DRAFT
FINAL PERIODIC REVIEW REPORT FOR
AREA 1495
FORT DRUM, NEW YORK

Prepared for:

UNITED STATES ARMY ENVIRONMENTAL COMMAND
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Contract No. W91ZLK-05-D-0011
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ACRONYMS

AEC	Amy Environmental Command
AAS	aquifer air sparge
AOC	area of concern
BTEX	benzene, toluene, ethylbenzene, and total xylenes
BV	bioventing
CA	contamination assessment
CDM	CDM Federal Programs Corporation
COCs	contaminants of concern
DPT	direct-push technology
EA	EA Engineering
EPA	Environmental Protection Agency
HHRA	human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
M-K	Mann-Kendall
µg/L	micrograms per liter
MNA	monitored natural attenuation
N:P:K	nitrogen: phosphorous: potassium
NYSDEC	New York State Department of Environmental Conservation
PAHs	polycyclic aromatic hydrocarbons
Plexus	Plexus Scientific Corporation
PRR	Periodic Review Report
Radian	Radian International LLC
RI	Remedial Investigation
SVE	soil vapor extraction
TPH	total petroleum hydrocarbons
USTs	underground storage tanks
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

Under United States Army Environmental Command (AEC) Contract No. W91ZLK-05-D-0011 Delivery Order 0004, Plexus Scientific Corporation (Plexus) has provided this comprehensive review of the environmental data collected at the Fort Drum Area 1495 from 1989 to 2011. This report is comprised of five elements that evaluate the environmental program at Area 1495:

- Historical review of the remedial program to date;
- A comparison of the initial and current concentration and extent of contamination at Area 1495;
- Time series and statistical evaluation of contaminant data trends;
- An evaluation of monitored natural attenuation (MNA); and,
- A human health risk assessment (HHRA) of the present condition of the site.

Review of these elements provides a comprehensive assessment of the program's progress and current conditions at the site. In addition, this review presents the required lines of evidence required to achieve regulatory closure. Based upon this evaluation, the Army has determined MNA has completely remediated the site in a manner that is fully protective of all identified sensitive receptors and monitoring may be terminated.

Historical Review

Sections 2 and 3 provide a historical review of the remedial and monitoring activities to date. The source of the contamination at Area 1495 was determined to be two underground storage tanks (USTs) and associated infrastructure containing gasoline. The tanks and associated fuel dispensers were removed from the Area 1495 in November 1994. From 1996 through 2004 active remediation of the site was conducted using a bioventing/soil vapor extraction (BV/SVE) remedial treatment system augmented by an aquifer air sparge (AAS) system installed in 2000. Following receipt of NYSDEC concurrence and approval based on the results of the semi-annual groundwater sampling events, the treatment system at Areas 1495 was shut down in February 2004. From 2004 to 2011 the site has been monitored under the basewide sampling program that has successfully evaluated MNA and the trend of groundwater contaminants. In 2004 the site entered into a MNA monitoring phase. Due to persistent low-level concentrations, Plexus operated an additional in-situ treatment at Area 1495 via a pilot test of a mobile ozone treatment system for one month in August 2009. Results of the pilot ozone application showed a significant rise in the concentrations of oxygen available that would enhance aerobic biodegradation.

Initial and Current Extent of Groundwater Contamination

Sections 4 and 5 outline the initial and current characterization of the groundwater contaminant plume at Area 1495. The primary contaminants of concern (COCs) at Area 1495 were

determined to be benzene, toluene, ethylbenzene, and total xylenes (BTEX). The concentrations of all four of these compounds exceeded NYSDEC screening criteria in groundwater monitoring wells 1495-MWS3 1495-MWS4, and 1495-MW30. The maximum recorded total BTEX concentration of 1,524 micrograms per liter (µg/L) was recorded at the site in 1995. The maximum concentration of benzene of 100 µg/L was recorded in 1996. Benzene has not exceeded screening criteria at the site since November 1998, toluene has not exceeded screening criteria since June 2002, and ethylbenzene exceeded screening criteria in Fall 2011 for the first time since April 2010. The maximum concentrations of ethylbenzene (210 µg/L) and total xylenes (1,300 µg/L) occurred in October 1995. During the Fall 2011, ethylbenzene (25.6 µg/L) and total xylenes (51.9 µg/L) were above their respective screening criteria. An evaluation of the contaminant plume aerial extent clearly illustrates that the plume continues to shrink.

Contaminant Data Trends

Section 5 outlines the contaminant data trends over the course of the site history. Time series data trend plots and Mann-Kendall (M-K) statistical evaluation were used to evaluate the nature and extent of contaminant degradation. Active remediation at the site ceased in February 2004, and since that time MNA and other natural processes have been the only mechanism for contaminant degradation. Time series and M-K data analysis show site-related COCs continue to decrease or remain stable over time. The total BTEX concentrations in the area of concern (AOC) source monitoring point (1495-MWS3) has decreased from 1,524 µg/L to 77.5 µg/L over a time period of 16 years.

Evaluation of MNA

Section 5 outlines the evidence showing MNA continues to occur at the site and has proven to be an effective remedial approach for reducing site-related contaminants. A constant supply of oxygenated groundwater continues to facilitate aerobic biodegradation of the contaminant plume. MNA data show the microbial population within the contaminant plume continues to use up the available oxygen, which demonstrates that the natural biodegradation mechanisms are still in place despite the absence of active remediation. To enhance future MNA at the site, an application of a nitrogen: phosphorous: potassium (N:P:K) solution was administered from January to March 2011 (Plexus, 2010a).

Updated HHRA

The updated HHRA reconfirms the findings of the 2009 HHRA performed to evaluate conditions at Area 1495. The updated HHRA concludes there is no risk to receptors under industrial worker or residential scenarios. In addition, current and future land use scenarios do not include residential zoning.

Conclusion and Recommendations

This Final Periodic Review Report (PRR) for Area 1495 provides the lines of evidence (as outlined in Section 7) to support a site close-out recommendation.

1.0 Introduction

The Fort Drum is located in upstate New York, approximately 10 miles northeast of Watertown and 80 miles north of Syracuse (**Figure 1-1**). The military installation encompasses approximately 168 square miles. The Area 1495 fueling facility site is located on the northern side of Oneida Avenue, between Fourth Street West and Fourth Street East (**Figure 1-2**). The area surrounding Area 1495 is an active rail line, which is used for the storage and mobilization of military vehicles and equipment. The former USTs and related piping associated with the Area 1495 fueling facility were removed in 1994. The current remedy at this site is MNA. Groundwater sampling and well gauging were performed, until August 2011, in accordance with AEC Contract No. W91ZLK-05-D-0011 Delivery Order 0004.

2.0 Site Background

Area 1495 previously contained two 25,000-gallon diesel USTs (**Figure 2-1**). In 1994, the two USTs and approximately 520 linear feet of piping were removed. In addition, 30 closure soil samples were collected. Volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) were the most frequently reported compounds detected during UST removal. The highest concentrations were generally reported in the piping and UST excavation areas, which suggested that residual product remained in the soil.

Sixteen subsurface soil samples were collected by Radian International LLC (Radian) in 1996 prior to the installation of the combined BV/SVE remedial treatment system at Area 1495. Elevated petroleum hydrocarbon concentrations were reported in the soil samples collected from the central dispenser piping and easternmost former UST location. Soil gas measurements of hydrocarbons, oxygen, and carbon dioxide were collected monthly after the BV/SVE system began operation in October 1997. In addition, respiration tests were conducted annually during the period of system operation to assess in-situ degradation rates.

Subsurface oxygen concentrations remained consistently greater than 17 percent, and average subsurface carbon dioxide concentrations increased during system operation. The subsurface oxygen measurements suggested the subsurface was not oxygen limited due to the use of the BV system, and carbon dioxide measurements were indicative of microbial respiration.

In 1998, Radian conducted constant rate and in-situ respiration tests, and collected soil and groundwater samples as part of an investigation to assess the effectiveness of the existing BV/SVE systems. Data collected indicated BTEX concentrations were being effectively reduced within the unsaturated zone; however, groundwater BTEX concentrations remained above applicable screening criteria in monitoring wells located within the former UST area.

An AAS system was installed in October 2000 to supplement the BV/SVE systems. The AAS system was designed to remediate soil and groundwater contamination in the saturated zone by injecting air through eight sparge wells with screened intervals placed below the water table.

Based on the results of the semi-annual groundwater sampling events, the treatment system at Area 1495 was shut down in February 2004. Continued elevated concentrations of dissolved petroleum hydrocarbons lead to additional treatment via a pilot test of a mobile ozone treatment system for a one month duration at Area 1495. The purpose of the ozone treatment system was to treat the remaining residual contaminants within the groundwater plume.

Groundwater sampling at Area 1495 has been conducted since 1995. The groundwater sampling program was conducted quarterly from 1995 to 1999, and then semi-annually from 1999 until the 2011.

3.0 Investigations and Remedial Program to Date

Groundwater and soil in the vicinity of Area 1495 were investigated starting in 1989. Two former fuel USTs and associated infrastructure were the focus of these investigations.

1990. A Remedial Investigation (RI) was conducted by CDM Federal Programs Corporation (CDM, 1990). The objective of the RI was to assess the nature and extent of soil and groundwater petroleum hydrocarbons at four areas along Gasoline Alley, including Area 1495. Soil and groundwater samples were collected and analyzed by CDM.

March 1994. Woodward-Clyde Federal Services performed a Contamination Assessment (CA) of vadose zone soil at each of the fueling areas along Gasoline Alley. The purpose of the CA was to characterize the nature and extent of COCs in vadose zone soil for comparison of detected concentrations with NYSDEC screening criteria, and to estimate the volume of soil requiring remediation.

1994. CDM conducted a groundwater plume reconnaissance using direct-push technology (DPT) to assess the nature and extent of COCs in groundwater and surface water along Gasoline Alley. Twenty DPT ground water samples were collected from Area 1495. Groundwater samples from Area 1495 contained concentrations of BTEX and total petroleum hydrocarbons (TPH) exceeding NYSDEC Maximum Contaminant Levels; the highest concentrations were reported near the central dispenser piping and easternmost former UST location.

1994. EA Engineering (EA) provided environmental oversight and analytical support during the removal of the 22 USTs at the nine former fuel storage facilities (including USTs situated at Area 1495). Soil samples were collected from the excavations and soil stockpiles and analyzed for VOCs, semi-volatile organic compounds, PAHs, and lead.

July 1995 through December 1997. Groundwater samples were collected on a quarterly schedule from wells at Area 1495. The first four sampling events (July and October 1995, and March and July 1996) were performed by Radian, and the subsequent three events (December 1996, and March and June 1997) were performed by Malcolm Pirnie. The objective of the groundwater sampling program has been to assess the lateral and vertical extent of the dissolved-phase hydrocarbon plume. The samples collected were analyzed for VOCs, PAHs, iron, manganese, and lead.

1996 through 1997. A BV/SVE system was installed and operated to remediate remaining contaminants at Area 1495. Soil gas hydrocarbons, oxygen, and carbon dioxide measurements were collected on a monthly basis.

1998. Radian performed constant rate and in-situ respiration tests at Area 1495. The results of the tests indicated the anticipated radius of influence of 40 feet would not be achieved under the then-current site conditions and equipment design specifications. However, further respiration tests concluded biodegradation of site contaminants was occurring.

October 2000. An AAS system was installed to supplement the BV/SVE system. The AAS system was designed to remediate soil and groundwater contamination in the saturated zone by injecting air through sparge wells with screened intervals placed below the water table.

2004. Following receipt of NYSDEC concurrence and approval based on the results of the semi-annual groundwater sampling events, the treatment system at Area 1495 was shut down in February 2004.

2004 to Present. Area 1495 has been monitored under the basewide groundwater monitoring program on a semi-annual basis. The sampling program includes analysis of groundwater for VOC and MNA parameters.

2009. Plexus completed a Risk Assessment for Building T-91. The findings showed that there is no human health risk associated with site related contaminants.

August 2009. Due to persistent low-level concentrations of contaminants at Area 1495, Plexus operated an additional in-situ treatment via a pilot test of a mobile ozone treatment system for one month in August 2009. Results of the pilot ozone application showed a significant rise in the concentrations of oxygen available to enhance aerobic biodegradation.

2011. Plexus administered an application of an N:P:K solution from January to March 2011. The purpose of this treatment is to ensure there are sufficient micro-nutrients for the indigenous microbial population.

2012. Plexus completed a Site Monitoring and Management Plan for Area 1495. Implementation of land use controls and changes to the sampling frequency were recommended based on site conditions, data trend analysis and human health and ecological risk scenarios. The land use controls included restricting groundwater use as a potable water source and preventing disturbance of soil below 4 ft below ground surface (bgs).

4.0 Initial Conditions and Contaminants of Concern

The results of the Plume Reconnaissance Report (CDM, 1995) conducted after the removal of the associated USTs showed groundwater in the vicinity of the UST excavation exceeded NYSDEC screening criteria. Twenty groundwater samples were collected from 22 DPT sample locations. Four monitoring wells (MW2, MW3, MW30 and MW31) were also sampled.

The investigation identified a small groundwater plume originating from Area 1495. BTEX compounds were detected in five DPT groundwater samples and two of the four monitoring wells. The signature for the TPH concentrations was indicative of gasoline (CDM, 1995). The highest concentration of total BTEX was 70 µg/L. The highest concentrations were located at MW30. Over the history of the groundwater sampling program at Area 1495, the highest recorded total BTEX concentrations were observed in October 1995 at 1,524 µg/L in monitoring well 1495-MWS3.

Figure 4-1 illustrates the groundwater sampling results for BTEX at Area 1495 during the DPT sampling event in August 1994. COCs at Area 1495 are primarily BTEX and associated gasoline-range organics.

5.0 Current Conditions and Data Trends

Plexus completed a Site Monitoring and Management Plan for Area 1495. Implementation of land use controls and changes to the sampling frequency were recommended based on site conditions, data trend analysis and human health and ecological risk scenarios. The land use controls included restricting groundwater use as a potable water source and preventing disturbance of soil below 4 ft below ground surface (bgs).

5.1 Current Conditions

The groundwater gauging program at Area 1495 has characterized the flow path associated with the unconfined surficial aquifer. **Figure 5-1** illustrates the elevation and direction of groundwater flow to the west.

Groundwater was analyzed for VOCs and MNA parameters during the Spring and Fall 2011 basewide sampling events. Concerning site COCs, during the Fall 2011 sampling event: total xylenes and ethylbenzene exceeded NYSDEC screening criteria at monitoring wells 1495-MWS3 and –MWS4; and only total xylenes exceeded NYSDEC screening criteria at monitoring well 1495-MW30 (**Table 5-1, Figure 5-2**).

5.2 Time Series and Statistical Data Analysis

To assess groundwater contamination trends over time (**Figure 5-3**), time series data have been evaluated for site-related contaminants exceeding NYSDEC screening criteria. **Figures 5-4 through 5-7** illustrate time series data for BTEX since May 1995. In addition, M-K trend analysis (**Table 5-2**) was performed for BTEX for the eleven groundwater monitoring wells in the basewide sampling program. The results show AOC wells 1495-MW30 and 1495-MWS3 exhibit decreasing or stable concentration trends, and no increasing trends were observed at the site.

5.3 MNA Evaluation

MNA parameter data collected during the Fall 2011 sampling event (**Figure 5-8**) show groundwater exhibits an anoxic and reducing environment within the contaminant plume. The groundwater upgradient of the contaminant plume is oxygenated and aerobic in nature. The upgradient oxygenated groundwater flowing into the contaminant plume is providing the required supply of oxygen that sustains aerobic biodegradation and promotes MNA. The apparent lack of oxygen within the contaminant plume demonstrates that the microbial community is using all the available oxygen and sustaining biodegradation of contaminants compounds. To ensure future MNA at the site, Plexus has added commercial fertilizer (24: 8: 16: N, P, K, respectively) using the current monitoring network at the site to enhance the mineralization of the dissolved petroleum hydrocarbons. Nutrients were applied using a gravity feed of one gallon of solution at each point, once a month for 3 months.

5.4 Plume Stability Evaluation

To assess groundwater plume stability, the aerial extent of the August 1994 BTEX plume was compared to the Fall 2011 BTEX plume. **Figure 4-1** illustrates the extent of the initial BTEX plume (EA, 1999) and **Figure 5-9** illustrates that the cumulative efforts of the Army have resulted in significant shrinkage of the plume by Fall 2011.

6.0 Risk Assessment

As part of this Final PRR, an HHRA was performed as an update to the 2009 HHRA for Area 1495 (Plexus, 2010b). All remaining contamination is confined to groundwater and soil associated with the fluctuating water table or smear zone. Impacted groundwater has been characterized and does not extend beyond the site boundary. As there is no discharge of site-related contaminants to surface water there are no exposure scenarios present for ecological receptors; therefore an ecological risk assessment has not been performed as part of this report.

Appendix A presents the findings of the 2011 HHRA for Area 1495. From a HHRA perspective, Area 1495 may be recommended for site closure. Carcinogenic risks for both the industrial worker and resident were not evaluated due to a lack of carcinogenic slope factors and unit risk factors. The industrial worker Hazard Index (HI) was below the Environmental Protection Agency (EPA) non-carcinogenic Hazard Quotient (HQ) threshold. Child and adult resident HIs were also below the EPA non carcinogenic HQ threshold.

7.0 Recommendations

Based on existing site conditions, demonstrated trend data analysis, and current human health and ecological risk scenarios, the recommendations of this Final PRR for Area 1495 include:

1. No further monitoring; and
2. Site close-out.

These recommendations are made based on the following site conditions:

- There is no risk to any ecological or human receptors associated with the current conditions at Area 1495;
- The MNA remedial action has remediated the site in a manner that is fully protective of all receptors and is still active at the site;
- Contaminant concentrations in AOC well 1495-MW30 do not exceed NYSDEC screening criteria (Rules and Regulations Part 703, New York Codes), with the exception of total xylenes, which was 6.7 µg/L over screening criteria;
- Contaminant concentrations in AOC well 1495-MWS3 do not exceed NYSDEC screening criteria, with the exception of ethylbenzene and total xylenes, which were 20.6 µg/L and 46.9 µg/L over screening criteria, respectively;
- Contaminant concentrations in the sentinel well (1495-MWS2) have only exceeded NYSDEC screening criteria during one sampling event in the past eight years. During the Fall 2011 sampling event, ethylbenzene and total xylenes concentrations were 1.3 µg/L and 12.3 µg/L over screening criteria, respectively. These results have been considered an isolated occurrence, as the natural regression of the plume was monitored beyond this monitoring point;
- Benzene and toluene do not exceed NYSDEC screening criteria at any site monitoring points; and
- The contaminant plume is stable or shrinking based on statistical and trend data analysis.

