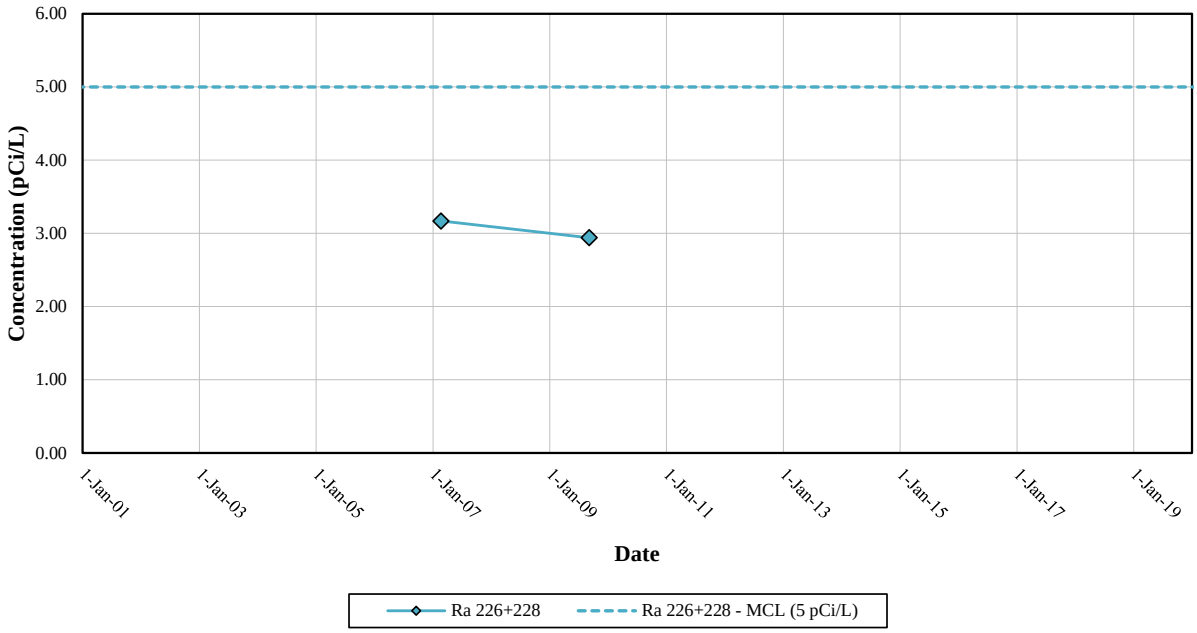


Well HMW-09
Ra 226+228 Concentrations vs. Time

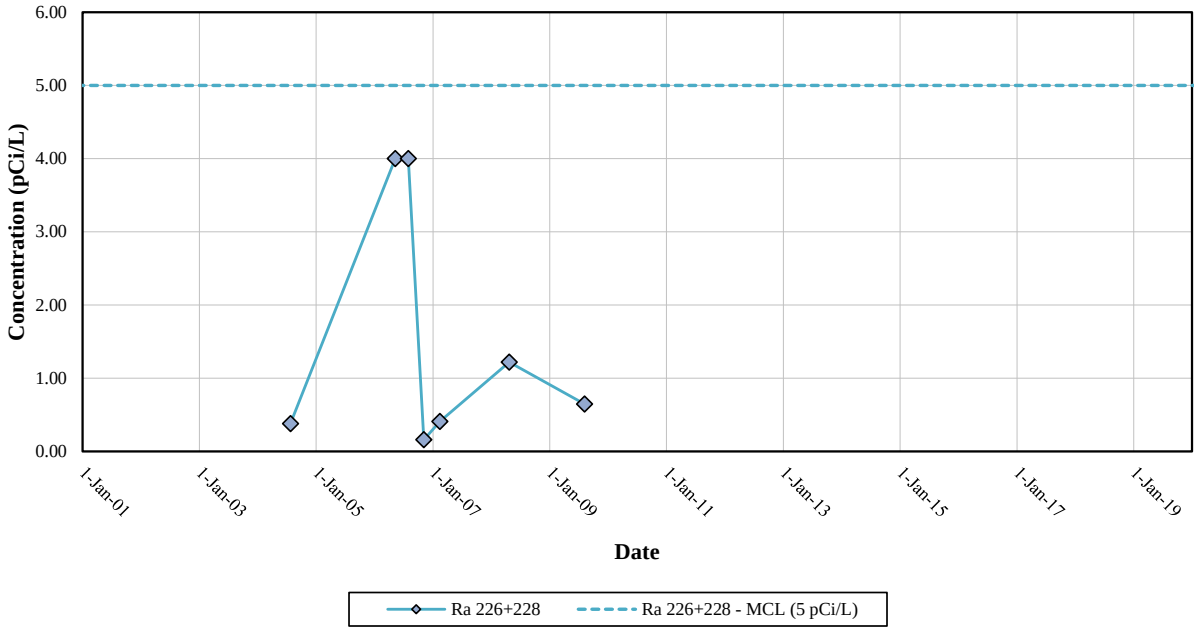


Appendix A
Time Series Plots
Eastside Shallow

Well HMWWT-6
Ra 226+228 Concentrations vs. Time

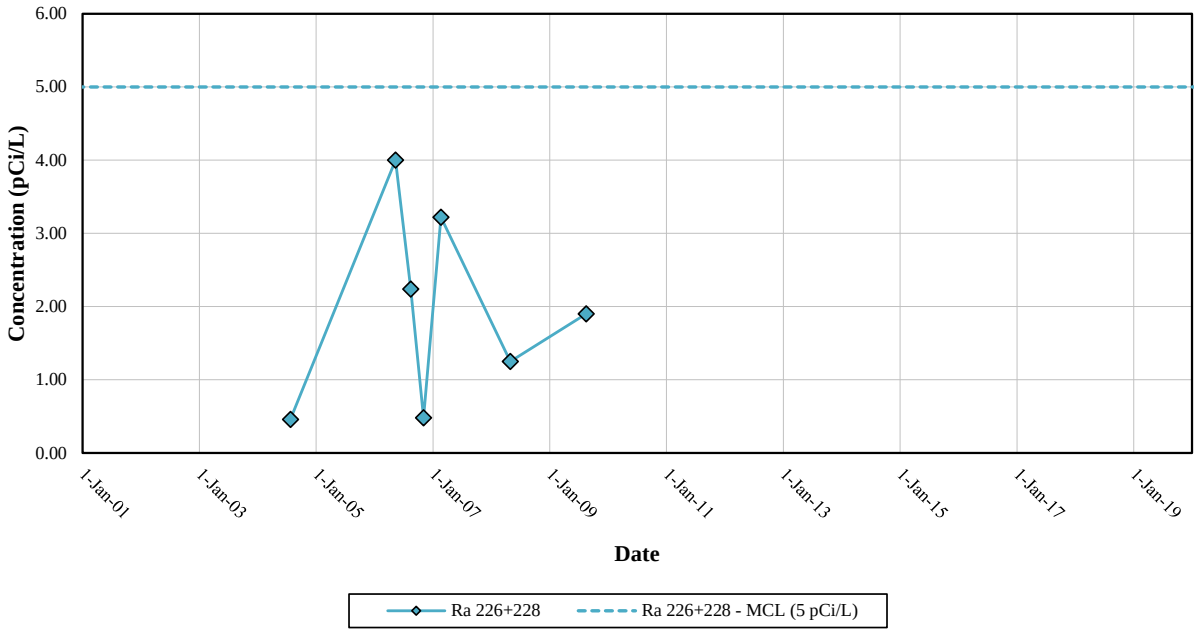


Well MCF-01B
Ra 226+228 Concentrations vs. Time

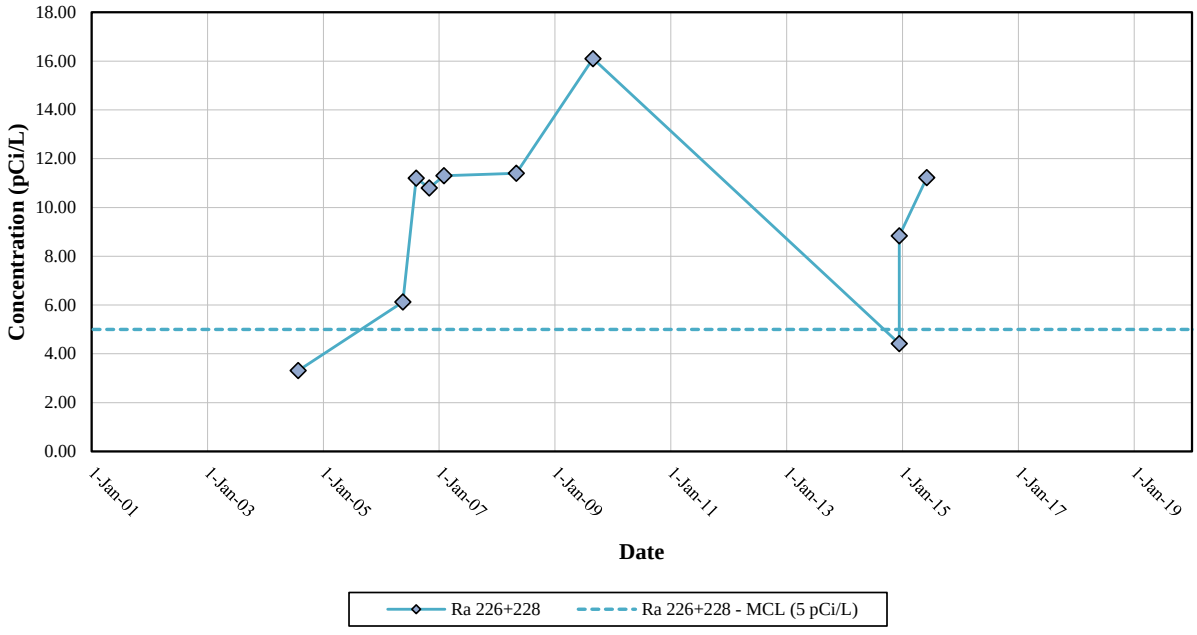


Appendix A
Time Series Plots
Eastside Shallow

Well MCF-03B
Ra 226+228 Concentrations vs. Time

