DEPARTMENT OF THE ARMY
WATERVLIET ARSENAL
1 Buffington Street
WATERVLIET, NY 121894000

August 24, 2006

REPLY TO
ATTENTION OF:

Public Works

Mr. Jim Reidy
U.S. Environmental Protection Agency
Chief – RCRA Programs Branch
290 Broadway, 22nd Floor
New York, New York 10007

Re: Corrective Measures Installation and Startup Report
Building 40 Bedrock Groundwater Corrective Measures
Main Manufacturing Area
Watervliet Arsenal, Watervliet, New York

Dear Mr. Reidy:

Enclosed please find one copy of the *Corrective Measures Installation and Startup Report, Building 40 Corrective Measures, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York.* Please contact JoAnn Kellogg of the Watervliet Arsenal at (518) 266-5286, or Stephen Wood of the United States Army Corps of Engineers at (410) 962-4874 if you have any questions concerning this report.

THOMAS E. POND
Chief, Public Works Division

Enclosure

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ATTN: Mr. Larry Rosenmann (2 copies)

Ms. Charlotte M. Bethoney
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Commander, U.S. Army Corps of Engineers, Baltimore District
10 South Howard Street, Baltimore, MD 21201
ATTN: Mr. Steve Wood

United States Army Corps of Engineers & Watervliet Arsenal

Report

Building 40 Groundwater Corrective Measures
Watervliet Arsenal
Watervliet, New York

Corrective Measures Installation and Startup Report

United States Army Corps of Engineers
Baltimore, Maryland

Prepared by:

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August 2006
2118047

INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

MALCOLM PIRNIE

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CM	Corrective Measures
CMMP	Corrective Measures Monitoring Plan
CVOCs	chlorinated volatile organic compounds
cDCE	cis 1,2-dichloroethene
DUSR	Data Usability Summary Report
DO	dissolved oxygen
EM	electromagnetic
gpm	gallons per minute
IPR	Interim Progress Meeting
lb/y	pounds per year
mg/l	milligram per liter
MMA	Main Manufacturing Area
NYSDEC	New York State Department of Environmental Conservation
ORP	oxidation reduction potential
PCE	tetrachloroethene
psi	pounds per square inch
RCRA	Resource Conservation and Recovery Act
TCE	trichloroethene
TDS	total dissolved solids
µg/l	microgram per liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UW	University of Waterloo
VC	vinyl chloride
VOCs	volatile organic compounds
WVA	Watervliet Arsenal

1.0 INTRODUCTION AND PURPOSE

On behalf of the Watervliet Arsenal (WVA), Malcolm Pirnie, Inc. (Malcolm Pirnie) is conducting a Corrective Measures (CM) program for the bedrock groundwater at Building 40 of the WVA, which is located in the City of Watervliet, New York (Figure 1-1). The CM program is being conducted under contract with the U.S. Army Corps of Engineers (USACE), Baltimore District in accordance with an Administrative Order on Consent between the WVA, the New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA). Details for the CM program are presented in the *Corrective Measures Work Plan, Building 40 Bedrock Groundwater, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York* (Malcolm Pirnie, 2004) (CM Work Plan) and *Corrective Measures Monitoring Program, Building 40 Bedrock Groundwater, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York* (Malcolm Pirnie, 2004a) (CMMP).

The CM program is designed to treat the chlorinated volatile organic compounds (CVOCs), composed primarily of tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and, to a lesser extent, vinyl chloride (VC), that are present in the bedrock groundwater and shale bedrock matrix at Building 40. This treatment is being accomplished using injections of sodium and potassium permanganate (herein collectively referred to as "permanganate") in the treatment area/locations specified in the CM Work Plan.

1.1 PURPOSE

The purpose of this Corrective Measures Installation and Startup Report (CM Startup Report) is to document the initiation of groundwater corrective measures activities at Building 40 and to present the results of the pre-injection activities specified in the CM Work Plan that were performed prior to the first permanganate injection in September 2004. This report also presents the results of the first year of permanganate injection events, which were conducted in September 2004, January 2005, May 2005, August 2005, and December 2005.

2.0 PRE-INJECTION CHARACTERIZATION ACTIVITIES

2.1 BOREHOLE GEOPHYSICAL AND ROCK CORE TESTING

2.1.1 Borehole Geophysical Testing

Borehole geophysical testing was conducted by the United States Geological Survey (USGS) at injection wells IW-1, IW-2, IW-3, IW-4, and MW-79 (Figure 2-1) in September 2004. The objectives of the geophysical characterization were to:

- Evaluate groundwater flow parameters (i.e., transmissivity) in each well borehole;
- Identify the depth and nature (i.e., width and relative flow) of major fractures intersecting each borehole;
- Compare geophysical characterization results to those previously collected at the WVA and further evaluate the primary transmissive features in the area of the corrective measures; and
- Evaluate the placement of temporary FLUTe™ multi-level monitoring wells that were to be placed in the injection wells to monitor injection efficacy in the area of Building 40.

The following tests were performed in each injection well:

- Three-arm Caliper;
- Fluid Temperature;
- Fluid Resistivity;
- Acoustic Televiewer; and
- Electromagnetic (EM) flow meter under ambient and pumping conditions.

During logging, fractures were identified in each borehole based on the combination of results from the various instruments. Single- and cross-borehole EM flow meter testing was then conducted to evaluate flow in the borehole and to evaluate connectivity between other wells/fractures in the corrective measures area. The results of the USGS geophysical testing are summarized in Table 2-1. Detailed geophysical testing results for each well are presented in Appendix A. Transmissivity calculations

were performed using the same methods (United States Geological Survey (USGS) flow modeling code FWRAP) as those used previously at the WVA (see CM Work Plan and/or *Characterization of Fractures and Flow Zones in a Contaminated Shale at the Watervliet Arsenal, Albany County, New York: USGS Open File Report 01-385* (Williams and Paillet, 2002)).

Table 2-2 and Figure 2-2 show the depth and distribution of the primary fracture features in the corrective measures area. As shown in Table 2-2, the geophysical testing identified three primary transmissive fracture zones in the corrective measures area. The zones have been designated the "Upper", "Middle", and "Lower" flow zones. The locations of these zones are shown in the three-dimensional profile on Figure 2-2. The three flow zones have a shallow easterly dip and plunge to the north. This northward plunge is most evident in the Upper and Lower flow zones, which drop approximately 70 feet and 50 feet, respectively, from the southern end of the corrective measures area to the northern end. The Middle flow zone also drops approximately 30 feet from the south to the north, but appears to be less extensive than the Upper and Lower flow zones. The Upper Zone, which was identified during previous testing at the WVA, covers most of the corrective measures area and appears to "daylight" at the bedrock surface in the vicinity of monitoring wells MW-34 and MW-65 in the southern portion of the corrective measures area. The Lower Zone is present over the entire corrective measures area. As mentioned above, the Middle zone is less extensive than the Upper and Lower zones and was shown to be present in the central portion of the corrective measures area from MW-65 in the south to IW-3 in the north. Cross-borehole testing has shown that there is a hydraulic connection between these three flow zones.

2.2 SUPPLEMENTAL ROCK CORE TESTING

During the Supplemental Investigation conducted in the corrective measures area in 2003, rock core samples were collected from monitoring wells MW-83 and MW-87, which are located in the central portion of the corrective measures area, for rock matrix pore water VOC analysis. Rock core sampling and analysis was conducted by personnel from the University of Waterloo (UW) using the same methods and procedures as those

utilized for previous studies at the WVA. The results of the rock core analyses were previously presented to the agencies as part of In-progress Review (IPR) meetings.

Figures 2-3 and 2-4 present the rock core VOC and estimated associated matrix pore water VOC concentrations in the samples collected from monitoring wells MW-83 and MW-87, respectively. As shown in these figures, matrix pore water PCE concentrations approaching aqueous solubility were present in both rock cores in the vertical interval between the Upper and Lower Flow zones (approximately 25 to 110 feet below ground surface (bgs). In particular, the depth intervals from 45 to 55 feet bgs and 80 to 100 feet bgs in MW-83 and from 90 to 100 feet bgs in MW-87 exhibited matrix pore water concentrations at more than 10 percent of aqueous PCE solubility. PCE and TCE were generally not detected at elevated concentrations in the rock core samples collected above or below the interval from 25 to 110 feet bgs - indicating that the majority of the VOC mass resides between the Upper and Lower flow zones.

3.0 MONITORING WELL INSTALLATION AND CONSTRUCTION

3.1 COMPLIANCE BOUNDARY WELLS

In accordance with the CM Work Plan, a multi-level compliance monitoring array consisting of six bedrock compliance boundary monitoring wells located along the eastern WVA property boundary was established during the Summer of 2004. These wells are MW-81, MW-82R, MW-83, MW-84R, MW-85R, and MW-86R. In accordance with the CM Work Plan and CMMP, each of these wells was completed with a three-zone multi-level monitoring system. The monitoring intervals are designed to evaluate the 'shallow', 'intermediate', and 'deep' portions of the compliance boundary (designated Zones I, II, III) from the bedrock surface to 150 feet bgs. The monitoring well screen intervals were adjusted slightly, where necessary, based on the presence of fractures identified during the geophysical profiling. Table 3-1 presents the monitoring intervals for each of the Boundary Wells. The relation of the monitoring zones to the fracture system discussed in Section 2 is shown on Figure 3-1.

3.2 WATER FLUTE™ WELLS

To further enhance the analysis of the permanganate injections in the injection wells to the west of Building 40 (MW-79 and MW-90), injection wells IW-1, IW-2, IW-3, IW-4, and MW-79 were outfitted with Water FLUTe™ multi-level monitoring systems in September 2004. These systems, which are manufactured by Flexible Liner Underground Technologies, Inc., consist of a pressurized flexible polyurethane-coated Nylon liner that is emplaced in a borehole by interior water pressure - sealing the borehole wall completely. Sampling intervals are set using exterior permeable spacers that lie between the borehole wall and the liner. Each sampling interval is sealed from the remainder of the borehole by the water pressure inside the liner. The water flows directly from the formation through the spacer and into a sampling tube equipped with a check-valve system. During sampling, water in the sampling tube is pushed to the surface using compressed nitrogen. The check-valve system prevents the water in the tube from contacting the nitrogen drive gas. Since the water in the sample tube flows directly from

the formation under natural hydrostatic pressure, it is only necessary to purge the small volume of water in the sampling tube before sampling. Because each sampling port/tube is self-contained, several sampling zones can be purged simultaneously. Water FLUTe™ systems can be removed from a borehole with relative ease by removing the water inside the liner and pulling the liner out of the well from the bottom up. Since the Water FLUTe™ liner material is not compatible with permanganate, the systems were planned to be removed upon the successful delivery of permanganate to the wells. Water FLUTe™ system construction details for the above-listed injection wells are presented in Table 3-2.

4.0 BASELINE MONITORING

In accordance with the CMMP, two baseline monitoring events were conducted in August 2004 prior to the first permanganate injection event. Baseline (and pre-injection) monitoring locations are presented in Table 4-1. The first monitoring event was conducted during the week of August 23, 2004. The second monitoring event was conducted during the week of September 13, 2004, approximately two weeks after the completion of the first monitoring event. Groundwater samples from each well were analyzed for VOCs to establish baseline concentrations from which to evaluate treatment efficacy. In addition to VOC analyses, samples from each well were also analyzed for potassium, sodium, sulfate, specific conductivity, and pH to allow for the evaluation of changes in groundwater chemistry during the injection program. Per the CMMP, the average concentration of each of the parameters analyzed during the two baseline monitoring events will be used as the baseline concentration. The results of the baseline monitoring are presented in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). Baseline VOC concentrations in the open boreholes of injection wells IW-1, IW-2, IW-3, and IW-4, which are not baseline monitoring locations, are shown in Table 4-2 for informational purposes. VOC data from the baseline monitoring events were validated in accordance with the CMMP. The Data Usability Summary Report (DUSR) for the baseline monitoring events is presented in Appendix C.

5.0 PERMANGANATE INJECTIONS AND MONITORING

Five permanganate injections have been performed in the corrective measures area as follows:

- **Injection 1:** September 30 - October 1, 2004
- **Injection 2:** January 31 - February 11, 2005
- **Injection 3A:** May 3 - May 5, 2005
- **Injection 3B:** July 6 - July 7, 2005
- **Injection 4:** August 22 - August 24, 2005
- **Injection 5:** December 5 - December 9, 2005

Pre-injection monitoring was conducted prior to each monitoring event in accordance with the CM Work Plan and CMMP. Permanganate distribution monitoring was conducted during and after each injection event; however, monitoring locations were adjusted from those listed in the CM Work Plan and CMMP due to the addition of the Water FLUTe™ systems to the monitoring network. These adjustments were discussed with the agencies during site visits and subsequent IPR meetings. Details for each injection and monitoring event are summarized in Table 5-1 and discussed below.

5.1 PERMANGANATE INJECTION NO. 1

5.1.1 Pre-Injection Monitoring

The baseline monitoring conducted in August and September 2004 (see Section 4.0) served as the pre-injection monitoring for Injection No.1. The results of the baseline monitoring are shown in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). VOC data from the baseline monitoring event were validated in accordance with the CMMP. The DUSR for the January 2005 VOC data is presented in Appendix C.

5.1.2 Injection Parameters

Approximately 2,000 gallons of a 10 percent sodium permanganate solution were injected into injection well MW-90 during Injection No. 1. The first 1,400 gallons of the solution were injected using gravity-feed methods. The initial injection rate using gravity-

feed was approximately 4.5 gallons per minute (gpm). However, this rate decreased steadily to approximately 1.0 gpm after the injection of 800 gallons of permanganate solution. Pressurized injection methods were utilized for the injection of the last 600 gallons, resulting in injection rates of 2.5 to 4.5 gpm. Injection pressures ranged between 15 to 20 pounds per square inch (psi) during the pressurized injections.

5.1.3 Distribution Monitoring

Distribution monitoring was conducted during and after Injection No. 1 using the Water FLUTe™ systems installed at MW-79 and IW-1 through IW-4 since these were the closest downgradient wells to the MW-90 injection location. Periodic monitoring of the compliance boundary wells was also conducted. The Water FLUTe™ systems were monitored for the following parameters:

- **Permanganate** (visual and concentration);
- **Anions/Cations** (chloride [Cl^-], bromide [Br^-], nitrate [NO_3], sulfate [SO_4^{2-}], lithium [Li^+], sodium [Na^+], ammonium [NH_4^+], potassium [K^+], magnesium [Mg^{2+}], manganese [Mn^{2+}], calcium [Ca^{2+}]);
- **Field parameters** (pH, conductivity, turbidity, dissolved oxygen [DO], temperature, total dissolved solids [TDS], oxidation-reduction potential [ORP]);
- **VOCs** (PCE, TCE, cDCE, trans 1,2-dichloroethene [tDCE], 1,1-DCE, and chloroform); and
- **Carbon isotopes.**

In accordance with the CMMP, field parameters and observations of permanganate presence were conducted during each monitoring event. Analyses of the remaining parameters, which were in addition to those listed in the CMMP, were conducted periodically to further evaluate the effects of the permanganate injection on contaminant concentrations and the geochemistry of the bedrock groundwater.

5.1.4 Injection Results

Permanganate was not observed in any of the monitoring wells during or after

Injection No.1; however, changes in geochemical parameters, specifically sodium, sulfate, conductivity, and chloride, were noted during the distribution monitoring. These changes, which are considered to be indicative of the effects of the permanganate injection at MW-90, are shown on Figures 5-1 through 5-5 for Water FLUTe™ wells IW-1, IW-2, IW-3, IW-4, and MW-79, respectively, and are discussed below. VOC monitoring results for the Water FLUTe™ wells are contained in Appendix D.

Sodium

Sodium concentrations in IW-1 (Zones 6,7,8,9), IW-4 (Zones 6,7,8,9), and MW-79 (Zones 4,8,9) increased during and/or immediately after Injection No. 1. The greatest increases were noted in wells MW-79 and IW-4, which are the closest monitoring points to the MW-90 injection well at 134 feet and 158 feet, respectively. The increases in sodium concentration are attributed to the disassociation of the sodium permanganate ($NaMnO_4$) in the groundwater after injection and are, therefore, considered indicative of the arrival of groundwater from the injection area at the downgradient monitoring points.

Sulfate

Sulfate concentrations at IW-1 (all zones), IW-2 (all zones), IW-3 (all zones except Zone 1), IW-4 (Zones 6,7,8,9), and MW-79 (Zones 3,4,5,6,9) increased during and/or immediately after Injection No. 1. The greatest increases were observed in monitoring wells MW-79 and IW-4. Increases in sulfate concentrations are attributed to the oxidation of reduced sulfur present as hydrogen sulfide (H_2S)and/or pyrite (FeS_2) in the groundwater and bedrock by the permanganate. The increases in sulfur concentrations in the downgradient monitoring points are also considered to be indicative of the arrival of groundwater from the injection location.

Conductivity

Conductivity measurements increased slightly in monitoring well IW-3 (Zones 5 through 9) and more significantly in wells IW-4 (Zones 7,8,9) and MW-79 (Zones

3,4,8,9). The increases in conductivity are likely associated with the disassociation of sodium permanganate injected at MW-90.

Chloride

It is expected that chloride concentrations in the groundwater downgradient of the injection area will increase as a result of the oxidation of the chlorinated VOCs and the subsequent release of chlorine anions. However, due to relatively high background concentrations at the WVA, changes in chloride concentrations were apparent only in MW-79 Zones 1,8, and 9.

5.2 PERMANGANATE INJECTION NO. 2

5.2.1 Pre-Injection Monitoring

Pre-injection monitoring was conducted from January 24-27, 2005. The results of the January 2005 pre-injection monitoring are shown in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). VOC data from the January 2005 monitoring event were validated in accordance with the CMMP. The DUSR for the January 2005 VOC data is presented in Appendix C.

5.2.2 Injection Parameters

Approximately 4,000 gallons of a 10 percent sodium permanganate solution were injected into injection well MW-90 during Injection No. 2. Initial gravity-feed methods resulted in an injection rate of less than two gpm. Pressurized injections were then attempted; however, a seal could not be maintained at the injection well head due to high backpressure in the well and sub-freezing temperatures at the time of injection. As a result, the majority of the permanganate was injected using gravity feed methods. Injection rates decreased significantly throughout the injection such that injection rates at the conclusion of the injection event were approximately 0.25 gpm. The cause of the decreased injection rates was attributed to the precipitation of manganese dioxide and/or iron and sulfur oxides along the borehole wall resulting from the interaction of the high concentration permanganate solution with the rock.

5.2.3 Distribution Monitoring

As with Injection No. 1, distribution monitoring was conducted during and after Injection No. 2 using the Water FLUTe™ systems installed at MW-79 and IW-1 through IW-4. Periodic monitoring of the compliance boundary wells was also conducted. The Water FLUTe™ systems were monitored for the same parameters as those monitored during Injection No. 1.

5.2.4 Injection Results

Permanganate was not observed in any of the monitoring wells during or after Injection No.2. Similar to Injection No. 1, changes in geochemical parameters, specifically sodium, sulfate, conductivity, and chloride, were noted during the distribution monitoring. Changes in geochemical parameters during Injection No. 2 are also shown on Figures 5-1 through 5-5 and are discussed below. As shown on Figures 5-1 through 5-5, changes in the concentrations of geochemical parameters during Injection No. 2 were more pronounced than those observed during Injection No. 1, which was likely due to the increased permanganate injection volume. VOC monitoring results for the Water FLUTe™ wells are contained in Appendix D.

<u>Sodium</u>

Sodium concentrations in IW-1 (Zones 9), IW-2 (Zones 2,3,4,8), IW-3 (Zones 4 through 9), IW-4 (Zones 5 through 9), and MW-79 (Zones 1,3,4,6) increased during and/or immediately after Injection No. 2. As with Injection No. 1, the greatest increases were noted in wells MW-79 and IW-4.

<u>Sulfate</u>

Sulfate concentrations at IW-1 (all zones), IW-2 (all zones), IW-3 (Zones 4 through 9), IW-4 (Zones 6,7,8,9), and MW-79 (Zones 3,4,5,6) increased during and/or immediately after Injection No. 2. The greatest increases were observed in monitoring wells MW-79, IW-3, and IW-4.

Conductivity

Conductivity measurements increased slightly in monitoring well IW-3 (Zones 5 through 9) and more significantly in wells IW-4 (Zones 7,8,9) and MW-79 (Zones 3,4,8,9). The increases in conductivity are likely associated with the disassociation of sodium permanganate injected at MW-90.

Chloride

Increases in chloride concentrations greater than background were observed in wells IW-1 (Zone 2) and MW-79 (Zone 1). Chloride concentrations at MW-79 Zones 8 and 9 were still elevated compared to concentrations recorded prior to Injection No. 1, but were essentially unchanged from the post-Injection No. 1 concentrations.

5.3 PERMANGANATE INJECTION NO. 3A

5.3.1 Pre-Injection Monitoring

Pre-injection monitoring was conducted from April 25-27, 2005. The results of the April 2005 pre-injection monitoring are shown in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). VOC data from the April 2005 monitoring event were validated in accordance with the CMMP. The DUSR for the April 2005 VOC data is presented in Appendix C.

5.3.2 Injection Parameters

Based on the results of the first two injection events, which did not result in the delivery of permanganate to the area of highest CVOC concentrations, the May 2005 injections were conducted at injection well MW-79. These changes were discussed with the agencies prior to the injection event. Approximately 4,000 gallons of a 5 percent sodium permanganate solution were injected into injection well MW-79 during Injection No. 3A. The FLUTe™ multi-level system was removed from MW-79 prior to the beginning of the injection event. The 5 percent sodium permanganate solution was utilized to prevent precipitation and subsequent clogging of the borehole wall that was thought to have occurred during the injection of the 10 percent sodium permanganate solution into

monitoring well MW-90. Initially, the injection targeted the zone from 70 to 90 feet bgs, which includes the major transmissive fracture in injection well MW-79 at 82 feet bgs, using an inflatable double-packer system. However, the lower packer failed after the injection of approximately 100 gallons of permanganate solution. Since a replacement packer was not available, the remainder of the injection was conducted using the entire open interval of injection well MW-79.

The permanganate solution was injected using pressurized injection methods after it was determined that the backpressure under gravity-feed conditions was not sufficient to inject the solution. The pressurized injection resulted in injection rates of 1.5 to 4.5 gpm. Injection pressures ranged between 15 to 20 psi during the injections.

5.3.3 Distribution Monitoring

Distribution monitoring was conducted during and after Injection No. 3A primarily using the Water FLUTe™ systems installed at IW-1 through IW-4. Periodic monitoring of the compliance boundary wells was also conducted. The Water FLUTe™ systems were monitored for the same parameters as those monitored during Injection No. 1.

5.3.4 Injection Results

Permanganate was observed in injection wells IW-1, IW-2, and IW-3 during and after Injection No. 3A. These wells are the closest downgradient wells to injection well MW-79. Permanganate was also observed in monitoring well MW-80, which is located to the south of injection well MW-79. Similar to the previous injections, changes in geochemical parameters, specifically sodium and sulfate, were noted during the distribution monitoring. Changes in geochemical parameters during Injection No. 3A are also shown on Figures 5-1 through 5-4 and are discussed below. As shown on Figures 5-1 through 5-4, changes in the concentrations of geochemical parameters during Injection No. 3A were more pronounced than those observed during the previous injection events. This difference is attributed to the fact that the observation wells were closer to the injection point during injection No. 3A and that permanganate was present in several of the monitored zones. VOC monitoring results for the Water FLUTe™ wells are contained in

Appendix D.

Permanganate

As shown on Table 5-1 and Figure 5-6, permanganate was observed in injection wells IW-1 (Zones 3 through 9), IW-2 (Zones 2 through 9), and IW-3 (Zones 4 through 9). The maximum permanganate concentrations in these monitoring zones ranged from less than 1.0 mg/l to approximately 37,900 mg/l. The highest permanganate concentrations were observed in IW-3, Zones 6,7,8. Permanganate concentrations in these zones were greater than 30,000 mg/l, which was equivalent to approximately 50% of the permanganate concentration injected into injection well MW-79. Permanganate concentrations greater than 20,000 mg/l were observed in IW-2, Zones 2 and 5. As shown on Figure 5-6, the permanganate residence time in injection wells IW-1 and IW-2 was approximately two weeks. The permanganate residence time in injection well IW-3 was approximately one month.

Sodium

As expected, sodium concentrations increased in all monitoring zones where permanganate was observed. Monitoring zones in which permanganate was not observed, but where increased sodium concentrations were noted were: IW-1 (Zone 2), IW-2 (Zones 1 and 2), IW-3 (Zones 4 through 9), and IW-4 (Zones 6 through 9).

Sulfate

Sulfate concentrations at IW-1 (all zones), IW-2 (all zones), IW-3 (Zones 5 through 9), and IW-4 (Zones 6 through 9), and MW-79 (Zones 3,4,5,6) increased during and/or immediately after Injection No. 3A.

Conductivity

Conductivity was not measured in the monitoring wells after Injection No. 3A due to the presence of the permanganate in the wells, which could have potentially damaged the field instrument.

Chloride

Increases in chloride concentrations greater than background were observed in wells IW-1 (Zones 1 and 2), and IW-3 (Zone 9). The chloride concentrations at injection well IW-1 Zone 2 were more than 200 mg/l greater than the maximum concentrations previously observed at IW-1. These increases may be associated with the oxidation of the CVOCs by the permanganate, which results in the release of chlorine ions.

5.4 PERMANGANATE INJECTION NO. 3B

Due to the failure of the double packer system during the May 2005 injections at MW-79 (Injection No. 3A), a supplemental injection was conducted at MW-79 in July 2005 using a double packer system to isolate the upper fracture zone in MW-79. The purpose of this injection was to attempt to better distribute permanganate to the shallow portions of the bedrock aquifer on the eastern side of Building 40 that did not receive permanganate during the April 2005 injections.

5.4.1 Pre-Injection Monitoring

Pre-injection monitoring was not conducted prior to the July 2005 supplemental injection.

5.4.2 Injection Parameters

Approximately 2,000 gallons of a 5 percent sodium permanganate solution were injected into the upper 20 feet of injection well MW-79 using a double packer apparatus during Injection No. 3B. The permanganate solution was injected using pressurized injection methods after it was determined that the backpressure under gravity-feed conditions was not sufficient to inject the solution. The pressurized injection resulted in injection rates of 3.5 to 5 gpm. Injection pressures ranged between 20 to 25 psi during the injections.

5.4.3 Distribution Monitoring

Distribution monitoring was conducted during and after Injection No. 3B primarily using the Water FLUTe™ systems installed at IW-1 through IW-4. Periodic monitoring of the compliance boundary wells was also conducted. The Water FLUTe™ systems were monitored for the presence of permanganate.

5.4.4 Injection Results

Permanganate was not observed in injection wells IW-1, IW-2, IW-3, or IW-4 during and after Injection No. 3B. These wells are the closest downgradient wells to injection well MW-79. Permanganate was observed in monitoring well MW-80, which is located to the south of injection well MW-79.

5.5 PERMANGANATE INJECTION NO. 4

5.5.1 Pre-Injection Monitoring

Pre-injection monitoring was conducted from August 15-17, 2005. The results of the August 2005 pre-injection monitoring are shown in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). VOC data from the August 2005 monitoring event were validated in accordance with the CMMP. The DUSR for the August 2005 VOC data is presented in Appendix C.

5.5.2 Injection Parameters

The CM Work Plan stated that injections in MW-79 and or MW-90 would continue until permanganate was detected in the monitoring wells east of Building 40 (Phase I Injections). Since this condition was met after Injection No. 3, the August 2005 (Injection No. 4) injections were conducted using all injection wells listed in the CM Work Plan. Approximately 4,000 gallons of a 5 percent sodium permanganate solution were injected into injection wells MW-79, IW-1, IW-2, IW-3, and IW-4 during Injection No. 4. The permanganate was distributed evenly across the injection wells, resulting in the injection of approximately 800 gallons of the permanganate solution into each injection well. The FLUTe™ multi-level systems were removed from injection wells IW-1, IW-2, IW-3, and IW-4

prior to the beginning of the injection event. However, the FLUTe™ multi-level system in IW-3 partially disintegrated in the well due to exposure to permanganate from Injection No. 3. As a result, only a portion of the FLUTe™ liner could be removed from the well. The injections were conducted using the entire open interval of the injection wells. Permanganate solution injection methods and rates are summarized below.

Table 5-2 Injection No.4 (August 2005) Parameters

Injection Well	Injection Method	Injection Pressure (psi)	Injection Rate (gpm)
MW-79	Pressurized	15-20	4-4.5
IW-1	Pressurized	gravity-5	4
IW-2	Pressurized	15-20	3-3.5
IW-3	Pressurized	gravity-50*	0.5-1
IW-4	Pressurized	gravity-5	4-5

Notes:
Gravity feed often performed overnight by draining remaining permanganate solution in mixing tank.
* Elevated pressure necessary due to partial FLUTe™ liner in well.

5.5.3 Distribution Monitoring

Distribution monitoring was conducted during and after Injection No. 4 primarily using the compliance boundary wells MW-81 through MW-86R. Monitoring was conducted in all three monitoring zones (designated I, II, and III for the shallow, middle, and deep zones, respectively) in each well. Periodic monitoring of the remaining wells included in the Building 40 groundwater monitoring program was also conducted. The wells were monitored for the presence of permanganate (both visual presence and concentration).

5.5.4 Injection Results

As shown in Table 5-3 and Figures 5-7 through 5-12, permanganate was observed in at least one zone in each of compliance boundary monitoring wells and in a total of nine of the 18 compliance boundary monitoring zones. Compliance monitoring zones where permanganate was observed were:

- MW-81 (Zones I and II)
- MW-82R (Zones II and III)
- MW-83 (Zones I and III)

- MW-84R (Zone I)
- MW-85R (Zone II)
- MW-86R (Zone II)

The maximum permanganate concentrations in these monitoring zones ranged from 26 mg/l [MW-82R(III)]to approximately 48,700 mg/l [MW-86R(II)]. The highest permanganate concentrations were observed in monitoring zones MW-86R (II), MW-82R(II), MW-84R(I), and MW-83(I). The permanganate concentration of 48,700 mg/l in monitoring zone MW-86R(II) was equivalent to approximately 80% of the injected permanganate concentration. Permanganate concentrations in the remaining compliance monitoring zones were generally less than 1,000 mg/l. As shown on Figures 5-7 through 5-12, permanganate residence times in the compliance monitoring zones following Injection No. 4 ranged from less than two weeks [MW-81(I), MW-81(II), MW-82R(II), MW-83(I), MW-85R(II)] to approximately one month [MW-83(III), MW-86R(II)].

5.6 PERMANGANATE INJECTION NO. 5

5.6.1 Pre-Injection Monitoring

Pre-injection monitoring was conducted from November 29 through December 1, 2005. The results of the December 2005 pre-injection monitoring are shown in Appendix B (Tables B-1 through B-12 and Figures B-1 through B-12). VOC data from the December 2005 monitoring event was validated in accordance with the CMMP. The DUSR for the December 2005 VOC data is presented in Appendix C.

5.6.2 Injection Parameters

Approximately 4,000 gallons of a 5 percent sodium permanganate solution were injected into injection wells MW-79, IW-1, IW-2, IW-3, and IW-4 during Injection No. 5. The injections were conducted using the entire open interval of the injection wells. Permanganate solution injection methods and rates are summarized below.

Table 5-4 Injection No.5 (December 2005) Parameters

Injection Well	Injection Method	Injection Pressure (psi)	Injection Rate (gpm)
MW-79	Pressurized	15-20	4-5
IW-1	Pressurized	0-5	2.5-3
IW-2	Pressurized	15-20	2
IW-3	Pressurized	30-50*	0.5-1
IW-4	Pressurized	0-5	5-10

Notes:
* Elevated pressure necessary due to partial FLUTe™ liner in well.
"0" psi indicates no backpressure in well during injection.

5.6.3 Distribution Monitoring

Distribution monitoring was conducted during and after Injection No. 5 primarily using the compliance boundary wells MW-81 through MW-86R. Monitoring was conducted in all three monitoring zones in each well. Periodic monitoring of the remaining wells included in the Building 40 groundwater monitoring program was also conducted. The wells were monitored for the presence of permanganate (both visual presence and concentration).

5.6.4 Injection Results

As shown in Table 5-3 and Figures 5-7 through 5-12, permanganate was observed in seven of the 18 compliance boundary monitoring zones during Injection No. 5. Compliance monitoring zones where permanganate was observed were:

- MW-82R (Zone III)
- MW-83 (Zones I and III)
- MW-84R (Zone I)
- MW-85R (Zones II and III)
- MW-86R (Zone II)

The maximum permanganate concentrations in these monitoring zones ranged from 5 mg/l [MW-82R(II)]to approximately 14,000 mg/l [MW-86R(II)]. As shown on Figures 5-7 through 5-12, permanganate residence times in the compliance monitoring zones following Injection No. 5 ranged from less than two weeks [MW-82R(II and III), MW-83(I), MW-85R(III)] to approximately two months [MW-83(III), MW-86R(II)].

6.0 VOC MASS DISCHARGE ANALYSES

6.1 INTEGRATED VOC MASS DISCHARGE TESTING

In accordance with the CM Work Plan, integrated VOC mass discharge testing is being conducted as part of the corrective measures to evaluate permanganate treatment efficacy with respect to mass destruction over the entire VOC treatment area. The testing consists of a 12-hour constant rate pumping test during which groundwater samples are collected from the purged groundwater on an hourly basis and water levels are measured in the surrounding monitoring wells to evaluate the pumping radius of influence and overall hydraulic characteristics of the bedrock aquifer. Two pumping tests will be performed as part of the testing: one prior to the initiation of permanganate injections and one after the completion of permanganate injections and rebound monitoring. The first of the two scheduled pumping tests was conducted on September 24, 2004, prior to the first sodium permanganate injection. The test was performed at injection well IW-2, which is located adjacent to the eastern side of Building 40 in the central portion of the VOC treatment area. Pumping test procedures and results for the first integrated VOC mass discharge test are discussed below.

6.1.1 Pumping Test Procedures

The pumping test was a 12-hour constant-flow pumping test designed to extract water from the treatment area to evaluate contaminant flux under known conditions (i.e., constant pumping rate). Water level measurements were recorded in 20 wells in the Building 40 vicinity prior to the pumping test to establish static water level conditions. Electronic pressure transducers (data loggers) were then installed in seven of these wells. Water levels in the remaining wells were measured manually using an electronic water level probe.

