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LIST OF ACRONYMS AND ABBREVIATIONS

AE	Architect–Engineer
Bgs	below ground surface
DOT	Department of Transportation
DO	Dissolved Oxygen
FS	Feasibility Study
ID	interior diameter
LOC	Level of Concern
MTBE	Methyl Tert-Butyl Ether
MAG	Mid-Atlantic Geosciences
ml/min	milliliters per minute
NJDEP	New Jersey Department of Environmental Protection
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
Shaw	Shaw Environmental & Infrastructure
TICs	Tentatively Identified Compounds
TCE	Trichloroethene
µg/L	Micrograms per Liter
USACE	U.S. Corps. of Engineers
USEPA	U.S. Environmental Protection Agency
UXO	Unexploded Ordnance
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION AND SCOPE OF WORK

1.1 OVERVIEW

This *600 Area MTBE Investigation Data Report* presents the results of field work and sampling that were conducted in the 600 Area to investigate methyl tertiary butyl ether (MTBE) detections in groundwater and surface water at Site 11 at Picatinny Arsenal, Rockaway Township, New Jersey. Site 11 is located in the northwestern portion of the 600 Area and is part of the larger 600 Area groundwater operable unit. The 600 Area site and building locations are depicted on **Figure 1**. Shaw Environmental & Infrastructure (Shaw) was tasked by the United States Army Corps of Engineers (USACE) Baltimore District to conduct the investigation and prepare this Data Report as proposed in the *600 Area MTBE Work Plan* (Shaw, 2009a), which was approved by the New Jersey Department of Environmental Protection (NJDEP) in 2009. This work is being performed under the Architect-Engineer (AE) contract number W912DR-05-D-0026, Delivery Order 6.

In 2006, exceedances of the level of concern (LOC) for MTBE were detected in groundwater samples collected from well 13MW-5 in Site 11 during sampling conducted as part of the 600 Area Data Report/Feasibility Study (FS, Shaw, 2010). MTBE was also detected in downstream and sidegradient surface water samples collected from 2004 to 2008. The 600 Area FS focused on groundwater and surface water contamination derived from Site 12, and the MTBE groundwater exceedances were not addressed further in the FS. Further investigation and sampling of Site 11 was proposed in the 600 Area MTBE Work Plan, which was intended to further delineate and monitor MTBE concentrations in groundwater and surface water. Suspected MTBE sources include past gasoline spills at Site 11 ranges.

It should be noted that this report is intended to focus on MTBE impacts to groundwater and surface water at Site 11; additional data collected during field sampling as part of the 600 Area FS investigation in April and May 2010 will be presented in the 600 Area FS Addendum.

1.2 SITE DESCRIPTION AND HISTORY

The Building 649 Area consists of a small elongate bulldozed and graded fill area that extends north from the site entrance at Bear Swamp Road to the base of an unnamed stream. The stream drains the Building 650 Area Pond and test site and flows southwest to a wetland located adjacent to the Building 647 Area. The Building 649 test area was used to test small portable munitions and consists of a rusted quench tank, various test stands, armored plates, and test plates. The Building 649 Area features are depicted on **Figure 2**.

Evaluation of facility aerial photographs in the United States Environmental Protection Agency (USEPA) Installation Assessment (USEPA, 1989) and other stereo photographs show an undeveloped site area in 1951; with initial Building 649 Area development and activity in 1962. A 1970 aerial photograph shows further expansion of the test area to the north toward the unnamed stream. Operations at that range ceased in 2000. Bedrock well 13MW-5 was installed in the Building 649 Area in 2006 as part of the 600 Area Groundwater Investigation.

The southern portion of the Building 650 Area consists of a bulldozed and graded fill material with scattered vegetation and a forested perimeter. A small pond drains offsite to the west via a pipe that runs under the site and discharges into a stream that flows behind the Building 649 Area. This is the active test area of the site, and included Building 650, various test stands, armor plate shields, target plates, and the burn pad. The range is primarily used for static detonation of munitions and Department of Transportation (DOT) hazard classification tests on propellants, fuses, and pyrotechnics. The DOT hazard classification test involves heating the propellant canisters or other test items rapidly over an oven filled with a small amount of gasoline. The Building 650 Area burn pad is depicted in **Figure 2**.