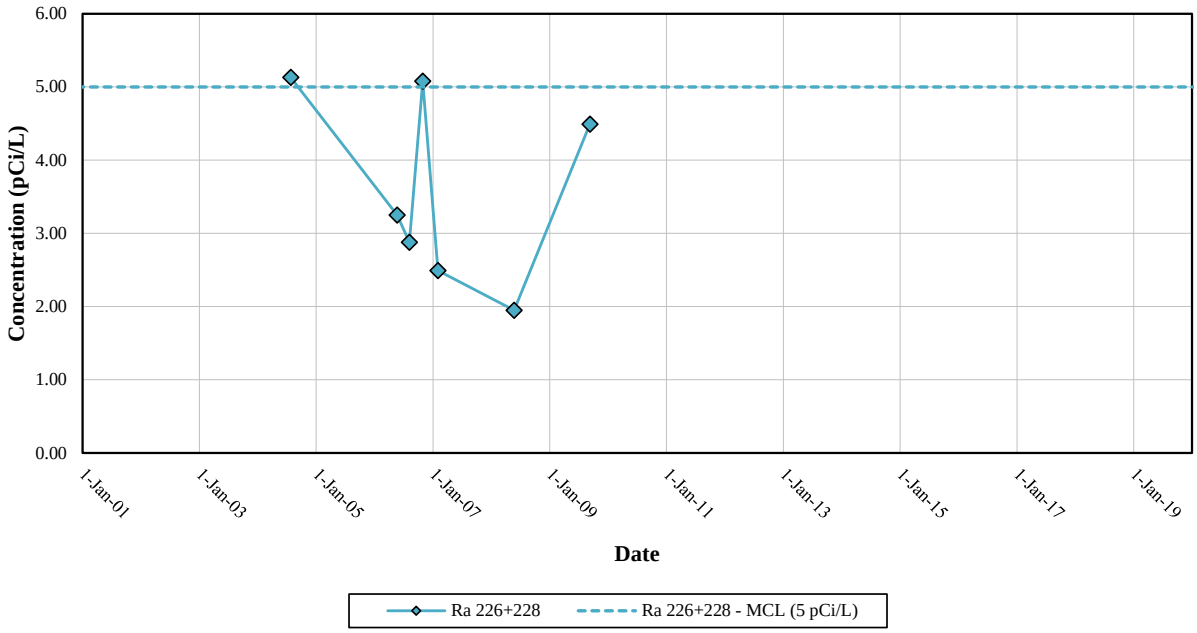


Well MCF-06B
Ra 226+228 Concentrations vs. Time

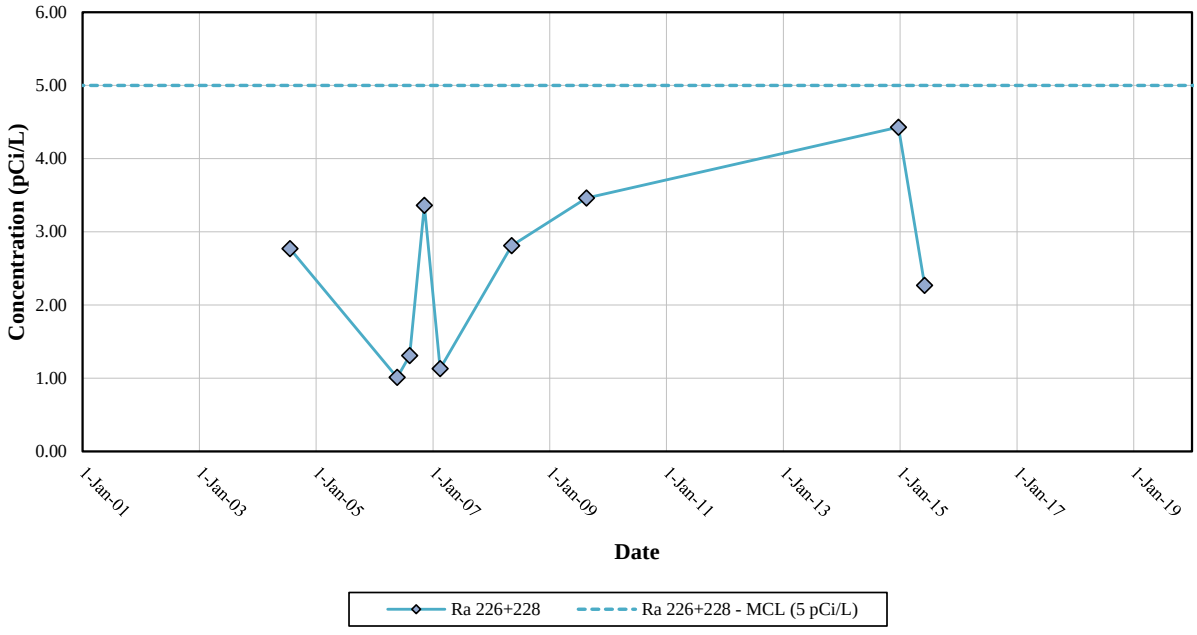


Appendix A
Time Series Plots
Eastside Shallow

Well MCF-06C
Ra 226+228 Concentrations vs. Time

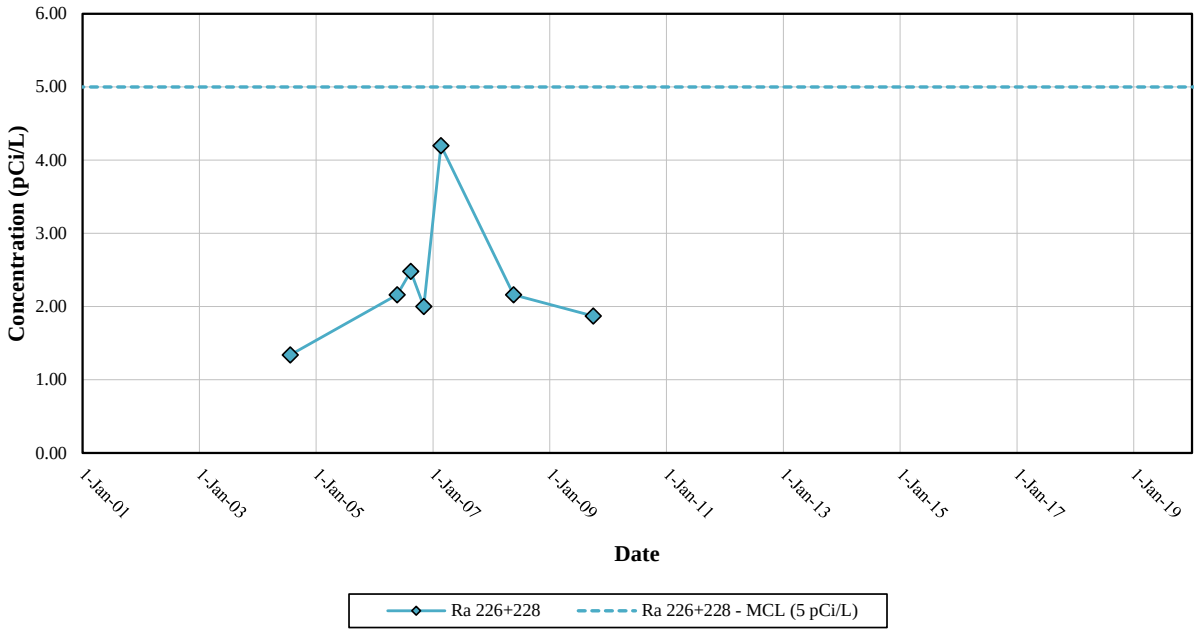


Well MCF-12B
Ra 226+228 Concentrations vs. Time

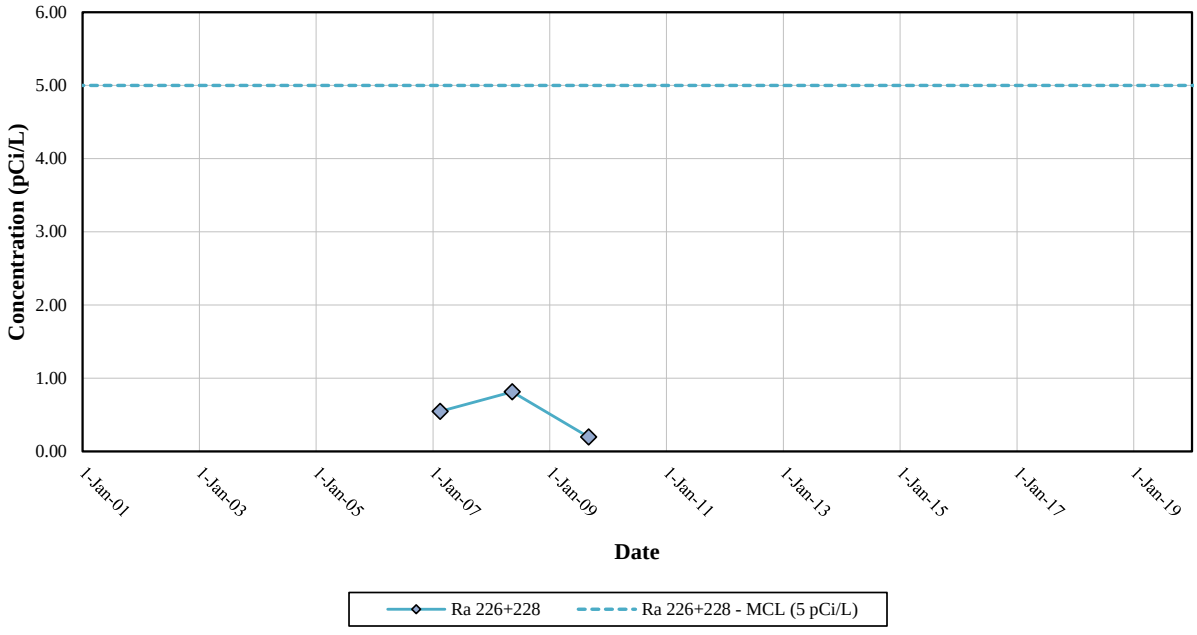


Appendix A
Time Series Plots
Eastside Shallow

Well MCF-16C
Ra 226+228 Concentrations vs. Time