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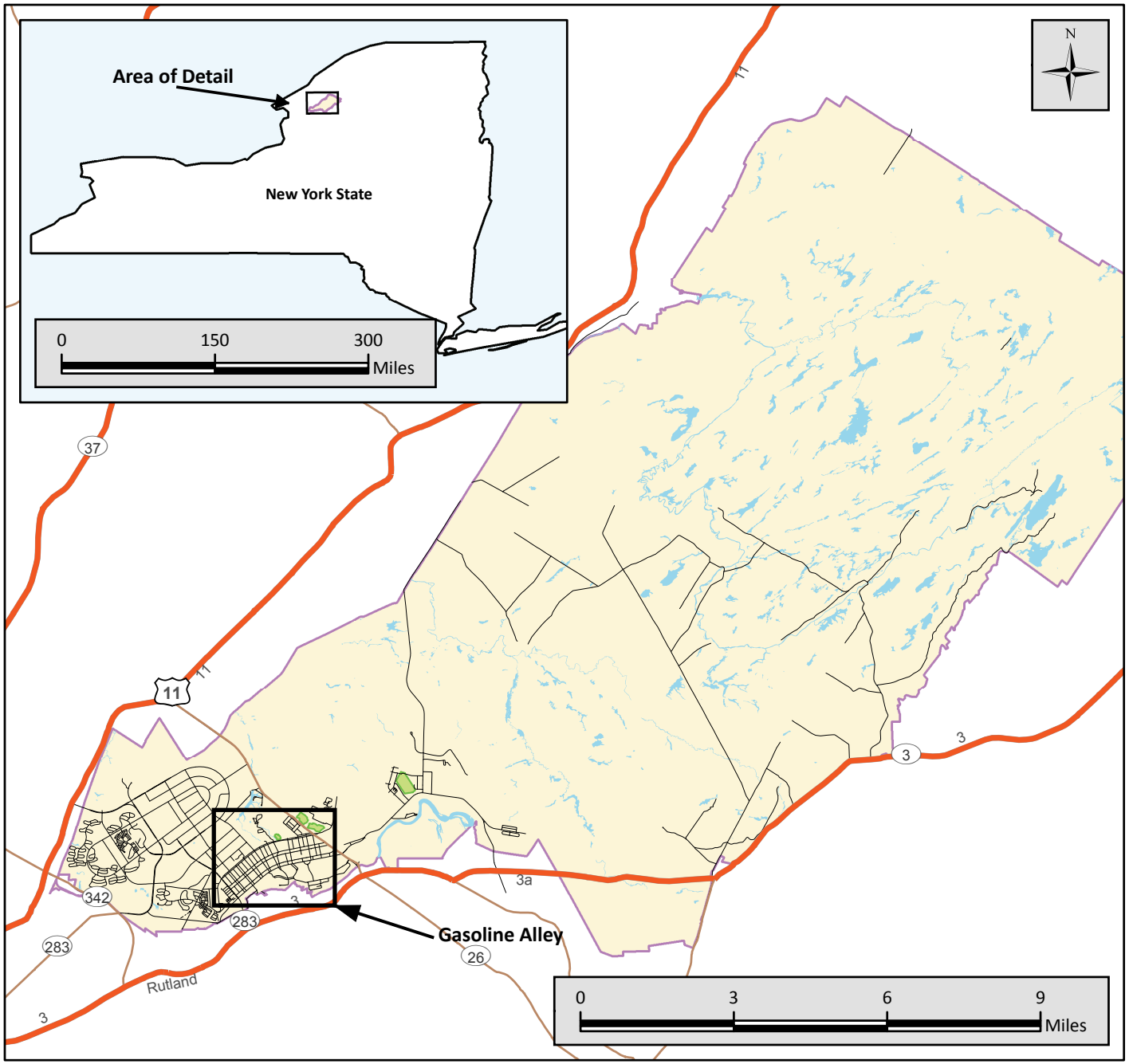
FIGURES



Legend

- Interstate
- Highway
- Major Road
- Local Road
- Fort Drum Roads
- Water
- Landfill
- Installation Area

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FIGURE 1-1

Site Location Map

Final Periodic Review Report for
Area 1495
Fort Drum, New York

Legend

- Fence Line
- Rail Road
- Paved Roadline
- Landfill Site
- Wetlands
- Building
- Paved Area

Fall 2011 BTEX Plume

- 1 µg/L
- 10 µg/L

Abbreviation Key:
µg/L = micrograms per liter

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FIGURE 1-2

Gasoline Alley Site Map

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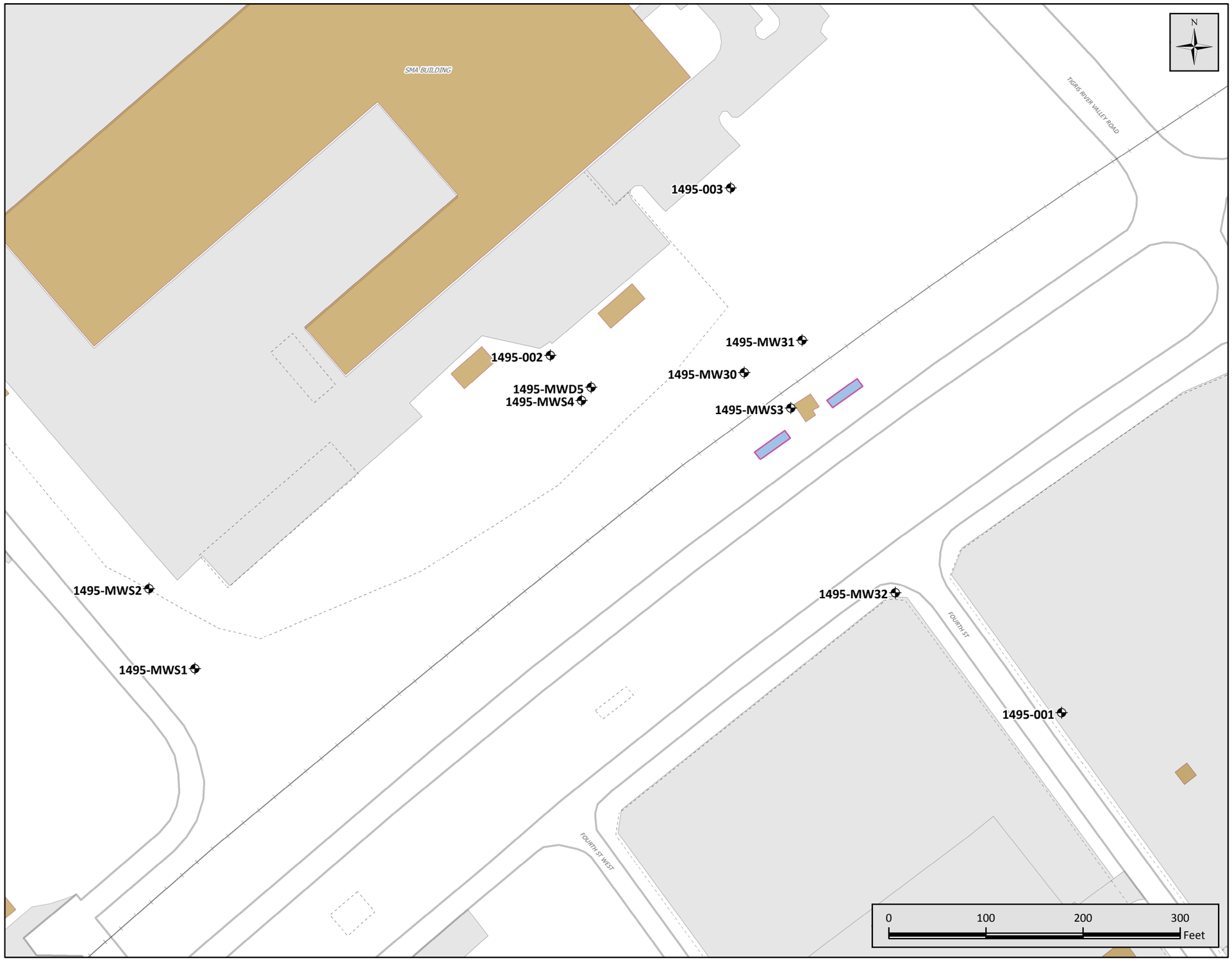

Legend

- Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

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FIGURE 2-1

Area 1495 Site Layout Map

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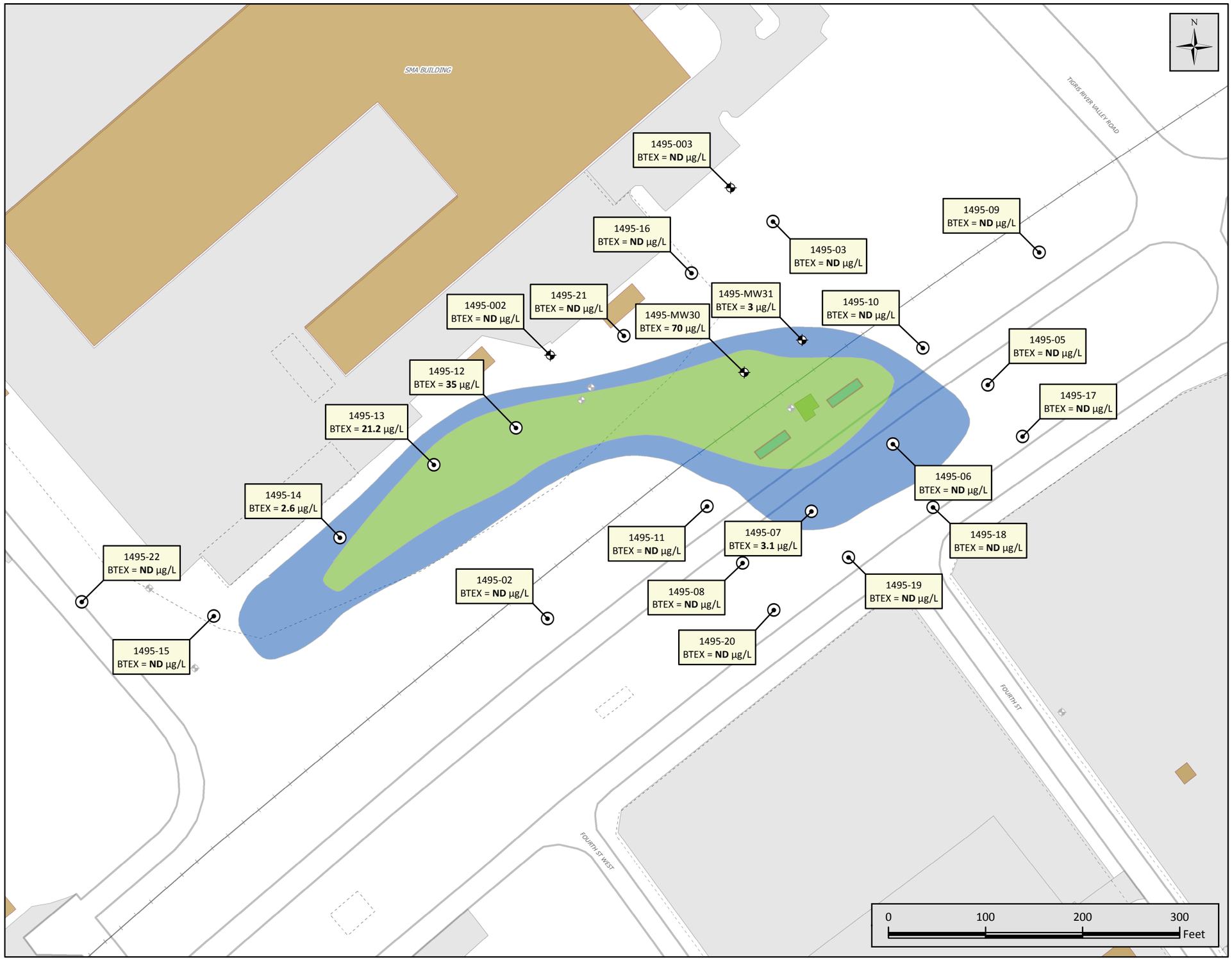

Legend

- Historical Direct Push Locations
- Sampled Wells
- Other Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

1995 BTEX Plume

- 1 µg/L
- 10 µg/L

BTEX Label Key:
Result values are expressed in units of µg/L followed by a qualifier if applicable.
µg/L = micrograms per liter

Location Well ID	Exceedence Criteria (µg/L):
B- **Benzene**	B - **1**
T- **Toluene**	T - **5**
E- **Ethyl Benzene**	E - **5**
X- **Total Xylenes**	X - **5**
BTEX- **Total BTEX**	

Qualifer Key:
U - Value is less than the method detection limit (MDL)
J - Value is greater than the MDL, but less than the reporting limit (RL)

Figure taken from EA Engineering's, 1995 "Comprehensive Contaminant Assessment Report Volume II: Areas 1195, 1295, 1395 and 1495, Gasoline Alley, Fort Drum, NY"

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FIGURE 4-1

Area 1495
Initial BTEX Concentrations in Groundwater, August 1994

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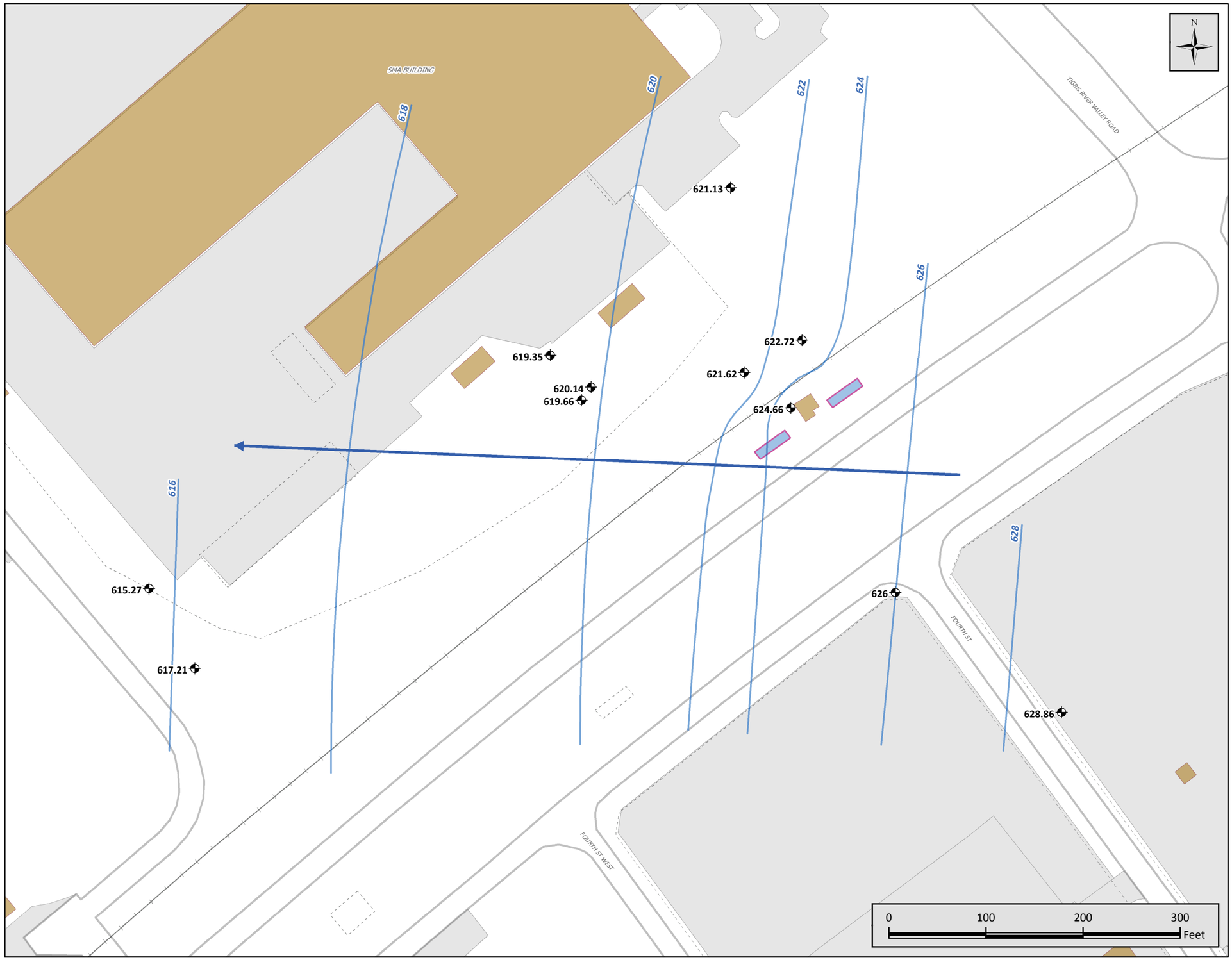

Legend

- Gauged Wells (ft MSL)
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

Abbreviation Key:
ft = Feet
MSL = Mean sea level

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FIGURE 5-1

Area 1495
Groundwater Contour Map
Fall 2011

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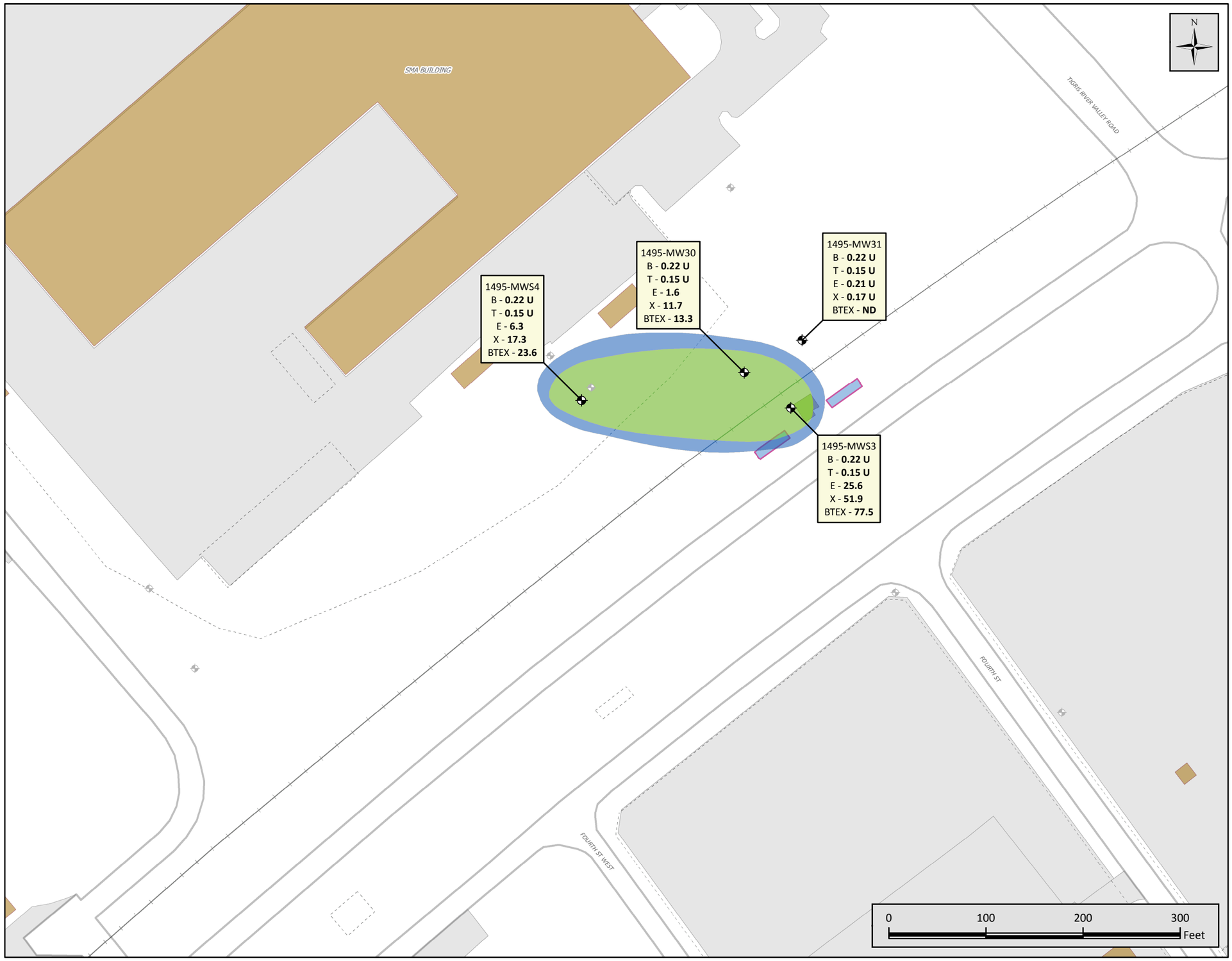