A submersible Grundfos Redi-Flo2 2-inch pump and controller was selected for the test. The pump was positioned ten feet above the bottom of the borehole in injection well IW-2. The pump discharge hose was connected to an in-line flow meter capable of measuring flow to the nearest 0.1 gallons per minute (gpm). The pumping test rate was

maintained at 1 gpm using the Redi-Flo2 controller. To ensure that discharge from the pumping test did not provide recharge to the bedrock and to facilitate proper disposal of the purged groundwater, two 1,000 gallon polyethylene tanks were staged near the injection well to temporarily contain water extracted during the pumping test.

Water levels were measured continually during the pumping test. The interval between measurements was approximately 10 minutes for the first hour of the test, 30 minutes for the second hour, and hourly for the remainder of the test. Figure 6-1 shows the drawdown in wells monitored during the pumping test at 30 minutes, 3 hours, 8 hours, and 11 hours after the pumping test was initiated. Water level data for multi-level wells MW-81, MW-82R, MW-83, MW-84R, MW-85R, and MW-86R were not included in these drawdown representations since the drawdown in each well was variable. Water level measurement data for all wells monitored during the pumping test are provided in Appendix D.

Figure 6-2 shows the water level drawdown in the compliance boundary wells as they relate to the Hudson River tides measured in Albany, New York on the day of the pumping test. As shown on Figure 6-2, a decrease in the drawdown was noted in all of the monitoring zones at approximately 10:00 AM. This corresponds with high tide in the Hudson River, which occurred between 9:00 AM and 10:00 AM. Drawdown in the monitoring zones began to increase again between 11:00 AM and 12:00 PM. This increase also corresponds to the lessening of the tide during this time.

6.1.2 Groundwater Sample Collection

Time-series VOC sampling was conducted during the pumping test to evaluate integrated (average) contaminant concentrations in the treatment area. Twelve groundwater samples were collected from the injection well IW-2 purge water during the pumping test. One sample was collected at the start of the test and one sample was collected every hour subsequent throughout the 12-hour test period. Samples were collected from the pump discharge line. Samples were sent to Severn Trent Laboratories for analysis of VOCs by USEPA Method 8260B, magnesium, potassium, and sodium by USEPA Method 6010B, chloride and sulfate by USEPA Method 300, alkalinity by USEPA

Method 310.1, and total dissolved solids (TDS) by USEPA Method 160.1. Prior to collecting each sample, conductivity, dissolved oxygen, oxidation-reduction potential, pH, temperature, and turbidity were measured using a Horiba U-22 water quality meter. Sample results for VOCs are summarized in Table 6-1. As shown in Table 6-1, the concentration of total VOCs in samples collected during the test ranged from 17,060 micrograms per liter (µg/L) to 26,870 µg/L. Field parameter measurements and the results for the remaining analyses are summarized in Table 6-2.

6.1.3 Pumping Test Evaluation

Pumping test data were evaluated by comparing drawdown verses time relationships for each monitoring well with Theis and Neumann theoretical curves. It should be noted that both of these methods assume that the aquifer is comprised of homogeneous porous media; however, for the purposes of this analysis, it was assumed that the bedrock aquifer would behave in a manner equivalent to that of a porous media. Water level data were plotted on log-log graph paper using the same scale as the Theis and Neumann "type curves". Several of the observation wells and individual zones of multilevel wells monitored during the pumping test had erratic water level readings which rendered the data unusable for type curve matching. Values for transmissivity were derived for each of the remaining observation wells once a "best fit" with the theoretical curves was obtained for the data. An average transmissivity for the pumping test area was then calculated. Type curves and transmissivity calculations for each well evaluated for this test are provided in Appendix E.

Calculated transmissivity values for wells included in the pumping test evaluation ranged from 2 to 77 ft^2/day using the Neumann method and from 6 to 64 ft^2/day using the Theis method. The average transmissivity calculated using the Neumann method was 29 ft^2/day. Although the average transmissivity was greater using the Theis method (37 ft^2/day), the results using the two methods generally correlated well.

6.1.4 Integrated Mass Discharge Estimate

6.1.4.1 Compliance Boundary Estimate

Results from the 12-hour pumping test and time-series VOC sampling were used to estimate the preliminary contaminant mass flux in the treatment area. The following assumptions were used to evaluate mass flux discharge:

- The cross-section of the treatment area (40,430 ft^2) was calculated using the distance between multi-level wells MW-81 and MW-86R (311 feet) and the thickness of bedrock that these wells penetrate (130 feet).
- The hydraulic conductivity of the bedrock was calculated based on transmissivity values derived from the pumping test using the equation T=kb. Where T is the transmissivity (ft^2/day), k is the hydraulic conductivity (ft/day), and b is the thickness of the aquifer (ft). For this estimation, the thickness of the aquifer was replaced with the thickness of bedrock that the wells penetrate (130 feet).
- The gradient of the water table is 0.003 ft/ft based on the hydraulic gradient in the Building 40 area calculated from WVA-wide water table groundwater elevations.
- The total VOC concentration used to calculate mass flux discharge is 26,400 µg/L. As shown on Figure 6-3, total VOC concentrations stabilized near this concentration before the end of the pumping test. The result used is the concentration of total VOCs in the last sample collected during the test.

Table 6-3 summarizes the integrated mass flux discharge evaluation. As shown in Table 6-3, based on the results of the pumping test, the estimated pre-treatment VOC mass discharge through the treatment area ranges from approximately 11 pounds per year (lb/y) to 21 lb/y, depending on the method used to evaluate transmissivity.

6.1.4.2 Pumping Well Discharge

As discussed in the CM Work Plan, the VOC mass discharge from the pumping well

during the baseline test will be compared to the discharge from the pumping well during the second pumping test. The baseline pumping well discharge was calculated using the following data.

- The pump discharge rate was 1.0 gpm (3.785 liters per minute).
- The average total VOC concentration in the discharge was 26,400 µg/L.

Using these data, the total VOC mass discharge from IW-2 during the pumping test was approximately 0.32 pounds per day (approximately 115.8 pounds per year).

6.2 VOC MASS DISCHARGE

Compliance boundary VOC mass discharge estimates were calculated for each compliance monitoring zone using the transmissivity values calculated for fractures that had detectable flow during the July 2004 geophysical testing (reported in the CMMP). Calculated transmissivity values for the compliance monitoring zones are presented in Table 6-4. The transmissivity values listed in Table 6-4 are the sum of the individual transmissivities for fractures with detectable flow that intersect each compliance monitoring zone. Mass discharge estimates were calculated using the following assumptions:

- **Discharge Zone Thickness:** Set as the thickness of the screened interval in each compliance monitoring zone.
- **Hydraulic Gradient:** Set at 0.003 ft/ft based on the hydraulic gradient in the Building 40 area calculated from WVA-wide water table groundwater elevations.
- **Horizontal Length of Discharge Zone:** Set as the distance between compliance monitoring wells.
- **VOC Concentration:** Set at the total VOC concentration in each compliance monitoring zone during each pre-injection monitoring event (average of two baseline events used for baseline estimates).

Compliance boundary VOC mass discharge estimates for the baseline and pre-injection monitoring events are presented in Table 6-5 and on Figure 6-4 . As shown in

Table 6-5, the estimated pre-injection (baseline) VOC mass discharge along the compliance boundary was approximately 10 lb/y, which was equivalent to the lower estimates of VOC mass discharge calculated from the integrated mass discharge testing. Table 6-6 (below) presents changes from baseline in the estimated compliance boundary VOC mass discharge estimated after each of the first four injection events. As shown in Table 6-6, the estimated compliance boundary VOC mass discharge was similar to the baseline following the first three injection events. However, the estimated compliance boundary VOC mass discharge measured in November 2005 was approximately 34 percent less than the baseline, indicating that the permanganate injections on the east side of Building 40 in August 2005 resulted in significant VOC treatment in the area upgradient of the compliance boundary. As shown in Table 6-5, this treatment was most pronounced in the northern portion of the compliance boundary, as reflected by the changes in VOC mass discharge in monitoring wells MW-84R, MW-85R, and MW-86R.

Table 6-6 Summary of Changes in Compliance Boundary VOC Mass Discharge

	Date			
	Jan. 2005	May 2005	Aug. 2005	Nov. 2005
Total VOC Mass Discharge (lb/y)	10.02	11.56	10.03	6.62
% of Baseline VOC Mass Discharge	*100%*	*115%*	*100%*	*66%*

As shown on Figure 6-4 and Table 6-5, the greatest contributions to the baseline compliance boundary VOC mass discharge were from the compliance monitoring zones that intersect the upper flow zone fracture system. The wells/zones are:

- MW-83 (Zone I)
- MW-84R (Zone I)
- MW-85R (Zone II)
- MW-86R (Zone II)

The percentage of the total estimated compliance boundary VOC mass discharge contributed by these zones is shown in Table 6-7 below. Monitoring zones in which

permanganate was observed during at least one monitoring event following the previous injection event are shaded in purple; however, it should be noted that none of these zones contained permanganate at the time of sampling.

Table 6-7 Contribution to Total Compliance Boundary VOC Mass Discharge

Well (Zone)	Percentage of Total Estimated Compliance Boundary VOC Mass Discharge (lb/y)				
	Baseline	Jan. 2005	May 2005	Aug. 2005	Dec. 2005
MW-83 (I)	5.5%	22.5%	25.1%	29.9%	35.0%
MW-84R (I)	13.2%	10.2%	10.0%	8.3%	10.2%
MW-85R (II)	25.1%	21.8%	18.4%	25.8%	1.3%
MW-86R (II)	26.1%	19.9%	12.8%	4.2%	12.84%
Total	**69.9%**	**74.4%**	**66.3%**	**68.2%**	**59.3%**

As shown in Table 6-7, these zones contribute approximately two thirds for the total compliance boundary VOC mass discharge.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn based on the data collected during the startup testing and the results of the permanganate injections conducted through December 2005.

1. The geophysical testing conducted in the injection and compliance boundary wells indicates that the majority of the groundwater flow in the Building 40 treatment area is confined to three primary fracture zones, designated "Upper", "Middle", and "Lower". These fracture zones have a shallow easterly dip and plunge to the north. The Upper and Lower flow zones appear to be laterally continuous throughout the treatment area; however it also appears that the Upper flow zone "daylights" at the bedrock surface in the southern portion of the treatment area in the vicinity of monitoring well MW-34. The Middle flow zone appears to be less extensive than the Upper and Lower zones. The majority of the VOC contamination in the groundwater and bedrock matrix resides between the Upper and Lower flow zones.
2. Permanganate injections conducted at injection well MW-90 did not result in the delivery of permanganate to the remaining injection wells or boundary wells; however, geochemical evidence of groundwater influenced by the MW-90 injection was seen at the remaining injection wells. The borehole clogging that resulted from the injection of the 10 percent at MW-90, along with the elevated sulfate concentrations in the downgradient groundwater, confirms the results of the laboratory pilot testing in that the rock has a relatively high oxidant demand and that pyrite accounts for a large portion of the rock oxidant demand.
3. Permanganate injections at injection well MW-79, where the highest concentrations of CVOCs were detected during the site investigation, successfully delivered permanganate to the Water FLUTe™-equipped injection wells on the east side of Building 40 (IW-1, IW-2, and IW-3). Based on the sample results from the Water FLUTe™ systems in injection wells IW-1, IW-2,

and IW-3, the permanganate was distributed vertically throughout the majority of the target treatment zone.

4. Permanganate injections at all five of the planned injection wells (MW-79, IW-1, IW-2, IW-3, and IW-4) resulted in the distribution of permanganate to at least one zone in all six of the compliance boundary monitoring wells (MW-81, MW-82R, MW-83, MW-84R, MW-85R, MW-86R). To date, permanganate has been delivered to nine of the 18 compliance boundary monitoring zones; collectively, these zones accounted for more than two thirds of the compliance boundary mass flux prior to the initiation of permanganate injections.

Based on these results, the following recommendations are made:

1. The permanganate treatment program should continue as it appears that portions of the corrective measures area are being treated by the permanganate injections. However, adjustments to the treatment program should be considered to increase the distribution and residence time of the permanganate.
2. Modify the permanganate injection locations to include injections at the MW-34/MW-51 monitoring well cluster. Inclusion of MW-34 (shallow zone) and MW-51 (middle zone) will allow for additional treatment of the southern end of the compliance boundary and will treat the high concentrations of CVOCs present at MW-51, to which permanganate has not yet been delivered.

8.0 REFERENCES

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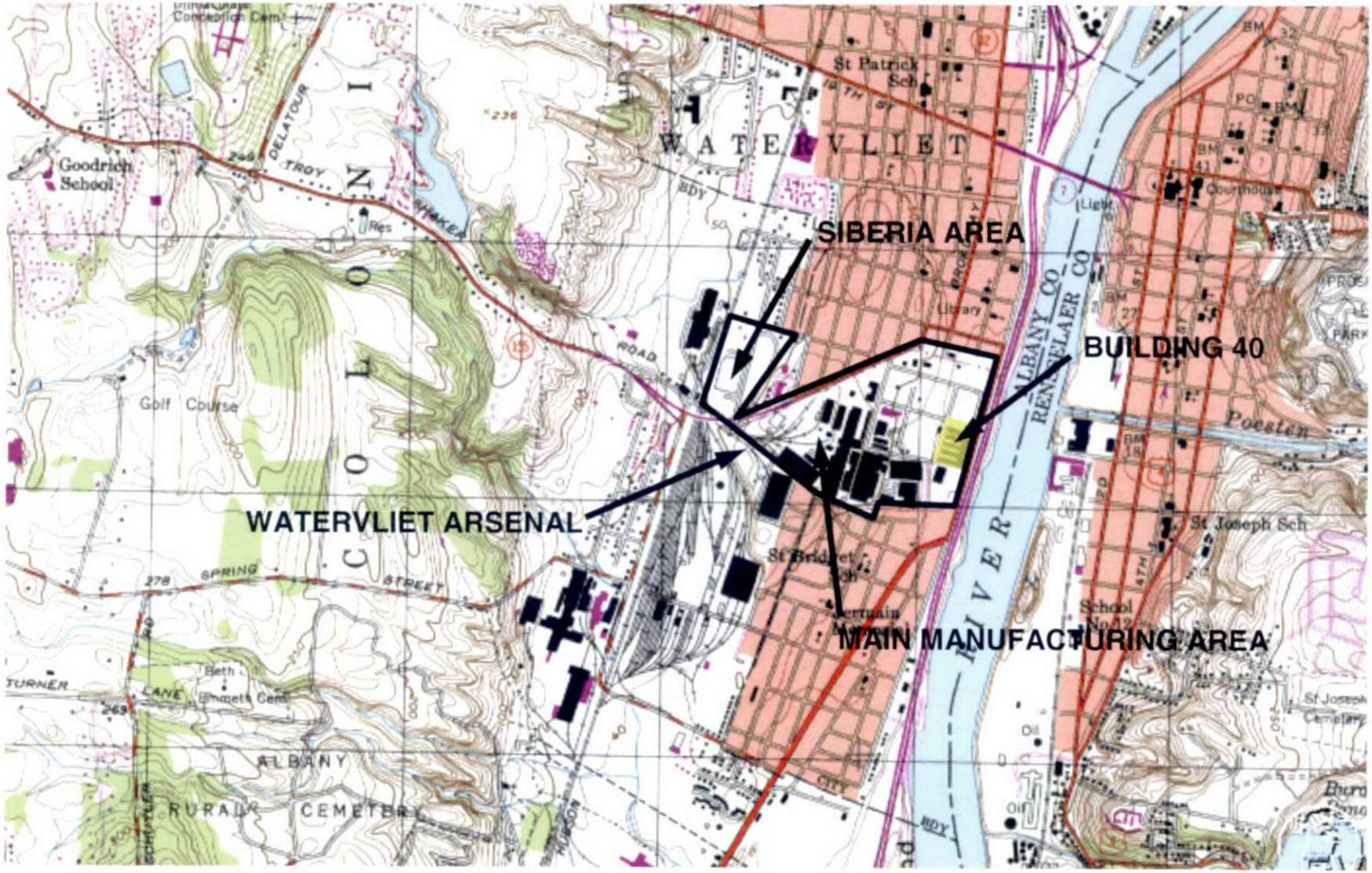

SOURCE: U.S.G.S 7.5 MIN. TROY SOUTH QUADRANGLE

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BUILDING 40 CORRECTIVE MEASURES
WATERVLIET ARSENAL, WATERVLIET, NEW YORK

SITE LOCATION

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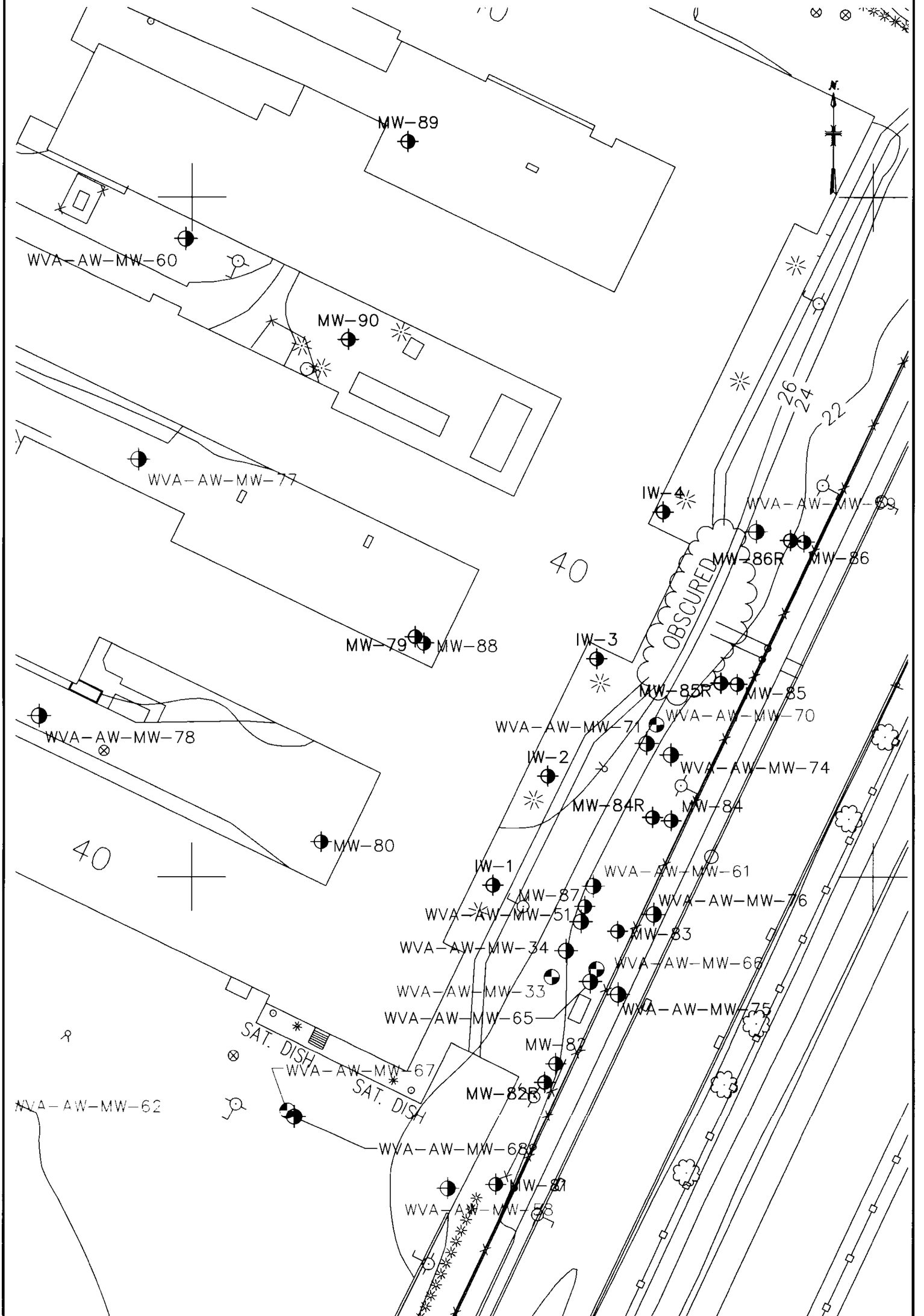
FIGURE 1-1



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SITE MAP

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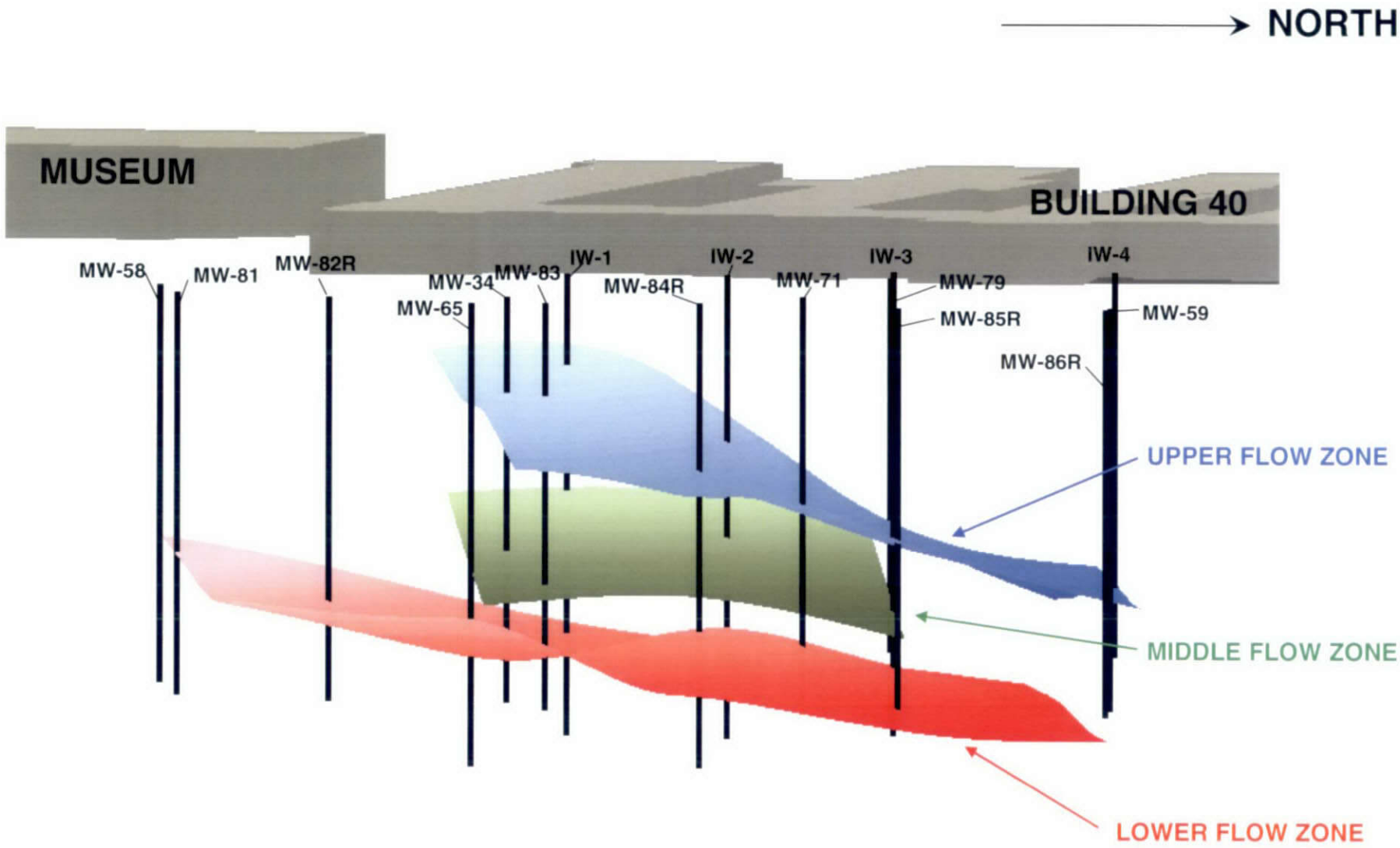
FIGURE 2-1



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BEDROCK FRACTURES IN THE BUILDING 40 TREATMENT AREA

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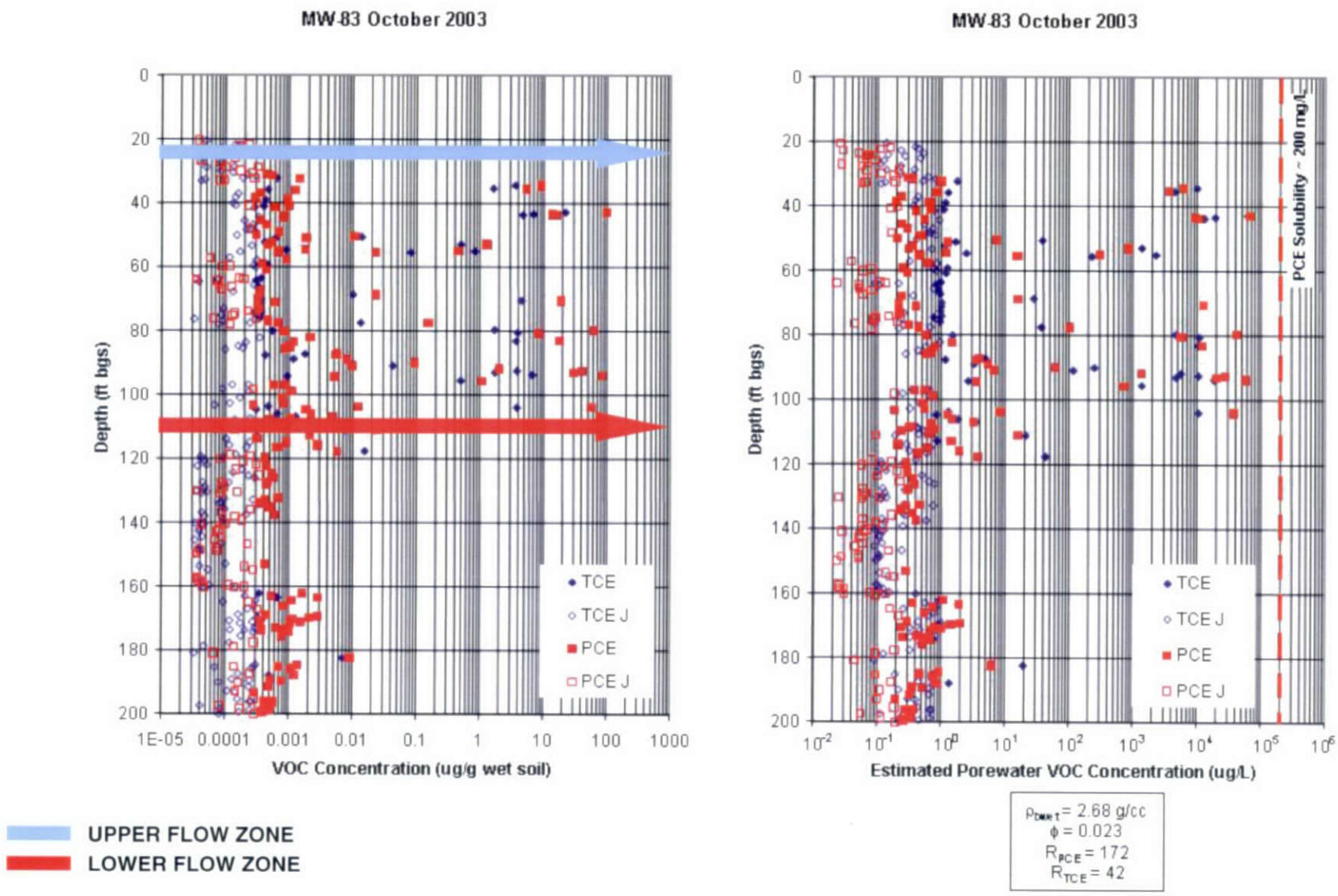
FIGURE 2-2



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ROCK CORE VOC TESTING RESULTS – MW-83

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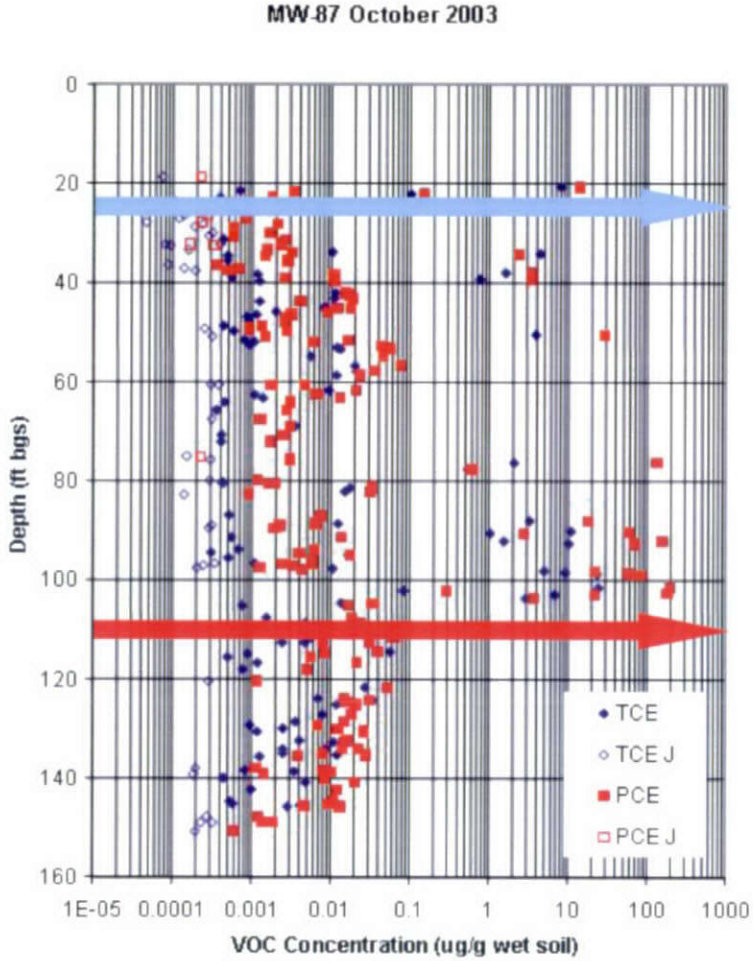
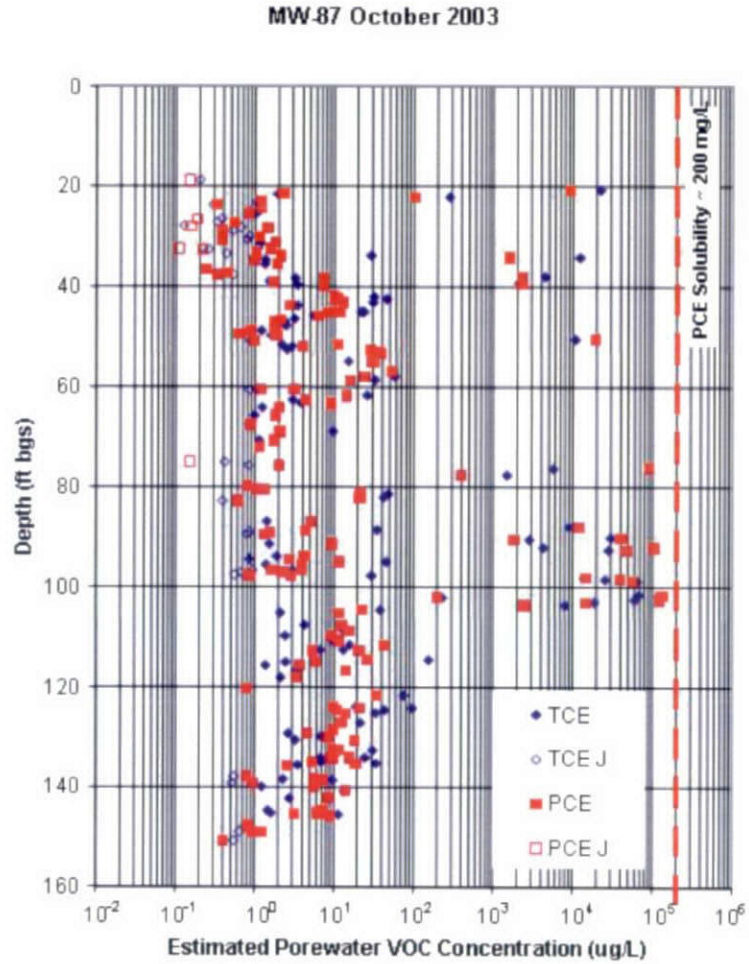
FIGURE 2-3





ρ_{bulk} = 2.68 g/cc
ϕ = 0.023
R_{PCE} = 172
R_{TCE} = 42

UPPER FLOW ZONE (approximated from adjacent wells)

LOWER FLOW ZONE (approximated from adjacent wells)

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ROCK CORE VOC TESTING RESULTS – MW-87