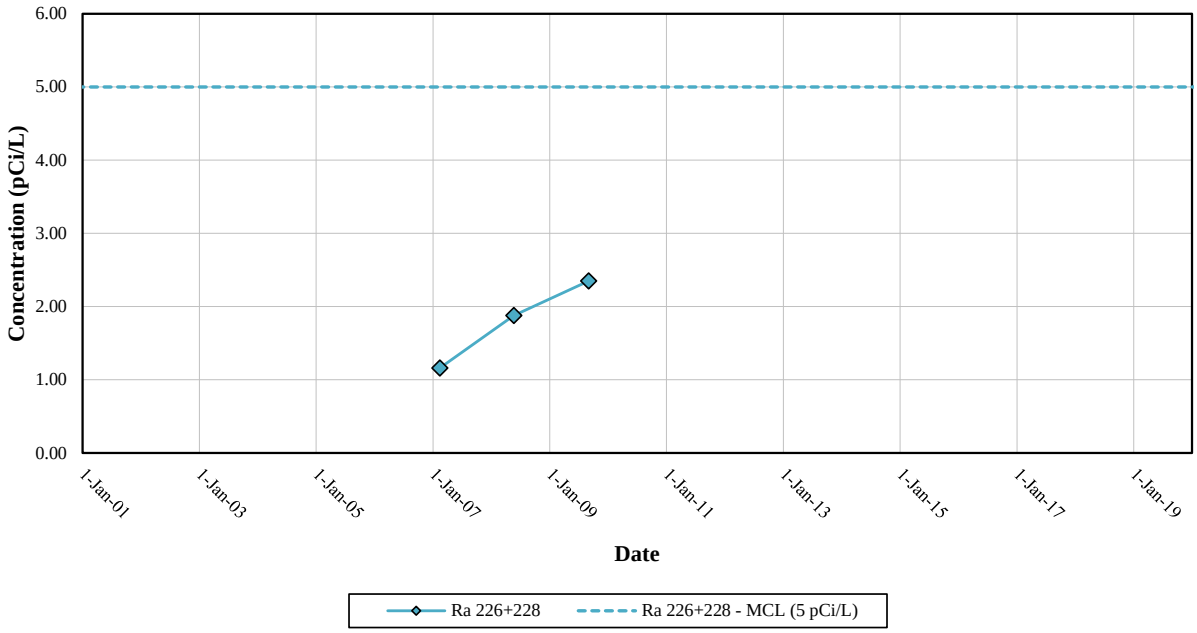


Well MW-13
Ra 226+228 Concentrations vs. Time

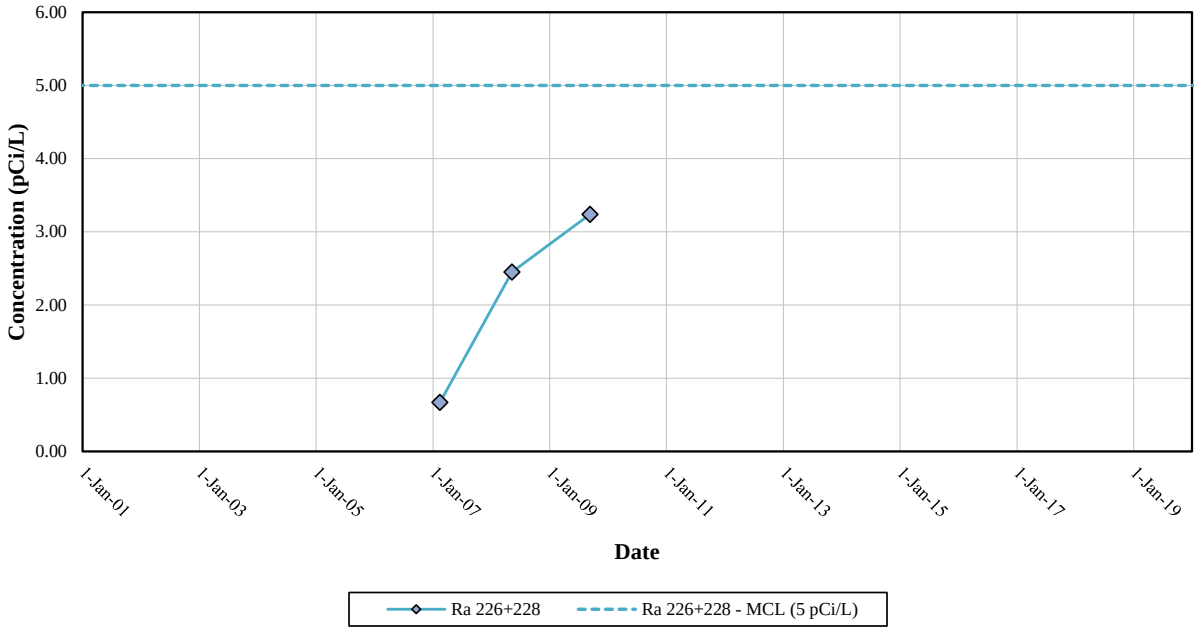


Appendix A
Time Series Plots
Eastside Shallow

Well MW-15
Ra 226+228 Concentrations vs. Time

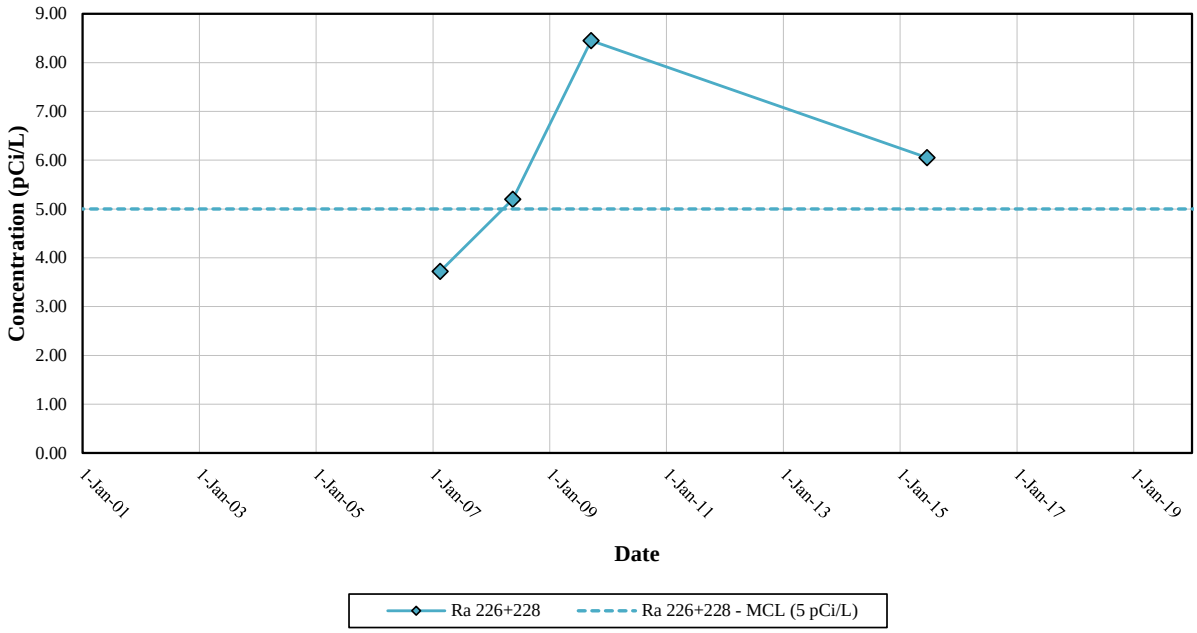


Well MW-3
Ra 226+228 Concentrations vs. Time

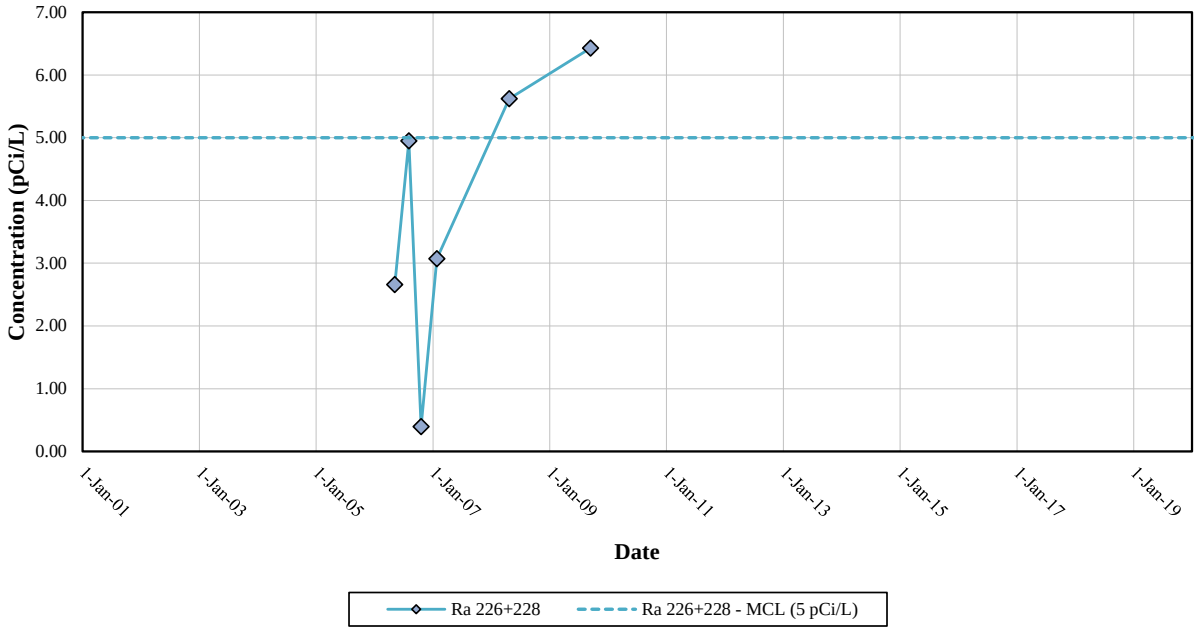


Appendix A
Time Series Plots
Eastside Shallow

Well MW-4
Ra 226+228 Concentrations vs. Time

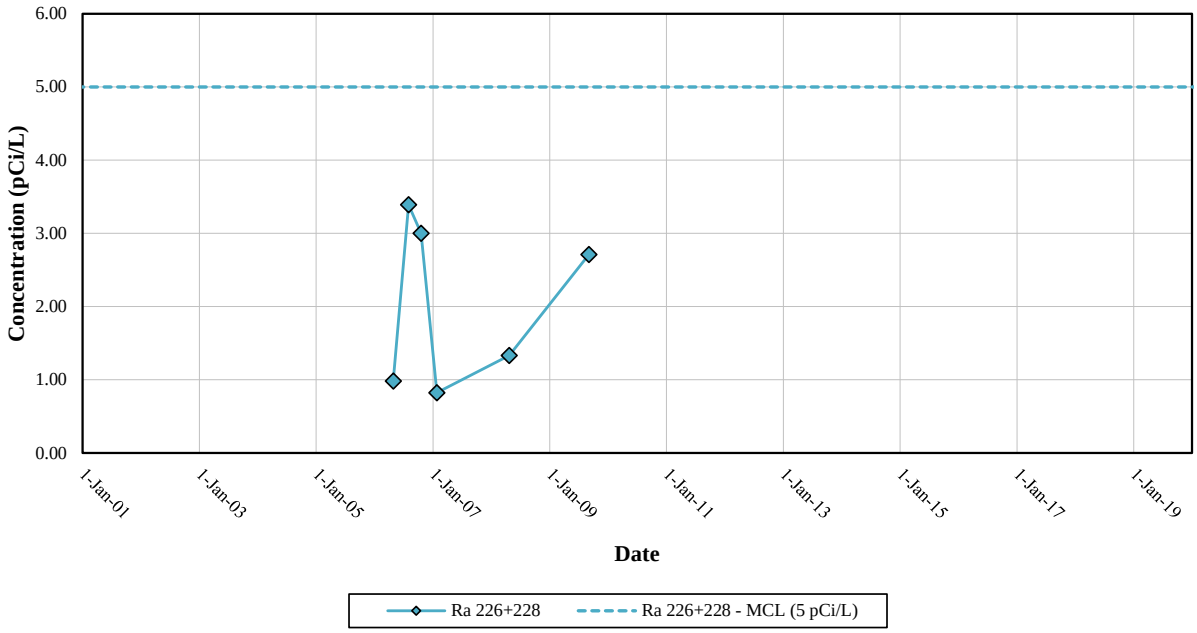


