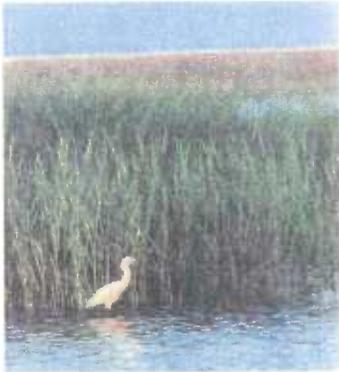


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END-OF SEQUENCE REPORT FOR SAMPLING EVENTS 1, 2, 3, AND 4 FOR SITE 12 NSWC  
INDIAN HEAD MD  
11/1/2005  
UNIVERSE TECHNOLOGIES



**UNIVERSE TECHNOLOGIES, INC.**  
Engineering and Scientific Solutions

**End-of-Sequence Report  
For Sampling Events  
1, 2, 3, and 4**

**For  
Site 12, Town Gut Landfill  
NDW-IH  
Indian Head, MD**

**Prepared For:  
Department of the Navy  
NAVFAC Washington  
1314 Harwood Street, SE  
Washington Navy Yard  
Washington, DC**

**Prepared By:  
Universe Technologies, Inc.  
9 East Second Street  
Frederick, MD 21701**

**Contract No: N62477-01-D-0076  
Delivery Order: 0011  
November 2005**



**UNIVERSE TECHNOLOGIES, INC.**  
Engineering and Scientific Solutions

*Client Retention is Our  
Highest Priority and  
Ultimate Goal*

November 30, 2005

Department of the Navy  
NAVFAC Washington  
1314 Harwood Street SE  
Washington Navy Yard  
Washington, DC 20374

Attn: Mr. Joe Rail

Subject: Revised End-of-Sequence Report for Sampling Events 1, 2, 3, and 4  
NDW-IH  
Indian Head, MD  
Contract No: N62477-01-D-0076

Dear Mr. Rail:

Universe Technologies, Inc. (UNITEC) has revised the End-of-Sequence Report as you requested. This report summarizes the results and trends from groundwater and surface water sampling activities conducted from March 2004 to May 2005 at Site 12, NDW-IH, Indian Head, Maryland.

UNITEC appreciates this opportunity to support the Navy on this project. Should you have any questions, concerning this or any other matter, please contact us at 301-695-0982.

Sincerely,



Michael Newberry  
Business Unit Manager

Distribution: Shawn Jorgensen, (3 Copies and PDF)  
Remedial Project Manager  
Indian Head Division  
Naval Surface Warfare Center  
101 Strauss Ave., Building D-327  
Indian Head, MD 20640

Joe Rail, (1 Copy and PDF)

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## LIST OF ACRONYMS

AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	Constituent of Concern
CIS-1,2-DCE	Cis-1,2-Dichloroethene
LTM	Long Term Monitoring
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MW	Monitoring Well
NAVFAC-WASH	Naval Facilities Engineering Command-Washington
NDW-IH	Naval District Washington-Indian Head
ROD	Record of Decision
RBC	Risk-Based Concentration
SW	Surface Water Sampling Location
SMCL	Secondary Maximum Contaminant Level
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
UCL95	Upper Confidence Limit 95%
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

## 1.0 Executive Summary

The following Constituents of Concern (COCs) were analyzed for in surface water and shallow groundwater during the four sampling events: arsenic, iron, lead, manganese, trichloroethene (TCE), cis-1-2-dichloroethene (CIS-1-2-DCE), and vinyl chloride (VC).

In general, concentrations in shallow groundwater and surface water of both filtered and unfiltered metals showed an upward trend throughout the sampling events. No trends were observed for concentrations of Volatile Organic Compounds (VOCs) in shallow groundwater or surface water. The trends observed in the concentrations of the COCs in shallow groundwater and surface water throughout the sampling events are summarized in Table 1 on page 5.

### GROUNDWATER

The regulatory criteria for the concentrations of the filtered and unfiltered metals in shallow groundwater were consistently exceeded throughout the sampling events. The sole exception to this was the concentration of filtered lead in shallow groundwater, which did not exceed the U.S. Environmental Protection Agency (USEPA) Action Level of 15 µg/l in any sampling event at any monitoring well. The Maximum Contaminant Levels (MCLs) of VOCs in shallow groundwater were not exceeded in any sampling event at any monitoring well. A summary of the regulatory criteria for COCs in groundwater is provided in Table 2 on page 6. A summary of the sampling locations and sampling events in which the regulatory criteria for the COCs in shallow groundwater was exceeded is provided in Table 3 on page 7.

### SURFACE WATER

The regulatory criteria for the concentrations of the filtered and unfiltered metals in surface water was consistently exceeded throughout the sampling events. The exception to this was the concentration of filtered and unfiltered lead in surface water, neither of which exceeded the Ambient Water Quality Criteria (AWQC) of 50 µg/l in any sampling event at any sampling location. The AWQCs of the VOCs TCE and VC were exceeded in the third sampling event at surface water sampling location 7 (SW-7). A summary of the regulatory criteria for the COCs in surface water is provided in Table 2 on page 6. A summary of the sampling locations and sampling events in which the regulatory criteria for the COCs in surface water were exceeded is provided in Table 4 on page 8.

### HUMAN HEALTH and ECOLOGICAL RISK ASSESSMENT

A human health risk assessment was performed for the site using methodology found in the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001. Hazard Quotients and Cancer Risks for human health were calculated for dermal contact with shallow groundwater and ingestion of shallow groundwater. The individual Hazard Quotients for each COC and exposure method were totaled to produce a value called the Hazard Index for the site. In addition, the individual Cancer Risks for each COC and exposure method were summed to

produce a total Cancer Risk for the site. The ecological risk assessment was based on USEPA Region III Freshwater Screening Benchmarks for an Ecological Risk Assessment.

It should be noted that the following was taken into account when the Human Health Risk Assessment and Ecological Risk Assessment for the site were performed:

- Human Health Risk Assessment calculations were conducted according to an industrial use scenario.
- Human Health Risk Assessment calculations were considered for shallow groundwater ingestion and dermal contact with shallow groundwater.
- The values used for the COC concentrations in shallow groundwater and surface water were the Upper Confidence Limit 95% (UCL95) values calculated based on a lognormal distribution.

According to the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001, Hazard Indexes above unity or one and total Cancer Risks above  $1.0 \times 10^{-4}$  are considered an unacceptable risk to human health. Both the Hazard Index (85.4066) and the total Cancer Risk ( $2.0 \times 10^{-4}$ ) for the site are above these thresholds. The major contributing factors to these values are the Cancer Risk from ingestion of arsenic in shallow groundwater at the site, and Hazard Quotients from ingestion of arsenic, iron, manganese and TCE in shallow groundwater at the site.

An ecological risk assessment for the site was performed based on the USEPA Region III Freshwater Screening Benchmarks for an Ecological Risk Assessment depicted in Table 10. Based on the UCL95 concentrations for the COCs in surface water (Table 9), arsenic, iron, lead and manganese were above the thresholds mentioned above. TCE and VC were below the thresholds, while no Freshwater Screening Benchmark was available for CIS-1-2-DCE. Based on this data, arsenic, iron, lead and manganese in surface water pose an ecological risk to the site.

## 2.0 Introduction

This End-of-Sequence Report was generated following the fourth shallow groundwater and surface water sampling event at Site 12 – Town Gut Landfill, Naval District Washington-Indian Head (NDW-IH), located in Indian Head, Maryland (Figures 1-3). Long Term Monitoring (LTM) is being conducted under Contract N62477-01D-0076, with copies of the report submitted to Naval Facilities Engineering Command-Washington (NAVFAC-WASH) and NDW-IH. The report presents a summary of the results and trends after the completion of four sampling events. This report covers the sampling events that occurred on 11 March 2004 (the first sampling event), 30 September 2004 (the second sampling event), 28 February 2005 (the third sampling event), and 3-5 May 2005 (the fourth sampling event). The sampling events were intended to be conducted in three month intervals, however delays were caused because of the requirement to incorporate low flow sampling methods.

## **2.1 Purpose and Objectives of Long Term Monitoring**

The purpose of LTM is to measure the concentrations of COCs specified in the Record of Decision (ROD). The constituents of concern specified in the ROD are the VOCs, TCE, VC, and CIS-1-2-DCE; and the metals arsenic, lead, iron, and manganese. The ROD was rendered for Site 12 where water is sampled from seven shallow groundwater monitoring wells (MW) and from four surface water sample locations (SW). The Navy and the USEPA were signatories to the Site 12 ROD along with concurrence from the Maryland Department of the Environment (MDE).

The objectives of the LTM program at Site 12 are as follows:

- Ensure that the remedy remains protective
- Monitor contaminants on a regular basis
- Identify contaminant concentration trends
- Ensure that contaminants do not affect a drinking water source
- Ensure that contaminants do not migrate off site
- Inspect and maintain the soil cover and vegetation
- Comply with MDE landfill post-closure regulations

## **2.2 Base Description**

NDW-IH, consisting of the Main Installation and Stump Neck Annex, is located along the Potomac River in Charles County, Maryland, approximately 25 miles southwest of Washington, DC. The Main Installation and Stump Neck Annex are noncontiguous, separated by Mattawoman Creek. The facility comprises approximately 3,500 acres, of which the Main Installation comprises 70 percent. Throughout the facility's history, operations have included ordnance research and production. Currently, operations include ordnance research and development, testing and evaluation, and storage. Administration and housing facilities are also located at the base. A map of NDW-IH is presented on the following page as Figure 1.

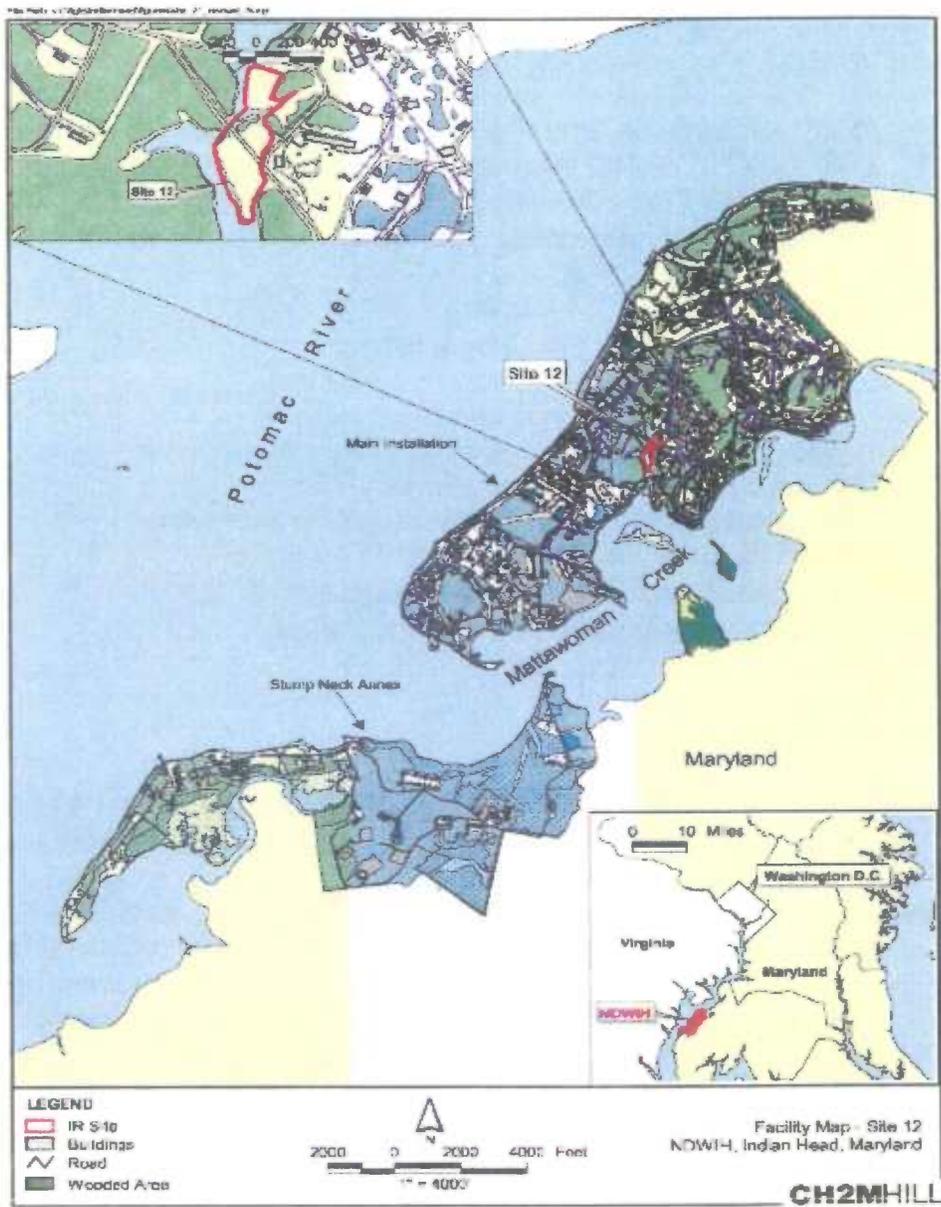


Figure 1:  
Site Location Map, Site 12, NDW-IH, Indian Head, Maryland

## 2.3 Site Description

Site 12 is centrally located on the Main Installation, comprising approximately 4 acres of undeveloped land (Figure 48). Atkins Road Extension and a portion of the Site 12 Pond, trisect the site, creating northern, central and southern portions.

Between 1968 and 1980, the site was used by NDW-IH to dispose of landscaping waste, fill material and rubble. Unauthorized dumping of paint, varnish and other chemicals may have occurred at the site as well. The site was investigated and remediated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The chosen remedy, a 2-foot thick, vegetated soil cover, was installed in 2003.

## 3.0 Summary of Sequence Results

The tables and figures in Appendix A show analyte concentrations within each monitoring well and surface water sampling location throughout the four sampling events for shallow groundwater and surface water. Table 2 on the next page shows the USEPA groundwater and surface water criteria for the Site 12 COCs.

## 4.0 Trends Analysis

In general, concentrations in shallow groundwater and surface water of both filtered and unfiltered metals showed an upward trend throughout the sampling events except as noted in Table 1. No trends were observed for concentrations of VOCs in groundwater and surface water. However, a spike was observed for the concentrations of TCE and VC in surface water during the third sampling event at SW-7. The trends observed in the concentrations of the COCs throughout the sampling events are summarized below in Table 1.

<b>COC</b>	<b>Sampling Locations in which an Upward Trend in Concentration was Observed</b>	<b>Sampling Locations in which a Downward Trend in Concentration was Observed</b>
<b>Unfiltered Arsenic</b>	---	MW-9
<b>Filtered Arsenic</b>	---	---
<b>Unfiltered Iron</b>	MW-7, SW-8, SW-9, SW-10	MW-11
<b>Unfiltered Lead</b>	MW-7, SW-8	MW-8
<b>Unfiltered Manganese</b>	SW-8, MW-10	---
<b>Filtered Manganese</b>	SW-7, MW-8, SW-8, MW-10, SW-10	---

## 5.0 Groundwater and Surface Water Regulatory Criteria

<b>Constituent</b>	<b>Groundwater</b>	<b>Surface Water</b>
TCE	5 MCL	2.7 AWQC
Cis-1,2-DCE	70 MCL	70 MCL
VC	2 MCL	2 AWQC
Arsenic	10 MCL	0.018 AWQC
Iron	22,000 RBC	300 AWQC
Lead	15 (Action Level)	15 (Action Level)
Manganese	50 SMCL	50 AWQC

### NOTES

All values are in ug/l

MCL – Maximum Contaminant Level

USEPA Drinking Water Standards and Health Advisories - 2004

SMCL – Secondary Maximum Contaminant Level

USEPA Drinking Water Standards and Health Advisory - 2004

AWQC – Ambient Water Quality Criteria, 40 CFR 131.36

40CFR131.36 – July 1, 2005

RBC- EPA Region 3 Risk-Based Concentration

USEPA Region III RBC Table – September 25, 2001

Action Level

USEPA Drinking Water Standards and Health Advisory-2004

## 5.1 Groundwater Regulatory Criteria

The regulatory criteria for the concentrations of the filtered and unfiltered metals in shallow groundwater were consistently exceeded throughout the sampling events. The sole exception to this was the concentration of filtered lead in shallow groundwater, which did not exceed the USEPA Action Level of 15 µg/l in any sampling event at any monitoring well. The MCLs of VOCs in groundwater were not exceeded in any sampling event at any monitoring well. A summary of the regulatory criteria for COCs in groundwater is provided in Table 2. A summary of the sampling locations and sampling events in which the regulatory criteria for the COCs was exceeded is provided on the next page in Table 3.