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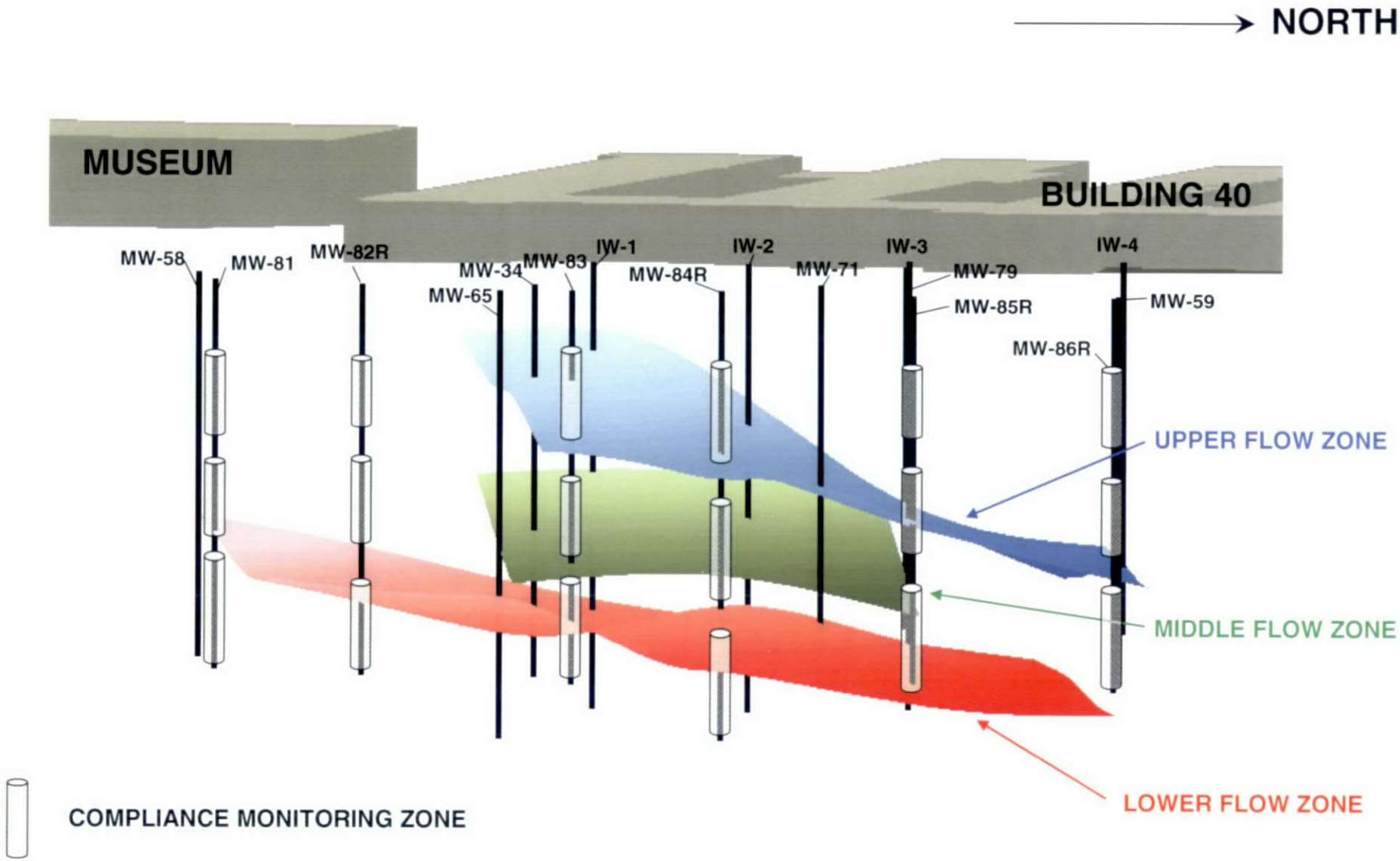
FIGURE 2-4



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COMPLIANCE MONITORING ZONES

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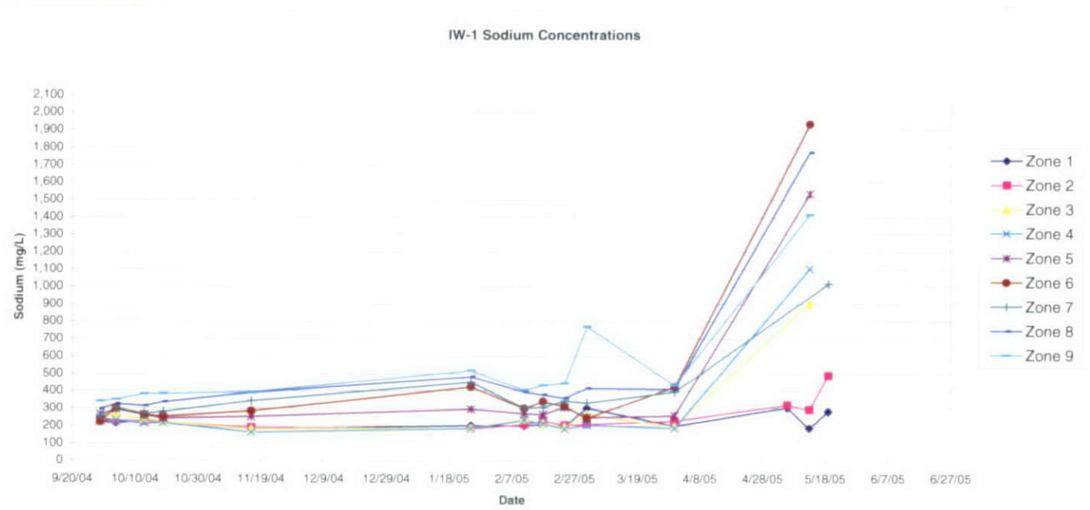
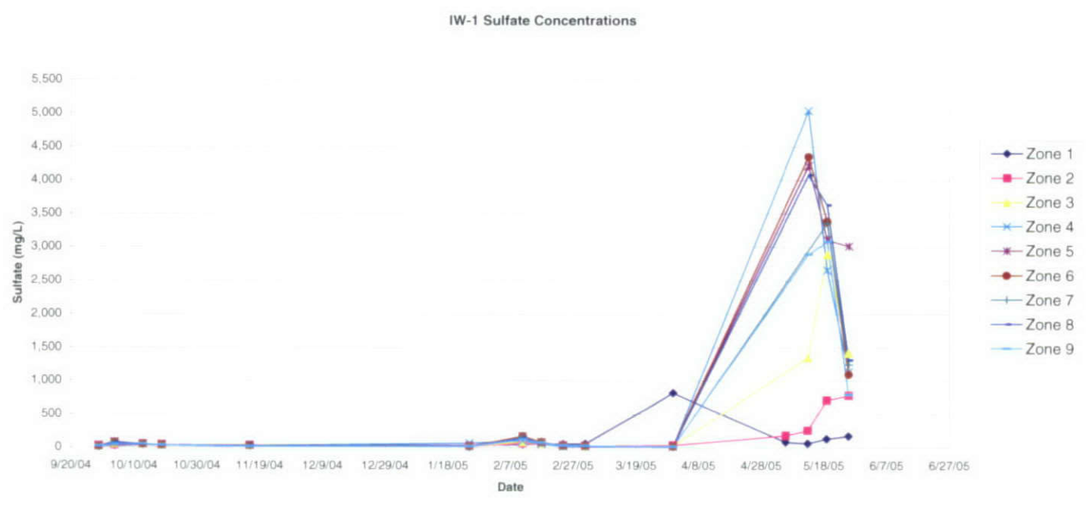
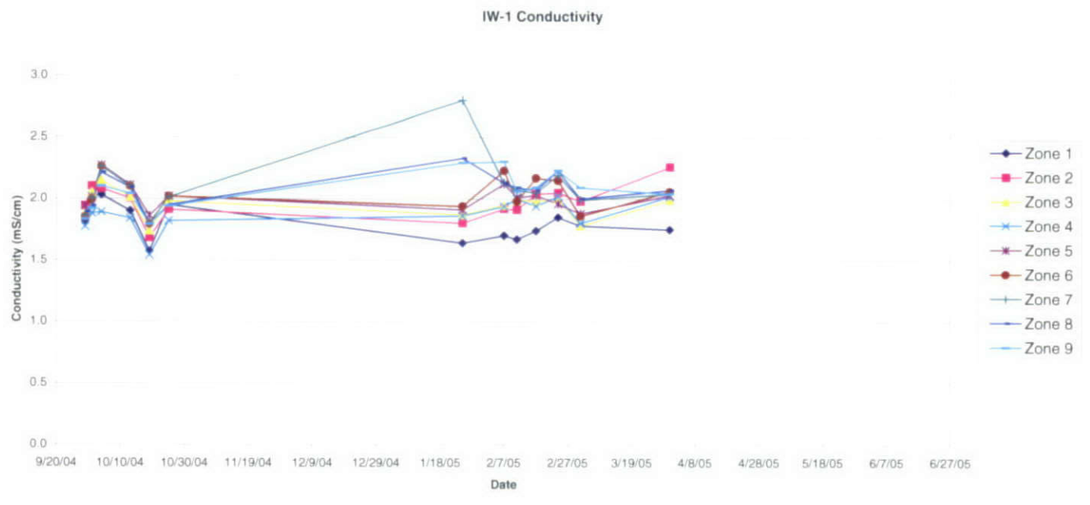
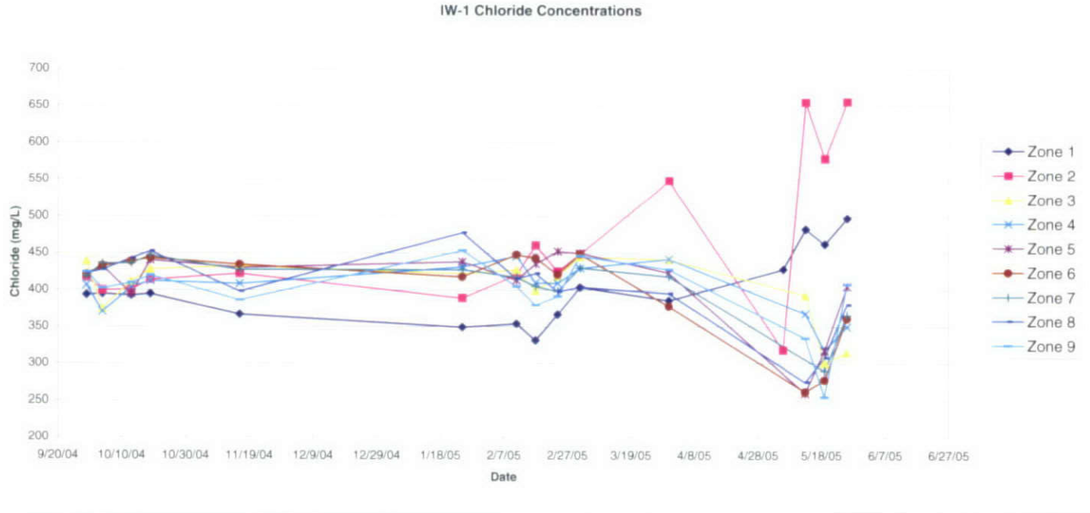
FIGURE 3-1









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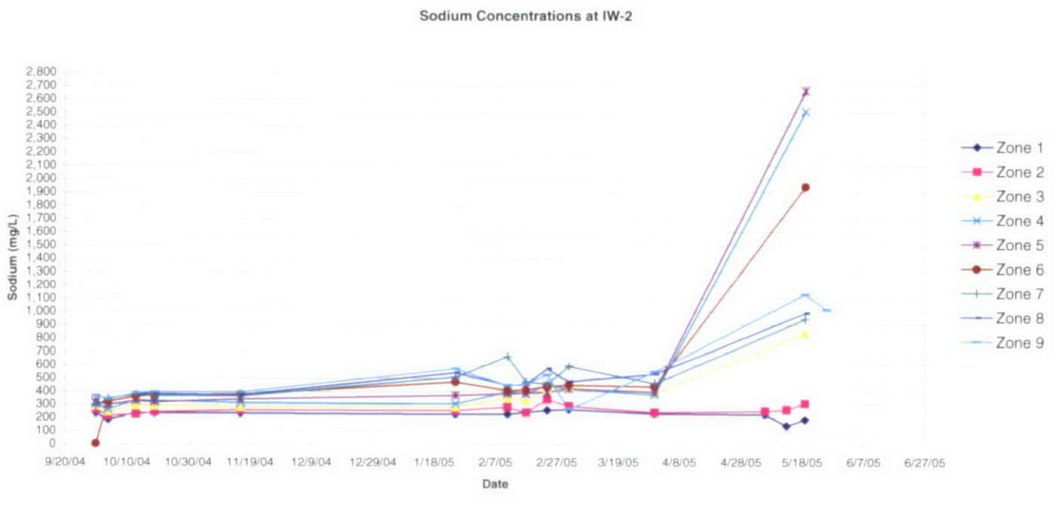
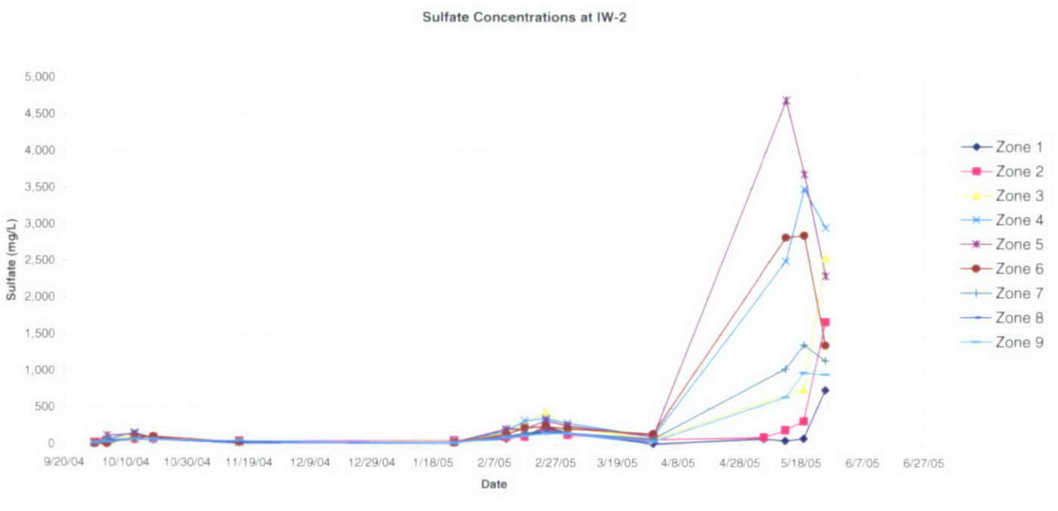
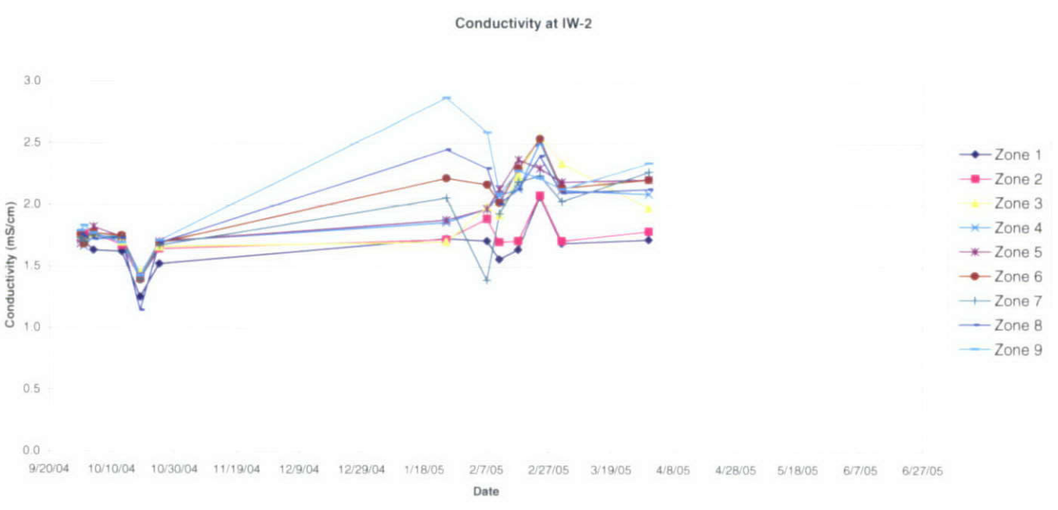
WATERVLIET ARSENAL, WATERVLIET, NEW YORK

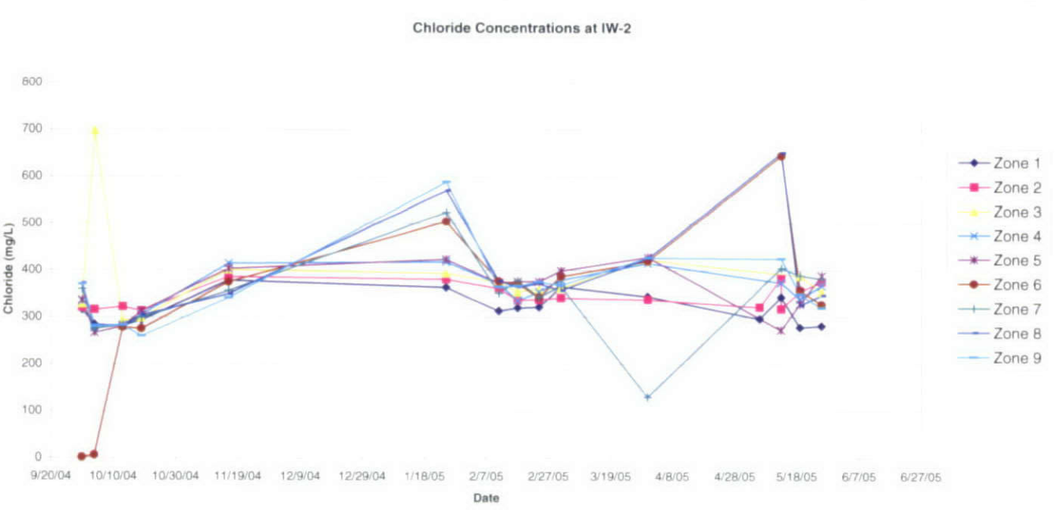
SUMMARY OF GEOCHEMICAL MONITORING AT IW-1

FIGURE 5-1









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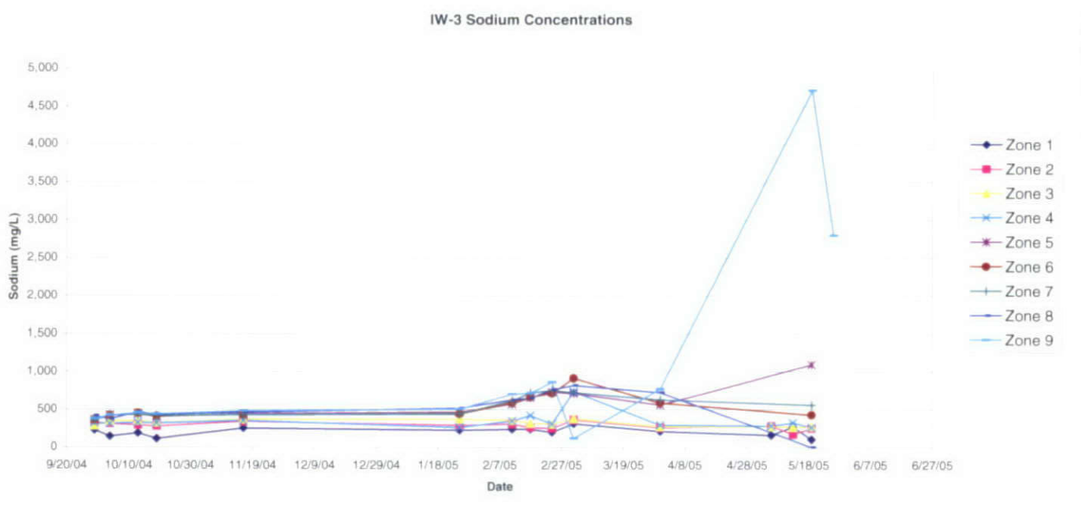
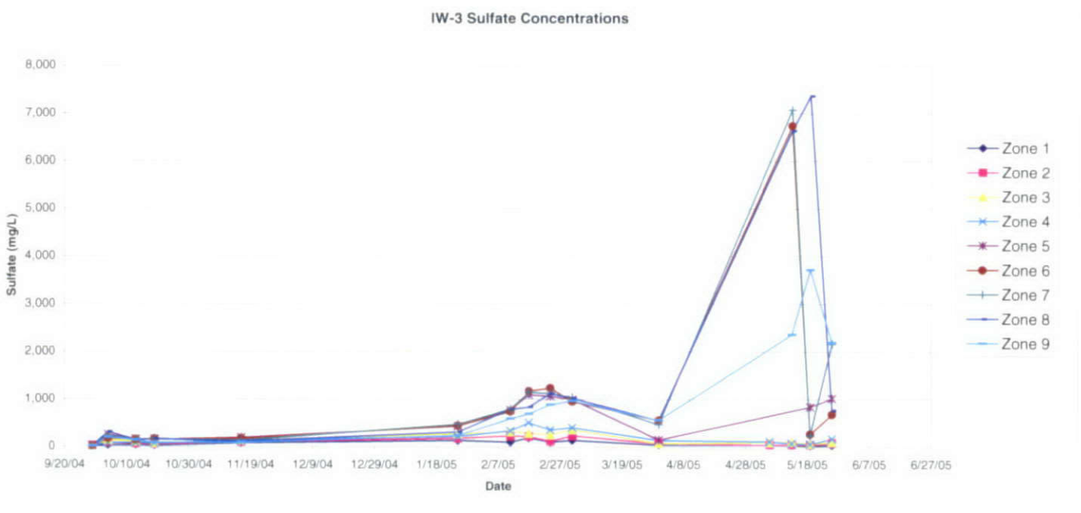
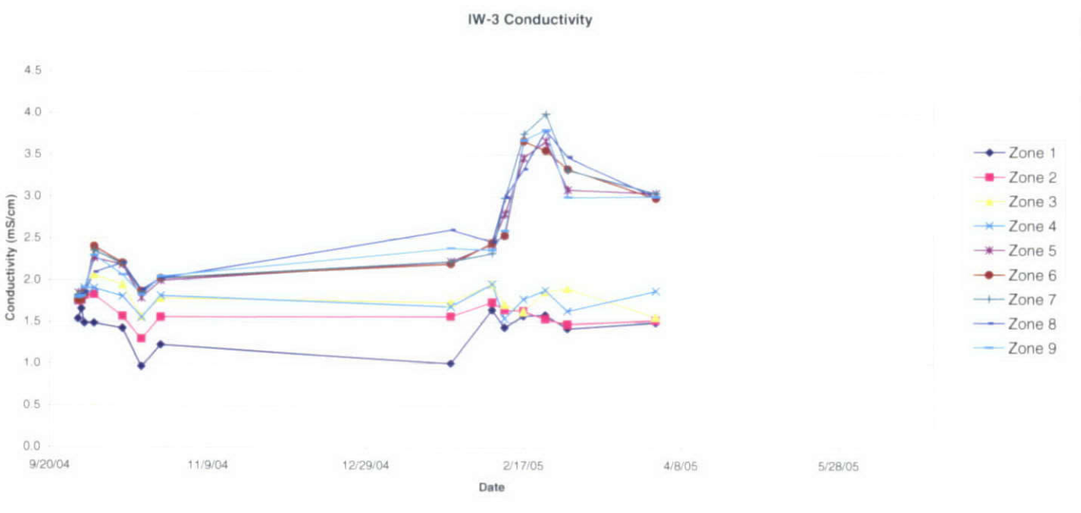
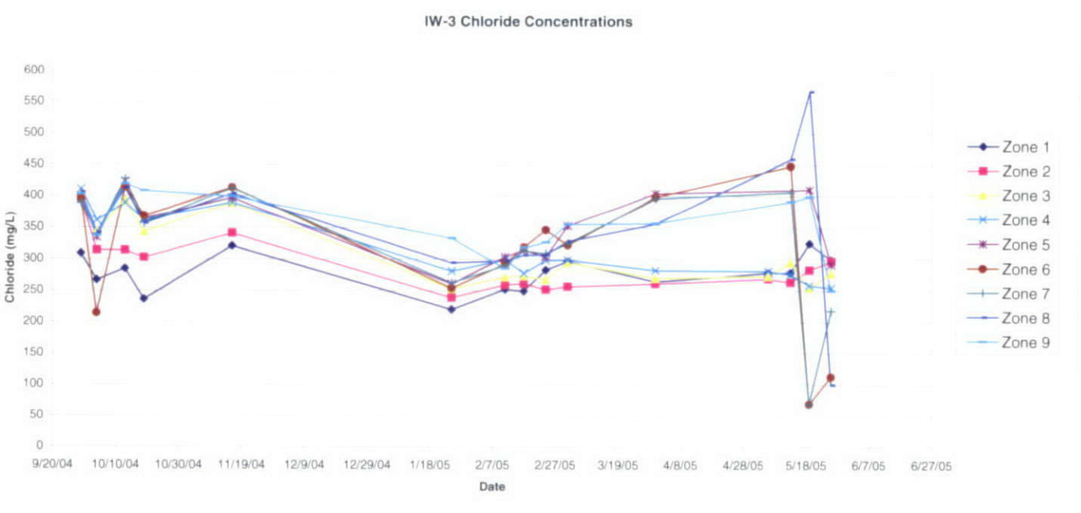
SUMMARY OF GEOCHEMICAL MONITORING AT IW-2

FIGURE 5-2









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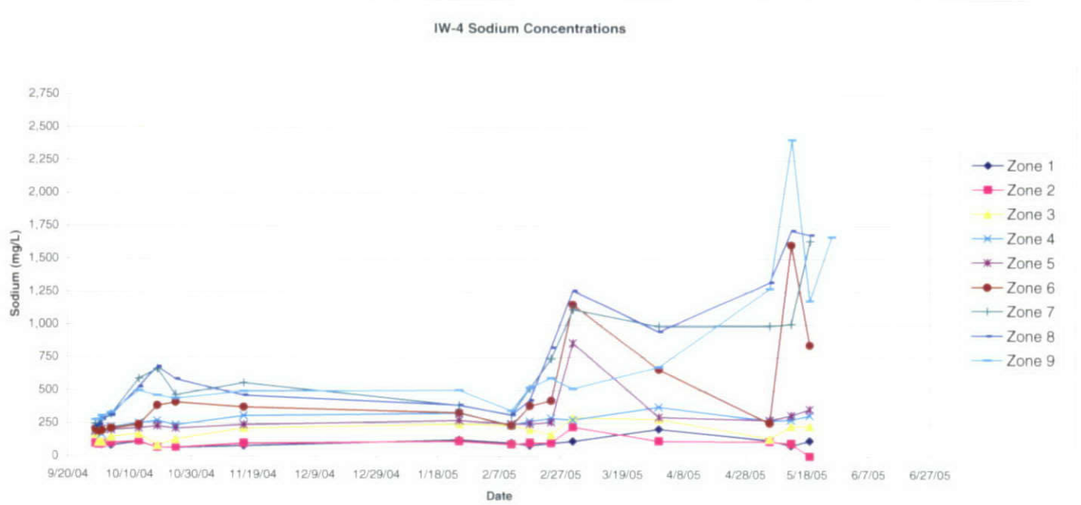
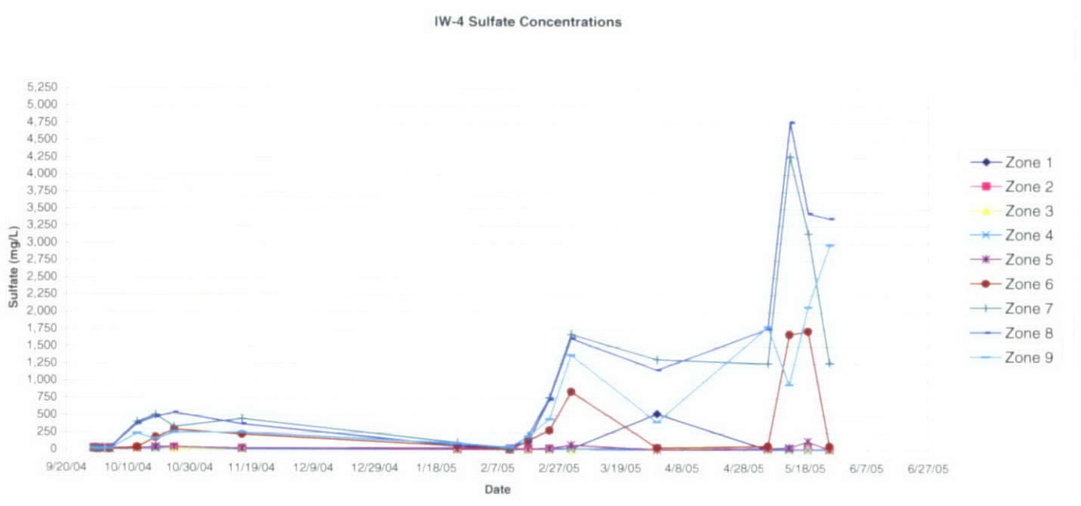
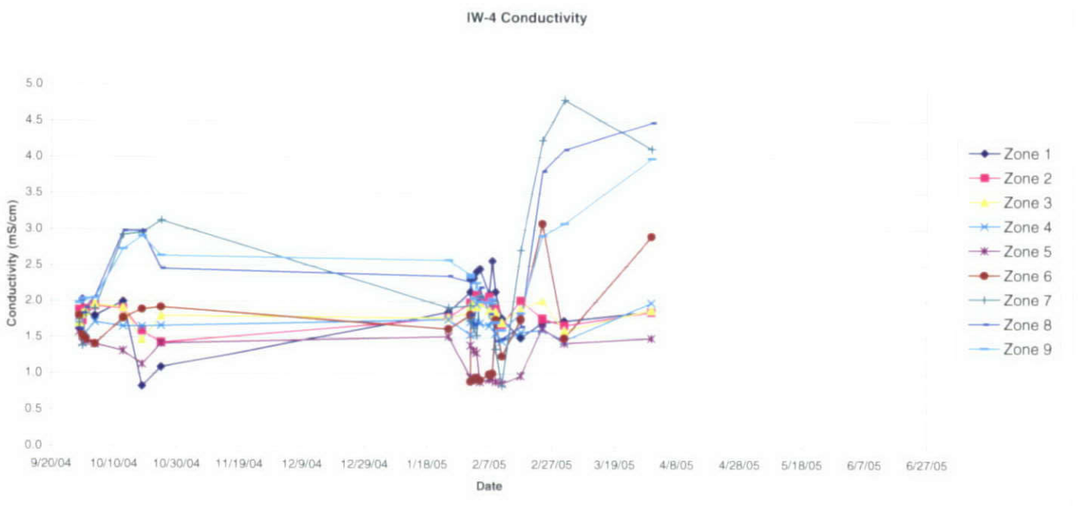
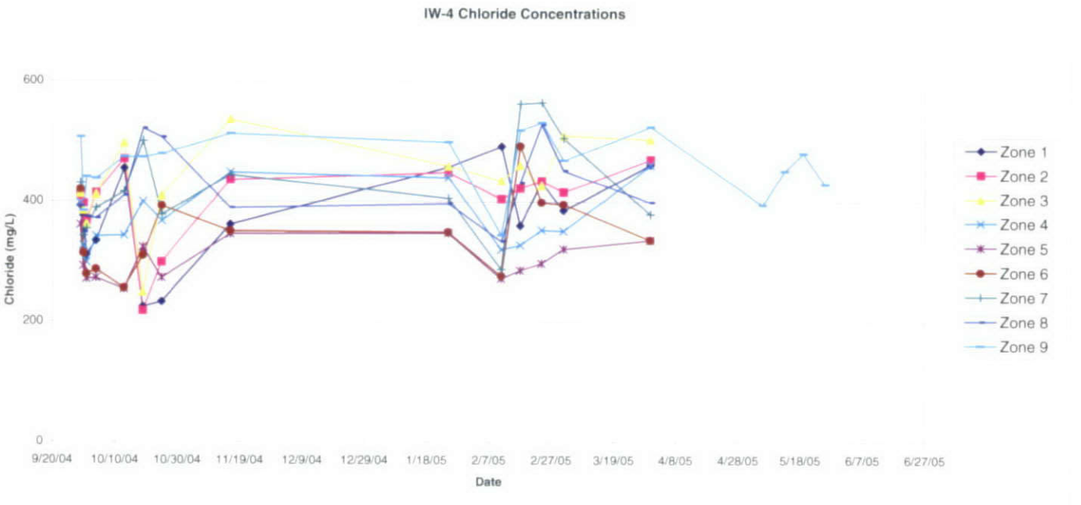
SUMMARY OF GEOCHEMICAL MONITORING AT IW-3