Well POD2-R
Ra 226+228 Concentrations vs. Time

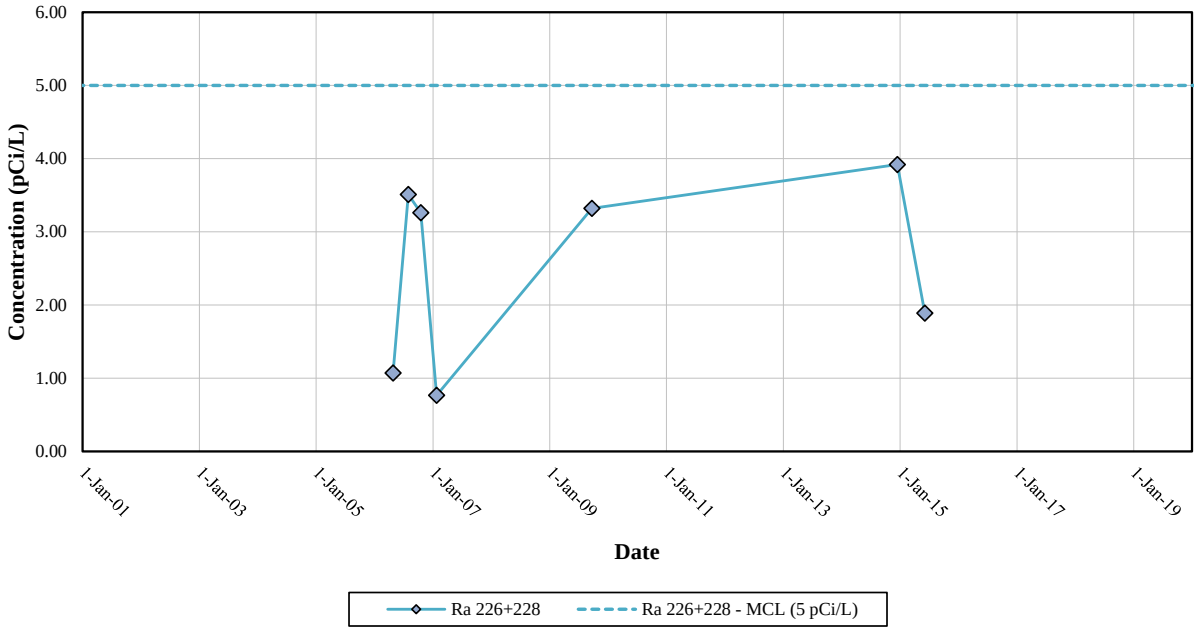


Appendix A
Time Series Plots
Eastside Shallow

Well POD8
Ra 226+228 Concentrations vs. Time

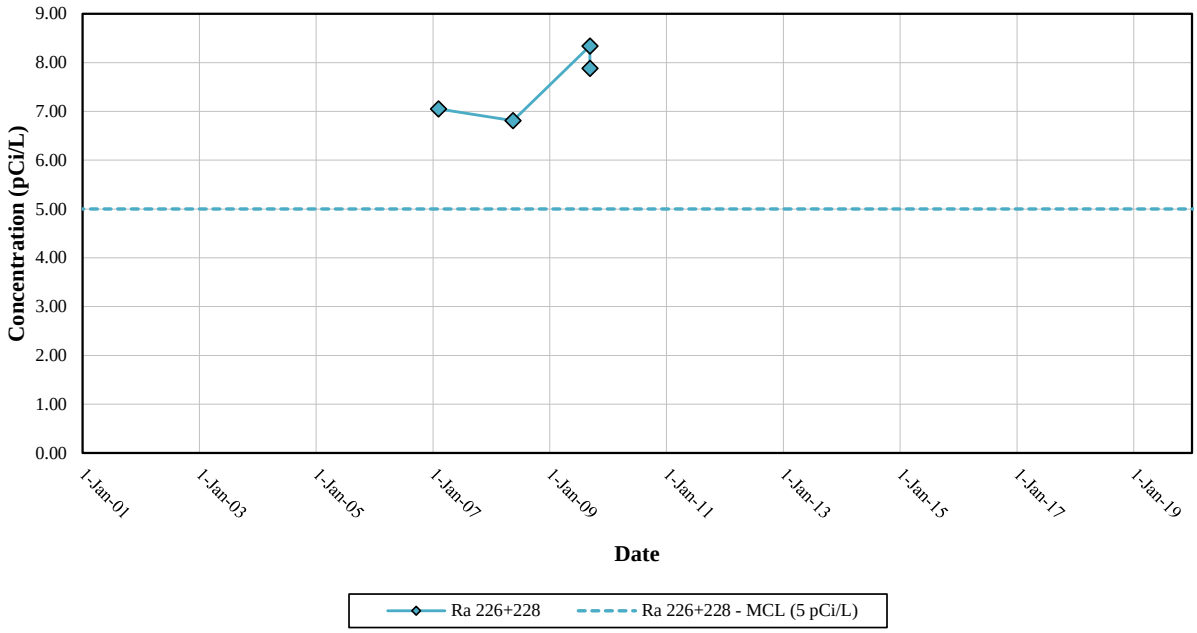


Well POU3
Ra 226+228 Concentrations vs. Time

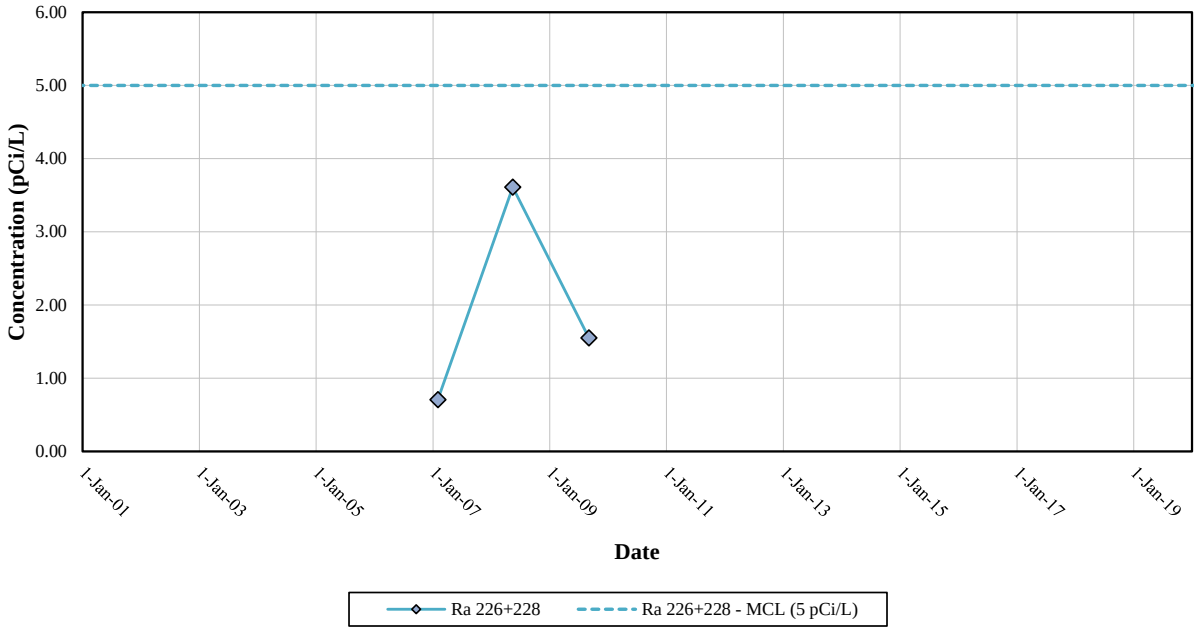


Appendix A
Time Series Plots
Eastside Shallow

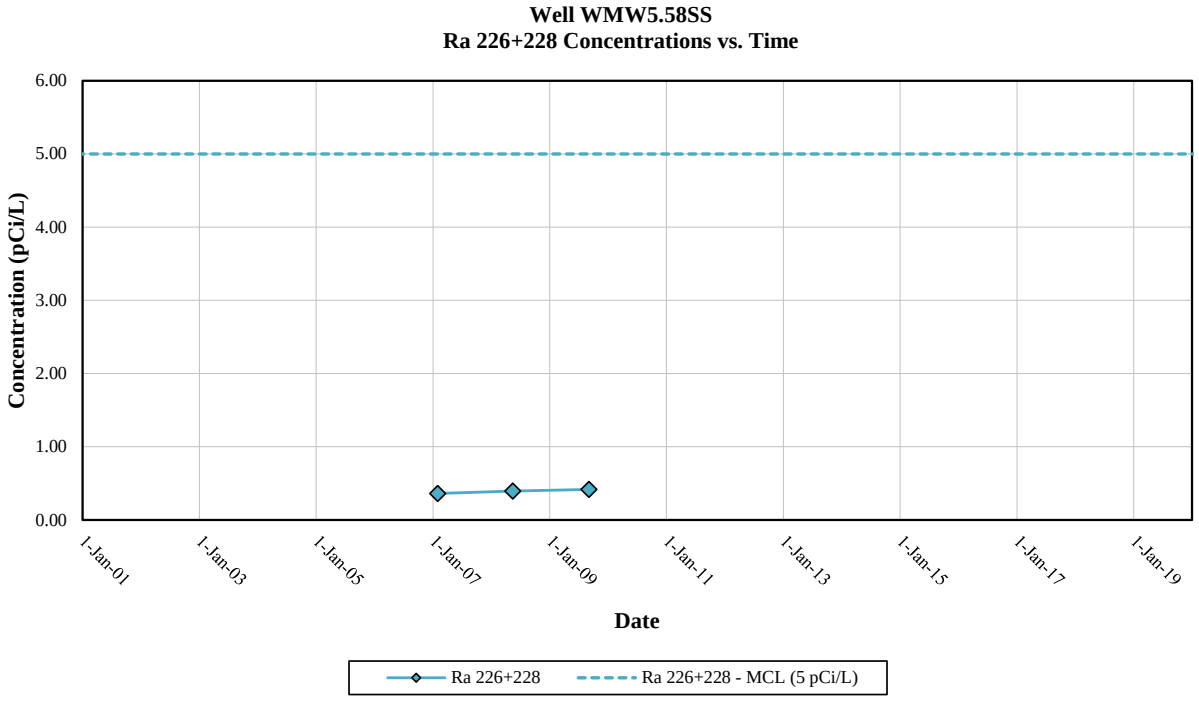
Well WMW5.58SD
Ra 226+228 Concentrations vs. Time