Legend

- Sampled Wells
- Other Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

Fall 2011 BTEX Plume

- 1 µg/L
- 10 µg/L

BTEX Label Key:
Result values are expressed in units of µg/L followed by a qualifier if applicable.
µg/L = micrograms per liter

Location Well ID
B- **Benzene**
T- **Toluene**
E- **Ethyl Benzene**
X- **Total Xylenes**
BTEX- **Total BTEX**

Exceedence Criteria (µg/L):
B - **1**
T - **5**
E - **5**
X - **5**

Qualifer Key:
U - Value is less than the method detection limit (MDL)
J - Value is greater than the MDL, but less than the reporting limit (RL)

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FIGURE 5-2

Area 1495
BTEX Concentrations in Groundwater
Fall 2011

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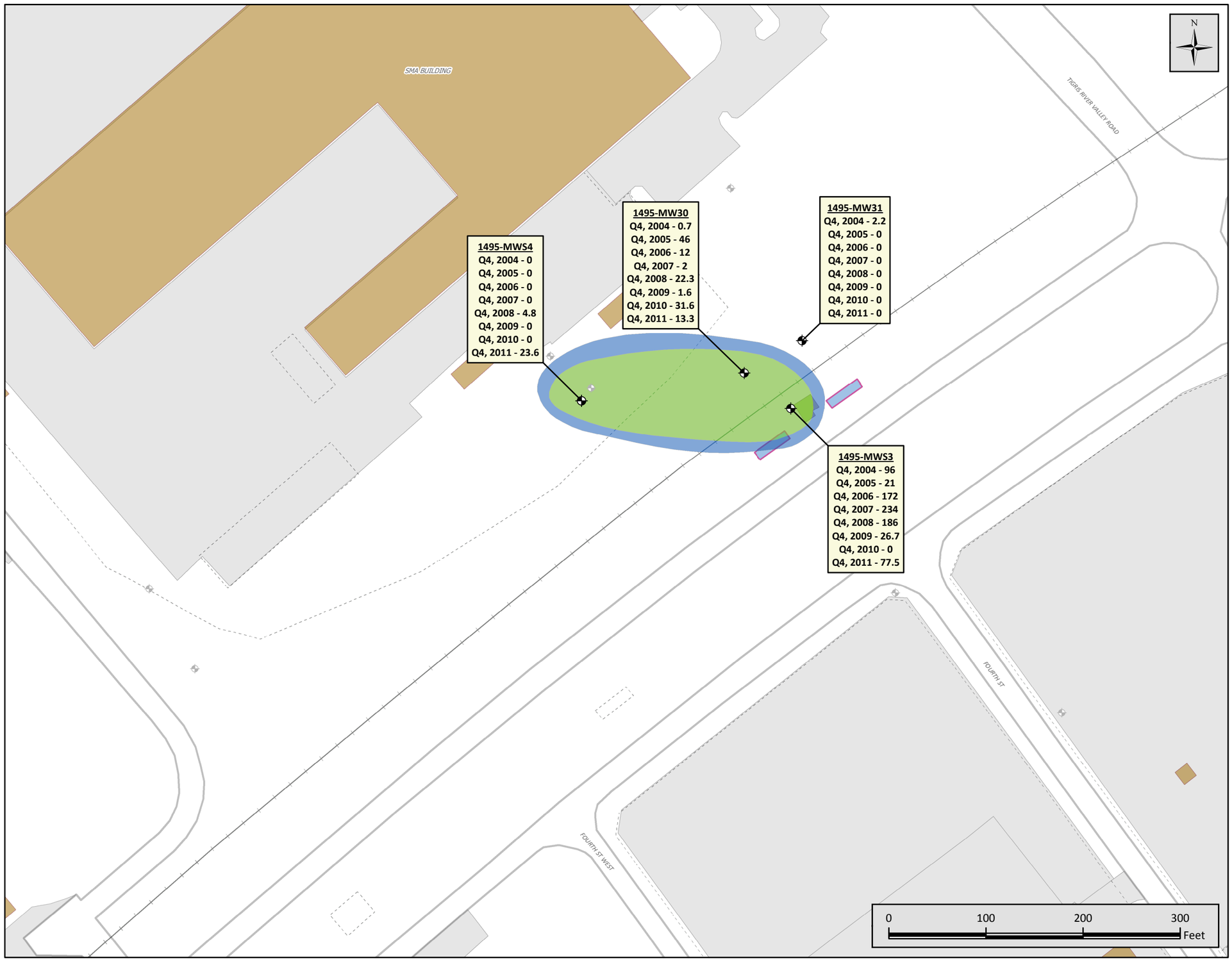

Legend

- Sampled Wells
- Other Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

Fall 2011 BTEX Plume

- 1 µg/L
- 10 µg/L

Historical Total BTEX Label Key:
Result values are expressed in units of micrograms per liter (µg/L)