FIGURE 5-3









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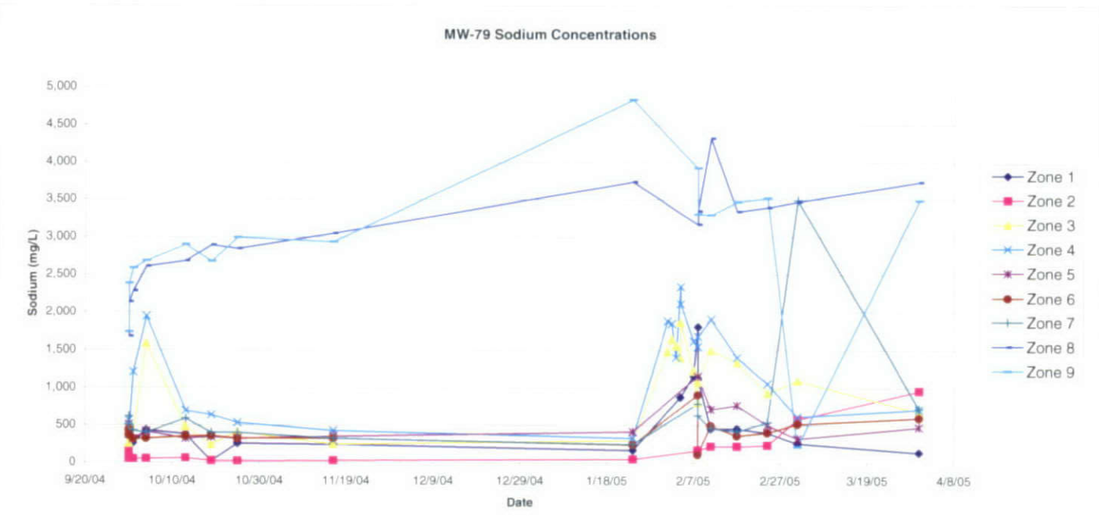
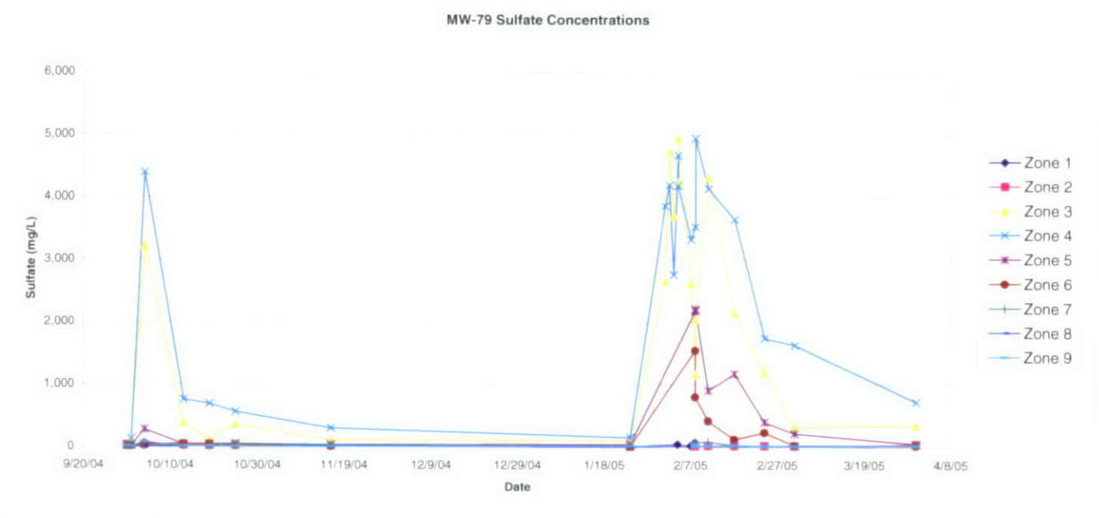
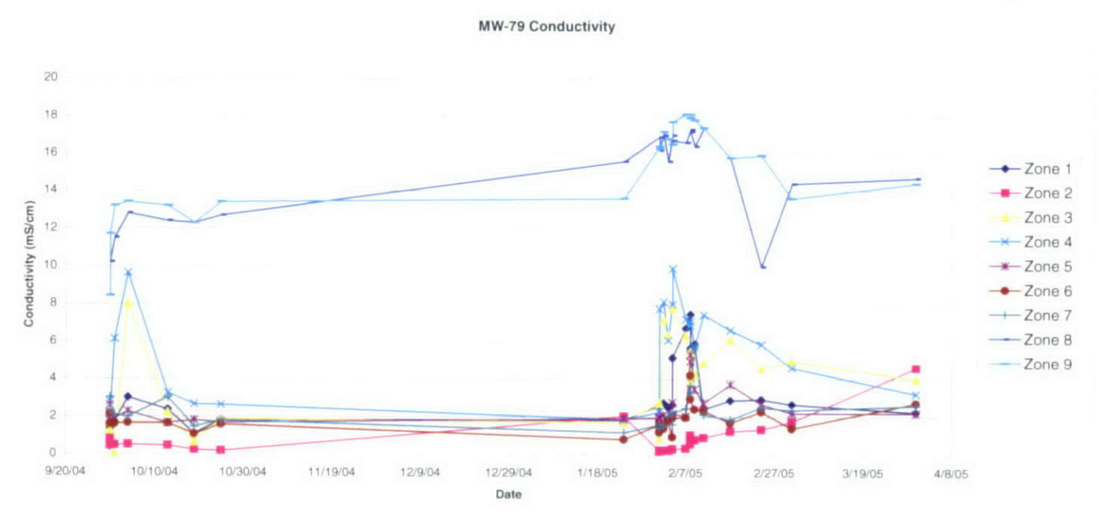
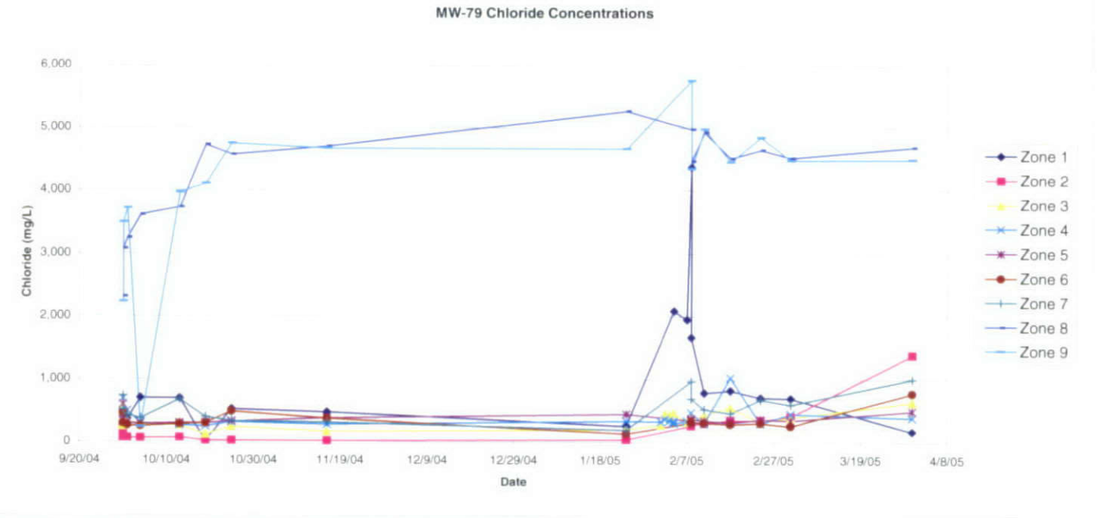
SUMMARY OF GEOCHEMICAL MONITORING AT IW-4

FIGURE 5-4









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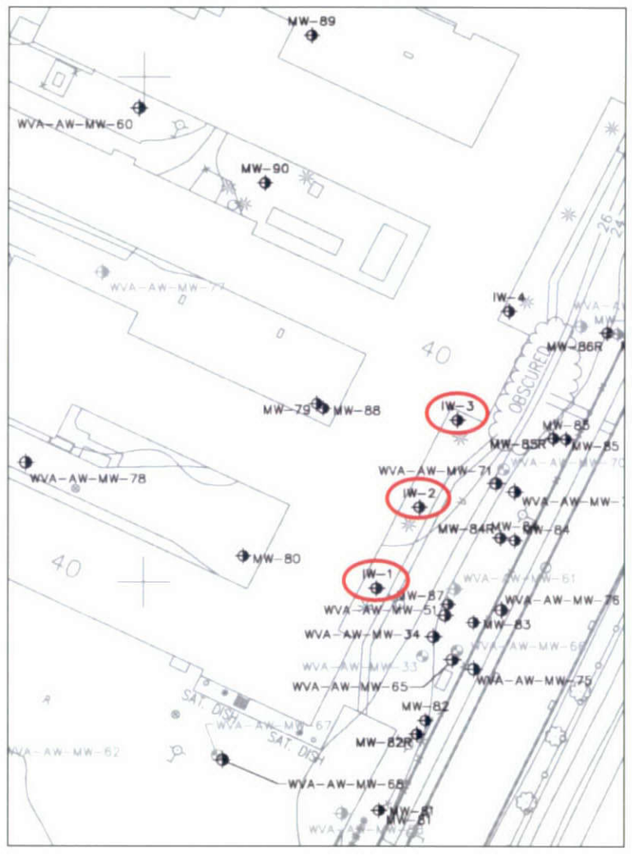
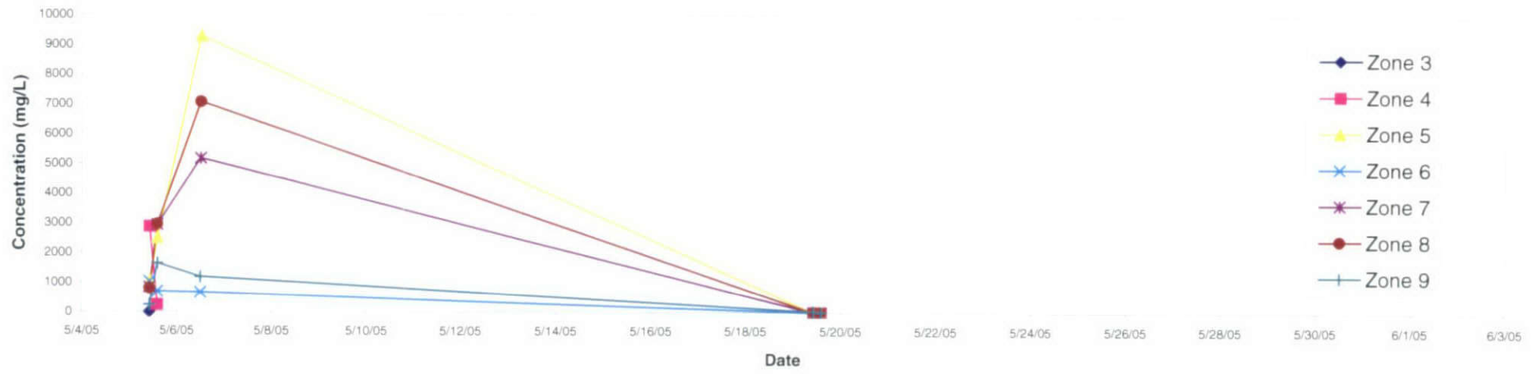
BUILDING 40 CORRECTIVE MEASURES
WATERVLIET ARSENAL, WATERVLIET, NEW YORK

SUMMARY OF GEOCHEMICAL MONITORING AT MW-79

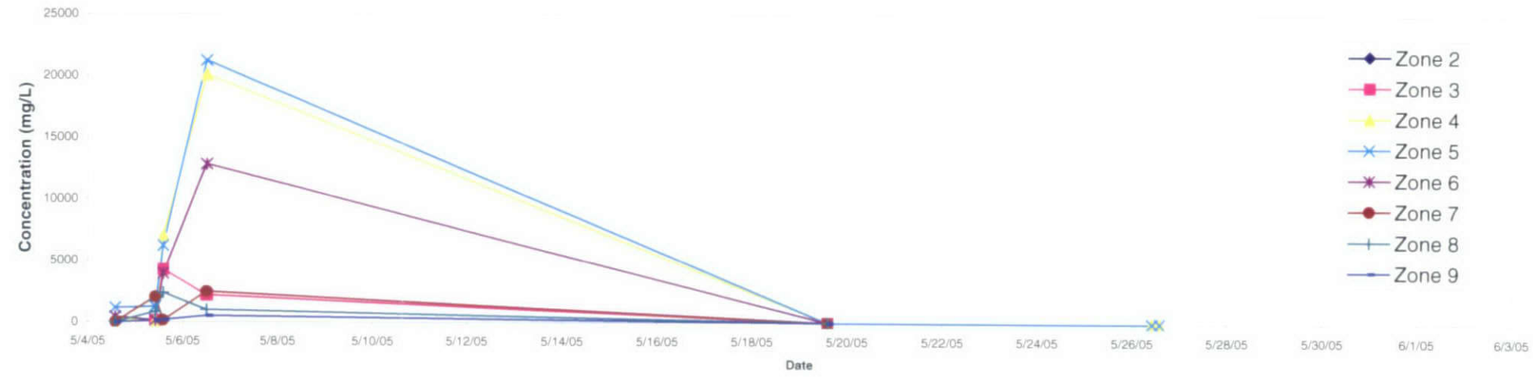
FIGURE 5-5



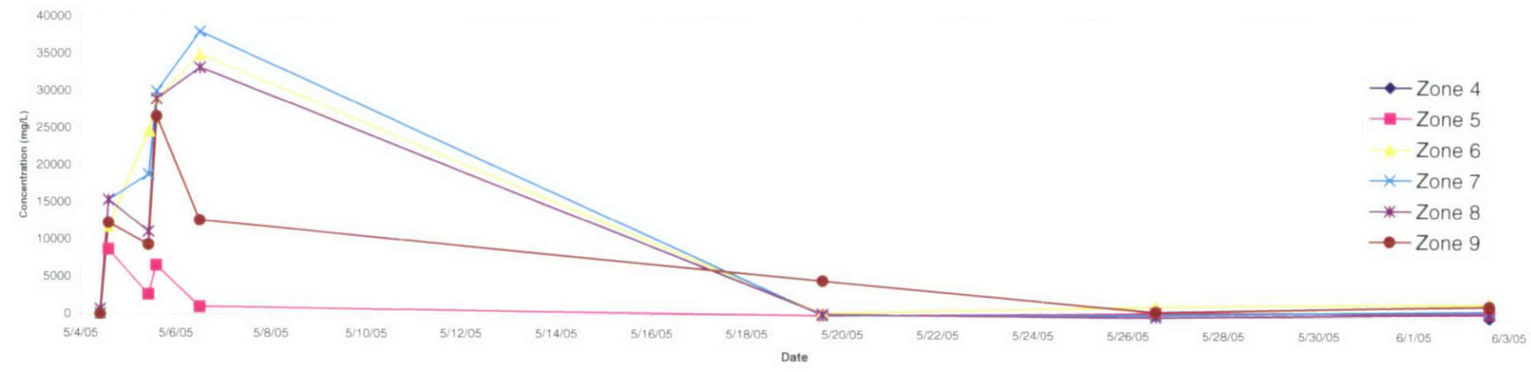
IW-1



IW-2



IW-3



Note: Vertical scales are not the same.

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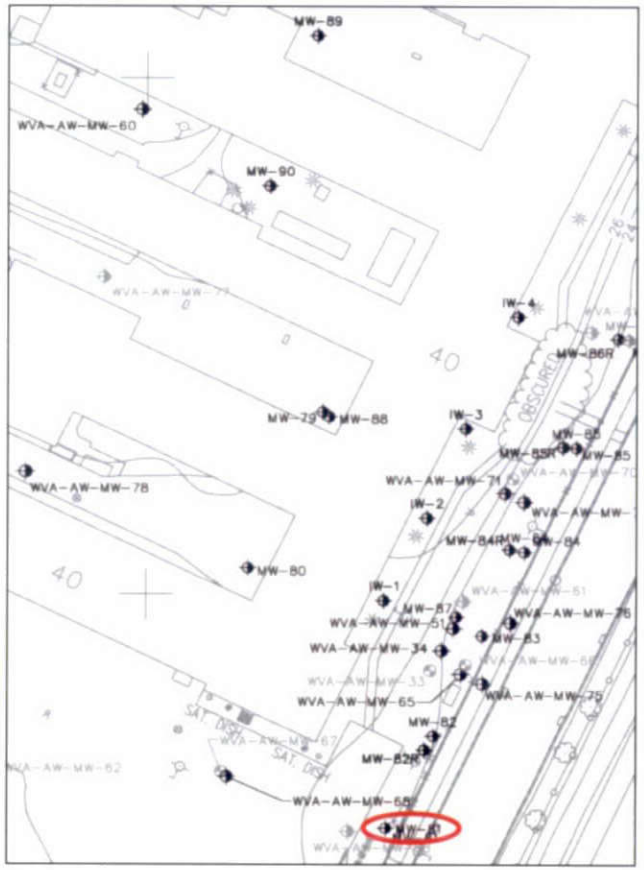
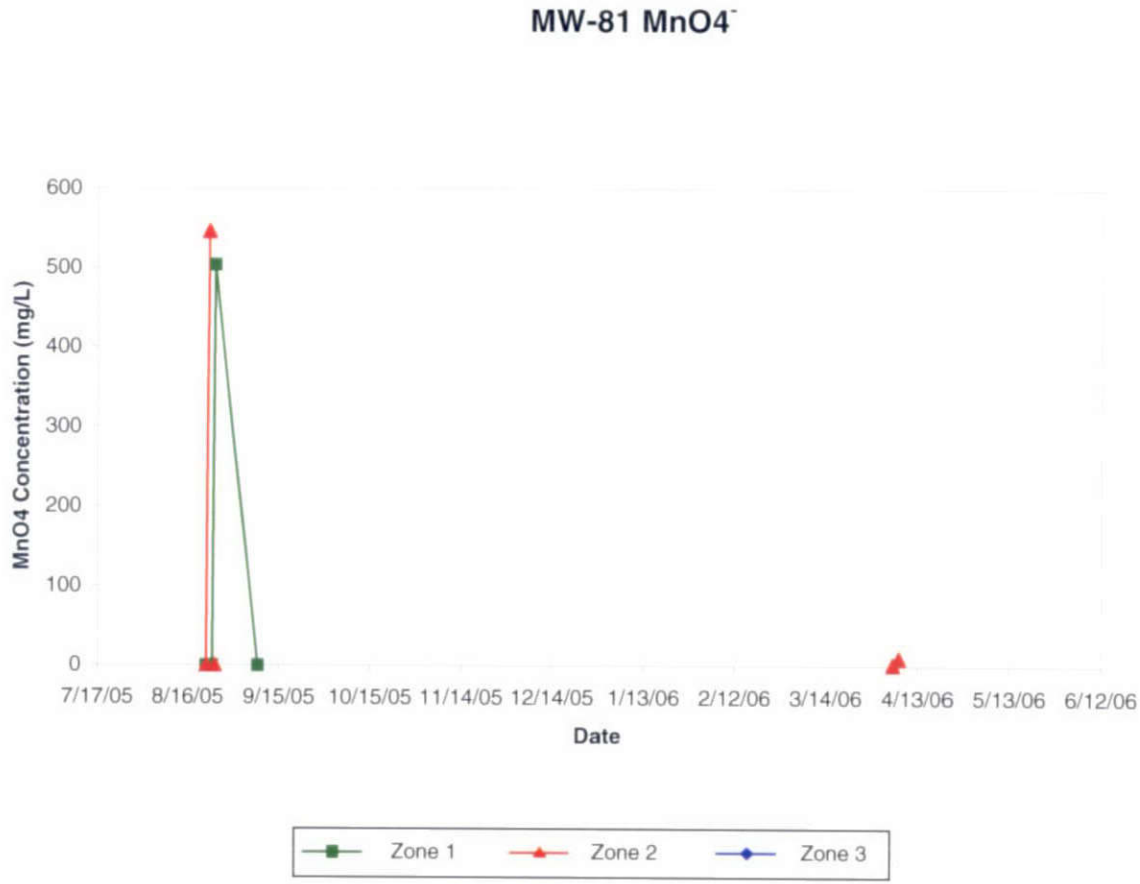
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

PERMANGANATE CONCENTRATIONS IN FLUTe WELLS IW-1, IW-2, AND IW-3

FIGURE 5-6





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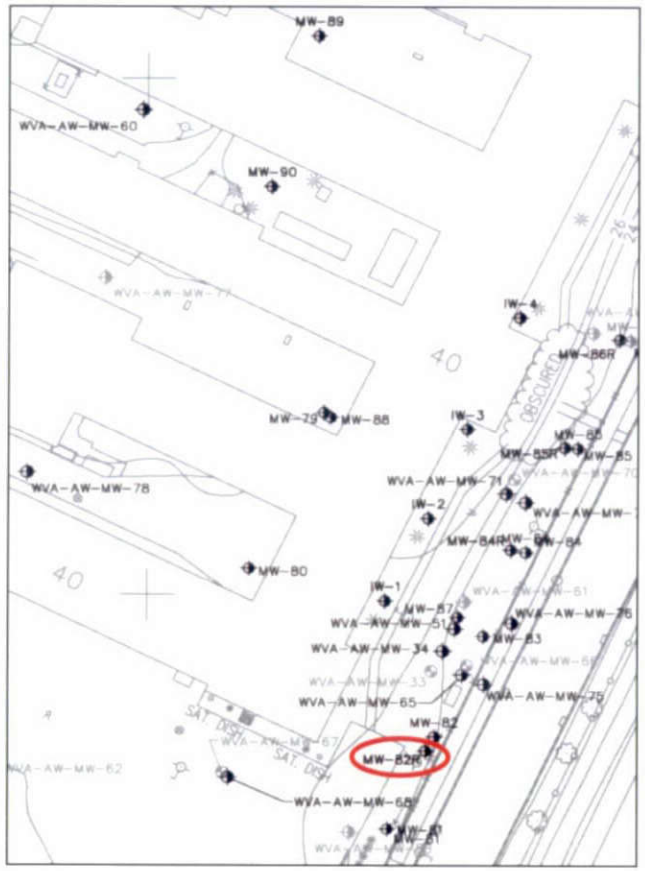
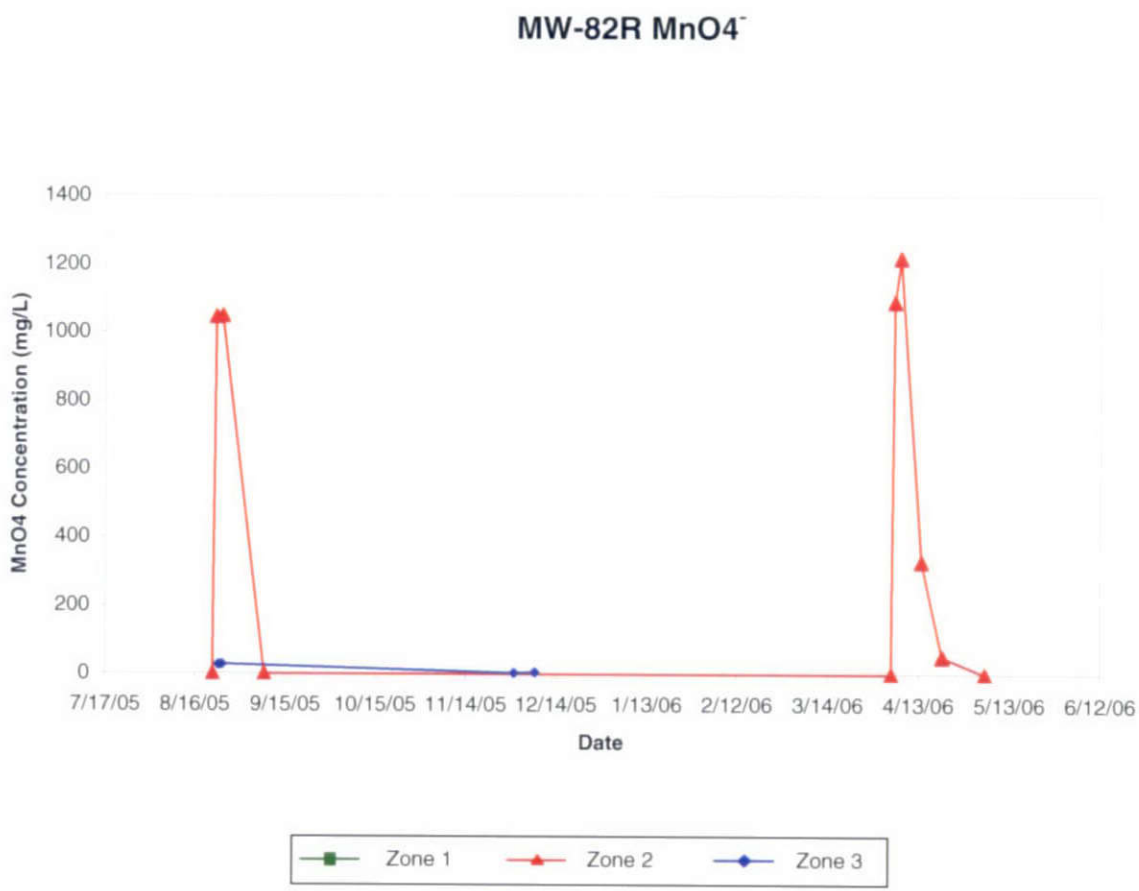
PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-81

FIGURE 5-7





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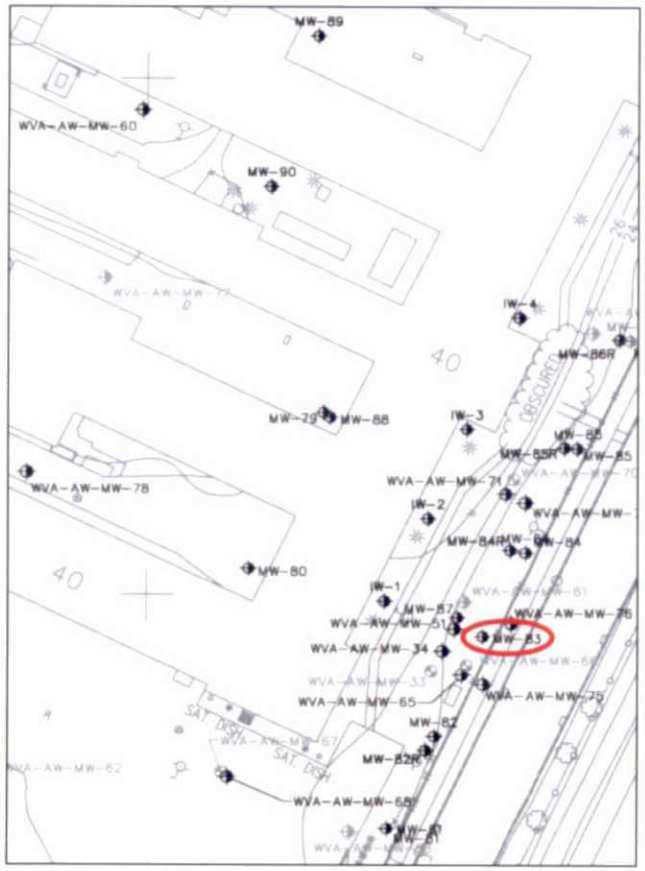
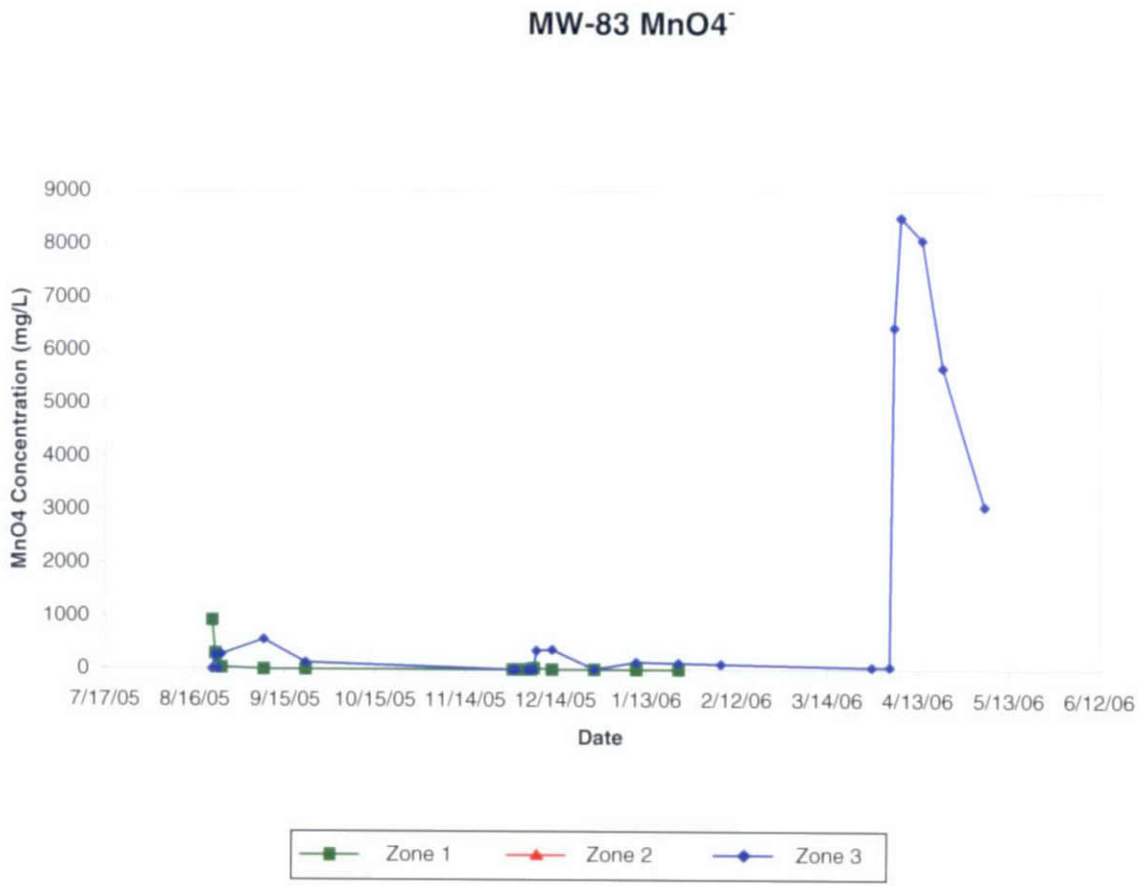
PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-82R

FIGURE 5-8





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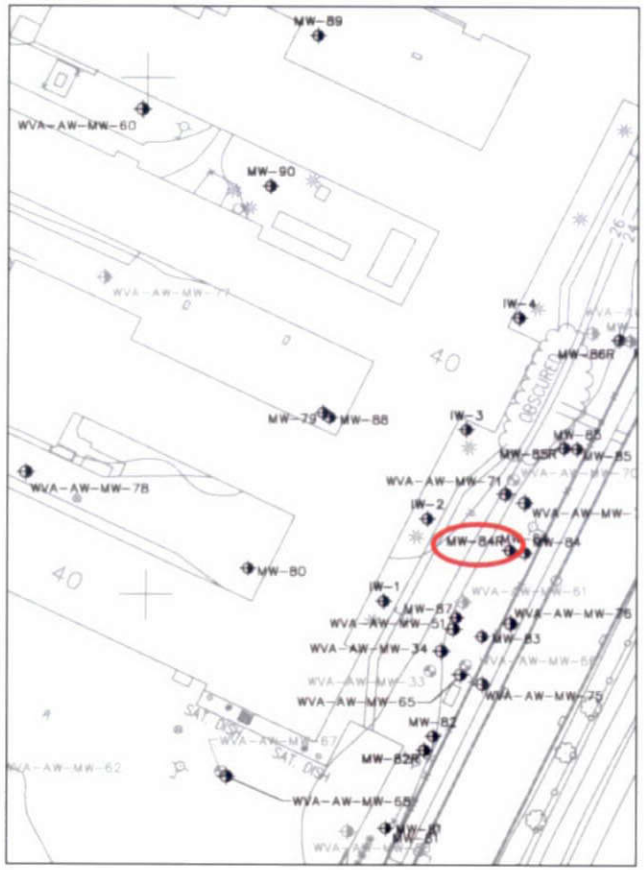
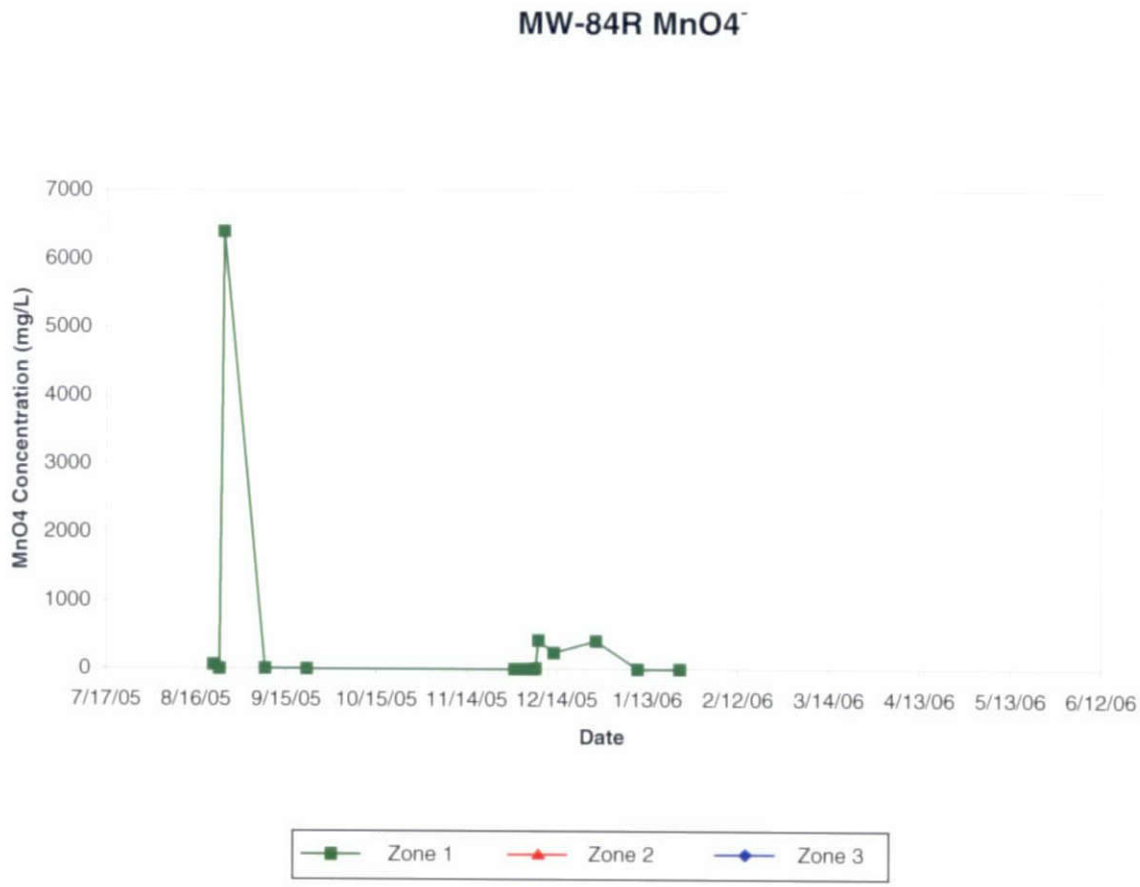
PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-83

