# 2015 Annual Monitoring Report
# Site 23 (PICA-065) Post Farm Landfill

## Picatinny Arsenal, New Jersey

***Prepared for***



***Prepared by***

**EA Engineering, Science, and Technology, Inc., PBC**
**Contract No. W91ZLK-13-D-0004-0009**

**March 2016**

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# Site 23 (PICA-065) Post Farm Landfill

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*Prepared by*

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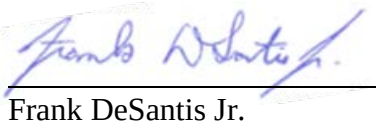
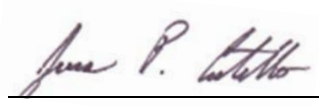


9 March 2016

Frank DeSantis Jr. — Date
Project Manager



9 March 2016

James Costello — Date
Deputy Program Manager

March 2016
EA Project No. 62686.09

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg/L | Micrograms per liter |
| ARCADIS | ARCADIS U.S., Inc. |
| DBA | Drum Burial Area |
| EA | EA Engineering, Science, and Technology, Inc., PBC |
| ft amsl | feet above mean sea level |
| NBA | Northern Burial Area |
| NJDEP | New Jersey Department of Environmental Protection |
| PICA | Picatinny Arsenal |
| RD | Remedial design |
| SCL | Site cleanup level |
| TAL | Target analyte list |
| USACE | United States Army Corps of Engineers |
| USAEC | United States Army Environmental Command |
| USEPA | United States Environmental Protection Agency |

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# 1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has been retained by the United States Army Environmental Command (USAEC) to perform Installation Restoration Program activities at Picatinny Arsenal (PICA), located in Morris County, New Jersey. This work is being performed under the Environmental Remediation Multiple Award Indefinite Delivery/Indefinite Quantity Contract W91ZLK-13-D-0004 Delivery Order 0009, and will be overseen by the USAEC and the United States Army Corps of Engineers (USACE), under approval by the New Jersey Department of Environmental Protection (NJDEP), and United States Environmental Protection Agency (USEPA) Region 2.

## 1.1 SITE BACKGROUND

PICA is a 5,853-acre government-operated munitions research and development facility located in Morris County, New Jersey, approximately 40 miles west of New York City and 4 miles northeast of Dover, New Jersey (**Figure 1**).

Site 23 (PICA-065) is approximately 10.3 acres in size and is located near the southern corner of PICA along the top of a ridge that forms the eastern boundary of the arsenal. The Site consists of the Drum Burial Area (DBA) located in the southern end of the Site, the Northern Burial Area (NBA), and the Central Borrow Pit, a cleared flat area located in the middle of the Site. Both the DBA and the NBA are landfilled areas and are currently surrounded by perimeter fencing. The Central Borrow Pit is open, and currently contains a linear mound of brush, debris, and fill dirt.

Environmental impacts at Site 23 (PICA-065) are associated with historical disposal of drummed industrial waste including caustic paint stripper, used hydraulic oils, wastewater from oil reservoirs, cleaning solvents, fly ash, and solid waste. The area surrounding the Site is currently used for recreational activities, primarily hunting.

## 1.2 SCOPE OF WORK

As stated in the Record of Decision (U.S. Army 2004), the selected response action for Site 23 (PICA-065) is long-term groundwater monitoring and implementation of land use controls. The long-term groundwater monitoring program for Site 23 (PICA-065), established in the Final Long-Term Monitoring Plan and Land Use Control Remedial Design (RD) (Shaw 2006), requires groundwater monitoring on the following schedule:

- Quarterly for a minimum of eight quarters
- Annually thereafter, if concentrations of analytes in any well have not increased or have remained consistent over a span of eight or more consecutive quarters.

In accordance with the RD (Shaw 2006), statistical assessments were conducted in 2007 and 2010 following 2 and 5 years of remedy implementation. Pursuant to the statistical assessment performed in 2007 as part of the Final 2007 Annual Monitoring Report (ARCADIS 2009) and the monitoring schedule specified in the RD (Shaw 2006); the long-term monitoring frequency