Well WMW5.58SI
Ra 226+228 Concentrations vs. Time



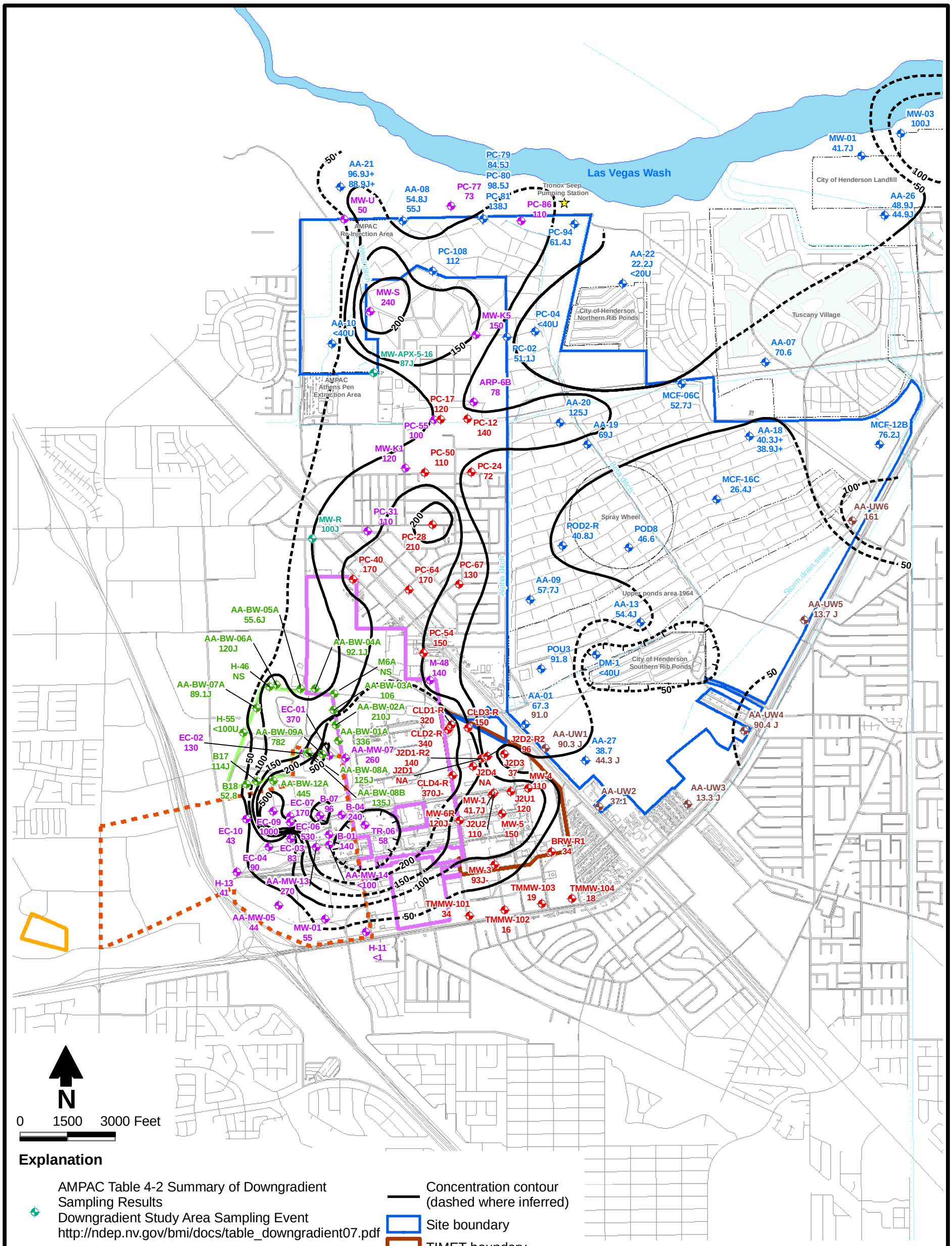
Appendix A
Time Series Plots
Eastside Shallow



Appendix C

2010 Plume Maps

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/ARSENIC_2006_2009_SHALLOW.MXD 013110



Explanation

- AMPAC Table 4-2 Summary of Downgradient Sampling Results Downgradient Study Area Sampling Event http://ndep.nv.gov/bmi/docs/table_downgradient07.pdf
- Reported results from BRC sampling 1st round April-June, 2006
- MWH Figure D-15 Arsenic in aluvial aquifer October-November 2007
- TIMET Figure 4-14 Arsenic in groundwater Spring 2006
- Second Quarter 2008 data (Companies Report dated 7/17/08)
- Data for proposed upgradient wells from 2009 sampling event

- Concentration contour (dashed where inferred)
- Site boundary
- TIMET boundary
- Tronox boundary
- AMPAC facility
- POSSM (The Companies)
- Las Vegas wash
- Streets
- Site AOC3 boundary

Note:
1. Values > MCL (10 µg/L)
2. NA = Not analyzed
3. NS = Not sampled
4. ND = Non detect
5. < = Non-detect at or above the reported concentration
6. For off-site wells, the screened zone is assumed to be shallow

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 4
Arsenic in the Shallow Zone (µg/L)
2006-2009

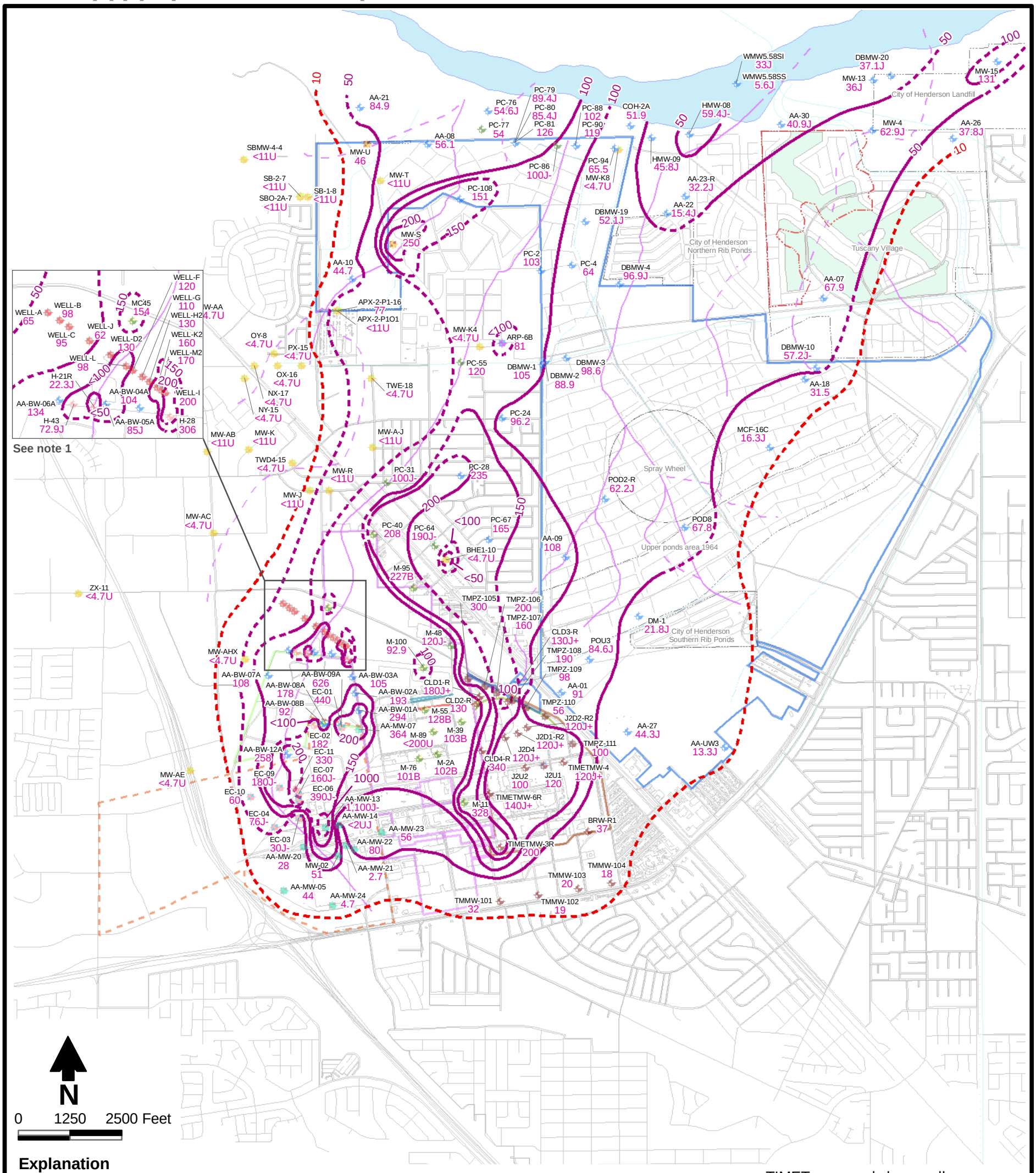
Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 1-13-10

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_Pre_CSM_tasks/GIS/MXDS/CHEMISTRY/ARSENIC_2006_SHALLOW.MXD 905011

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/MODEL LAYERS 2010/ARSENIC_LAYER1.MXD 017290



Explanation

Well Site - Date of Data

- AMPAC - 2004
- AMPAC - 2008
- BRC - 2008
- BRC - 2009
- Kerr-McGee - 2007
- Kerr-McGee - 2008
- Montrose - 2008
- Montrose - 2009
- OSM - 2008
- Stauffer - 2008
- Stauffer - 2009
- TIMET - 2006
- TIMET - 2007
- TIMET - 2008
- TIMET - 2009
- Tronox - 2008

M-11 / 328 — Monitoring well designation / Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- MCL = 10 ug/L
- BCL = 10 ug/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2008a; TIMET, 2008b; TIMET, 2010

Notes:

1. POSSM Groundwater Extraction/Air Stripping/Re-injection System.
2. Data from 2004 not used for contouring.
3. MCL = U.S. EPA Maximum Contaminant Level
4. BCL = Basic Comparison Level
5. MCL = 10 ug/L
6. BCL = 10 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