FIGURE 5-9





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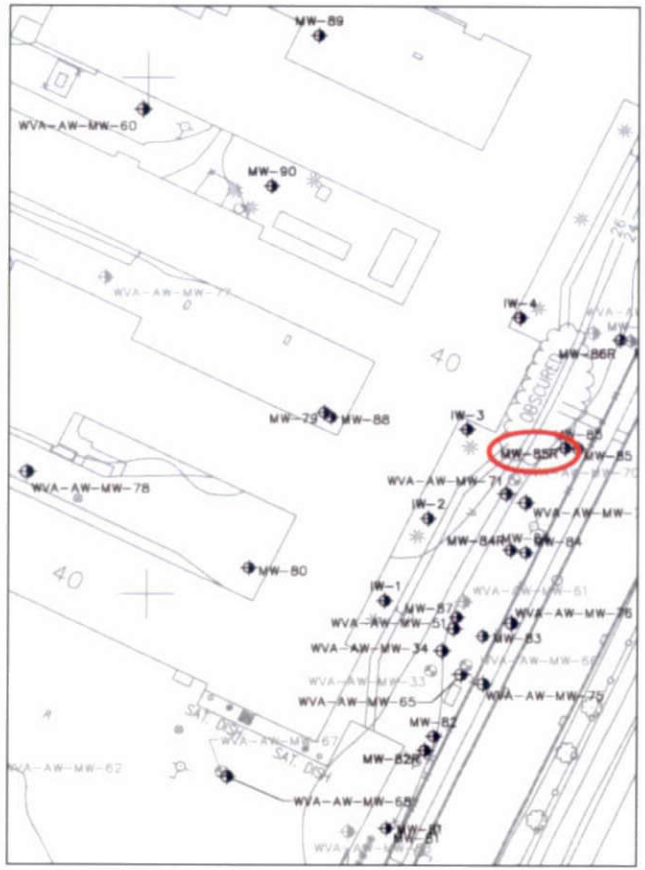
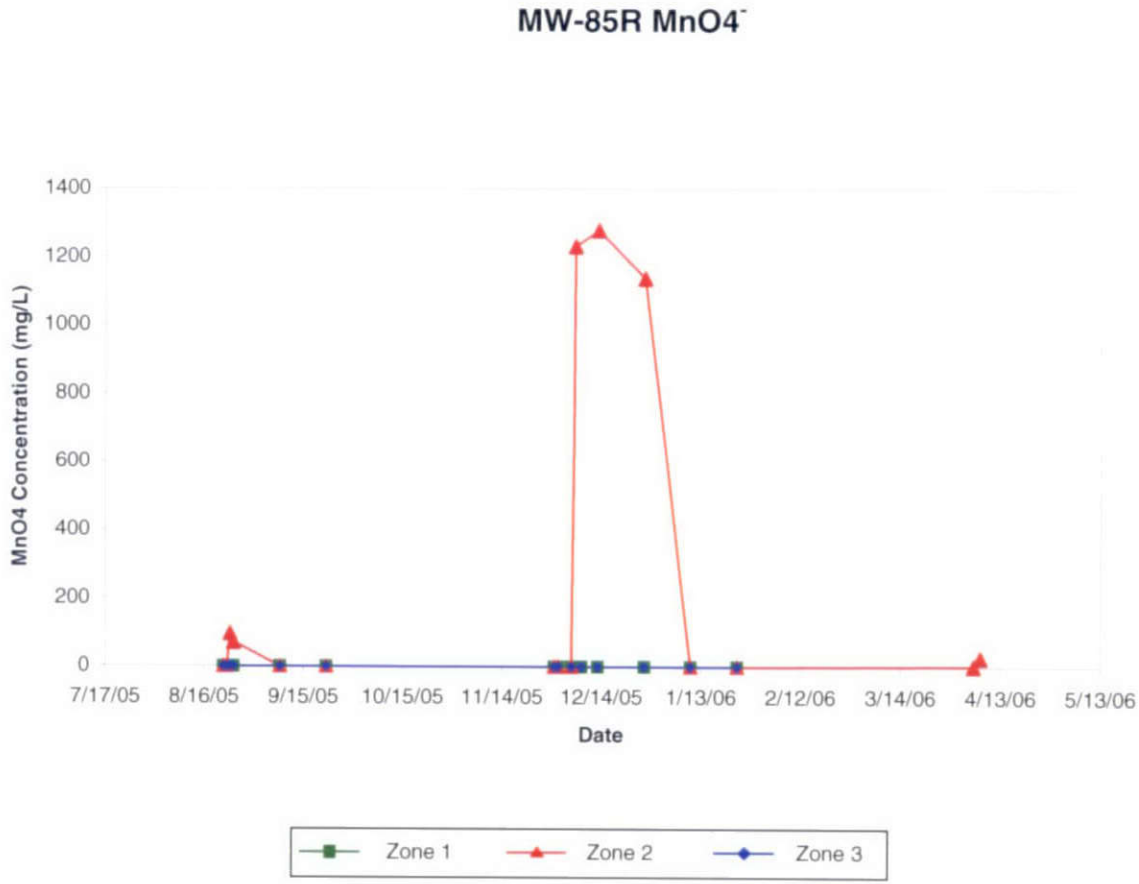
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-84R

FIGURE 5-10





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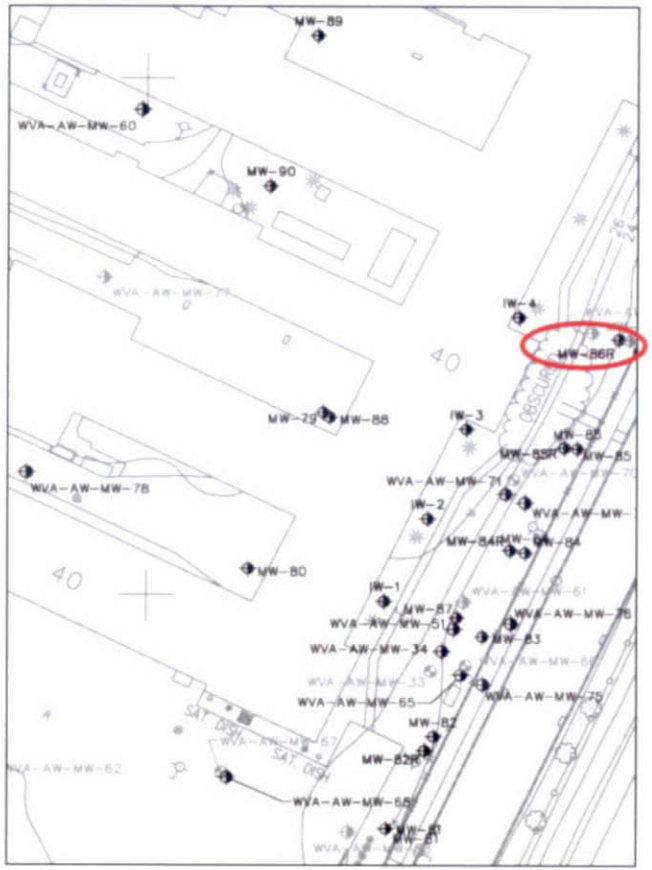
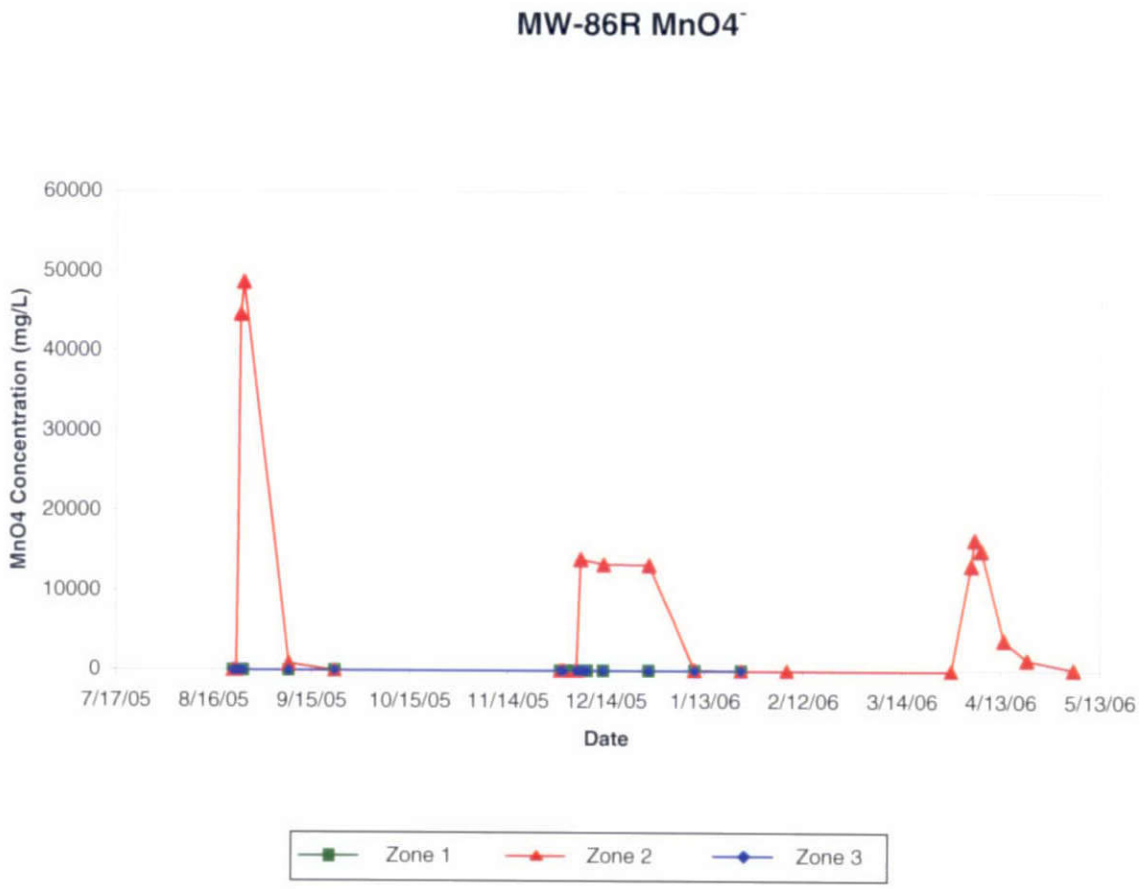
PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-85R

FIGURE 5-11





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PERMANGANATE CONCENTRATIONS IN MONITORING WELL MW-86R

FIGURE 5-12

N

30 MINUTES

3 HOURS

8 HOURS

11 HOURS

MW-89
MW-90
MW-4
MW-59
MW-79
MW-3
MW-2
MW-80
MW-1
MW-87
MW-51
MW-34
MW-58

APPROXIMATE SCALE

0 30 60 120 180 240 300

Feet

LEGEND

DRAWDOWN (FEET)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 22.55

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BUILDING 40 CORRECTIVE MEASURES
WATERVLIET ARSENAL, WATERVLIET, NEW YORK

INTEGRATED MASS DISCHARGE TEST DRAWDOWN (NO MULTI-LEVEL WELLS) – SEPTEMBER 24, 2004

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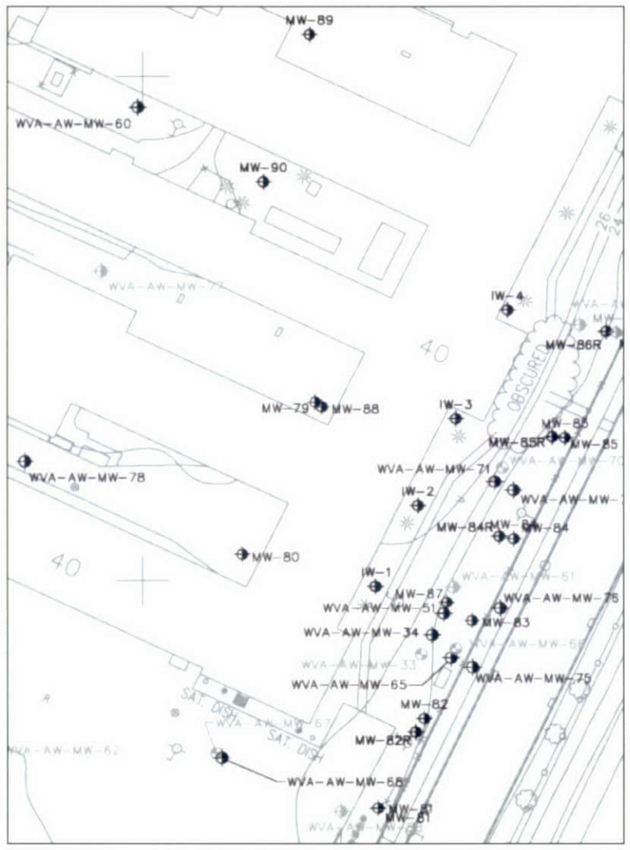
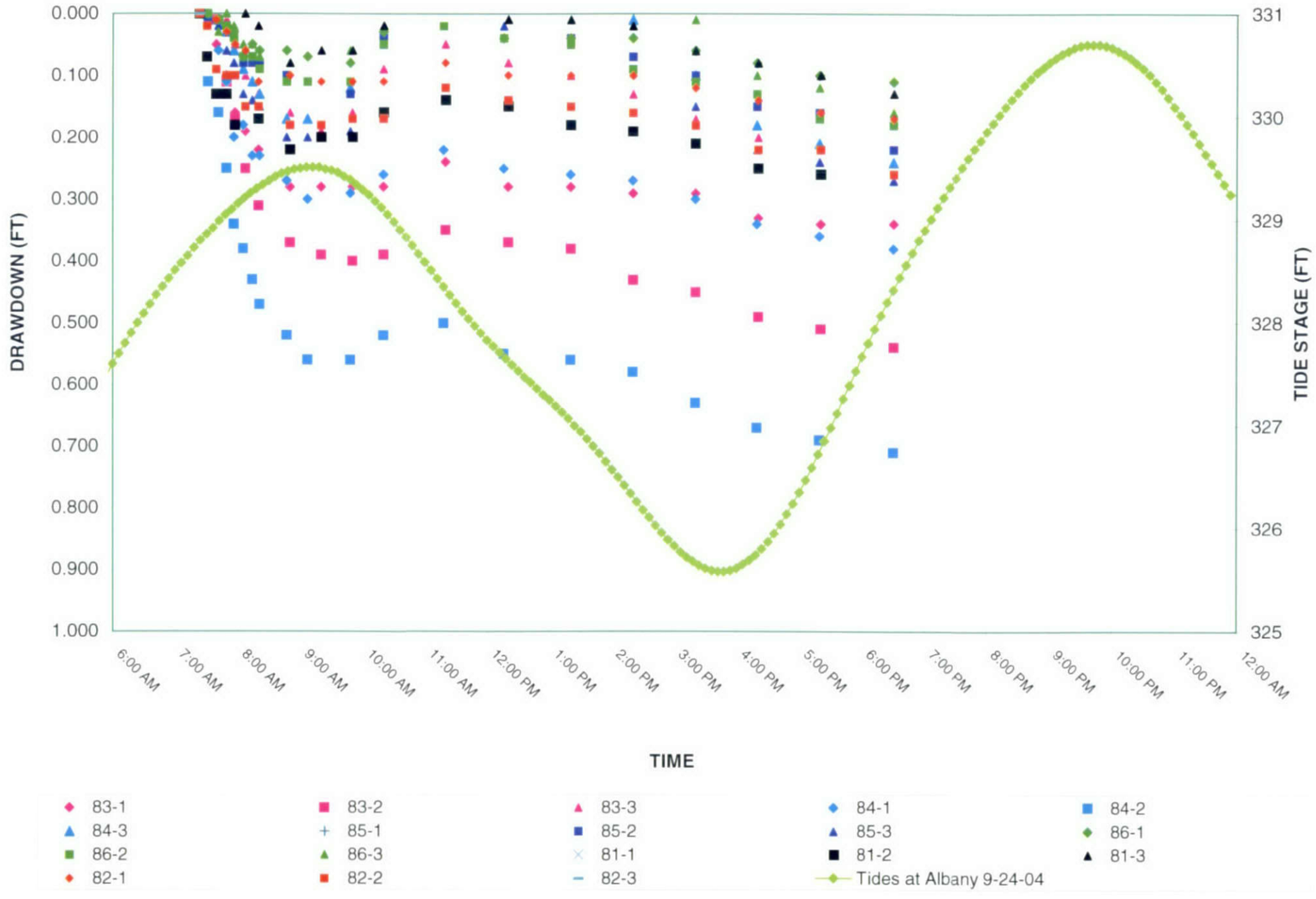
FIGURE 6-1





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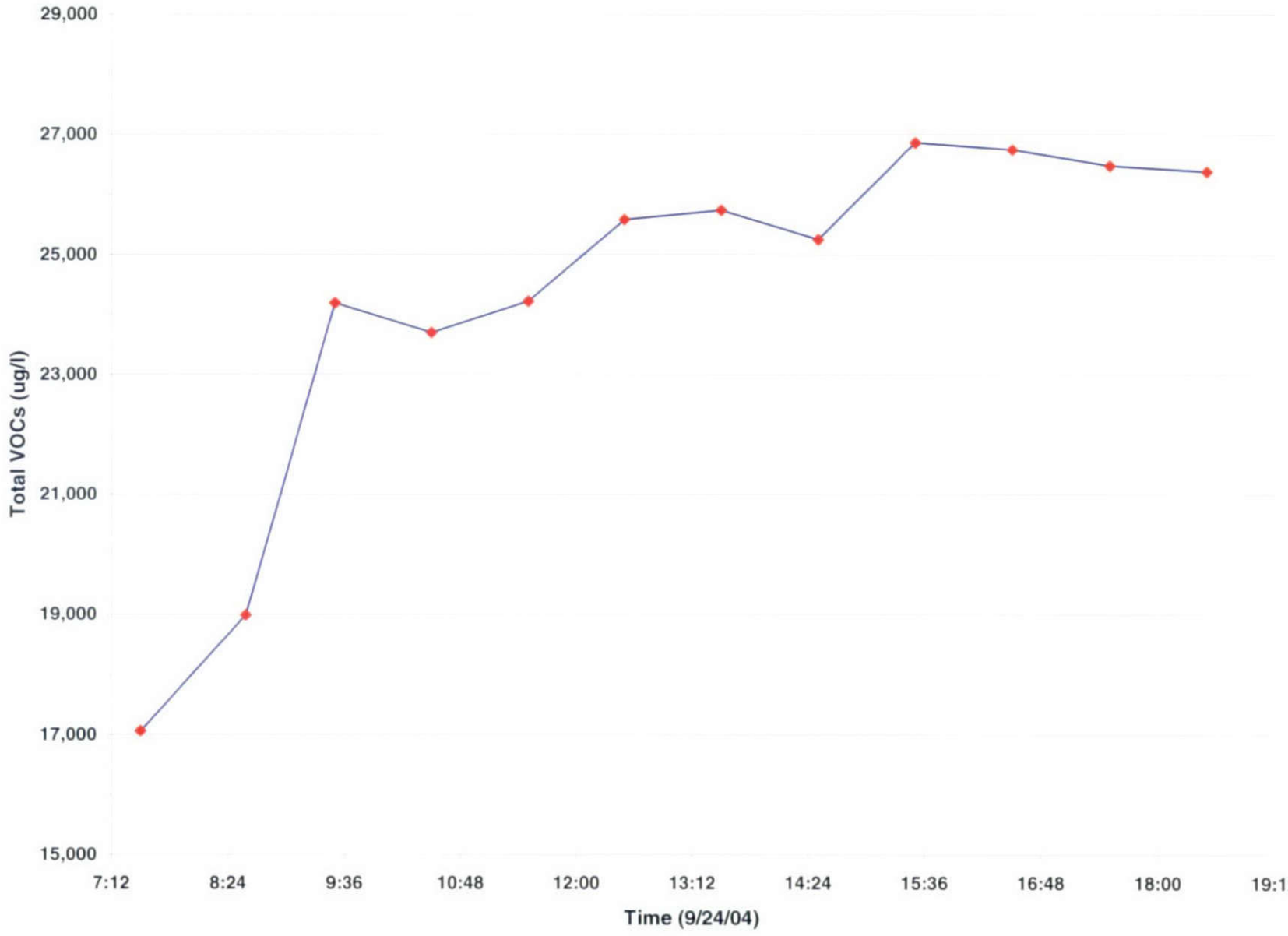
CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

INTEGRATED MASS DISCHARGE TEST DRAWDOWN VS. HUDSON RIVER TIDES

FIGURE 6-2



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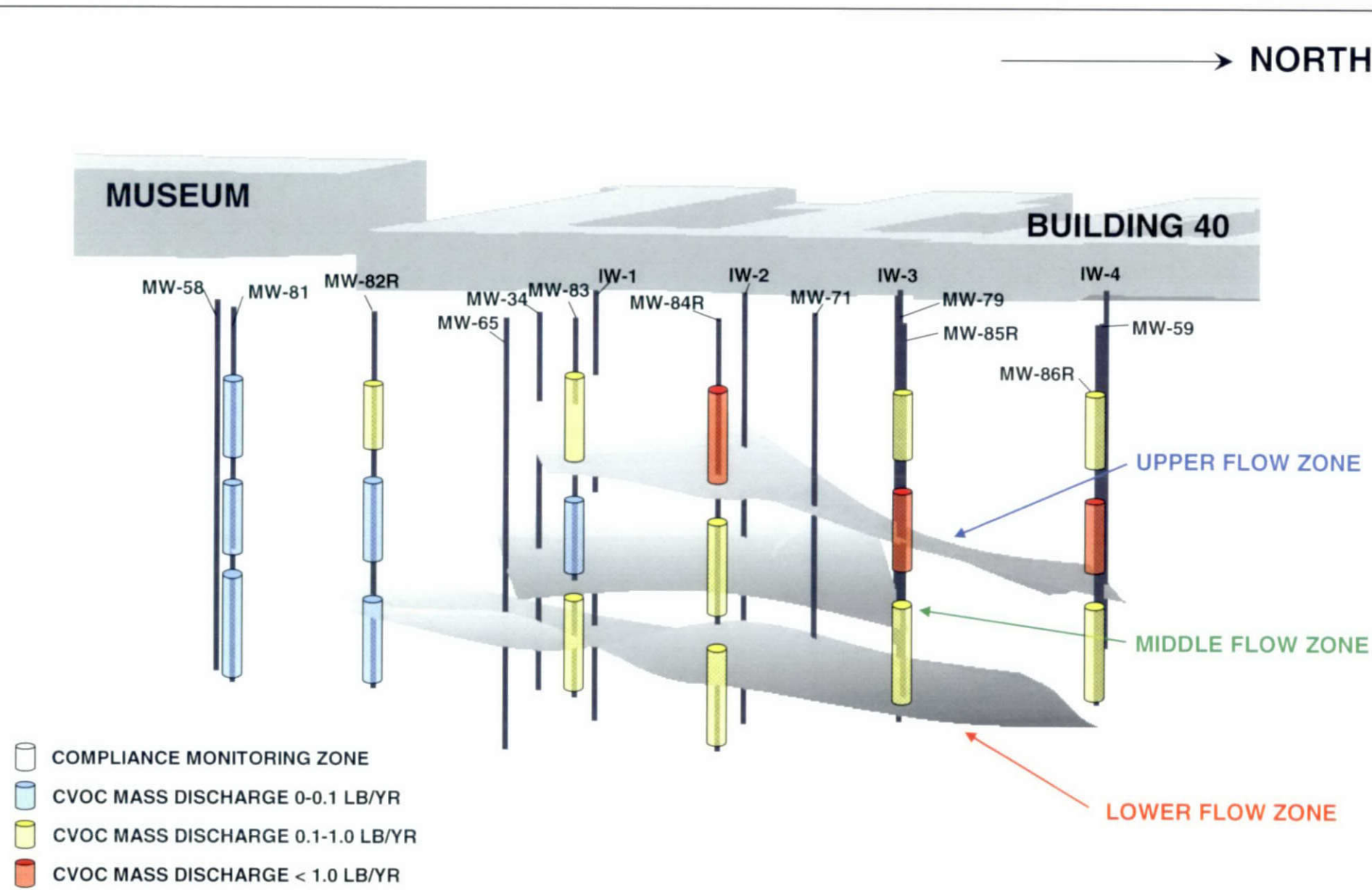
BUILDING 40 CORRECTIVE MEASURES
WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TOTAL VOCs VS. TIME IN IW-2 PUMP DISCHARGE

FIGURE 6-3



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WATERVLIET ARSENAL, WATERVLIET, NEW YORK

BASELINE CVOC MASS DISCHARGE IN COMPLIANCE MONITORING ZONES

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FIGURE 6-4

Table 2-1
USGS Geophysical Testing Results Summary
Building 40 Injection Wells
Watervliet Arsenal, Watervliet, New York

Intra-Borehole Testing

Well	Total Depth (feet bgs)	Well Diameter (inches)	Casing Depth (feet bgs)	Water Level (feet bgs)	Specific Capacity (gpm/foot)	Pumping Rate (gpm)	Drawdown (feet)	Duration (minutes)
IW-1	150	6	24	13.56	0.62	1.7	2.73	53
IW-2	150	6	24	13.77	0.08	0.45	5.88	54
IW-3	150	6	19	13.19	0.06	0.56	9*	68
IW-4	150	6	18	13.58	0.68	1.25	1.84	59
MW-79	150	4	17.5	14.94	0.31	0.75	2.41	51

Calculated Transmissivities

Well	Fracture Depth (feet bgs)	Transmissivity ($feet^2$/day)	Water Level (feet bgs)
IW-1	25	42	14.28
	61	21	13.08
	71	42	13.08
	113**	<1	
IW-2	24	7	14.54
	49	4	13.54
	80	2	11.54
	115**	<0.1	
IW-3	22	8.5	13.73
	81	1	12.33
	101	1.5	10.73
IW-4	21	14	13.25
	81	13.5	13.13
MW-79	18	12.5	15.51
	82	50	14.81
	122	6	14.86

Notes:
bgs: below ground surface
gpm: gallons per minute
* Water level did not stabilize during test.
** Fracture identified by fluid logs.

Table 2-2
Distribution of Fractures in Monitoring and Injection Wells
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

	SOUTH															*NORTH*
Depth (ft AMSL)	MW-58	81	82R	MW-34	MW-65	IW1	83	IW2	84R	79	IW3	MW-71	85R	IW4	86R	MW-59
20																
10										7.42						
0		-4.53	-3.19	-6.44	-5.43	-1.53	-6.59	-0.75			1.17	-7.24	-4.03	-0.69	-5.82	
-10			-17.19		-16.43		-13.59		-10.17							
-20								-25.75								
-30						-37.53	-31.59		-30.17							
-40			-47.19			-47.53						-44.24				
-50	-55.46	-58.73	-55.19		-59.43			-56.75		-56.58	-56.83		-50.03			
-60					-69.43								-58.03		-66.82	
-70			-73.19					-69.75	-72.17		-79.83			-70.69	-74.82	-71.83
-80		-89.53							-82.17							
-90					-91.43	-88.53	-92.59	-91.75	-99.17							
-100													-106.03			
-110															-115.82	
-120																
-130																

Notes:
ft AMSL - feet above mean sea level
Fracture in Upper Flow Zone
Fracture in Middle Flow Zone
Fracture in Lower Flow Zone

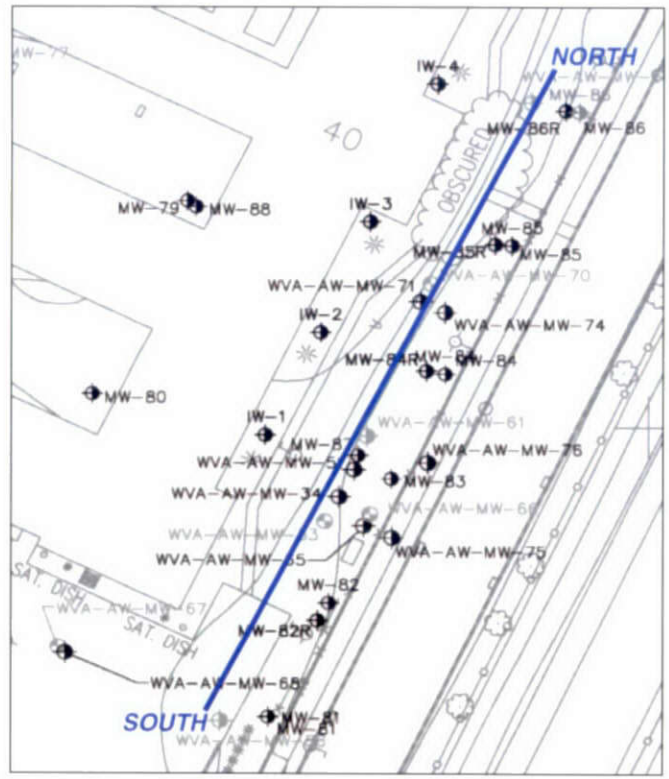

Table 3-1
Summary of Compliance Boundary Monitoring Well Construction
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

Monitoring Well	Casing Depth (feet bgs)	Description	Interval (feet bgs)	Length of Interval (feet)	Screen Interval (feet bgs)	Screen Length (feet)
MW-81	23	Zone 1 Bentonite Seal	18-23	5		
		Sand 1	23-60	37	29-59	30
		Zone 2 Bentonite Seal	60-65	5		
		Sand 2	65-101	36	70-100	30
		Zone 3 Bentonite Seal	101-106	5		
		Sand 3	106-150	44	109-149	40
MW-82R	21	Zone 1 Bentonite Seal	16-21	5		
		Sand 1	21-58	37	27-57	30
		Zone 2 Bentonite Seal	58-63	5		
		Sand 2	63-103	40	67-102	35
		Zone 3 Bentonite Seal	103-108	5		
		Sand 3	108-150	42	114-149	35
MW-83	19	Zone 1 Bentonite Seal	14-19	5		
		Sand 1	19-60	41	24-59	35
		Zone 2 Bentonite Seal	60-65	5		
		Sand 2	65-101	36	70-100	30
		Zone 3 Bentonite Seal	101-106	5		
		Sand 3	106-150	44	109-149	40
MW-84R	22	Zone 1 Bentonite Seal	17-22	5		
		Sand 1	22-60	38	24-59	35
		Zone 2 Bentonite Seal	60-65	5		
		Sand 2	65-106	41	70-105	35
		Zone 3 Bentonite Seal	106-111	5		
		Sand 3	111-150	39	114-149	35
MW-85R	23	Zone 1 Bentonite Seal	18-23	5		
		Sand 1	23-58	35	27-57	30
		Zone 2 Bentonite Seal	58-63	5		
		Sand 2	63-103	40	67-102	35
		Zone 3 Bentonite Seal	103-108	5		
		Sand 3	108-150	42	114-149	35
MW-86R	24	Zone 1 Bentonite Seal	19-24	5		
		Sand 1	24-60	36	29-59	30
		Zone 2 Bentonite Seal	60-65	5		
		Sand 2	65-103	38	72-102	30
		Zone 3 Bentonite Seal	103-108	5		
		Sand 3	108-150	42	114-149	35

Notes:
bgs - below ground surface

Table 3-2
Water Flute Multi-Level Monitoring Well Construction
Building 40
Watervliet Arsenal, Watervliet, New York

Well: Diameter (nominal): Casing Depth (ft. bgs):	IW-1 6-inch 24	IW-1 Flow Zones	IW-2 6-inch 24	IW-2 Flow Zones	IW-3 6-inch 20	IW-3 Flow Zones	IW-4 6-inch 18	IW-4 Flow Zones	MW-79 4-inch 18	MW-79 Flow Zones
1	25 - 35	25	25 - 35	24	18 - 28	22	17 - 27	20-26	17 - 27	18
2	40 - 50		40 - 50	49	33 - 43		32 - 42		32 - 42	
3	55 - 65	61	55 - 65		48 - 58		47 - 57		47 - 57	
4	70 - 80	71	70 - 80	80	63 - 73		62 - 72		62 - 72	
5	85 - 95		85 - 95	93	78 - 88	78 - 83	77 - 87		77 - 87	82
6	100 - 110	112	100 - 110		93 - 103	101 - 105	92 - 102	94	92 - 102	
7	115 - 125		115 - 125	115	108 - 118		107 - 117		107 - 117	
8	130 - 140		130 - 140		123 - 133		122 - 132		122 - 132	
9	145 - 150		145 - 150		138 - 148		137 - 147		137 - 147	

Notes:
As installed in September 2004.
ft. bgs: feet below ground surface
All wells are completed with flush mount well covers.

