THIRD FIVE-YEAR REVIEW REPORT FOR ORDNANCE WORKS DISPOSAL AREAS SUPERFUND SITE MONONGALIA COUNTY, WEST VIRGINIA

Prepared by

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SEP 12 2016

Date

ORDNANCE WORKS DISPOSAL AREAS SITE
FIVE-YEAR REVIEW REPORT No. 3

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LIST OF ACRONYMS

µg/L	micrograms per Liter
ABS	ABS Environmental Services, Inc.
ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BOD	Biochemical oxygen demand
BTAG	USEPA Biological Technical Assistance Group
BTU	British Thermal Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	Contaminant of Potential Concern
cPAH	Carcinogenic Polynuclear Aromatic Hydrocarbon
CY	cubic yards
DoD	Department of Defense
DuPont	E. I. DuPont de Nemours and Company
EA	Endangerment Assessment
Ecotune	Ecotune Environmental Consultants
ERI	Ecological Restoration, Inc.
ESC	Environmental Strategies Corporation
FAQs	Frequently Asked Questions
FIT	Field Investigation Team
FR	Federal Register
FS	Feasibility Study
FYR	Five-Year Review
GE	General Electric
GTPP	Grant Town Power Plant, American Bituminous Power Partners, LP
HI	Hazard Index
ILCR	Increased Lifetime Cancer Risk
IRIS	USEPA's Integrated Risk Information System Database
Law	Law Engineering and Environmental Services, Inc.
MDC	Maximum Detected Concentrations
MDL	method detection limit
mg/kg	milligrams per kilogram
MIP	Morgantown Industrial Park
MIPA	Morgantown Industrial Park Associates, Limited Partnership
MOW	Morgantown Ordnance Works
MSL	mean sea level
NCP	National Contingency Plan
NHANESIII	National Health and Nutrition Evaluation Survey
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OU-1	Operable Unit 1
OU-2	Operable Unit 2
OWDA	Ordnance Works Disposal Area
OWR	WVDEP Office of Water Resources
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl

LIST OF ACRONYMS (continued)

PM	Project Manager
ppm	Parts per million (mg/1)
PQL	Practical Quantitation Limit
PRP	Potentially Responsible Party
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RSL	Regional Screening Level
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFW	Roy F. Weston, Inc.
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SES	Sevenson Environmental Services
SF	Slope Factor
SVOCs	semivolatilte organic compounds
TAL	Target Analyte List
TBCs	To Be Considereds
TCLP	Toxicity Characteristic Leaching Procedure
USACE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
WVDEP	West Virginia Department of Environmental Protection

EXECUTIVE SUMMARY

USEPA Region III, conducted this Third Five-Year Review (FYR) of the remedial actions implemented at Operable Unit 1 (OU-1) of the Ordnance Works Disposal Areas (ODWA) Superfund Site (also known as the Morgantown Ordnance Works Site or MOW), located in Morgantown, Monongalia County, West Virginia. The purpose of this FYR was to determine if the remedial actions that have been implemented are protective of human health and the environment. The review process consisted of the following activities: notification and involvement of stakeholders, review of existing and relevant documentation and data, identification and review of recent and new information, and an assessment of Site conditions. This report documents the review process and presents the findings, conclusions, and recommendations. It is important to note that Operable Unit 2 of this Site was addressed under removal authorities. Since all of the contaminated material was removed, no operation and maintenance (O&M) of OU-2 is required and it is therefore not part of this Five-Year Review.

This FYR concludes that the remedy is protective of human health and the environment. The PRPs have implemented the remedy at Operable Unit One in accordance with the remedial action objectives of the 1999 ROD, and it is currently functioning as intended. The landfill has not been found to be a significant source of contamination to the groundwater in the area and the COCs identified in the 1999 ROD have not been detected in groundwater samples during this FYR period. The multi-layer RCRA landfill cap was determined to be effective in containing hazardous waste materials, the treatment wetland ponds appeared to be functioning as intended, and Site access restrictions were found to be functional. Institutional controls are in place to prohibit disturbing the landfill cap, use of groundwater, and non-commercial use of any kind within OU1. Operation and Maintenance including annual inspections, leachate monitoring and treatment wetland monitoring are performed pursuant to the 2012 Operation and Maintenance Plan. Additionally, results of this FYR report indicate that the remedial action objectives for the selected remedy have been achieved.

As part of this Five-Year Review the Government Performance Results Act (GPRA) Measures have also been reviewed. The GPRA Measures and their status are provided as follows**:**

Environmental Indicators:
Human Health: Long-Term Human Health Protection Achieved (HHPA)
Groundwater Migration: Contaminated Groundwater Migration Under Control (GMUC)

Sitewide RAU:
The Site achieved Site-Wide for Anticipated Use (SWRAU) on November 29, 2011.

Other Comments
No other comments

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Ordnance Works Disposal Areas Site		
EPA ID: WVD000850404		
Region: Region III	**State:** WV	**City/County:** Monongalia County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:** Click here to enter text.
Author name (Federal or State Project Manager): Christian Matta
Author affiliation: U.S. EPA
Review period: 9/2011 - 8/2016
Date of site inspection: April 5, 2016
Type of review: Statutory
Review number: 3
Triggering action date: 9-16-2011
Due date *(five years after triggering action date)*: 9-16-2016

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU-1

Issues and Recommendations Identified in the Five-Year Review:
There are no issues or recommendations identified during this review period.

Sitewide Protectiveness Statement (if applicable)
Protectiveness Determination: Protective *Addendum Due Date:N/A*
Protectiveness Statement: This FYR concludes that the remedy is protective of human health and the environment. The remedy has been implemented in accordance with the remedial action objectives of the 1999 ROD, and it is currently functioning as intended. The landfill has not been found to be a significant source of contamination to the groundwater in the area and the COCs identified in the 1999 ROD have not been detected in groundwater samples during this FYR period. The multi-layer RCRA landfill cap was determined to be effective in containing hazardous waste materials, the treatment wetland ponds appeared to be functioning as intended, and Site access restrictions were found to be functional. Institutional controls are in place to prohibit disturbing the landfill cap, use of groundwater, and non-commercial use of any kind within OU1. Operation and Maintenance including annual inspections, leachate monitoring and treatment wetland monitoring are performed pursuant to the 2012 Operation and Maintenance Plan. Additionally, results of this FYR report indicate that the remedial action objectives for the selected remedy.

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA), Region III, with assistance from the West Virginia Department of Environmental Protection (WVDEP), conducted this Third Five-Year Review (FYR) of the Ordnance Works Disposal Areas Site (OWDA or Site), pursuant to the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA), Section 121(c), National Oil and Hazardous Substances Contingency Plan (NCP) Section 300.400(f)(4)(ii), and OSWER Directives 9355.7-02 (May 23, 1991), 9355.7-02A (July 26, 1994), and 9355.7-03A (December 21, 1995). The Comprehensive Five-Year Review Guidance, EPA 540-R-01-007 (USEPA, 2001), was consulted in preparation of this FYR. This is a post-Superfund Amendments and Reauthorization Act of 1986 (SARA) remedial action, enforcement-lead response action, statutory review. The triggering action for this statutory review is the signature date of the Second Five Year Review, September 16, 2011.

This document will become part of the Site file and is the Third FYR for the OWDA Site. This review evaluated the OU-1 remedial measures at the OWDA. The review process consisted of the following activities: (1) notification and involvement of stakeholders, (2) review of existing and relevant documentation and data, (3) identification and review of recent and new information, and (5) an assessment of current Site conditions.

This report presents the methods, findings, conclusions, and recommendations for the FYR of the former OWDA. The purpose of the FYR is to ensure that a remedial action remains protective of human health and the environment and is functioning as designed.

USEPA in consultation with the WVDEP prepared this FYR report pursuant to CERCLA Section 121(c) and the NCP, 40 CFR 300.430(f)(4)(ii).

CERCLA §121(c) states the following:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section {104} {106}, the President shall take or require such action. The President shall report to the congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

USEPA interpreted this requirement further in NCP, 40 CFR 300.430(f)(4)(ii) as:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

1.1 Purpose of Review

The primary purpose of this FYR was to evaluate whether the response actions undertaken at OU-1 are functioning as intended and remain protective of human health and the environment. Another objective was to identify and provide recommended remedies for any issues of concern associated with the implemented response actions. Section 121(c) of CERCLA, as amended by SARA, and §300.430(f)(4)(ii) of the NCP mandate that a post-SARA remedial action be reviewed no less often than every five years after initiation of the remedial action at sites where hazardous substances, pollutants, or contaminants remain at levels above those that allow for unlimited use and unrestricted exposure. This is the Third FYR for the OWDA Site.

1.2 Site Overview

The OWDA is part of the former Morgantown Ordnance Works (MOW), and is located approximately one mile southwest of the city of Morgantown, West Virginia, along the west bank of the Monongahela River (See Figure1). The OWDA Site is often referred to as the MOW Site. The OWDA Site is located within a 670 acre industrial park known as the Morgantown Industrial Park which is owned by Enroute Properties, Inc. The property which comprises the OWDA OU-1 Site is currently owned by the Morgantown Industrial Park Associates (MIPA) which are the previous owners of the Morgantown Industrial Park (MIP). For the purposes of environmental investigation and remediation, OWDA is made up of three segments:

1) OU-1 encompasses a small portion of the MIP formerly used for disposal of tar and other wastes;
2) Two tracts of land currently owned and operated by Crompton Corporation (purchased from General Electric (GE) Company in 2003). The tracts are known as the North Plant and South Plant. Crompton/GE properties are not covered under the Superfund Program, but are covered by Resource Conservation Recovery Act (RCRA) Corrective Action authorities.
3) Operable Unit 2 (OU-2) covers all other parts of MIP, including abandoned production areas, never used parts of the property (undeveloped woodlands), and currently leased parcels.

1.3 Current Status of Operable Units

All OU-1 remedial action work has been completed as part of the overall requirements of the Administrative Order for Remedial Design and Remedial Action, Docket No. III-90-27-DC, signed by USEPA on June 20, 1990. The named Respondents are Rockwell International Corporation, Olin Corporation, GE Specialty Chemical, Inc., and Morgantown Industrial Park Associates, Limited Partnership (MIPA).

OU-2 encompasses all other parts of the MIP. OU-2 is not included within the Site's NPL boundary. OU-2 comprised the remainder of the property, not including the currently active Crompton/GE Facility, and was addressed through a removal action performed in 1997 that included the following actions:

- Removal of water/debris from on-site sumps and pits;
- Off-site disposal of soils/sediments;
- Backfilling and re-vegetation of excavated areas; and
- Elimination of physical hazards.

USEPA has indicated that it does not expect further CERCLA responses for OU-2, as documented in the OU-1 ROD:

> "EPA does not anticipate further CERCLA response actions within OU-2 of the OWDA, expansion of the NPL listing to include OU-2, or issuance of a ROD for OU-2. Although cleanup actions deemed necessary by EPA at the GE properties within OU-2 will likely occur under RCRA, the Agency has reserved its right to perform or require CERCLA response actions in connection with such properties."

As of the date of this FYR, the GE properties are being addressed through EPA's RCRA corrective action program. Since all of the contaminated material was removed, no operation and maintenance (O&M) of OU-2 is required and it is therefore not part of this Five-Year Review. Actions taken to address OU-2 are documented in the August 20, 1997 Final Report, Morgantown Ordnance Works, OU-2 Removal Action Report.

TABLE 1

OWNERSHIP CHRONOLOGY

1940 – 1945 E.I. Dupont de Nemours under lease to U.S. Government produced hexamine from Ammonia and methanol	**1962 – 1978** Purchased and operated by Morgantown Ordnance Works, Inc. Leased to Sterling/Rockwell. 1964, Borg Warner purchase
1945 – 1950 Sharon Steel and Heyden Chemical leased property for coke plant and ammonia production	**1978-1982** Purchased and operated by Princess Coals, Inc.
1951-1958 Olin Mathieson leased property and produced ammonia methyl alcohol, formaldehyde, hexamine and ethylene diamine	**1982** Purchased by Morgantown Industrial Park Associates (MIPA), Limited Partnership
1958-1962 Facility remained idle	**1982-Present** Owned by MIPA

2.0 SITE CHRONOLOGY

Table 2	
REMEDIAL ACTIVITIES/EPA DOCUMENTATION CHRONOLOGY	
1981 PCB Site Discovery. Two lagoons used for chrome plating waste disposal were excavated and disposed of by Rockwell Int'l	**1996** Sept: USEPA executed Consent Order for a Removal Action with the PRPs for OU-2
1982 October: State Site Investigations Sept: Preliminary Assessment	**1997** March: Treatability Studies for Bioremediation. Focused FS for OU-1 June: Removal Action complete for OU-2
1983 April: USEPA Region III Field Investigation Team (FIT) site inspection and sampling of aqueous and soil sediment and air samples	**1998** Sept: Focused FS approved by USEPA
1984 May thru June: PCB-containing drums disposed. July: USEPA Region III FIT Team site inspection	**1999** June: USEPA issues Proposed Remedial Action Plan identifying a new remedy for OU-1. Sept: Third (final) ROD for OU-1
1986 June: Site added to National Priorities List	**2001** September: Implementation of the Remedial Action for the 1999 ROD. Feb: Final Design approved
1988 RI/FS completed. March: First ROD - selected cleanup actions for the disposal area of the plant, OU-1	**2003** July: Construction effectively completed September: Final Inspection
1989 June: Superfund Program Draft Proposed Plan Sept: Second ROD for OU-1	**2006** First Five-Year Review
	2011 Second Five-Year Review

3.0 BACKGROUND

This document details a FYR conducted for OU-1 of the OWDA in Morgantown, West Virginia. The purpose of the FYR is to evaluate whether the response actions and original performance standards remain protective of human health and the environment. USEPA is the lead agency for OWDA. USEPA in consultation with the WVDEP conducted the FYR and prepared this report.

3.1 Physical Characteristics

The OWDA Site is located in Monongalia County, West Virginia, on the west bank of the Monongahela River approximately one-mile southwest of the city of Morgantown. The Site lies within the Appalachian Plateau Physiographic Province of northern West Virginia. The topography surrounding the Site is rugged and dominated by the Chestnut Ridge – a long anticlinal mountain in the Allegheny Mountain Range located seven miles east of Morgantown. At the OWDA, the elevation of the ground surface in the areas investigated ranges from 975 feet above mean sea level (MSL) to 1010 feet above MSL. The Monongahela River is adjacent to the Site at 825 feet above MSL, with a fairly steep cliff separating the river from the waste disposal area and former drum staging area. All surface runoff drains to the river. The actual land surface of the Site has been altered by such activities as waste pond excavations, backfilling, removal of soil, and grading. Drainage swales that discharge both storm and surface water from the Site extend beyond the fenced perimeter and ultimately discharge to the Monongahela River. The regional groundwater flow direction is also eastward towards the Monongahela River.