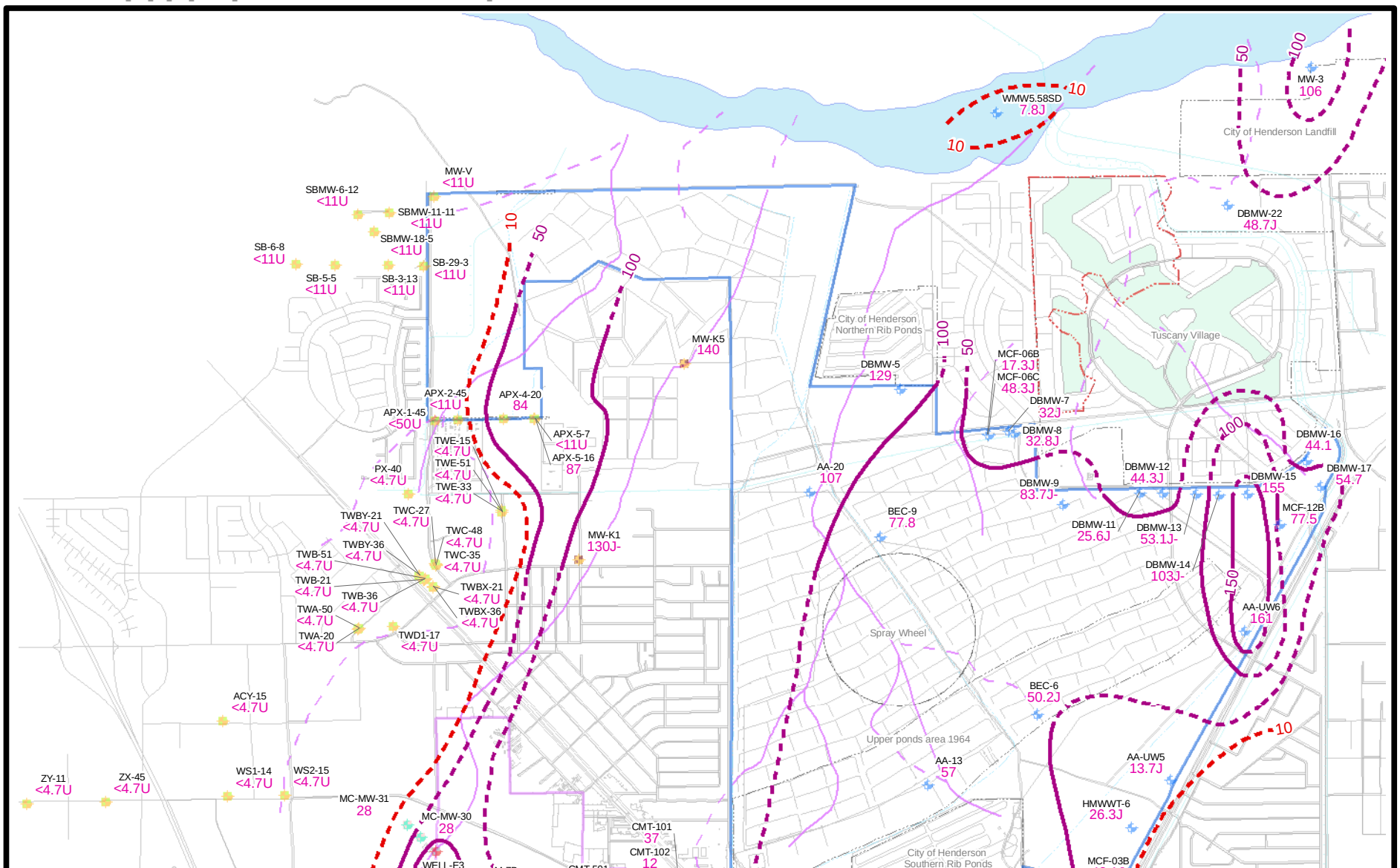
Arsenic
Shallow Zone Layer 1

Daniel B. Stephens & Associates, Inc.
Basic Remediation Company

Prepared by: DBS&A CRS
Date 09-27-10

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/Arsenic_LAYER1.MXD 016040

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/MODEL LAYERS 2010/ARSENIC_LAYER2.MXD 017290



Explanation

Well Site - Date of Data

- AMPAC - 2004
- AMPAC - 2008
- BRC - 2009
- Kerr-McGee - 2007
- Kerr-McGee - 2008
- Montrose - 2008
- Montrose - 2009
- OSM - 2008
- Olin - 2008
- Stauffer - 2009
- TIMET - 2008
- TIMET - 2009
- Tronox - 2009

M-13 / 51.6B — Monitoring well designation / Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- MCL = 10 ug/L
- BCL = 10 ug/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2008b; TIMET, 2010

Note:

1. MCL = U.S. EPA Maximum Contaminant Level
2. BCL = Basic Comparison Level
3. MCL = 10 ug/L
4. BCL = 10 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

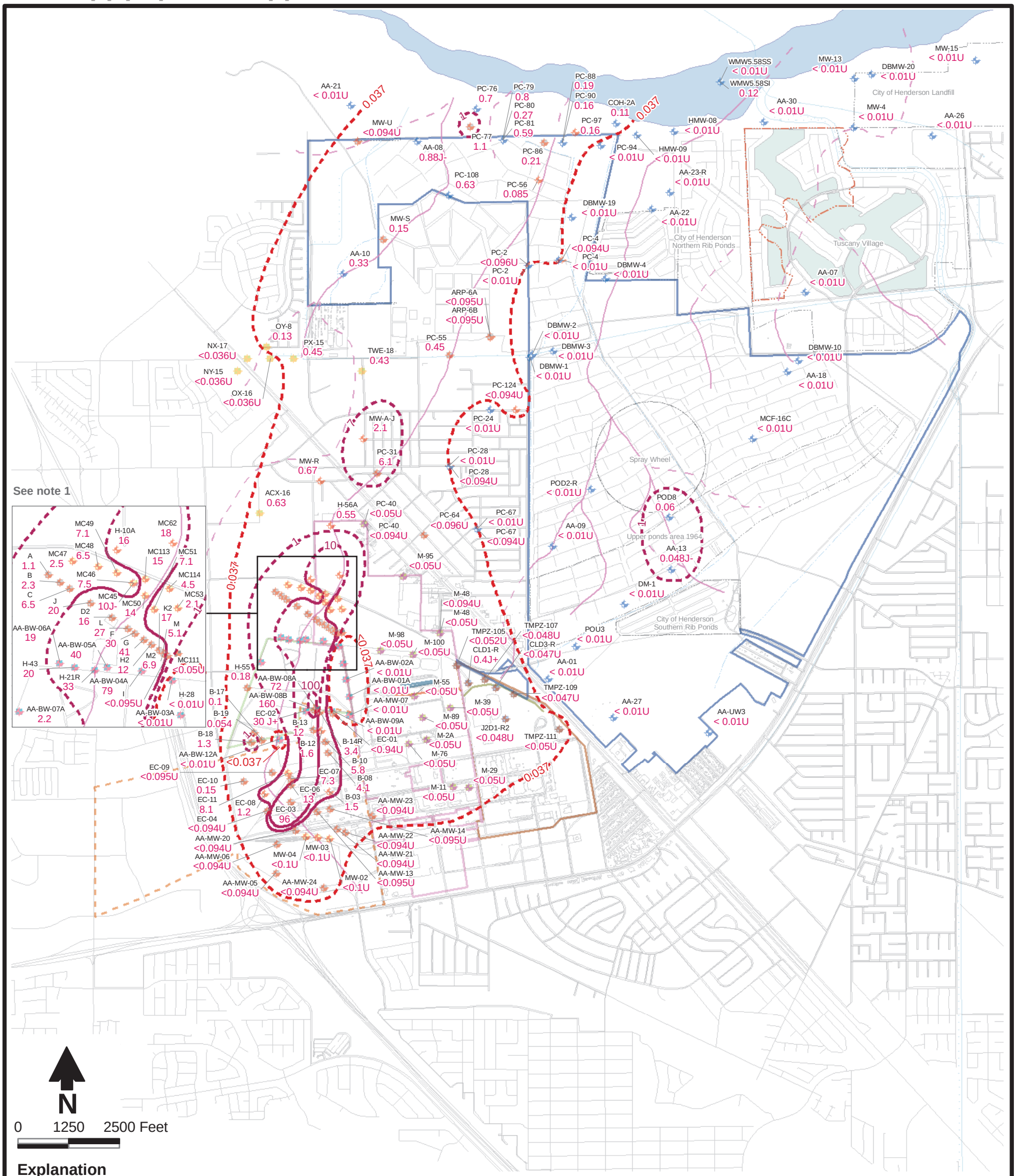
Arsenic
Shallow Zone Layer 2

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A CRS	09-27-10	S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/ARSENIC_LAYER2.MXD 016240

S:/PROJECTS/BRC/ES10.0136_BRC_MISC_EASTSIDE_TASKS/GIS/MXDS/CHEMISTRY/BETA_BHC_LAYER1.MXD 017290



Explanation

Well Site - Date of Data

- AMPAC - 2004
- BRC - 2009
- CAMU - 2009
- POSSOM - 2005
- POSSOM - 2006
- POSSOM - 2007
- POSSOM - 2008
- POSSOM - 2009
- TIMET - 2006
- TIMET - 2008
- Tronox - 2006

M-29 <0.05U — Monitoring well designation Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- BCL = 0.037 ug/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010

Notes:

1. POSSM Groundwater Extraction/Air Stripping/Re-injection System
2. This parameter has no MCL
3. MCL = U.S. EPA Maximum Contaminant Level
4. BCL = Basic Comparison Level
5. BCL = 0.037 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

Beta BHC
Shallow Zone Layer 1

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Basic Remediation COMPANY

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DBS&A CRS	09-27-10	S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/beta_BHC_LAYER1.MXD 019040

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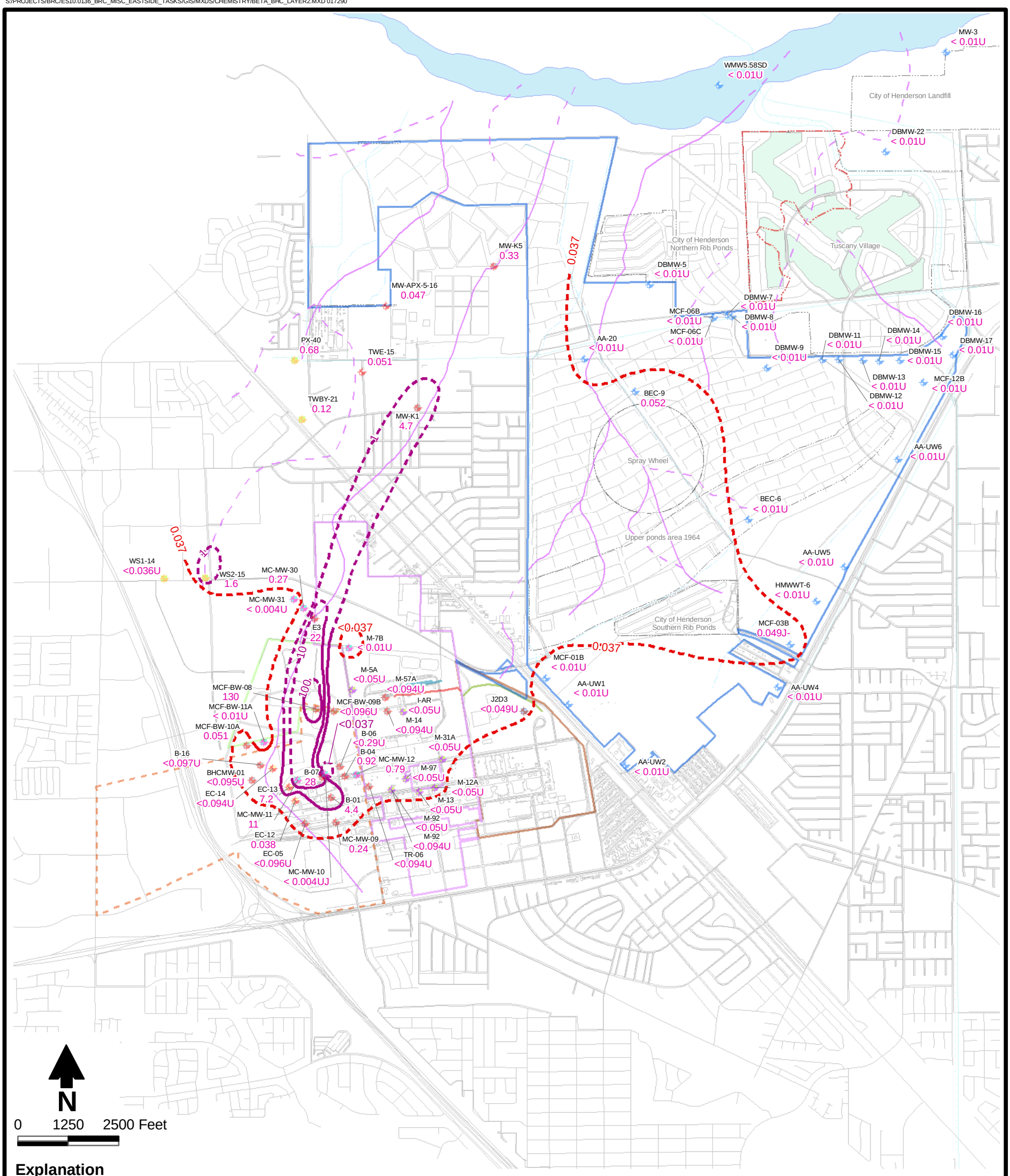