Evaluation of facility aerial photographs show an undeveloped Building 650 Area with wetlands in 1951, with initial site development and activity in 1962. The 1962 aerial photograph shows a clearly defined test area and burn pad, and presence of a pond in the former wetland area. A 1970 aerial photograph shows further expansion of the test area to the west and north. A cement burn pad and cage was constructed in 2006 at the test site as an interim remedial measure to

minimize the potential for gasoline contact with site soils. Bedrock monitoring wells 13MW-9 was installed in the Building 650 Area (near the burn pad) in 2006 as part of the 600 Area Groundwater Investigation. Bedrock monitoring well 13MW-12 was installed in 2008 near the pond as part of the 600 Area RDX Groundwater Investigation (Shaw, 2009b).

1.3 PHYSICAL SETTING

Site 11 is located in the northwestern portion of the 600 Area and is part of the larger 600 Area groundwater operable unit. The 600 Area operable unit is characterized by a trichloroethene (TCE) groundwater plume which is addressed in a separate FS. The 600 Area site and building locations are depicted on **Figure 1**. A small pond lies at the head of the Site 11 drainage, and discharges to a small perennial stream throughout the year. The pond is probably spring fed from the bedrock aquifer. The stream flows approximately 250 feet southwest to a small wetland, where it is routed under Bear Swamp Road to Picatinny Lake. The stream gains considerable flow between the pond discharge and stream discharge point, and likewise, is probably spring fed. The Pond watershed is approximately 12 acres, and consists mainly of steep wooded hillside with extensive outcrops and shallow soils.

The 600 area is bisected by northeast–southwest trending geologic structures (fold and faults) which form a series of wetlands and ponds along their trace. These features are seasonal groundwater discharge zones, and form the headwaters (springs) for a number of 600 Area ponds and streams, including the Site 11 Pond. Groundwater flow ranges from south to southwest in Site 11, and generally follows the hillside topography. There is no unconsolidated aquifer in the study area, and all wells are installed in bedrock.

1.4 PREVIOUS SITE 11 SAMPLING RESULTS

Site 11 MTBE groundwater data was collected as part of the 600 Area FS and is summarized in **Figure 3**. Two MTBE groundwater LOC exceedances were detected at well 13MW-5 in July 2006 [130 micrograms per liter (µg/l)] and October 2006 (140 µg/l). The LOC for MTBE is 70 µg/l. MTBE was also detected at 13MW-5 in sampling conducted in March 2007 (51 µg/l), June 2007 (35 µg/l), October 2007 (21 µg/l), and July 2008 (10 µg/l). MTBE was not detected in nearby sidegradient bedrock wells 13MW-9 and 13MW-11. Low concentrations of MTBE were detected at wells 13MW-3 and 13MW-4, but may be derived from a source in Site 12.

Low concentrations of toluene were also detected at wells 13MW-4 and 13MW-6 at various times from 2005 to 2008. Additional volatile organic compounds (VOCs) detected in several of the area wells are being addressed in separate investigations within the 600 Area.

Site 11 surface water sampling data was collected as part of the 600 Area Investigation and are summarized in **Figure 4**. MTBE was detected at surface water sample location 13SW-6 in January 2006 at a concentration of 3.9 µg/l. The LOC for MTBE is 70 µg/l. Low concentrations of MTBE were also detected at 13SW-6 during sampling in October 2007 (0.39J µg/l) and June 2008 (0.22J µg/l) and upstream sample location 11SW-3 in November 2004 (0.98J µg/l), June 2007 (0.41J µg/l), October 2007 (1.7 µg/l), and June 2008 (1.2 µg/l). MTBE was not detected in the 650 Area pond (11SW-1), but was detected at downstream sample location 11SW-2 in November 2004 (0.36J µg/l) and January 2006 (1.8 µg/l). Four rounds of samples were not collected at 11SW-2 due to dry conditions. MTBE was not detected in sediment samples collected at the Site 11 sample locations.

Low concentrations of toluene were also detected at surface water sampling location 11SW-1 in August 2006 (0.22J µg/l) and June 2008 (0.23J µg/l) and at 11SW-3 in November 2004 (1.2 µg/l). Additional VOCs detected in surface water samples collected in the area are being addressed in separate investigations within the 600 Area.