3.2 Land Use and Resource Use

The original MOW property consisted of approximately 849-acres which through sales and changes in ownership has resulted in the current MIP which now consists of approximately 670-acres owned by Enroute Properties, Inc., approximately 24-acres owned by Monongahela Railway Company (an active railroad), and approximately 120-acres owned by various private companies or individuals. As of 2016 Morgantown Industrial Park Associates (MIPA) remains the owner of the property that comprises OU-1which is located within the MIP. All other property within the MIP formerly owned by MIPA is now owned by Enroute Properties, Inc. who operates a commercial and industrial complex by leasing property to various companies, and plans to continue to do so. Within one-mile of the Site are several residences, one known private drinking water well, natural wetlands, livestock grazing areas, a junk yard, and Crompton employees located at the South Plant.

The landfill, treatment wetlands, and several shallow monitoring wells are within a fenced area with locked gates. A synthetic membrane cap was constructed over the former OU-1 landfill area in 2003. Ten groundwater monitoring wells exist around the capped area. The landfill and treatment wetlands area is not a likely candidate for redevelopment and institutional controls are in place preventing residential development in OU-1.

3.3 History of Contamination

The property where the OWDA is located has been occupied and used for a variety of chemical production and industrial operations since the 1940s. Beginning in October 1940, the property was operated by E. I. DuPont de Nemours and Company (DuPont) under contract to the U.S. Department of War (now Department of Defense (DoD)). DuPont produced hexamethylenetetramine (i.e. hexamine) from ammonia and methanol and small amounts of "heavy water". The waste products resulting from the coal-burning manufacturing process of ammonia and methanol were sulfur and light oil (75-percent toluene and benzene). The primary

on-site disposal area was the landfill in the southern portion of the facility, which was later designated as part of OU-1. In 1946, Sharon Steel operated a coke plant and Heyden Chemical operated an ammonia production facility. Beginning in 1951, Mathieson Chemical Corporation (now Olin Corporation) produced ammonia, methyl alcohol, formaldehyde, hexamine, and ethylene diamine at the site. Blue catalyst pellets that were used in the production of ammonia were disposed on the ground surface throughout the site.

The U.S. Government sold the property in 1962 to Morgantown Ordnance Works, Inc. This private corporation leased a portion of the property to Sterling Faucet; Rockwell International acquired all assets of Sterling Faucet in 1968 and in 1973 the two companies merged. Rockwell/Sterling operated a chrome-plating facility until 1976. Rockwell had constructed two lagoons adjacent to the existing landfill to dispose of chrome-plating wastes. Princess Coals, Inc., acquired the property from MOW, Inc., in 1978, but did not actively lease or operate a chemical production facility. The MOW property was acquired from Princess Coals by a group of private individuals in 1982 that became Morgantown Industrial Park, Inc. and subsequently changed its name to Morgantown Industrial Park Associates, Limited Partnership (MIPA). MIPA no longer owns the industrial park but has retained ownership of the OU-1 Site property.

In 1964, Weston Chemical Company, Inc., had purchased certain parcels of property from the industrial park and began operation of an organic chemical production facility. Weston was later acquired by Borg-Warner Chemical Corporation. In 1988, GE purchased the stock of Borg-Warner Specialty Chemicals, Inc., and the name was subsequently changed to GE Specialty Chemicals, Inc. (the North and South Plants). This 62-acre GE facility became Crompton Corporation in August 2003. The Crompton facilities are currently active, although GE Chemical has an agreement with USEPA to remediate under RCRA Corrective Action authorities. Additional information regarding the status of the RCRA action can be found in Section 1.3 above.

The northern section of OU-1 was an abandoned, inactive landfill that was estimated to have a fill depth of 20 feet below-ground-surface (bgs) at its thickest location. No records exist on the quantities or types of material disposed of in the landfill. Eyewitness reports and direct observations revealed that the landfill contains construction debris, slag, ash, and catalyst pellets. Leachate from the landfill drained to the northeast into an existing wetland. The wetland drained directly to Swale 3, which eventually discharged into the Monongahela River. The sediment layer of both the wetland and the upper portion of Swale 3 were determined during the pre-design sampling event to have been impacted by heavy metals.

3.4 Initial Response

As a result of the chemical and industrial activities that occurred during the property's history, hazardous substances were generated, stored, and ultimately disposed of on the southern portion of the industrial park, thereby creating a landfill. This disposal area became known by USEPA as OU-1. OU-1 is a roughly six-acre site located approximately 0.5 miles south of the original main plant area.

Studies and remedial activities at the disposal site began in 1981. Oils, some contaminated with various levels of polychlorinated biphenyls (PCBs) from abandoned transformers used during the industrial activities at the OWDA, were stored in approximately 38 drums at various locations in the vicinity of the landfill/lagoon area. In addition, transformers and switch tanks, some of which contained no liquid reservoirs but were contaminated with PCBs, were discovered on the OWDA. A portion of the former Lagoon Area was excavated in 1981 to address metal-plating wastes disposed in two surface impoundments by Rockwell between 1970 and 1976. During this removal action, miscellaneous wastes including coal tars were observed in the lagoon. The site was first inspected by the USEPA Region III Field Investigative Team (FIT) in April 1983. The oil-containing drums and carcasses were removed and disposed of in 1984. A follow-up inspection was performed by the USEPA Region III FIT in July 1984. The area referred to as OU-1 was proposed for inclusion on USEPA's National Priorities List (NPL) on October 15, 1984 (47 FR 58476). USEPA considers OU-1 to be comprised of the following:

(a) OU-1
- Inactive landfill,
- Two lagoons and surrounding impacted area,
- A 'scraped area' used for shallow waste disposal,
- Former drum staging area,
- Several streams with associated wetlands.

Final listing of OU-1 on the NPL occurred on June 10, 1986 (48 FR 40674). The named Potentially Responsible Parties (PRPs) were Rockwell International Corporation, Olin Corporation, GE, and MIPA.

The RI/FS was completed in 1988. Sampling events on the property during the Remedial Investigation (RI), the Phase II Interim Design Tasks, and Feasibility Studies (FS) occurred in various phases between 1980 and 1998. Sampling included groundwater, surface and subsurface soils, surface water, and sediment.

3.5 Basis For Taking Action

As part of the 1988 RI/FS report, USEPA prepared an Endangerment Assessment (EA) for the OWDA in order to identify and define possible existing and future human health risks associated with exposure to the contaminants present in the various media at OU-1. The surface and subsurface soils, surface water, and sediment of OU-1 were all impacted to varying degrees by organic and inorganic contaminants. RI test pits in the Scraped Area revealed cinder-like backfill material, blue and black catalyst pellets, and yellow solid material.

USEPA considered the impact of Site-related contamination on human health for both present and future potential exposure pathways and concluded that OU-1 presented an unacceptable risk to human health from soil and sediment contamination. Groundwater was not found to present an unacceptable risk. There were no exceedances of Maximum Contaminant Levels (MCLs) in the 1986, 1987 or 1998 groundwater sampling events. The groundwater was not and is not currently used as a drinking water source. Institutional controls prohibiting the use of

groundwater for potable uses were implemented as part of a September 29, 2006 environmental covenant in accordance with the West Virginia Universal Environmental Covenants Act.

Additional borings in the Scraped Area exposed visible tar from ground surface to a depth of eight-feet below ground surface (bgs) and detected concentrations of total carcinogenic Polynuclear Aromatic Hydrocarbons (cPAHs) ranging from 94 parts-per-million (ppm) to 36,000 ppm. Some elevated levels of inorganic contaminants were detected in the 1988 RI but were not detected in the scraped area during the 1996 Phase II Interim Design Tasks. Further investigation during the Phase II Interim Design Tasks indicated cPAH concentrations ranging from 3.2 to 30,000 ppm, however, the inorganic contaminants detected during the 1988 RI were again not noted.

Ecological Risks (e.g., the threats to organisms in the streams and wetland) were not evaluated at the time of the RI/FS. However, in August 1998, following a review of the 1988 RI data, USEPA's Biological Technical Assistance Group (BTAG) concluded that inorganic contaminants were present in surface water and sediments within OU-1 at levels that are acutely toxic to potentially affected ecosystems. BTAG agreed that environmental protectiveness would be achieved if inorganic compounds in specific drainage areas (swales) were cleaned up to background levels. There was no evidence that contamination from the OWDA affected the Monongahela River.

4.0 OU-1 REMEDIAL ACTION

As a result of the manufacturing operations conducted at the OWDA, hazardous substances were generated and subsequently disposed at OU-1. During the RI/FS in 1988, it was determined that the surface and subsurface soils, surface water and sediment of OU-1 were all impacted to varying degrees by organic and inorganic contaminants such as heavy metals and PAHs.

The following were associated with OU-1:

- Landfill: The northern section of OU-1 was an abandoned, inactive landfill estimated to have a fill depth of 20 feet at its thickest location. No records exist on quantities or types of material disposed of in the landfill. Waste materials identified on-site include construction debris, slag, ash, and catalyst pellets. Leachate from the original inactive landfill drained to the northeast into an existing wetland.

- Lagoons: Two lagoons, formerly used for chrome-plating waste disposal between 1970 and 1976, were excavated and disposed of in an approved off Site landfill by Rockwell International in 1981.

- Scraped Area: This area was used for shallow disposal of wastes. The wastes identified were construction debris, oil-like stained soils, tar, and catalyst pellets. Chemical analyses of soil and fill material in the scraped area indicated concentrations of metals, cPAHs, and arsenic.

- Drum Staging Area: Drums that were originally scattered throughout the site were collected, staged, and sampled in 1984 in the drum staging area.

- Streams: Three streams pass through the site. Analytical samples from surface water indicated relatively low concentrations of cPAHs, arsenic, lead copper, chromium, zinc, cadmium, and mercury, the parameters of concern. However, cPAHs were detected at relatively high concentrations at sediment sampling locations down-gradient of the Scraped Area and Landfill.

4.1 OU-1 Remedy Selection

Three RODs have been signed for OU-1. The 1988 and 1989 RODs have been superseded, and the remedies described in them were not implemented. The remedy in the 1999 ROD was implemented and is the focus for this FYR.

4.1.1 1988 Record of Decision

The remedy selected in the 1988 ROD, onsite incineration and containment, focused on source control of soils and sediments contaminated with cPAHs and heavy metals. The remedy required on-site incineration with containment to treat contaminated soils found in the former Lagoon Area and the Scraped Area, as well as sediments found in the settling zones of the three streams down-gradient of the waste management area. The remedy required the construction of a multi-layer RCRA cap on the inactive landfill, required 30-years of monitoring and an assessment of impacts of the remedial action to existing wetlands along with wetland mitigation.

4.1.2 1989 Record of Decision

USEPA determined that PRPs had not received notice of the original OU1 proposed plan and opened an additional thirty-day comment period for responsible parties to comment on the ROD. Based on comments received during this period, USEPA conducted a focused FS in 1989 to re-evaluate the alternatives described in the March 1988 ROD and to conduct a risk-based analysis of cleanup levels.

During this analysis, USEPA specifically focused on eight contaminants: cPAHs, arsenic, cadmium, chromium, copper, lead, mercury, and zinc. The focused FS was completed in June 1989. A new ROD was issued by USEPA in September 1989, which selected a "preferred" and a "contingency" remedial action for OU-1. The preferred remedy included treatment of organic contaminants using bioremediation and the contingency remedy utilized soil washing.

In June 1990, USEPA issued an administrative order requiring the PRPs to implement the remedy described in the 1989 ROD. USEPA later agreed to adopt a less stringent cleanup level for cPAH cleanup, due to a change in the cancer potency factor for benzo (a) pyrene in USEPA's Integrated Risk Information System (IRIS). In March 1997, the treatability studies for bioremediation were completed. It was determined that bioremediation was not cost-effective

and could not meet the cleanup standards set in the ROD within a reasonable timeframe. USEPA and the PRPs agreed that the soil washing contingency action was also deficient and a second focused FS was conducted in 1997-1998.

4.1.3 1999 Record of Decision

USEPA issued another ROD in 1999 selecting a new remedy for OU-1 based on the results of a second focused FS. The following remedial action objectives were included in the 1999 ROD:

- Eliminate the potential for direct contact with organic contaminants in surface and subsurface soils and sediments that exceed the cPAH Cleanup Standard;
- Eliminate the potential for direct contact with inorganic contaminants in surface and subsurface soils that exceed risk-based cleanup standards established in the September 1989 ROD;
- Reduce or eliminate inorganic contaminants in sediments to the cleanup levels set forth in Table 7 of the ROD;
- Reduce the potential for organic and inorganic contaminants in surface and subsurface soils and sediments to migrate to the groundwater or to migrate offsite;
- Reduce or eliminate the threat of direct contact with contaminants in the landfill; and
- Reduce or eliminate the threat of migration of contaminants from the landfill.

The 1999 ROD included the following actions as part of the selected alternative, Alternative 5:

- Excavation of all visibly stained tar-like material from the Lagoon Area, Scraped Area, and stream sediments and transportation of this visibly contaminated waste material to an off-site thermal treatment facility for treatment;
- Excavation of all soils contaminated with cPAHs in excess of the cPAH Cleanup Standard and soils contaminated with inorganic compounds in excess of the inorganic cleanup standards set in the September 1989 ROD from the Lagoon Area and the Scraped Area and consolidation of this contaminated soil into the existing landfill;
- Excavation of all sediments contaminated with cPAHs in excess of the cPAH Cleanup Standards and sediments contaminated with inorganic compounds above background levels from the wetland area and drainage swales 1, 2, and consolidation of these sediments into the existing landfill;
- Backfilling, re-grading, and re-vegetating the excavations in the Lagoon Area and the Scraped Area;
- Restoration of streams and wetland areas where sediment was excavated;
- Construction of a multi-layer RCRA cap over the existing landfill;
- Long-term monitoring of sediment, streams and groundwater;
- Maintenance of the existing perimeter fence; and
- Implementation of institutional controls to protect the cap and prohibit residential development, recreational use, schools and child care facilities.

The cleanup standards for the 1999 ROD are attached as Table 6 and Table 7. Neither the March 1988 ROD nor the September 1989 ROD required actions for groundwater. There was no evidence that the groundwater had been significantly impacted by disposal operations at OU1 and no unacceptable risks were posed to receptors of the groundwater at OU1. Therefore, the remedy selected in the 1999 ROD did not include a groundwater remediation component.

4.2 Remedy Implementation

Based on the final ROD, the Pre-Design Work Plan and Pre-Design Investigation Report were prepared and submitted to USEPA by Environmental Strategies Corporation (ESC) in August 2000 and January 2001, respectively. Upon approval, the PRPs prepared the remedial design to guide the construction of the remedy. The remedial action specified in the 1999 ROD was divided into two segments in order to expedite implementation. The Tar and Soil Excavation Work Plan was approved by USEPA in July 2001. This allowed excavation to begin in September 2001 while the cap was being designed. The Final Design Report for construction of the cap was submitted to USEPA in April 2002. The cap was not constructed until all excavation was complete. The work plans for both the replacement and treatment wetlands were appended to the Final Design Report.