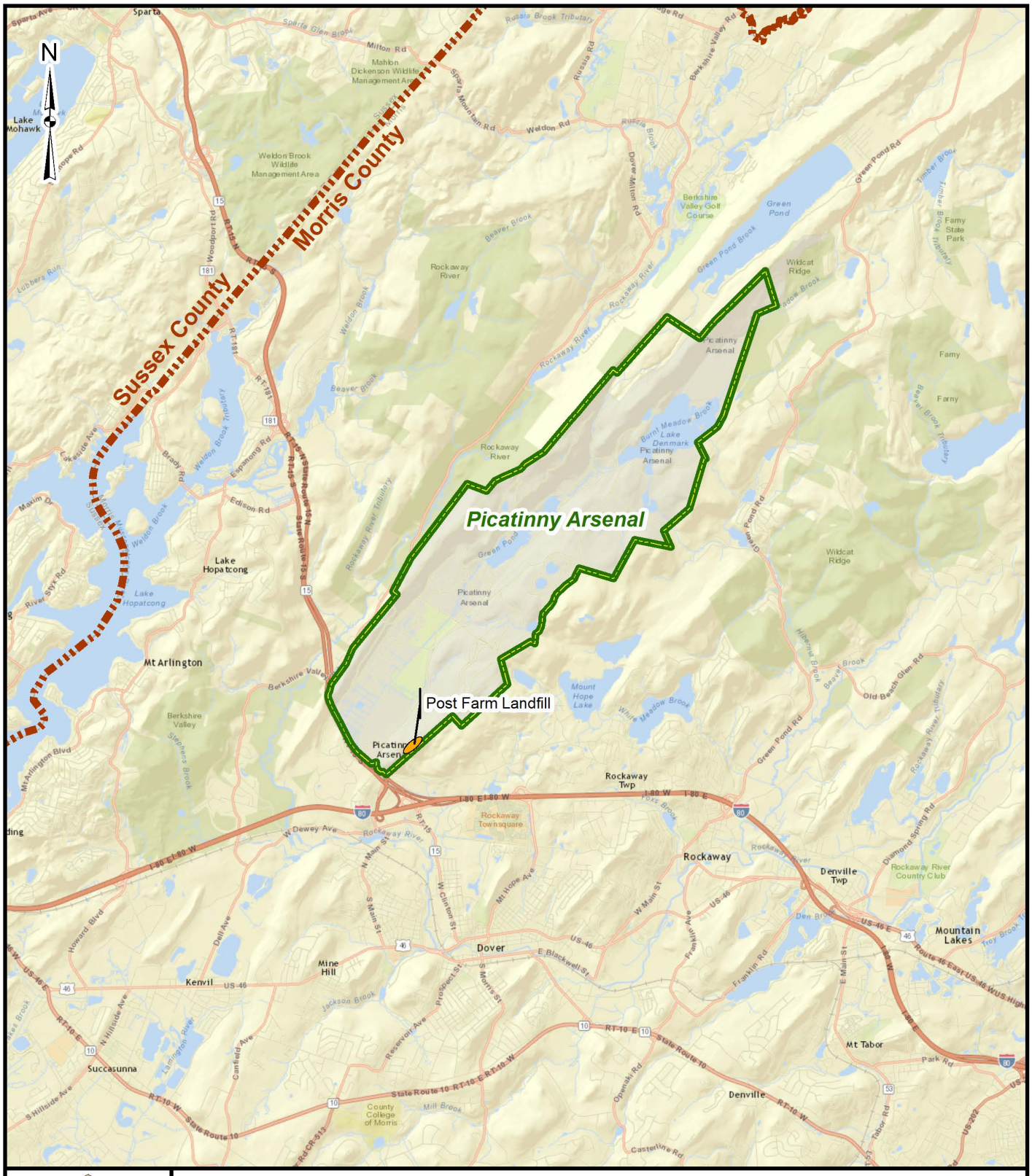
was reduced to annual sampling. Groundwater monitoring was conducted annually beginning in 2008 and continued through 2015.

Based on analytical results, the second statistical assessment conducted in 2010, and the conditions set forth in the exit strategy documented in the RD (Shaw 2006), the long-term monitoring program was reduced to include annual sampling at:

- C-DM23-03 for cadmium and field parameters
- C-MW-14[1] for target analyte list (TAL) metals and radiologicals
- Seep and spring locations (one of each) for *cis*-1,2-dichloroethene.

The long-term monitoring schedule for Site 23 (PICA-065) is presented in **Table 1**.

[1] In 2013, groundwater monitoring well C-MW23-1B replaced C-MW-14 due to C-MW-14 consistently being dry.

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2015 ANNUAL REPORT
SITE 23 - POST FARM LANDFILL (PICA-065)
PICATINNY ARSENAL

**Figure 1**
**Site Location Map**

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**Table 1**
**Monitoring Schedule**

| Calendar Year | | 2003 | | | | 2006 | 2007 | | | | 2008 | | | | 2009 | | | | 2010 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Operation Year | | First | | | | | Second | | | | Third | | | | Fourth | | | | Fifth | | | |
| Sample Date | | Jan-Mar | Apr-Jun | Jul-Sep | Oct-Dec | Apr-Jun | Jan-Mar | Apr-Jun | Jul-Sep | Oct-Dec | Jan-Mar | Apr-Jun | Jul-Sep | Oct-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec |
| Quarter (Calender) | | 1st | 2nd | 3rd | 4th | 2nd | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Sample ID | Media | | | | | | | | | | | | | | | | | | | | | |
| C-DM23-01 | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-DM23-02 | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | Cadmium and Radium-226 | NS | NS | NS | Cadmium and Radium-226 | NS | NS | NS | Cadmium and Radium-226 | NS |
| C-DM23-03 | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | Cadmium | NS | NS | NS | Cadmium | NS | NS | NS | Cadmium | NS |
| C-MW23-1B | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | gross beta | NS | NS | NS | gross beta | NS | NS | NS | gross beta | NS |
| C-MW23-4B | Groundwater | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | NS | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-MW23-5B | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-MW-14[1] | Groundwater | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | NS | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS |
| C-23-MW-001 | Groundwater | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-23-MW-002 | Groundwater | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-23-MW-003 | Groundwater | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals, VOCs | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-23-MW-004 | Groundwater | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals, VOCs | TAL Metals, Radiologicals | NS | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | TAL Metals, Radiologicals | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS | NS | NS | Radium-226 | NS |
| C-MW23-1B[2] | Groundwater | -- | -- | -- | -- | | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Seep | Surface Water | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS |
| Spring | Surface Water | TAL Metals, Radiologicals, VOCs | NS | NS | VOCs | VOCs | NS | NS | NS | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS |

Notes:

[1]C-MW-14 is historically dry, therefore no samples have been collected; monitoring well C-MW23-1B replaced this location in

[2]C-MW23-1B has been added to the monitoring regimen to replace C-MW-14 during the 2013 calendar year

= Completed

= Planned

cis-1,2-DCE - cis-1,2-dichloroethene
NS - Not sampled
TAL - Target analyte list
VOCs - Volatile organic compounds
TAL Metals by United States Environmental Protection Agency (USEPA) SW-846 Method 3010A/6010B and 7470A
Radiologicals (gross alpha and gross beta) by USEPA 900.0
Radiologicals (Alpha Spectroscopy Radioisotopes) by USEPA 901.1, 903.0, 904.0 and 908.0
Radiologicals (Gamma Spectroscopy Radioisotopes) by USEPA 901.1 (modified)
VOCs by USEPA SW-846 Method 5030B/8260B

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**Table 1**
**Monitoring Schedule**

| Calendar Year | | 2011 | | | | 2012 | | | | 2013 | | | | 2014 | | | | 2015 | | | | 2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Operation Year | | Sixth | | | | Seventh | | | | Eighth | | | | Ninth | | | | Tenth | | | | Eleventh | | | |
| Sample Date | | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec | Jan-Mar | Apr-Jun | Jul-Aug | Sep-Dec |
| Quarter (Calender) | | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Sample ID | Media | | | | | | | | | | | | | | | | | | | | | | | | |
| C-DM23-01 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-DM23-02 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-DM23-03 | Groundwater | NS | NS | Cadmium | NS | NS | NS | Cadmium | NS | NS | NS | NS | Cadmium | NS | NS | Cadmium | NS | NS | NS | Cadmium | NS | NS | NS | Cadmium | NS |
| C-MW23-1B | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-MW23-4B | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-MW23-5B | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-MW-14[1] | Groundwater | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS |
| C-23-MW-001 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-23-MW-002 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-23-MW-003 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-23-MW-004 | Groundwater | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C-MW23-1B[2] | Groundwater | -- | -- | -- | -- | -- | -- | -- | -- | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS | NS | NS | TAL Metals, Radiologicals | NS |
| Seep | Surface Water | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | NS | cis-1,2-DCE | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS |
| Spring | Surface Water | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | NS | cis-1,2-DCE | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS | NS | NS | cis-1,2-DCE | NS |

Notes:
[1]C-MW-14 is historically dry, therefore no samples have been collected; monitoring well C-MW23-1B
[2]C-MW23-1B has been added to the monitoring regimen to replace C-MW-14 during the 2013
= Completed
= Planned
cis-1,2-DCE - cis-1,2-dichloroethene
NS - Not sampled
TAL - Target analyte list
VOCs - Volatile organic compounds
TAL Metals by United States Environmental Protection Agency (USEPA) SW-846 Method
Radiologicals (gross alpha and gross beta) by USEPA 900.0
Radiologicals (Alpha Spectroscopy Radioisotopes) by USEPA 901.1, 903.0, 904.0 and 908.0
Radiologicals (Gamma Spectroscopy Radioisotopes) by USEPA 901.1 (modified)
VOCs by USEPA SW-846 Method 5030B/8260B

# 2. SAMPLING ACTIVITIES

This section summarizes the long-term monitoring activities conducted as part of the 2015 sampling event. Field forms are provided as **Appendix A**.

## 2.1 GROUNDWATER DEPTH MEASUREMENTS

Water levels and the depths of wells in the monitoring well network, consisting of ten wells, were measured on 21 September 2015. The groundwater elevations for the September 2015 sampling event are presented in **Table 2** and a groundwater elevation contour map is provided as **Figure 2**.

**Table 2 Well Specification and Groundwater Elevation Summary**

| Well ID | Well Diameter (inches) | Aquifer | Measuring Point Elevation (ft amsl) | Screen Interval (ft amsl) | 9/21/2015 | |
|---|---|---|---|---|---|---|
| | | | | | DTW (ft bmp) | GWE (ft amsl) |
| C-DM23-01 | 4 | Bedrock | 853.26 | 826.26 - 816.26 | 20.02 | 833.24 |
| C-DM23-02 | 4 | Bedrock | 838.84 | 805.84 - 795.84 | 39.25 | 799.59 |
| C-DM23-03 | 4 | Bedrock | 880.58 | 845.58 - 835.58 | 39.87 | 840.71 |
| C-MW23-1B | 4 | Bedrock | 852.14 | 824.14 - 814.14 | 12.77 | 839.37 |
| C-MW23-4B | 4 | Bedrock | 832.56 | 794.56 - 784.56 | 35.85 | 796.71 |
| C-MW23-5B | 4 | Bedrock | 837.85 | 819.85 - 809.85 | 21.51 | 816.34 |
| C-MW-14 | 4 | Overburden | 852.03 | --- | DRY | DRY |
| C-23-MW-001* | 4 | Bedrock | 813.57 | 774.67 - 764.67 | NM | NM |
| C-23-MW-002 | 4 | Bedrock | 814.78 | 785.78 - 775.78 | NM | NM |
| C-23-MW-004 | 4 | Bedrock | 836.00 | 793.50 - 783.50 | 23.70 | 812.30 |