1.5 MTBE FIELD INVESTIGATION SCOPE OF WORK

The MTBE Field Investigation and Data Report scope of work is addressed in the *600 Area MTBE Work Plan* (Shaw, 2009a). The MTBE field investigation was conducted in a number of sequential steps which are summarized as follows:

- Installation of shallow bedrock monitoring well 13MW-13 at the entrance to the Building 649 Area;
- Measurement of water levels in 12 existing wells and the newly installed bedrock well;
- Collection of groundwater samples from six existing wells and the newly installed bedrock well for VOCs plus 10 tentatively identified compounds (VOCs + TICs) and MTBE; and
- Collection of one round of surface water samples at locations 11SW-1, 11SW-2, 11SW-3, 13SW-6, and 11SW-10.

It should be noted that this report is intended to focus on MTBE impacts to groundwater and surface water at Site 11; additional data collected during field sampling as part of the 600 Area FS investigation in April and May 2010 will be presented in the 600 Area FS Addendum.

2.0 RESULTS OF THE 600 AREA MTBE INVESTIGATION

2.1 BEDROCK MONITORING WELL INSTALLATION

Bedrock well 13MW-13 was installed in December 2009 at the entrance for the Building 649 Test Area downgradient from well 13MW-5 to measure deep groundwater quality, specifically MTBE plume migration from potential upgradient sources. The well location is depicted on **Figure 2**. There is no overburden groundwater aquifer in the study area and bedrock was generally encountered at less than two feet during well drilling and soil sampling activities.

Prior to drilling, all drill rig work areas were investigated for shallow unexploded ordnance (UXO) by a certified UXO technician using a Schonstedt magnetic locator. The well location was marked in advance of drilling, and was hand dug and checked for UXO using a Schonstedt locator until refusal at eight inches bgs. The borehole was then checked in two feet increments until the drill bit advanced a minimum 10 feet into weathered bedrock.

Well 13MW-13 was installed by B&B Drilling using the air rotary method. A Shaw geologist logged the boring and provided technical oversight of all drilling activities. Drilling of well 13MW-13 began on December 10, 2009, with advancement of a 10 inch interior diameter (ID) borehole to 18.0 feet below ground surface (bgs). Weathered conglomerate bedrock was encountered at 2.5 feet bgs at well 13MW-13. A six inch ID steel casing was installed and pressure tremie grouted to the borehole and allowed to cure overnight. The boring for 13MW-13 was further advanced on December 11, 2009 using a 5 7/8 inch diameter bit, and encountered possible water-bearing fractures at 170 and 172 feet bgs. The borehole was advanced to a total depth of approximately 179 feet bgs. At this time, the well was not completed in order to perform a geophysical survey on the well to accurately determine water-bearing fractures for optimal screen placement. Polyvinyl chloride (PVC) casing was placed into the open borehole and covered with a well cap.

On February 4, 2010 Mid-Atlantic Geosciences (MAG) performed a geophysical survey of the borehole for well 13MW-13 to locate and characterize fractures and potential water-bearing zones intersecting the boring. MAG conducted Fluid Temperature, Fluid Conductivity, Natural Gamma, 3-Arm Caliper, Acoustic Televiewer, Short and Long Resistivity, Single Point Resistance, and Heat Pulse Flowmeter logging in the well to evaluate the fractures. The survey identified the total depth of the boring as 178.4 feet bgs, the depth to water as 27.9 feet bgs, the diameter of the casing to be six inches, and the bottom of the casing at approximately 18.5 feet bgs. The logging indicated a significant open, water-bearing fracture at 170 feet bgs. The well geophysical report is provided in **Appendix A**.

Subsequent to receipt and evaluation of the geophysics results, well 13MW-13 was completed by B&B Drilling on April 7, 2010. The well was constructed with a 20.0 feet length of two inch ID PVC 10 slot screen, which was installed from 156 to 176 feet bgs. Morie #1 filter sand was installed from the well screen base at 176 feet bgs to 153.5 feet bgs, and was topped by a 0.5 foot interval of Morie #000 filter sand. The well annular space was grouted to the surface with a bentonite-cement grout and the riser pipe was cut two feet above grade. A 6.5 inch ID protective casing was placed over the six inch steel casing and the top of this casing was set four inches above the top of inner PVC casing. The well pad was then constructed at grade and the well was completed with a well identification tag and well plug with lock. The Shaw well boring log and NJDEP well permit are provided in **Appendix B**.