**Table 3.  
Groundwater Regulatory Limits of COCs Exceeded by Sampling Location**

Sampling Round	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>COC</b>				
<b>Unfiltered Arsenic</b>	MW-9, MW-10	NONE	MW-9	MW-12
<b>Filtered Arsenic</b>	NONE	NONE	NONE	NONE
<b>Unfiltered Iron</b>	MW-8, MW-9, MW-10, MW-11, MW-12, MW-13	MW-8, MW-9, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13
<b>Filtered Iron</b>	MW-8, MW-9, MW-10, MW-11, MW-13	MW-11, MW-13	MW-8, MW-9, MW-10, MW-11, MW-13	MW-8, MW-9, MW-10, MW-11, MW-13
<b>Unfiltered Lead</b>	MW-7, MW-8, MW-12	NONE	MW-7, MW-9	MW-7, MW-10
<b>Filtered Lead</b>	NONE	NONE	NONE	NONE
<b>Unfiltered Manganese</b>	All Locations Above SMCL	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	All Locations Above SMCL
<b>Filtered Manganese</b>	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13	MW-7, MW-8, MW-9, MW-10, MW-11, MW-13
<b>Cis-1-2-DCE</b>	NONE	NONE	NONE	NONE
<b>TCE</b>	NONE	NONE	NONE	NONE
<b>VC</b>	NONE	NONE	NONE	NONE

## 5.2 Surface Water Regulatory Criteria

The regulatory criteria for the concentrations of the filtered and unfiltered metals in surface water were consistently exceeded throughout the sampling events. The exception to this was the concentration of filtered and unfiltered lead in surface water, neither of which exceeded the Action Level of 15 µg/l in any sampling event at any sampling location. The MCL of 70 µg/l in surface water of the VOC CIS-1-2-DCE was not exceeded in any sampling event at any sampling location. The MCLs of the VOCs TCE and VC were exceeded in the third sampling event at SW-7. A summary of the regulatory criteria for the COCs in surface water is provided in Table 2 on page 6. A summary of the sampling locations and sampling events in which the regulatory criteria for the COCs was exceeded is provided in Table 4.

<b>Table 4.</b>				
<b>Surface Water Regulatory Limits of COCs Exceeded by Sampling Location</b>				
<b>Sampling Round</b>	<b>1<sup>st</sup></b>	<b>2<sup>nd</sup></b>	<b>3<sup>rd</sup></b>	<b>4<sup>th</sup></b>
<b>COC</b>				
<b>Unfiltered Arsenic</b>	SW-7, SW-9	SW-7	SW-9	SW-7, SW-9, SW-10
<b>Filtered Arsenic</b>	Filtered Arsenic was Not Analyzed for Surface Water in the 1 <sup>st</sup> Sampling Round	NONE	NONE	NONE
<b>Unfiltered Iron</b>	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC
<b>Filtered Iron</b>	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC
<b>Unfiltered Lead</b>	NONE	NONE	NONE	NONE
<b>Filtered Lead</b>	NONE	NONE	NONE	NONE
<b>Unfiltered Manganese</b>	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC
<b>Filtered Manganese</b>	All Sampling Locations Above AWQC	SW-10	All Sampling Locations Above AWQC	All Sampling Locations Above AWQC
<b>Cis-1-2-DCE</b>	NONE	NONE	NONE	NONE
<b>TCE</b>	NONE	NONE	SW-7	NONE
<b>VC</b>	NONE	NONE	SW-7	NONE

## 6.0 Human Health and Ecological Risk Evaluation

A human health risk assessment was performed for the site using methodology found in the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001. Hazard Quotients and Cancer Risks for human health were calculated for dermal contact with shallow groundwater and ingestion of shallow groundwater. The individual Hazard Quotients for each COC and exposure method were totaled to produce a value called the Hazard Index for the site. In addition, the individual Cancer Risks for each COC and exposure method were summed to produce a total Cancer Risk for the site. The ecological risk assessment was based on USEPA Region III Freshwater Screening Benchmarks for an Ecological Risk Assessment. The following COCs were included in this risk assessment: arsenic, iron, lead, manganese, TCE, CIS-1-2-DCE, and VC.

It should be noted that the following was taken into account when the Human Health Risk Assessment and Ecological Risk Assessment for the site were performed:

- Human Health Risk Assessment calculations were conducted according to an industrial use scenario.
- Human Health Risk Assessment calculations were considered for shallow groundwater ingestion and dermal contact with shallow groundwater.
- The values used for the COC concentrations in shallow groundwater and surface water were the Upper Confidence Limit 95% (UCL95) values calculated based on a lognormal distribution.

#### HUMAN HEALTH RISK ASSESSMENT

Constituent of Concern	UCL95 Concentration in Shallow Groundwater in $\mu\text{g/l}$
Arsenic	19.01
Iron	89049.48
Lead	36.27
Manganese	13336.77
CIS-1-2-DCE	2.5
TCE	2.5
VC	5.0

A Hazard Quotient and Cancer Risk were calculated for each COC for the following exposure methods: dermal contact with shallow groundwater and ingestion of shallow groundwater using the UCL95 values. A summary of the UCL95 concentrations of the COCs in shallow groundwater is presented above in Table 5. Hazard Quotients and Cancer Risks for each COC for the different exposure methods are presented in Tables 6 and 7. Table 8 provides a summary of the Hazard Index and total Cancer Risk for the site.

Constituent of Concern	Hazard Quotient	Cancer Risk
Arsenic	0.0506	$1.9 \times 10^{-6}$
Iron	0.2381	NCSF
Lead	NRFD	NCSF
Manganese	0.5350	NCSF
CIS-1-2-DCE	0.0002	NCSF
TCE	0.0001	$5.5 \times 10^{-10}$
VC	0.0012	$4.8 \times 10^{-7}$
<b>Total</b>	<b>0.8252</b>	<b><math>2.3 \times 10^{-6}</math></b>
NCSF-Cancer Risk can not be calculated because no Cancer Slope Factor is available		
NRFD-Hazard Quotient can not be calculated because no Reference Dose is available		

Table 7. Summary of Ingestion of Shallow Groundwater Risk Site 12, NDW-IH Indian Head, Maryland		
Constituent of Concern	Hazard Quotient	Cancer Risk
Arsenic	5.1690	$1.9 \times 10^{-4}$
Iron	24.2034	NCSF
Lead	NRFD	NCSF
Manganese	54.3736	NCSF
CIS-1-2-DCE	0.0203	NCSF
TCE	0.6793	$6.5 \times 10^{-6}$
VC	0.1358	$3.8 \times 10^{-9}$
<b>Total</b>	<b>84.5814</b>	<b><math>2.0 \times 10^{-4}</math></b>
NCSF-Cancer Risk can not be calculated because no Cancer Slope Factor is available		
NRFD-Hazard Quotient can not be calculated because no Reference Dose is available		

Table 8. Summary of Hazard Quotients and Cancer Risks for all Exposure Methods Site 12, NDW-IH Indian Head, Maryland		
Constituent of Concern	Hazard Quotient	Cancer Risk
Dermal Contact with Shallow Groundwater	0.8252	$2.3 \times 10^{-6}$
Ingestion of Shallow Groundwater	84.5814	$2.0 \times 10^{-4}$
<b>Total</b>	<b>85.4066 (Hazard Index)</b>	<b><math>2.0 \times 10^{-4}</math></b>

According to the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001, Hazard Indexes above unity or one and total Cancer Risks above  $1.0 \times 10^{-4}$  are considered an unacceptable risk to human health. Both the Hazard Index (85.4066) and the total Cancer Risk ( $2.0 \times 10^{-4}$ ) for the site are above these thresholds. The major contributing factors to these values are the Cancer Risk from ingestion of arsenic in shallow groundwater at the site, and Hazard Quotients from ingestion of arsenic, iron, manganese, and TCE in shallow groundwater at the site.

#### ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment for the site was performed based on the USEPA Region III Freshwater Screening Benchmarks for an Ecological Risk Assessment depicted in Table 10. Based on the UCL95 concentrations for the COCs in surface water (Table 9), arsenic, iron, lead and manganese were above the thresholds mentioned above. TCE and VC were below the thresholds, while no Freshwater Screening Benchmark was available for CIS-1-2-DCE. Based on this data, arsenic, iron, lead and manganese in surface water pose an ecological risk to the site.

Constituent of Concern	UCL95 Concentration in Surface Water in $\mu\text{g/l}$
Arsenic	9.52
Iron	6169.26
Lead	6.80
Manganese	502.01
CIS-1-2-DCE	2.5
TCE	3.90
VC	7.18

COC	Freshwater Screening Benchmark in $\mu\text{g/l}$
Arsenic	5.0
Iron	300
Lead	2.5
Manganese	120
CIS-1-2-DCE	None Available
TCE	21
VC	930

## 7.0 Conclusions and Recommendations

Four sampling events have been conducted as part of the LTM at Site 12, NDW-IH. The field effort consisted of water level gauging and shallow groundwater and surface water sampling. As discussed above, some regulatory criteria were exceeded in shallow groundwater and surface water samples collected at the site. The results of the human health risk assessment indicate that ingestion of shallow groundwater at the site should be considered an unacceptable risk to human health. The results of the ecological risk assessment indicate that concentrations of arsenic, iron, lead and manganese in surface water pose an ecological risk to the site. However, few conclusions can be drawn at this point, due to the absence of temporal or spatial trends.

There are no recommendations at this time, other than to continue LTM as scheduled.

# APPENDIX A

## Summary Tables and Figures of Shallow Groundwater and Surface Water Contaminant Concentrations

**Table 11.**  
**MW-7 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	8.6	<2.4
Iron	15400.0	11700	47900	48800
Lead	21.0	9.3	34.3	37.1
Manganese	305.0	52.3	154.0	224.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	675.0	35.7	360.0	380.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	111.0	65.3	58.4	103.0

Dilution Factor is 1

**Table 12.**  
**MW-8 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	89700.0	88000.0	87600.0	90900.0
Lead	16.0	2.2	<2.1	<2.1
Manganese	2500.0	2780.0	2670.0	2670.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	82300.0	3400.0	89600.0	91300.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	2440.0	2640.0	2670.0	2700.0

Dilution Factor is 1

**Table 13.**  
**MW-9 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	28.3	<2.4	13.9	8.9
Iron	120000.0	34300.0	116000.0	65600.0
Lead	13.9	<2.1	25.8	<2.1
Manganese	1580.0	473.0	997.0	1630.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	8.3	<2.4	<2.4	<2.4
Iron	99600.0	1430.0	40500.0	68200.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	2130.0	409.0	1500.0	1520.0

Dilution Factor is 1

**Table 14.**  
**MW-10 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	20.6	<2.4	<2.4	<2.4
Iron	54100.0	16500.0	32600.0	114000.0
Lead	10.0	5.2	3.8	111.0
Manganese	889.0	682.0	1010.0	1410.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	<2.4	<2.4	8.4	<2.4
Iron	28000.0	<17.4	41500.0	41300.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	711.0	588.0	1010.0	957.0

Dilution Factor is 1

**Table 15.**  
**MW-11 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	113000.0	99700.0	37500.0	60500.0
Lead	<2.1	<2.1	5.9	<2.1
Manganese	1430.0	1240.0	821.0	5690.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	113000.0	22700.0	48100.0	57900.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	1440.0	1190.0	842.0	5170.0

Dilution Factor is 1

**Table 16.**  
**MW-12 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	<2.4	448.0
Iron	22100.0	12400.0	10900.0	21500.0
Lead	38.3	10.9	8.4	13.0
Manganese	281.0	39.3	40.3	71.4
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	541.0	<17.4	1580.0	<17.4
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	22.4	11.6	24.7	19.47

Dilution Factor is 1

**Table 17.**  
**MW-13 Contaminant Shallow Groundwater Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	<2.4	<2.4
Iron	89100.0	84900.0	54500.0	71000.0
Lead	13.2	<2.1	<2.1	<2.1
Manganese	7270.0	8020.0	5430.0	61500.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	78700.0	41300.0	57100.0	70800.0
Lead	<2.1	<2.1	<2.1	<2.1
Manganese	6990.0	7820.0	5360.0	6070.0

Dilution Factor is 1

**Table 18.**  
**SW-7 Contaminant Surface Water Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	17.0	<5.0
VC	<10.0	<10.0	23.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	10.6	8.1	<2.4	14.3
Iron	9640.0	2890.0	4110.0	14600.0
Lead	10.7	3.9	2.5	6.0
Manganese	526.0	115.0	387.0	642.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	853.0	564.0	2190.0	1010.0
Lead	2.3	2.7	<2.1	<2.1
Manganese	151.0	1.9	390.0	502.0

Dilution Factor is 1

**Table 19.**  
**SW-8 Contaminant Surface Water Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	2450.0	2760.0	2400.0	4570.0
Lead	4.4	4.9	2.2	5.8
Manganese	215.0	167.0	311.0	333.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	372.0	581.0	1050.0	575.0
Lead	NA	<2.1	<2.1	<2.1
Manganese	58.0	3.1	331.0	218.0

Dilution Factor is 1

**Table 20.**  
**SW-9 Contaminant Surface Water Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	8.6	<2.4	9.3	10.2
Iron	4140.0	2470.0	6040.0	4750.0
Lead	4.3	6.1	9.8	4.7
Manganese	354.0	84.9	400.0	486.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	768.0	363.0	1510.0	377.0
Lead	NA	<2.1	2.7	<2.1
Manganese	185.0	13.7	316.0	393.0

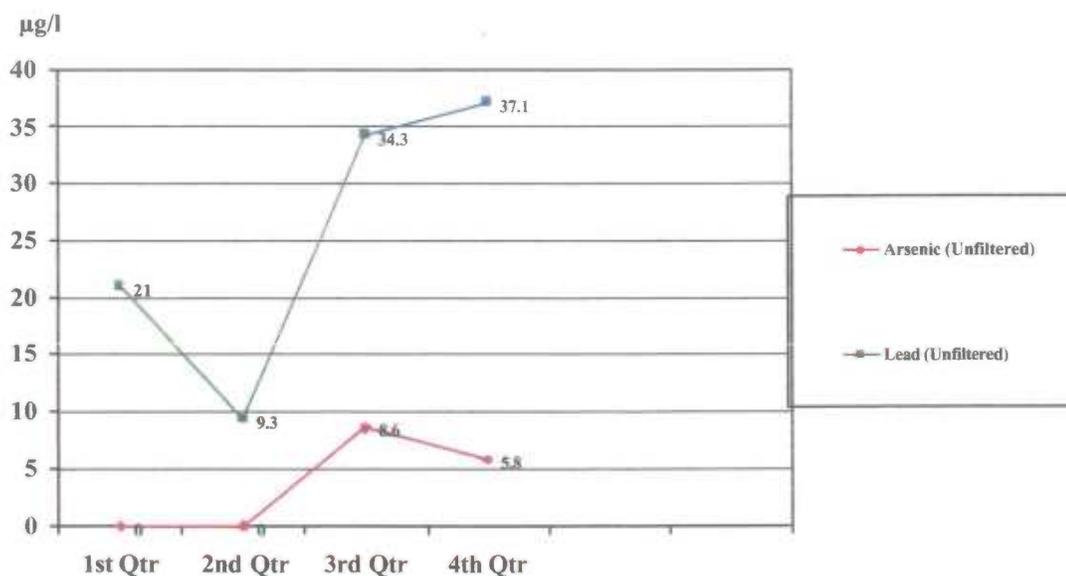
Dilution Factor is 1

**Table 21.**  
**SW-10 Contaminant Surface Water Concentrations**

Sampling Record	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
<b>Date of Collection</b>				
<b>Volatile Organic Compounds (ug/L)</b>				
CIS-1-2-DCE	<5.0	<5.0	<5.0	<5.0
TCE	<5.0	<5.0	<5.0	<5.0
VC	<10.0	<10.0	<10.0	<10.0
<b>Metals (ug/L) (Unfiltered)</b>				
Arsenic	<2.4	<2.4	<2.4	10.2
Iron	2740.0	1730.0	1680.0	4750.0
Lead	2.9	3.8	9.8	4.7
Manganese	500.0	184.0	392.0	486.0
<b>Metals (ug/L) (Filtered)</b>				
Arsenic	NA	<2.4	<2.4	<2.4
Iron	341.0	1730.0	914.0	377.0
Lead	NA	3.8	<2.1	<2.1
Manganese	62.6	184.0	384.0	393.0

Dilution Factor is 1

**Figure 2.**  
**MW-7 Contaminant Ground Water Concentrations**  
**for Arsenic and Lead**



Note: Unfiltered arsenic samples for Quarters 1 and 2, and filtered arsenic and lead samples for all four quarters were all below the Method Detection Limit (MDL).