Explanation

Well Site - Date of Data

- AMPAC - 2004
- BRC - 2009
- CAMU - 2009
- POSSOM - 2006
- POSSOM - 2007
- POSSOM - 2008
- POSSOM - 2009
- TIMET - 2006
- Tronox - 2006

M-13 <0.05U — Monitoring well designation, Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- BCL = 0.037 ug/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010

Notes:

1. This parameter has no MCL
2. MCL = U.S. EPA Maximum Contaminant Level
3. BCL = Basic Comparison Level
4. BCL = 0.037 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

Beta BHC
Shallow Zone Layer 2

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by:	Date
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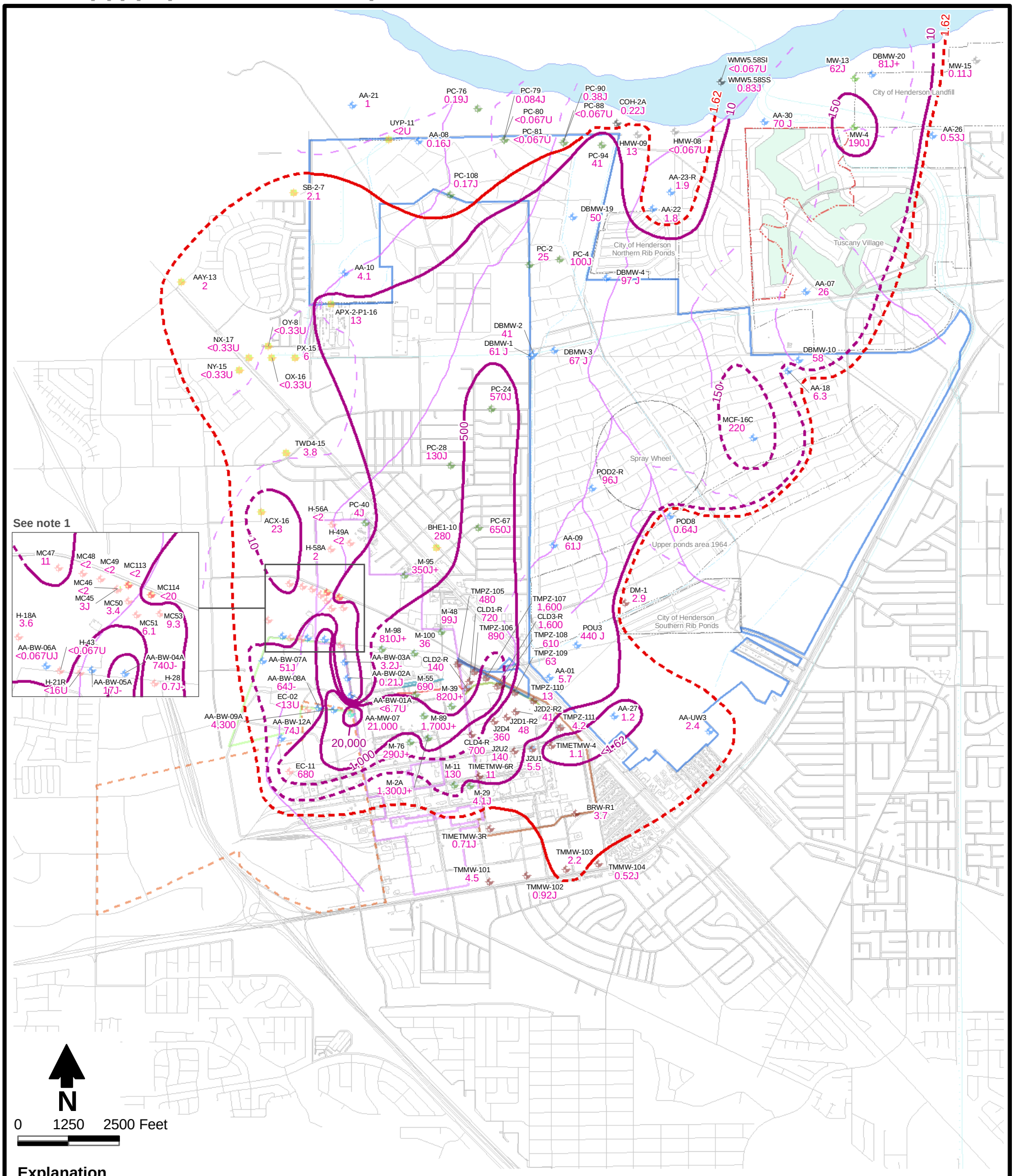
S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/beta_BHC_LAYER1.MXD 019040

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/MODEL LAYERS 2010/CHLOROFORM_LAYER1.MXD 017290



Explanation

Well Site - Date of Data

- Site not known - 2009
- AMPAC - 2004
- BRC - 2009
- City of Henderson - 2009
- Kerr-McGee - 2006
- Kerr-McGee - 2009
- Montrose - 2009
- OSM Companies - 2009
- SNWA - 2009
- Stauffer - 2006
- Stauffer - 2009
- TIMET - 2006
- TIMET - 2008
- TIMET - 2009

MW-02 3.7 Monitoring well designation Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- BCL = 1.62 ug/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2007; TIMET, 2008a; TIMET, 2008b; TIMET, 2010

Notes:

1. POSSM Groundwater Extraction/Air Stripping/Re-injection System
2. This parameter has no MCL
3. MCL = U.S. EPA Maximum Contaminant Level
4. BCL = Basic Comparison Level
5. BCL = 1.62 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

Chloroform
Shallow Zone Layer 1

Daniel B. Stephens & Associates, Inc.

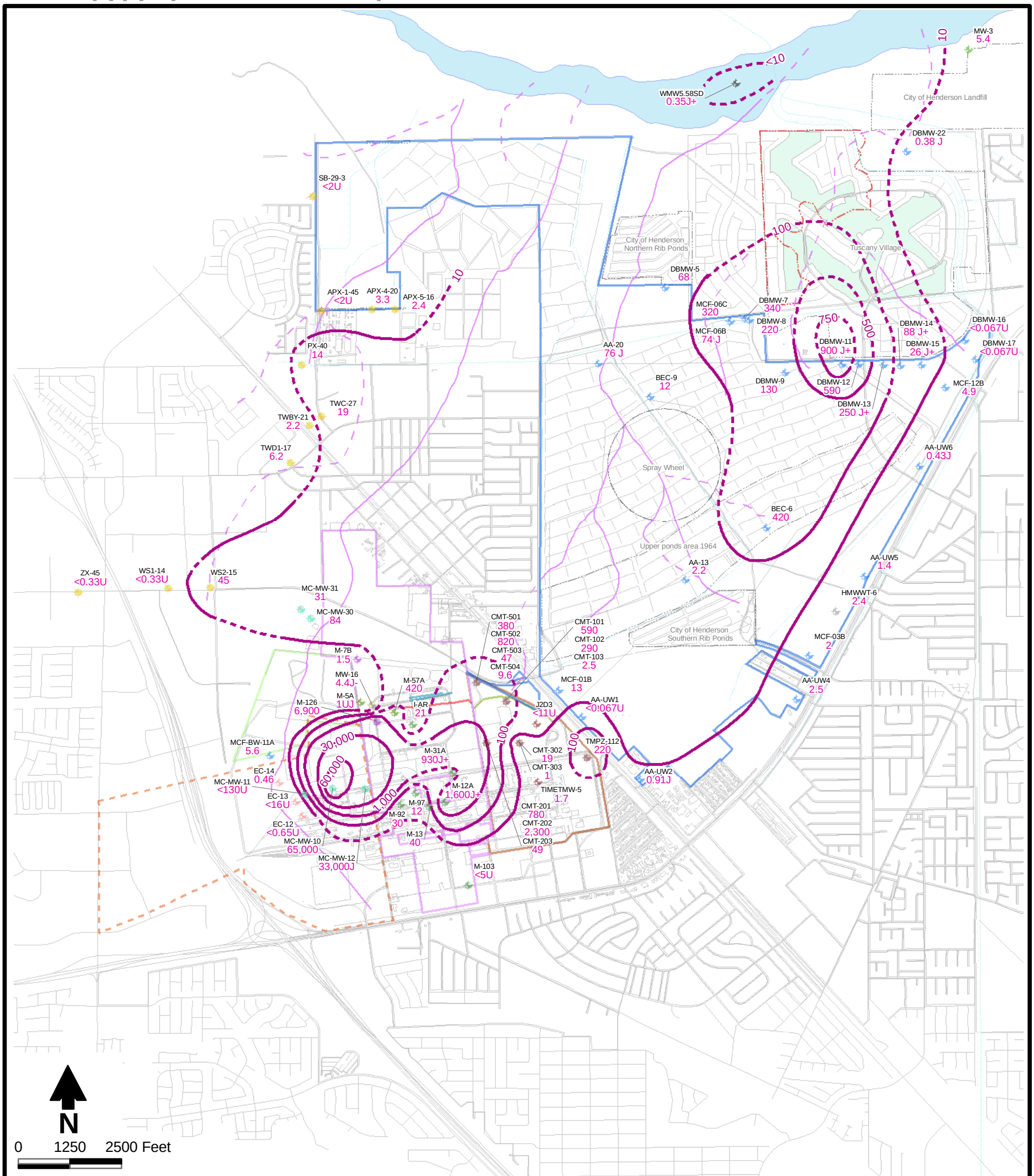
Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 09-27-10

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/CHLOROFORM_LAYER1.MXD 015050

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/MODEL LAYERS 2010/CHLOROFORM_LAYER2.MXD 017290