**Notes:**
* - Measuring point elevation estimated.
--- - not available
DTW - depth to water
ft bmp - feet below measuring point
ft amsl - feet above mean sea level
GWE - groundwater elevation
NM – Not measured

## 2.2 GROUNDWATER AND SURFACE WATER SAMPLING

The 2015 annual groundwater monitoring event consisted of collecting groundwater samples at C-DM23-03 and C-MW23-1B. Due to dry well conditions observed at C-MW-14 since 2008, C-MW23-1B replaced C-MW-14 in the sampling regime in 2013 (ARCADIS 2014). Monitoring well C-MW23-1B was selected to represent the data gap at C-MW-14, as it is the nearest well hydraulically down gradient of C-MW-14.

Groundwater samples were collected on 21 September 2015. Groundwater samples were collected using the low flow sampling method and were submitted to Accutest Laboratories of New England, located in Marlborough, Massachusetts, for analysis of TAL metals and cadmium by USEPA Method 6020/6010 and radiologicals Gross Alpha/Beta & Radium-226 by methods

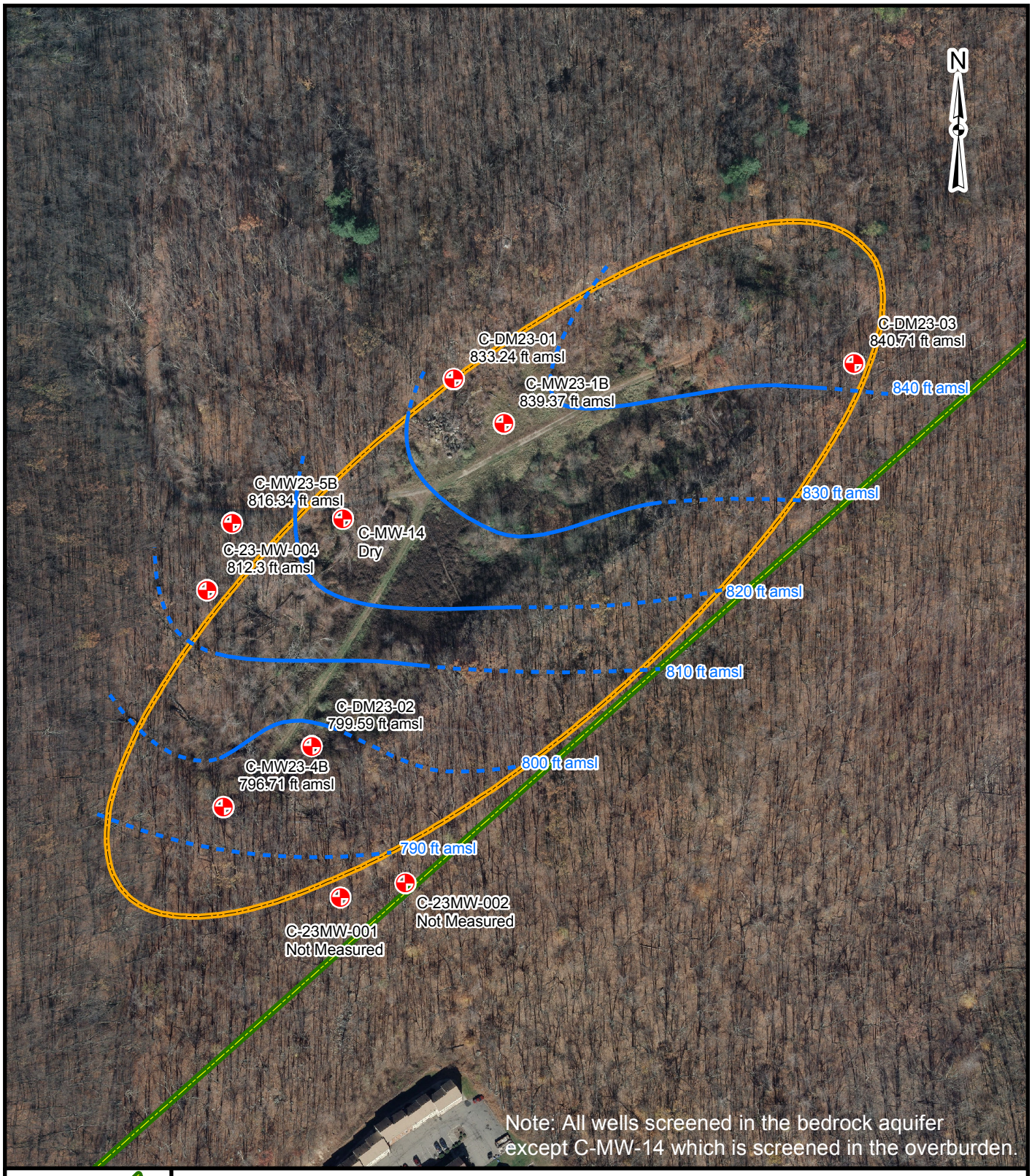
E900 & E903.1, respectively. The following water quality parameters were also measured using a handheld multi-parameter instrument: pH, specific conductance, temperature, dissolved oxygen, and oxidation reduction potential.