ESC served as the PRPs' general contractor and engineer for most of the remedial action. ESC was responsible for planning, oversight, reporting, sampling, and engineering. Sevenson Environmental Services (SES) excavated and reconstructed the swales and constructed the landfill cap. Kipin Industries was responsible for excavation, processing, and coordinating off-site thermal treatment of tar and transportation of soil to the landfill. Grant Tower Power Plant (GTPP) received and treated the processed tar by using it as fuel. Ecological Restoration, Inc., (ERI) designed and built the treatment wetlands and the replacement wetland.

4.2.1 Site Preparation

SES first cleared and grubbed the area and improved the access road. A tar processing area was constructed. Large vegetation was removed from the swales, and trees and stumps were ground and mixed into the landfill sub-grade.

4.2.2 Excavation

Excavation of tar and soil in the lagoon, swales and scraped area began on September 18, 2001 and was completed on August 1, 2002. Tar and tar-like materials were excavated and stockpiled separately from impacted soils, which were defined as soil that had no visible tar present but PAH or metals content suspected to be above the cleanup standards. This impacted soil was transported to the on-site landfill for disposal, while the tar and tar-like materials were kept on-site for processing and subsequent shipment as fuel to the Grant Town power plant. The excavation area had been divided into cells, and confirmation samples were taken from each wall and floor of the open cells to determine if the cells were "clean" and could be backfilled. If the cell was not clean, excavation continued. In some cells, excavation continued to a depth of nearly 30-feet bgs, due to the discovery of free-phase oil. In the Scraped Area, excavation

volumes were more than double the original estimate due to construction debris being encountered. This material was placed into the landfill, because it did not include any tar or tar-like material.

Free-phase oil was discovered in the Lagoon Area in clay and rock. Approximately 10,000 cubic yards (CY) of soil and shale were excavated down to a maximum depth of approximately 30 feet bgs. The oil appeared to be trapped within the layers of horizontal shale fractures, occasionally percolating through vertical fractures.

Two mounded areas near the scraped areas were investigated. Approximately 50 CY of tar was found in one of them, and approximately 800 CY of material was excavated. Confirmation samples verified that no additional tar in one mound required excavation. No excavation was necessary in the other mound, based on test pits. Small, isolated pieces of tar from throughout the site were processed in the same manner as the other tar material.

During excavation of the three swales, tar was found only in Swale 1. Excavation down to six-feet bgs was required to remove the tar. Swales 2 and 3 were excavated to a depth of two-feet bgs. Also, the existing wetland at the intersection of Swale 3 and the railroad track was excavated. This is the wetland to which leachate from the former landfill drained. Excavation ceased when wall and floor confirmation samples yielded results below cleanup levels required by the 1999 ROD.

A total of approximately 45,000 CY was excavated, with 40,000 CY placed into the on-site landfill and approximately 5,000 CY of tar, tar-like material, and coke breeze mixed with additives shipped to Grant Town Power Plant (GTPP). From the Scraped and Lagoon Areas, approximately 27,000 CY was excavated. About 10,000 CY of sediment was removed from the swales. SES removed 3,000 CY as part of the final work area excavation.

4.2.3 Processing of Tar and Tar-Like Material

Tar and tar-like material was stockpiled and mixed with additives to achieve the necessary 7,580-British Thermal Unit (BTU) value and shipped to GTPP for use as a coal waste synfuel. The first shipment was made in October 2001. Tar processing activities were completed in July 2002 with the last of the product shipped to GTTP in August 2002. A total of 14,623 tons of product was shipped.

4.2.4 Landfill Cap

During the summer and fall of 2002, the existing landfill material and excavated material and sediment were graded and compacted to meet the final design contour. The final cover system consisted of (1) a vegetated top cover 24-inches thick, (2) a lateral drainage layer of non-woven geosynthetic filter fabric bonded to both sides, and (3) a low-permeability layer with a 40-mil upper component and a geosythetic clay liner as the lower component. A gas vent layer was constructed at the highest point of the cap (ridge) and consisted of a stone trench and pipe for gas emissions. A leachate collection and conveyance system was constructed to collect leachate with initial leachate infiltration collected with a 4-inch high density poly-ethylene (HDPE) corrugated

perforated pipe and transferred to a 4-inch HDPE corrugated solid pipe for ultimate conveyance to the constructed wetlands. Placement of the final cover system began in May 2003 and was completed in July 2003. Drainage ditches were created around the perimeter of the cap to convey surface runoff and silt fencing was installed on the cap's face as a temporary measure prior to establishment of vegetation. Landfill leachate is treated by use of constructed treatment wetlands that are located below the leachate collection system at the toe of the landfill.

4.2.5 Treatment Wetlands

A collection system captures any leachate produced within the landfill and funnels it to a series of three constructed wetlands (also referred to as Ponds 1, 2 and 3 or cells 1, 2 and 3). These wetlands were completed prior to the landfill cap. The first pond is primarily a settling basin for heavier particulates. It has a limestone bed covered with organic compost. The leachate flows through the limestone, which helps precipitate out any iron. Cattails were established to ensure aerobic conditions and dissuade wildlife from entering.

The second pond is constructed of a two-foot limestone bed, two feet of leaf compost mixed with crushed limestone, and two feet of water. Water enters at the surface and flows downward to a collection pipe beneath the limestone layer. The purpose of this pond is to allow sulfate-reducing bacteria to thrive, which will reduce zinc and copper concentrations. This pond requires anaerobic conditions, therefore it contains no plants. Ongoing maintenance is required to ensure that this pond remains free of vegetation.

The third or polishing pond removes any remaining metals and biochemical oxygen demand (BOD) from the leachate. This shallow pond was planted with cattails to dissuade wildlife from entering it.

After leachate is processed through the final treatment wetland, effluent then drains from the wetland area to an area directly below the treatment wetlands referred to as Swale 3. Below Swale 3 is a functioning railroad track with an existing tile/culvert running under the track. After exiting the culvert, water continues to drain down an embankment, toward the river floodplains and eventually to the Monongahela River.

4.2.6 Replacement Wetland

Seven-tenths of an acre of existing wetlands was lost in the vicinity of swale 3 as part of the remedial action, and were replaced with 1.05 acres of wetlands along the Monongahela River in 2002.

4.3 Systems Operation/O&M

Site O&M requirements are contained in the 2012 Revised Final Operations and Maintenance/Post Closure Plan (2012 O&M Plan). This plan includes inspection of the landfill cover, wetlands, and associated drainage systems and sampling requirements for groundwater and treatment wetland effluent. Additionally, the sampling frequency of the treatment wetlands effluent and groundwater has been changed from the semi-annual schedule that was in place

during the previous Five-Year Review period. The change in sampling frequency is supported by the consistent lack of significant detections of Site COCs in groundwater samples collected from the 10 wells that were sampled prior to this FYR period for the ten year period following completion of the cap and due to the implementation of ICs which prohibit use of the groundwater at OU-1.

Pursuant to the 2012 O&M Plan, shallow wells MW-1 through MW-6 were to be sampled in the spring of 2012. Following the spring event of 2012, no further sampling of the shallow monitoring wells is required. Monitoring of the shallow groundwater was to be replaced with monitoring of the influent and effluent from the Treatment Wetlands Ponds on the third and fifth year of the remaining future FYR periods.

The bedrock monitoring wells included in the revised sampling schedule called for sampling of DGW-01 and DGW-06. Monitoring of the two bedrock monitoring wells occurred during April 2012 and December 2014. Pursuant to the approved 2012 O&M Plan, no further sampling of the bedrock monitoring wells will be required provided the sample results from the April 2012 and December 2014 sampling events is consistent with historical data. The following table illustrates the sampling frequency called for during the 2011 to 2016 FYR period:

Year	Bedrock Wells	Shallow Wells	Treatment Wetlands Influent Point	Treatment Wetlands Effluent Point
2012	DGW-01 & DGW-06	MW-1 through MW-6	No Sampling	Sample
2013	No Sampling	No Sampling	No Sampling	No Sampling
2014	DGW-01 & DGW-06	No Sampling	Sample	Sample
2015	No Sampling	No Sampling	No Sampling	No Sampling
2016	No Sampling	No Sampling	Sample	Sample

The sampling program for the fourth FYR has also been modified by the 2012 O&M Plan. During the fourth FYR period from 2016 through 2021 groundwater will no longer be monitored and treatment wetland influent and effluent will be sampled during the 3rd and 5th years of the review period if sufficient leachate is present for sampling.

4.3.1 Treatment Wetlands Inspection

The treatment wetlands were initially inspected every six months during the first two years of the O&M period. Presently, the wetlands are being inspected annually. Leachate from the landfill has declined to the extent that water is no longer flowing routinely from treatment cell 3. Over time native wetland vegetation has become established in treatment cells 2 and 3 and planted cattails cover treatment cell 1. The maintenance plan called for mowing of vegetation in treatment cell 2. However, given the decline in leachate and the presence of native vegetation, it is no longer necessary to mow this cell. Mowing in the vicinity of the cells can now be limited to the berms surrounding the cells to permit access to monitoring wells.

During the April 2016 FYR Site visit, the ponds appeared to be in good condition, with some standing water in them. No effluent was seen to be coming from pond 3. Evidence of burrowing from animals was not noted to be extensive or of any concern. The integrity of the treatment ponds system has been monitored and has not required modification to date. Monitoring of the treatment wetlands should continue and periodic monitoring of the landfill leachate, when flowing, should be conducted both prior to the treatment wetlands (influent) and after the wetlands (effluent) to ensure the treatment wetlands are performing correctly.

4.3.2 Replacement Wetlands Inspection

The replacement wetlands are inspected annually as part of the landfill cap inspection. Beginning in 2008 the PRPs undertook efforts to eradicate invasive plant species from the replacement wetlands at the request of the EPA and WVDEP. Personnel from EPA's BTAG have inspected the replacement wetlands every spring to mark invasive plant species for removal during normal landfill cap maintenance activities. The invasive plant species removal efforts have been successful and should continue as necessary.

Recent inspections of the mitigation wetland located adjacent to the Monongahela River has verified that the wetland has developed into a high quality mosaic of forested, shrub-scrub, and emergent wetlands habitats. Invasive plants are present, but at low density as a result of the control measures implemented after construction. The presence of numerous wetland terrestrial, aquatic and avian species was noted through visual and auditory observation. No further actions are needed for this wetland at this time. However, as part of the ongoing O&M activities the wetland will be monitored to ensure the invasive plant species density remains low and if needed, periodic control measures are taken to ensure the continued success of this wetland.

4.3.3 Landfill Inspection

A landfill inspection checklist was developed as part of the original O&M plan and is completed during inspections along with photo documentation. Inspections currently occur on a semi-annual basis. During the April 2016 FYR inspection the landfill cap appeared in good condition and did not have apparent areas of erosion or areas of distressed vegetation. No cracking and or movement of surficial soils was evident on the top of the landfill cap slope. Storm-water conveyance channels appeared in good condition and no obvious signs of ponding water were evident throughout. Overall the vegetative cover was robust and well established.

The cap vegetation fully meets the cover requirements of the remedial design. As part of the ongoing O&M activities the vegetation will be maintained by mowing every 5 years in advance of the FYR Site inspection. Alternatively, mowing can be eliminated as long as invasive species and deep-rooted trees are controlled using injectable herbicides or cutting on a 5-year cycle. Native shrubs can be allowed to grow on the cap as their root systems are shallow and will not reach the impermeable layers of the cap. General access paths should be maintained as needed to ensure monitoring wells, treatment wetlands and the landfill cap can be accessed for maintenance and inspections.

4.3.4 Progress Since Last Five Year Review

This is the third FYR for this Site. The second FYR found that the PRPs had implemented the remedy at OU-1 in accordance with the remedial action objectives of the 1999 ROD, and it was functioning as intended. The remedy was protective of human health and the environment. The second FYR found no issues effecting protectiveness of the remedy and no recommendations were made. Routine O&M has continued along with required sampling as described above since the second FYR.

5.0 FIVE-YEAR REVIEW PROCESS

This FYR consisted of the following activities: the involvement of stakeholders, the review of existing and relevant documentation and data, the identification and review of recent and new information, an initial assessment of site conditions, actions taken by the PRPs to resolve deficiencies, an inspection, and the preparation of this report.

5.1 Administrative Components

This FYR was conducted by USEPA Region III with assistance provided by the West Virginia Department of Environmental Protection.

5.2 Stakeholder and Community Notification and Involvement

Notification of stakeholders of the FYR was performed by USEPA Region III. An advertisement was placed in the Dominion Post on May 6, 2016 notifying the public of the preparation of the Five-Year Review Report and that the finalized Report will be available on-line no later than September 2016.

5.3 Document Review

Reviews of relevant documents including RODs, correspondence, and O&M records, were conducted as part of this FYR. Remediation levels identified in RODs were also reviewed, and Applicable or Relevant and Appropriate Requirements (ARARs) and toxicity factors were checked for updates.

The following Site related documents were reviewed for this Second Five Year Review.

- March 1988 Record of Decision for the Ordnance Works Disposal Areas Site.
- September 1989 Record of Decision for the Ordnance Works Disposal Areas Site.
- September 1999 Record of Decision for the Ordnance Works Disposal Areas Site.
- Environmental Covenant Ordnance Works Disposal Areas Site, Operable Unit NO.1, Morgantown, West Virginia, September 12, 2006.
- First Five-Year Review Report for the Ordnance Works Disposal Areas Site, September 18, 2006.
- Second Five-Year Review Report for the Ordnance Works Disposal Areas Site, September 16, 2011.

- November 1, 2011 through October 31, 2012 monitoring report, Morgantown Ordnance Works Site, Operable Unit 1.
- November 1, 2012 through December 31, 2015 monitoring report, Morgantown Ordnance Works Site, Operable Unit 1.

5.4 Data Review

As part of the ongoing Operation and Maintenance activities, the treatment wetlands and groundwater are to be sampled to ensure the remedy components are functioning as designed.

5.4.1 Wetlands Effluent Sampling

Effluent from the treatment wetlands was monitored quarterly through November 2008 after which semi-annual sampling began in April 2009 and continued until 2011. Pursuant to the 2012 O&M Plan, only the effluent was to be sampled in 2012 and then both the influent and effluent were to be sampled during 2014 and 2016. The effluent must meet regulatory criteria established by the WVDEP Office of Water Resources (OWR). Effluent samples are analyzed for chemical oxygen demand, total organic carbon, total suspended solids, total phenols, cPAHs, cyanide (free and total), total and dissolved iron, copper, zinc, and hardness.

Leachate from the landfill has declined to the extent that water is no longer flowing routinely from treatment cell 3. As a result, there has not been sufficient treatment wetlands effluent to sample since November 2009. Therefore, since leachate has not been flowing from the treatment wetlands during routine sampling events since 2009, there is no data to show for this FYR period (2011-2016). However, the leachate flow will be monitored on an annual basis as part of the landfill inspection. If treatment wetland influent or effluent is present, it will be sampled pursuant to the approved 2012 O&M Plan during the next FYR (2016 through 2021) period during the 3rd and 5th years of the review period unless conditions warrant a change in the frequency of sampling. Based on the absence of leachate flow during this FYR period, and sample results from previous FYRs, it appears that the treatment wetlands have adequately treated any leachate from the landfill since they became established.