Location Well ID
Quarter, Year - Total BTEX (µg/L)
Q4, 2008 - 2,000

NS = Not Sampled

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FIGURE 5-3

Area 1495
Historical BTEX Concentrations in Groundwater, Fall 2004 to Fall 2011

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Fort Drum, New York

Figure 5-4:
BTEX Time Series Trend Graph for Monitoring Well 1495-MW30

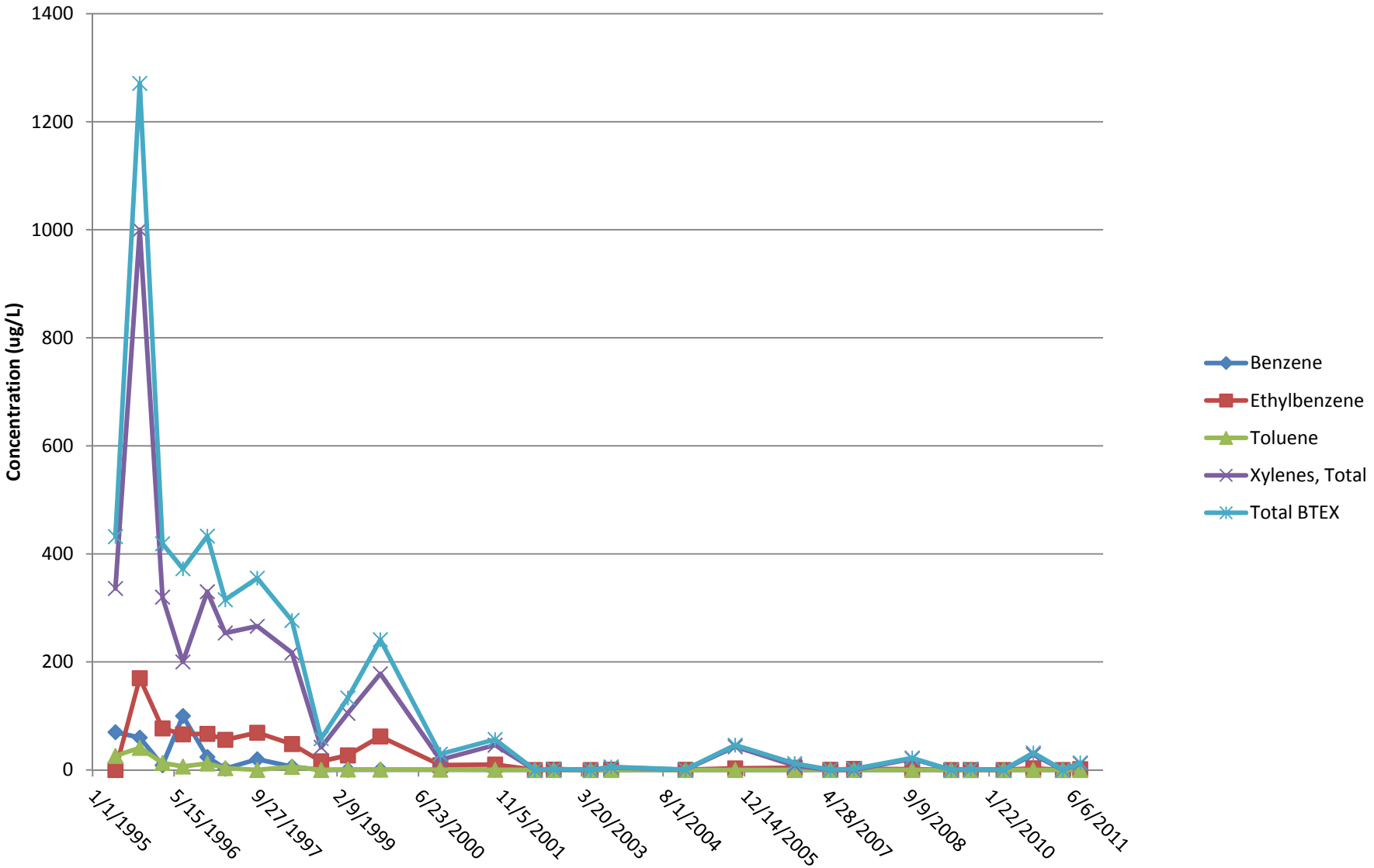


Figure 5-5:
BTEX Time Series Trend Graph for Monitoring Well 1495-MW31

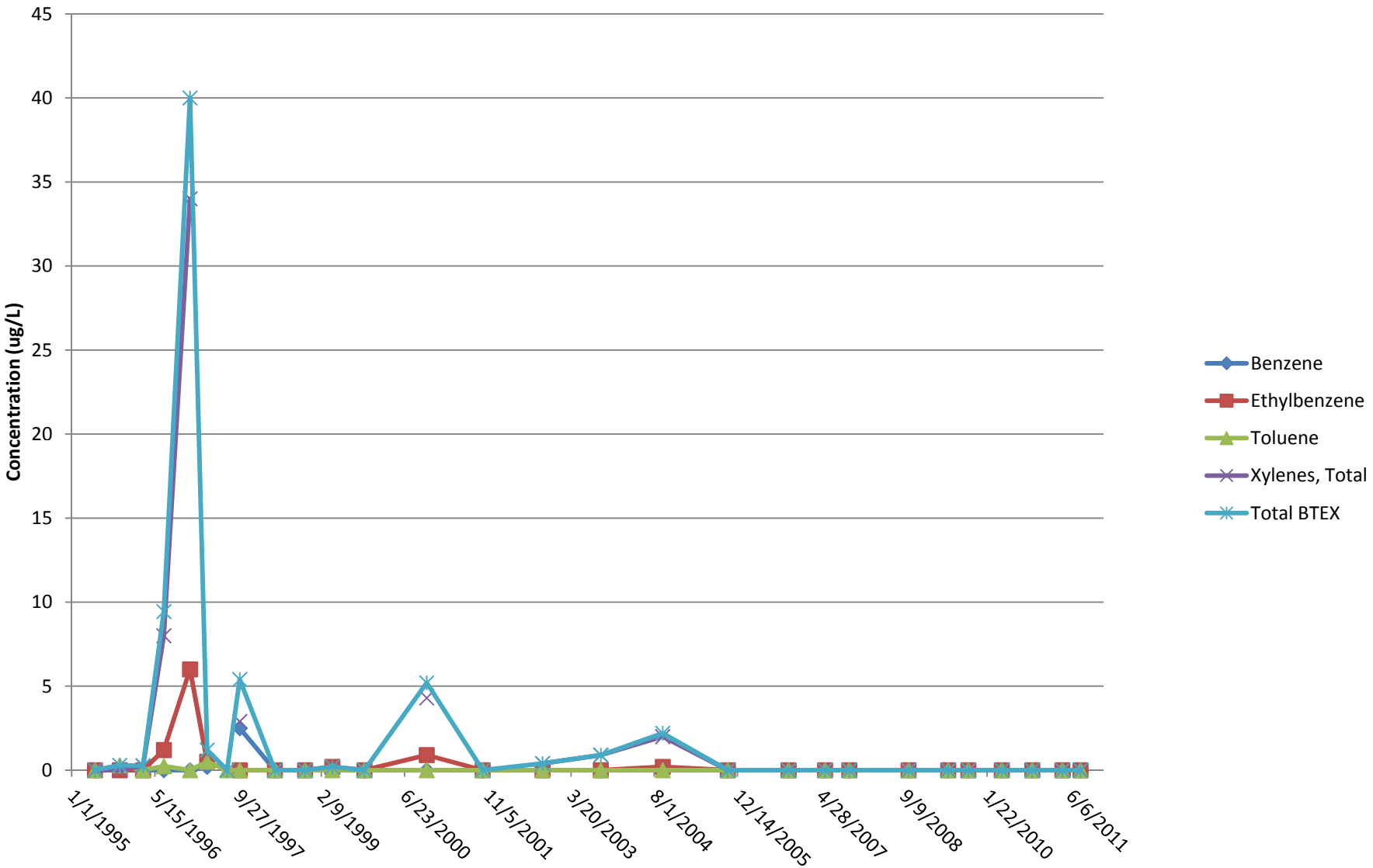


Figure 5-6:
BTEX Time Series Trend Graph for Monitoring Well 1495-MWS3

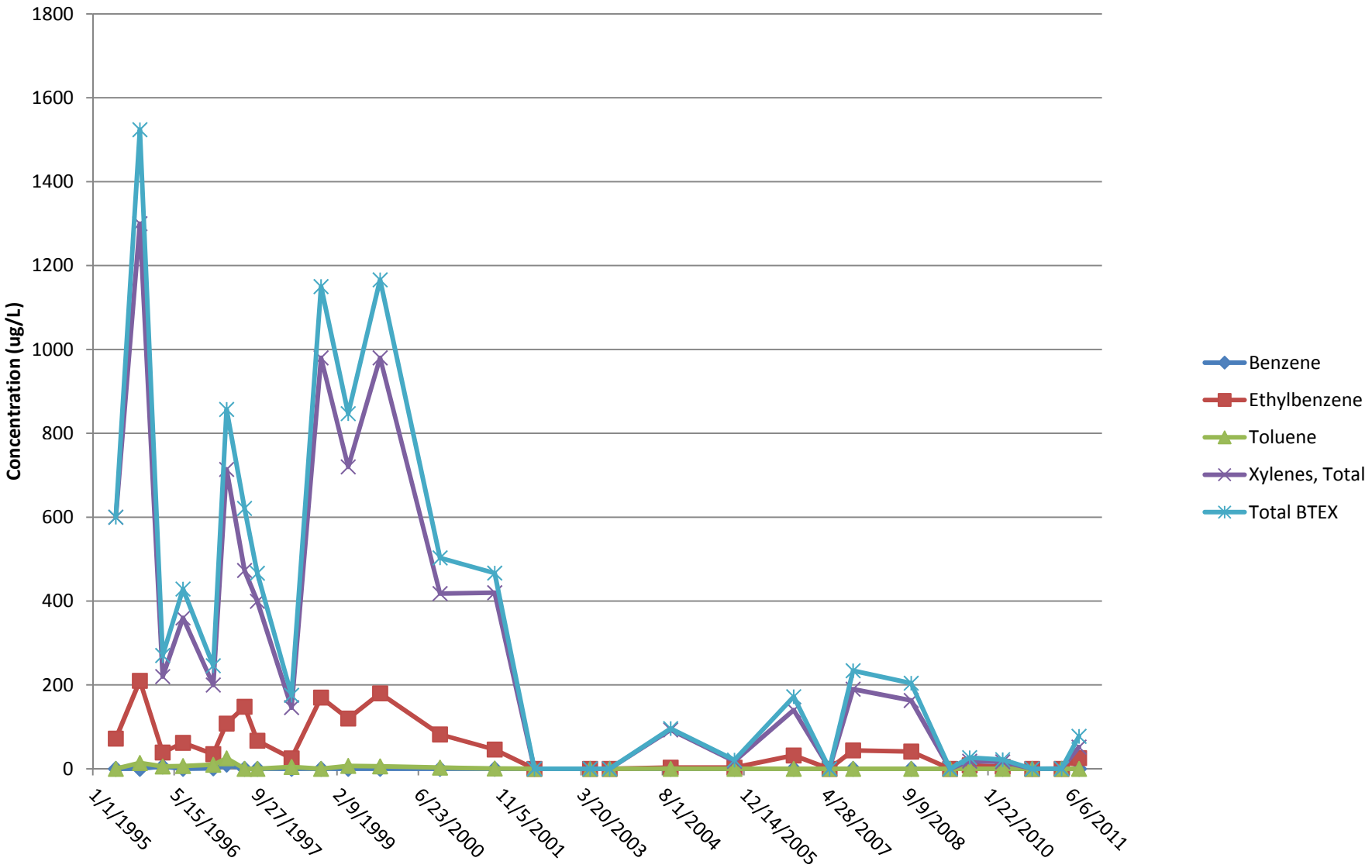
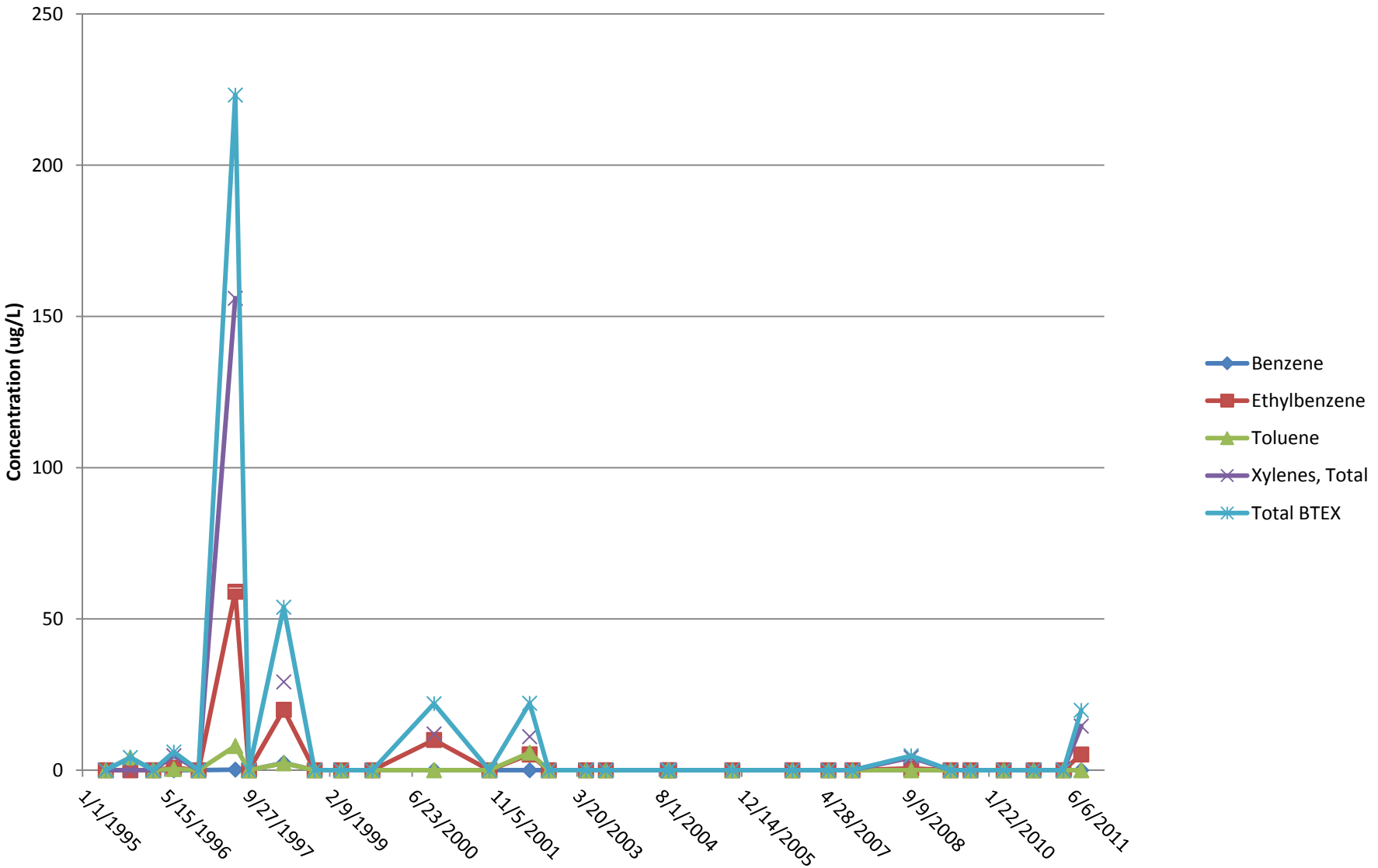
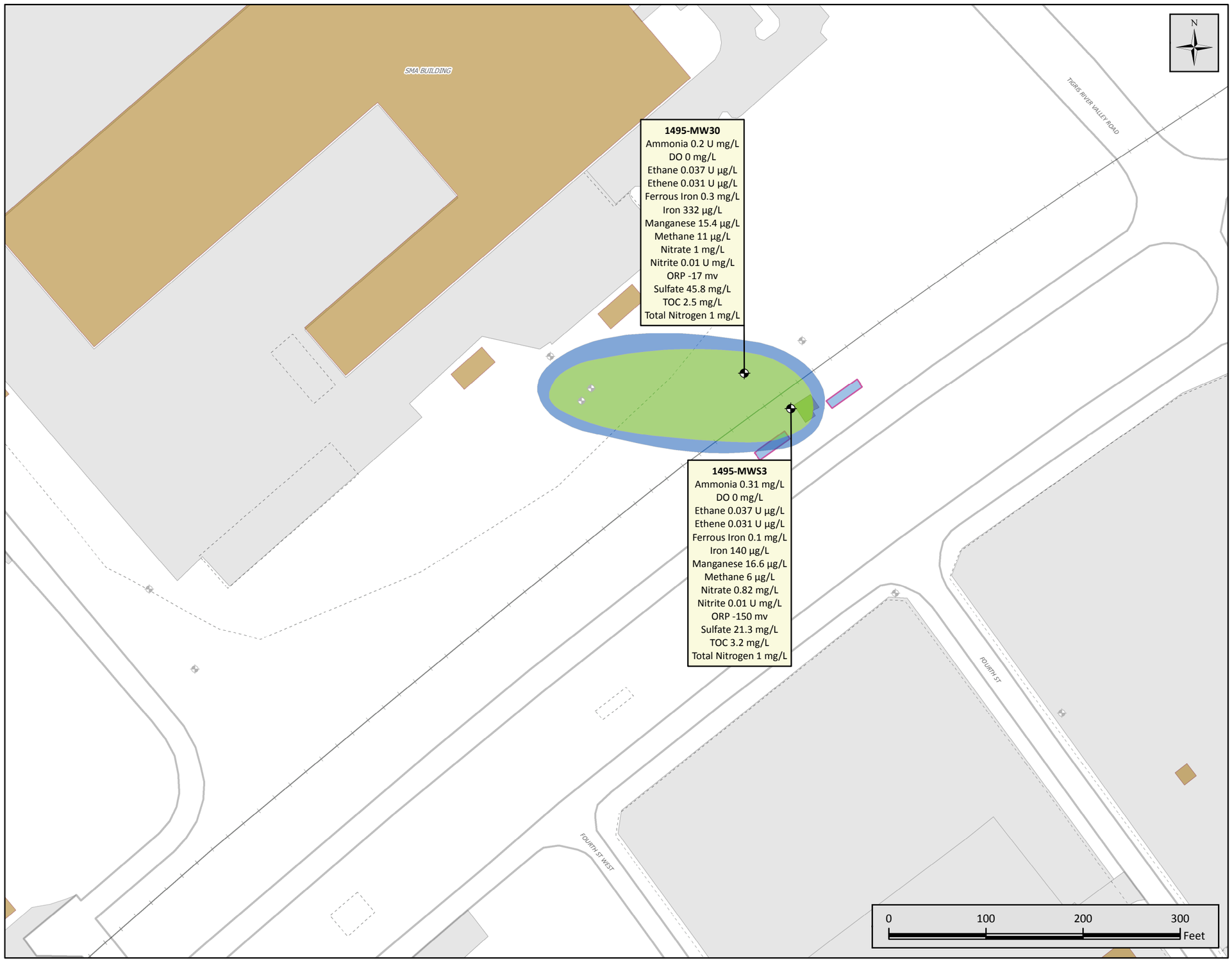


Figure 5-7:
BTEX Time Series Trend Graph for Monitoring Well 1495-MWS4





Legend

- Sampled Wells
- Other Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

Fall 2011 BTEX Plume

- 1 µg/L
- 10 µg/L

Monitored Natural Attenuation Label Key:
Result values are expressed in units of µg/L and mg/L followed by a qualifier if applicable

Abbreviation Key:
µg/L = micrograms per liter
DO - Dissolved Oxygen
mg/L = milligrams per liter
mV = millivolts
NS - Not Sampled
ORP - Oxidation Reduction Potential
TOC - Total Organic Carbon

Qualifer Key:
U - Value is less than the method detection limit (MDL)

25 years of excellence
PLEXUS scientific
4501 Ford Ave.
Suite 1200
Alexandria, VA 22302
(P) 703.820.3339
(F) 703.845.8568

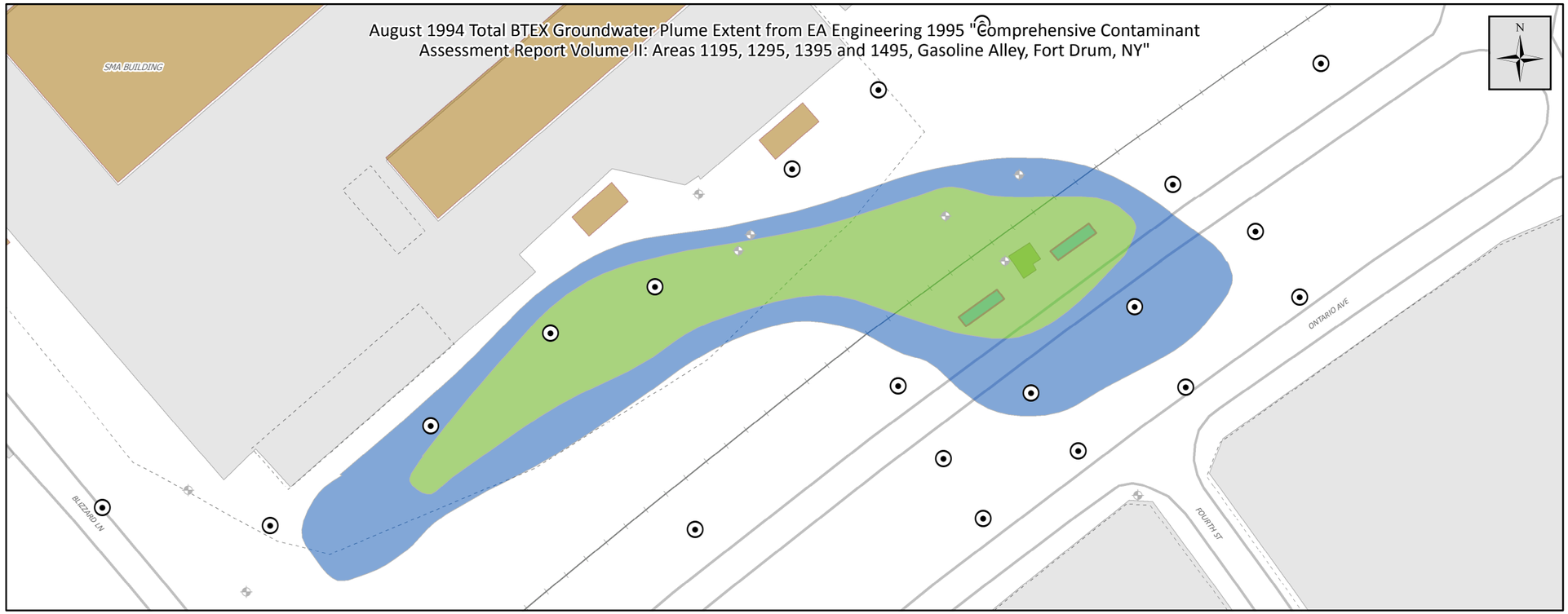
Created By: BAB
Date: April 2013

FIGURE 5-8

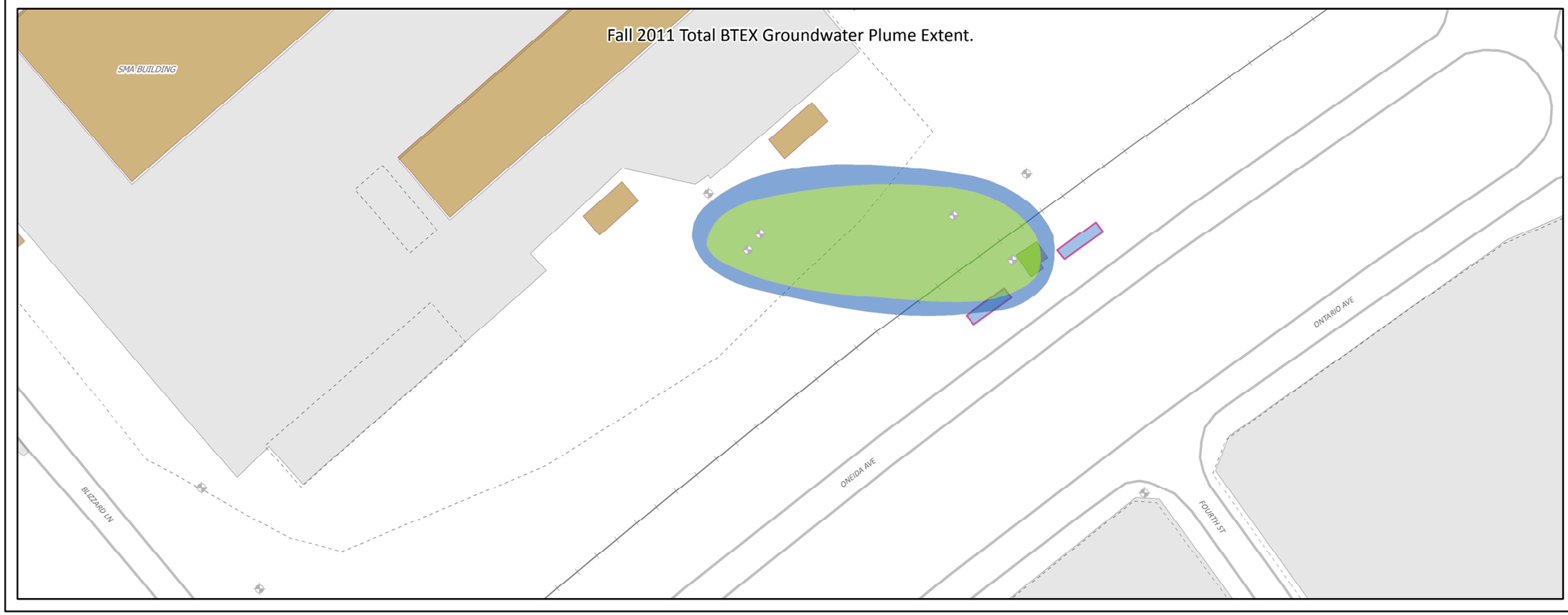
Area 1495
MNA Parameters
Fall 2011

Final Periodic Review Report for
Area 1495
Fort Drum, New York

August 1994 Total BTEX Groundwater Plume Extent from EA Engineering 1995 "Comprehensive Contaminant Assessment Report Volume II: Areas 1195, 1295, 1395 and 1495, Gasoline Alley, Fort Drum, NY"



Fall 2011 Total BTEX Groundwater Plume Extent.



Legend

- Historical Direct Push Locations
- Monitoring Wells
- Former UST
- Fence Line
- Rail Road
- Paved Roadline
- Building
- Paved Area

BTEX Plume

- 1 µg/L
- 10 µg/L

BTEX = Benzene, Toluene, Ethylbenzene & Total Xylenes
µg/L = micrograms per liter

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Created By: BAB
Date: April 2013

FIGURE 5-9

Area 1495
BTEX Concentrations in Groundwater, August 1994 and Fall 2011

Final Periodic Review Report for
Area 1495
Fort Drum, New York

TABLES

Table 5-1:

Historical BTEX and Napthalene concentrations at Area 1495 monitoring wells

Location	SampleDate	Benzene		Ethylbenzene		Toluene		Xylene (Total)		Total BTEX	Iron		Manganese	
1495-001	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	7		0.75	
	5-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	5		0.62	
1495-002	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	0.4		0.02	
	18-Oct-95	0.2	U	0.2	U	0.2	U	0.2	U	0	0.64		0.05	
	5-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	0.57		0.04	
	8-Jul-96	0.2	U	0.2	U	0.2	U	0.2	U	0	NS		NS	
	5-Dec-96	1	U	1	U	1	U	1	U	0	NS		NS	
	26-Mar-97	0.2	U	0.5	U	0.5	J	1	U	0.5	NS		NS	
	23-Jul-97	0.2	U	0.5	U	0.5	J	1		1.5	NS		NS	
	7-Oct-97	0.2	U	0.5	U	0.5	U	1	U	0	NS		NS	
1495-003	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	1.7		0.12	
	18-Oct-95	0.2	U	0.2	U	0.2	U	0.2	U	0	1.7		0.11	
	14-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	1.6		0.08	
1495-MW30	21-May-95	**70**		8	U	**26**		**336**		432	1.9		0.07	
	17-Oct-95	**60**		**170**		**41**		**1,000**		1,271	3.6		0.1	
	5-Mar-96	**8.8**		**77**		**13**		**320**		418.8	3.2		0.1	
	8-Jul-96	**100**		**66**		**6.5**		**200**		372.5	NS		NS	
	5-Dec-96	**24**		**67**		**12**		**330**		433	NS		NS	
	25-Mar-97	2.3		**55.8**		3.4		**253.6**		315.1	NS		NS	
	7-Oct-97	**19.9**		**69**		25	U	**266.1**		355	NS		NS	
	8-May-98	**6**		**48**		**5.8**		**217**		276.8	NS		NS	
	3-Nov-98	2.5	U	**16**		2.5	U	**42**		58	38.9	U	10	
	16-Apr-99	0.3		**27**		1		**105**		133.3	NS		NS	
	1-Nov-99	0.4	J	**62**		0.8	J	**178**		241.2	171		17	
	3-Nov-00	0.7	J	**9**		0.6	J	**19**		29.3	NS		NS	
	5-Oct-01	5	U	**10**		0.4	J	**46**		56.4	NS		NS	
	6-Jun-02	5	U	5	U	5	U	5	U	0	NS		NS	
	30-Sep-02	5	U	0.7	J	5	U	1.3	JB	2	NS		NS	
	14-May-03	5	U	5	U	5	U	5	U	0	NS		NS	
	17-Sep-03	5	U	0.7	J	5	U	5	J	5.7	NS		NS	
	16-Dec-04	0.2	J	0.5	J	5	U	15	U	0.7	NS		NS	
	17-Oct-05	5	U	3	J	5	U	**43**		46	NS		NS	
	17-Oct-06	5	U	4	J	5	U	**8**	**J**	12	NS		NS	
	24-May-07	5	U	0.4	J	5	U	15	U	0.4	NS		NS	
	16-Oct-07	1	U	2		1	U	3	U	2	NS		NS	
	7-Oct-08	0.26	U	1.5		0.15	U	**20.8**		22.3	**496**		110	
	3-Jun-09	0.23	U	1	U	0.3	U	1	U	0	**1,180**		31.7	
	1-Oct-09	0.23	U	0.27	U	0.3	U	1.6		1.6	**1,670**		319	
	21-Apr-10	0.23	U	0.27	U	0.3	U	0.25	U	0	150	J	38.9	
	20-Oct-10	0.23	U	3.2		0.3	U	**28.4**		31.6	NS		NS	
	19-Apr-11	0.23	U	0.27	U	0.3	U	0.25	U	0	**907**		21.3	
	4-Aug-11	0.22	U	1.6		0.15	U	**11.7**		13.3	**332**		15.4	

Table 5-1:

Historical BTEX and Napthalene concentrations at Area 1495 monitoring wells

Location	SampleDate	Benzene		Ethylbenzene		Toluene		Xylene (Total)		Total BTEX	Iron		Manganese	
1495-MW31	21-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	1		0.04	
	17-Oct-95	0.2	U	0.2	U	0.29		0.2	U	0.29	1		0.06	
	5-Mar-96	0.2	U	0.2	U	0.2	U	0.26		0.26	0.9		0.11	
	8-Jul-96	0.2	U	1.2		0.24		**8**		9.44	NS		NS	
	12-Dec-96	1	U	**6**		1	U	**34**		40	NS		NS	
	25-Mar-97	0.2	J	0.5	J	0.5	J	1	U	1.2	NS		NS	
	23-Jul-97					0.5	U	0.5	U	0	NS		NS	
	7-Oct-97	2.5		0.5	U	0.5	U	2.9		5.4	NS		NS	
	6-May-98	0.5	U	0.5	U	0.5	U	1	U	0	NS		NS	
	3-Nov-98	0.5	U	0.5	U	0.5	U	0.5	U	0	NS		NS	
	16-Apr-99	5	U	0.2		5	U	5	U	0.2	NS		NS	
	26-Oct-99	5	U	5	U	5	U	5	U	0	NS		NS	
	3-Nov-00	5	U	0.9	J	5	U	4.3	J	5.2	NS		NS	
	5-Oct-01	5	U	5	U	5	U	5	U	0	NS		NS	
	30-Sep-02	5	U	5	U	5	U	5	U	0	NS		NS	
	15-Sep-03	5	U	5	U	5	U	0.9	J	0.9	NS		NS	
	21-Sep-04	5	U	0.2	J	5	U	2	J	2.2	NS		NS	
	17-Oct-05	5	U	5	U	5	U	15	U	0	NS		NS	
	17-Oct-06	5	U	5	U	5	U	15	U	0	NS		NS	
	24-May-07	5	U	5	U	5	U	15	U	0	NS		NS	
	17-Oct-07	1	U	1	U	1	U	3	U	0	NS		NS	
	7-Oct-08	0.26	U	0.27	U	0.15	U	0.39	U	0	152		8.3	J
	2-Jun-09	0.23	U	0.27	U	0.3	U	0.25	U	0	227		8.3	J
	1-Oct-09	0.23	U	0.27	U	0.3	U	0.25	U	0	**1,190**		66.9	
	20-Apr-10	0.23	U	0.27	U	0.3	U	0.25	U	0	**512**		14.5	B
	20-Oct-10	0.23	U	0.27	U	0.3	U	0.25	U	0	NS		NS	
	19-Apr-11	0.23	U	0.27	U	0.3	U	0.25	U	0	NS		NS	
	5-Aug-11	0.22	U	0.21	U	0.15	U	0.17	U	0	NS		NS	
1495-MW32	21-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	0.04	U	0.4	
	17-Oct-95	0.2	U	0.3		0.2	U	1		1.3	0.05		1.1	
	5-Mar-96	0.2	U	0.2	U	0.22		0.56		0.78	0.31		2.3	
	8-Jul-96	0.2	U	0.2	U	0.2	U	0.2	U	0	NS		NS	
	12-Dec-96	1	U	1	U	1	U	1	U	0	NS		NS	
	25-Mar-97	0.3		0.5	U	0.8		2.1	J	3.2	NS		NS	
	25-Jul-97	0.2	U	0.5	U	0.5	U	1	U	0	NS		NS	
	8-Oct-97	0.2	U	0.5	U	0.5	U	1	U	0	NS		NS	
	2-Nov-98	NS		NS		NS		NS		NS	46.1	U	1.6	
	28-Oct-99	NS		NS		NS		NS		NS	55.2		**2,520**	
1495-MWD5	22-May-95	2	U	0.2	U	**6.6**		0.2	U	6.6	3		0.17	
	17-Oct-95	0.2	U	0.2	U	0.2	U	0.2	U	0	0.43		0.01	
	5-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	2		0.13	
1495-MWS1	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	4.3		0.44	
	17-Oct-95	0.2	U	0.2	U	0.2	U	0.2	U	0	1.3		0.09	
	4-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	1.2		0.11	
1495-MWS2	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	1.8		0.12	
	18-Oct-95	0.2	U	0.2	U	0.2	U	0.2	U	0	0.44		0.02	
	4-Mar-96	0.2	U	0.2	U	0.2	U	0	U	0	3.8		0.29	

Table 5-1:

Historical BTEX and Napthalene concentrations at Area 1495 monitoring wells

Location	SampleDate	Benzene		Ethylbenzene		Toluene		Xylene (Total)		Total BTEX	Iron		Manganese	
1495-MWS3	22-May-95	8	U	**72**		8	U	600	U	72	5.2		0.24	
	17-Oct-95	10	U	**210**		**14**		**1,300**		1,524	1.4		0.08	
	5-Mar-96	**5.6**		**39**		**5.7**		**220**		270.3	4.3		0.44	
	8-Jul-96	2	U	**62**		**6.7**		**360**		428.7	NS		NS	
	10-Jan-97	1.1		**35**		**9.8**		**200**		245.9	NS		NS	
	2-Apr-97	**10**	**J**	**108**		**25**	**J**	**714**		857	NS		NS	
	21-Jul-97	10	U	**148**		25	U	**473**		621	NS		NS	
	8-Oct-97	10	U	**67**		25	U	**399.5**		467	NS		NS	
	6-May-98	2.5	U	**25**		4.5		**146**		175.5	NS		NS	
	3-Nov-98	10	U	**170**		10	U	**980**		1,150	NS		NS	
	19-Apr-99	25	U	**120**		**7**		**720**		847	**461**		78.7	
	1-Nov-99	25	U	**180**		**6**	**J**	**980**		1,166	NS		NS	
	3-Nov-00	5	U	**82**		3	J	**418**		503	NS		NS	
	5-Oct-01	5	U	**46**		0.8	J	**420**		466.8	NS		NS	
	6-Jun-02	5	U	5	U	5	U	5	U	0	NS		NS	
	14-May-03	5	U	5	U	5	U	5	U	0	NS		NS	
	11-Sep-03	5	U	5	U	5	U	10	U	0	NS		NS	
	20-Sep-04	5	U	3	J	5	U	**93**		96	NS		NS	
	17-Oct-05	5	U	3	J	5	U	**18**		21	NS		NS	
	16-Oct-06	5	U	**32**		5	U	**140**		172	NS		NS	
	24-May-07	5	U	5	U	5	U	15	U	0	NS		NS	
	16-Oct-07	1	U	**44**		1	U	**190**		234	NS		NS	
	7-Oct-08	0.26	U	**37**		0.15	U	**149**		186	57.7	B	31.5	
	3-Jun-09	0.23	U	0.27	U	0.3	U	0.25	U	0	45.2	J	15	U
	1-Oct-09	0.23	U	**8.4**		0.3	U	**18.3**		26.7	**2,800**		93	
	22-Apr-10	0.23	U	**5.1**		0.3	U	**16.8**		21.9	**31,500**		64.7	
	20-Oct-10	0.23	U	0.27	U	0.3	U	0.25	U	0	42.5	J	15	U
	19-Apr-11	0.23	U	0.27	U	0.3	U	0.34	J	0.34	60		12.1	
	4-Aug-11	0.22	U	**25.6**		0.15		**51.9**		77.5	140		16.6	

Table 5-1:

Historical BTEX and Napthalene concentrations at Area 1495 monitoring wells

Location	SampleDate	Benzene		Ethylbenzene		Toluene		Xylene (Total)		Total BTEX	Iron		Manganese	
1495-MWS4	22-May-95	0.2	U	0.2	U	0.2	U	0.2	U	0	8.6		2.2	
	18-Oct-95	0.2	U	0.2	U	4.2		0.2	U	4.2	0.09		0.02	
	5-Mar-96	0.2	U	0.2	U	0.2	U	0.2	U	0	1.6		0.34	
	8-Jul-96	0.2	U	0.83		0.41		4.8		6.04	NS		NS	
	5-Dec-96	1	U	1	U	1	U	1	U	0	NS		NS	
	16-Jul-97	0.2		**59**		**8**		**166**		233.2	NS		NS	
	7-Oct-97	0.2	U	0.5	U	0.5	U	1	U	0	NS		NS	
	6-May-98	2.4		**20**		2.3		**29.2**		53.9	NS		NS	
	9-Nov-98	0.5	U	0.5	U	0.5	U	0.5	U	0	38.9	U	8.2	
	19-Apr-99	5	U	5	U	5	U	5	U	0	NS		NS	
	26-Oct-99	5	U	5	U	5	U	5	U	0	NS		NS	
	3-Nov-00	5	U	**10**		5	U	**12**	**J**	22	NS		NS	
	5-Oct-01	5	U	5	U	5	U	5	U	0	NS		NS	
	6-Jun-02	5	U	**5.23**		**5.81**		**11.1**		22.14	NS		NS	
	30-Sep-02	5	U	5	U	5	U	5	U	0	NS		NS	
	14-May-03	5	U	5	U	5	U	5	U	0	NS		NS	
	11-Sep-03	5	U	5	U	5	U	10	U	0	NS		NS	
	22-Sep-04	5	U	5	U	5	U	15	U	0	NS		NS	
	29-Sep-04	1	U	1	U	1	U	3	U	0	NS		NS	
	18-Oct-05	5	U	5	U	5	U	15	U	0	NS		NS	
	17-Oct-06	5	U	5	U	5	U	15	U	0	NS		NS	
	24-May-07	5	U	5	U	5	U	15	U	0	NS		NS	
	17-Oct-07	1	U	1	U	1	U	3	U	0	NS		NS	
	7-Oct-08	0.26	U	0.6	J	0.15	U	4.2		4.8	225		69.9	
	3-Jun-09	0.23	U	0.27	U	0.3	U	1	U	0	14.8	J	15	U
	2-Oct-09	0.23	U	0.27	U	0.3	U	0.25	U	0	152		36.2	
	21-Apr-10	0.23	U	0.27	U	0.3	U	0.25	U	0	208	J	49.9	
	20-Oct-10	0.23	U	0.27	U	0.3	U	0.25	U	0	NS		NS	
	19-Apr-11	0.23	U	0.27	U	0.3	U	0.25	U	0	NS		NS	
	5-Aug-11	0.2	U	**6.3**		0.15	U	**17.3**		23.6	NS		NS	

11 Concentration exceeds NYSDEC's groundwater screening criteria.

All analytical vlues shown are in units of µg/L (Micrograms per Liter) followed by a result qualifier if applicable
NS - Indicates that the well was not sampled for this analyte during the sampling event.

Qualifier Key

U - Analyte not detected in sample. Value reported is the quantitation/detection limit.

J - Analyte is detected but the reported value is a quantitative estimate

B - Analyte found in both the sample and method blank.

Table 5-2:
Mann-Kendall Trend Analysis for Monitoring Wells at Area 1495

COC	Well	N	N_D	S	α	Decreasing Trend?	Increasing Trend?
Benzene	1495-001	2	0	0	1.0000		
	1495-002	8	0	0	0.5480		
	1495-003	3	0	0	1.0000		
	1495-MW30	29	12	-232	0	Yes	
	1495-MW31	27	2	-29	0.2810		
	1495-MW32	8	1	3	0.4060		
	1495-MWD5	3	0	0	1.0000		
	1495-MWS1	3	0	0	1.0000		
	1495-MWS2	3	0	0	1.0000		
	1495-MWS3	30	3	-64	0.1320		
	1495-MWS4	31	2	-35	0.2830		
Ethylbenzene	1495-001	2	0	0	1.0000		
	1495-002	8	0	0	0.5480		
	1495-003	3	0	0	1.0000		
	1495-MW30	29	22	-214	0	Yes	
	1495-MW31	27	6	-70	0.0760		
	1495-MW32	8	1	-5	0.3170		
	1495-MWD5	3	0	0	1.0000		
	1495-MWS1	3	0	0	1.0000		
	1495-MWS2	3	0	0	1.0000		
	1495-MWS3	30	23	-183	0.0010	Yes	
	1495-MWS4	31	7	-33	0.2950		
Toluene	1495-001	2	0	0	1.0000		
	1495-002	8	2	8	0.1990		
	1495-003	3	0	0	1.0000		
	1495-MW30	29	11	-229	0	Yes	
	1495-MW31	28	3	-62	0.1150		
	1495-MW32	8	2	1	0.5000		
	1495-MWD5	3	1	0	1.0000		
	1495-MWS1	3	0	0	1.0000		
	1495-MWS2	3	0	0	1.0000		
	1495-MWS3	30	10	-173	0.0010	Yes	
	1495-MWS4	31	5	-90	0.0660		
Total BTEX	1495-001	2	0	0	1.0000		
	1495-002	8	2	9	0.1690		
	1495-003	3	0	0	1.0000		
	1495-MW30	29	24	-256	0.0000	Yes	
	1495-MW31	28	12	-104	0.0210	Yes	
	1495-MW32	8	3	-4	0.3600		
	1495-MWD5	3	1	0	1.0000		
	1495-MWS1	3	0	0	1.0000		
	1495-MWS2	3	0	0	1.0000		
	1495-MWS3	30	23	-196	0.0000	Yes	
	1495-MWS4	31	10	-25	0.3430		
Xylenes, Total	1495-001	2	0	0	1.0000		
	1495-002	6	1	5	0.2350		
	1495-003	3	0	0	1.0000		
	1495-MW30	29	22	-243	0	Yes	
	1495-MW31	21	9	-70	0.0180	Yes	
	1495-MW32	6	3	2	0.4300		
	1495-MWD5	3	0	0	1.0000		
	1495-MWS1	3	0	0	1.0000		
	1495-MWS2	3	0	0	1.0000		
	1495-MWS3	30	23	-195	0	Yes	
	1495-MWS4	25	9	-16	0.3640		

Notes:
N: Number of Samples
N_D: Number of Detections
S: Man-Kendall Statistic
α: Significance Level

APPENDIX A
HUMAN HEALTH RISK ASSESSMENT

AVATAR ENVIRONMENTAL

TECHNICAL MEMORANDUM

TO: Greg Kendall, Plexus Scientific

FROM: Kristina Early, Avatar Environmental
cc: Charles Dobroski, Avatar Environmental

DATE: 10 December 2010

SUBJECT: Fort Drum, Gasoline Alley Area 1495 Groundwater Human Health Risk Assessment (HHRA)

Introduction

As a subcontractor to Plexus Scientific, Avatar Environmental was tasked with developing this Technical Memorandum to provide a summary of the potential human health risks resulting from exposure to refined petroleum and other chemical contamination in groundwater at the Gasoline Alley Area 1495 of Fort Drum. This risk assessment evaluates the most recent groundwater data with the intent of determining whether this area may undergo closure with regard to further environmental evaluations.

Data Evaluation/Reduction

Data evaluated in the HHRA include groundwater samples collected from Area 1495 in the spring and fall of 2010. The following guidelines for data reduction were used to produce the data summary.

- If an analyte was not positively identified in any sample for a given medium because it was reported as a nondetect (indicated by a "U" qualifier), or because it was present as a result of blank contamination (indicated by a "B" qualifier for organics), it was not addressed for that medium;

- Analytical results with a "U" qualifier represent nondetect samples for the analyte evaluated. The full detection limit (DL) value was used for nondetect samples in subsequent calculations (i.e., the arithmetic mean and the 95 percent upper-confidence limit of the mean [95% UCL]); and

- If a sample duplicate was collected and analyzed, the average of the two reported concentrations was used for subsequent calculations unless there was a greater than 30% difference in water concentrations, in which case the higher of the two concentrations was used. In the case of a detected sample and a nondetect duplicate, the detected concentration was carried through subsequent calculations.

Note that unvalidated data from the fall of 2010 was used in the HHRA. Subsequent to the evaluation, data validation was completed. Therefore, the HHRA was not revised to include the validated data. Table 1 presents the data summary for the groundwater at Area 1495.

A contaminant of potential concern (COPC) selection process was conducted to identify those analytes that were detected in the groundwater at levels that could pose a potential risk to potentially exposed human receptors. The criteria that were used to determine COPCs include:

- Non-detection – If an analyte was not detected in any samples, it was not evaluated as a COPC. Note that it was assumed that the analytical results met all of the project-specific data quality objectives (DQOs) and that a comparison of sample quantitation limits (SQLs) with benchmarks was unnecessary.

- A comparison of detected concentrations with screening criteria – If the maximum detected concentration for a given analyte was greater than the lower of its New York State Department of Environmental Conservation (NYSDEC) Ambient Water Quality Standards and Guidance Values for Class GA Groundwater (NYSDEC, 2008) or its NYSDEC Maximum Contaminant Levels (MCLs) for drinking water (NYSDEC, 2006), it was identified as a COPC.

Table 2 presents the COPC selection process for the analytes that were detected in groundwater at Area 1495. The only change that would potentially affect the HHRA based on data validation was that manganese at sample location 1495-MWS3 is now considered a non-detect. Given that manganese was eliminated as a COPC based on a comparison of the maximum detected concentration to the NYSDEC screening criteria, the change in qualifier has no effect on the results of the HHRA.

Exposure Setting

The following description of the exposure setting for the subject area is taken from the *September 2002 Final Risk Assessment* (Malcom Pirnie, 2002), *September 2000 Final Risk Assessment* (Malcom Pirnie, 2000), and the *2008 Annual Basewide Groundwater and Surface Water Monitoring Report* (Plexus Scientific, 2009):

> Fort Drum is an active military base located in upstate New York, approximately 10 miles northeast of Watertown, 80 miles north of Syracuse, and 25 miles southeast of the U.S./Canadian border. Fort Drum occupies a large portion of northeastern Jefferson County and a portion of western Lewis County and encompasses approximately 107,265 acres.

Area 1495, located in the southwestern portion of Gasoline Alley, contained two 25,000 gallon USTs of unknown material to store unleaded gasoline prior to the early 1970s. In the early 1970s, these USTs were replaced with two 25,000 gallon steel USTs, which were used to store unleaded gasoline. These tanks were used in 1990 for the same purpose (no action taken in 1990 toward the tanks), and were removed during the fall of 1994.

Identification of Potentially Exposed Human Populations and Exposure Pathways

Based on the exposure setting and the current and potential future land uses, the potentially exposed populations include:

- Commercial/Industrial Worker. An employee could be exposed to contaminants in groundwater through potential consumption of drinking water (i.e., groundwater is assumed to be the source of drinking water). This worker is assumed to spend the majority of his/her time at work indoors.

- Resident Child and Adult. Area 1495 could be developed into a residential property in the future. Ingestion of, dermal contact with, and inhalation of COPCs in groundwater under future use conditions are evaluated. For dermal exposure to groundwater, adult exposure is associated with showering, and child exposure is associated with bathing. Inhalation of VOCs while showering is evaluated for the adult. Because the aerosolization of VOCs from bath water is not significant, this pathway is not evaluated for the bathing child.

Exposure Point Concentrations (EPCs)

EPCs are the representative COPC concentrations to which a receptor is assumed to be exposed. EPA's ProUCL software program (Version 4.0) was used for calculating the 95 percent upper-confidence limits of the mean (95% UCLs) in this HHRA. This program allows the user to calculate distribution-specific UCLs, as well as UCLs for data that do not exhibit a specific distribution (EPA, 2010a).

The following general guidelines were used to determine UCLs and EPCs, guided by both the ProUCL Technical Manual (EPA, 2010a) and the ProUCL User's Guide (EPA, 2010b).

- If fewer than 8 samples were collected, the EPC was based on the maximum detected concentration.

- If 8 or more samples were collected and the data set contained less than 50% detections, a nonparametric-based UCL (either Kaplan-Meier [KM] or bootstrapping derived)/EPC was calculated if there were at least 4 detections. Note that the bootstrapping method was not considered unless there were at least 10 detections. If there were fewer than 4 detections, the maximum detected concentration was used.

- If 8 or more samples were collected and the data set contained at least 50% detections, the appropriate distribution of the data set was determined and the use of estimation procedures (e.g., KM, bootstrapping) was considered (instead of the simple substitution method) for censored results (i.e., non-detects) in calculating UCLs/EPCs.