Table 4-1
Compliance Monitoring Summary
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

Monitoring Wells	Analyses (Method)
MW-81	VOCs (USEPA 8260B)
MW-82R	Sulfate (USEPA 300.0)
MW-83	Potassium (USEPA 6010B)
MW-84R	Sodium (USEPA 6010B)
MW-85R	Specific Conductance (Field)
MW-86R	pH (Field)
MW-34	Turbidity (Field)
MW-51	
MW-60	
MW-80	
MW-87	
MW-89	

Table 4-2
Summary of Baseline Monitoring Results - Injection Wells IW-1,2,3,4
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	Units	IW-1 08/31/04	IW-2 08/30/04	IW-3 08/31/04	IW-4 08/30/04
Chloromethane	ug/L	14 U	280 U	70 U	7 U
Vinyl chloride	ug/L	**240**	**640 J**	**470**	**5 J**
Bromomethane	ug/L	27 U	540 U	140 U	14 U
Chloroethane	ug/L	17 U	340 U	85 U	8 U
1 1-Dichloroethene	ug/L	8 U	160 U	40 U	4 U
Carbon disulfide	ug/L	4 U	80 U	20 U	2 U
Acetone	ug/L	20 UB	400 UB	100 UB	10 U
Methylene chloride	ug/L	6 U	120 U	30 U	3 U
trans-1 2-Dichloroethene	ug/L	5 U	100 U	25 U	2 U
1 1-Dichloroethane	ug/L	4 U	80 U	20 U	2 U
cis-1 2-Dichloroethene	ug/L	**1100**	**5600**	**4500**	**170**
2-Butanone (MEK)	ug/L	16 U	320 U	80 U	8 U
Chloroform	ug/L	6 U	120 U	30 U	3 U
1 1 1-Trichloroethane	ug/L	9 U	180 U	45 U	4 U
Carbon tetrachloride	ug/L	6 U	120 U	30 U	3 U
Benzene	ug/L	5 U	100 U	25 U	2 U
1 2-Dichloroethane	ug/L	6 U	120 U	30 U	3 U
Trichloroethene	ug/L	**65**	**2200**	**680**	**27**
1 2-Dichloropropane	ug/L	7 U	140 U	35 U	4 U
Bromodichloromethane	ug/L	7 U	140 U	35 U	4 U
cis-1 3-Dichloropropene	ug/L	4 U	80 U	20 U	2 U
4-Methyl-2-pentanone (MIBK)	ug/L	9 U	180 U	45 U	4 U
Toluene	ug/L	4 U	80 U	20 U	2 UB
trans-1 3-Dichloropropene	ug/L	8 U	160 U	40 U	4 U
1 1 2-Trichloroethane	ug/L	8 U	160 U	40 U	4 U
Tetrachloroethene	ug/L	**200**	**19000**	**2000**	**400**
2-Hexanone	ug/L	7 U	140 U	35 U	4 U
Dibromochloromethane	ug/L	5 U	100 U	25 U	2 U
Chlorobenzene	ug/L	5 U	100 U	25 U	2 U
Ethylbenzene	ug/L	5 U	100 U	25 U	2 U
Styrene	ug/L	7 U	140 U	35 U	4 U
Bromoform	ug/L	8 U	160 U	40 U	4 U
1 1 2 2-Tetrachloroethane	ug/L	7 U	140 U	35 U	4 U
Xylenes (total)	ug/L	9 U	180 U	45 U	4 U
TOTAL VOCs	**ug/L**	**1605**	**27440**	**7650**	**602**

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Table 5-1
Permanganate Injection Summary
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

Injection No.	Date	Injection Location	Permanganate Concentration	Amount Injected (gallons)	Monitored Locations Where Permanganate Observed
1	9/30/05-10/1/05	MW-90	10%	2,000	Not observed
2	1/31/05 - 2/11/05	MW-90	10%	4,000	Not observed
3	5/3/05 - 5/5/05	MW-79 (lower)	5%	4,000	IW-1, IW-2, IW-3
3a	7/6/05 - 7/7/05	MW-79 (upper)	5%	2,000	MW-80
4	8/15/05 - 8/17/05	MW-79; IW-1,2,3,4	5%	4,000	MW-80,81,82R,83,84R,85R,86R
5	11/29/05 - 12/1/05	MW-79; IW-1,2,3,4	5%	4,000	MW-80, 82R,83,84R,85R,86R

Table 5-3
Summary of Permanganate Presence and Concentration
August and December 2005 Injections
Watervliet Arsenal, Watervliet, New York

	Date	MW-81-1	MW-81-2	MW-81-3	MW-82R-1	MW-82R-2	MW-82R-3	MW-83-1	MW-83-2	MW-83-3
Injection No. 4	8/22/05							922.3		
	8/23/05		546.7			1047.6		296.3		265.7
	8/24/05						26.1			
	8/25/05	503.9				1050.6	26.9	28.0		274.9
	9/8/05									561.5
	9/22/05									123.7
	11/30/05						3			
	12/1/05									
Injection No. 5	12/5/05									
	12/6/05									
	12/7/05						5	22		
	12/8/05									354
	12/13/05							0		370
	12/27/05									9
	1/10/06									136
	1/24/06									118
	2/7/06									103

Notes:
Permanganate visually observed.
Orange color visually observed.
Permanganate concentrations in mg/L

Table 5-3
Summary of Permanganate Presence and Concentration
August and December 2005 Injections
Watervliet Arsenal, Watervliet, New York

	Date	MW-84R-1	MW-84R-2	MW-84R-3	MW-85R-1	MW-85R-2	MW-85R-3	MW-86R-1	MW-86R-2	MW-86R-3
Injection No. 4	8/22/05	62.3								
	8/23/05									
	8/24/05					95.9			44617.8	
	8/25/05	6403.6				70.8			48700.2	
	9/8/05	2.9							882.3	
	9/22/05									
	11/30/05									
	12/1/05									
Injection No. 5	12/5/05									
	12/6/05					1233			14044.00	
	12/7/05	8								
	12/8/05	421								
	12/13/05	237				1279			13386	
	12/27/05	413				1139			13326	
	1/10/06	0							70	
	1/24/06								0	
	2/7/06								5	

Notes:
Permanganate visually observed.
Orange color visually observed.
Permanganate concentrations in mg/L

Table 6-1
Summary of Pump Discharge VOC Monitoring Results
IW-2 Integrated Mass Discharge Test
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Compounds	Units	IW-2 (9/24/04)											
Sampling Time		7:30	8:35	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30
Chloromethane	ug/L	140 U	140 U	140 U	140 U	140 U	140 U	280 U	280 U	280 U	280 U	280 U	280 U
Vinyl chloride	ug/L	640	860	860	890	780	760	770 J	710 J	710 J	700 J	720 J	640 J
Bromomethane	ug/L	270 U	270 U	270 U	270 U	270 U	270 U	540 U	540 U	540 U	540 U	540 U	540 U
Chloroethane	ug/L	170 U	170 U	170 U	170 U	170 U	170 U	340 U	340 U	340 U	340 U	340 U	340 U
1 1-Dichloroethene	ug/L	80 U	80 U	80 U	80 U	80 U	80 U	160 U	160 U	160 U	160 U	160 U	160 U
Carbon disulfide	ug/L	40 U	40 U	40 U	40 U	40 U	40 U	80 U	80 U	80 U	80 U	80 U	80 U
Acetone	ug/L	200 U	200 U	200 U	200 U	200 U	200 U	400 U	400 U	400 U	400 U	400 U	400 U
Methylene chloride	ug/L	110 JB	130 JB	130 JB	110 JB	140 JB	120 JB	270 JB	240 JB	260 JB	250 JB	260 JB	240 JB
trans-1 2-Dichloroethene	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	100 U	100 U	100 U	100 U	100 U	100 U
1 1-Dichloroethane	ug/L	40 U	40 U	40 U	40 U	40 U	40 U	80 U	80 U	80 U	80 U	80 U	80 U
cis-1 2-Dichloroethene	ug/L	5500	5700	6100	6200	5900	6100	6200	5900	6200	6100	5900	6000
2-Butanone (MEK)	ug/L	160 U	160 U	160 U	160 U	160 U	160 U	320 U	320 U	320 U	320 U	320 U	320 U
Chloroform	ug/L	60 U	60 U	60 U	60 U	60 U	60 U	120 U	120 U	120 U	120 U	120 U	120 U
1 1 1-Trichloroethane	ug/L	90 U	90 U	90 U	90 U	90 U	90 U	180 U	180 U	180 U	180 U	180 U	180 U
Carbon tetrachloride	ug/L	60 U	60 U	60 U	60 U	60 U	60 U	120 U	120 U	120 U	120 U	120 U	120 U
Benzene	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	100 U	100 U	100 U	100 U	100 U	100 U
1 2-Dichloroethane	ug/L	60 U	60 U	60 U	60 U	60 U	60 U	120 U	120 U	120 U	120 U	120 U	120 U
Trichloroethene	ug/L	810	1300	2100	2500	2400	2600	2500	2400	2700	2700	2600	2500
1 2-Dichloropropane	ug/L	70 U	70 U	70 U	70 U	70 U	70 U	140 U	140 U	140 U	140 U	140 U	140 U
Bromodichloromethane	ug/L	70 U	70 U	70 U	70 U	70 U	70 U	140 U	140 U	140 U	140 U	140 U	140 U
cis-1 3-Dichloropropene	ug/L	40 U	40 U	40 U	40 U	40 U	40 U	80 U	80 U	80 U	80 U	80 U	80 U
4-Methyl-2-pentanone (MIBK)	ug/L	90 U	90 U	90 U	90 U	90 U	90 U	180 U	180 U	180 U	180 U	180 U	180 U
Toluene	ug/L	40 U	40 U	40 U	40 U	40 U	40 U	80 U	80 U	80 U	80 U	80 U	80 U
trans-1 3-Dichloropropene	ug/L	80 U	80 U	80 U	80 U	80 U	80 U	160 U	160 U	160 U	160 U	160 U	160 U
1 1 2-Trichloroethane	ug/L	80 U	80 U	80 U	80 U	80 U	80 U	160 U	160 U	160 U	160 U	160 U	160 U
Tetrachloroethene	ug/L	10000	11000	15000	14000	15000	16000	16000	16000	17000	17000	17000	17000
2-Hexanone	ug/L	70 U	70 U	70 U	70 U	70 U	70 U	140 U	140 U	140 U	140 U	140 U	140 U
Dibromochloromethane	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	100 U	100 U	100 U	100 U	100 U	100 U
Chlorobenzene	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	100 U	100 U	100 U	100 U	100 U	100 U
Ethylbenzene	ug/L	50 U	50 U	50 U	50 U	50 U	50 U	100 U	100 U	100 U	100 U	100 U	100 U
Styrene	ug/L	70 U	70 U	70 U	70 U	70 U	70 U	140 U	140 U	140 U	140 U	140 U	140 U
Bromoform	ug/L	80 U	80 U	80 U	80 U	80 U	80 U	160 U	160 U	160 U	160 U	160 U	160 U
1 1 2 2-Tetrachloroethane	ug/L	70 U	70 U	70 U	70 U	70 U	70 U	140 U	140 U	140 U	140 U	140 U	140 U
Xylenes (total)	ug/L	90 U	90 U	90 U	90 U	90 U	90 U	180 U	180 U	180 U	180 U	180 U	180 U
Total VOCs	ug/L	17060	18990	24190	23700	24220	25580	25740	25250	26870	26750	26480	26380

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Table 6-2
Summary of Pump Discharge Inorganic Parameter Monitoring Results
IW-2 Integrated Mass Discharge Test
Building 40
Watervliet Arsenal, Watervliet, New York

Inorganic Parameters	Units	IW-2 (9/24/04)											
Sampling Time		**7:30**	**8:35**	**9:30**	**10:30**	**11:30**	**12:30**	**13:30**	**14:30**	**15:30**	**16:30**	**17:30**	**18:30**
Manganese	ug/L	439	842	1100	1200	1280	1310	1330	1390	1370	1430	1400	1470
Potassium	ug/L	9850 N	13300 N	13900 N	13300 N	13200 N	13000 N	12700 N	12900 N	12500 N	13000 N	12500 N	12800 N
Sodium	ug/L	217000 N	206000 N	194000 N	179000 N	174000 N	173000 N	165000 N	170000 N	165000 N	173000 N	168000 N	169000 N
Solids Total Dissolved (TDS)	mg/L	800	790	830	840	820	810	810	840	820	850	850	840
Chloride	mg/L	283	311	329	332	339	338	344	337	347	343	342	341
Sulfate	mg/L	16.1	19.5	23.2	25.1	25.8	26.3	26.5	26.5	26.5	26.2	26.1	26
Alkalinity Total as CaCO3	mg/L	310	297	295	279	273	269	270	267	266	265	265	265
Field Parameters													
Specific Conductance	mhos/cm	1.57	1.67	1.73	1.75	1.74	1.74	1.75	1.75	1.75	1.72	1.73	1.73
Dissolved Oxygen	mg/l	4.48	7.74	4.8	4.21	6.24	5.57	5.84	6.71	8.32	7.16	6.63	7.83
Redox Potential	mvolts	-66	-91	-150	-140	-117	-116	-114	-111	-101	-112	-106	-108
pH	SU	6.09	7	7.55	7.5	7.58	7.51	7.56	7.55	7.56	7.48	7.51	7.53
Temperature	degrees C	14.79	16.23	17.44	17.64	18.46	18.72	18.4	18.03	17.55	17.62	17.11	16.61
Field Turbidity	ntu	117	31.9	112	90.4	24.4	18.3	14.4	13.2	10.6	12.7	8.8	11.7

Notes:
U: Not detected. Reporting limit provided.
B: Detected in blank.
J: Estimated.
N: Compound identified qualitatively

Table 6-3
IW-2 Integrated Mass Discharge Test Evaluation
Building 40
Watervliet Arsenal, Watervliet, New York

Test Method	Thickness	T	K		Length	X-Sec Area	Gradient	Total VOCs	VOC Mass Discharge
	(ft)	(ft^2/d)	(ft/d)	(ft/s)	(ft)	(ft^2)		(ug/l)	(lb/y)
Neuman Average	130	29	0.22	2.58E-06	311	40,430	0.003	26400	16.3
Neuman Geometric Mean	130	20	0.15	1.78E-06	311	40,430	0.003	26400	11.2
Theis Average	130	37	0.28	3.29E-06	311	40,430	0.003	26400	20.8
Theis Geometric Mean	130	32	0.25	2.85E-06	311	40,430	0.003	26400	18.0

Notes:
T: transmissivity
K: Hydraulic conductivity
ft: feet
d: day
s: second
ug/l: micrograms per liter
lb/y: pounds per year

Table 6-4
Summary of Transmissivity Values
Compliance Boundary Monitoring Wells
Building 40 Corrective Measures
Watervliet Arsenal, Watervliet, New York

Monitoring Zone	Transmissivity (square feet/day)
MW-61	
I	1.20
II	74.50
III	20.60
MW-62R	
I	132.80
II	25.60
III	0.10
MW-63	
I	47.46
II	0.10
III	7.80
MW-64R	
I	20.70
II	1.80
III	7.20
MW-65R	
I	25.20
II	127.35
III	1.89
MW-66R	
I	49.00
II	157.60
III	16.00

Table 6-5
Summary of Compliance Boundary VOC Mass Discharge
Building 40
Watervliet Arsenal, Watervliet, New York

Zone ID	Mass Discharge (lb/yr)				
	Baseline	January 2005	May 2005	August 2005	November 2005
MW-81-1	0.000	0.000	0.000	0.000	0.000
MW-81-2	0.002	0.001	0.001	0.001	0.001
MW-81-3	0.001	0.001	0.001	0.001	0.001
MW-82-1	0.173	0.753	1.183	0.767	0.577
MW-82-2	0.028	0.033	0.028	0.051	0.038
MW-82-3	0.000	0.000	0.000	0.000	0.000
MW-83-1	0.552	2.260	2.912	3.004	2.322
MW-83-2	0.009	0.010	0.009	0.006	0.010
MW-83-3	0.310	0.119	0.121	0.142	0.089
MW-84-1	1.323	1.026	1.158	0.832	0.676
MW-84-2	0.557	0.529	0.765	0.684	0.544
MW-84-3	0.913	0.740	0.883	0.843	0.780
MW-85-1	0.311	0.088	0.084	0.037	0.020
MW-85-2	2.518	2.189	2.129	2.590	0.089
MW-85-3	0.110	0.011	0.268	0.331	0.312
MW-86-1	0.223	0.101	0.056	0.058	0.046
MW-86-2	2.623	1.998	1.487	0.423	0.851
MW-86-3	0.375	0.165	0.479	0.260	0.272
Total	**10.028**	**10.023**	**11.564**	**10.031**	**6.627**

Legend

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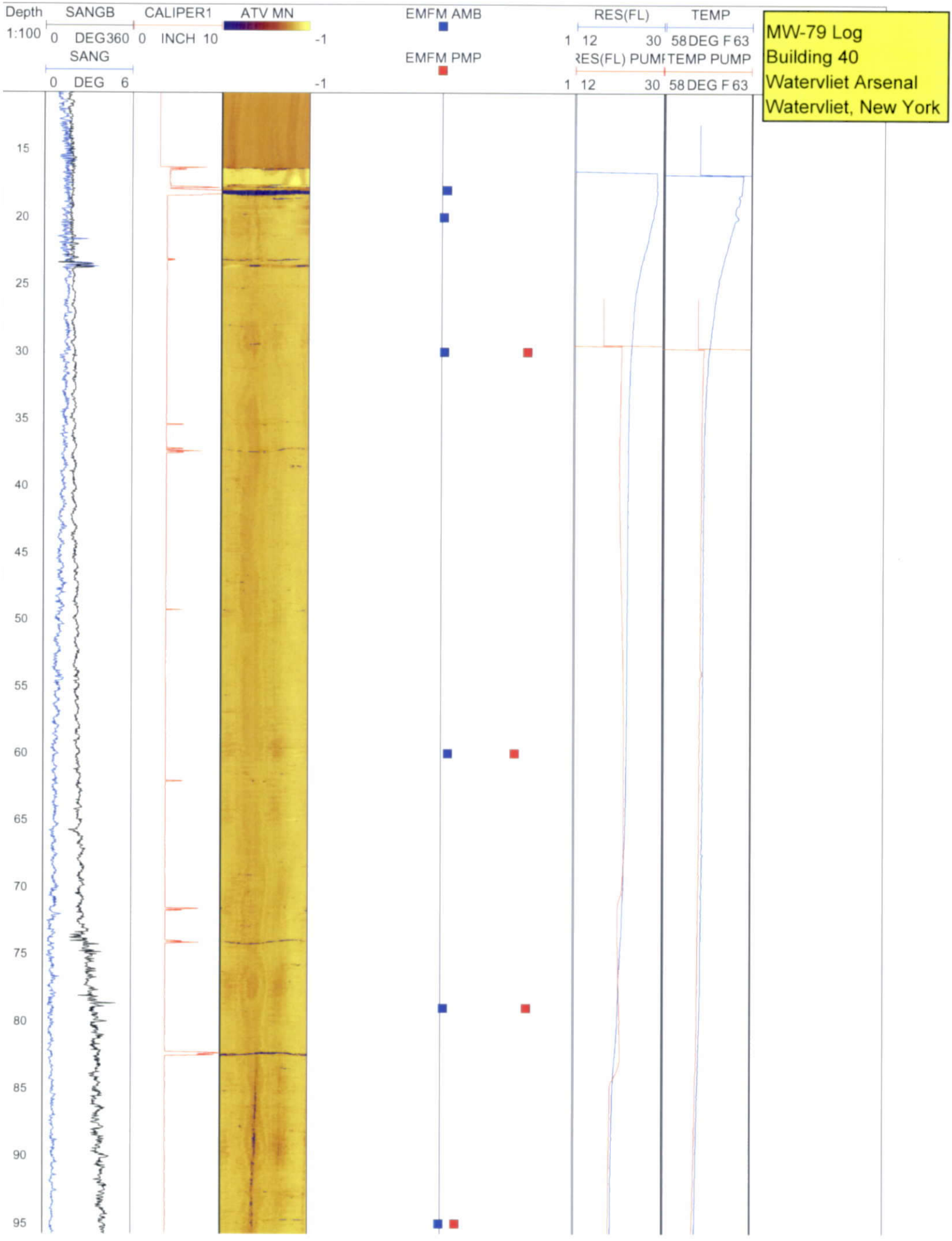
0.1 - 1.0	
>1.0	

APPENDIX A

USGS Geophysical Testing Results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EMFM PMP
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1 12 30
RES(FL) PUMP
TEMP
58 DEG F 63
TEMP PUMP
58 DEG F 63
MW-79 Log
Building 40
Watervliet Arsenal
Watervliet, New York
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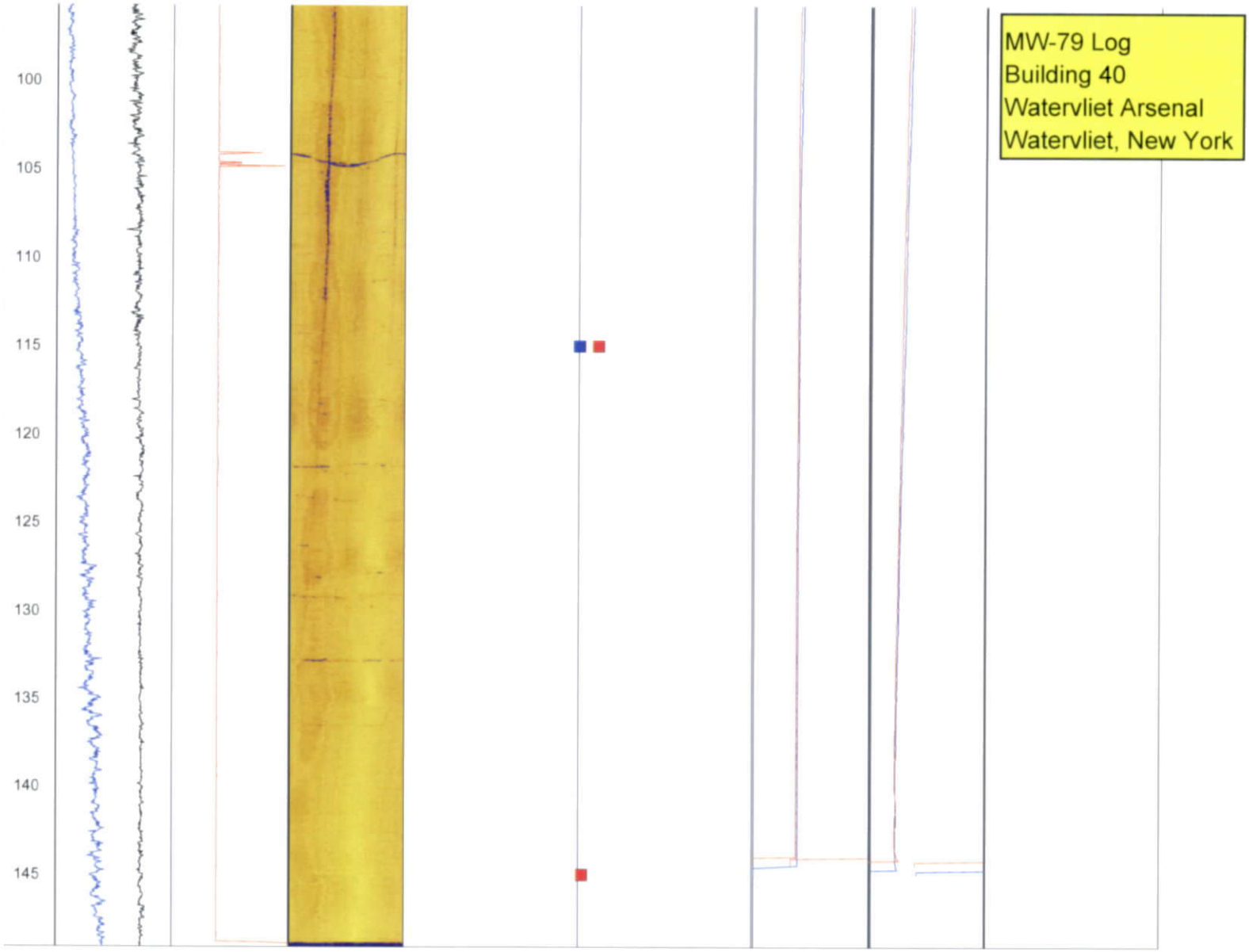
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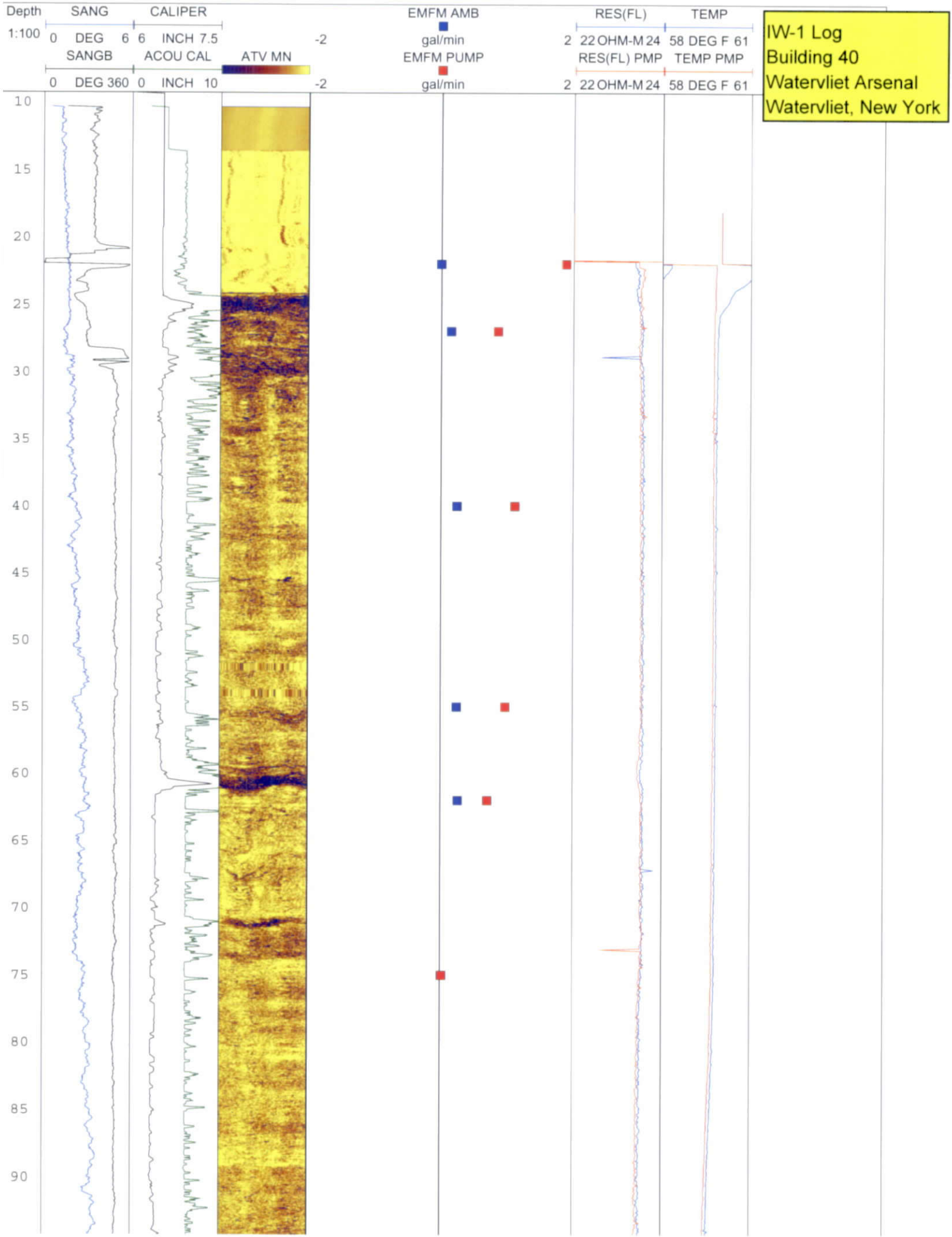
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ATV MN
-2
-2
EMFM AMB
gal/min
EMFM PUMP
gal/min
RES(FL)
2 22 OHM-M 24
RES(FL) PMP
2 22 OHM-M 24
TEMP
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TEMP PMP
58 DEG F 61
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30
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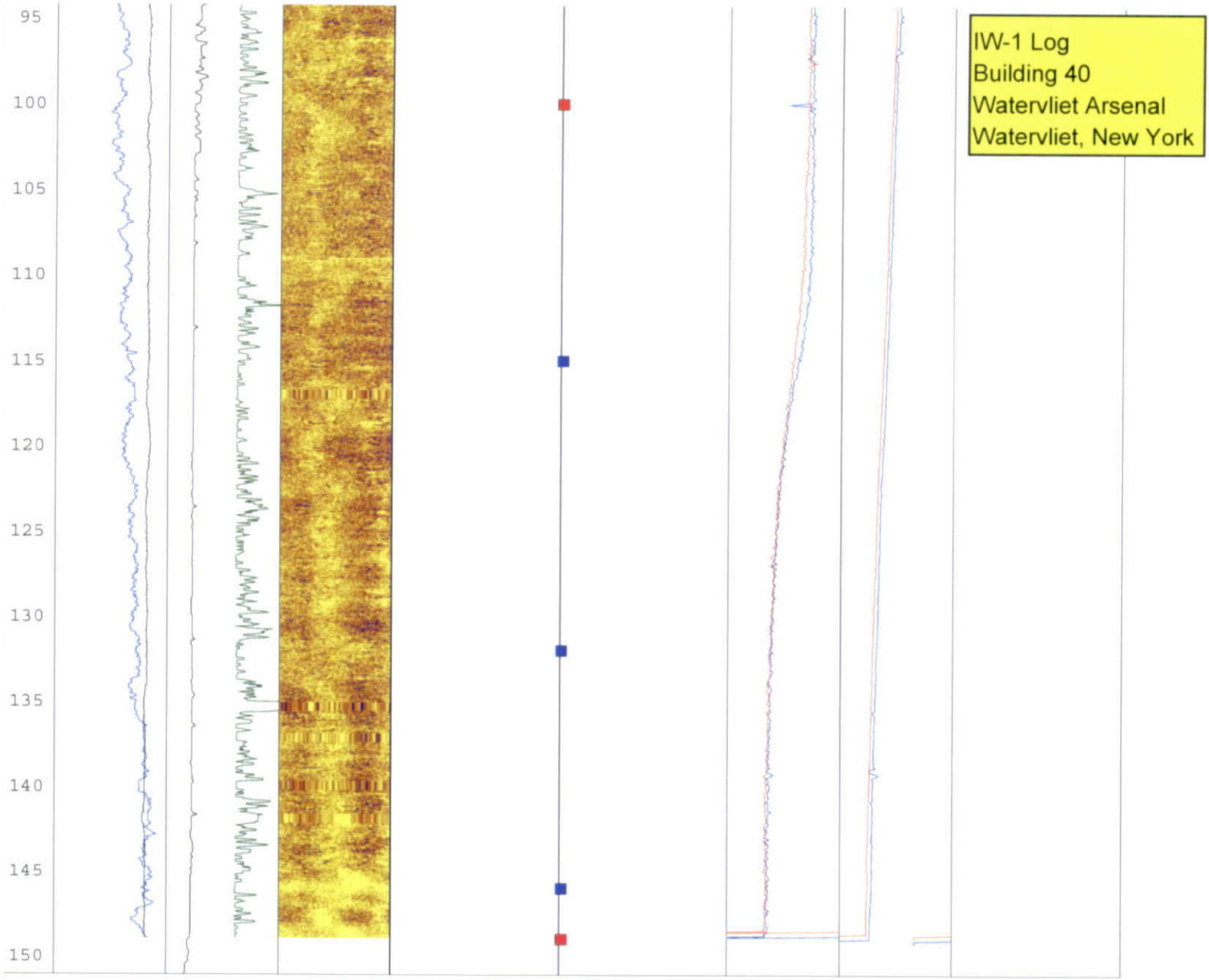
Building 40
Watervliet Arsenal
Watervliet, New York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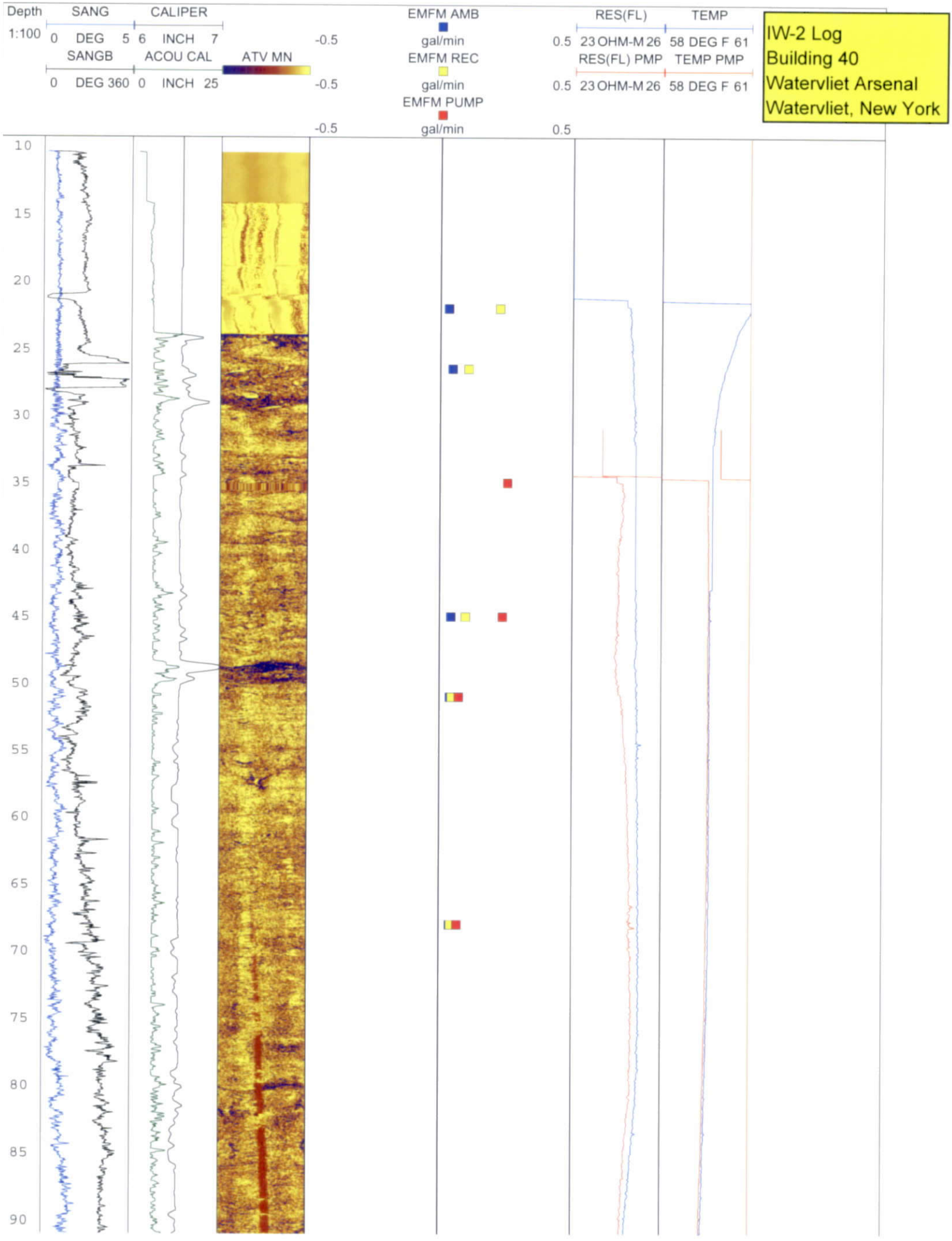
Building 40
Watervliet Arsenal
Watervliet, New York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gal/min
EMFM PUMP
gal/min
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RES(FL) PMP
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TEMP PMP
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Watervliet Arsenal
Watervliet, New York
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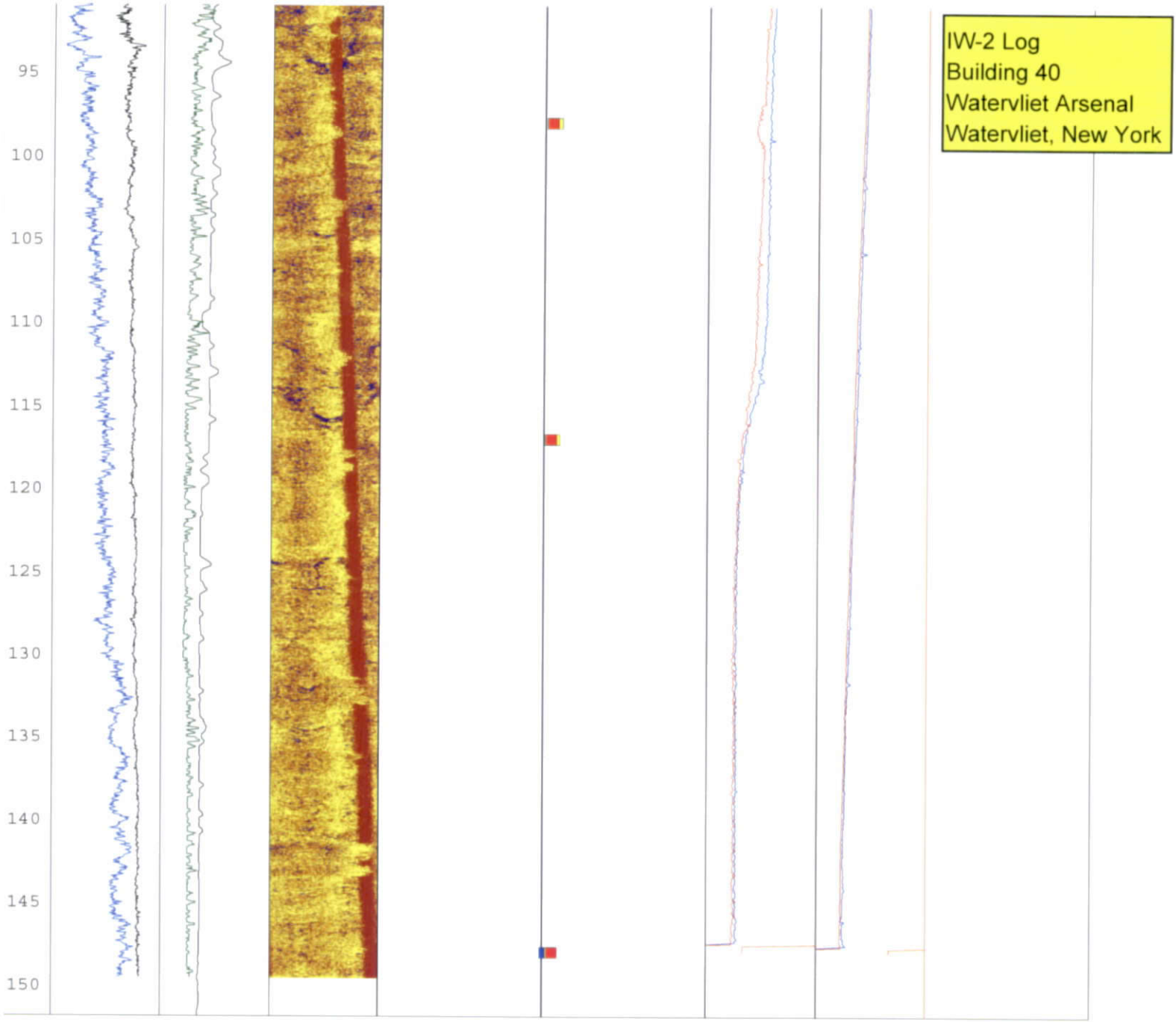
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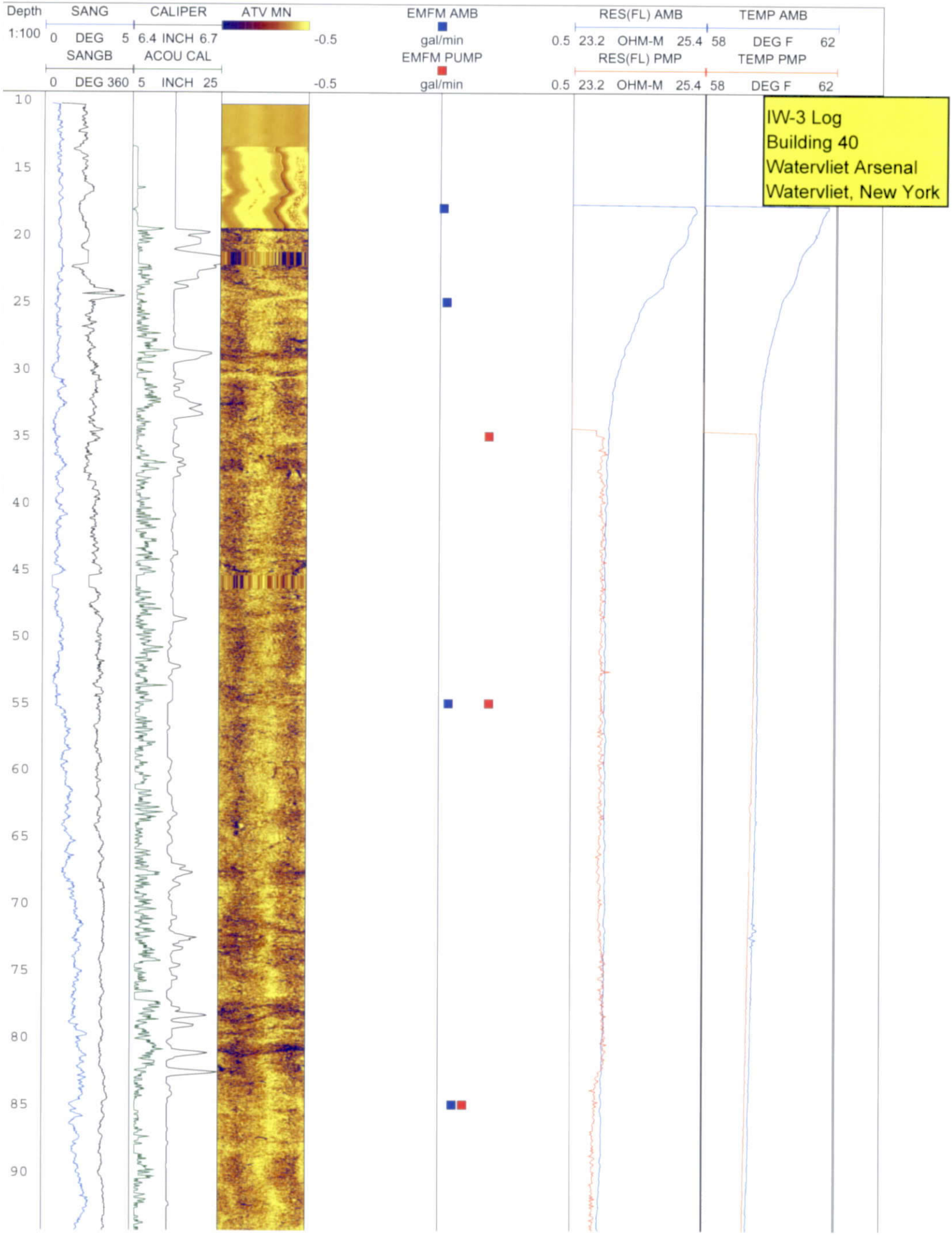
IW-2 Log
Building 40
Watervliet Arsenal
Watervliet, New York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-0.5
EMFM AMB
gal/min
EMFM PUMP
gal/min
RES(FL) AMB
0.5 23.2 OHM-M 25.4
RES(FL) PMP
0.5 23.2 OHM-M 25.4
TEMP AMB
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TEMP PMP
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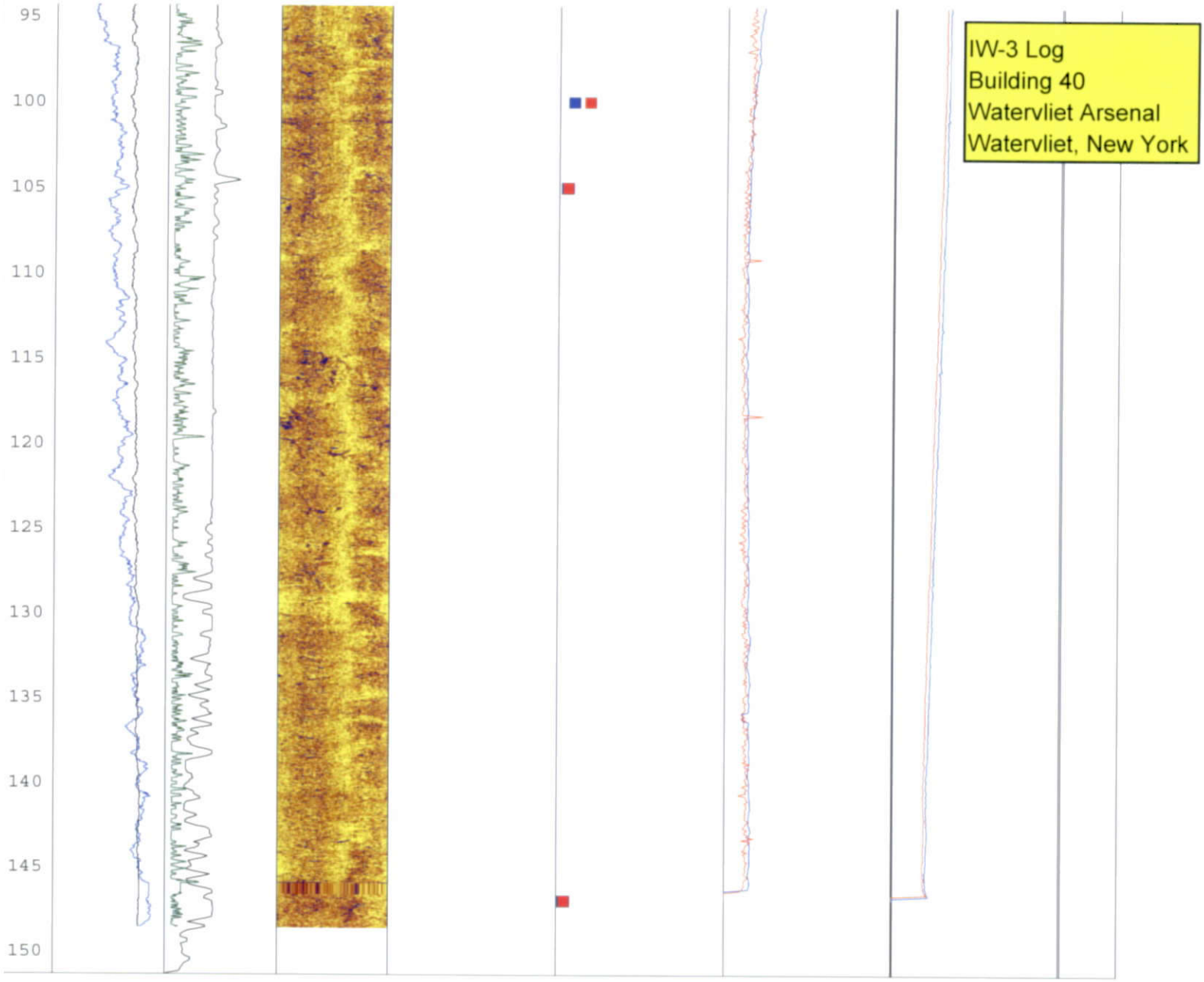
Building 40
Watervliet Arsenal
Watervliet, New York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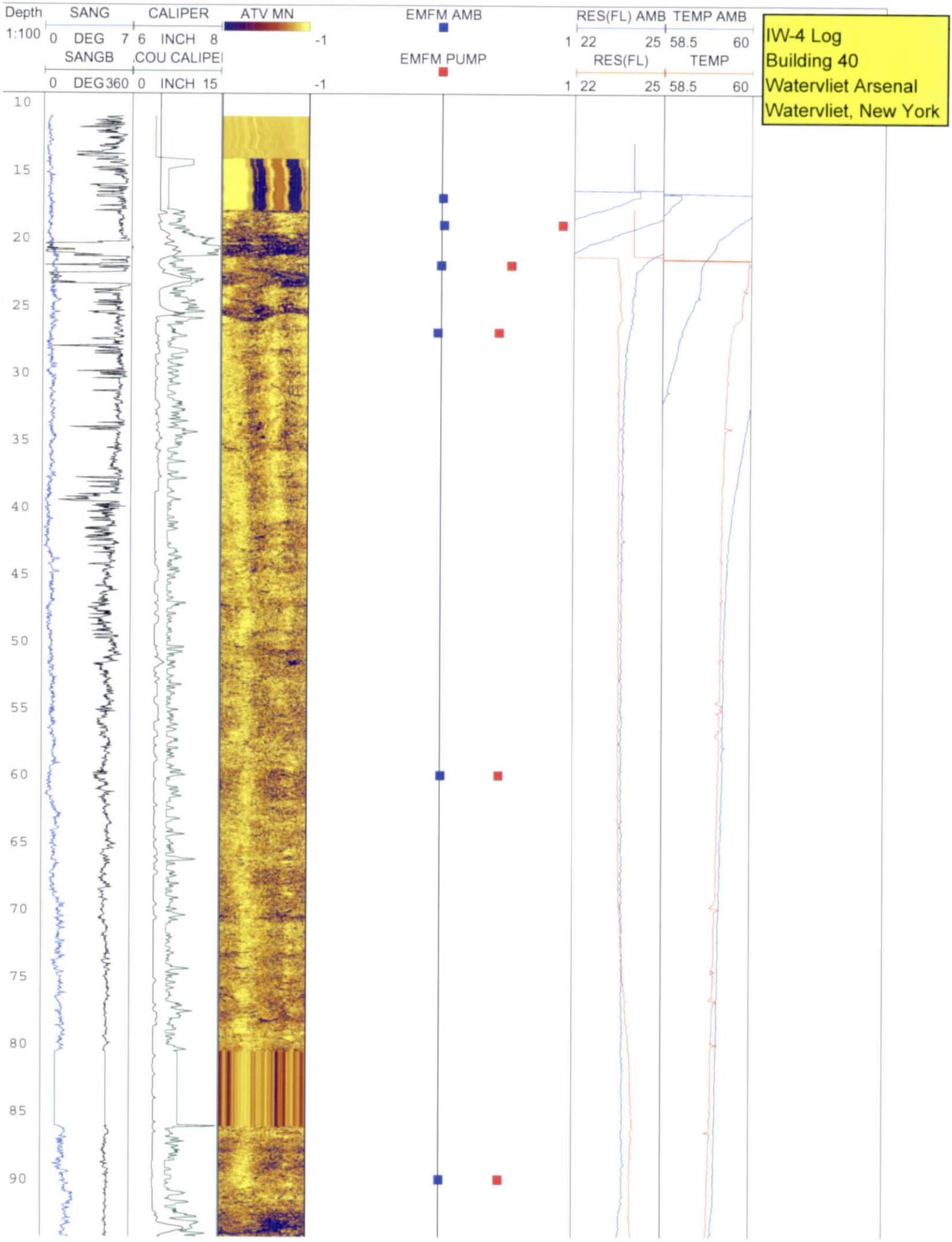
Watervliet Arsenal
Watervliet, New York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1 22 25 58.5 60
RES(FL)
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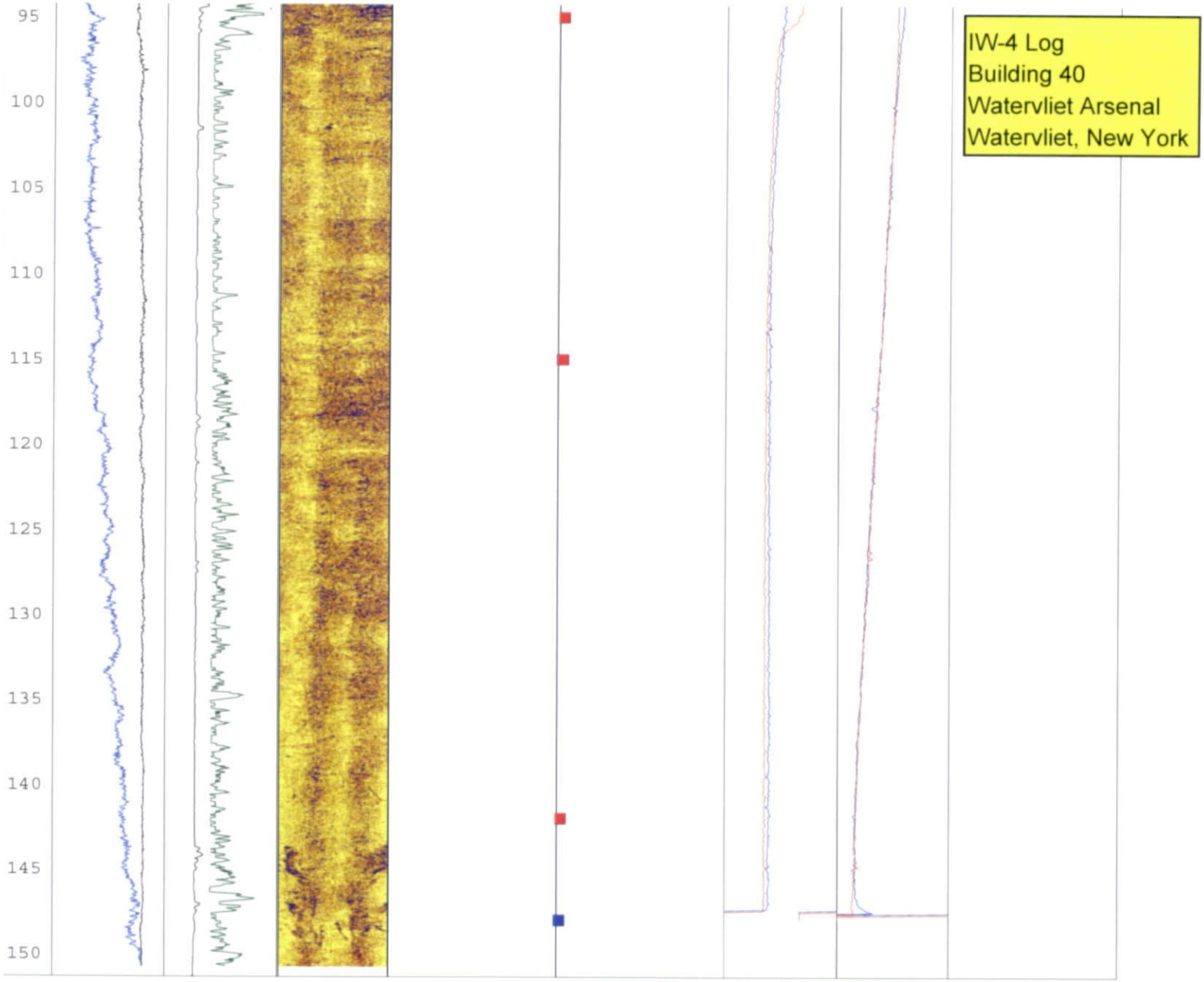
IW-4 Log
Building 40
Watervliet Arsenal
Watervliet, New York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IW-4 Log
Building 40
Watervliet Arsenal
Watervliet, New York