The following scheduled activities were not conducted during 2015:

- Seep and spring sampling for *cis*-1,2-dichloroethene. The seep and spring samples were not collected as no seeping of groundwater and no surface water was observed in the areas depicted on the Site map. Based on a review of historical analytical data for the seep and spring locations, samples have only been collected in these locations during the first and fourth quarters of 2003, and the second quarter of 2006.

## 2.3 DATA VALIDATION AND USABILITY

All data collected were third party validated in accordance with the U.S. Environmental USEPA National Functional Guideline for Organic Data Review, dated August 2014. The validation criteria for long-term monitoring data include a review of the laboratory report narrative for noted deficiencies and the potential impact to data usability. Therefore, a review of chain-of-custodies, sample preservation, sample receipt logs, and a review of quality control parameters were performed for all data packages. No major deficiencies were identified during the data validation; therefore, no additional review was performed. A copy of the Data Validation Report is included with **Appendix B**.




Installation Boundary

Post Farm Landfill (PICA-065)

Groundwater Elevation Contour

Inferred Groundwater Elevation Contour

Groundwater Monitoring Well

0 300

Feet

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SITE 23 - POST FARM LANDFILL (PICA-065)
PICATINNY ARSENAL

**Figure 2**
**Groundwater Elevation Contour Map**

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# 3. LONG-TERM MONITORING RESULTS

Results from the 2015 groundwater sampling event are summarized below. Groundwater monitoring well locations and 2015 sample results are presented on Figure 3. Laboratory analytical reports and Data Validation reports are provided in **Appendix B**.

## 3.1 GROUNDWATER ELEVATIONS

Historical groundwater elevation data indicate that groundwater flows generally to the southwest. Groundwater elevations collected in September 2015 ranged from 840.71 feet above mean sea level (ft amsl) at C-DM23-03 to 796.71 ft amsl at C-MW23-4B. Depth to groundwater measurements and corresponding groundwater elevations are provided in Table 2 and groundwater contours are provided on **Figure 2**.

## 3.2 GROUNDWATER MONITORING RESULTS

Cadmium was detected in C-DM23-03 at a concentration of 6.0 micrograms per liter (µg/L), which is greater than the site cleanup level (SCL) of 4 µg/L. Historical concentrations of cadmium at C-DM23-03 are provided in Table 3. Cadmium was not detected at the upgradient well, C-MW23-1B. Additionally, there were no exceedances of the SCL for TAL metals or radiological analytes in the groundwater sample collected from monitoring well C-MW23-1B. Groundwater quality parameters for the sampling event are provided in **Table 3**.

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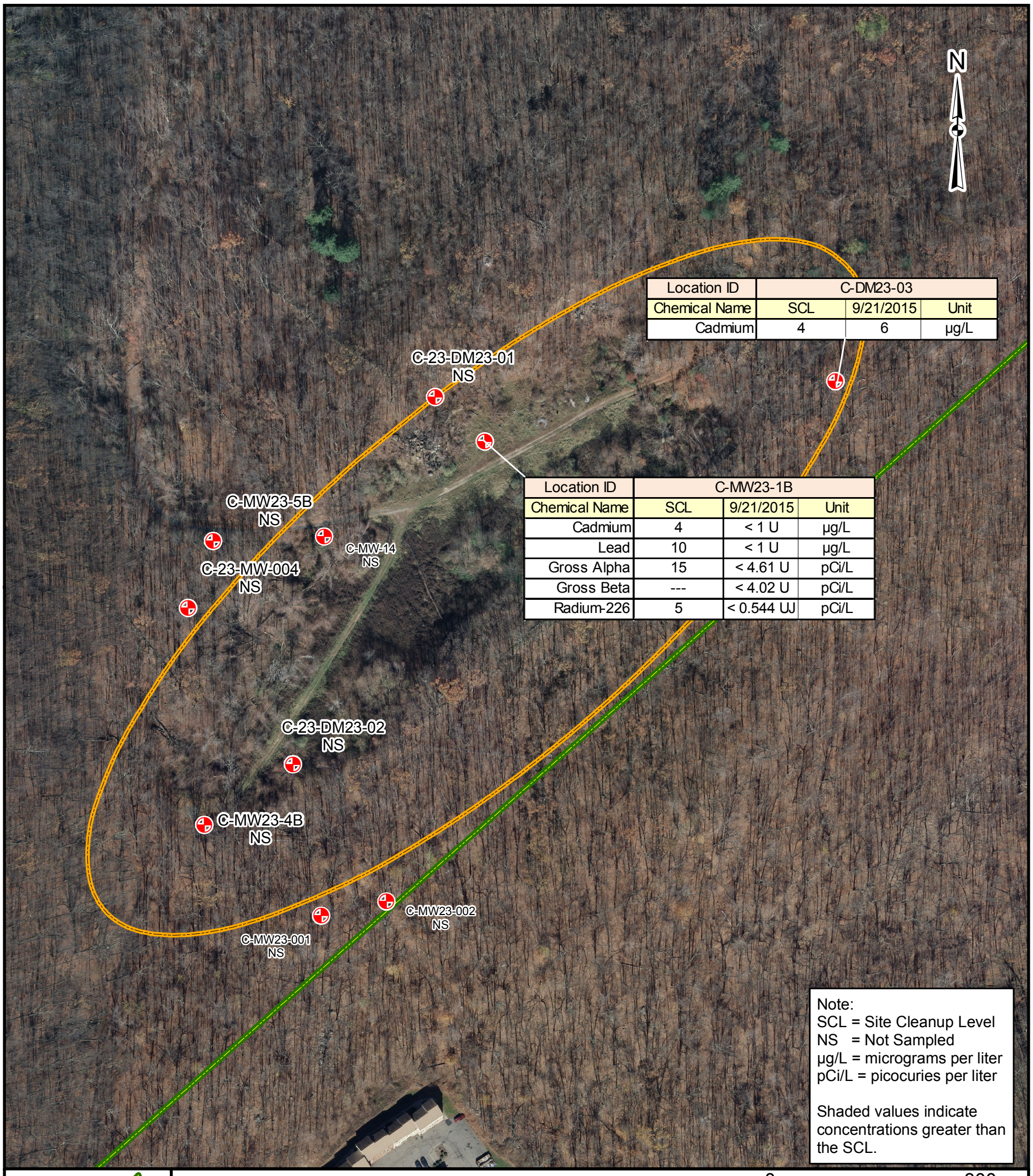