Table 3 presents the UCLs and EPCs that were used to estimate the risks associated with groundwater exposure. Appendix A presents the ProUCL output for the COPCs that were evaluated using the ProUCL software program.

Exposure Equations and Parameters

The mathematical models and exposure assumptions that were used to calculate the exposure doses (chronic daily intakes; CDIs) of COPCs for each receptor population through the applicable exposure routes are presented in Tables 4 through 15. Exposure doses are dependent upon the magnitude, frequency, and duration of exposure. They are estimated by combining the COPC concentration (i.e., the EPC) and the exposure parameters. Two types of exposure doses are calculated. The cancer dose (lifetime average daily dose [LADD]) is averaged over a 70-year lifetime. The noncancer average daily dose (ADD) is averaged over the actual exposure duration for each receptor.

Summary of Toxicity Values Used in HHRA

Tables 16 through 19 present the available toxicity values (oral, dermal, and inhalation) for each COPC, as well as the source, the EPA weight-of evidence category, the route of administration, and the critical effect.

Risk Results

The Fort Drum Area 1495 cancer risks and noncancer hazard indices (HIs) are presented in Tables 20 through 26.

<u>Commercial/Industrial Worker</u>

Total cancer risk: 2.0E-07

Total noncancer hazard: HI: 0.45

<u>Age-Adjusted Resident</u>

Total cancer risk: Ingestion/Dermal – 1.3E-06

- The risk from potential exposure to ethylbenzene was at the lower end of the USEPA target risk range of 1E-06 to 1E-04.

<u>Child Resident</u>

Total noncancer hazard: HI: 3.0

- Potential exposure to iron exceeded a noncancer hazard quotient (HQ) of 1.0.

Adult Resident

Total cancer risk: Inhalation – 1.2E-10

Total noncancer hazard: HI: Ingestion/Dermal - 1.3, Inhalation – 0.000095

- Potential exposure to iron due to the ingestion/dermal pathway slightly exceeded a noncancer hazard quotient (HQ) of 1.0.

Summary

From a HHRA perspective, Area 1495 could be recommended for closure. Industrial worker risks were below EPA's cancer risk and noncancer HQ thresholds. Residential cancer risks for ingestion and dermal exposure were at the low end of the target risk range based on exposure to ethylbenzene (cancer risk of 1.3E-06), but were well below the 1E-04 threshold. The noncancer HQ threshold was exceeded based on ingestion and dermal exposure by the child (total HI of 3.0) and adult (total HI of 1.3) residents. The child and adult resident noncancer HQ threshold exceedances were based on exposure to iron which slightly exceeded one with HQs of 2.9 and 1.2, respectively.

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Table 1
Summary of Analytes Detected in 2010 Groundwater
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

CAS Number	Analyte	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency[a]	Detection Limits[b]	Arithmetic Mean[c]	Standard Deviation[c]
95636	1,2,4-Trimethylbenzene	4.40E-01	4.37E+01	µg/L	1495-MW30	4/8	2.80E-01 - 2.80E-01	9.63E+00	1.59E+01
108678	1,3,5-Trimethylbenzene	1.60E+00	1.07E+01	µg/L	1495-MWS3	4/8	3.00E-01 - 3.00E-01	3.03E+00	3.92E+00
67663	Chloroform	2.80E-01	1.60E+00	µg/L	1495-MW30	3/8	2.30E-01 - 2.30E-01	4.41E-01	4.77E-01
74840	Ethane	1.20E-01	1.20E-01	µg/L	1495-MWS3DUP	1/5	1.10E-02 - 1.10E-02	3.28E-02	4.87E-02
74851	Ethene	1.60E-01	1.60E-01	µg/L	1495-MWS3DUP	1/5	2.00E-02 - 2.00E-02	4.80E-02	6.26E-02
100414	Ethylbenzene	3.20E+00	5.10E+00	µg/L	1495-MWS3	2/8	2.70E-01 - 2.70E-01	1.24E+00	1.87E+00
98828	Isopropylbenzene	1.30E+00	2.00E+00	µg/L	1495-MWS3	3/8	5.70E-01 - 5.70E-01	9.44E-01	5.54E-01
179601231	m,p-Xylene	1.20E+01	2.64E+01	µg/L	1495-MW30	2/8	2.50E-01 - 2.50E-01	4.99E+00	9.58E+00
74828	Methane	1.00E-01	6.90E+00	µg/L	1495-MWS3	3/5	2.20E-02 - 2.20E-02	1.57E+00	3.00E+00
91203	Naphthalene	1.50E+00	4.00E+00	µg/L	1495-MWS3	2/8	9.70E-01 - 9.70E-01	1.42E+00	1.06E+00
104518	n-Butylbenzene	5.10E-01	1.50E+00	µg/L	1495-MW31	2/8	4.70E-01 - 4.70E-01	6.04E-01	3.62E-01
103651	n-Propylbenzene	5.40E-01	6.90E+00	µg/L	1495-MW31	4/8	2.40E-01 - 2.40E-01	1.47E+00	2.34E+00
95476	o-Xylene	2.00E+00	4.80E+00	µg/L	1495-MWS3	2/8	2.50E-01 - 2.50E-01	1.04E+00	1.64E+00
99876	p-Isopropyltoluene	7.90E-01	2.90E+00	µg/L	1495-MWS3	3/8	6.90E-01 - 6.90E-01	1.01E+00	7.69E-01
135988	sec-Butylbenzene	3.40E-01	1.20E+00	µg/L	1495-MW31	4/8	2.20E-01 - 2.20E-01	4.31E-01	3.39E-01
1330207	Xylene (total)	1.68E+01	2.84E+01	µg/L	1495-MW30	2/8	2.50E-01 - 2.50E-01	5.84E+00	1.08E+01
7439896	Iron	4.25E+01	3.15E+04	µg/L	1495-MWS3	5/5	NA	6.48E+03	1.40E+04
7439965	Manganese	7.10E+00	6.47E+01	µg/L	1495-MWS3	5/5	NA	3.50E+01	2.41E+01

[a]Number of sampling locations at which analyte was detected compared with total number of sampling locations.

[b]Based on nondetected samples.

[c]Nondetects were included at the full detection limit.

µg/L = Micrograms per liter.

NA = Not applicable.

Table 2
COPC Selection Process for Analytes Detected in 2010 Groundwater
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

CAS Number	Analyte	Maximum Concentration	Units	Location of Maximum Concentration	NYSDEC Human Health Screening Criteria[a] (µg/L)	Ratio of Maximum Concentration to NYSDEC Screening Criteria	COPC
95636	1,2,4-Trimethylbenzene	4.37E+01	µg/L	1495-MW30	5.00E+00	8.74	X
108678	1,3,5-Trimethylbenzene	1.07E+01	µg/L	1495-MWS3	5.00E+00	2.14	X
67663	Chloroform	1.60E+00	µg/L	1495-MW30	5.00E+00	0.32	
74840	Ethane	1.20E-01	µg/L	1495-MWS3DUP	5.00E+00	0.024	
74851	Ethene	1.60E-01	µg/L	1495-MWS3DUP	5.00E+01	0.0032	
100414	Ethylbenzene	5.10E+00	µg/L	1495-MWS3	5.00E+00	1.02	X
98828	Isopropylbenzene	2.00E+00	µg/L	1495-MWS3	5.00E+00	0.40	
179601231	m,p-Xylene	2.64E+01	µg/L	1495-MW30	5.00E+00	5.28	X
74828	Methane	6.90E+00	µg/L	1495-MWS3	5.00E+00	1.38	X
91203	Naphthalene	4.00E+00	µg/L	1495-MWS3	5.00E+00	0.80	
104518	n-Butylbenzene	1.50E+00	µg/L	1495-MW31	5.00E+00	0.30	
103651	n-Propylbenzene	6.90E+00	µg/L	1495-MW31	5.00E+00	1.38	X
95476	o-Xylene	4.80E+00	µg/L	1495-MWS3	5.00E+00	0.96	
99876	p-Isopropyltoluene	2.90E+00	µg/L	1495-MWS3	5.00E+00	0.58	
135988	sec-Butylbenzene	1.20E+00	µg/L	1495-MW31	5.00E+00	0.24	
1330207	Xylene (total)	2.84E+01	µg/L	1495-MW30	5.00E+00	5.68	X
7439896	Iron	3.15E+04	µg/L	1495-MWS3	3.00E+02	105	X
7439965	Manganese	6.47E+01	µg/L	1495-MWS3	3.00E+02	0.22	

[a] Screening criteria based on the minimum of the NYSDEC Ambient Water Quality Standards for Class GA Groundwater and the NYSDEC Maximum Contaminant Levels (MCLs).

µg/L = Micrograms per liter.

NYSDEC = New York State Department of Environmental Conservation.

Table 3
Summary of Exposure Point Concentrations for COPCs in 2010 Groundwate
Fort Drum Gasoline Alley Facility - Area 149
Fort Drum, NY

COPC	Maximum Detected Concentration (µg/L)	Data Distribution[a]	Calculation Method[a]	95% UCL[a] (µg/L)	Exposure Point Concentration[b] (µg/L)
1,2,4-Trimethylbenzene	4.37E+01	Normal	95% KM (t) UCL	2.12E+01	2.12E+01
1,3,5-Trimethylbenzene	1.07E+01	Normal	95% KM (t) UCL	6.16E+00	6.16E+00
Ethylbenzene	5.10E+00	ND	ND	NC	5.10E+00
m,p-Xylene	2.64E+01	ND	ND	NC	2.64E+01
Methane	6.90E+00	ND	ND	NC	6.90E+00
n-Propylbenzene	6.90E+00	Normal	95% KM (t) UCL	3.25E+00	3.25E+00
Xylene (total)	2.84E+01	ND	ND	NC	2.84E+01
Iron	3.15E+04	ND	ND	NC	3.15E+04

[a]Based on ProUCL recommendation.

[b]The UCL or the maximum detected concentration, whichever value is lower.

NC=Not calculated. The maximum concentration used for EPC due to high percentage of nondetects and/or less than 4 detected values.

ND=Not determined. The maximum concentration used for EPC due to high percentage of nondetects and/or less than 4 detected values.

Table 4
Values Used for Daily Intake Calculations
Reasonable Maximum Exposure - Groundwater - Commercial/Industrial Worker
Fort Drum Gasoline Alley Facility
Fort Drum, NY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor Population: Commercial/Industrial Worker
Receptor Age: Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Tapwater	EPC	Exposure Point Concentration	COPC-specific	µg/L	Calculated	Chronic daily intake (mg/kg-day) =
		IRW	Ingestion Rate of Water	2	L/day	EPA, 2002	EPC x IRW x CF x FI x EF x ED x 1/BW x 1/AT
		FI	Fraction Ingested	0.5	unitless	Professional Judgement	
		EF	Exposure Frequency	250	days/year	EPA, 2002	
		ED	Exposure Duration	25	years	EPA, 2002	
		CF	Conversion Factor	1.00E-03	mg/µg	-----	
		BW	Body Weight	70	kg	EPA, 1997	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	9,125	days	Calculated	

Table 5
Values Used for Daily Intake Calculations
Reasonable Maximum Exposure - Groundwater - Resident
Fort Drum Gasoline Alley Facility
Fort Drum, NY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Tapwater	EPC	Exposure Point Concentration	COPC-specific	µg/L	Calculated	Chronic daily intake (CDI)(mg/kg-day) =
Child/Adult (Cancer)		IFW_{adj}	Age-adjusted water ingestion factor	1.1	L-year/kg-day	Calculated	$EPC \times IFW_{adj} \times CF \times FI \times EF \times 1/AT_C$
		FI	Fraction Ingested	1	unitless	EPA, 1989	Where
		EF	Exposure Frequency	350	days/year	EPA, 2002	$IFW_{adj} = (IRW_c \times ED_c \times 1/BW_c) + (IRW_a \times ED_a \times 1/BW_a)$
		ED_c	Exposure Duration - child	6	years	EPA, 2002	
		ED_a	Exposure Duration - adult	24	years	EPA, 2002	
		IRW_c	Ingestion Rate of Water - child	1	L/day	EPA, 2002	
		IRW_a	Ingestion Rate of Water - adult	2	L/day	EPA, 2002	
		BW_c	Body Weight - child	15	kg	EPA, 1997	
		BW_a	Body Weight - adult	70	kg	EPA, 1997	
		CF	Conversion Factor	0.001	mg/µg	-----	
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		AT_{NC}	Averaging Time (Non-Cancer)	8,760	days	Calculated	

Table 5
Values Used for Daily Intake Calculations
Reasonable Maximum Exposure - Groundwater - Resident
Fort Drum Gasoline Alley Facility
Fort Drum, NY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tapwater	SFS_{adj}	Age-adjusted skin contact factor	8,811	event-year-cm^2/kg-day	Calculated	Dermally Absorbed Dose (DAD) (mg/kg-day) =
Child/Adult (Cancer)	While Bathing/	SA_c	Skin Surface Area Available for Contact - child	6,600	cm^2	EPA, 2004	$DA_{EVENT-adj} \times SFS_{adj} \times EF \times 1/AT_C$
	Showering	SA_a	Skin Surface Area Available for Contact - adult	18,000	cm^2	EPA, 2004	
		DA_{EVENT}	Absorbed Dose Per Event	See Table 6	mg/cm^2-event	EPA, 2004	$SFS_{adj} = (SA_c \times EV_c \times ED_c \times 1/BW_c) + (SA_a \times EV_a \times ED_a \times 1/BW_a)$
		EV_c	Event Frequency - child	1	event/day	EPA, 2004	$DA_{EVENT-adj}$ Calculations
		EV_a	Event Frequency - adult	1	event/day	EPA, 2004	$t_{event-adj} = (ED_c \times t_{event-c}) + (ED_a \times t_{event-a})/(ED_c + ED_a)$
		EF	Exposure Frequency	350	days/year	EPA, 2002	
		ED_c	Exposure Duration - child	6	years	EPA, 2002	if $t_{event-adj} \leq t^*$, then $DA_{EVENT-adj}$ (Organic) =
		ED_a	Exposure Duration - adult	24	years	EPA, 2002	$2\ FA \times K_p \times C_w \times CF_1 \times CF_2 \times \sqrt{(6\tau_{event} \times t_{event-adj}/\pi)}$
		BW_c	Body Weight - child	15	kg	EPA, 1997	
		BW_a	Body Weight - adult	70	kg	EPA, 1997	otherwise if $t_{event-adj} > t^*$, then $DA_{EVENT-adj}$ (Organic) =
		AT_C	Averaging Time (Cancer)	25,550	days	EPA, 1989	$FA \times K_p \times C_w \times CF_1 \times CF_2 \times$
		$t_{event-adj}$	Age-adjusted event duration	0.66	hr/event	Calculated	$[((t_{event-adj})/(1+B)) + 2\tau_{event}((1 + 3B + 3B^2)/(1+B)^2)$
		$t_{event-c}$	Event Duration - child	1	hr/event	EPA, 2004	
		$t_{event-a}$	Event Duration - adult	0.58	hr/event	EPA, 2004	$DA_{EVENT-adj}$ (Inorganic) =
		FA	Fraction Absorbed Water	See Table 6	unitless	EPA, 2004	$K_p \times C_w \times CF_1 \times CF_2 \times t_{event-adj}$
		K_p	Dermal Permeability Coefficient	See Table 6	cm/hour	EPA, 2004	
		C_w	Chemical Concentration in Water	COPC-specific	µg/L	Calculated	
		CF_1	Conversion Factor	0.001	mg/µg	-----	
		CF_2	Conversion Factor	0.001	L/cm^3	-----	
		B	Ratio of Permeability Coefficient	See Table 6	unitless	EPA, 2004	
		t*	Time to Reach Steady State	See Table 6	hour	EPA, 2004	
		t_{event}	Lag Time Per Event	See Table 6	hr/event	EPA, 2004	

Table 5
Values Used for Daily Intake Calculations
Reasonable Maximum Exposure - Groundwater - Resident
Fort Drum Gasoline Alley Facility
Fort Drum, NY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tapwater	SA	Skin Surface Area Available for Contact	6,600	cm^2	EPA, 2004	Dermally Absorbed Dose (DAD) (mg/kg-day) =
Child (Noncancer)	While Bathing	DA_{EVENT}	Absorbed Dose Per Event	See Table 7	mg/cm^2-event	EPA, 2004	$DA_{EVENT} \times EV \times SA \times EF \times ED \times 1/BW \times 1/AT_{NC}$
		EV	Event Frequency	1	event/day	EPA, 2004	
		EF	Exposure Frequency	350	days/year	EPA, 2002	$\underline{DA_{EVENT}\ Calculations}$
		ED	Exposure Duration	6	years	EPA, 2002	if $t_{event} \le t^*$, then DA_{EVENT} (Organic) =
		BW	Body Weight	15	kg	EPA, 1997	$2\ FA \times K_p \times C_w \times CF_1 \times CF_2 \times \sqrt{(6\tau_{event} \times t_{event}/\pi)}$
		AT_{NC}	Averaging Time (Non-Cancer)	2,190	days	Calculated	
		FA	Fraction Absorbed Water	See Table 7	unitless	EPA, 2004	otherwise if $t_{event} > t^*$, then DA_{EVENT} (Organic) =
		K_p	Dermal Permeability Coefficient	See Table 7	cm/hour	EPA, 2004	$FA \times K_p \times C_w \times CF_1 \times CF_2 \times$
		C_w	Chemical Concentration in Water	COPC-specific	µg/L	Calculated	$[((t_{event})/(1+B)) + 2\tau_{event}((1 + 3B + 3B^2)/(1+B)^2)$
		CF_1	Conversion Factor	0.001	mg/µg	-----	
		CF_2	Conversion Factor	0.001	L/cm^3	-----	DA_{EVENT} (Inorganic) =
		B	Ratio of Permeability Coefficient	See Table 7	unitless	EPA, 2004	$K_p \times C_w \times CF_1 \times CF_2 \times t_{event}$
		t*	Time to Reach Steady State	See Table 7	hour	EPA, 2004	
		t_{event}	Lag Time Per Event	See Table 7	hr/event	EPA, 2004	
		t_{event}	Event Duration	1	hr/event	EPA, 2004	
Dermal	Tapwater	SA	Skin Surface Area Available for Contact	18,000	cm^2	EPA, 2004	Dermally Absorbed Dose (DAD) (mg/kg-day) =
Adult (Noncancer)	While Showering	DA_{EVENT}	Absorbed Dose Per Event	See Table 7	mg/cm^2-event	EPA, 2004	$DA_{EVENT} \times EV \times SA \times EF \times ED \times 1/BW \times 1/AT_{NC}$
		EV	Event Frequency	1	event/day	EPA, 2004	
		EF	Exposure Frequency	350	days/year	EPA, 2002	$\underline{DA_{EVENT}\ Calculations}$
		ED	Exposure Duration	24	years	EPA, 2002	if $t_{event} \le t^*$, then DA_{EVENT} (Organic) =
		BW	Body Weight	70	kg	EPA, 1997	$2\ FA \times K_p \times C_w \times CF_1 \times CF_2 \times \sqrt{(6\tau_{event} \times t_{event}/\pi)}$
		AT_{NC}	Averaging Time (Non-Cancer)	8,760	days	Calculated	
		FA	Fraction Absorbed Water	See Table 7	unitless	EPA, 2004	otherwise if $t_{event} > t^*$, then DA_{EVENT} (Organic) =
		K_p	Dermal Permeability Coefficient	See Table 7	cm/hour	EPA, 2004	$FA \times K_p \times C_w \times CF_1 \times CF_2 \times$
		C_w	Chemical Concentration in Water	COPC-specific	µg/L	Calculated	$[((t_{event})/(1+B)) + 2\tau_{event}((1 + 3B + 3B^2)/(1+B)^2)$
		CF_1	Conversion Factor	0.001	mg/µg	-----	
		CF_2	Conversion Factor	0.001	L/cm^3	-----	DA_{EVENT} (Inorganic) =
		B	Ratio of Permeability Coefficient	See Table 7	unitless	EPA, 2004	$K_p \times C_w \times CF_1 \times CF_2 \times t_{event}$
		t*	Time to Reach Steady State	See Table 7	hour	EPA, 2004	
		t_{event}	Lag Time Per Event	See Table 7	hr/event	EPA, 2004	
		t_{event}	Event Duration	0.58	hr/event	EPA, 2004	