5.4.2 Groundwater Sampling

To ensure that the landfill cover is functioning properly and that the landfill is not an active source of contamination, a monitoring program is in place. From March 2007 through August 2011, the groundwater monitoring wells were sampled semi-annually. Pursuant to the 2012 O&M Plan groundwater samples were collected in 2012 and 2014 (See Figure 2). The groundwater samples were analyzed for Semi Volatile Compounds (SVOCs) and Target Analyte List (TAL) metals. Analytical results summary tables for this FYR period can be found in Attachment B. Since groundwater was not the subject of the 1999 ROD there are no formal cleanup levels established in the ROD. Groundwater monitoring has been conducted to ensure the landfill is not a significant source of contamination since it is not lined and did exist prior to consolidating OU1 soils, sediments and OU2 related wastes into the landfill. For purposes of determining if the landfill may be a significant source of contamination to the groundwater the sampling results are compared to MCLs where established and Regional Screening Levels

(RSLs) where no MCL has been established. RSLs used were for a cancer risk equal to the most conservative or lowest level of risk within EPA's risk range 1E-06 and a hazard index (HI) of 0.1.

Shallow Monitoring Wells

Sample results indicate that SVOCs napthalene and phenol consistent with historical coal tar contamination were detected in shallow wells MW1, MW2 and MW4 during this FYR period. The highest concentration of napthalene detected was 0.2 µg/L during the April 2012 sampling event in monitoring well MW-1 which is just above the RSL of 0.165 µg/L. The highest concentration of phenol detected was 2 µg/L during the May 2011 sampling event in monitoring well MW-2 which is below the RSL of 577 µg/L. As a result, the landfill has not been found to be a significant source of Site related contamination to the groundwater. Due to a lack of sufficient water, MW3 was not sampled during the 2012 sampling event.

Bis (2-Ethylhexyl) phthalate was detected during the April 2012 sampling event at three of the monitoring wells MW-1 (13 µg/L), MW-4 (3 µg/L), and MW-5 (2 µg/L). This chemical has previously been detected in the background wells in addition to the field blanks. As can be seen on Figure 2, MW-1 is upgradient of shallow wells MW-4 and MW-5. Monitoring well MW-2 is downgradient of MW-4 and MW-5. Monitoring well MW-6, which historically has had detections exceeding the MCL, is considered the background well and is upgradient of the landfill.

No COCs identified in the 1999 ROD were detected in groundwater samples during this FYR period at levels of concern. Bis (2-Ethylhexyl) phthalate is the only SVOC that has exceeded the associated MCL since May 2011 and is not a COC pursuant to the 1999 ROD. All other SVOCs are below the associated MCL. Naphthalene also slightly exceeded its RSL of 0.17 µg/L in MW1. Overall the low SVOC contaminant concentrations detected are not indicative of the landfill being a significant source of contamination to the groundwater. The data are consistent with detections found during the second FYR period. The SVOC analytical summary tables for each monitoring well can be found in Attachment B along with the associated MCL or RSL.

Four inorganic contaminants (cobalt, iron, manganese and thallium) were found to exceed the associated MCL or RSL during this FYR period. The inorganic analytical results for each well are summarized in the tables found in Attachment B.

Cobalt was detected in the sample for MW-2 during the April 2012 sampling event at a concentration of 21.1 µg/L which exceeds its associated RSL of 0.6 µg/L at a HI=0.1. Cobalt also was found in MW-2 during the May 2011 sampling event at 6.6 µg/L and the August 2011 sampling at 16.3 µg/L, both of which exceed the RSL. Cobalt was also found in MW-4 at 0.96 µg/L during the August 2011 sampling event and in the background monitoring well MW-6 at 3.2 µg/L during the May 2011 sampling event, 1.3 µg/L during the August sampling event and 2.9 µg/L during the April 2012 sampling event. While it appears that there is localized contamination from cobalt in the area of the landfill it is important to note that cobalt was found in the background monitoring well which is indicative of cobalt contamination upgradient of the landfill area. Cobalt is not a COC pursuant to the 1999 ROD.

Iron was found to exceed the RSL of 1,400 µg/L in MW-4 at 3,760 µg/L during the August 2011 sampling event. Iron was also found to exceed the RSL in background monitoring well MW-6 during the May 2011 sampling event at 8,020 µg/L, August 2011 sampling event at 11,600 µg/L and the April 2012 sampling event at 13,300 µg/L. Based on the frequency of detections of iron and the concentrations detected in background monitoring well MW-6 it appears there is elevated iron upgradient of the landfill.

Manganese was found at concentrations exceeding the associated RSL of 43.0 µg/L at a HI=0.1 in samples for monitoring wells MW-2 (25,400 µg/L), MW-4 (511 µg/L), MW-5 (62 µg/L) and MW-6 (5,310 µg/L) during the 2012 sampling event. Manganese was also found in MW-1 (114 µg/L), MW-2 (7,100 µg/L), MW-4 (337 µg/L), MW-5 (455 µg/L) and MW-6 (4,960 µg/L) during the May 2011 sampling event. During the August 2011 sampling event manganese was found in MW-1 (439 µg/L), MW2- (15,000 µg/L), MW-4 (3,030 µg/L), MW-5 (1,220 µg/L) and MW-6 (3,750 µg/L). Manganese concentrations have been as high as 42,500 µg/L in September 2005 to as low as 1,710 µg/L in September 2006 demonstrating that large fluctuations in the manganese concentration do occur. Manganese has been consistently detected at concentrations above 3,500 µg/L in MW-6 which is the shallow background well. Overall, concentrations seen during this third FYR are consistent with historical manganese concentrations. As a result the landfill has not been found to be a significant source of manganese to the groundwater.

Thallium was found in monitoring well MW-2 at 6.5 µg/L during the August 2011 sampling event which exceeds the associated MCL of 2.0 µg/L. Thallium was not found in any other monitoring well during this FYR period. Sporadic historic detections of thallium are indicative of anomalous detections and do not indicate that the landfill is a significant source of thallium contamination.

The detections of cobalt, iron, manganese and thallium are consistent with concentrations and frequency of detections seen during the previous FYR periods. Cobalt, iron, manganese and thallium are the only inorganic contaminants found to exceed the associated MCL or RSL since May 2011in the shallow monitoring wells and shallow background well. Detections of cobalt higher than the associated RSL have occurred historically but not on a consistent basis and not in all wells. Concentrations of naturally occurring manganese can vary greatly and be quite high in this region based upon the minerology of the regional bedrock. As a result it is likely that the high manganese concentrations found in MW-2 may be the result of the effect of degradation processes mobilizing naturally occurring manganese causing an increase in the manganese concentrations found in the shallow groundwater. Thallium has only been sporadically detected and has been found to exceed the current MCL (2.0 µg/L) on three occasions which does not indicate the landfill is a significant source of thallium. In addition, it should be noted that cobalt, iron, manganese and thallium are not COCs pursuant to the 1999 ROD.

Review of the shallow groundwater data from the 2012 groundwater monitoring event in conjunction with historical data indicate that the landfill is not a significant source of contamination to the shallow groundwater.

Bedrock Wells

Pursuant to the 2012 O&M Plan, the upgradient bedrock well DGW-1 and downgradient bedrock well DGW-6 were the only bedrock wells sampled during this FYR period. There were no SVOCs found during the April 2012 sampling event or during the December 2014 sampling event. Bis (2-Ethylhexyl) phthalate was detected in DGW-1 during the May 2011 sampling event at a concentration of 4 µg/L and in DGW-6 during the August 2011 sampling event at a concentration of 4 µg/L but has not been detected since. Bis (2-Ethylhexyl) phthalate is the only SVOC detected in DGW-1 or DGW-6 since May 2011 and the concentrations detected were below the associated MCL or RSL. Analytical summary tables are found in Attachment B.

Beryllium is the only inorganic found to exceed the associated MCL in either bedrock well. Beryllium was found in background monitoring well DGW-1 at a concentration of 26 µg/L during the August 2011 sampling event which exceeds the MCL of 4 µg/L at an HI=0.1. Given that this is the background well and beryllium was not detected in the downgradient bedrock monitoring well DGW-6 during this FYR period or previous FYR periods, the landfill is not considered to be the source of the beryllium.

Manganese was found to exceed the associated RSL. During the December 2014 sampling event, manganese was found at a concentration of 470 µg/L in bedrock monitoring well DGW-6, which exceeds the associated RSL of 43.0 µg/L at an HI=0.1. Manganese was also found to exceed the RSL from monitoring well DGW-6 during the May 2011 (55 µg/L), August 2011 (94.9 µg/L) and April 2012 (116 µg/L) sampling events. Sample results for background monitoring well DGW-1 found manganese concentrations exceeding the RSL during the August 2011(222 µg/L) and April 2012 (67 µg/L) sampling events. The concentration of manganese only slightly exceeds the RSL corresponding to an HI=0.1 and is not expected to pose an unacceptable risk and is within concentrations that would be expected given the mineralogy found in the area. Review of the concentrations of inorganics that were detected in both the April 2012 sampling event and December 2014 sampling event in conjunction with the historical data indicate that the landfill is not a significant source of contamination to the bedrock groundwater.

Based on the sampling data from this Third FYR, the cap appears to prevent leaching of contaminants into the groundwater. For the analyzed parameters (SVOCs and TAL metals), detections are sporadic and do not identify a groundwater plume. There is no increase in the landfill monitoring wells to levels significantly above regulatory criteria. The concentrations of contaminants detected above the respective MCL or RSL values have not been increasing in an appreciable manner. The groundwater is not used as a drinking water source and the September 12, 2006 Environmental Covenant prohibits use of the groundwater for potable and non-potable purposes. Furthermore, no COCs identified in the 1999 ROD were detected at levels which pose an unacceptable risk.

5.5 Interviews

Due to the historic lack of public interest no community interviews were conducted as part of this Third FYR. The Site is located in a large industrial park and there are no full time residents living directly down gradient of the Site. Representatives from WVDEP and the PRPs were present and participated in the Five Year Review Site Inspection. During the inspection attendees discussed general issues and recommendations relating to ongoing Site O&M activities.

5.6 Site Conditions Inspection

The PRPs inspect the remedy at OU-1 and sample groundwater and wetland effluent in accordance with the approved 2012 O&M Plan. The inspection results are forwarded to the USEPA and WVDEP Project Managers (PMs).

On April 5, 2016 representatives from USEPA Region III, WVDEP, and the PRPs inspected OU-1 for this FYR, as summarized in Sections 4.3.1, 4.3.2, and 4.3.3. The landfill cap appeared in good condition and did not have apparent areas of erosion or areas of distressed vegetation. No cracking and or movement of surficial soils was evident on the top of the landfill cap slope. Storm-water conveyance channels appeared in good condition and no obvious signs of ponding water were evident throughout. Overall the vegetative cover was robust and well established. The monitoring wells were in good condition and the fence surrounding the landfill and treatment weatlands was intact and restricts access. It was noted that during the performance of O&M activities, additional signage is needed on the fence to identify the Site as a Superfund Site.

6 TECHNICAL ASSESSMENT

6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended by the decision documents. All construction associated with the ROD is complete. Monitoring wells are intact, the landfill cap is in excellent condition and the fence is intact and restricts access. The results of this Third FYR indicate that the remedy is functioning in accordance with design documents. The excavation and capping of contaminated soil and sediments has achieved the Remedial Action Objectives (RAOs) identified in the 1999 ROD and which are discussed in Section 4.3.1 above.

Since the completion of the remedial action activities, the following Site conditions relating to the implementation of the selected remedy have been achieved:

- The fence is intact and in good repair;
- The landfill cap remains intact;
- The monitoring wells are functional;
- Landfill leachate generation has significantly decreased to the extent that collection of leachate treatment system samples is not normally possible, and;
- There is no evidence of excessive trespassing or significant vandalism.

Based on the 2012 and 2014 O&M sampling, the cap appears to prevent leaching of contaminants into the groundwater. There is no significant increase in the levels of SVOCs and TAL metals in the landfill monitoring wells when compared to MCLs or RSLs.

Maintenance activities related to the landfill, treatment wetlands, and fence are addressed in the April 2012 Operation and Maintenance Post-Closure Plan. Regular maintenance such as mowing when needed, removal of silt from drainage areas, and re-vegetation of barren areas must continue to be performed.

Institutional controls were implemented as part of a September 29, 2006 environmental covenant in accordance with the West Virginia Universal Environmental Covenants Act, WV Code Chapter 22, Article 22B. The environmental covenant restricts use of the property on which OU-1 is located to commercial industrial uses, prohibits the use of groundwater, prohibits excavation in the capped area or disturbance of other remedy components, and provides for access by regulatory agencies and the PRPs.

6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Although there have been changes in toxicity criteria and exposure assumptions, these changes are not expected to impact the protectiveness of the remedy for the Site. During this review, the four following types of assumptions made in the OU-1 ROD and how those assumptions may differ at the present time were considered:

- Standards and "to be considereds" (TBCs);
- Cleanup levels;
- Exposure pathways; and
- Toxicity and other contaminant characteristics.

As discussed in Section 4.3.1 above, the RAO's found in the 1999 ROD remain valid and have been achieved. The cleanup levels included in the 1999 ROD remain protective have been achieved and are attached as Tables 6 and 7. Institutional controls are in place and the remedy components are protected.

6.2.1 Standards and TBCs

Twenty-three Applicable or Relevant and Appropriate Requirements (ARARs) are identified in the 1999 OU-1 ROD. The two location-specific ARARs applied only during construction of the remedial action, so they no longer apply. Of the 21 action-specific ARARs, 12 applied only during implementation of the remedial action, and therefore no longer apply. The West Virginia (WV) Groundwater Protection Act, 47 CSR 58-4.2, applies to the installation of monitoring wells, which has been completed, and the abandonment of monitoring wells, which is a future action; any future abandonment of wells shall comply with these regulations. Four of the ARARs are RCRA sections and only one of those, 40 C.F.R. § 265.117 Post-closure care and use of property as hazardous waste management units, had been amended since the signing of the

ROD. The changes made to 265.117 are not substantial and therefore do not impact the selected remedy. The four remaining ARARs are WV state regulations. Portions of the WV Air Pollution Control (45 CSR 4) and Groundwater Protection Acts (47 CSR 58-4.9.d to 4.9.g and 47 CSR 58-8.1(c)) have not been amended since the ROD was signed. The WV Environmental Quality Board establishes criteria for surface water quality via 46 CSR 1. This regulation has undergone several changes since the signing of the 1999 ROD, but the only pertinent, significant change is the requirement to analyze discharges for dissolved copper instead of total copper. Since sampling began in August 2003, the effluent from the treatment wetlands has been analyzed for both total and dissolved copper. There have been no other significant changes to the standards or TBCs since the 1999 ROD was signed that require changes to the remedy.