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SITE 23 - POST FARM LANDFILL (PICA-065)
PICATINNY ARSENAL

**Figure 3**
**Groundwater Concentration Map**

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**Table 3 Groundwater Monitoring Results**

| | | | | Location ID | C-DM23-03 | | | | | | | | C-MW23-1B | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample Date | 10/21/2008 | 11/18/2009 | 10/8/2010 | 9/9/2011 | 9/11/2012 | 1/8/2014[1] | 7/8/2014 | 9/21/2015 | 11/18/2013[2] | 7/8/2014[2] | 9/21/2015 |
| | NJDEP SWQC | Units | PICA 065 SCLs | | | | | | | | | | | | |
| **COCs** | | | | | | | | | | | | | | | |
| Aluminum | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 100 U | 100 U | 25 U |
| Arsenic | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 5 U | 5 U | 2 U |
| Barium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 14.5 | 12.3 | 11.6 |
| Beryllium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 5 U | 5 U | 0.5 U |
| Cadmium | 120 | µg/L | 4 | | **4.15 J** | **4.79 J** | **4.72 J** | **7.35 J** | **5.88** | 0.518 J | **5.61 J** | **6.00** | 10 U | 10 U | 1 U |
| Calcium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 15300 | 14700 | 14800 |
| Chromium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 10 U | 10 U | 4 U |
| Cobalt | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 10 U | 10 U | 0.5 U |
| Copper | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 10 U | 10 U | 4 U |
| Iron | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 81 | 202 | 25 U |
| Lead | | µg/L | 10 | | NS | NS | NS | NS | NS | NS | NS | NS | 5 U | 5 U | 1 U |
| Magnesium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 6000 | 5050 | 5180 |
| Manganese | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 5 | 6.33 J | 3.9 J |
| Nickel | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 20 U | 20 U | 2 U |
| Potassium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 1580 | 1510 | 1470 |
| Silver | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 5 | 5 | 1 U |
| Sodium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 7070 | 5960 | 5890 |
| Vanadium | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 7.77 | 7.77 | 10 U |
| Zinc | | µg/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 10 U | 10 U | 5 U |
| Gross Alpha | | pCi/L | 15 | | NS | NS | NS | NS | NS | NS | NS | NS | 0.383 U | 0.323 U | 4.61 U |
| Gross Beta | | pCi/L | -- | | NS | NS | NS | NS | NS | NS | NS | NS | 1.42 U | 2.86 U | 4.02 U |
| Radium-226 | | pCi/L | 5 | | NS | NS | NS | NS | NS | NS | NS | NS | 1.52 | 1.13 | < 0.544 UJ |
| **Water Quality Field Parameters** | | | | | | | | | | | | | | | |
| Dissolved Oxygen | | mg/l | --- | | 8.22 | 9.63 | 9.62 | 0.23 | 8.74 | 9.86 | 0.32 | 4.1 | 6.55 | 1.28 | 1.64 |
| Oxidation Reduction Potential | | mV | --- | | 130.7 | -234.3 | 222.5 | 266 | 256 | 99.5 | 241 | 279 | 158.9 | 201.7 | 294 |
| pH | | S.U. | --- | | 5.51 | 5.06 | 5.57 | 5.05 | 4.99 | 9.55 | 5.65 | 5 | 6.62 | 5.84 | 5.57 |
| Turbidity | | n.t.u | --- | | 0 | 1.69 | 0.14 | 2.72 | 1.6 | 0 | 22 | 29.4 | 0 | 39.8 | 0.63 |
| Specific Conductance | | $mScm^{-1}$ | --- | | 0.266 | 0.163 | 0.186 | 0.201 | 0.190 | 0.151 | 0.228 | 0.18 | 0.149 | 0.166 | 0.14 |
| Temperature | | °C | --- | | 11.34 | 15.25 | 10.46 | 11.55 | 8.33 | 9.58 | 12.35 | 11.74 | 13.43 | 13.59 | 15.21 |

**Notes:**

[1]C-DM23-3 was inadvertently not sampled during the 2013 calendar year; therefore a sample was collected January 2014 to provide as near a representative 2013 sample; this location was sampled

[2]Analytical results in the 2013 and 2014 Annual Reports were presented as being in micrograms per liter; however the concentrations were in milligrams per liter.