Table 5
Values Used for Daily Intake Calculations
Reasonable Maximum Exposure - Groundwater - Resident
Fort Drum Gasoline Alley Facility
Fort Drum, NY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor Population: Residents
Receptor Age: Child/Adult

Exposure Route	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Tapwater	E	Inhalation Exposure per Shower	See Tables 8 through 15	mg/kg/day	Calculated	Exposure Concentration (EC)(mg/m^3) =
Adult	While Showering	BW	Body Weight	70	kg	EPA, 1989	E x BW x CF1 x 1/VR x CF2 x EF x ED x 1/AT
		CF1	Conversion Factor	1.00E+03	L/m^3	-----	
		VR	Ventilation Rate	1.50E+01	L/minute	Foster and Chrostowski, 1987	
		CF2	Conversion Factor	6.94E-04	d/min	-----	
		EF	Exposure Frequency	350	days/year	EPA, 2002	
		ED	Exposure Duration	24	years	EPA, 2002	
		AT-C	Averaging Time (Cancer)	25,550	hours	EPA, 2009b	
		AT-NC	Averaging Time (Non-Cancer)	8,760	hours	EPA, 2009b	

Table 6

Age-Adjusted Absorbed Dose per Event (DA_{event}) Calculations[a]
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	EPC[b] (µg/L)	EPC[b] (mg/cm^3)	FA (unitless)	K_p (cm/hr)	τ_{event} (hr/event)	B (unitless)	t^* (hr)	DA_{event} (mg/cm^2-event)[c] Age-Adjusted
1,2,4-Trimethylbenzene	2.12E+01	2.12E-05	1.0 [d]	1.05E-01 [e]	4.95E-01 [f]	4.43E-01 [g]	1.19E+00	3.51E-06
1,3,5-Trimethylbenzene	6.16E+00	6.16E-06	1.0 [d]	6.08E-02 [e]	4.95E-01 [f]	2.57E-01 [g]	1.19E+00	5.92E-07
Ethylbenzene	5.10E+00	5.10E-06	1.0	4.90E-02	4.20E-01	2.00E-01	1.01E+00	3.64E-07
m,p-Xylene	2.64E+01	2.64E-05	1.0	5.30E-02	4.20E-01	2.00E-01	1.01E+00	2.04E-06
Methane	6.90E+00	6.90E-06	1.0 [d]	6.75E-03 [e]	1.29E-01 [f]	1.04E-02 [g]	3.10E-01	4.34E-08
n-Propylbenzene	3.25E+00	3.25E-06	1.0 [d]	9.17E-02 [e]	4.95E-01 [f]	3.87E-01 [g]	1.19E+00	4.70E-07
Xylene (total)	2.84E+01	2.84E-05	1.0	5.30E-02	4.20E-01	2.00E-01	1.01E+00	2.19E-06
Iron	3.15E+04	3.15E-02	NA	1.00E-03	NA	NA	NA	2.08E-05

[a] EPA, 2004
[b] See Table 3
[c] t_{event} was age-adjusted assuming t_{event} of 1 for 6 years and t_{event} 0.58 for 24 years. Adjusted value equals 0.66.
[d] In the absence of chemical-specific data, the FA was conservatively assumed to be 1.
[e] Calculated based on Equation 3.8 in EPA, 2004.
[f] Calculated based on Equation A.4 in EPA, 2004.
[g] Calculated based on Equation A.1 in EPA, 2004.

B = Ratio of the permeability coefficient of a COPC through the stratum corneum relative to its permeability coefficient across the viable epidermis.
FA = Fraction absorbed.
K_p = Dermal permeability coefficient.
NA = Not applicable.
τ_{event} = Lag time per event.
t^* = Time to reach steady-state.

Table 7

Child and Adult Absorbed Dose per Event (DA_{event}) Calculations[a]
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	EPC[b] (µg/L)	EPC[b] (mg/cm^3)	FA (unitless)	K_p (cm/hr)	τ_{event} (hr/event)	B (unitless)	t^* (hr)	DA_{event} (mg/cm^2-event)[c] Child	DA_{event} (mg/cm^2-event)[c] Adult
1,2,4-Trimethylbenzene	2.12E+01	2.12E-05	1.0 [d]	1.05E-01 [e]	4.95E-01 [f]	4.43E-01 [g]	1.19E+00	4.33E-06	3.29E-06
1,3,5-Trimethylbenzene	6.16E+00	6.16E-06	1.0 [d]	6.08E-02 [e]	4.95E-01 [f]	2.57E-01 [g]	1.19E+00	7.29E-07	5.55E-07
Ethylbenzene	5.10E+00	5.10E-06	1.0	4.90E-02	4.20E-01	2.00E-01	1.01E+00	4.48E-07	3.41E-07
m,p-Xylene	2.64E+01	2.64E-05	1.0	5.30E-02	4.20E-01	2.00E-01	1.01E+00	2.51E-06	1.91E-06
Methane	6.90E+00	6.90E-06	1.0 [d]	6.75E-03 [e]	1.29E-01 [f]	1.04E-02 [g]	3.10E-01	5.92E-08	3.97E-08
n-Propylbenzene	3.25E+00	3.25E-06	1.0 [d]	9.17E-02 [e]	4.95E-01 [f]	3.87E-01 [g]	1.19E+00	5.79E-07	4.41E-07
Xylene (total)	2.84E+01	2.84E-05	1.0	5.30E-02	4.20E-01	2.00E-01	1.01E+00	2.70E-06	2.05E-06
Iron	3.15E+04	3.15E-02	NA	1.00E-03	NA	NA	NA	3.15E-05	1.83E-05

[a] EPA, 2004
[b] See Table 3
[c] Calculated based on Equation 3.2 or 3.3 for organics and Equation 3.4 for inorganics in EPA, 2004a where t_{event} equals 1.0 for children and 0.58 for adults.
[d] In the absence of chemical-specific data, the FA was conservatively assumed to be 1.
[e] Calculated based on Equation 3.8 in EPA, 2004.
[f] Calculated based on Equation A.4 in EPA, 2004.
[g] Calculated based on Equation A.1 in EPA, 2004.

B = Ratio of the permeability coefficient of a COPC through the stratum corneum relative to its permeability coefficient across the viable epidermis.
FA = Fraction absorbed.
K_p = Dermal permeability coefficient.
NA = Not applicable.
τ_{event} = Lag time per event.
t^* = Time to reach steady-state.

Table 8

Inhalation Exposure Per Shower (E)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$E = \frac{VR \times S}{BW \times R \times 10^{6}} \times \frac{D_S + \exp(-R \times D_T)}{R - \frac{\exp[R \times (D_S - D_T)]}{R}}$$

Parameter	Definition	Value	Reference
E	Inhalation exposure per shower ($\mu g/m^3$).		
VR	Ventilation rate (L/minute).	15	Foster and Chrostowski, 1987
S	Indoor VOC generation rate ($\mu g/m^3$-minute).	Calculated	See Table 9
BW	Body weight (kg).	70	EPA, 1989
R	Air exchange rate ($minute^{-1}$).	90	Foster and Chrostowski, 1987; upper-bound value
CF	Conversion factor.	10^6	Foster and Chrostowski, 1987
Ds	Shower duration (minute).	34.8	EPA, 1997; RME value

Table 9

Indoor VOC Generation Rate (S)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$S = \frac{C_{WD} \times FR}{SV}$$

Parameter	Definition	Value	Reference
S	Indoor VOC generation rate (µg/m^3-minute).		
C_{WD}	Concentration leaving shower droplet after time t_s (µg/L).	Calculated	See Table 10
FR	Indoor shower water flow rate (L/minute).	10	Foster and Chrostowski, 1987
SV	Shower room air volume (m^3).	12	Professional Judgement

Table 10

Concentration Leaving Shower Droplet After Time T_S (C_{WD})
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$C_{WD} = C_{WO} \times \left(1 - \exp\left(-\frac{K_{aL} \times t_s}{60 \times d}\right)\right)$$

Parameter	Definition	Value	Reference
C_{WD}	Concentration leaving shower droplet after time t_s (µg/L).		
C_{WO}	Shower water concentration (µg/L).	COPC-Specific	See Table 3
K_{aL}	Adjusted overall mass transfer coefficient (cm/hr).	Calculated	See Table 11
t_s	Shower droplet drop time (seconds).	0.5	Foster and Chrostowski, 2003
d	Shower droplet diameter (mm).	1	Foster and Chrostowski, 1987

Table 11

Adjusted Overall Mass Transfer Coefficient (Ka_L)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$K_{aL} = K_L \times \left(\frac{T_1 \times \mu_s}{T_s \times \mu_1} \right)^{-0.5}$$

Parameter	Definition	Value	Reference
Ka_L	Adjusted overall mass transfer coefficient (cm/hr).		
K_L	Overall mass transfer coeeficient (cm/hr).	Calculated	See Table 12
T_1	Calibration water temperature of K_L (K).	293	Foster and Chrostowski, 1987
μ_s	Water viscosity at T_s (cp).	0.59	Foster and Chrostowski, 1987
T_s	Shower water temperature (K).	318	Foster and Chrostowski, 1987; upper-bound value
μ_1	Water viscosity at T_1 (cp).	1.002	Foster and Chrostowski, 2003

Table 12

Overall Mass Transfer Coefficient (K_L)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$K_L = \left(\frac{1}{k_{l(VOC)}} + \frac{R \times T}{H \times k_{g(VOC)}} \right)^{-1}$$

Parameter	Definition	Value	Reference
K_L	Overall mass transfer coefficient (cm/hr).		
$k_{l\,(VOC)}$	Liquid-film mass transfer coefficient for VOC (cm/hr).	Calculated; COPC-Specific	See Table 13
R	Gas constant (atm-m^3/mol-K).	0.000082	Foster and Chrostowski, 1987
T	Absolute temperature (K).	293	Foster and Chrostowski, 1987
H	Henry's law constant (atm-m^3/mol).	COPC-Specific	See Table 15
$k_{g\,(VOC)}$	Gas-film mass transfer coefficient for VOC (cm/hr).	Calculated; COPC-Specific	See Table 14

Table 13

Liquid-Film Mass Transfer Coefficient ($k_{l\,(VOC)}$)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$k_{l\,(VOC)} = k_{l(CO_2)} \times \left(\frac{44}{MW_{VOC}} \right)^{0.5}$$

Parameter	Definition	Value	Reference
$k_{l\,(VOC)}$	Liquid-film mass transfer coefficient for VOC (cm/hr).		
$k_{l\,(CO2)}$	Liquid-film mass transfer coefficient for CO_2(cm/hr).	20	Foster and Chrostowski, 1987
MW_{VOC}	Molecular weight of VOC (g/mol).	COPC-Specific	See Table 15

Table 14

Gas-Film Mass Transfer Coefficient ($kg_{(VOC)}$)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

$$k_{g\,(VOC)} = k_{g(H_2O)} \times \left(\frac{18}{MW_{VOC}} \right)^{0.5}$$

Parameter	Definition	Value	Reference
$K_{g\,(VOC)}$	Gas-film mass transfer coefficient for VOC (cm/hr).		
$kg_{(H2O)}$	Gas-film mass transfer coefficient for H_2O (cm/hr).	3,000	Foster and Chrostowski, 1987
MW_{VOC}	Molecular weight of VOC (g/mol).	COPC-Specific	See Table 15

Table 15

COPC-Specific Henry's Law Constant (H) and Molecular Weight (MW)
Fort Drum Gasoline Alley Facility – Area 1495
Fort Drum, NY

COPC	H (atm-m^3/mol)	MW (g/mol)
1,2,4-Trimethylbenzene	6.2E-03 (HSDB, 2010)	120.191 (HSDB, 2010)
1,3,5-Trimethylbenzene	8.8E-03 (HSDB, 2010)	120.191 (HSDB, 2010)
Ethylbenzene	7.9E-03 (HSDB, 2010)	106.16 (HSDB, 2010)
m,p-Xylene	6.6E-03 (HSDB, 2010)	106.17 (HSDB, 2010)
Methane	6.6E-01 (HSDB, 2010)	16.04 (HSDB, 2010)
n-Propylbenzene	1.1E-02 (HSDB, 2010)	120.19 (HSDB, 2010)
Xylenes	6.6E-03 (HSDB, 2010)	106.17 (HSDB, 2010)

Table 16
Noncancer Toxicity Data - Oral and Dermal
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	Oral RfD Value	Oral RfD Units	GI_{abs} Oral Absorption Efficiency for Dermal[a]	Dermal RfD[a] Value	Dermal RfD[a] Units	Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Source(s)	Date(s)[b]
1,2,4-Trimethylbenzene	NA	---	---	NA	---	---	---	---	---
1,3,5-Trimethylbenzene	1.00E-02	(mg/kg-day)	1.0	1.00E-02	(mg/kg-day)	---	---	PPRTV	ORNL RSL Table (11/10)
Ethylbenzene	1.00E-01	mg/kg/day	1.0	1.00E-01	(mg/kg-day)	Liver, Kidney	1,000	IRIS	12/3/2010
m,p-Xylene	2.00E-01	(mg/kg-day)	1.0	2.00E-01	(mg/kg-day)	Body Weight	1,000	IRIS	12/3/2010
Methane	NA	---	---	NA	---	---	---	---	---
n-Propylbenzene	1.00E-01	(mg/kg-day)	1.0	1.00E-01	(mg/kg-day)	---	---	PPRTV	ORNL RSL Table (11/10)
Xylene (total)	2.00E-01	(mg/kg-day)	1.0	2.00E-01	(mg/kg-day)	Body Weight	1,000	IRIS	12/3/2010
Iron	7.00E-01	(mg/kg-day)	1.0	7.00E-01	(mg/kg-day)	---	---	PPRTV	ORNL RSL Table (11/10)

[a]Source: EPA, 2004.

[b]Represents date source was searched.

Definitions:
IRIS=Integrated Risk Information System
NA=Not available
ORNL=Oak Ridge National Laboratory
PPRTV=Provisional Peer-Reviewed Toxicity Value
RfD=Reference dose
RSL=Regional Screening Level

Table 17
Noncancer Toxicity Data - Inhalation
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	Inhalation RfC Value	Inhalation RfC Units	Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Source(s)	Date(s)[a]
1,2,4-Trimethylbenzene	7.00E-03	mg/m^3	---	---	PPRTV	ORNL RSL Table (11/10)
1,3,5-Trimethylbenzene	NA	---	---	---	---	---
Ethylbenzene	1.00E+00	mg/m^3	Developmental	300	IRIS	12/3/2010
m,p-Xylene	1.00E-01	mg/m^3	Nervous System	300	IRIS	12/3/2010
Methane	NA	---	---	---	---	---
n-Propylbenzene	1.00E+00	mg/m^3	---	---	PPRTV	ORNL RSL Table (11/10)
Xylene (total)	1.00E-01	mg/m^3	Nervous System	300	IRIS	12/3/2010

[a]Represents date source was searched.

IRIS=Integrated Risk Information System
NA=Not available
ORNL=Oak Ridge National Laboratory
PPRTV=Provisional Peer-Reviewed Toxicity Value
RfC=Reference concentration
RSL=Regional Screening Level

Table 18
Cancer Toxicity Data - Oral and Dermal
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	Oral CSF		GI_{abs} Oral Absorption Efficiency for Dermal[a]	Dermal CSF[a]		Weight of Evidence/ Cancer Guideline Description	Source(s)	Date(s)[b]
	Value	Units		Value	Units			
1,2,4-Trimethylbenzene	NA	---	---	NA	---	---	---	---
1,3,5-Trimethylbenzene	NA	---	---	NA	---	---	---	---
Ethylbenzene	1.10E-02	$(mg/kg\text{-}day)^{-1}$	1.0	1.10E-02	$(mg/kg\text{-}day)^{-1}$	D	CalEPA	ORNL RSL Table (11/10)
m,p-Xylene	NA	---	---	NA	---	---	---	---
Methane	NA	---	---	NA	---	---	---	---
n-Propylbenzene	NA	---	---	NA	---	---	---	---
Xylene (total)	NA	---	---	NA	---	---	---	---
Iron	NA	---	---	NA	---	---	---	---

[a]Source: EPA, 2004.
[b]Represents date source was searched

Definitions: D - Not classified as to human carcinogenicity.
CalEPA=California Environmental Protection Agency
CSF = Cancer slope factor
NA=Not available
ORNL=Oak Ridge National Laboratory
RSL=Regional Screening Level

Table 19
Cancer Toxicity Data - Inhalation
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

COPC	Unit Risk		Weight of Evidence/ Cancer Guideline Description	Source(s)	Date(s)[a]
	Value	Units			
1,2,4-Trimethylbenzene	NA	---	---	---	---
1,3,5-Trimethylbenzene	NA	---	---	---	---
Ethylbenzene	2.50E-06	$(\mu g/m^3)^{-1}$	D	CalEPA	ORNL RSL Table (11/10)
m,p-Xylene	NA	---	---	---	---
Methane	NA	---	---	---	---
n-Propylbenzene	NA	---	---	---	---
Xylene (total)	NA	---	---	---	---

[a]Represents date source was searched.