Figure 3.  
MW-7 Contaminant Ground Water Concentrations  
for Iron

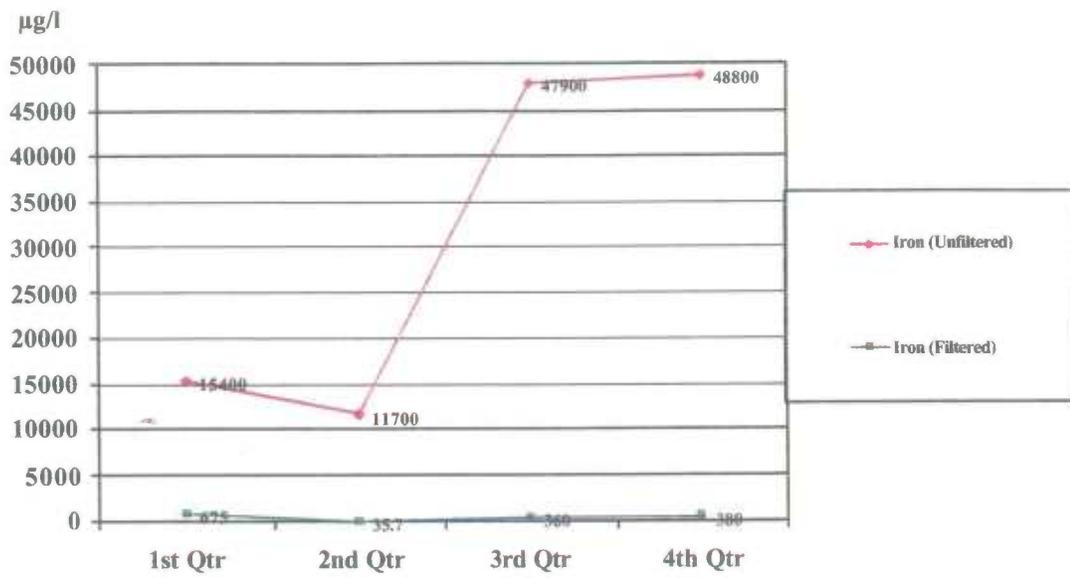
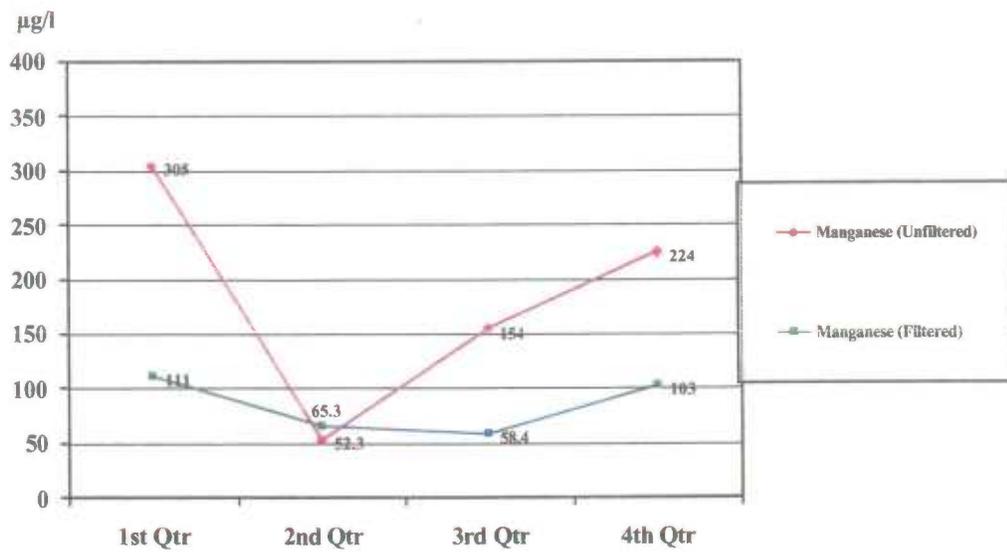
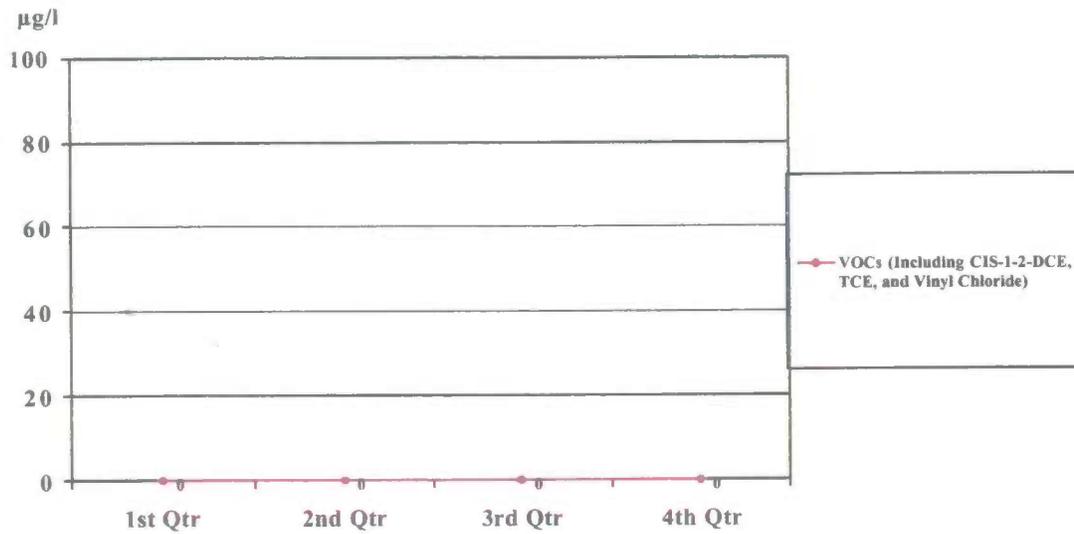


Figure 4.  
MW-7 Contaminant Ground Water Concentrations  
for Manganese

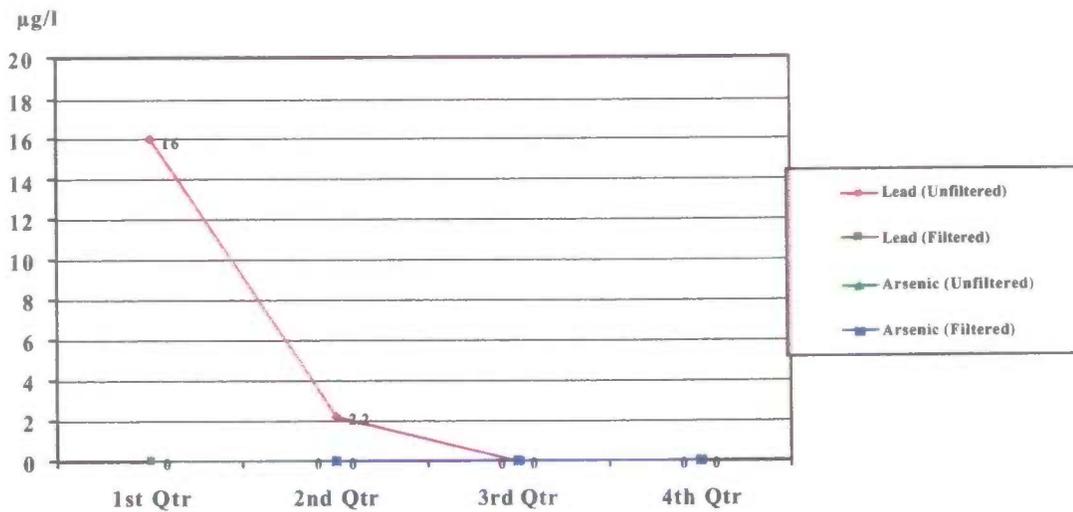


**Figure 5.**  
**MW-7 Contaminant Ground Water Concentrations**  
**for VOCs**



Note: VOC samples for all four quarters were below the MDL.

**Figure 6.**  
**MW-8 Contaminant Ground Water Concentrations**  
**for Lead and Arsenic**



Note: Unfiltered arsenic samples and filtered arsenic and lead samples were all below the MDL for all four quarters. Unfiltered lead samples were below the MDL for Quarters 3 and 4.

Figure 7.  
MW-8 Contaminant Ground Water Concentrations  
for Iron

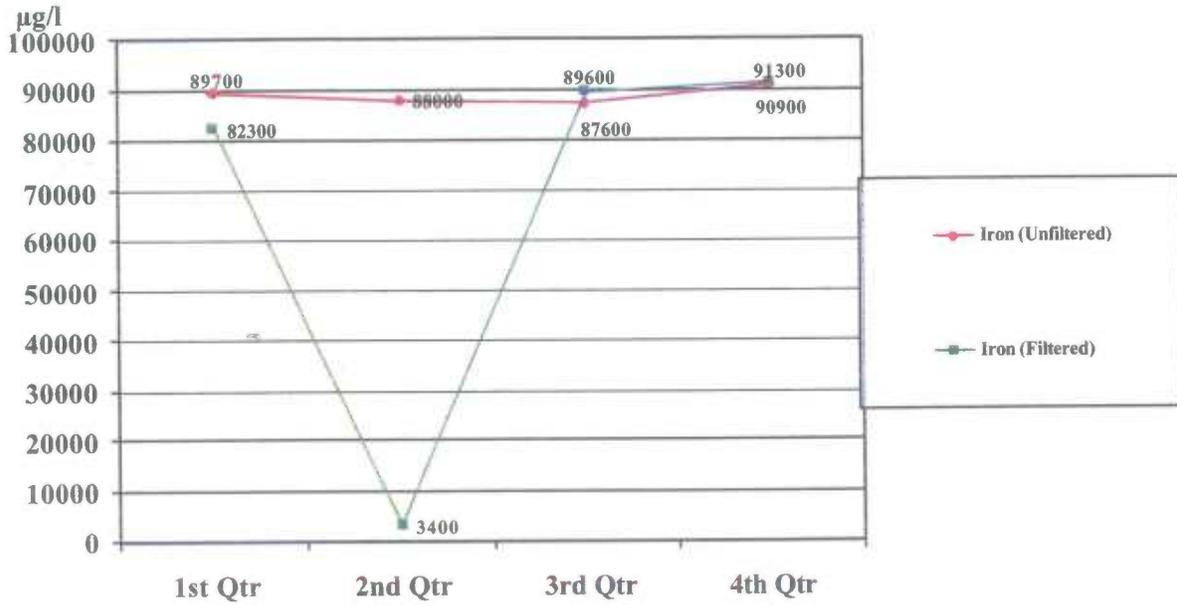
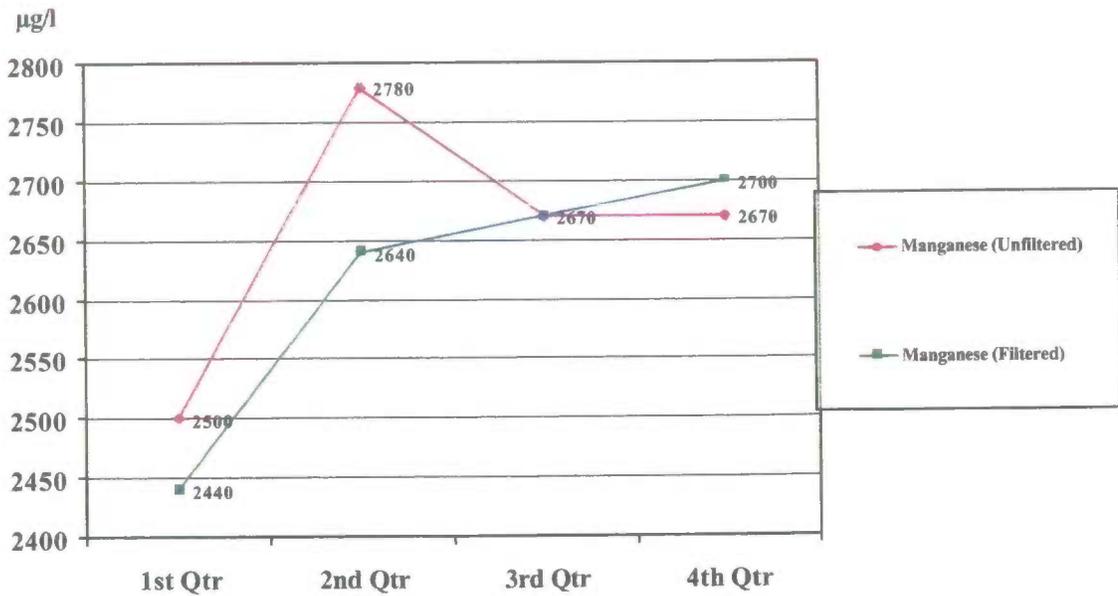
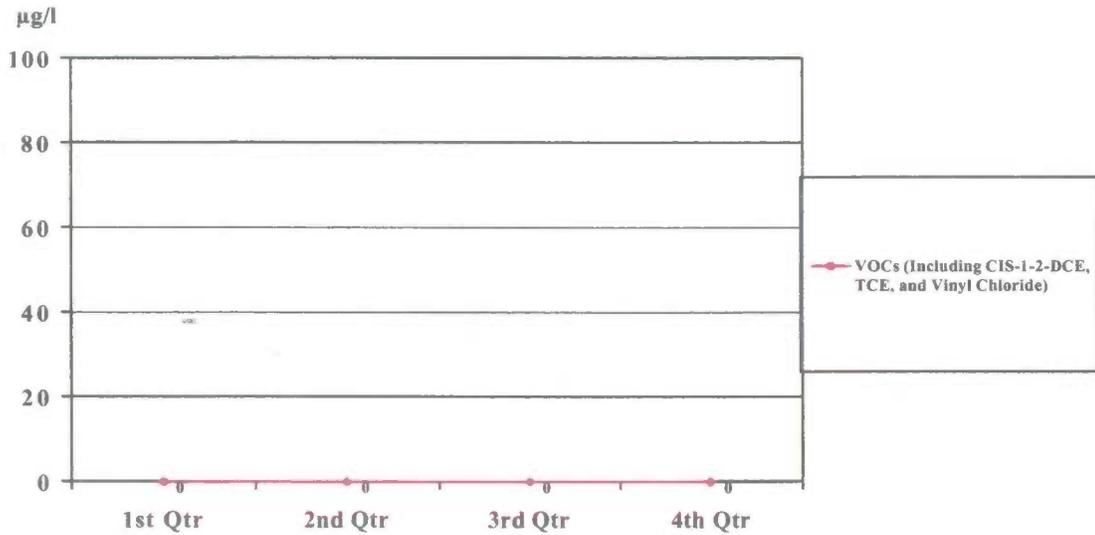


Figure 8.  
MW-8 Contaminant Ground Water Concentrations  
for Manganese

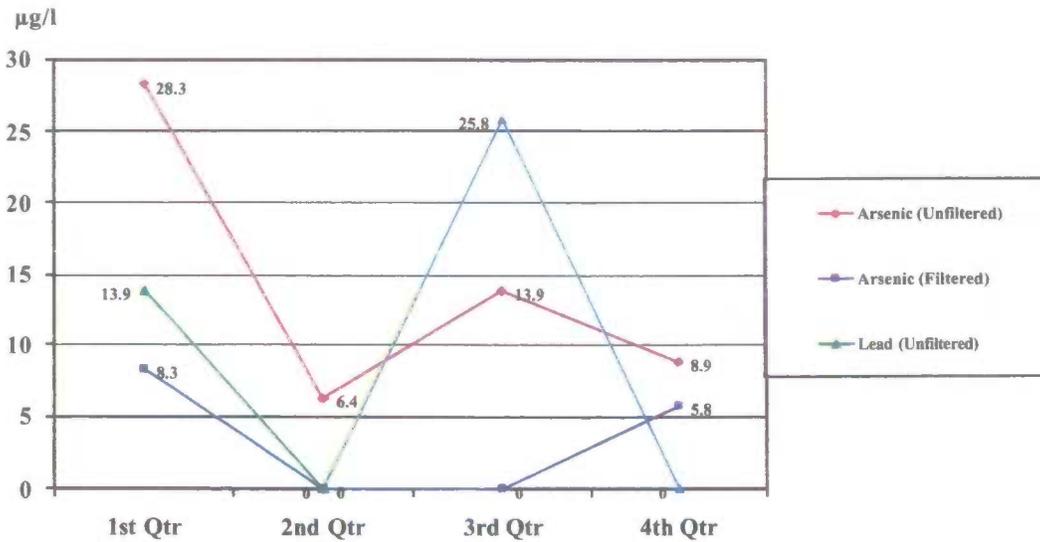


**Figure 9.**  
**MW-8 Contaminant Ground Water Concentrations**  
**for VOCs**



Note: VOC samples for all four quarters were below the MDL.

**Figure 10.**  
**MW-9 Contaminant Ground Water Concentrations**  
**for Arsenic and Lead**



Note: Unfiltered lead samples for the 2<sup>nd</sup> and 4<sup>th</sup> Quarters, filtered lead samples for all four sampling events, and filtered arsenic for the 2<sup>nd</sup> and 3<sup>rd</sup> Quarters were all below the MDL.