Values exceeding the applicable screening criterion are boldfaced and shaded.

"---" - not applicable

°C - degrees Celsius

pCi/L - picocuries per liter

µg/l - microgram per liter

cfs - cubic feet per second

COCs - constituents of concern

mg/l - milligram per liter

$mScm^{-1}$ - milliSieman per centimeter

$mSm^{-1}$ - milliSieman per meter

mV - millivolt

n.t.u - nephelometric turbidity units

S.U. - standard units

J - Indicates an estimated result.

U - Indicates analyte was analyzed but not detected

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# 4. EVALUATION OF DATA TRENDS

A cadmium trend plot and Mann-Kendall trend analysis performed on C-DM23-03 are provided within **Appendix C**. Cadmium concentrations have generally been stable with minor fluctuations since the start of long-term monitoring. Results of the Mann-Kendall trend analysis did not identify a significant increasing or decreasing trend (**Appendix C**). There was a notable decline in cadmium concentrations in the groundwater sample collected at C-DM23-03 in January 2014 (0.518 µg/L). In July 2014 and September 2015, concentrations of cadmium returned to concentrations consistent with historical results. Although cadmium was detected at a concentration greater than the SCL of 4.0 µg/L in annual groundwater samples collected at C-DM23-03 from 2008 through 2012 and in 2014, the concentrations of cadmium have not exceeded the historical maximum concentration (7.8 µg/L) detected during the first quarterly sampling event (5 February 2003). Furthermore, it should be noted that the trigger value for cadmium, as specified in the RD, is 18.7 µg/L. Based on review of data collected to date, cadmium concentrations in C-DM23-03 are not expected to exceed the trigger value.

In 2013, groundwater monitoring well C-MW23-1B replaced C-MW-14 due to C-MW-14 consistently being dry. No exceedances for TAL metals or radiologicals have been observed through three annual sampling events. Eight data points have not been established for C-MW23-1B, and therefore a trend plot cannot be developed.

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# 5. REMEDY PERFORMANCE AND FUTURE ACTIONS

At the start of long-term monitoring (first quarter 2003) there were 11 groundwater monitoring wells included in the long-term monitoring regimen. Based upon the results of the statistical analysis conducted in 2007 and 2010, nine of the eleven wells were removed from the groundwater sampling program. The Record of Decision did not specify a specific remedial timeframe for the long-term monitoring component of this remedy. However, the results of the 2010 statistical analysis indicated a majority (9 of 11) of the groundwater wells had observed sustained declines in constituent of concern concentrations and warranted removal from the long-term monitoring program. The duration and frequency of monitoring (greater or lesser) is subject to change based upon evaluation of the data collected and agreement by USEPA and the NJDEP. The long-term monitoring schedule is provided in **Table 1**. A flow chart depicting the long-term groundwater monitoring exit strategy is presented on **Figure 4**.

In accordance with the exit strategy, a statistical analysis (Mann-Kendell) of long-term monitoring data is required at five year intervals. The results of this analysis are presented in Appendix C. The analytical results for cadmium at C-DM23-03 from the previous eight sampling events (21 October 2008 through 21 September 2015) were analyzed using the Mann-Kendall test. The results are used to determine whether the concentrations of an analyte in a well have or have not increased. The results of the Mann-Kendall test indicate that there is no trend.

The annual sampling results and the statistical analysis were evaluated against the following conditions and are presented in **Table 4**:

- Condition A: Removal of wells/analytes from monitoring based on consistent observation of concentrations less than SCLs.

- Condition B: Continue annual monitoring if constituent concentrations at a sampling point are “consistent” over eight or more consecutive periods.

- Condition C: Investigate more aggressive remedial alternatives if constituent concentrations for two consecutive periods are greater than the “trigger” value for cadmium (18.7 µg/L) and concentrations are increasing at one or more sampling points. Statistically significant increases will be determined using the Mann-Kendell test during the five year statistical assessment.

Concentrations of cadmium in C-DM-23-03 were greater than SCLs and remain stable as no statistical trend was observed using the Mann-Kendall test. Concentrations of cadmium have not been observed to be greater than the trigger value. As a result, the recommendation is to continue annual sampling with no revisions to the long-term monitoring program for this location.

TAL metals and radiologicals have not been observed in C-MW23-1B through three annual sampling events. As a result, the recommendation is to remove C-MW23-1B from the long term monitoring program as it meets Condition A and concentrations of COCs are less than SCLs.

Future monitoring at C-DM23-03 will continue annually in accordance with the exit strategy detailed in the RD (Shaw 2006) and the results of the statistical assessment.