Definitions: D - Not classifiable as a human carcinogen.
CalEPA=California Environmental Protection Agency
NA = Not available.
ORNL=Oak Ridge National Laboratory
RSL=Regional Screening Level

Table 20

asonable Maximum Exposure Doses and Cancer Risks for Indoor Worker Exposure to 2010 Groundw
Fort Drum Gasoline Alley Facility - Area 149
Fort Drum, NY

COPC	EPC (µg/L)	Cancer		
		Exposure Dose		Cancer Risk
		Tapwater Ingestion (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Tapwater Ingestion
1,2,4-Trimethylbenzene	2.12E+01	7.39E-05	NA	NA
1,3,5-Trimethylbenzene	6.16E+00	2.15E-05	NA	NA
Ethylbenzene	5.10E+00	1.78E-05	1.10E-02	1.96E-07
m,p-Xylene	2.64E+01	9.23E-05	NA	NA
Methane	6.90E+00	2.41E-05	NA	NA
n-Propylbenzene	3.25E+00	1.14E-05	NA	NA
Xylene (total)	2.84E+01	9.92E-05	NA	NA
Iron	3.15E+04	1.10E-01	NA	NA
			Total	**2.0E-07**

Table 21

Reasonable Maximum Exposure Doses and Hazard Quotients for Indoor Worker Exposure to 2010 Groundwater
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

		Noncancer			
		Exposure Dose			Hazard Quotient
COPC	EPC (µg/L)	Tapwater Ingestion (mg/kg-day)	Oral RfD (mg/kg-day)	Primary Target Organ	Tapwater Ingestion
1,2,4-Trimethylbenzene	2.12E+01	2.07E-04	NA	---	NA
1,3,5-Trimethylbenzene	6.16E+00	6.03E-05	1.00E-02	---	0.0060
Ethylbenzene	5.10E+00	4.99E-05	1.00E-01	Liver, Kidney	0.00050
m,p-Xylene	2.64E+01	2.58E-04	2.00E-01	Body Weight	0.0013
Methane	6.90E+00	6.75E-05	NA	---	NA
n-Propylbenzene	3.25E+00	3.18E-05	1.00E-01	---	0.00032
Xylene (total)	2.84E+01	2.78E-04	2.00E-01	Body Weight	0.0014
Iron	3.15E+04	3.08E-01	7.00E-01	---	0.44
				Total	0.45
				Total Liver HI	0.00050
				Total Kidney HI	0.00050
				Total Body Weight HI	0.0027

Table 22

Reasonable Maximum Exposure Doses and Cancer Risks for Age-Adjusted Residential Exposure to 2010 Groundwater - Ingestion and Dermal Contact
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

		Cancer						
		Age-Adjusted Exposure Doses				Age-Adjusted Cancer Risks		
COPC	EPC (µg/L)	Tapwater Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Dermal CSF $(mg/kg\text{-}day)^{-1}$	Tapwater Ingestion	Dermal Contact	Total
1,2,4-Trimethylbenzene	2.12E+01	3.15E-04	4.24E-04	NA	NA	NA	NA	NA
1,3,5-Trimethylbenzene	6.16E+00	9.16E-05	7.15E-05	NA	NA	NA	NA	NA
Ethylbenzene	5.10E+00	7.59E-05	4.39E-05	1.10E-02	1.10E-02	8.34E-07	4.83E-07	1.32E-06
m,p-Xylene	2.64E+01	3.93E-04	2.46E-04	NA	NA	NA	NA	NA
Methane	6.90E+00	1.03E-04	5.24E-06	NA	NA	NA	NA	NA
n-Propylbenzene	3.25E+00	4.83E-05	5.68E-05	NA	NA	NA	NA	NA
Xylene (total)	2.84E+01	4.22E-04	2.64E-04	NA	NA	NA	NA	NA
Iron	3.15E+04	4.68E-01	2.51E-03	NA	NA	NA	NA	NA
					Total	8.3E-07	4.8E-07	1.3E-06

Table 23

Reasonable Maximum Exposure Doses and Cancer Risks for Adult Residential Exposure to 201
Groundwater - Inhalation
Fort Drum Gasoline Alley Facility - Area 149
Fort Drum, NY

COPC	EPC (µg/L)	Cancer		
		Adult Exposure Concentrations		Cancer Risks
		Inhalation (mg/m^3)	URF $(\mu g/m^3)^{-1}$	Inhalation
1,2,4-Trimethylbenzene	2.12E+01	1.91E-07	NA	NA
1,3,5-Trimethylbenzene	6.16E+00	5.63E-08	NA	NA
Ethylbenzene	5.10E+00	4.92E-08	2.50E-06	1.2E-10
m,p-Xylene	2.64E+01	2.54E-07	NA	NA
Methane	6.90E+00	1.58E-07	NA	NA
n-Propylbenzene	3.25E+00	2.98E-08	NA	NA
Xylene (total	2.84E+01	2.73E-07	NA	NA
			Total	1.2E-10

Table 24

Reasonable Maximum Exposure Doses and Hazard Quotients for Child Residential Exposure to 2010 Groundwater - Ingestion and Derm Contact
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

		Noncancer							
		Child Exposure Doses					Child Hazard Quotients		
COPC	EPC (µg/L)	Tapwater Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Tapwater Ingestion	Dermal Contact	Hazard Index
1,2,4-Trimethylbenzene	2.12E+01	1.35E-03	1.82E-03	NA	NA	---	NA	NA	NA
1,3,5-Trimethylbenzene	6.16E+00	3.94E-04	3.07E-04	1.00E-02	1.00E-02	---	0.039	0.031	0.070
Ethylbenzene	5.10E+00	3.26E-04	1.89E-04	1.00E-01	1.00E-01	Liver, Kidney	0.0033	0.0019	0.0051
m,p-Xylene	2.64E+01	1.69E-03	1.06E-03	2.00E-01	2.00E-01	Body Weight	0.0084	0.0053	0.014
Methane	6.90E+00	4.41E-04	2.50E-05	NA	NA	---	NA	NA	NA
n-Propylbenzene	3.25E+00	2.08E-04	2.44E-04	1.00E-01	1.00E-01	---	0.0021	0.0024	0.0045
Xylene (total)	2.84E+01	1.82E-03	1.14E-03	2.00E-01	2.00E-01	Body Weight	0.0091	0.0057	0.015
Iron	3.15E+04	2.01E+00	1.33E-02	7.00E-01	7.00E-01	---	2.9	0.019	2.9
								Total	3.0
								Total Liver HI	0.0051
								Total Kidney HI	0.0051
								Total Body Weight HI	0.028

Table 25

Reasonable Maximum Exposure Doses and Hazard Quotients for Adult Residential Exposure to 2010 Groundwater - Ingestion and Dermal Contact
Fort Drum Gasoline Alley Facility - Area 1495
Fort Drum, NY

		Noncancer							
		Adult Exposure Doses					Adult Hazard Quotients		
COPC	EPC (µg/L)	Tapwater Ingestion (mg/kg-day)	Dermal Contact (mg/kg-day)	Oral RfD (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Tapwater Ingestion	Dermal Contact	Hazard Index
1,2,4-Trimethylbenzene	2.12E+01	5.80E-04	8.12E-04	NA	NA	---	NA	NA	NA
1,3,5-Trimethylbenzene	6.16E+00	1.69E-04	1.37E-04	1.00E-02	1.00E-02	---	0.017	0.014	0.031
Ethylbenzene	5.10E+00	1.40E-04	8.41E-05	1.00E-01	1.00E-01	Liver, Kidney	0.0014	0.00084	0.0022
m,p-Xylene	2.64E+01	7.23E-04	4.71E-04	2.00E-01	2.00E-01	Body Weight	0.0036	0.0024	0.0060
Methane	6.90E+00	1.89E-04	9.78E-06	NA	NA	---	NA	NA	NA
n-Propylbenzene	3.25E+00	8.90E-05	1.09E-04	1.00E-01	1.00E-01	---	0.00089	0.0011	0.0020
Xylene (total)	2.84E+01	7.78E-04	5.06E-04	2.00E-01	2.00E-01	Body Weight	0.0039	0.0025	0.0064
Iron	3.15E+04	8.63E-01	4.50E-03	7.00E-01	7.00E-01	---	1.2	0.0064	1.2
								Total	1.3
								Total Liver HI	0.0022
								Total Kidney HI	0.0022
								Total Body Weight HI	0.012

Table 26

Reasonable Maximum Exposure Doses and Hazard Quotients for Adult Residential Exposure to 2010 Groundwater
Inhalation
Fort Drum Gasoline Alley Facility - Area 149
Fort Drum, NY

		Noncancer			
		Adult Exposure Concentrations			Hazard Quotients
COPC	EPC (µg/L)	Inhalation (mg/m^3)	RfC (mg/m^3)	Target Organ	Inhalation
1,2,4-Trimethylbenzene	2.12E+01	5.58E-07	7.00E-03	---	0.000080
1,3,5-Trimethylbenzene	6.16E+00	1.64E-07	NA	---	NA
Ethylbenzene	5.10E+00	1.44E-07	1.00E+00	Developmenta	0.00000014
m,p-Xylene	2.64E+01	7.39E-07	1.00E-01	Nervous System	0.0000074
Methane	6.90E+00	4.61E-07	NA	---	NA
n-Propylbenzene	3.25E+00	8.69E-08	1.00E+00	---	0.000000087
Xylene (total	2.84E+01	7.95E-07	1.00E-01	Nervous System	0.0000080
				Total	0.000095
				Total Developmental HI	0.00000014
				Total Nervous System HI	0.000015

Appendix A
ProUCL Output for Area 1495 Groundwater
Fort Drum Gasoline Alley Facility
Fort Drum, NY

1				**General UCL Statistics for Data Sets with Non-Detects**								
2			**User Selected Options**									
3			From File	1245.wst								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	**1,2,4-Trimethylbenzene**											
10												
11						**General Statistics**							
12					Number of Valid Data	8			Number of Detected Data	4		
13					Number of Distinct Detected Data	4			Number of Non-Detect Data	4		
14									Percent Non-Detects	50.00%		
15												
16				**Raw Statistics**					**Log-transformed Statistics**			
17					Minimum Detected	0.44			Minimum Detected	-0.821		
18					Maximum Detected	43.7			Maximum Detected	3.777		
19					Mean of Detected	18.99			Mean of Detected	2.073		
20					SD of Detected	18.83			SD of Detected	2.033		
21					Minimum Non-Detect	0.28			Minimum Non-Detect	-1.273		
22					Maximum Non-Detect	0.28			Maximum Non-Detect	-1.273		
23												
24												
25					**Warning: There are only 4 Distinct Detected Values in this data**							
26					**Note: It should be noted that even though bootstrap may be performed on this data set**							
27					**the resulting calculations may not be reliable enough to draw conclusions**							
28												
29					**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**							
30												
31						**UCL Statistics**							
32				**Normal Distribution Test with Detected Values Only**					**Lognormal Distribution Test with Detected Values Only**			
33					Shapiro Wilk Test Statistic	0.961			Shapiro Wilk Test Statistic	0.884		
34					5% Shapiro Wilk Critical Value	0.748			5% Shapiro Wilk Critical Value	0.748		
35				**Data appear Normal at 5% Significance Level**					**Data appear Lognormal at 5% Significance Level**			
36												
37				**Assuming Normal Distribution**					**Assuming Lognormal Distribution**			
38					DL/2 Substitution Method				DL/2 Substitution Method			
39					Mean	9.563			Mean	0.0536		
40					SD	15.92			SD	2.536		
41					95% DL/2 (t) UCL	20.23			95% H-Stat (DL/2) UCL	40936		
42												
43					Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method			
44					**MLE yields a negative mean**				Mean in Log Scale	-0.904		
45									SD in Log Scale	3.649		
46									Mean in Original Scale	9.518		
47									SD in Original Scale	15.95		
48									95% t UCL	20.2		
49									95% Percentile Bootstrap UCL	19.23		
50									95% BCA Bootstrap UCL	22.11		
51												
52				**Gamma Distribution Test with Detected Values Only**					**Data Distribution Test with Detected Values Only**			
53					k star (bias corrected)	0.34			**Data appear Normal at 5% Significance Level**			
54					Theta Star	55.77						
55					nu star	2.724						
56												
57					A-D Test Statistic	0.264			**Nonparametric Statistics**			
58					5% A-D Critical Value	0.673			Kaplan-Meier (KM) Method			
59					K-S Test Statistic	0.673			Mean	9.713		
60					5% K-S Critical Value	0.406			SD	14.8		
61				**Data appear Gamma Distributed at 5% Significance Level**					SE of Mean	6.04		
62									95% KM (t) UCL	21.16		
63				**Assuming Gamma Distribution**					95% KM (z) UCL	19.65		
64					Gamma ROS Statistics using Extrapolated Data				95% KM (jackknife) UCL	20.26		
65					Minimum	0.44			95% KM (bootstrap t) UCL	20.98		
66					Maximum	44.75			95% KM (BCA) UCL	27.88		
67					Mean	18.99			95% KM (Percentile Bootstrap) UCL	27.88		
68					Median	14.84			95% KM (Chebyshev) UCL	36.04		
69					SD	17.38			97.5% KM (Chebyshev) UCL	47.44		
70					k star	0.635			99% KM (Chebyshev) UCL	69.81		
71					Theta star	29.88						
72					Nu star	10.17			**Potential UCLs to Use**			
73					AppChi2	4.045			95% KM (t) UCL	21.16		
74					95% Gamma Approximate UCL	47.71			95% KM (Percentile Bootstrap) UCL	27.88		
75					95% Adjusted Gamma UCL	N/A						
76	**Note: DL/2 is not a recommended method.**											
77												
78					**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**							
79					**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**							
80					**For additional insight, the user may want to consult a statistician.**							

Appendix A
ProUCL Output for Area 1495 Groundwater
Fort Drum Gasoline Alley Facility
Fort Drum, NY

81	**1,3,5-Trimethylbenzene**											
82												
83	**General Statistics**											
84					Number of Valid Data	8				Number of Detected Data		4
85					Number of Distinct Detected Data	4				Number of Non-Detect Data		4
86										Percent Non-Detects		50.00%
87												
88	**Raw Statistics**							**Log-transformed Statistics**				
89					Minimum Detected	1.6				Minimum Detected		0.47
90					Maximum Detected	10.7				Maximum Detected		2.37
91					Mean of Detected	5.75				Mean of Detected		1.52
92					SD of Detected	4.007				SD of Detected		0.832
93					Minimum Non-Detect	0.3				Minimum Non-Detect		-1.204
94					Maximum Non-Detect	0.3				Maximum Non-Detect		-1.204
95												
96												
97	**Warning: There are only 4 Distinct Detected Values in this data**											
98	**Note: It should be noted that even though bootstrap may be performed on this data set**											
99	**the resulting calculations may not be reliable enough to draw conclusions**											
100												
101	**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**											
102												
103												
104	**UCL Statistics**											
105	**Normal Distribution Test with Detected Values Only**							**Lognormal Distribution Test with Detected Values Only**				
106					Shapiro Wilk Test Statistic	0.971				Shapiro Wilk Test Statistic		0.971
107					5% Shapiro Wilk Critical Value	0.748				5% Shapiro Wilk Critical Value		0.748
108	**Data appear Normal at 5% Significance Level**							**Data appear Lognormal at 5% Significance Level**				
109												
110	**Assuming Normal Distribution**							**Assuming Lognormal Distribution**				
111					DL/2 Substitution Method					DL/2 Substitution Method		
112					Mean	2.95				Mean		-0.188
113					SD	3.98				SD		1.906
114					95% DL/2 (t) UCL	5.616				95% H-Stat (DL/2) UCL		349.7
115												
116					Maximum Likelihood Estimate(MLE) Method					Log ROS Method		
117					Mean	0.527				Mean in Log Scale		0.199
118					SD	6.365				SD in Log Scale		1.603
119					95% MLE (t) UCL	4.79				Mean in Original Scale		3.077
120					95% MLE (Tiku) UCL	5.773				SD in Original Scale		3.883
121										95% t UCL		5.679
122										95% Percentile Bootstrap UCL		5.27
123										95% BCA Bootstrap UCL		5.783
124												
125	**Gamma Distribution Test with Detected Values Only**							**Data Distribution Test with Detected Values Only**				
126					k star (bias corrected)	0.751		**Data appear Normal at 5% Significance Level**				
127					Theta Star	7.656						
128					nu star	6.009						
129												
130					A-D Test Statistic	0.219		**Nonparametric Statistics**				
131					5% A-D Critical Value	0.66				Kaplan-Meier (KM) Method		
132					K-S Test Statistic	0.66				Mean		3.675
133					5% K-S Critical Value	0.397				SD		3.214
134	**Data appear Gamma Distributed at 5% Significance Level**									SE of Mean		1.312
135										95% KM (t) UCL		6.161
136	**Assuming Gamma Distribution**									95% KM (z) UCL		5.833
137					Gamma ROS Statistics using Extrapolated Data					95% KM (jackknife) UCL		5.994
138					Minimum	1.344				95% KM (bootstrap t) UCL		5.657
139					Maximum	10.7				95% KM (BCA) UCL		8.45
140					Mean	5.75				95% KM (Percentile Bootstrap) UCL		7.55
141					Median	5.525				95% KM (Chebyshev) UCL		9.394
142					SD	3.706				97.5% KM (Chebyshev) UCL		11.87
143					k star	1.481				99% KM (Chebyshev) UCL		16.73
144					Theta star	3.883						
145					Nu star	23.69		**Potential UCLs to Use**				
146					AppChi2	13.62				95% KM (t) UCL		6.161
147					95% Gamma Approximate UCL	10.01				95% KM (Percentile Bootstrap) UCL		7.55
148					95% Adjusted Gamma UCL	N/A						
149	**Note: DL/2 is not a recommended method.**											
150												
151	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
152	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
153	**For additional insight, the user may want to consult a statistician.**											
154												
155												

Appendix A
ProUCL Output for Area 1495 Groundwater
Fort Drum Gasoline Alley Facility
Fort Drum, NY

n-Propylbenzene

General Statistics

Number of Valid Data	8	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	4
		Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.54	Minimum Detected	-0.616
Maximum Detected	6.9	Maximum Detected	1.932
Mean of Detected	2.703	Mean of Detected	0.502
SD of Detected	2.946	SD of Detected	1.167
Minimum Non-Detect	0.24	Minimum Non-Detect	-1.427
Maximum Non-Detect	0.24	Maximum Non-Detect	-1.427

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Test Statistic	0.936
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.411	Mean	-0.809
SD	2.372	SD	1.596
95% DL/2 (t) UCL	3	95% H-Stat (DL/2) UCL	32.63
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.39
		SD in Log Scale	2.29
		Mean in Original Scale	1.38
		SD in Original Scale	2.392
		95% t UCL	2.982
		95% Percentile Bootstrap UCL	2.783
		95% BCA Bootstrap UCL	3.646

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.455	**Data appear Normal at 5% Significance Level**	
Theta Star	5.935		
nu star	3.643		
A-D Test Statistic	0.329	**Nonparametric Statistics**	
5% A-D Critical Value	0.665	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.665	Mean	1.621
5% K-S Critical Value	0.402	SD	2.103
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.859
		95% KM (t) UCL	3.248
Assuming Gamma Distribution		95% KM (z) UCL	3.034
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3.069
Minimum	1E-12	95% KM (bootstrap t) UCL	4.164
Maximum	6.9	95% KM (BCA) UCL	3.978
Mean	2.711	95% KM (Percentile Bootstrap) UCL	3.675
Median	1.854	95% KM (Chebyshev) UCL	5.364
SD	2.689	97.5% KM (Chebyshev) UCL	6.984
k star	0.205	99% KM (Chebyshev) UCL	10.17
Theta star	13.24		
Nu star	3.276	**Potential UCLs to Use**	
AppChi2	0.459	95% KM (t) UCL	3.248
95% Gamma Approximate UCL	19.36	95% KM (Percentile Bootstrap) UCL	3.675
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.