Explanation

Well Site - Date of Data

- Site not known - 2007
- Site not known - 2009
- AMPAC - 2004
- BRC - 2009
- City of Henderson - 2009
- Kerr-McGee - 2006
- Kerr-McGee - 2007
- Montrose - 2009
- SNWA - 2009
- Stauffer - 2009
- TIMET - 2008
- TIMET - 2009
- Tronox - 2007
- Tronox - 2009

EC-13
3
Monitoring well designation
Result (ug/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2008b; TIMET, 2010

Notes:

1. This parameter has no MCL
2. MCL = U.S. EPA Maximum Contaminant Level
3. BCL = Basic Comparison Level
4. BCL = 1.62 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

Chloroform
Shallow Zone Layer 2

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 09-27-10

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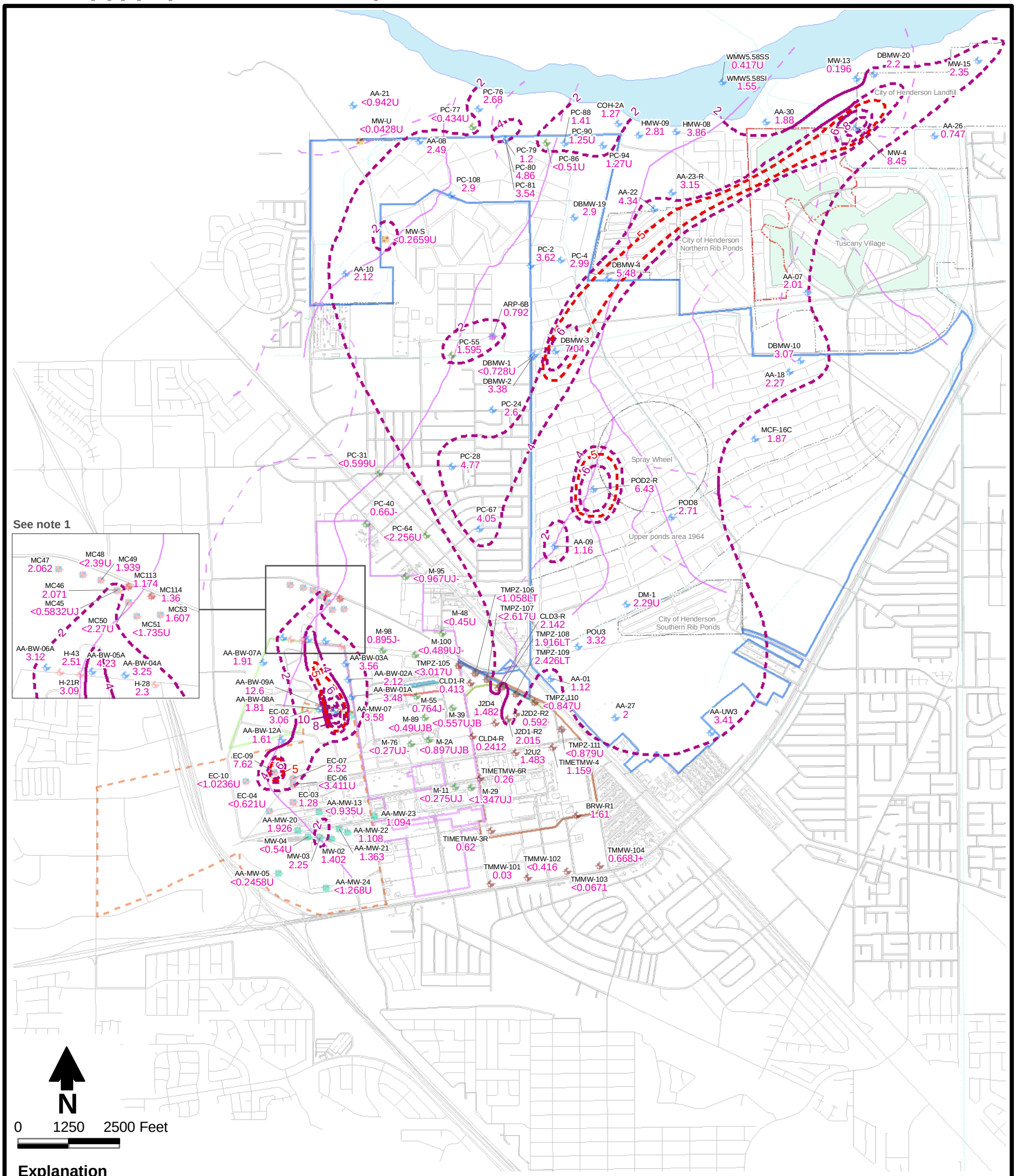
S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/MODEL LAYERS 2010/RADIUM226+228_LAYER1.MXD 017290



Explanation

Well Site - Date of Data

- AMPAC - 2008
- BRC - 2009
- Kerr-McGee - 2006
- Kerr-McGee - 2008
- Montrose - 2008
- Montrose - 2009
- OSM - 2008
- Stauffer - 2006
- Stauffer - 2008
- Stauffer - 2009
- TIMET - 2008
- TIMET - 2009
- Tronox - 2008

EC-07 2.52 — Monitoring well designation Result (pCi/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- MCL = 5 pCi/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2008a; TIMET, 2008b; TIMET, 2010

Notes:

1. POSSM Groundwater Extraction/Air Stripping/Re-injection System
2. This parameter has no BCL
3. MCL = U.S. EPA Maximum Contaminant Level
4. BCL = Basic Comparison Level
5. MCL = 5 pCi/L

BMI Common Areas (Eastside)
Henderson, Nevada

Radium 226+228
Shallow Zone Layer 1

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 09-27-10

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/RADIUM226+228_LAYER1.MXD 016040

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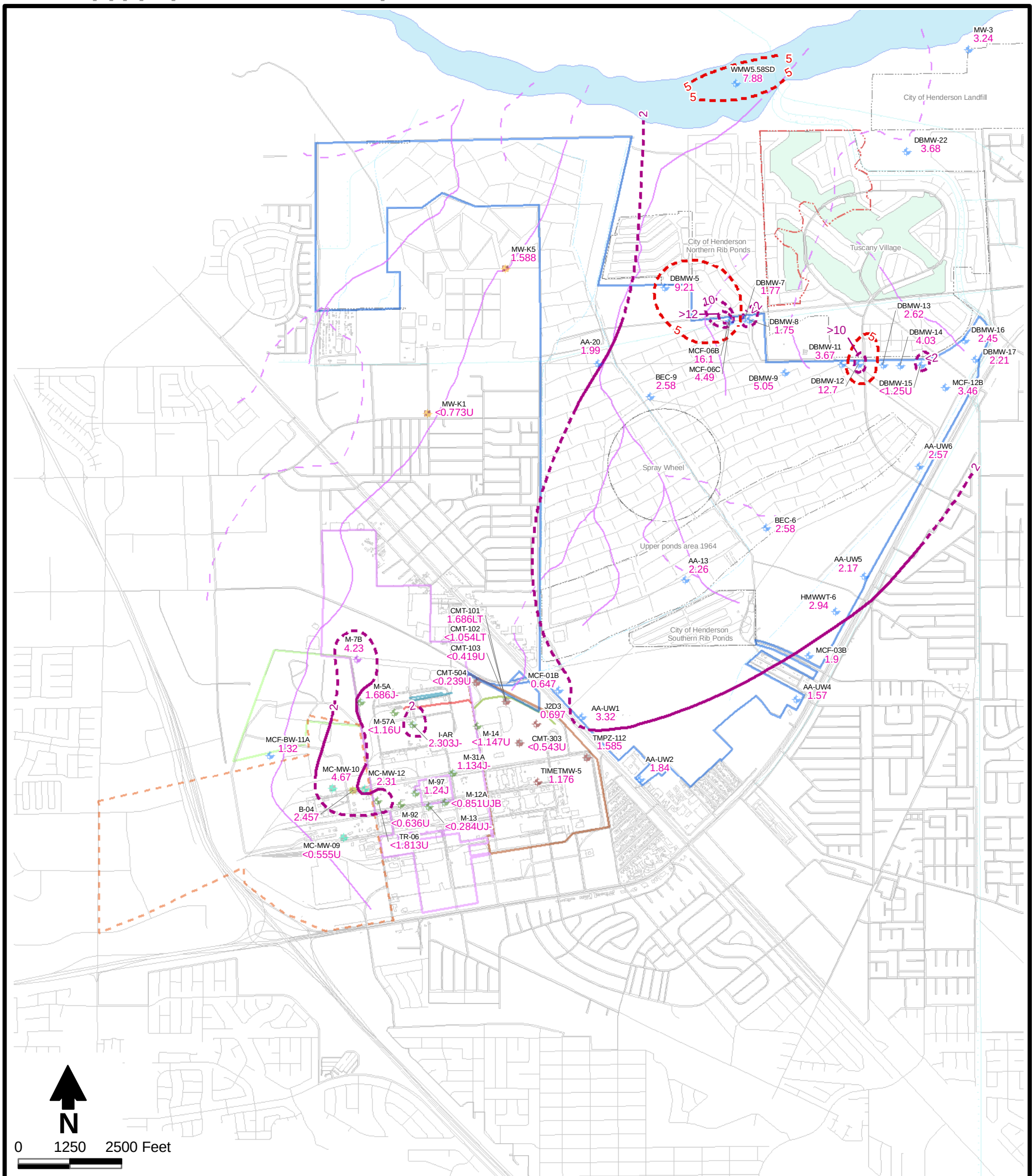

Explanation

Well Site - Date of Data

- AMPAC - 2008
- BRC - 2009
- Kerr-McGee - 2006
- Kerr-McGee - 2008
- Montrose - 2008
- Montrose - 2009
- Olin - 2008
- TIMET - 2008
- TIMET - 2009
- Tronox - 2009

M-10
620
Monitoring well designation
Result (pCi/L)

- Site boundary
- Gravel pit circa 1976. Source: Aerial photograph dated 1976
- TIMET boundary
- Tronox boundary
- POSSM (The Companies)
- Site AOC3 boundary
- Las Vegas Wash
- TIMET proposed slurry wall September 2008
- Tronox groundwater recharge trench
- Tronox slurry wall
- Street
- Concentration contour (dashed where inferred)
- Interpreted paleochannel location
- MCL = 5 pCi/L

References:

1. DBS&A, 2010b
2. BRC and ERM, 2010
3. NDEP, 2010
4. TIMET, 2008b; TIMET, 2010

Notes:

1. This parameter has no BCL
2. MCL = U.S. EPA Maximum Contaminant Level
3. BCL = Basic Comparison Level
4. MCL = 5 pCi/L

BMI Common Areas (Eastside)
Henderson, Nevada

Radium 226+228
Shallow Zone Layer 2

Daniel B. Stephens & Associates, Inc.

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 09-27-10

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/LAYER_MODEL/RADIUM226+228_LAYER2.MXD 016240