Figure 11.  
MW-9 Contaminant Ground Water Concentrations  
for Iron

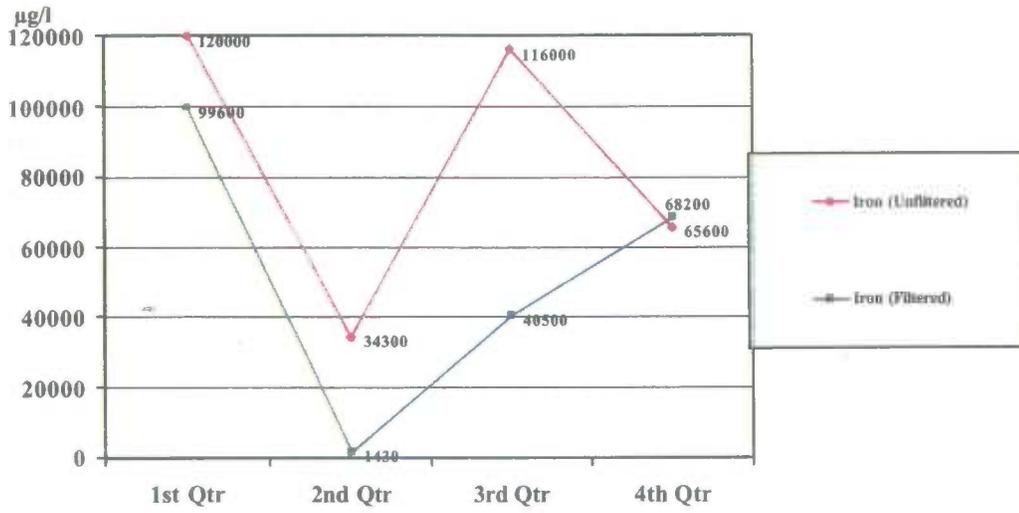


Figure 12.  
MW-9 Contaminant Ground Water Concentrations  
for Manganese

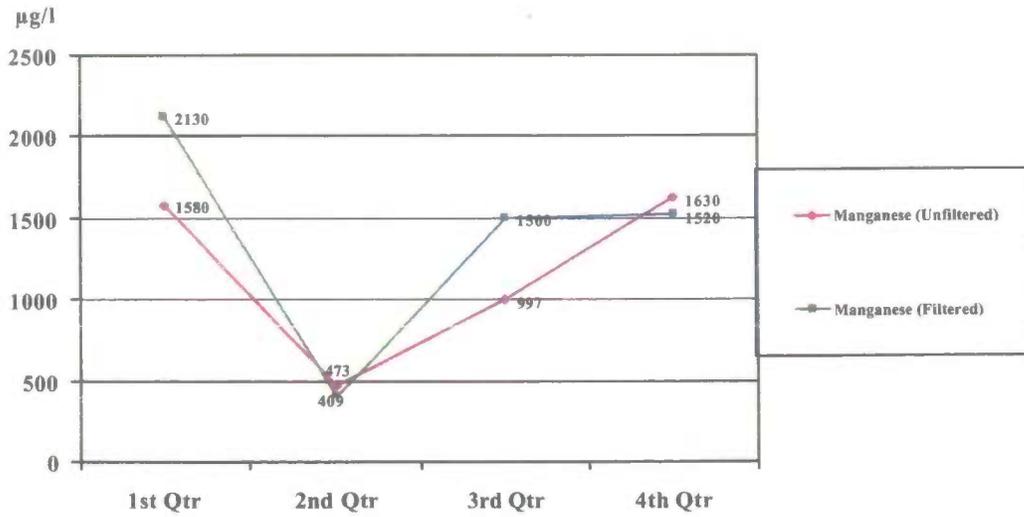


Figure 13.  
MW-9 Contaminant Ground Water Concentrations  
for VOCs

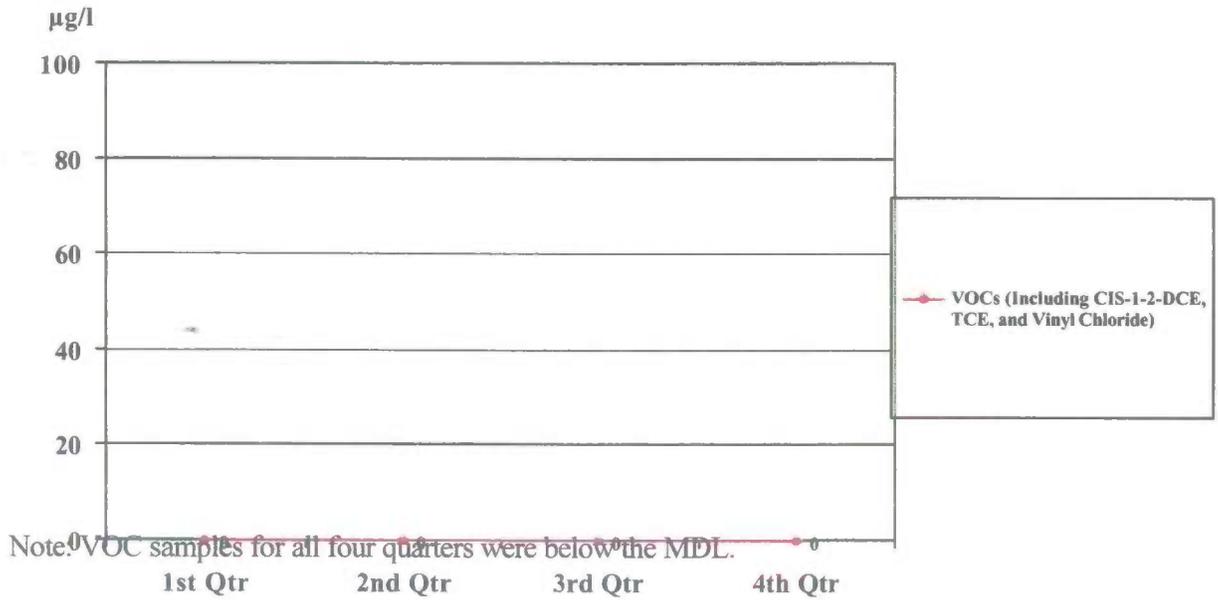
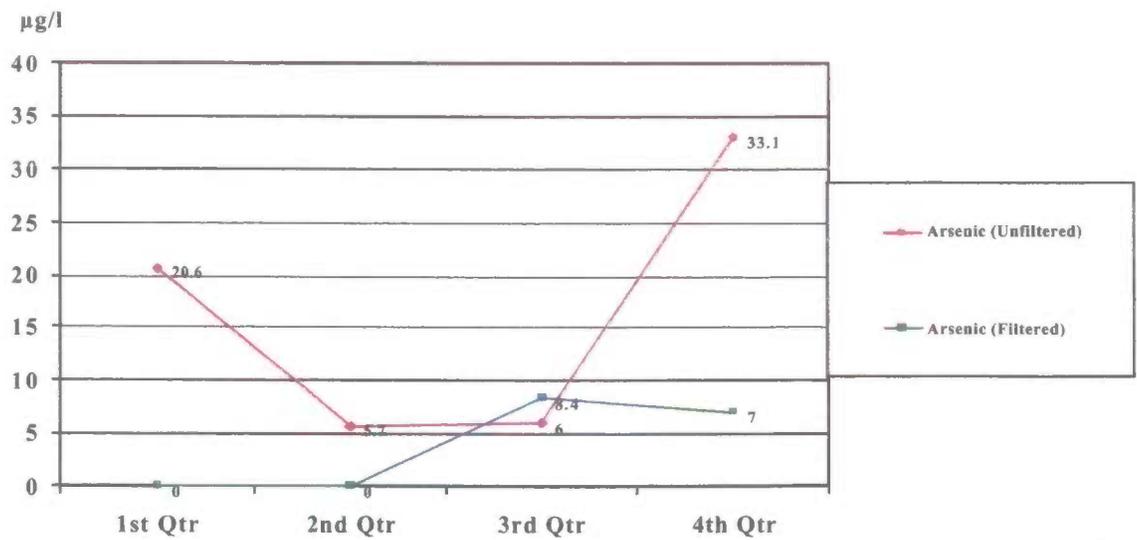
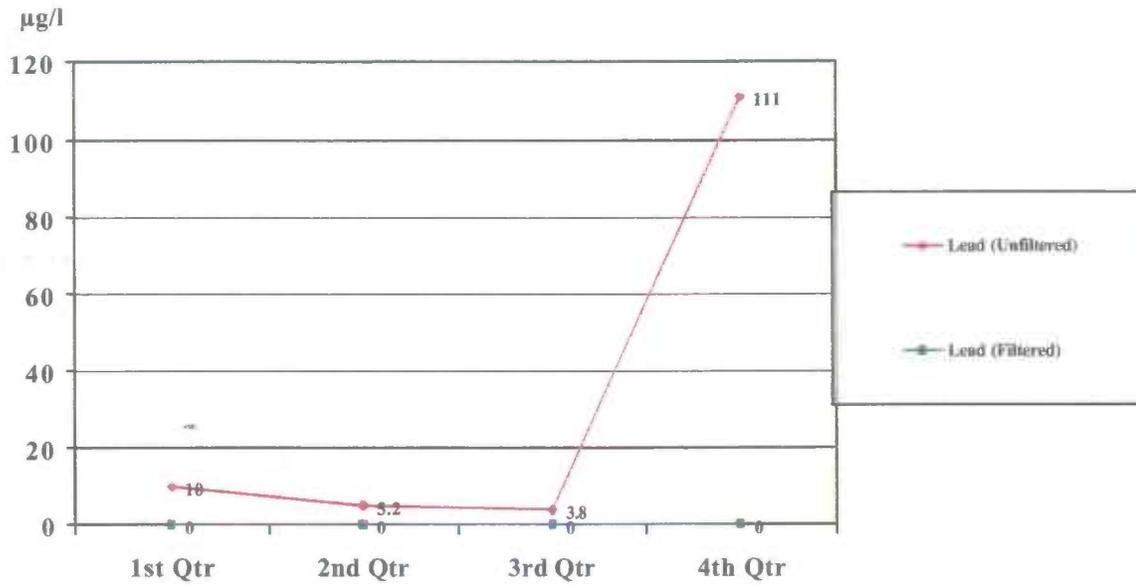


Figure 14.  
MW-10 Contaminant Ground Water Concentrations  
for Arsenic



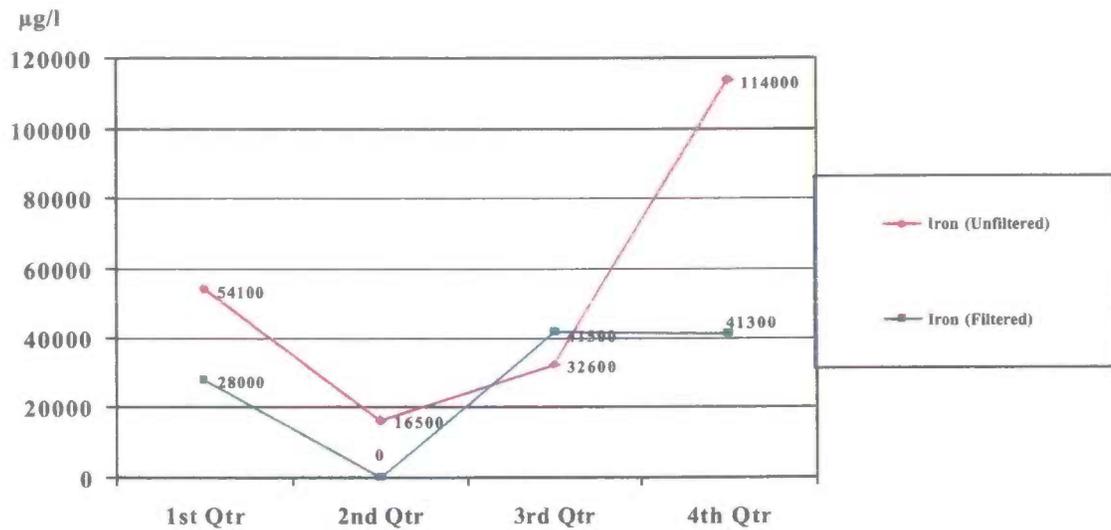
Note: Filtered arsenic samples for the 2<sup>nd</sup> and 4<sup>th</sup> Quarters were below the MDL.

Figure 15.  
MW-10 Contaminant Ground Water Concentrations  
for Lead



Note: Filtered lead samples for all four quarters were below the MDL.

Figure 16.  
MW-10 Contaminant Ground Water Concentrations  
for Iron



Note: The filtered iron sample for the 2<sup>nd</sup> Quarter was below the MDL.

Figure 17.  
MW-10 Contaminant Ground Water Concentrations  
for Manganese

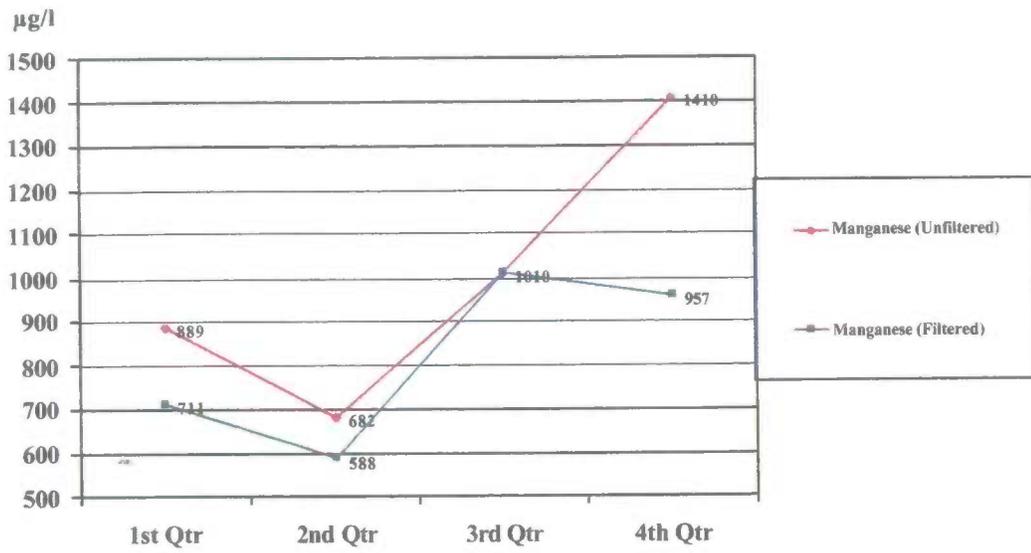
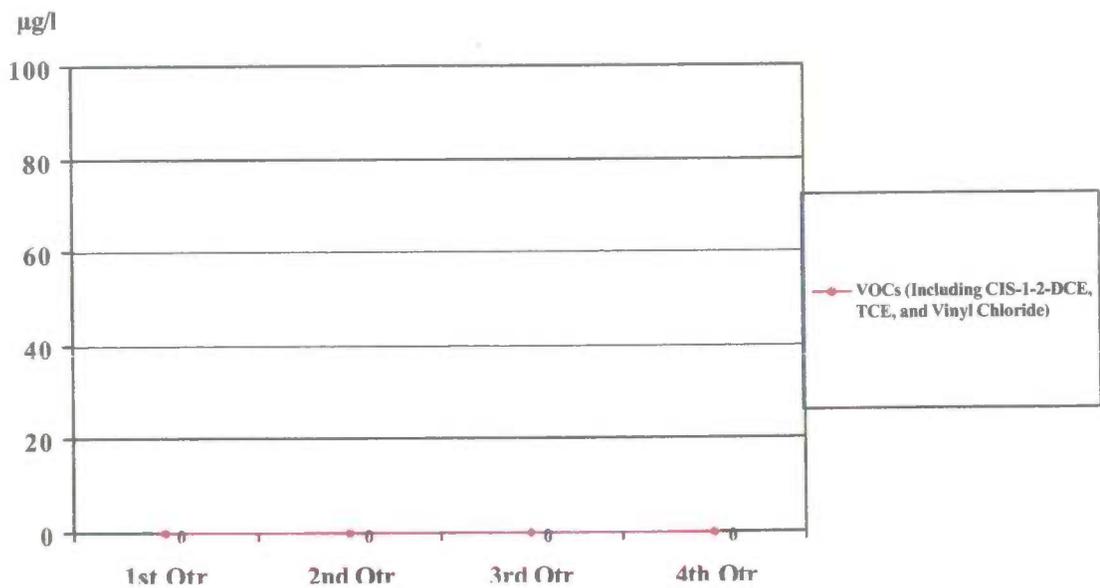
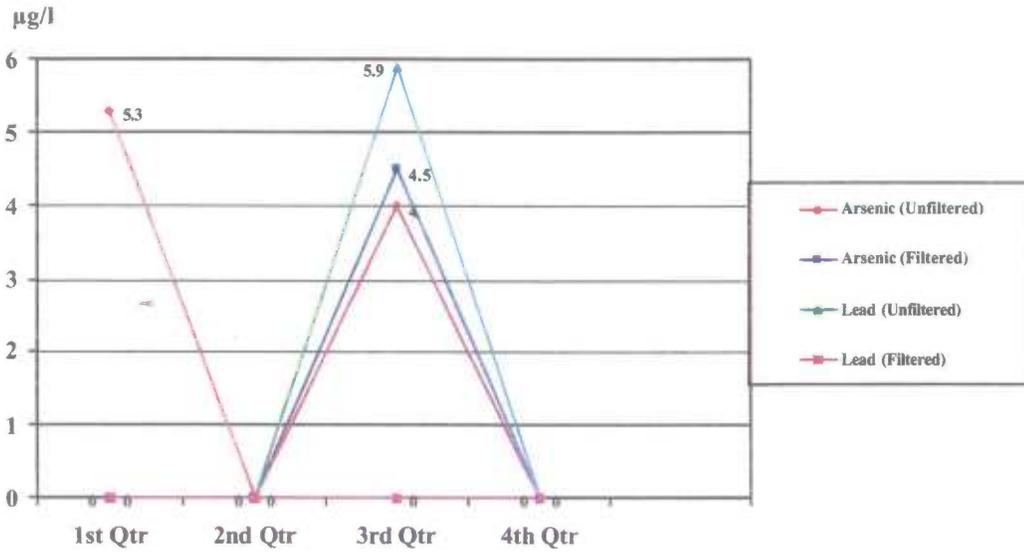


Figure 18.  
MW-10 Contaminant Ground Water Concentrations  
for VOCs



Note: VOC samples for all four quarters were below the MDL.