6.2.2 Exposure Pathways

Three exposure pathways considered in the 1999 ROD were: ingestion of soil, dermal contact, and inhalation of dust. No groundwater exposure pathway existed, since groundwater at and downgradient of OU1 was not used as a drinking water source. Groundwater in the area of OU1 consists of several small perched aquifers that occur above the regional water table which is the predominant source of groundwater flowing into the Monongahela River. The future use scenario used to evaluate the cleanup levels in the 1999 OU-1 ROD was an industrial worker, which is still accurate. If these standards were achieved, USEPA determined at that time the combined carcinogenic risk from exposure to arsenic and cPAHs will be 5×10^{-5}. This value is within the range of 1×10^{-4} to 1×10^{-6} established by USEPA as being representative of an acceptable risk.

Sediment cleanup levels were established to protect ecological receptors and establish sediment levels at or near background.

6.2.3 Cleanup Levels

Cleanup standards shown in the 1999 ROD are all risk-based, except sediment cleanup levels which are based on background levels. Contaminated material was either removed off-site or capped in the on-site landfill limiting exposure. Further, the landfill is fenced to control access to the landfill cap and treatment wetlands. The Environmental Covenant provides for Institutional Controls that limits use of the property to commercial/industrial uses and protects the cap.

Since some modification to exposure assumptions or toxicity criteria may have occurred, the Increased Lifetime Cancer Risk (ILCR) and the Hazard Index (HI) was recalculated for the 1999 ROD cleanup levels, in accordance with current toxicity criteria and applicable risk methodologies in the USEPA's Risk Assessment Guidance for Superfund (RAGS).

The cleanup levels in Table 6 were substituted for maximum detected concentrations in the risk-ratio screening process and ILCR and HIs were calculated using the online RSL calculator, May 2016. The receptor evaluated was an industrial worker, as in the 1999 ROD. As performed for that ROD, incidental exposure from ingestion of soil, dermal contact, and inhalation of dust were evaluated for the industrial worker.

The cleanup levels remain protective because the recalculated risks and hazards based on the cleanup levels for soil (Table 6) are within USEPA's acceptable risk management range of a cancer risk of1×10^{-4} to 1×10^{-6} , and a HI less than one based on target organs.

6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that questions the protectiveness of the remedy.

7.0 ISSUES

No issues affecting protectiveness of the remedy were identified during this Five Year Review.

8.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

There are no recommendations or follow-up actions associated with this Five Year Review. Normal O&M activities outlined in the 2012 O&M plan should continue in order maintain protectiveness and functionality of the remedy components. Based on RAOs associated with the remedy having been achieved, the OWDA Site should be considered for deletion from the NPL.

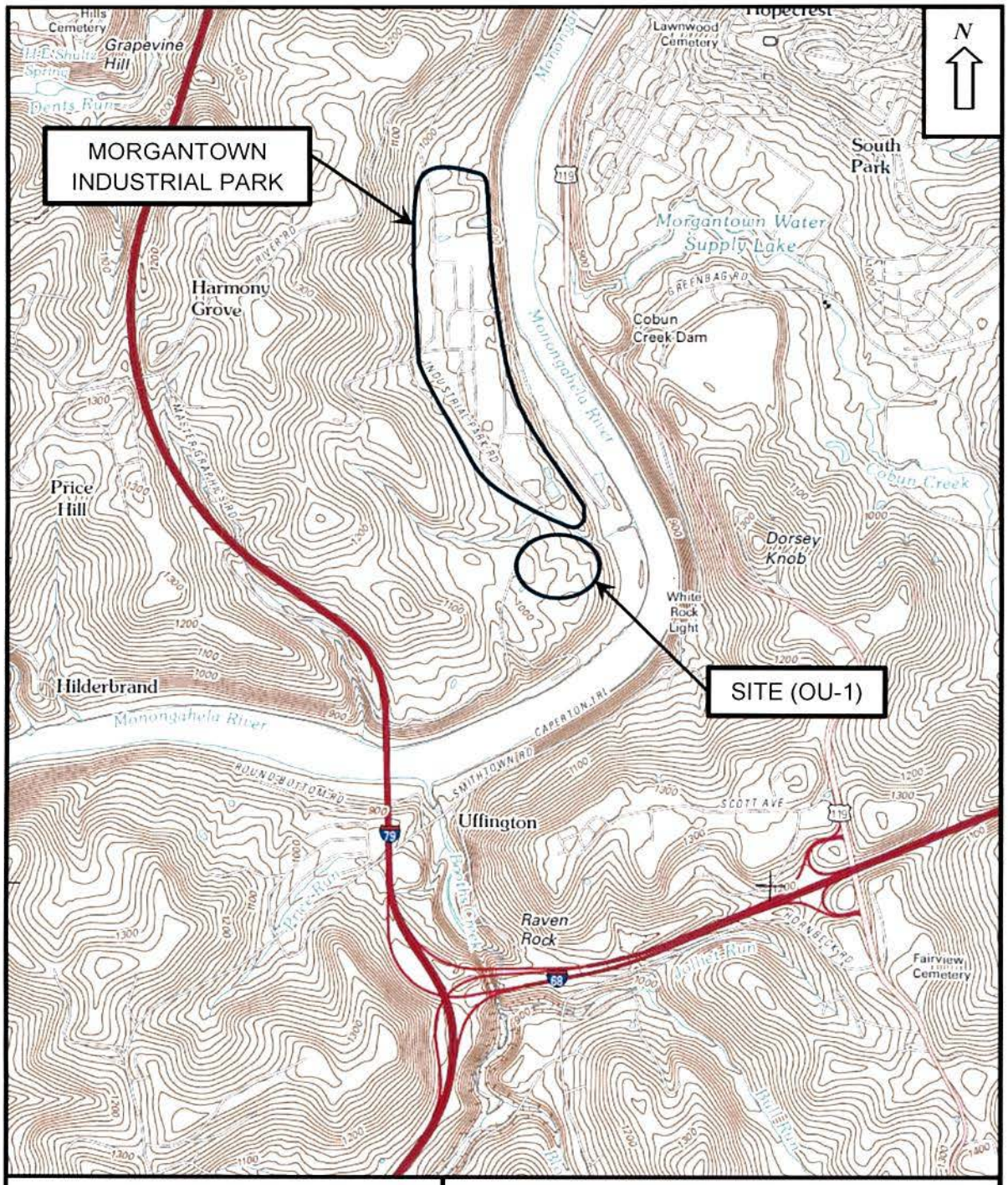
9.0 PROTECTIVENESS STATEMENT

This FYR concludes that the remedy is protective of human health and the environment. The PRPs have implemented the remedy at Operable Unit One in accordance with the remedial action objectives of the 1999 ROD, and it is currently functioning as intended. The landfill has not been found to be a significant source of contamination to the groundwater in the area and the COCs identified in the 1999 ROD have not been detected in groundwater samples during this FYR period. The multi-layer RCRA landfill cap was determined to be effective in containing hazardous waste materials, the treatment wetland ponds appeared to be functioning as intended, and Site access restrictions were found to be functional. Institutional controls are in place to prohibit disturbing the landfill cap, use of groundwater, non-commercial use of any kind within OU1. Operation and Maintenance including annual inspections, leachate monitoring and treatment wetland monitoring are performed pursuant to the 2012 Operation and Maintenance Plan. Results of this FYR report indicate that the remedial action objectives for the selected remedy have been achieved.

10.0 NEXT REVIEW

The next FYR of remedial actions implemented on the OWDA should occur within five years of the completion date on the cover of the final version of this report. FYRs will continue as long as waste remains in place above levels that allow for unlimited use and unrestricted exposure.

Attachment A
Figures

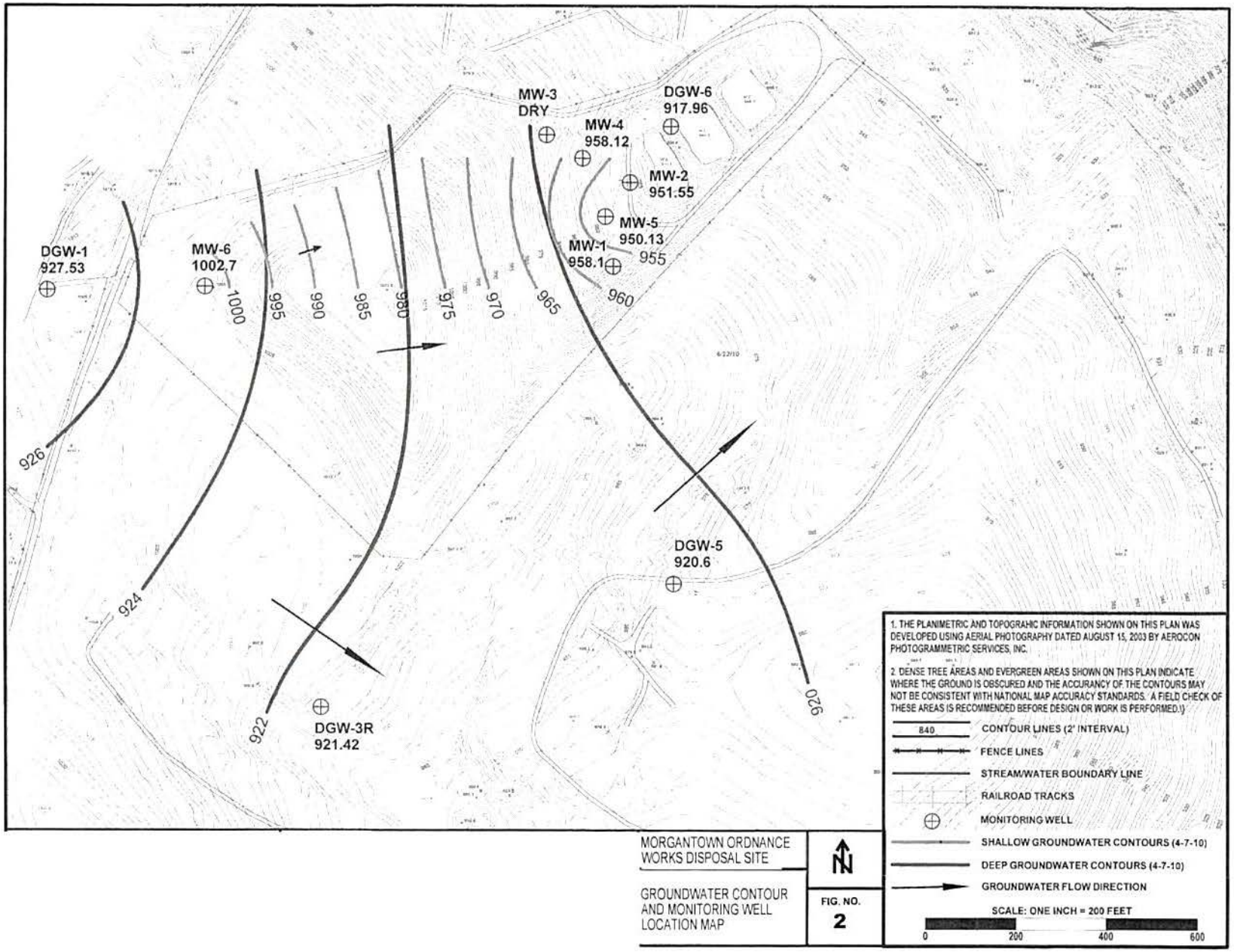


SITE LOCATION

WEST VIRGINIA

SITE LOCATION MAP

ORDNANCE WORKS DISPOSAL AREAS
SUPERFUND SITE
CITY OF MORGANTOWN
MONONGALIA COUNTY, WEST VIRGINIA
(MAP SCALE 1:28,800)


MW-3
DRY
DGW-6
917.96
MW-4
958.12
MW-2
951.55
MW-5
950.13
MW-1
958.1
DGW-1
927.53
MW-6
1002.7
DGW-5
920.6
DGW-3R
921.42
1000
995
990
985
980
975
970
965
960
955
926
924
922
920
1. THE PLANIMETRIC AND TOPOGRAHIC INFORMATION SHOWN ON THIS PLAN WAS DEVELOPED USING AERIAL PHOTOGRAPHY DATED AUGUST 15, 2003 BY AEROCON PHOTOGRAMMETRIC SERVICES, INC.
2. DENSE TREE AREAS AND EVERGREEN AREAS SHOWN ON THIS PLAN INDICATE WHERE THE GROUND IS OBSCURED AND THE ACCURANCY OF THE CONTOURS MAY NOT BE CONSISTENT WITH NATIONAL MAP ACCURACY STANDARDS. A FIELD CHECK OF THESE AREAS IS RECOMMENDED BEFORE DESIGN OR WORK IS PERFORMED.\)
840
CONTOUR LINES (2' INTERVAL)
FENCE LINES
STREAM/WATER BOUNDARY LINE
RAILROAD TRACKS
MONITORING WELL
SHALLOW GROUNDWATER CONTOURS (4-7-10)
DEEP GROUNDWATER CONTOURS (4-7-10)
GROUNDWATER FLOW DIRECTION
SCALE: ONE INCH = 200 FEET
0
200
400
600
MORGANTOWN ORDNANCE WORKS DISPOSAL SITE
GROUNDWATER CONTOUR AND MONITORING WELL LOCATION MAP
FIG. NO.
2

Attachment B
Analytical Summary Tables

SHALLOW WELLS

PARAMETER	WELL	MW-1				Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012		RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L	**39**	**22**	**13**		5.56	6.0
butyl benzyl phthalate	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L			0.2	J	0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum-DISS[6]	ug/L					2,000	
Antimony-DISS	ug/L					0.779	6
Arsenic-DISS	ug/L					0.0517	10.0
Barium-DISS	ug/L	17	20	19.59		377	2,000
Beryllium-DISS	ug/L					2.46	4
Cadmium	ug/L					0.922	5
Calcium-DISS	ug/L	1,100	75,700	78,500		NS	NS
Chromium-DISS	ug/L						100
Cobalt-DISS	ug/L					0.601	
Copper-DISS	ug/L		2.7 J	5.6	J	79.9	1,300
Iron-DISS	ug/L		68.1 J	15.8	J	1,400	
Lead-DISS	ug/L						15
Magnesium-DISS	ug/L	46,100	43,000	45,600		NS	NS
Manganese-DISS	ug/L	**114**	**439**	35.6		43.4	
Mercury	ug/L					0.566	2
Nickel-DISS	ug/L					39.2	
Potassium-DISS	ug/L	2,780	3,140	3,560		NS	NS
Selenium-DISS	ug/L			28.9		9.98	5
Silver-DISS	ug/L					9.41	
Sodium-DISS	ug/L	22,900	19,300	22,800		NS	NS
Thallium	ug/L					0.02	2.0
Vanadium-DISS	ug/L					8.64	
Zinc-DISS	ug/L	9.7 J	27.8	10.6	J	600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in