The completed well was developed on April 8, 2010 by overpumping with a decontaminated submersible pump to remove fine grain sediment from the well. Development was monitored to record the total discharge volume and record groundwater parameters (pH, conductivity, turbidity, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), water level, and turbidity) using a calibrated YSI multimeter with a flow-through cell. A total of 99 gallons was pumped from the well during development; the purge water measured a final turbidity of 0.0 nephelometric turbidity units (NTU). The well development log is provided in **Appendix C**.

The completed well was surveyed by Volosin Associates, a New Jersey-licensed surveyor. The latitude and longitude of the wells were referenced to the New Jersey State Plane North American Datum of 1983 (NAD 83) in feet (to nearest 10 feet) and by geographic coordinates (to 1/10 of a second). The surveyor also determined the elevation of top of inner casing (TIC) and grade to within one hundredth of a foot referenced to the North American Vertical Datum of 1988 (NAVD 88). The TIC measurement point was marked with a permanent marker by the surveyor for use as a water level measuring point. A copy of the Monitoring Well Certification Form B is located in **Appendix B**.

2.2 WATER LEVEL MEASUREMENT AND GROUNDWATER FLOW

A round of synoptic water levels was taken on May 12, 2010 at 12 existing 600 Area wells and the newly installed well 13MW-13. A groundwater elevation contour map was prepared from the data and is shown in **Figure 5**. Groundwater flow in the Site 11 MTBE study area is toward the south-southwest and loosely follows hillside topography. Measured water levels are near or at the surface at wells 13MW-9 and 13MW-12, and the Site 11 pond and upper portions of the stream are believed to be spring fed.

2.3 INVESTIGATION SAMPLING RESULTS

2.3.1 Groundwater Sampling Results

Groundwater sampling was conducted at six existing bedrock monitoring wells and the newly installed bedrock well (13MW-13) located at Site 11 in April 2010. The sampled well locations are depicted on **Figure 1**.

All wells were purged and sampled using USEPA low flow methodology and utilized dedicated (in well) Teflon-lined tubing and a decontaminated Grundfos® submersible pump. The Grundfos® pump was installed at the approximate midpoint of each bedrock well screen and adjacent to water bearing fracture(s). Groundwater parameters (temperature, pH, conductivity, ORP, DO, turbidity and water level) were measured every five minutes during purging using a calibrated YSI 6280 multimeter and electronic water level indicator, and were recorded on well purge data sheets (**Appendix C**). A pumping rate of 300 milliliters per minute (ml/min) or less was maintained during purging. Upon parameter stabilization, the flow-through cell and multimeter were disconnected, and samples were collected. The pumping rate was maintained during sampling.

Groundwater samples were shipped to Empirical Laboratories, LLC (NJDEP Certified Laboratory #TN473) in Nashville, Tennessee for VOCs + TICs and MTBE analysis using USEPA Method 8260B.

Six VOCs were detected in one or more of the groundwater samples collected. Of these, only TCE exceeded the groundwater LOC. TCE was detected in the samples collected from well 13MW-4 (8.64 µg/l) and well 13MW-11 (24.7 µg/l), both exceeding the groundwater LOC of 1.0 µg/l. The detection of TCE above the LOC in these groundwater samples is consistent with historical results and is likely associated with historical operations at Site 12 and will be addressed in the 600 Area FS Addendum.

MTBE was detected in the samples collected from well 13MW-5 (including duplicate sample 13MW-5 DUP) at concentrations of 7.26 µg/l and 6.96 µg/l, respectively. MTBE was detected in the sample collected from well 13MW-13 at a concentration of 3.65 µg/l. These detections of MTBE are well below the groundwater LOC of 70 µg/l. When compared to historical results, MTBE has decreased substantially in well 13MW-5 and was detected at an even lower concentration at the newly installed, nearby downgradient, deep bedrock well, 13MW-13.

Groundwater sampling results are summarized in **Table 1 and Figure 3**. The other wells included in **Table 1** were sampled in May 2010 as part of the 600 Area FS investigation. The results for other wells will be evaluated in the 600 Area FS Addendum. Analytical results are included as **Appendix D**.