**Figure 19.**  
**MW-11 Contaminant Ground Water Concentrations**  
**for Arsenic and Lead**



Note: The following samples were below the MDL: unfiltered arsenic for the 2<sup>nd</sup> and 4<sup>th</sup> Quarters, unfiltered lead for the 1<sup>st</sup>, 2<sup>nd</sup>, and 4<sup>th</sup> Quarters, filtered arsenic for the 1<sup>st</sup>, 2<sup>nd</sup>, and 4<sup>th</sup> Quarters, and filtered lead for all four quarters.

**Figure 20.**  
**MW-11 Contaminant Ground Water Concentrations**  
**for Iron**

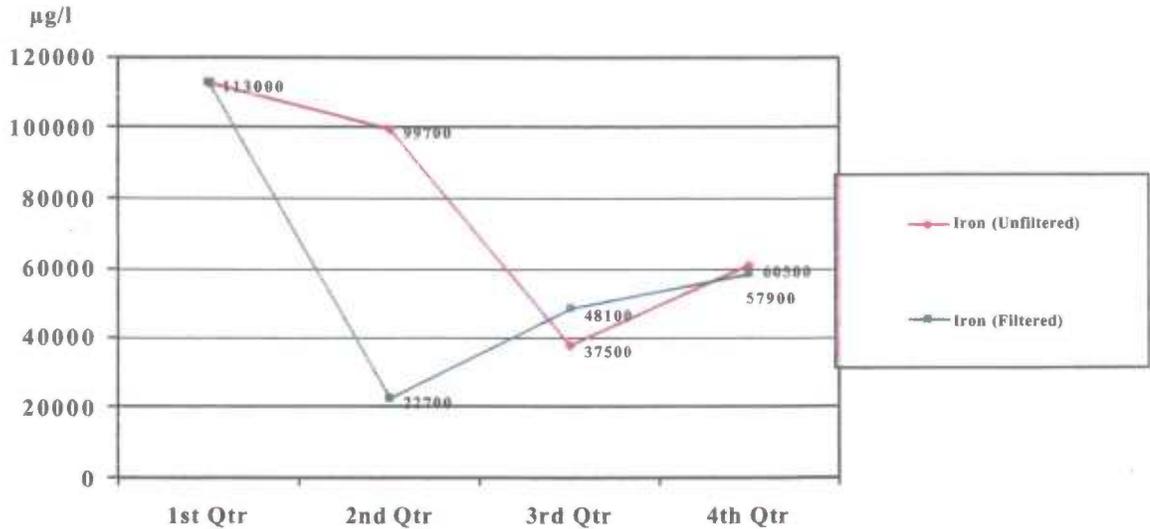


Figure 21.  
MW-11 Contaminant Ground Water Concentrations  
for Manganese

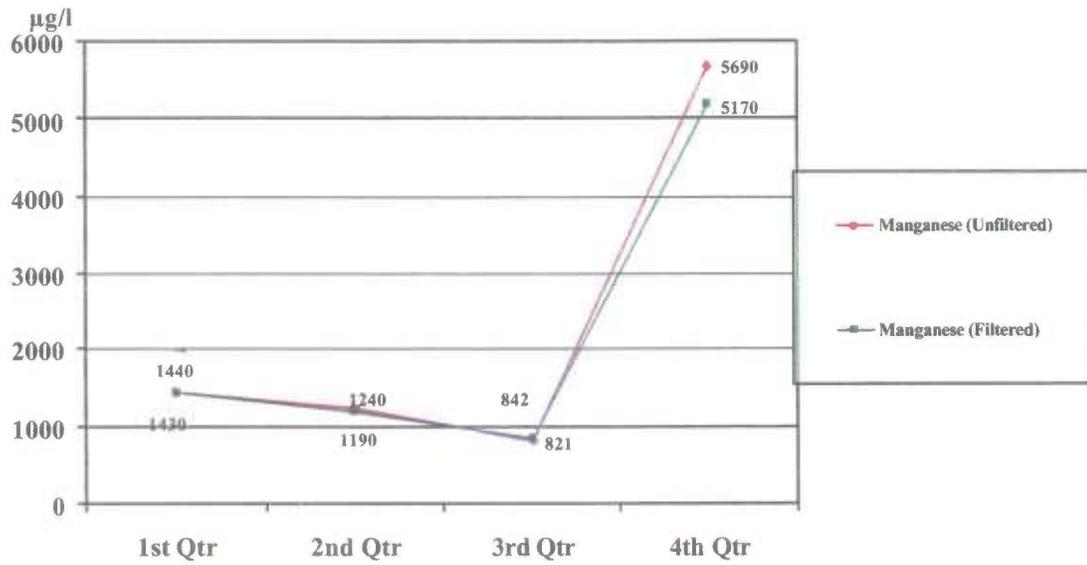
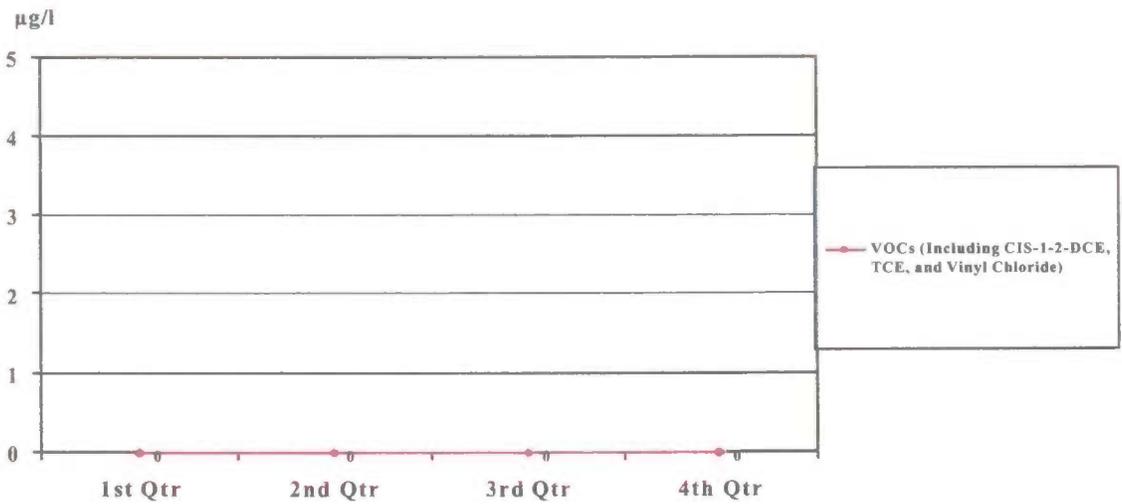
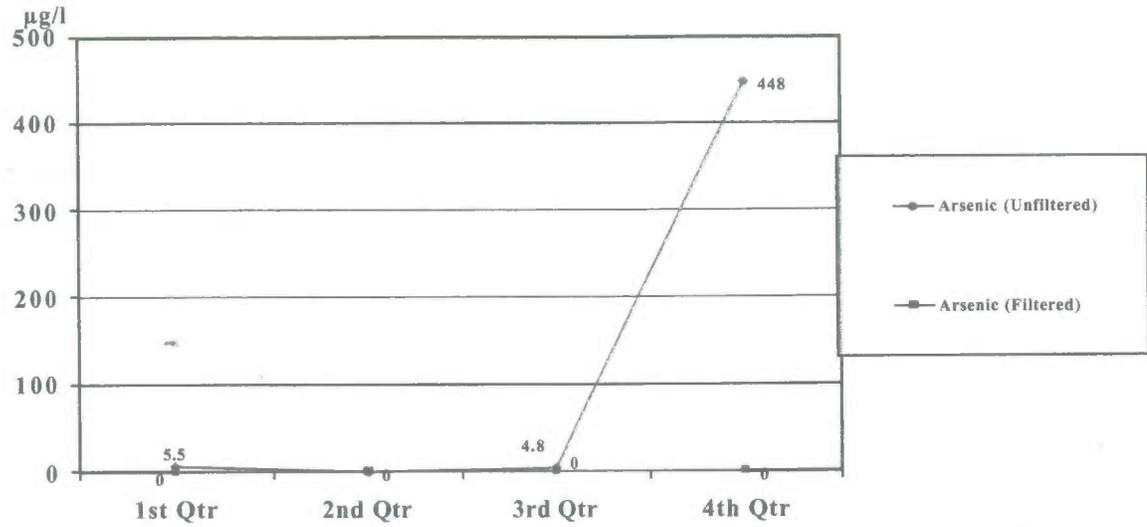


Figure 22.  
MW-11 Contaminant Ground Water Concentrations  
for VOCs



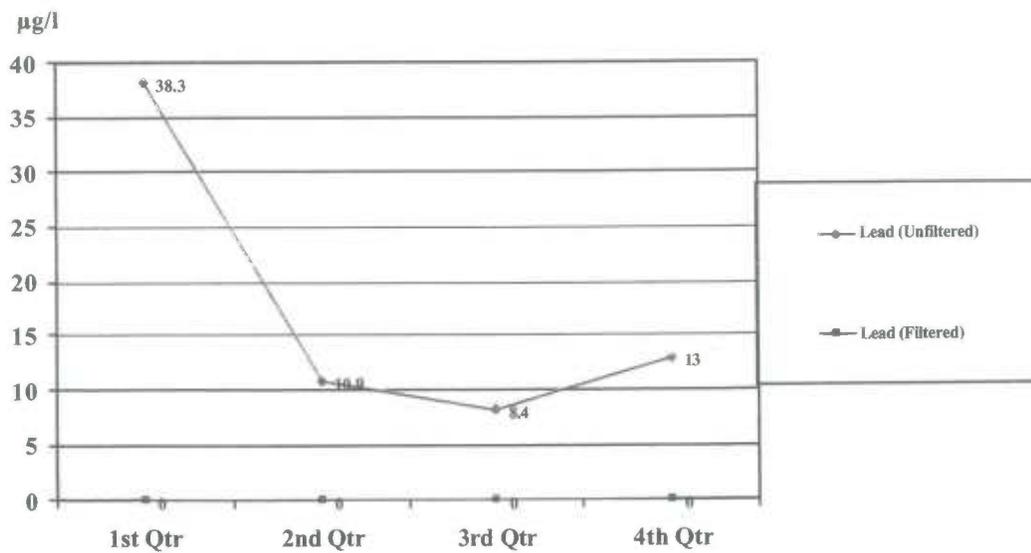
Note: VOC samples for all four quarters were below the MDL.

Figure 23.  
MW-12 Contaminant Ground Water Concentrations  
for Arsenic



Note: The unfiltered arsenic sample for the 1<sup>st</sup> Quarter and the filtered arsenic samples for all four quarters were below the MDL.

Figure 24.  
MW-12 Contaminant Ground Water Concentrations  
for Lead



Note: The filtered lead samples collected for all four quarters were below the MDL.

Figure 25.  
MW-12 Contaminant Ground Water Concentrations  
for Iron

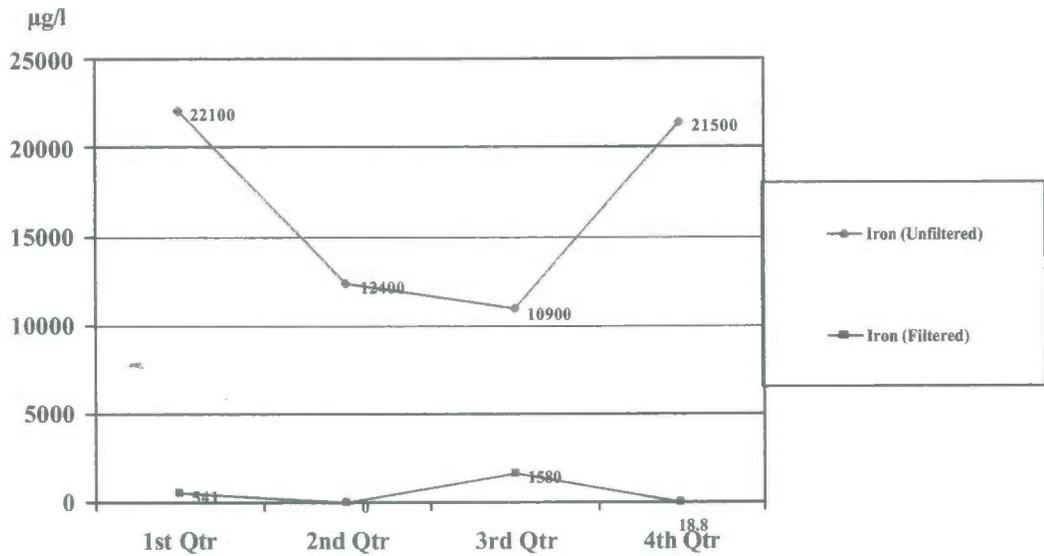


Figure 26.  
MW-12 Contaminant Ground Water Concentrations  
for Manganese

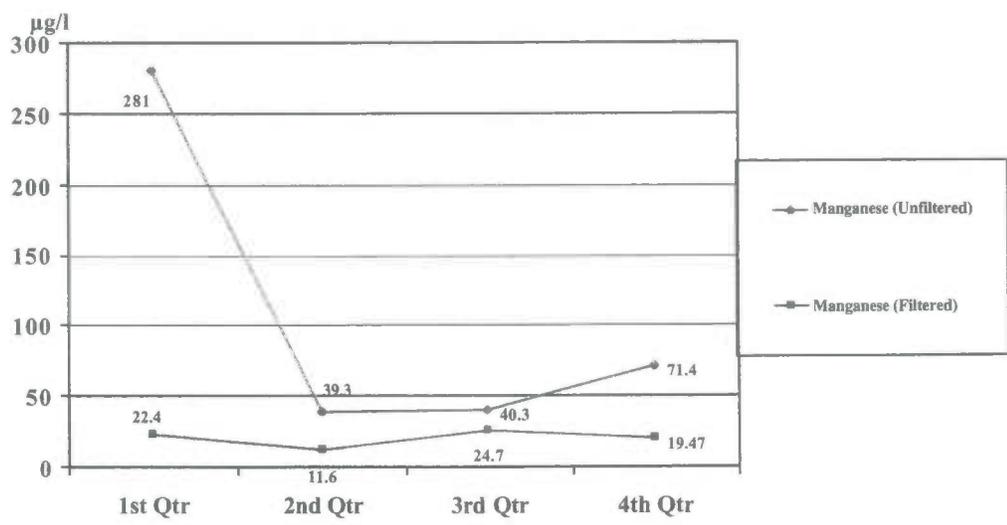
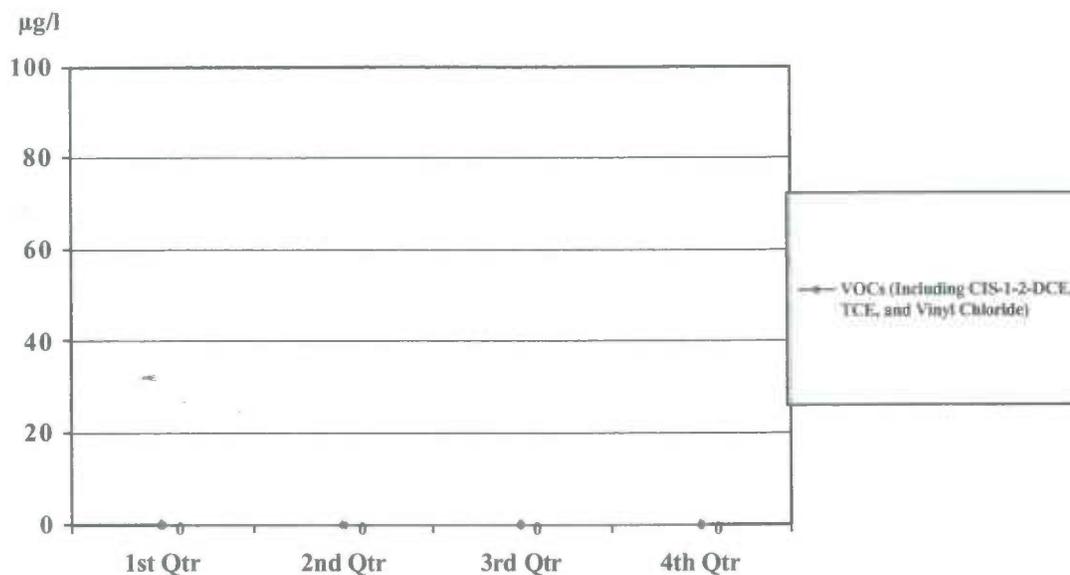
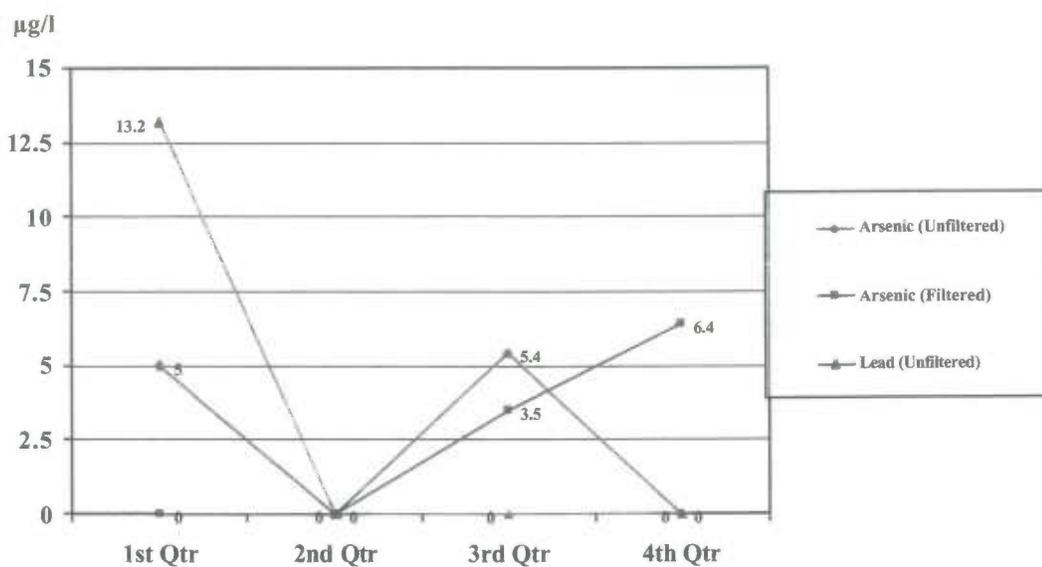