APPENDIX B

Groundwater Monitoring Results
(Tables and Figures B-1 through B-12)

Table B-1
MW-34
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/04	1/26/05		4/26/05		8/17/05		11/30/05	
Chloromethane	5	ug/L	---	250	U	250	U	250	U	250	U
Vinyl chloride	2	ug/L	515	260		410		340		480	
Bromomethane		ug/L	---	250	U	250	U	250	U	250	U
Chloroethane	5	ug/L	---	250	U	250	U	250	U	250	U
1 1-Dichloroethene	5	ug/L	---	250	U	250	U	250	U	250	U
Carbon disulfide		ug/L	---	250	U	250	U	250	U	250	UJ
Acetone		ug/L	---	500	U	500	U	500	U	500	U
Methylene chloride	5	ug/L	250 U	250	U	250	U	250	U	250	U
trans-1 2-Dichloroethene	5	ug/L	---	250	U	250	U	250	U	250	U
1 1-Dichloroethane	5	ug/L	---	250	U	250	U	250	U	250	U
cis-1 2-Dichloroethene	5	ug/L	5950	4700		5500		3800		5000	
2-Butanone (MEK)		ug/L	---	500	U	250	U	500	UB	500	U
Chloroform	7	ug/L	---	250	U	250	U	250	U	250	U
1 1 1-Trichloroethane	5	ug/L	---	250	U	250	U	250	U	250	U
Carbon tetrachloride	5	ug/L	---	250	U	250	U	250	U	250	U
Benzene	1	ug/L	---	250	U	250	U	250	U	250	U
1 2-Dichloroethane	0.6	ug/L	---	250	U	250	U	250	U	250	U
Trichloroethene	5	ug/L	1350	830		540		500		690	
1 2-Dichloropropane	1	ug/L	---	250	U	250	U	250	U	250	U
Bromodichloromethane		ug/L	---	250	U	250	U	250	U	250	U
cis-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	250	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	500	U	500	U	500	U	500	U
Toluene	5	ug/L	---	250	U	250	U	250	U	250	U
trans-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	250	U
1 1 2-Trichloroethane	1	ug/L	---	250	U	250	U	250	U	250	U
Tetrachloroethene	5	ug/L	2650	1200		690		530		1100	
2-Hexanone		ug/L	---	500	U	500	U	500	U	500	U
Dibromochloromethane		ug/L	---	250	U	250	U	250	U	250	U
Chlorobenzene	5	ug/L	---	250	U	250	U	250	U	250	U
Ethylbenzene	5	ug/L	---	250	U	250	U	250	U	250	U
Styrene	5	ug/L	---	250	U	250	U	250	U	250	U
Bromoform		ug/L	---	250	U	250	U	250	U	250	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	250	U	250	U	250	U	250	U
Xylenes (total)	5	ug/L	---	250	U	250	U	250	U	250	U
Total VOCs		ug/L	10481	7240		7640		5420		7520	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/17/2005		11/30/2005	
Potassium		mg/L	21.55	20.5		24		28.3		22.1	
Sodium	200	mg/L	183.5	134		173		236		207	
Sulfate	250	mg/L	28.8	52.2		42.1		71.3		180	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-2
MW-51
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/26/2005		8/17/2005		11/30/2005	
Chloromethane	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Vinyl chloride	2	ug/L	240	1400	J	3400		1500	J	1500	J
Bromomethane		ug/L	---	2500	U	2500	U	2500	U	2500	U
Chloroethane	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
1 1-Dichloroethene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Carbon disulfide		ug/L	---	2500	U	2500	U	2500	U	2500	UJ
Acetone		ug/L	---	5000	U	5000	U	5000	U	5000	U
Methylene chloride	5	ug/L	250 U	2500	U	2500	U	2500	U	2500	U
trans-1 2-Dichloroethene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
1 1-Dichloroethane	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
cis-1 2-Dichloroethene	5	ug/L	1300	7100		13000		8000		7600	
2-Butanone (MEK)		ug/L	---	5000	U	2500	U	5000	UB	5000	U
Chloroform	7	ug/L	---	2500	U	2500	U	2500	U	2500	U
1 1 1-Trichloroethane	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Carbon tetrachloride	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Benzene	1	ug/L	---	2500	U	2500	U	2500	U	2500	U
1 2-Dichloroethane	0.6	ug/L	---	2500	U	2500	U	2500	U	2500	U
Trichloroethene	5	ug/L	1650	13000		21000		18000		26000	
1 2-Dichloropropane	1	ug/L	---	2500	U	2500	U	2500	U	2500	U
Bromodichloromethane		ug/L	---	2500	U	2500	U	2500	U	2500	U
cis-1 3-Dichloropropene	0.4	ug/L	---	2500	U	2500	U	2500	U	2500	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	5000	U	5000	U	5000	U	5000	U
Toluene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
trans-1 3-Dichloropropene	0.4	ug/L	---	2500	U	2500	U	2500	U	2500	U
1 1 2-Trichloroethane	1	ug/L	---	2500	U	2500	U	2500	U	2500	U
Tetrachloroethene	5	ug/L	13500	40000		60000		51000		66000	
2-Hexanone		ug/L	---	5000	U	5000	U	5000	U	5000	U
Dibromochloromethane		ug/L	---	2500	U	2500	U	2500	U	2500	U
Chlorobenzene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Ethylbenzene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Styrene	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Bromoform		ug/L	---	2500	U	2500	U	2500	U	2500	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Xylenes (total)	5	ug/L	---	2500	U	2500	U	2500	U	2500	U
Total VOCs		ug/L	15860	64000		102400		81000		103600	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/17/2005		11/30/2005	
Potassium		mg/L	32.65	15.5		18.4		18		18.2	
Sodium	200	mg/L	102.5	310		321		321		402	
Sulfate	250	mg/L	5.66	11.7		12.6		11		15.8	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-3
MW-60
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/25/2005		8/16/2005		11/29/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	5	U
Vinyl chloride	2	ug/L	---	5	U	5	U	5	U	5	U
Bromomethane		ug/L	---	5	U	5	U	5	U	5	U
Chloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon disulfide		ug/L	---	5	U	5	U	5	U	5	UJ
Acetone		ug/L	---	5	U	10	U	10	UB	10	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
cis-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Butanone (MEK)		ug/L	---	5	U	10	U	10	UB	10	U
Chloroform	7	ug/L	---	5	U	5	U	5	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	5	U
Benzene	1	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	5	U
Trichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	5	U
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	10	U
Toluene	5	ug/L	---	5	U	5	U	5	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	5	U
Tetrachloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Hexanone		ug/L	---	10	U	10	U	10	U	10	U
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	5	U
Chlorobenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Styrene	5	ug/L	---	5	U	5	U	5	U	5	U
Bromoform		ug/L	---	5	U	5	U	5	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	5	U
Total VOCs		ug/L				5		5		0	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		8/16/2005		11/29/2005	
Potassium		mg/L	5.29	5.2		4.9		4.41		4.89	
Sodium	200	mg/L	**202.5**	135		**234**		**233**		177	
Sulfate	250	mg/L	2.655	1.4		3.4		1.92		1.18	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-4
MW-80
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/25/2005		11/29/2005	
Chloromethane	5	ug/L	---	5	U	5	U	NS	
Vinyl chloride	2	ug/L	0.8 J	0.8	J	1.6	J	NS	
Bromomethane		ug/L	---	5	U	5	U	NS	
Chloroethane	5	ug/L	---	5	U	5	U	NS	
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	NS	
Carbon disulfide		ug/L	---	5	U	5	U	NS	
Acetone		ug/L	---	5	U	10	U	NS	
Methylene chloride	5	ug/L	5 U	5	UB	5	UB	NS	
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	NS	
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	NS	
cis-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	NS	
2-Butanone (MEK)		ug/L	---	5	U	10	U	NS	
Chloroform	7	ug/L	---	5	U	5	U	NS	
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	NS	
Carbon tetrachloride	5	ug/L	---	5	U	5	U	NS	
Benzene	1	ug/L	---	5	U	5	U	NS	
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	NS	
Trichloroethene	5	ug/L	---	5	U	5	U	NS	
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	NS	
Bromodichloromethane		ug/L	---	5	U	5	U	NS	
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	NS	
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	NS	
Toluene	5	ug/L	---	5	U	5	U	NS	
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	NS	
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	NS	
Tetrachloroethene	5	ug/L	---	5	U	5	U	NS	
2-Hexanone		ug/L	---	10	U	10	U	NS	
Dibromochloromethane		ug/L	---	5	U	5	U	NS	
Chlorobenzene	5	ug/L	---	5	U	5	U	NS	
Ethylbenzene	5	ug/L	---	5	U	5	U	NS	
Styrene	5	ug/L	---	5	U	5	U	NS	
Bromoform		ug/L	---	5	U	5	U	NS	
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	NS	
Xylenes (total)	5	ug/L	---	5	U	5	U	NS	
Total VOCs		ug/L		0.8		6.6			

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		11/29/2005	
Potassium		mg/L	10.665	22.9		23.8		NS	
Sodium	200	mg/L	**209.5**	**275**		**317**		NS	
Sulfate	250	mg/L	5.73	0.814	B	1.22		NS	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