2.3.2 Surface Water Sampling Results

Surface water samples were collected at locations 11SW-1, 11SW-2, 11SW-3, 13SW-6, and new sample location 11SW-10 in April 2010. The surface water sample locations are depicted on **Figure 4**. Surface water parameters (temperature, pH, conductivity, ORP, DO, and turbidity) were measured prior to sampling using a calibrated YSI 6820 multimeter. Surface water samples were collected using a dedicated open sample container and transferred to a labeled sample bottle for shipment to the laboratory. Surface water samples were shipped to Empirical Laboratories, LLC in Nashville, Tennessee for VOCs + TICs and MTBE analysis using USEPA Method 8260B.

Two VOCs were detected in one or more surface water samples collected. Of these, only TCE exceeded the surface water LOC. TCE was detected in surface water sample 11SW-3 at a concentration of 4.22 µg/l, which is above the surface water LOC of 1.0 µg/l. The detection of TCE above the LOC in this surface water sample is consistent with historical results and is likely associated with the historical operations at Site 12 and will be addressed in the 600 Area FS Addendum.

MTBE was not detected in the surface water samples collected for this investigation. Surface water sampling results are summarized in **Table 2 and Figure 4**. The other surface water samples included in **Table 2** were sampled in May 2010 as part of the 600 Area FS investigation. The results for the other surface water samples will be evaluated in the 600 Area FS Addendum.

2.3.3 Results of QA/QC Sampling

Quality Assurance/Quality Control (QA/QC) sampling was conducted as part of the groundwater and surface water sampling program. Two field rinsate blanks (GW041910R1 and GW042010R1) were collected of the Grundfos® groundwater sampling pumps. One duplicate field sample was collected from each sampling media to demonstrate data reproducibility. One laboratory trip blank (GW041910T1) accompanied field samples throughout the sampling event and during shipment to the laboratory. All rinsate, duplicate, and trip QA/QC samples were analyzed for VOCs + TICs and MTBE using USEPA Method 8260B.

Results of the QA/QC rinsate and trip QA/QC samples are presented in **Table 3**. Common laboratory contaminants (e.g., acetone, chloroform, methylene chloride) and minimal concentrations of other VOCs were detected in the QA/QC samples. Target analytes, MTBE and TCE, were not detected in the blank samples. Results of the duplicate sample analyses are presented by media in **Tables 1 and 2**.

3.0 CONCLUSIONS

1. MTBE was only detected in two of seven wells sampled during April 2010 as a part of this investigation. MTBE was detected at concentrations well below the MTBE groundwater LOC (70 µg/l). When compared to historical results, MTBE has decreased substantially in well 13MW-5 from a maximum of 140 µg/l in October 2006 to the current concentration of 7.11 µg/l (average of samples 13MW-5 [7.26 µg/l] and its duplicate 13MW-5 DUP [6.96 µg/l]). From October 2006, there have been five sampling events at 13MW-5 over the course of four years. During these five consecutive sampling events, the MTBE level at 13MW-5 has been below the LOC. MTBE was detected at an even lower concentration at the newly installed, nearby downgradient, deep bedrock well, 13MW-13 (3.65 µg/l). MTBE was not detected in sidegradient wells 13MW-9 and 13MW-11. Low concentrations of MTBE have been historically detected at well 13MW-4, but were not detected during April 2010 sampling. MTBE was not detected in downgradient well 13MW-6.

2. MTBE was not detected in surface water samples collected during this investigation and has not been detected above the applicable LOC (70 µg/l) in any of the surface water samples historically. The highest historical MTBE surface water detection was at sample location 13SW-6 where a concentration of 3.9 µg/l was detected in January 2006. Concentrations of MTBE have decreased at this surface water sampling location since January 2006 to not being detected currently. There are no indications of residual MTBE impacts to 600 Area surface water.

3. Detections of TCE in groundwater and surface water samples above applicable LOCs are related to other source areas and are being addressed in the 600 Area FS Addendum.

4. No Further Action is recommended with respect to the 600 Area MTBE Investigation for the following reasons:

   - Low concentrations of MTBE detected in groundwater are below the LOC, and MTBE was not detected in surface water;
   - Decreasing nature of MTBE concentrations in groundwater and surface water; and
   - Extent of MTBE groundwater and surface water contamination is delineated and bounded by clean downgradient wells and surface water sample locations.

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TABLES

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WELL GEOPHYSICAL REPORT

APPENDIX B
NJDEP WELL PERMIT, MONITORING WELL LOG, AND FORM B

APPENDIX C
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APPENDIX D
ANALYTICAL RESULTS