Figure 27.  
MW-12 Contaminant Ground Water Concentrations  
for VOCs



Note: VOC samples for all four quarters were below the MDL.

Figure 28.  
MW-13 Contaminant Ground Water Concentrations  
for Arsenic and Lead



Note: The following samples were below the MDL: unfiltered arsenic collected during the 2<sup>nd</sup> and 4<sup>th</sup> Quarters, unfiltered lead collected during the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> Quarters, filtered arsenic collected during the 1<sup>st</sup> and 2<sup>nd</sup> Quarters, and filtered lead for all four quarters.

Figure 29.  
MW-13 Contaminant Ground Water Concentrations  
for Iron

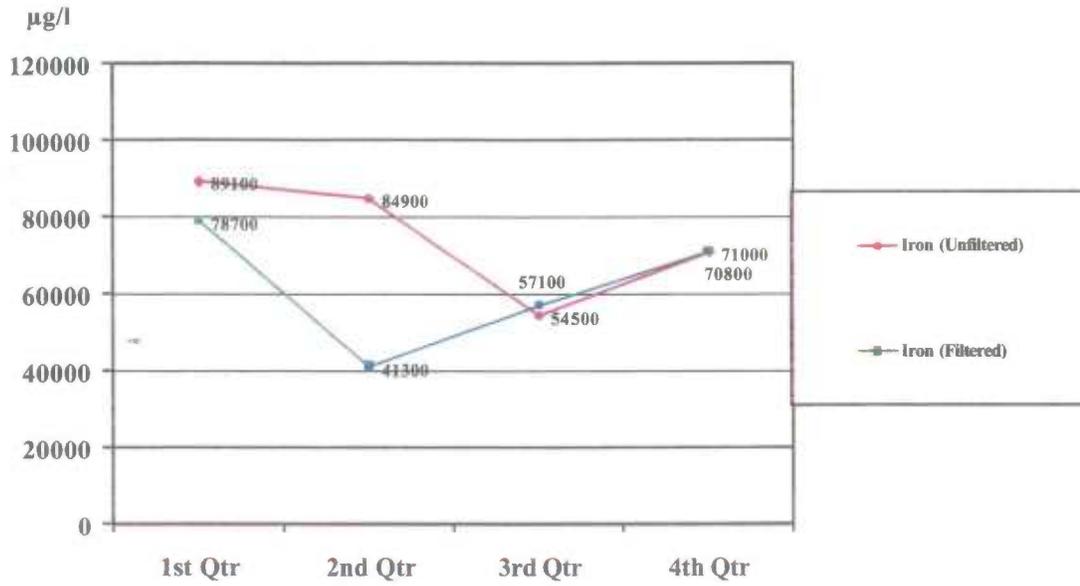


Figure 30.  
MW-13 Contaminant Ground Water Concentrations  
for Manganese

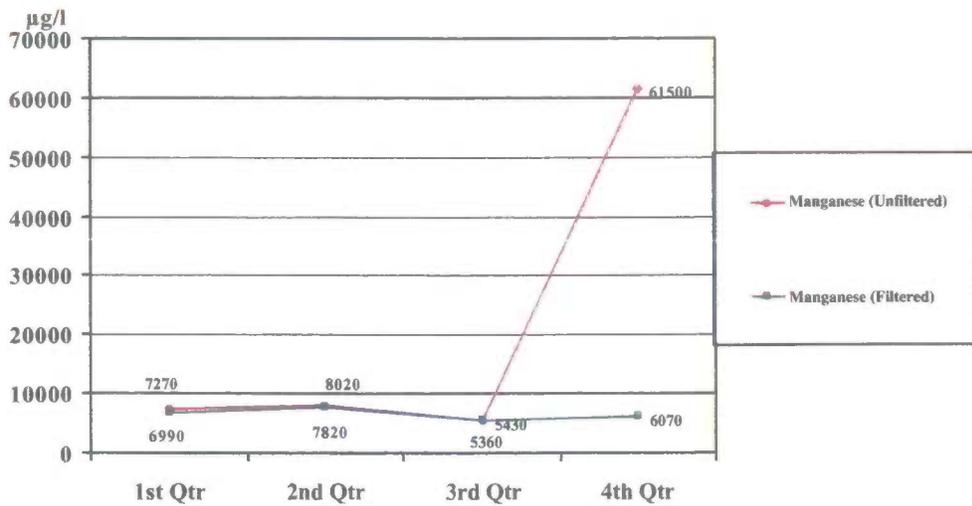
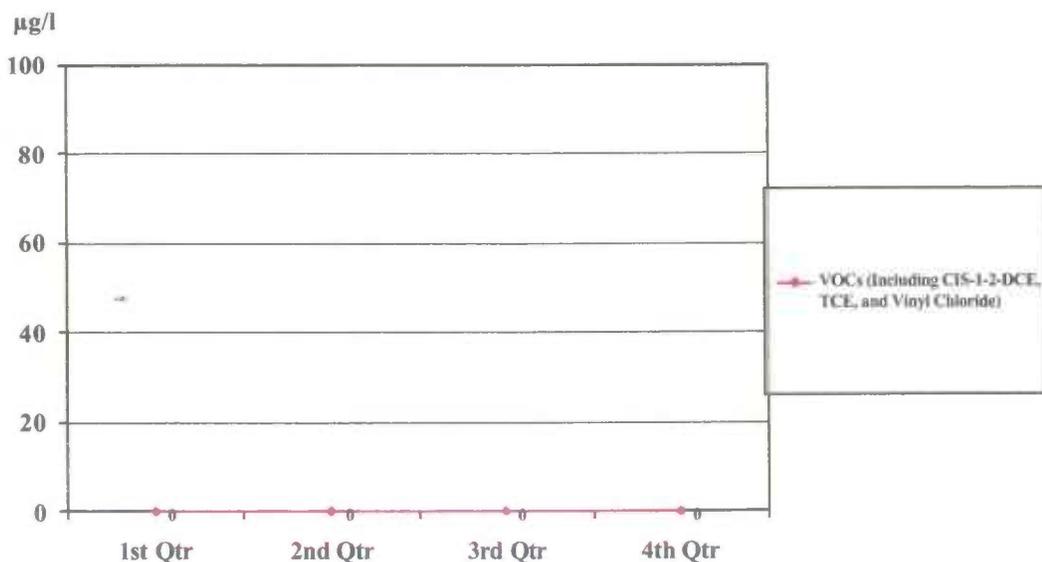
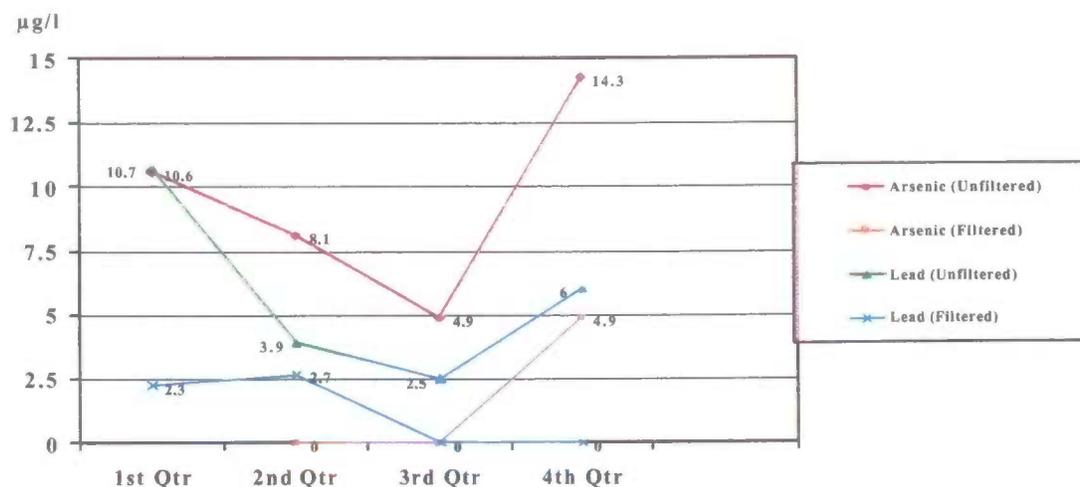


Figure 31.  
MW-13 Contaminant Ground Water Concentrations  
for VOCs



Note: VOC samples for all four quarters were below the MDL.

Figure 32.  
SW-7 Contaminant Surface Water Concentrations  
for Arsenic and Lead



Note: Filtered arsenic was not sampled during the 1<sup>st</sup> Quarter. Filtered arsenic samples were below the MDL for Quarters 2 and 3. Filtered lead samples were below the MDL for Quarters 3 and 4.

Figure 33.  
SW-7 Contaminant Surface Water Concentrations  
for Iron

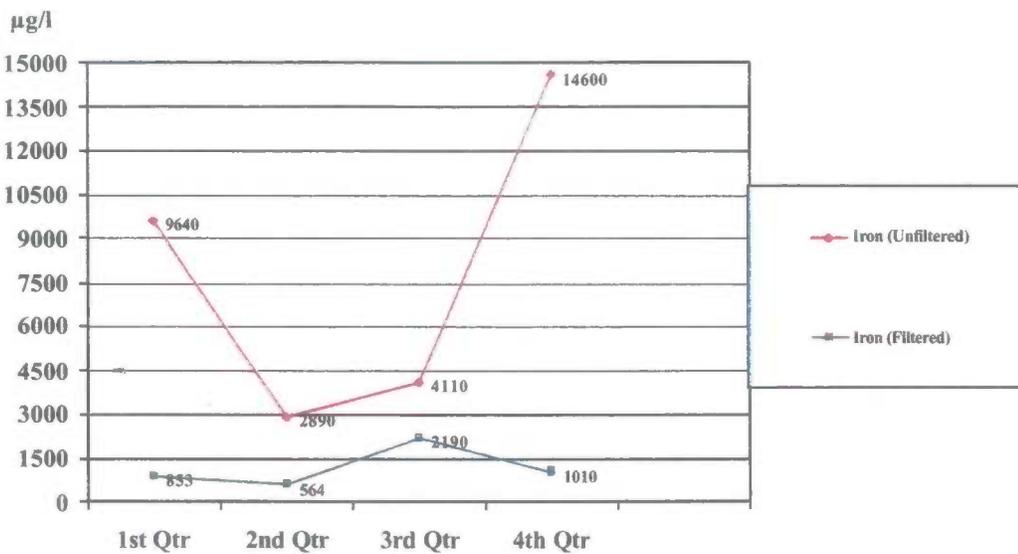
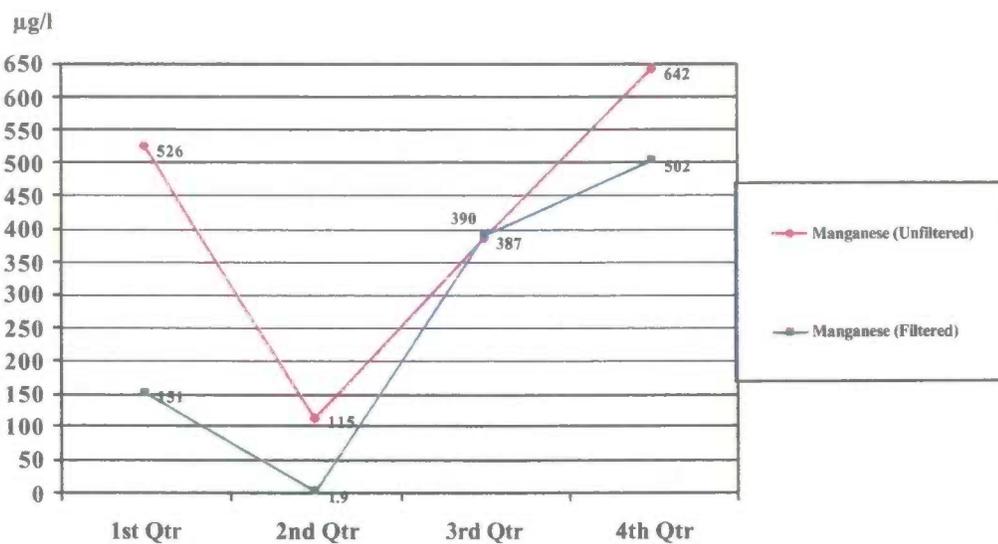
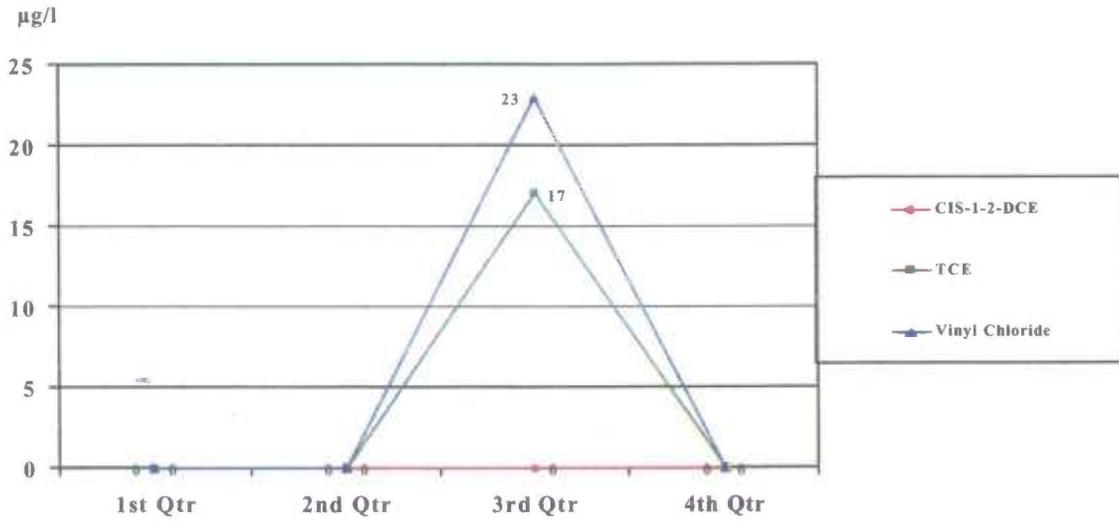


Figure 34.  
SW-7 Contaminant Ground Water Concentrations  
for Manganese

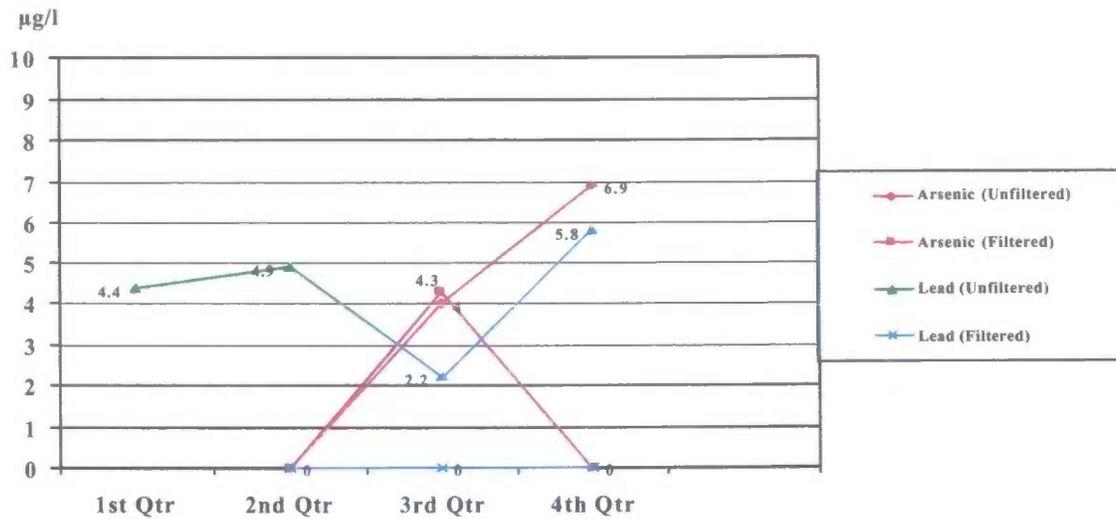


**Figure 35.**  
**SW-7 Contaminant Ground Water Concentrations**  
**for VOCs**



Note: CIS-1-2-DCE samples were below the MDL for all four quarters. TCE and VC samples were below the MDL for Quarters 1, 2, and 4.