SHALLOW WELLS (continued)

PARAMETER	WELL	MW-2					Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011		8/16/2011	4/17/2012		RSL	MCL
Acenaphthene	ug/L						53.5	
Acenaphthylene	ug/L						NS	NS
Anthracene	ug/L						177	
Benzo(a)anthracene	ug/L						0.012	
Benzo(a)pyrene	ug/L						0.00343	0.2
Benzo(b)fluoranthene	ug/L						0.0343	
Benzo(k)fluoranthene	ug/L						0.343	
Benzo(ghi)perylene	ug/L						NS	NS
bis(2-Ethylhexyl) phthalate	ug/L	3	J				5.56	6.0
butyl benzyl phthalate	ug/L						16.3	
Carbazole	ug/L						NS	NS
4-Chloroaniline	ug/L						NS	NS
Chrysene	ug/L						3.43	
Dibenz(a,h)anthracene	ug/L						0.00343	NS
Dibenzofuran	ug/L						0.786	
Diethylphthalate	ug/L						1,480	NS
Di-n-butyl phthalate	ug/L						90.2	NS
Fluoranthene	ug/L						80.2	
Fluorene	ug/L						29.4	
Indeno(1,2,3-cd)pyrene	ug/L						0.0343	NS
4-Methylphenol	ug/L						NS	NS
Naphthalene	ug/L				0.1	J	0.165	
3-Nitroaniline	ug/L						NS	NS
Nitrobenzene	ug/L						0.14	
Phenanthrene	ug/L						NS	NS
Phenol	ug/L	2	J				577	
Pyrene	ug/L						12.1	
INORGANICS[2]								
Aluminum-DISS[6]	ug/L			115 J	85.4	J	2,000	
Antimony-DISS	ug/L						0.779	6
Arsenic-DISS	ug/L						0.0517	10.0
Barium-DISS	ug/L	13.9		32.3	10		377	2,000
Beryllium-DISS	ug/L						2.46	4
Cadmium	ug/L			0.41 J			0.922	5
Calcium-DISS	ug/L	110,000		107,000	142,000		NS	NS
Chromium-DISS	ug/L			1.5 J				100
Cobalt-DISS	ug/L	**6.6**		**16.3**	**21.1**		0.601	
Copper-DISS	ug/L			3.1 J	5.1	J	79.9	1,300
Iron-DISS	ug/L	95.8	J	539	227		1,400	
Lead-DISS	ug/L							15
Magnesium-DISS	ug/L	24,100		20,800	34,600		NS	NS
Manganese-DISS	ug/L	**7,100**		**15,000**	**25,400**		43.4	
Mercury	ug/L						0.566	2
Nickel-DISS	ug/L	3.1	J	5.4 J	3	J	39.2	
Potassium-DISS	ug/L	4,180		4,540	4460		NS	NS
Selenium-DISS	ug/L				24		9.98	5
Silver-DISS	ug/L			1.7 J	1.8	J	9.41	
Sodium-DISS	ug/L	35,700		31,600	30,300		NS	NS
Thallium	ug/L			6.5 J			0.02	2.0
Vanadium-DISS	ug/L				5.2		8.64	
Zinc-DISS	ug/L	272		479	290		600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter

SHALLOW WELLS (continued)

PARAMETER	WELL	MW-3			Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012	RSL	MCL
Acenaphthene	ug/L	Dry	Dry	Dry	53.5	
Acenaphthylene	ug/L				NS	NS
Anthracene	ug/L				177	
Benzo(a)anthracene	ug/L				0.012	
Benzo(a)pyrene	ug/L				0.00343	0.2
Benzo(b)fluoranthene	ug/L				0.0343	
Benzo(k)fluoranthene	ug/L				0.343	
Benzo(ghi)perylene	ug/L				NS	NS
bis(2-Ethylhexyl) phthalate	ug/L				5.56	6.0
butyl benzyl phthalate					16.3	
Carbazole	ug/L				NS	NS
4-Chloroaniline	ug/L				NS	NS
Chrysene	ug/L				3.43	
Dibenz(a,h)anthracene	ug/L				0.00343	NS
Dibenzofuran	ug/L				0.786	
Diethylphthalate	ug/L				1,480	NS
Di-n-butyl phthalate	ug/L				90.2	NS
Fluoranthene	ug/L				80.2	
Fluorene	ug/L				29.4	
Indeno(1,2,3-cd)pyrene	ug/L				0.0343	NS
4-Methylphenol	ug/L				NS	NS
Naphthalene	ug/L				0.165	
3-Nitroaniline	ug/L				NS	NS
Nitrobenzene	ug/L				0.14	
Phenanthrene	ug/L				NS	NS
Phenol	ug/L				577	
Pyrene	ug/L				12.1	
INORGANICS[2]						
Aluminum-DISS[6]	ug/L				2,000	
Antimony-DISS	ug/L				0.779	6
Arsenic-DISS	ug/L				0.0517	10.0
Barium-DISS	ug/L				377	2,000
Beryllium-DISS	ug/L				2.46	4
Cadmium	ug/L				0.922	5
Calcium-DISS	ug/L				NS	NS
Chromium-DISS	ug/L					100
Cobalt-DISS	ug/L				0.601	
Copper-DISS	ug/L				79.9	1,300
Iron-DISS	ug/L				1,400	
Lead-DISS	ug/L					15
Magnesium-DISS	ug/L				NS	NS
Manganese-DISS	ug/L				43.4	
Mercury	ug/L				0.566	2
Nickel-DISS	ug/L				39.2	
Potassium-DISS	ug/L				NS	NS
Selenium-DISS	ug/L				9.98	5
Silver-DISS	ug/L				9.41	
Sodium-DISS	ug/L				NS	NS
Thallium	ug/L				0.02	2.0
Vanadium-DISS	ug/L				8.64	
Zinc-DISS	ug/L				600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in

SHALLOW WELLS (continued)

PARAMETER	WELL	MW-4				Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012		RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L		**10**	3	J	5.56	6.0
Butyl benzyl phthalate	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L			0.1	J	0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum-DISS[6]	ug/L		275			2,000	
Antimony-DISS	ug/L					0.779	6
Arsenic-DISS	ug/L					0.0517	10.0
Barium-DISS	ug/L	24.3	42	29.1		377	2,000
Beryllium-DISS	ug/L		0.27 J			2.46	4
Cadmium	ug/L		0.31 J			0.922	5
Calcium-DISS	ug/L	50,200	44,200	46,400		NS	NS
Chromium-DISS	ug/L						100
Cobalt-DISS	ug/L		0.96 J			0.601	
Copper-DISS	ug/L		1.5 J	5.1	J	79.9	1,300
Iron-DISS	ug/L		3,760	153	J	1,400	
Lead-DISS	ug/L						15
Magnesium-DISS	ug/L	40,800	35,500	37,400		NS	NS
Manganese-DISS	ug/L	337	**3030**	**511**		43.4	
Mercury	ug/L					0.566	2
Nickel-DISS	ug/L	5 J	12.1	1.5	J	39.2	
Potassium-DISS	ug/L	1,770	1,690	1480		NS	NS
Selenium-DISS	ug/L			17.3	J	9.98	5
Silver-DISS	ug/L					9.41	
Sodium-DISS	ug/L	125,000	110,000	88,200		NS	NS
Thallium	ug/L					0.02	2.0
Vanadium-DISS	ug/L					8.64	
Zinc-DISS	ug/L		7.2 J			600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in

SHALLOW WELLS (continued)

PARAMETER	WELL	MW-5				Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012		RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L	**6**	3 J	2	J	5.56	6.0
Butyl benzyl phthalate	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L					0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum-DISS[6]	ug/L		227			2,000	
Antimony-DISS	ug/L					0.779	6
Arsenic-DISS	ug/L					0.0517	10.0
Barium-DISS	ug/L	28.2	16.4	11.8		377	2,000
Beryllium-DISS	ug/L		0.25 J			2.46	4
Cadmium	ug/L		0.27 J			0.922	5
Calcium-DISS	ug/L	55,200	72,300	76,000		NS	NS
Chromium-DISS	ug/L						100
Cobalt-DISS	ug/L					0.601	
Copper-DISS	ug/L		2.2 J	4.5	J	79.9	1,300
Iron-DISS	ug/L		345	61.1	J	1,400	
Lead-DISS	ug/L						15
Magnesium-DISS	ug/L	41,500	28,100	29,800		NS	NS
Manganese-DISS	ug/L	**455**	**1220**	62		43.4	
Mercury	ug/L					0.566	2
Nickel-DISS	ug/L	4.1 J	3.2 J	1.2	J	39.2	
Potassium-DISS	ug/L	1,760	2,810	2280		NS	NS
Selenium-DISS	ug/L			24		9.98	5
Silver-DISS	ug/L					9.41	
Sodium-DISS	ug/L	126,000	25,900	26,900		NS	NS
Thallium	ug/L					0.02	2.0
Vanadium-DISS	ug/L					8.64	
Zinc-DISS	ug/L		44.4	4.5	J	600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in

SHALLOW WELLS (continued)

PARAMETER	WELL	MW-6 (Background)				Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011		4/17/2012	RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L					5.56	6.0
Butyl benzyl phthalate	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L					0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum-DISS[6]	ug/L					2,000	
Antimony-DISS	ug/L					0.779	6
Arsenic-DISS	ug/L			5.4	J	0.0517	10.0
Barium-DISS	ug/L	308	374	312		377	2,000
Beryllium-DISS	ug/L					2.46	4
Cadmium	ug/L		0.57 J			0.922	5
Calcium-DISS	ug/L	107,000	92,100	139,000		NS	NS
Chromium-DISS	ug/L						100
Cobalt-DISS	ug/L	3.2 J	1.3 J	2.9	J	0.601	
Copper-DISS	ug/L		2.2 J	4.8	J	79.9	1,300
Iron-DISS	ug/L	8,020	11,600	13,300		1,400	
Lead-DISS	ug/L						15
Magnesium-DISS	ug/L	12,500	7,910	13,800		NS	NS
Manganese-DISS	ug/L	**4,960**	**3,750**	**5,310**		43.4	
Mercury	ug/L					0.566	2
Nickel-DISS	ug/L					39.2	
Potassium-DISS	ug/L	3,510	4,080	3,430		NS	NS
Selenium-DISS	ug/L			28.9		9.98	5
Silver-DISS	ug/L					9.41	
Sodium-DISS	ug/L	24,900	24,300	12,000		NS	NS
Thallium	ug/L					0.02	2.0
Vanadium-DISS	ug/L			1.4	J	8.64	
Zinc-DISS	ug/L		12.1 J			600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter

BEDROCK WELL

PARAMETER	WELL	DGW-1(Background)				Regulatory Criteria[5]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012	12/11/2014	RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L	4 J				5.56	6.0
Butyl benzyl phyenyl	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L					0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum	ug/L	203	222		49	2,000	
Antimony	ug/L					0.779	6
Arsenic	ug/L					0.0517	10.0
Barium	ug/L	879	260	688	830	377	2,000
Beryllium	ug/L		**26** J			2.46	4
Cadmium	ug/L		0.3 J			0.922	5
Calcium	ug/L	53,700	44,800	37,800	37,000	NS	NS
Chromium	ug/L		3.9 J				100
Cobalt	ug/L					0.601	
Copper	ug/L	3 J	3.3 J	5 J	33	79.9	1,300
Iron	ug/L	1,250	1,020	140 J	410	1,400	
Lead	ug/L						15
Magnesium	ug/L	14,400	11,100	12,200	12,000	NS	NS
Manganese	ug/L	40.7	222	67	14	43.4	
Mercury	ug/L		0.039 J			0.566	2
Nickel	ug/L	4.1 J	1.9 J			39.2	
Potassium	ug/L	3,130	2,430	2,080	2,200	NS	NS
Selenium	ug/L			16 J		9.98	5
Silver	ug/L					9.41	
Sodium	ug/L	35,200	36,500	28,100	27,000	NS	NS
Thallium	ug/L					0.02	2.0
Vanadium	ug/L		1 J			8.64	
Zinc	ug/L	17.8 J	6.5 J			600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in field due to high turbidity. Otherwise, sample was unfiltered.

BEDROCK WELL

PARAMETER	WELL	DGW-6				Regulatory Criteria[6]	
SVOCS[1]	DATE	5/24/2011	8/16/2011	4/17/2012	12/11/2014	RSL	MCL
Acenaphthene	ug/L					53.5	
Acenaphthylene	ug/L					NS	NS
Anthracene	ug/L					177	
Benzo(a)anthracene	ug/L					0.012	
Benzo(a)pyrene	ug/L					0.00343	0.2
Benzo(b)fluoranthene	ug/L					0.0343	
Benzo(k)fluoranthene	ug/L					0.343	
Benzo(ghi)perylene	ug/L					NS	NS
bis(2-Ethylhexyl) phthalate	ug/L		4 J			5.56	6.0
butyl benzyl phthalate	ug/L					16.3	
Carbazole	ug/L					NS	NS
4-Chloroaniline	ug/L					NS	NS
Chrysene	ug/L					3.43	
Dibenz(a,h)anthracene	ug/L					0.00343	NS
Dibenzofuran	ug/L					0.786	
Diethylphthalate	ug/L					1,480	NS
Di-n-butyl phthalate	ug/L					90.2	NS
Fluoranthene	ug/L					80.2	
Fluorene	ug/L					29.4	
Indeno(1,2,3-cd)pyrene	ug/L					0.0343	NS
4-Methylphenol	ug/L					NS	NS
Naphthalene	ug/L					0.165	
3-Nitroaniline	ug/L					NS	NS
Nitrobenzene	ug/L					0.14	
Phenanthrene	ug/L					NS	NS
Phenol	ug/L					577	
Pyrene	ug/L					12.1	
INORGANICS[2]							
Aluminum	ug/L	338			21	2,000	
Antimony	ug/L					0.779	6
Arsenic	ug/L					0.0517	10.0
Barium	ug/L	127	86.9	120	75	377	2,000
Beryllium	ug/L					2.46	4
Cadmium	ug/L					0.922	5
Calcium	ug/L	133,000	100,000	102,000	67,000	NS	NS
Chromium	ug/L	4.7 J					100
Cobalt	ug/L					0.601	
Copper	ug/L	6.4 J	1.5 J	5 J	30	79.9	1,300
Iron	ug/L	336	81.3 J	168 J	950	1,400	
Lead	ug/L						15
Magnesium	ug/L	20,500	22,400	23,800	21,000	NS	NS
Manganese	ug/L	55	94.9	116	**470**	43.4	
Mercury	ug/L	0.13				0.566	2
Nickel	ug/L				6.7	39.2	
Potassium	ug/L	3,450	1,740	1,580	1,600	NS	NS
Selenium	ug/L			28.4		9.98	5
Silver	ug/L					9.41	
Sodium	ug/L	17,700	9,780	10,900	8,900	NS	NS
Thallium	ug/L					0.02	2.0
Vanadium	ug/L					8.64	
Zinc	ug/L		3.8 J			600	