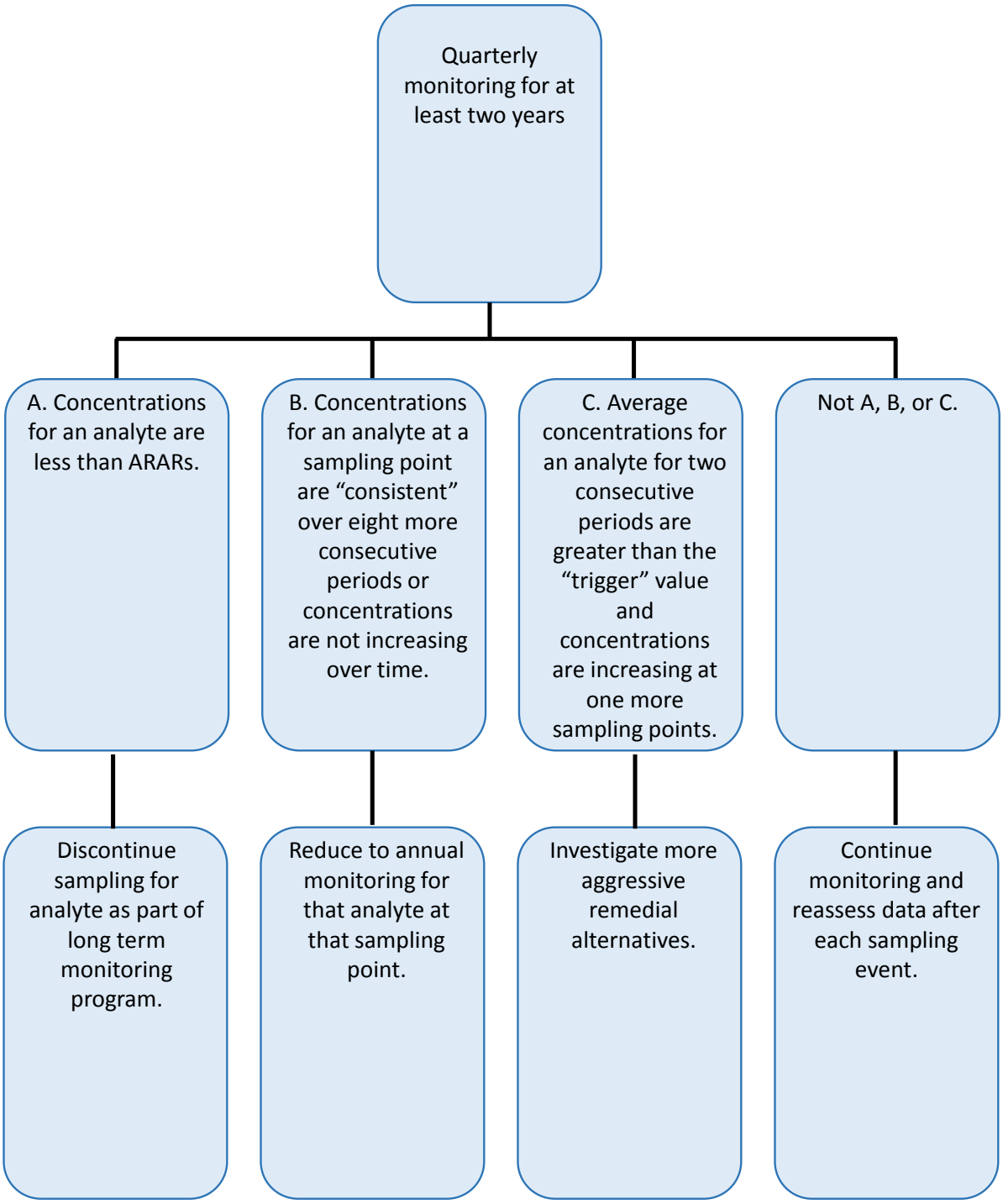


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**Figure 4**
**Long-Term Groundwater Monitoring Flow Chart**

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**Table 4 Exit Strategy Analysis**

| Well | Media | Current LTM Program | Condition A | | Condition B | | Condition C | | LTM Program Revision | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Measurement for Analyte are Above ARARs | If Yes, which Analyte? | Measurements for Analyte at a Sampling Point are Consistent Over Eight or More Periods or Are Not Increasing | If Increasing, which Analytes? | Average Concentration for Analyte for Two Consecutive Periods are Above "Trigger Value" | If Yes, which Analyte? | | |
| C-DM23-03 | Groundwater | TAL Metals | Yes | Cadmium | No trend | -- | No | -- | No Change | Sampled annually |
| C-MW23-1B | Groundwater | TAL Metals | No | -- | NA[2] | -- | | | Remove from Program | Condition A (no ARAR exceedances) |
| | | Radiologicals | No | -- | | | | | Remove from Program | Condition A (no ARAR exceedances) |
| Seep | Surface Water | VOCs | ND | -- | -- | -- | | | No Change | Area will continue to be inspected and sampled, if located |
| Spring | Surface Water | VOCs | No[1] | -- | -- | -- | | | No Change | Area will continue to be inspected and sampled, if located |

**Notes:**
1. Based on three sample events conducted prior to 2012.
2. Trend was not able to be determined due to lack of data sets.
ARAR - Applicable or Relevant and Appropriate Requirement
LTM - Long Term Monitoring
ND - No data

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# 6. REFERENCES

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