**Figure 36.**  
**SW-8 Contaminant Surface Water Concentrations**  
**for Arsenic and Lead**



Note: Filtered and unfiltered arsenic samples were not collected during the 1<sup>st</sup> Quarter. The unfiltered arsenic sample was below the MDL for the 2<sup>nd</sup> Quarter. The filtered arsenic samples were below the MDL for Quarters 2 and 4. The filtered lead samples were below the MDL for Quarters 2, 3, and 4.

Figure 37.  
SW-8 Contaminant Surface Water Concentrations  
for Iron

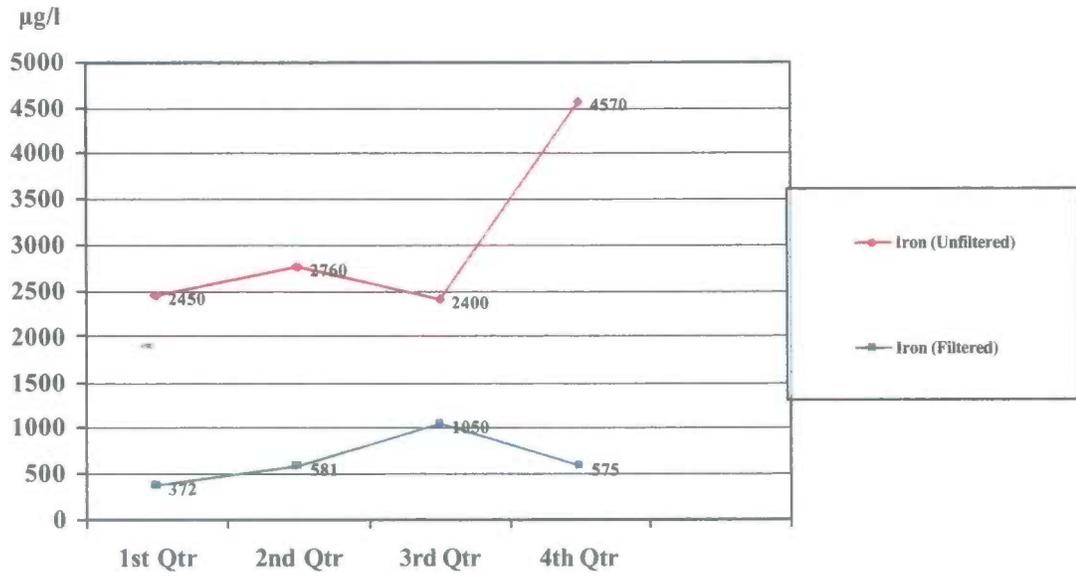


Figure 38.  
SW-8 Contaminant Ground Water Concentrations  
for Manganese

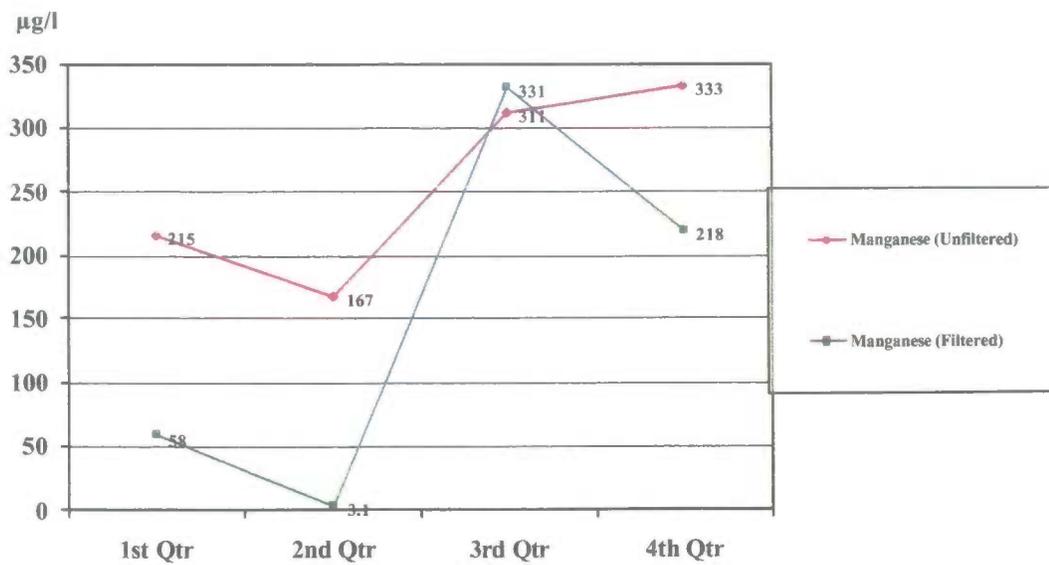
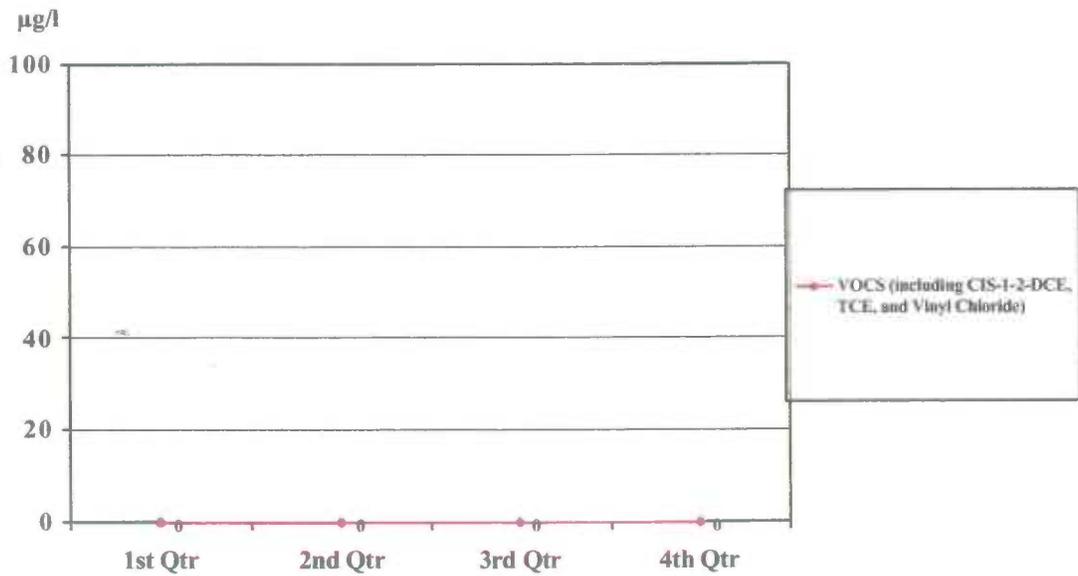
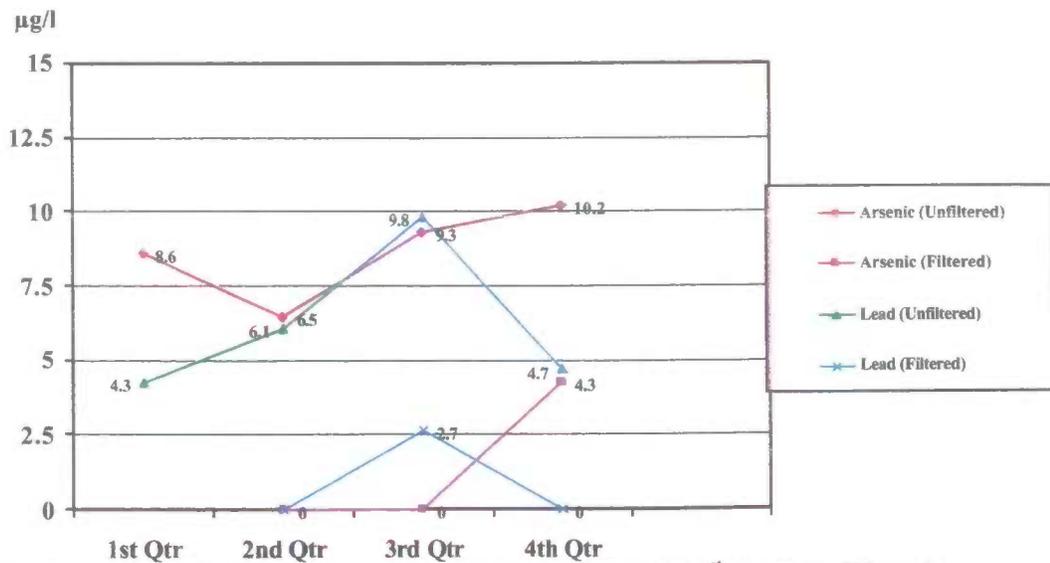


Figure 39.  
SW-8 Contaminant Ground Water Concentrations  
for VOCs



Note: VOC samples for all four quarters were below the MDL.

Figure 40.  
SW-9 Contaminant Surface Water Concentrations  
for Arsenic and Lead



Note: Filtered arsenic and lead samples were not collected during the 1<sup>st</sup> Quarter. Filtered arsenic samples for the 2<sup>nd</sup> and 3<sup>rd</sup> Quarters and filtered lead samples for the 2<sup>nd</sup> and 4<sup>th</sup> Quarters were below the MDL.

Figure 41.  
SW-9 Contaminant Surface Water Concentrations  
for Iron

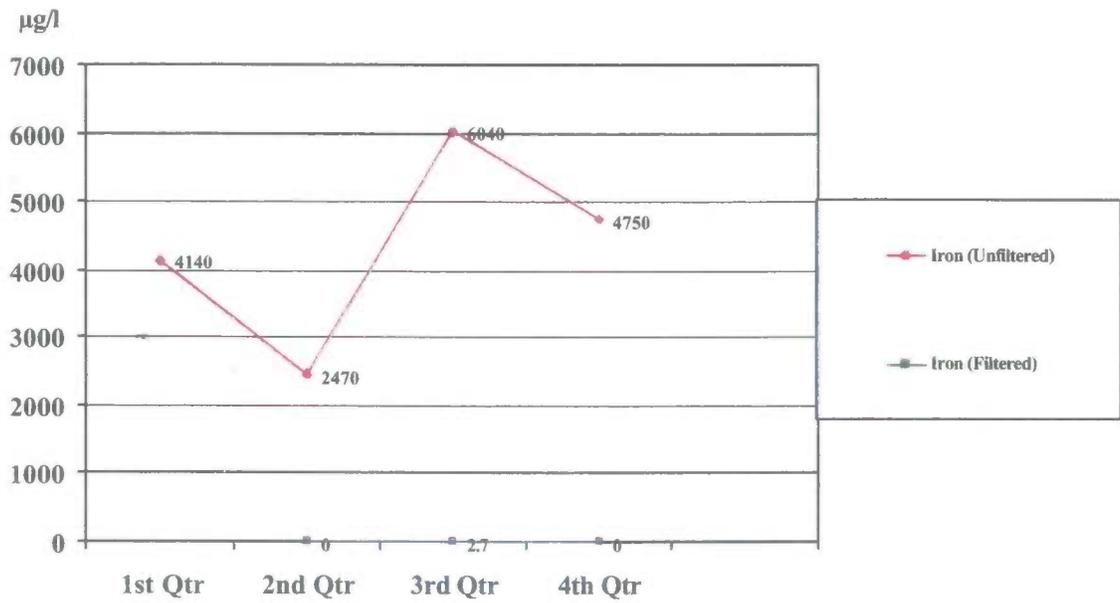
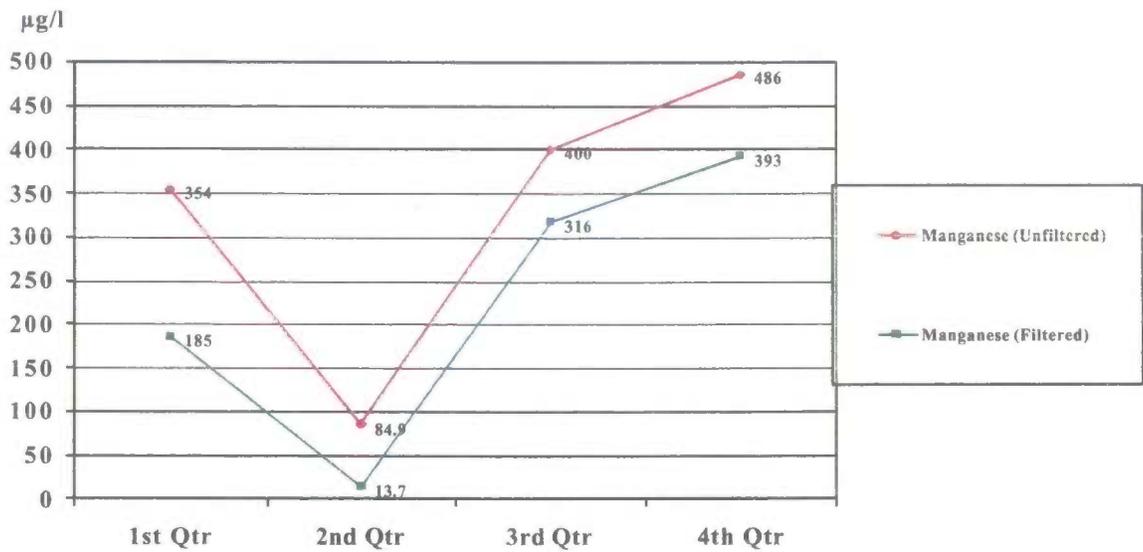
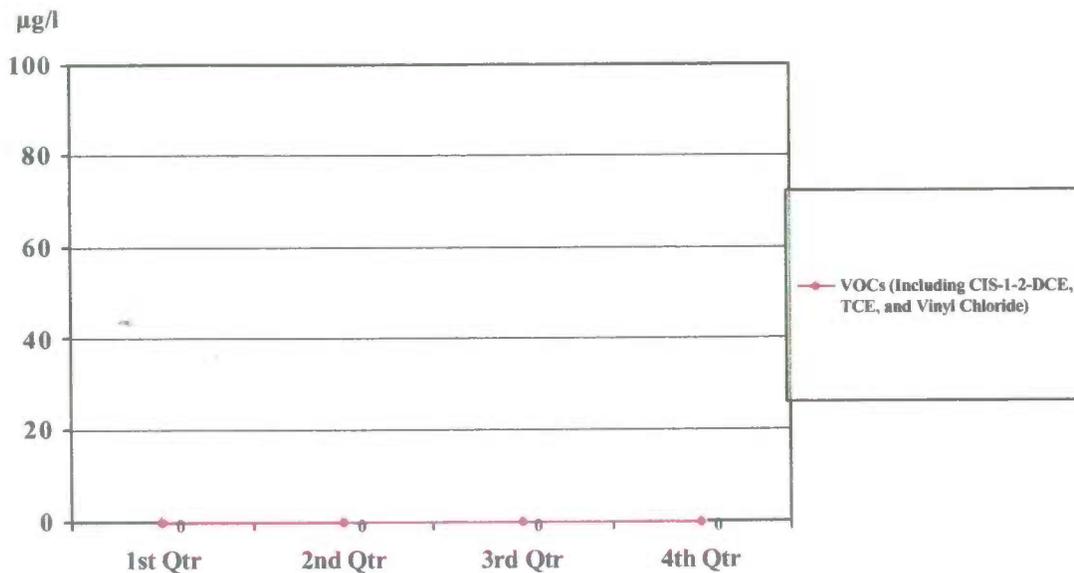


Figure 42.  
SW-9 Contaminant Ground Water Concentrations  
for Manganese



**Figure 43.**  
**SW-9 Contaminant Ground Water Concentrations**  
**for VOCs**



Note: VOC samples for all four quarters were below the MDL.