NOTE:

1. For SVOC analyses, J indicates an estimated value, B indicates analyte detected in method blank.
2. For inorganic analyses, B indicates an estimated value, J indicates analyte detected in method blank.
3. Blank space indicates that analyte not detected in a concentration exceeding the Method Detection Limit.
4. Bold indicates the sample exceeds the Regulatory Criteria.
5. MCL taken from 46 CSR 12A Appendix A. Other criteria is the Regional Screening Level (RSL) for tap water taken from the EPA Region III RSL Table . at 1E-06 and HI=0.1 based on the updated May 2016 RSL Table. NS indicates no value published for the analyte.
6. DISS indicates that sample was filtered through a 0.45 micron filter in

Attachment C
Cleanup Standards Tables

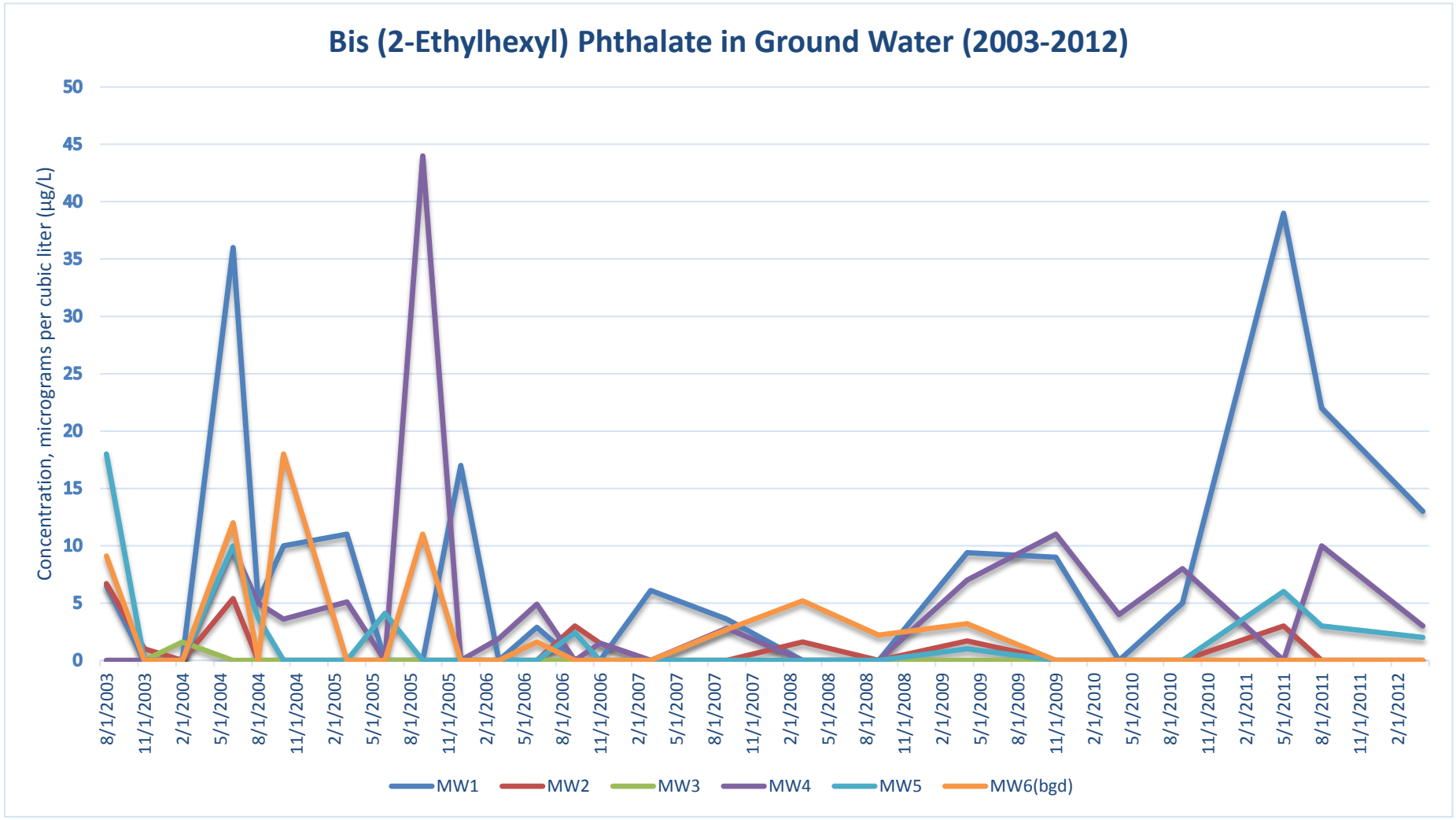
Table 6 - Cleanup Standard for Soils	
Contaminant	**Cleanup Level (mg/kg)**
Total cPAHs	**78 (18.2 B(a)P equivalent)**
Arsenic	**88.8**
Cadmium	**642**
Copper	**41,100**
Lead	**500**

Reference:
1999 Record of Decision
Ordnance Works Disposal Areas Site

Table 7 Sediment Cleanup Levels	
Contaminant	**(ppm)**
Arsenic	**9.62**
Cadmium	**0.35**
Chromium	**30.2**
Copper	**22.7**
Lead	**31.6**
Mercury	**ND**
Zinc	**86.8**

Reference:
1999 Record of Decision
Ordnance Works Disposal Areas Site

Attachment D
Trend Graphs


Bis (2-Ethylhexyl) Phthalate in Ground Water (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
50
45
40
35
30
25
20
15
10
5
0
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
2/1/2010
5/1/2010
8/1/2010
11/1/2010
2/1/2011
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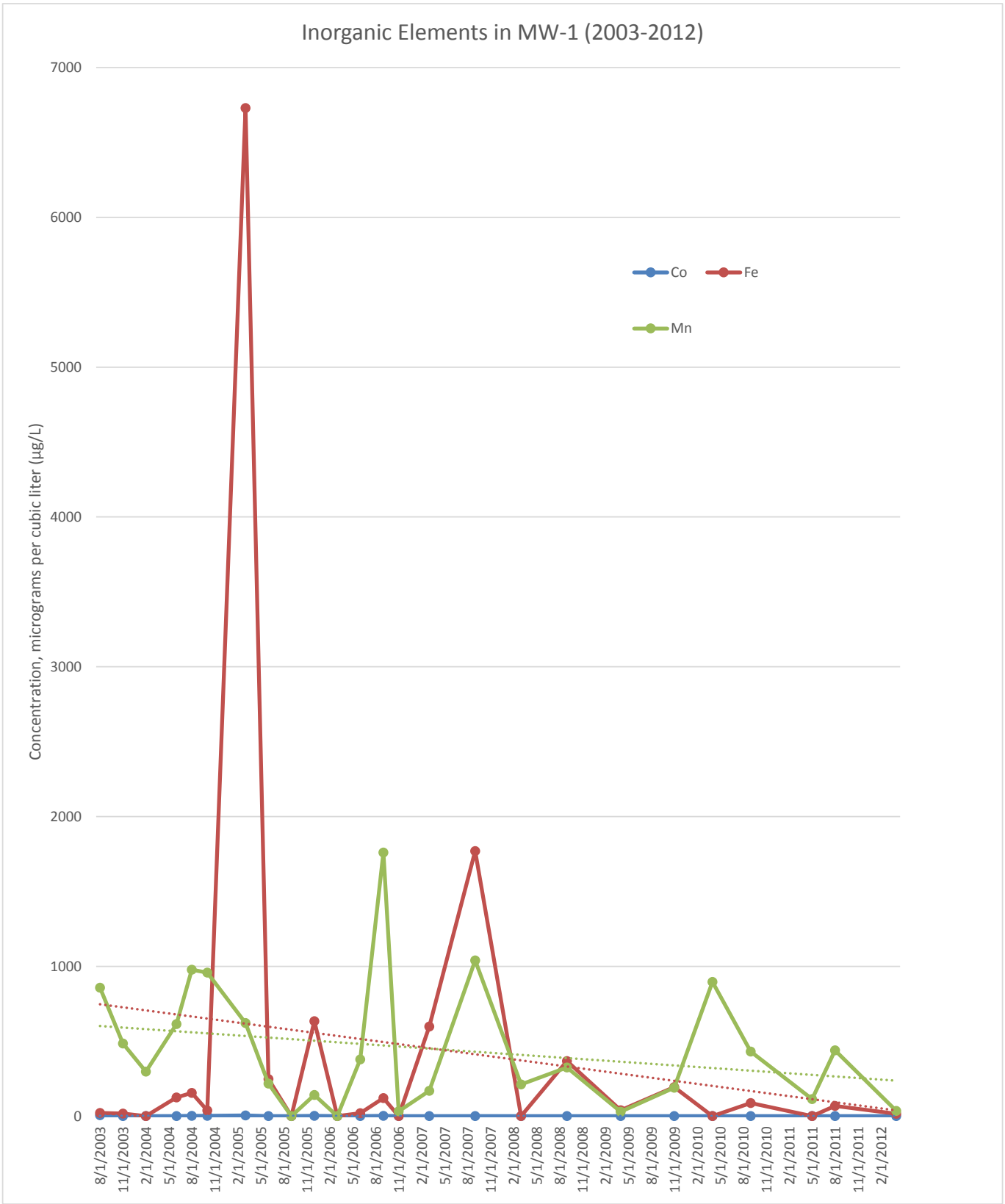
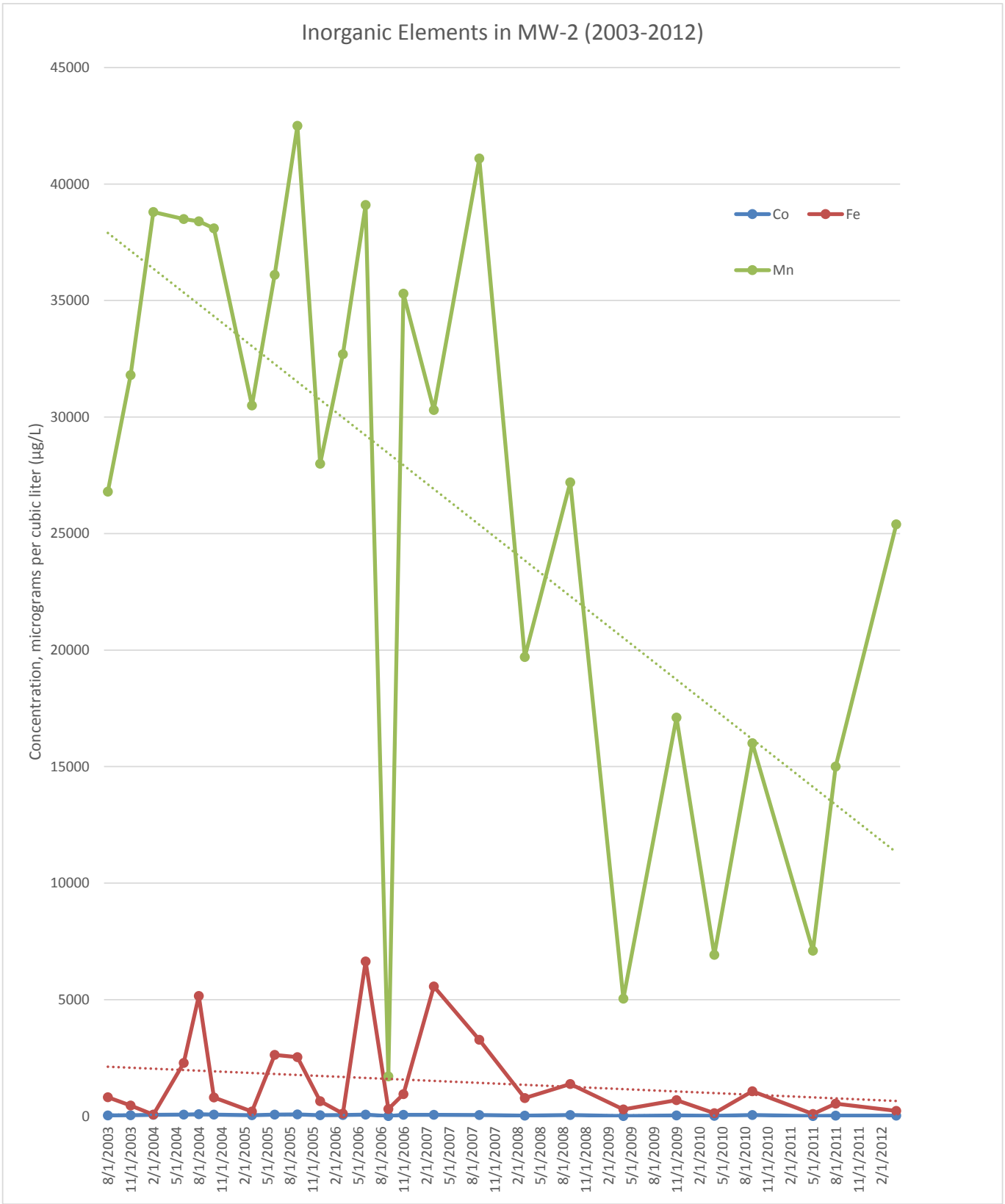
8/1/2011
11/1/2011
2/1/2012
MW1
MW2
MW3
MW4
MW5
MW6(bgd)


Inorganic Elements in MW-1 (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
7000
6000
5000
4000
3000
2000
1000
0
Co
Fe
Mn
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
2/1/2010
5/1/2010
8/1/2010
11/1/2010
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012