**Figure 44.**  
**SW-10 Contaminant Surface Water Concentrations**  
**for Arsenic and Lead**

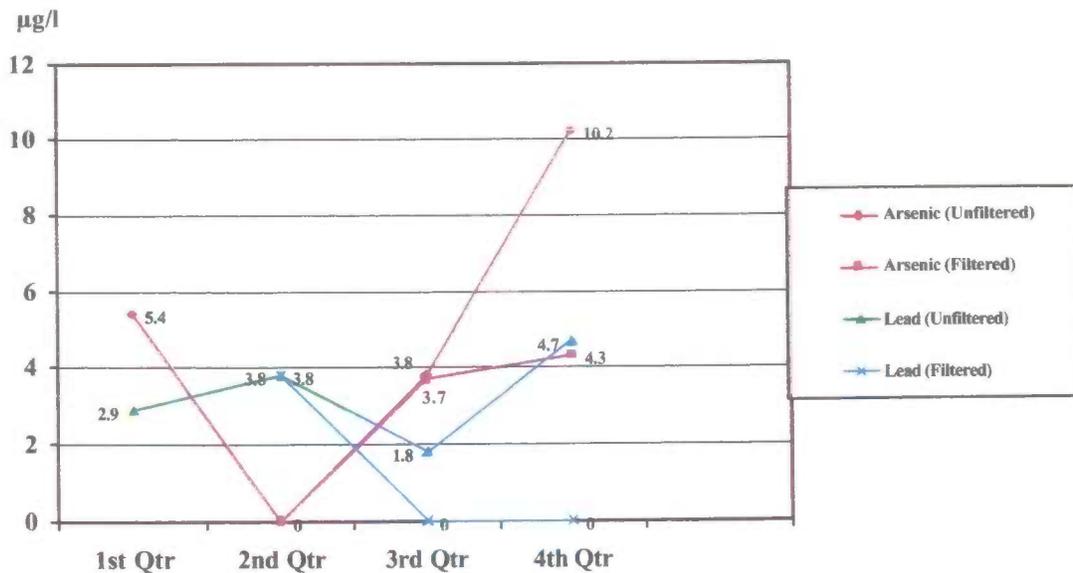


Figure 45.  
SW-10 Contaminant Surface Water Concentrations  
for Iron

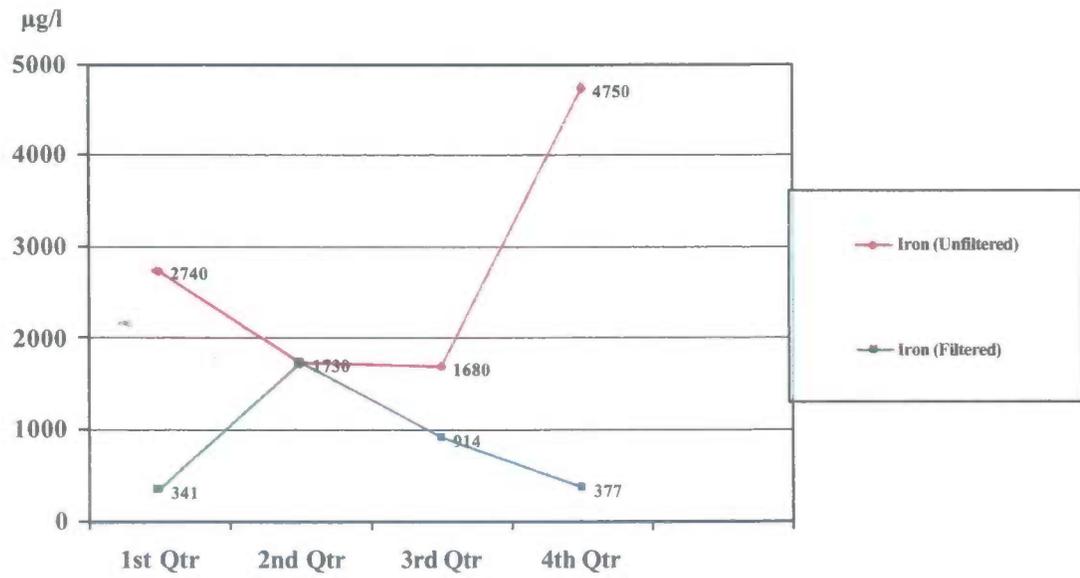
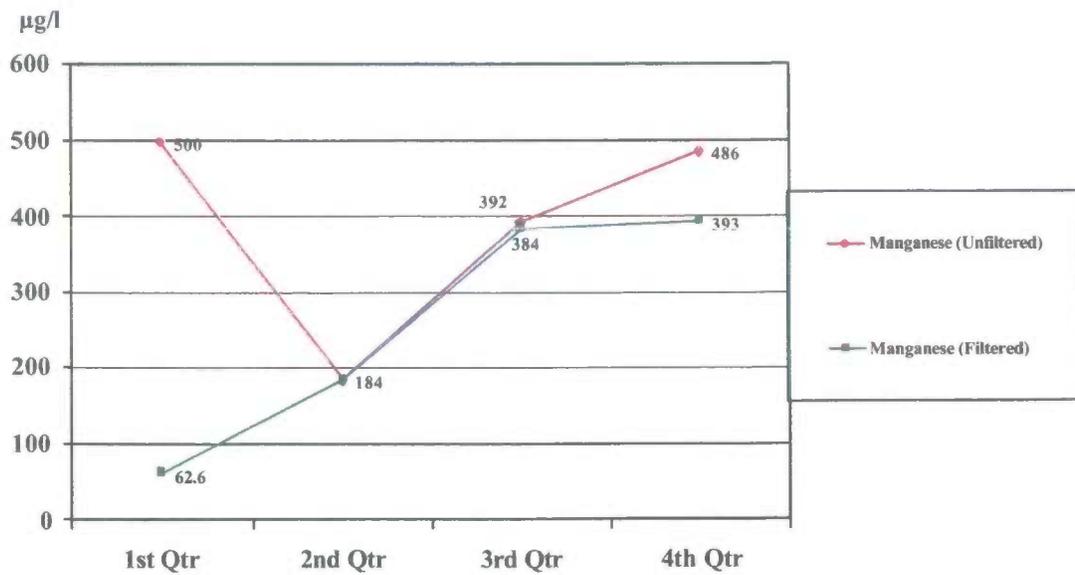
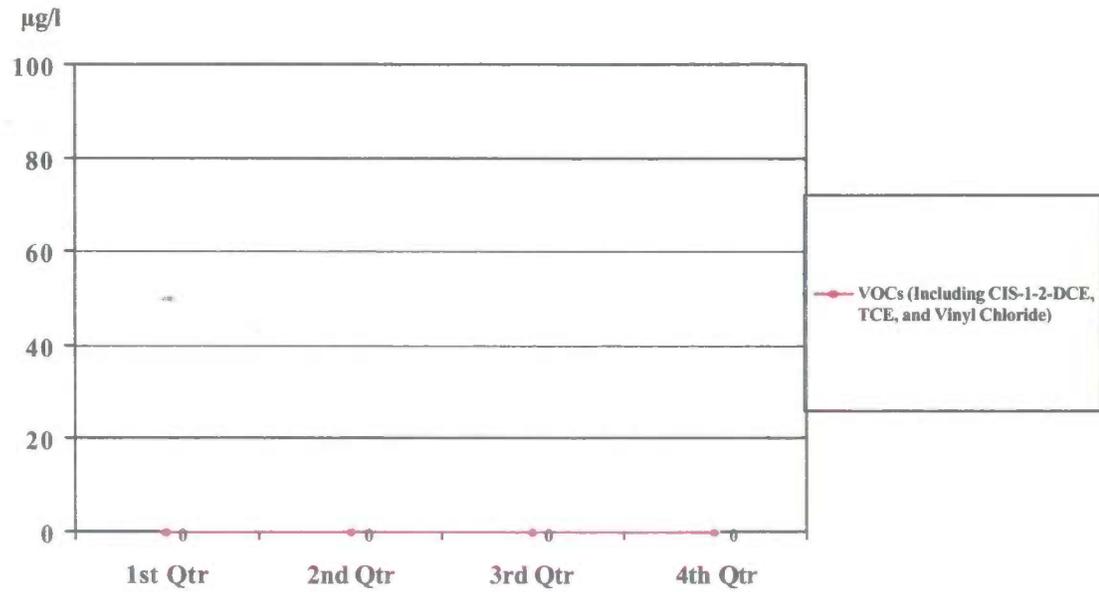


Figure 46.  
SW-10 Contaminant Ground Water Concentrations  
for Manganese



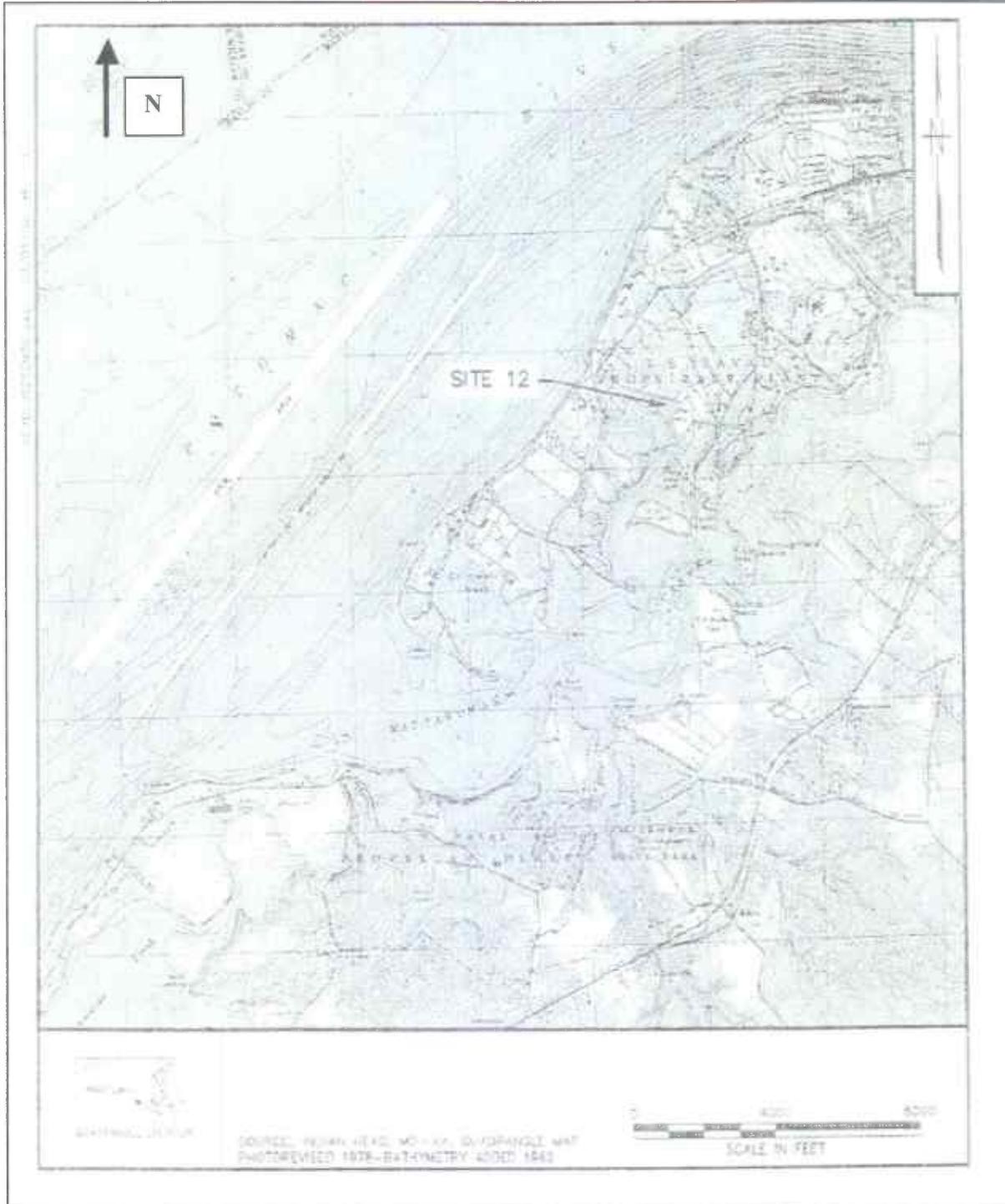
**Figure 47.**  
**SW-10 Contaminant Ground Water Concentrations**  
**for VOCs**



Note: VOC samples for all four quarters were below the MDL.

# APPENDIX B

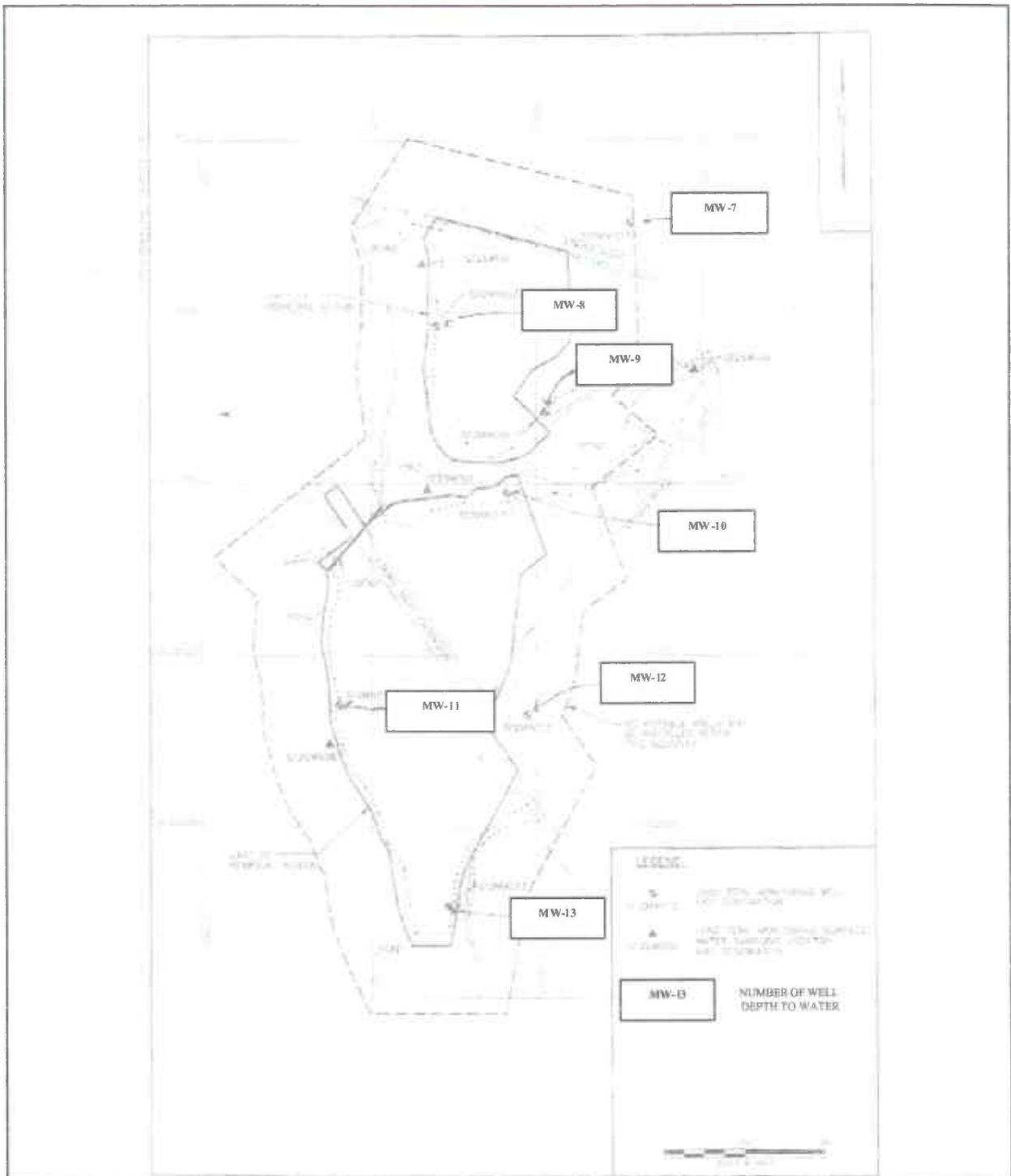
## Site 12 Maps



**NDW-IH  
Indian Head, MD**

**Site 12 Location and Topographic Map  
Indian Head, Maryland  
7.5 Minute USGS Quadrangle**

**UNITEC Contract No. N62477-01-D-0076  
Figure 48.**



NDW-IH  
Indian Head, Maryland

Site 12 Map/Sampling Locations  
And Topographic Map  
Indian Head, Maryland

UNITEC Contract No. N62477-01-D-0076  
Figure 49.

# APPENDIX C

## References

## REFERENCES

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