Inorganic Elements in MW-2 (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Co
Fe
Mn
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
2/1/2010
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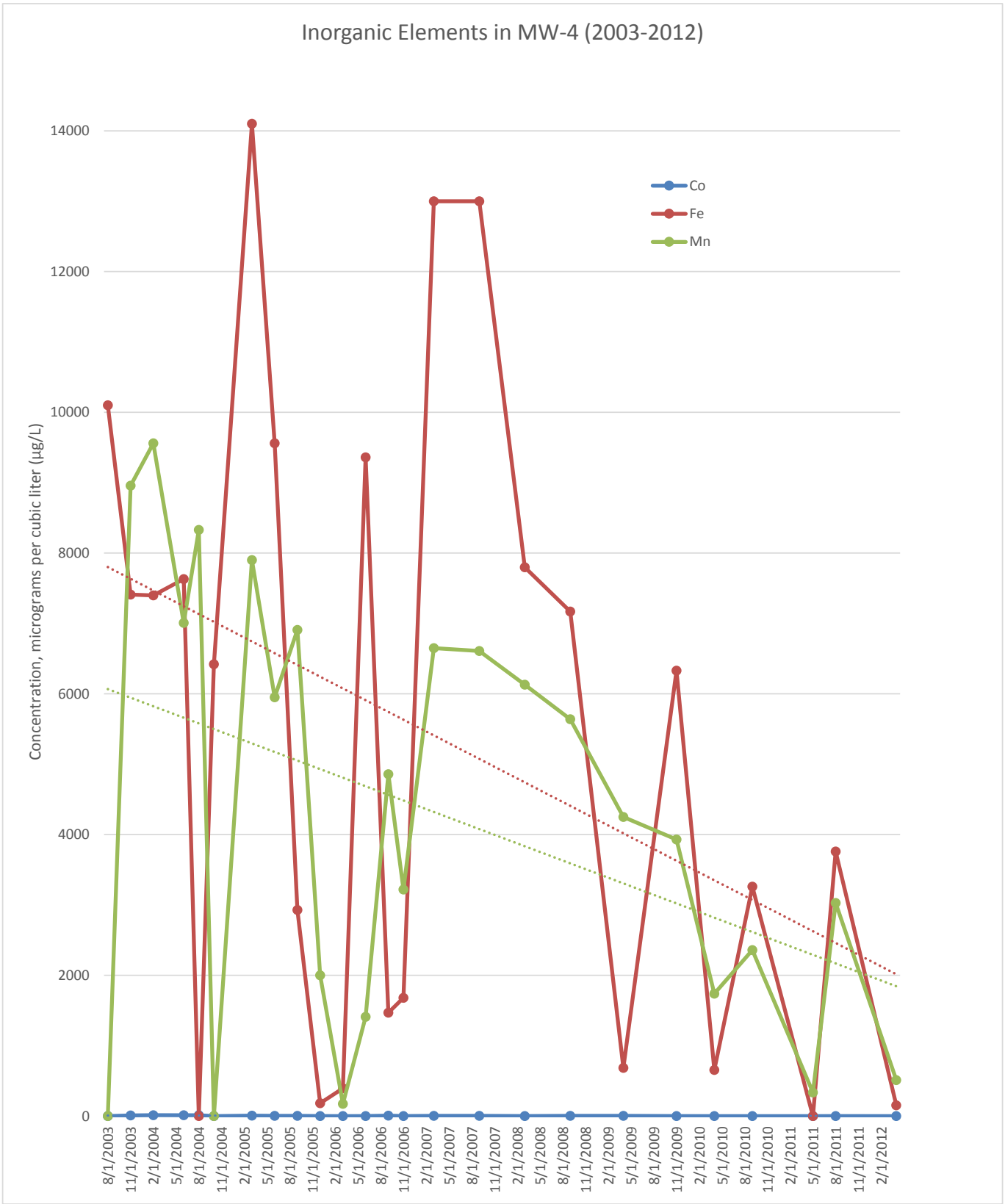
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012


Inorganic Elements in MW-4 (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
14000
12000
10000
8000
6000
4000
2000
0
Co
Fe
Mn
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
2/1/2010
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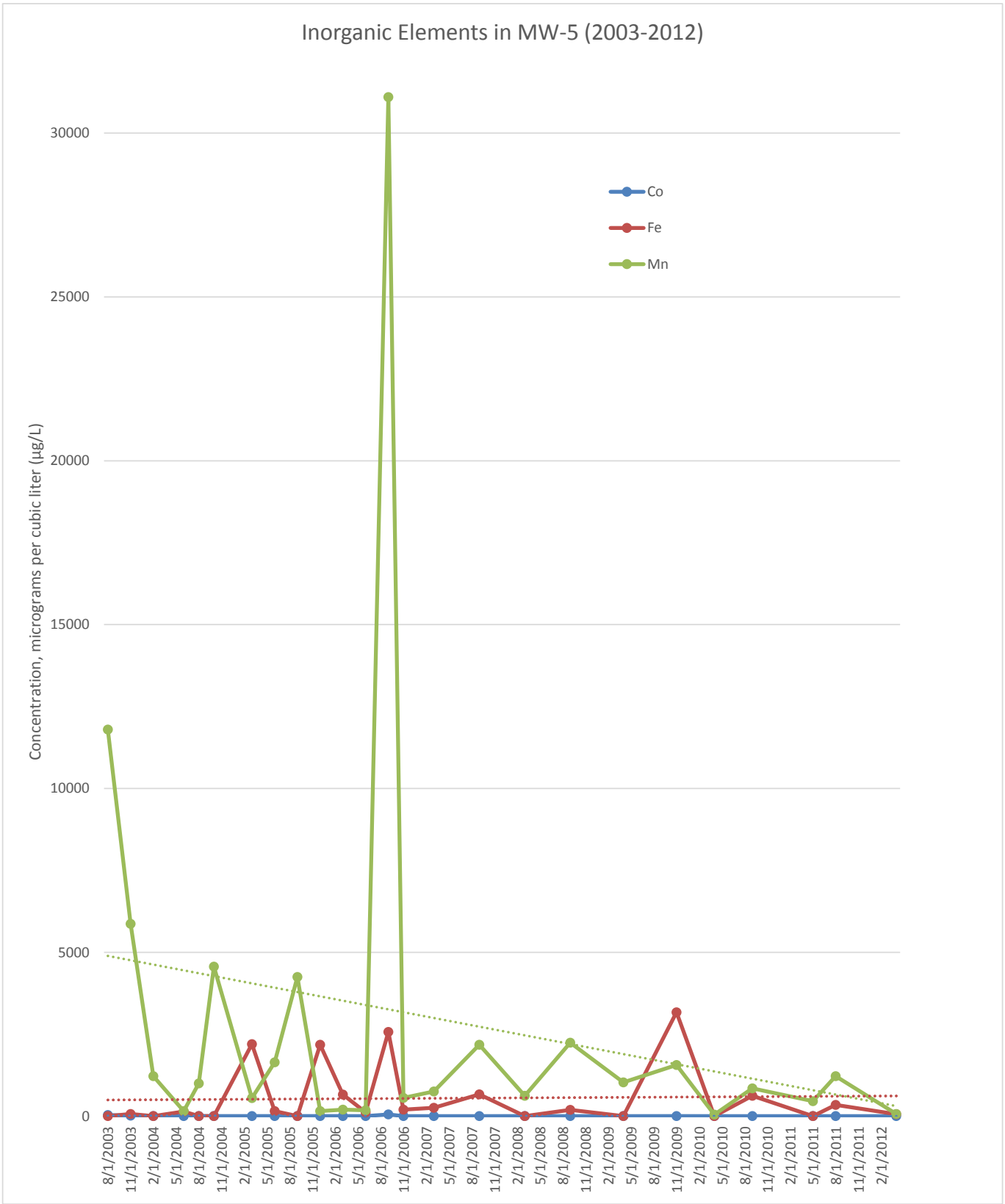
8/1/2010
11/1/2010
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012


Inorganic Elements in MW-5 (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
30000
25000
20000
15000
10000
5000
0
Co
Fe
Mn
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
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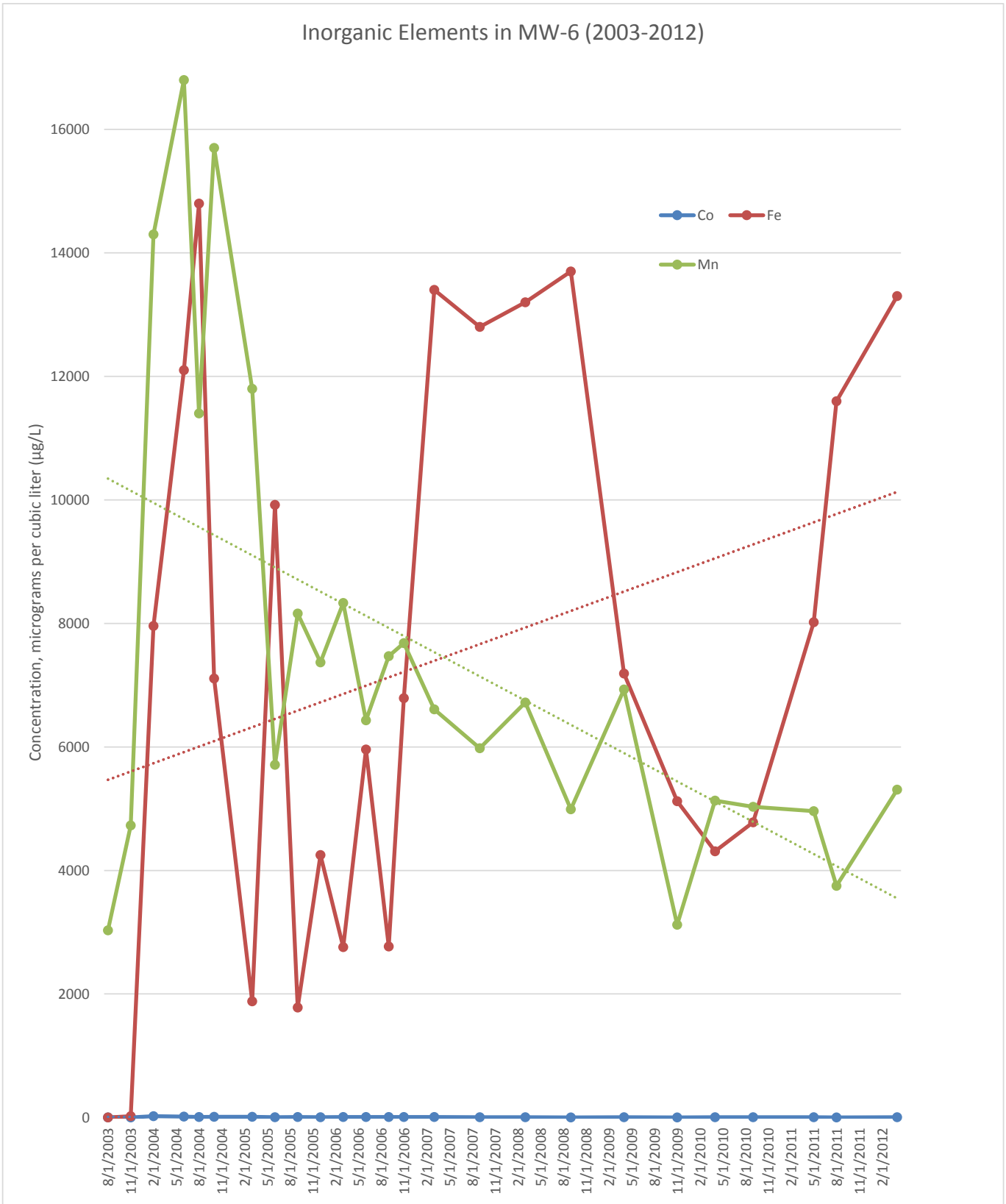
11/1/2010
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012


Inorganic Elements in MW-6 (2003-2012)
Concentration, micrograms per cubic liter (µg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
Co
Fe
Mn
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
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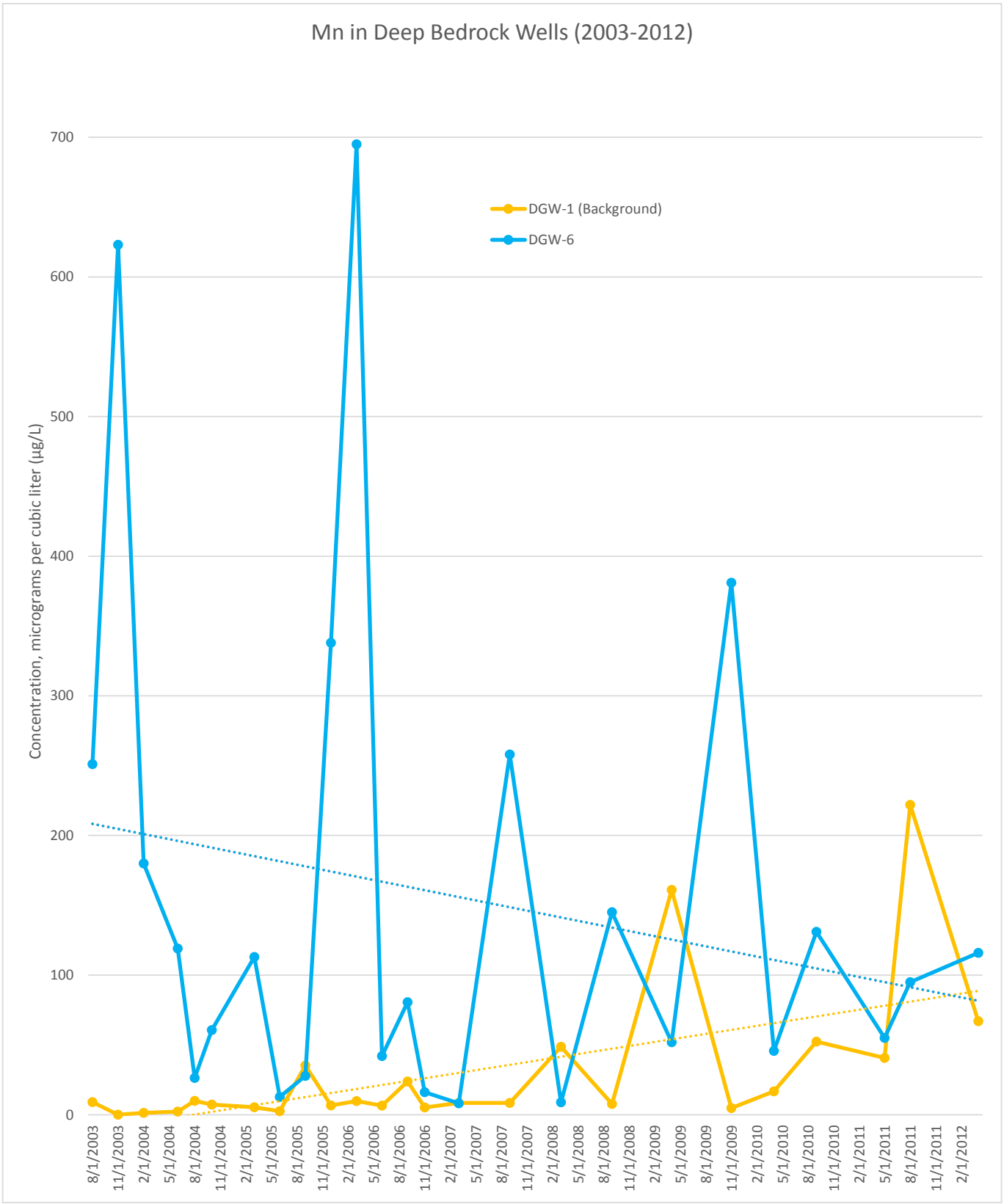
11/1/2010
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012


Mn in Deep Bedrock Wells (2003-2012)
DGW-1 (Background)
DGW-6
Concentration, micrograms per cubic liter (µg/L)
700
600
500
400
300
200
100
0
8/1/2003
11/1/2003
2/1/2004
5/1/2004
8/1/2004
11/1/2004
2/1/2005
5/1/2005
8/1/2005
11/1/2005
2/1/2006
5/1/2006
8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
5/1/2008
8/1/2008
11/1/2008
2/1/2009
5/1/2009
8/1/2009
11/1/2009
2/1/2010
5/1/2010
8/1/2010
11/1/2010
2/1/2011
5/1/2011
8/1/2011
11/1/2011
2/1/2012