NS: not sampled, permanganate present

Highlighted results exceed NYS Standards

Table B-5
MW-87
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/26/2005		8/16/2005		11/29/2005	
Chloromethane	5	ug/L	---	120	U	250	U	250	U	250	U
Vinyl chloride	2	ug/L	520	120	J	380		490		730	
Bromomethane		ug/L	---	120	U	250	U	250	U	250	U
Chloroethane	5	ug/L	---	120	U	250	U	250	U	250	U
1 1-Dichloroethene	5	ug/L	---	120	U	250	U	250	U	250	U
Carbon disulfide		ug/L	---	120	U	250	U	250	U	250	UJ
Acetone		ug/L	---	250	U	500	UB	250	U	500	U
Methylene chloride	5	ug/L	---	250	UB	250	UB	250	UB	250	UB
trans-1 2-Dichloroethene	5	ug/L	26	120	U	250	U	250	UM	29	J
1 1-Dichloroethane	5	ug/L	---	120	U	250	U	250	U	250	U
cis-1 2-Dichloroethene	5	ug/L	6500 J	2300		5700		5800		5600	
2-Butanone (MEK)		ug/L	---	250	U	250	U	250	U	500	U
Chloroform	7	ug/L	---	120	U	250	U	250	U	250	U
1 1 1-Trichloroethane	5	ug/L	---	120	U	250	U	250	U	250	U
Carbon tetrachloride	5	ug/L	---	120	U	250	U	250	U	250	U
Benzene	1	ug/L	---	120	U	250	U	250	U	250	U
1 2-Dichloroethane	0.6	ug/L	---	120	U	250	U	250	U	250	U
Trichloroethene	5	ug/L	2150	250		1600		1900		1300	
1 2-Dichloropropane	1	ug/L	---	120	U	250	U	250	U	250	U
Bromodichloromethane		ug/L	---	120	U	250	U	250	U	250	U
cis-1 3-Dichloropropene	0.4	ug/L	---	120	U	250	U	250	U	250	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	250	U	500	U	500	U	500	U
Toluene	5	ug/L	---	120	U	250	U	250	U	250	U
trans-1 3-Dichloropropene	0.4	ug/L	---	120	U	250	U	250	U	250	U
1 1 2-Trichloroethane	1	ug/L	---	120	U	250	U	250	U	250	U
Tetrachloroethene	5	ug/L	6400 J	240		3800		3500		3300	
2-Hexanone		ug/L	---	250	U	500	U	500	U	500	U
Dibromochloromethane		ug/L	---	120	U	250	U	250	U	250	U
Chlorobenzene	5	ug/L	---	120	U	250	U	250	U	250	U
Ethylbenzene	5	ug/L	---	120	U	250	U	250	U	250	U
Styrene	5	ug/L	---	120	U	250	U	250	U	250	U
Bromoform		ug/L	---	120	U	250	U	250	U	250	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	120	U	250	U	250	U	250	U
Xylenes (total)	5	ug/L	---	120	U	250	U	250	U	250	U
Total VOCs		ug/L	15598	3160		11980		11940		11180	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/16/2005		11/29/2005	
Potassium		mg/L	20.5	15.9		20		21.8		19.5	
Sodium	200	mg/L	196.5	159		185		268		245	
Sulfate	250	mg/L	32.55	41.9		44.3		207		203	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-6
MW-89
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/25/2005		8/16/2005		11/29/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	5	U
Vinyl chloride	2	ug/L	---	5	U	5	U	5	U	5	U
Bromomethane		ug/L	---	5	U	5	U	5	U	5	U
Chloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon disulfide		ug/L	---	5	U	5	U	5	U	5	UJ
Acetone		ug/L	---	5	U	5	U	5	U	5	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
cis-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Butanone (MEK)		ug/L	---	5	U	10	U	10	UB	10	U
Chloroform	7	ug/L	---	5	U	5	U	5	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	5	U
Benzene	1	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	5	U
Trichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	5	U
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	10	U
Toluene	5	ug/L	---	5	U	5	U	5	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	5	U
Tetrachloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Hexanone		ug/L	---	10	U	10	U	10	U	10	U
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	5	U
Chlorobenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Styrene	5	ug/L	---	5	U	5	U	5	U	5	U
Bromoform		ug/L	---	5	U	5	U	5	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	5	U
Total VOCs		ug/L	7			10		10		5	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		8/16/2005		11/29/2005	
Potassium		mg/L	12.85	22.2		6.53		15.1		8.79	
Sodium	200	mg/L	128.5	**550**		194		**280**		114	
Sulfate	250	mg/L	16.9	825		38.9		92.9		53.4	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-7a
MW-81-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	5	U
Vinyl chloride	2	ug/L	1.9	5	U	2	J	4.6	J	2.9	J
Bromomethane		ug/L	---	5	U	5	U	5	U	5	U
Chloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon disulfide		ug/L	1.2	5	U	5	U	5	U	5	UJ
Acetone		ug/L	---	10	U	10	U	10	UB	10	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
cis-1 2-Dichloroethene	5	ug/L	12.5	14		11		14		12	
2-Butanone (MEK)		ug/L	---	10	U	10	UB	10	UB	10	U
Chloroform	7	ug/L	---	5	U	5	U	5	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	5	U
Benzene	1	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	5	U
Trichloroethene	5	ug/L	1	1.5	J	0.91	J	0.96	J	5	U
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	5	U
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	10	U
Toluene	5	ug/L	---	5	U	5	U	5	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	5	U
Tetrachloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Hexanone		ug/L	---	10	U	10	U	10	U	10	U
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	5	U
Chlorobenzene	5	ug/L	0.75	5	U	5	U	5	U	5	U
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Styrene	5	ug/L	---	5	U	5	U	5	U	5	U
Bromoform		ug/L	---	5	U	5	U	5	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	5	U
Total VOCs		ug/L	18.4	15.5		18.91		24.56		19.9	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	8.74	14.3		9.01	E	12.4		9.69	
Sodium	200	mg/L	168.5	296		176		233		196	
Sulfate	250	mg/L	33.2	25.4		20.6		20.3		14.8	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-7b
MW-81-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	5	U
Vinyl chloride	2	ug/L	0.65	5	U	5	U	5	UM	0.92	J
Bromomethane		ug/L	---	5	U	5	U	5	U	5	U
Chloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon disulfide		ug/L	---	5	U	5	U	5	U	5	UJ
Acetone		ug/L	---	10	U	10	U	10	UB	10	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
cis-1 2-Dichloroethene	5	ug/L	**9**	**7.2**		**7.3**		**5.3**		**5.5**	
2-Butanone (MEK)		ug/L	---	10	U	10	UB	10	UB	10	U
Chloroform	7	ug/L	---	5	U	5	U	5	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	5	U
Benzene	1	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	5	U
Trichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	5	U
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	10	U
Toluene	5	ug/L	---	5	U	5	U	5	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	5	U
Tetrachloroethene	5	ug/L	---	5	U	5	U	2.5	J	5	U
2-Hexanone		ug/L	---	10	U	10	U	10	U	10	U
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	5	U
Chlorobenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Styrene	5	ug/L	---	5	U	5	U	5	U	5	U
Bromoform		ug/L	---	5	U	5	U	5	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	5	U
Total VOCs		ug/L	14.35	7.2		12.3		12.8		6.42	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	9.545	15.5		11.7	E	10.3		9.59	
Sodium	200	mg/L	174.5	**317**		**218**		**217**		182	
Sulfate	250	mg/L	27.7	34		29.2		29.5		46.2	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-7c
MW-81-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	5	U
Vinyl chloride	2	ug/L	2.5	4.1	J	8.5		9.3		10	
Bromomethane		ug/L	---	5	U	5	U	5	U	5	U
Chloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon disulfide		ug/L	---	5	U	5	U	5	U	5	UJ
Acetone		ug/L	---	10	U	10	U	10	UB	10	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
cis-1 2-Dichloroethene	5	ug/L	15	14		17		11		8.7	
2-Butanone (MEK)		ug/L	---	10	U	10	UB	10	UB	10	U
Chloroform	7	ug/L	---	5	U	5	U	5	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	5	U
Benzene	1	ug/L	---	5	U	5	U	5	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	5	U
Trichloroethene	5	ug/L	0.85	5	U	5	U	5	U	5	U
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	5	U
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	10	U
Toluene	5	ug/L	---	5	U	5	U	5	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	5	U
Tetrachloroethene	5	ug/L	---	5	U	5	U	5	U	5	U
2-Hexanone		ug/L	---	10	U	10	U	10	U	10	U
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	5	U
Chlorobenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	5	U
Styrene	5	ug/L	---	5	U	5	U	5	U	5	U
Bromoform		ug/L	---	5	U	5	U	5	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	5	U
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	5	U
Total VOCs		ug/L	18.95	18.1		30.5		25.3		23.7	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	9.94	8.76		8.29	E	7.17		6.64	
Sodium	200	mg/L	397.5	416		364		363		343	
Sulfate	250	mg/L	19.05	31.9		37.1		18		24.7	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-8a
MW-82R-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	25	U	50	U	25	U	20	U
Vinyl chloride	2	ug/L	**11**	**47**		**63**		**110**		**250**	
Bromomethane		ug/L	---	25	U	50	U	25	U	20	U
Chloroethane	5	ug/L	---	25	U	50	U	25	U	20	U
1 1-Dichloroethene	5	ug/L	---	25	U	50	U	25	U	20	U
Carbon disulfide		ug/L	---	25	U	50	U	25	U	20	UJ
Acetone		ug/L	---	50	U	50	U	25	U	40	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	0.55	25	U	50	U	2.7	J	2.9	J
1 1-Dichloroethane	5	ug/L	---	25	U	50	U	25	U	20	U
cis-1 2-Dichloroethene	5	ug/L	**150**	**500**		**700**		**570**		**370**	
2-Butanone (MEK)		ug/L	---	50	U	50	U	25	U	40	U
Chloroform	7	ug/L	---	25	U	50	U	25	U	20	U
1 1 1-Trichloroethane	5	ug/L	---	25	U	50	U	25	U	20	U
Carbon tetrachloride	5	ug/L	---	25	U	50	U	25	U	20	U
Benzene	1	ug/L	---	25	U	50	U	25	U	20	U
1 2-Dichloroethane	0.6	ug/L	---	25	U	50	U	25	U	20	U
Trichloroethene	5	ug/L	**30.5**	**120**		**220**		**140**		**100**	
1 2-Dichloropropane	1	ug/L	---	25	U	50	U	25	U	20	U
Bromodichloromethane		ug/L	---	25	U	50	U	25	U	20	U
cis-1 3-Dichloropropene	0.4	ug/L	---	25	U	50	U	25	U	20	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	50	U	100	U	50	U	40	U
Toluene	5	ug/L	---	25	U	50	U	25	U	20	U
trans-1 3-Dichloropropene	0.4	ug/L	---	25	U	50	U	25	U	20	U
1 1 2-Trichloroethane	1	ug/L	---	25	U	50	U	25	U	20	U
Tetrachloroethene	5	ug/L	**125**	**710**		**1100**		**530**		**330**	
2-Hexanone		ug/L	---	50	U	100	U	50	U	40	U
Dibromochloromethane		ug/L	---	25	U	50	U	25	U	20	U
Chlorobenzene	5	ug/L	---	25	U	50	U	25	U	20	U
Ethylbenzene	5	ug/L	---	25	U	50	U	25	U	20	U
Styrene	5	ug/L	---	25	U	50	U	25	U	20	U
Bromoform		ug/L	---	25	U	50	U	25	U	20	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	25	U	50	U	25	U	20	U
Xylenes (total)	5	ug/L	---	25	U	50	U	25	U	20	U
Total VOCs		ug/L	317.65	1382		2188		1407.7		1055	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	24.5	21.9		28.4	E	26.8		21.9	
Sodium	200	mg/L	**206**	182		**221**		**244**		**288**	
Sulfate	250	mg/L	51.3	28.3		25.3		64.1		144	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-8b
MW-82R-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	10	U	10	U	10	U	5	U
Vinyl chloride	2	ug/L	44.5	74		71		150		160	
Bromomethane		ug/L	---	10	U	10	U	10	U	5	U
Chloroethane	5	ug/L	---	10	U	10	U	10	U	5	U
1 1-Dichloroethene	5	ug/L	---	10	U	10	U	10	U	5	U
Carbon disulfide		ug/L	---	10	U	10	U	10	U	5	UJ
Acetone		ug/L	---	20	U	20	U	10	U	10	U
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	0.75	10	U	10	U	1.5	J	1.4	J
1 1-Dichloroethane	5	ug/L	---	10	U	10	U	10	U	5	U
cis-1 2-Dichloroethene	5	ug/L	215	240		180		320		200	
2-Butanone (MEK)		ug/L	---	20	U	10	U	20	UB	10	U
Chloroform	7	ug/L	---	10	U	10	U	10	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	10	U	10	U	10	U	5	U
Carbon tetrachloride	5	ug/L	---	10	U	10	U	10	U	5	U
Benzene	1	ug/L	---	10	U	10	U	10	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	10	U	10	U	10	U	5	U
Trichloroethene	5	ug/L	---	10	U	10	U	7.3	J	0.91	J
1 2-Dichloropropane	1	ug/L	---	10	U	10	U	10	U	5	U
Bromodichloromethane		ug/L	---	10	U	10	U	10	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	10	U	10	U	10	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	20	U	20	U	20	U	10	U
Toluene	5	ug/L	---	10	U	10	U	10	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	10	U	10	U	10	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	10	U	10	U	10	U	5	U
Tetrachloroethene	5	ug/L	3	10	U	3	J	10	U	0.8	J
2-Hexanone		ug/L	---	20	U	20	U	20	U	10	U
Dibromochloromethane		ug/L	---	10	U	10	U	10	U	5	U
Chlorobenzene	5	ug/L	---	10	U	10	U	10	U	5	U
Ethylbenzene	5	ug/L	---	10	U	10	U	10	U	5	U
Styrene	5	ug/L	---	10	U	10	U	10	U	5	U
Bromoform		ug/L	---	10	U	10	U	10	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	10	U	10	U	10	U	5	U
Xylenes (total)	5	ug/L	---	10	U	10	U	10	U	5	U
Total VOCs		ug/L	262.75	319		269		483.8		368.11	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	11.6	9.94		14.5	E	12.5		9.89	
Sodium	200	mg/L	155	135		199		214		150	
Sulfate	250	mg/L	18.75	13.8		15.3		27.7		41.2	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-8c
MW-82R-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Chloromethane	5	ug/L	---	5	U	5	U	5	U	NS	
Vinyl chloride	2	ug/L	25	15		76		15		NS	
Bromomethane		ug/L	---	5	U	5	U	5	U	NS	
Chloroethane	5	ug/L	---	5	U	5	U	5	U	NS	
1 1-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	NS	
Carbon disulfide		ug/L	---	5	U	5	U	5	U	NS	
Acetone		ug/L	---	5	U	10	U	10	UB	NS	
Methylene chloride	5	ug/L	---	5	UB	5	UB	5	UB	NS	
trans-1 2-Dichloroethene	5	ug/L	---	5	U	5	U	5	U	NS	
1 1-Dichloroethane	5	ug/L	---	5	U	5	U	5	U	NS	
cis-1 2-Dichloroethene	5	ug/L	124.5	65		42		1.1	J	NS	
2-Butanone (MEK)		ug/L	---	5	U	10	UB	10	UB	NS	
Chloroform	7	ug/L	---	5	U	5	U	5	U	NS	
1 1 1-Trichloroethane	5	ug/L	---	5	U	5	U	5	U	NS	
Carbon tetrachloride	5	ug/L	---	5	U	5	U	5	U	NS	
Benzene	1	ug/L	---	5	U	5	U	5	U	NS	
1 2-Dichloroethane	0.6	ug/L	---	5	U	5	U	5	U	NS	
Trichloroethene	5	ug/L	1.4	5	U	5	U	5	U	NS	
1 2-Dichloropropane	1	ug/L	---	5	U	5	U	5	U	NS	
Bromodichloromethane		ug/L	---	5	U	5	U	5	U	NS	
cis-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	NS	
4-Methyl-2-pentanone (MIBK)		ug/L	---	10	U	10	U	10	U	NS	
Toluene	5	ug/L	---	0.34	J	5	U	5	U	NS	
trans-1 3-Dichloropropene	0.4	ug/L	---	5	U	5	U	5	U	NS	
1 1 2-Trichloroethane	1	ug/L	---	5	U	5	U	5	U	NS	
Tetrachloroethene	5	ug/L	---	5	U	5	U	5	U	NS	
2-Hexanone		ug/L	---	10	U	10	U	10	U	NS	
Dibromochloromethane		ug/L	---	5	U	5	U	5	U	NS	
Chlorobenzene	5	ug/L	---	5	U	5	U	5	U	NS	
Ethylbenzene	5	ug/L	---	5	U	5	U	5	U	NS	
Styrene	5	ug/L	---	5	U	5	U	5	U	NS	
Bromoform		ug/L	---	5	U	5	U	5	U	NS	
1 1 2 2-Tetrachloroethane	5	ug/L	---	5	U	5	U	5	U	NS	
Xylenes (total)	5	ug/L	---	5	U	5	U	5	U	NS	
Total VOCs		ug/L	165.1	80.34		118		21.1			

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		11/30/2005	
Potassium		mg/L	12.7	11.7		13.6	E	10.9		NS	
Sodium	200	mg/L	287	337		349		339		NS	
Sulfate	250	mg/L	50.1	55.5		55		58.6		NS	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

NS: not sampled, permanganate present

Highlighted results exceed NYS Standards

Table B-9a
MW-83-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/25/2005		4/27/2005		8/15/2005		9/22/2005		11/30/2005	
Chloromethane	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Vinyl chloride	2	ug/L	**151.5**	**120**	J	**150**	J	**420**		**690**		**170**	J
Bromomethane		ug/L	---	250	U	250	U	250	U	500	U	250	U
Chloroethane	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
1 1-Dichloroethene	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Carbon disulfide		ug/L	---	250	U	250	U	250	U	500	U	250	UJ
Acetone		ug/L	---	500	U	250	U	250	U	1000	U	500	U
Methylene chloride	5	ug/L	---	250	UB	250	UB	250	UB	250	UB	250	UB
trans-1 2-Dichloroethene	5	ug/L	12.75	250	U	250	U	250	U	500	U	250	U
1 1-Dichloroethane	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
cis-1 2-Dichloroethene	5	ug/L	**2470**	**4300**	J	**4900**		**5900**		**5300**		**4500**	
2-Butanone (MEK)		ug/L	---	500	U	250	U	250	U	1000	U	500	U
Chloroform	7	ug/L	---	250	U	250	U	250	U	500	U	250	U
1 1 1-Trichloroethane	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Carbon tetrachloride	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Benzene	1	ug/L	---	250	U	250	U	250	U	500	U	250	U
1 2-Dichloroethane	0.6	ug/L	---	250	U	250	U	250	U	500	U	250	U
Trichloroethene	5	ug/L	**507.5**	**3000**	J	**3700**		**3600**		**3200**		**3000**	
1 2-Dichloropropane	1	ug/L	---	250	U	250	U	250	U	500	U	250	U
Bromodichloromethane		ug/L	---	250	U	250	U	250	U	500	U	250	U
cis-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	500	U	250	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	500	U	500	U	500	U	1000	U	500	U
Toluene	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
trans-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	500	U	250	U
1 1 2-Trichloroethane	1	ug/L	---	250	U	250	U	250	U	500	U	250	U
Tetrachloroethene	5	ug/L	**744**	**6400**	J	**8600**		**7900**		**6100**		**6400**	
2-Hexanone		ug/L	---	500	U	500	U	500	U	1000	U	500	U
Dibromochloromethane		ug/L	---	250	U	250	U	250	U	500	U	250	U
Chlorobenzene	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Ethylbenzene	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Styrene	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Bromoform		ug/L	---	250	U	250	U	250	U	500	U	250	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Xylenes (total)	5	ug/L	---	250	U	250	U	250	U	500	U	250	U
Total VOCs		ug/L	3388.35	14070		18100		18570		15540		14320	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		9/22/2005		11/30/2005	
Potassium		mg/L	21.8	18.7		21.4	E	20.7		NS		21.8	
Sodium	200	mg/L	193	165		195		**297**		NS		**215**	
Sulfate	250	mg/L	42.15	88.5		82.8		154		NS		137	

Notes:
U: Not detected. Reporting limit provided.
B: Detected in blank.
J: Estimated.
Highlighted results exceed NYS Standards

Table B-9b
MW-83-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/27/2005		8/15/2005		12/1/2005	
Chloromethane	5	ug/L	---	500	U	500	U	250	U	500	U
Vinyl chloride	2	ug/L	**400**	**390**	J	**550**		**320**		**530**	
Bromomethane		ug/L	---	500	U	500	U	250	U	500	U
Chloroethane	5	ug/L	---	500	U	500	U	250	U	500	U
1 1-Dichloroethene	5	ug/L	---	500	U	500	U	250	U	500	U
Carbon disulfide		ug/L	---	500	U	500	U	250	U	500	UJ
Acetone		ug/L	---	1000	U	500	U	250	U	1000	U
Methylene chloride	5	ug/L	---	500	UB	500	UB	250	UB	500	UB
trans-1 2-Dichloroethene	5	ug/L	---	500	U	500	U	250	U	500	U
1 1-Dichloroethane	5	ug/L	---	500	U	500	U	250	U	500	U
cis-1 2-Dichloroethene	5	ug/L	**8100**	**8000**		**9700**		**6100**		**8000**	
2-Butanone (MEK)		ug/L	---	1000	U	1000	U	250	U	1000	U
Chloroform	7	ug/L	---	500	U	500	U	250	U	500	U
1 1 1-Trichloroethane	5	ug/L	---	500	U	500	U	250	U	500	U
Carbon tetrachloride	5	ug/L	---	500	U	500	U	250	U	500	U
Benzene	1	ug/L	---	500	U	500	U	250	U	500	U
1 2-Dichloroethane	0.6	ug/L	---	500	U	500	U	250	U	500	U
Trichloroethene	5	ug/L	**4700**	**5000**		**4100**		**3000**		**5300**	
1 2-Dichloropropane	1	ug/L	---	500	U	500	U	250	U	500	U
Bromodichloromethane		ug/L	---	500	U	500	U	250	U	500	U
cis-1 3-Dichloropropene	0.4	ug/L	---	500	U	500	U	250	U	500	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	1000	U	1000	U	500	U	1000	U
Toluene	5	ug/L	---	500	U	500	U	250	U	500	U
trans-1 3-Dichloropropene	0.4	ug/L	---	500	U	500	U	250	U	500	U
1 1 2-Trichloroethane	1	ug/L	---	500	U	500	U	250	U	500	U
Tetrachloroethene	5	ug/L	**11700**	**12000**		**7800**		**6800**		**12000**	
2-Hexanone		ug/L	---	1000	U	1000	U	500	U	1000	U
Dibromochloromethane		ug/L	---	500	U	500	U	250	U	500	U
Chlorobenzene	5	ug/L	---	500	U	500	U	250	U	500	U
Ethylbenzene	5	ug/L	---	500	U	500	U	250	U	500	U
Styrene	5	ug/L	---	500	U	500	U	250	U	500	U
Bromoform		ug/L	---	500	U	500	U	250	U	500	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	500	U	500	U	250	U	500	U
Xylenes (total)	5	ug/L	---	500	U	500	U	250	U	500	U
Total VOCs		ug/L	22891	25890		23150		16970		26330	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		12/1/2005	
Potassium		mg/L	12.95	13.2		15.3	E	17.7		16.3	
Sodium	200	mg/L	**308**	**354**		**366**		**398**		**413**	
Sulfate	250	mg/L	86.1	64.6		72		58.3		44.2	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-9c
MW-83-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/27/2005		8/15/2005		12/1/2005	
Chloromethane	5	ug/L	---	120	U	120	U	120	U	50	U
Vinyl chloride	2	ug/L	**670**	**390**		**430**		**260**		**150**	
Bromomethane		ug/L	---	120	U	120	U	120	U	50	U
Chloroethane	5	ug/L	---	120	U	120	U	120	U	50	U
1 1-Dichloroethene	5	ug/L	---	120	U	120	U	120	U	50	U
Carbon disulfide		ug/L	---	120	U	120	U	120	U	50	UJ
Acetone		ug/L	---	250	U	250	UB	120	U	100	U
Methylene chloride	5	ug/L	---	120	UB	120	UB	120	UB	50	UB
trans-1 2-Dichloroethene	5	ug/L	---	120	U	13	J	18	J	13	J
1 1-Dichloroethane	5	ug/L	---	120	U	120	U	120	U	50	U
cis-1 2-Dichloroethene	5	ug/L	**6350**	**2900**		**2900**		**3200**		**1500**	
2-Butanone (MEK)		ug/L	---	250	U	120	U	120	U	100	U
Chloroform	7	ug/L	---	120	U	120	U	120	U	50	U
1 1 1-Trichloroethane	5	ug/L	---	120	U	120	U	120	U	50	U
Carbon tetrachloride	5	ug/L	---	120	U	120	U	120	U	50	U
Benzene	1	ug/L	---	120	U	120	U	120	U	50	U
1 2-Dichloroethane	0.6	ug/L	---	120	U	120	U	120	U	50	U
Trichloroethene	5	ug/L	**915**	**240**		**200**		**450**		**230**	
1 2-Dichloropropane	1	ug/L	---	120	U	120	U	120	U	50	U
Bromodichloromethane		ug/L	---	120	U	120	U	120	U	50	U
cis-1 3-Dichloropropene	0.4	ug/L	---	120	U	120	U	120	U	50	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	250	U	250	U	250	U	100	U
Toluene	5	ug/L	---	120	U	120	U	120	U	50	U
trans-1 3-Dichloropropene	0.4	ug/L	---	120	U	120	U	120	U	50	U
1 1 2-Trichloroethane	1	ug/L	---	120	U	120	U	120	U	50	U
Tetrachloroethene	5	ug/L	**2600**	**500**		**410**		**640**		**1100**	
2-Hexanone		ug/L	---	250	U	250	U	250	U	100	U
Dibromochloromethane		ug/L	---	120	U	120	U	120	U	50	U
Chlorobenzene	5	ug/L	---	120	U	120	U	120	U	50	U
Ethylbenzene	5	ug/L	---	120	U	120	U	120	U	50	U
Styrene	5	ug/L	---	120	U	120	U	120	U	50	U
Bromoform		ug/L	---	120	U	120	U	120	U	50	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	120	U	120	U	120	U	50	U
Xylenes (total)	5	ug/L	---	120	U	120	U	120	U	50	U
Total VOCs		ug/L	10572.5	4150		4193		4928		3043	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/27/2005		8/15/2005		12/1/2005	
Potassium		mg/L	23	20.1		24.7	E	30.6		23.9	
Sodium	200	mg/L	**217.5**	192		224		**323**		**287**	
Sulfate	250	mg/L	28.55	21		29.1		**314**		173	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-10a
MW-84R-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/26/2005		8/15/2005		9/22/2005		12/1/2005	
Chloromethane	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Vinyl chloride	2	ug/L	330	280		460		160	J	250	UH	290	
Bromomethane		ug/L	---	250	U	250	U	250	U	250	U	250	U
Chloroethane	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
1 1-Dichloroethene	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Carbon disulfide		ug/L	---	250	U	250	U	250	U	250	U	250	UJ
Acetone		ug/L	---	500	U	500	U	250	U	500	U	500	U
Methylene chloride	5	ug/L	---	500	UB	500	UB	250	UB	500	UB	500	UB
trans-1 2-Dichloroethene	5	ug/L	---	33	J	250	U	30	J	86	J	43	J
1 1-Dichloroethane	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
cis-1 2-Dichloroethene	5	ug/L	7000	7500		9000		6700		4900		5200	
2-Butanone (MEK)		ug/L	---	500	U	250	J	250	U	500	U	500	U
Chloroform	7	ug/L	---	250	U	250	U	250	U	250	U	250	U
1 1 1-Trichloroethane	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Carbon tetrachloride	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Benzene	1	ug/L	---	250	U	250	U	250	U	250	U	250	U
1 2-Dichloroethane	0.6	ug/L	---	250	U	250	U	250	U	250	U	250	U
Trichloroethene	5	ug/L	2150	2100		2100		1400		1400		1400	
1 2-Dichloropropane	1	ug/L	---	250	U	250	U	250	U	250	U	250	U
Bromodichloromethane		ug/L	---	250	U	250	U	250	U	250	U	250	U
cis-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	250	U	250	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	500	U	500	U	500	U	500	U	500	U
Toluene	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
trans-1 3-Dichloropropene	0.4	ug/L	---	250	U	250	U	250	U	250	U	250	U
1 1 2-Trichloroethane	1	ug/L	---	250	U	250	U	250	U	250	U	250	U
Tetrachloroethene	5	ug/L	6900	2800		2500		1600		1900		1300	
2-Hexanone		ug/L	---	500	U	500	U	500	U	500	U	500	U
Dibromochloromethane		ug/L	---	250	U	250	U	250	U	250	U	250	U
Chlorobenzene	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Ethylbenzene	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Styrene	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Bromoform		ug/L	---	250	U	250	U	250	U	250	U	250	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Xylenes (total)	5	ug/L	---	250	U	250	U	250	U	250	U	250	U
Total VOCs		ug/L	16399.5	12713		14810		10390		9036		8733	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/15/2005		9/22/2005		12/1/2005	
Potassium		mg/L	47.5	32.7		38.7		56.8		NS		48.1	
Sodium	200	mg/L	218.5	230		266		262		NS		291	
Sulfate	250	mg/L	107.4	126		226		241		NS		309	

Notes:
U: Not detected. Reporting limit provided.
B: Detected in blank.
J: Estimated.
Highlighted results exceed NYS Standards

Table B-10b
MW-84R-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/26/2005		8/15/2005		9/22/2005		12/1/2005	
Chloromethane	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Vinyl chloride	2	ug/L	---	**490**	J	**1100**	J	**2500**	U	**5000**	UH	**550**	J
Bromomethane		ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Chloroethane	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 1-Dichloroethene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Carbon disulfide		ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	UJ
Acetone		ug/L	---	5000	U	5000	U	2500	U	5000	U	5000	U
Methylene chloride	5	ug/L	---	5000	UB	5000	UB	2500	UB	5000	UB	5000	UB
trans-1 2-Dichloroethene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 1-Dichloroethane	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
cis-1 2-Dichloroethene	5	ug/L	**5100**	**7100**		**11000**		**6300**		**6400**		**8400**	
2-Butanone (MEK)		ug/L	---	5000	U	2600	J	2500	U	10000	U	5000	U
Chloroform	7	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 1 1-Trichloroethane	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Carbon tetrachloride	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Benzene	1	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 2-Dichloroethane	0.6	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Trichloroethene	5	ug/L	**8150**	**9600**		**14000**		**16000**		**11000**		**12000**	
1 2-Dichloropropane	1	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Bromodichloromethane		ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
cis-1 3-Dichloropropene	0.4	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	5000	U	5000	U	5000	U	10000	U	5000	U
Toluene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
trans-1 3-Dichloropropene	0.4	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 1 2-Trichloroethane	1	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Tetrachloroethene	5	ug/L	**58000**	**50000**		**69000**		**62000**		**58000**		**47000**	
2-Hexanone		ug/L	---	5000	U	5000	U	5000	U	10000	U	5000	U
Dibromochloromethane		ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Chlorobenzene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Ethylbenzene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Styrene	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Bromoform		ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Xylenes (total)	5	ug/L	---	2500	U	2500	U	2500	U	5000	U	2500	U
Total VOCs		ug/L	71475	72190		102700		89300		80400		72950	

Analyte	**NYS Standards**	**Units**	**Baseline**	**1/25/2005**		**4/26/2005**		**8/15/2005**		**8/15/2005**		**12/1/2005**	
Potassium		mg/L	9.605	8.66		9.77		12		12		14.7	
Sodium	200	mg/L	**315**	**318**		**340**		**388**		**388**		**444**	
Sulfate	250	mg/L	35.3	52.1		53.1		223		223		**303**	

Notes:
U: Not detected. Reporting limit provided.
B: Detected in blank.
J: Estimated.
Highlighted results exceed NYS Standards

Table B-10c
MW-84R-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/26/2005		4/26/2005		8/15/2005		12/1/2005	
Chloromethane	5	ug/L	---	500	U	500	U	500	U	500	U
Vinyl chloride	2	ug/L	**575**	**380**	J	**510**		**470**	J	**1100**	
Bromomethane		ug/L	---	500	U	500	U	500	U	500	U
Chloroethane	5	ug/L	---	500	U	500	U	500	U	500	U
1 1-Dichloroethene	5	ug/L	---	500	U	500	U	500	U	500	U
Carbon disulfide		ug/L	---	500	U	500	U	500	U	500	UJ
Acetone		ug/L	---	1000	U	1000	U	500	U	1000	U
Methylene chloride	5	ug/L	---	500	UB	500	UB	500	UB	500	UB
trans-1 2-Dichloroethene	5	ug/L	---	500	U	500	U	500	UM	500	U
1 1-Dichloroethane	5	ug/L	---	500	U	500	U	500	U	500	U
cis-1 2-Dichloroethene	5	ug/L	**8950**	**6600**		**8400**		**8000**		**9500**	
2-Butanone (MEK)		ug/L	---	1000	U	500	U	500	U	1000	U
Chloroform	7	ug/L	---	500	U	500	U	500	U	500	U
1 1 1-Trichloroethane	5	ug/L	---	500	U	500	U	500	U	500	U
Carbon tetrachloride	5	ug/L	---	500	U	500	U	500	U	500	U
Benzene	1	ug/L	---	500	U	500	U	500	U	500	U
1 2-Dichloroethane	0.6	ug/L	---	500	U	500	U	500	U	500	U
Trichloroethene	5	ug/L	**5500**	**4300**		**6000**		**7300**		**7700**	
1 2-Dichloropropane	1	ug/L	---	500	U	500	U	500	U	500	U
Bromodichloromethane		ug/L	---	500	U	500	U	500	U	500	U
cis-1 3-Dichloropropene	0.4	ug/L	---	500	U	500	U	500	U	500	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	1000	U	1000	U	1000	U	1000	U
Toluene	5	ug/L	---	500	U	500	U	500	U	500	U
trans-1 3-Dichloropropene	0.4	ug/L	---	500	U	500	U	500	U	500	U
1 1 2-Trichloroethane	1	ug/L	---	500	U	500	U	500	U	500	U
Tetrachloroethene	5	ug/L	**20500**	**15000**		**16000**		**13000**		**9100**	
2-Hexanone		ug/L	---	1000	U	1000	U	1000	U	1000	U
Dibromochloromethane		ug/L	---	500	U	500	U	500	U	500	U
Chlorobenzene	5	ug/L	---	500	U	500	U	500	U	500	U
Ethylbenzene	5	ug/L	---	500	U	500	U	500	U	500	U
Styrene	5	ug/L	---	500	U	500	U	500	U	500	U
Bromoform		ug/L	---	500	U	500	U	500	U	500	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	500	U	500	U	500	U	500	U
Xylenes (total)	5	ug/L	---	500	U	500	U	500	U	500	U
Total VOCs		ug/L	32540	26780		31910		30270		27900	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/15/2005		12/1/2005	
Potassium		mg/L	16.9	12.8		15		21.6		26.1	
Sodium	200	mg/L	**286.5**	**268**		**293**		**384**		**526**	
Sulfate	250	mg/L	25.45	26.9		28.6		**502**		**923**	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-11a
MW-85R-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/26/2005		8/15/2005		12/1/2005	
Chloromethane	5	ug/L	---	25	U	25	U	10	U	5	U
Vinyl chloride	2	ug/L	50.5	22	J	130		100		68	
Bromomethane		ug/L	---	25	U	25	U	10	U	5	U
Chloroethane	5	ug/L	---	25	U	25	U	10	U	5	U
1 1-Dichloroethene	5	ug/L	---	25	U	25	U	10	U	5	U
Carbon disulfide		ug/L	---	25	U	25	U	10	U	5	UJ
Acetone		ug/L	---	50	U	25	U	10	U	10	U
Methylene chloride	5	ug/L	---	25	UB	25	UB	10	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	5.5	3.2	J	25	U	10	U	1.4	J
1 1-Dichloroethane	5	ug/L	---	25	U	25	U	10	U	5	U
cis-1 2-Dichloroethene	5	ug/L	1400	700		550		190		100	
2-Butanone (MEK)		ug/L	---	50	U	25	U	20	UB	10	U
Chloroform	7	ug/L	---	25	U	25	U	10	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	25	U	25	U	10	U	5	U
Carbon tetrachloride	5	ug/L	---	25	U	25	U	10	U	5	U
Benzene	1	ug/L	---	25	U	25	U	10	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	25	U	25	U	10	U	5	U
Trichloroethene	5	ug/L	235	5.7	J	25	U	14		0.79	J
1 2-Dichloropropane	1	ug/L	---	25	U	25	U	10	U	5	U
Bromodichloromethane		ug/L	---	25	U	25	U	10	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	25	U	25	U	10	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	50	U	50	U	20	U	10	U
Toluene	5	ug/L	---	25	U	25	U	10	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	25	U	25	U	10	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	25	U	25	U	10	U	5	U
Tetrachloroethene	5	ug/L	950	11	J	25	U	3.6	J	1	J
2-Hexanone		ug/L	---	50	U	50	U	20	U	10	U
Dibromochloromethane		ug/L	---	25	U	25	U	10	U	5	U
Chlorobenzene	5	ug/L	---	25	U	25	U	10	U	5	U
Ethylbenzene	5	ug/L	---	25	U	25	U	10	U	5	U
Styrene	5	ug/L	---	25	U	25	U	10	U	5	U
Bromoform		ug/L	---	25	U	25	U	10	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	25	U	25	U	10	U	5	U
Xylenes (total)	5	ug/L	---	25	U	25	U	10	U	5	U
Total VOCs		ug/L	2647.5	766.9		755		327.6		176.19	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/15/2005		12/1/2005	
Potassium		mg/L	23.05	14.8	E	12.4		10.8		10.1	
Sodium	200	mg/L	297.5	295		280		262		245	
Sulfate	250	mg/L	196	63		52.9		33.3		26.2	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-11b
MW-85R-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/26/2005		8/15/2005		9/22/2005		12/1/2005	
Chloromethane	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Vinyl chloride	2	ug/L	**50**	**37**	J	**110**	J	**32**	J	**34**	J	**2.7**	J
Bromomethane		ug/L	---	100	U	120	U	120	U	200	U	5	U
Chloroethane	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
1 1-Dichloroethene	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Carbon disulfide		ug/L	---	100	U	120	U	120	U	200	U	5	UJ
Acetone		ug/L	---	200	U	250	U	120	U	200	U	10	U
Methylene chloride	5	ug/L	---	100	UB	120	UB	120	UB	200	UB	5	UB
trans-1 2-Dichloroethene	5	ug/L	**10.5**	**13**	J	120	U	120	UM	200	U	0.63	J
1 1-Dichloroethane	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
cis-1 2-Dichloroethene	5	ug/L	**2000**	**2700**		**2500**		**2400**		**3500**		**88**	
2-Butanone (MEK)		ug/L	---	200	U	120	U	120	U	400	U	10	U
Chloroform	7	ug/L	---	100	U	120	U	120	U	200	U	5	U
1 1 1-Trichloroethane	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Carbon tetrachloride	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Benzene	1	ug/L	---	100	U	120	U	120	U	200	U	5	U
1 2-Dichloroethane	0.6	ug/L	---	100	U	120	U	120	U	200	U	5	U
Trichloroethene	5	ug/L	**325**	**260**		**240**		**520**		**730**		**16**	
1 2-Dichloropropane	1	ug/L	---	100	U	120	U	120	U	200	U	5	U
Bromodichloromethane		ug/L	---	100	U	120	U	120	U	200	U	5	U
cis-1 3-Dichloropropene	0.4	ug/L	---	100	U	120	U	120	U	200	U	5	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	200	U	250	U	250	U	400	U	10	U
Toluene	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
trans-1 3-Dichloropropene	0.4	ug/L	---	100	U	120	U	120	U	200	U	5	U
1 1 2-Trichloroethane	1	ug/L	---	100	U	120	U	120	U	200	U	5	U
Tetrachloroethene	5	ug/L	**2100**	**730**		**660**		**1200**		**1800**		**43**	
2-Hexanone		ug/L	---	200	U	250	U	250	U	400	U	10	U
Dibromochloromethane		ug/L	---	100	U	120	U	120	U	200	U	5	U
Chlorobenzene	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Ethylbenzene	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Styrene	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Bromoform		ug/L	---	100	U	120	U	120	U	200	U	5	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Xylenes (total)	5	ug/L	---	100	U	120	U	120	U	200	U	5	U
Total VOCs		ug/L	4327	3840		3750		4512		6630		155.33	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/15/2005		9/22/2005		12/1/2005	
Potassium		mg/L	29.75	35.8	E	29.9		28.9		NS		25.6	
Sodium	200	mg/L	**199.5**	**296**		**325**		**245**		NS		**265**	
Sulfate	250	mg/L	35.9	111		**281**		**75.1**		NS		101	

Notes:
U: Not detected. Reporting limit provided.
B: Detected in blank.
J: Estimated.
Highlighted results exceed NYS Standards

Table B-11c
MW-85R-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/26/2005		8/16/2005		12/1/2005	
Chloromethane	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Vinyl chloride	2	ug/L	**550**	**570**	J	**730**	J	**730**	J	**1900**	J
Bromomethane		ug/L	---	1000	U	1000	U	1000	U	2000	U
Chloroethane	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
1 1-Dichloroethene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Carbon disulfide		ug/L	---	1000	U	1000	U	1000	U	2000	UJ
Acetone		ug/L	---	2000	U	2000	U	2000	UB	4000	UB
Methylene chloride	5	ug/L	---	1000	UB	1000	UB	1000	UB	2000	UB
trans-1 2-Dichloroethene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
1 1-Dichloroethane	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
cis-1 2-Dichloroethene	5	ug/L	**3250**	**120**		**3400**		**3000**		**3400**	
2-Butanone (MEK)		ug/L	---	2000	U	1000	U	1000	U	4000	U
Chloroform	7	ug/L	---	1000	U	1000	U	1000	U	2000	U
1 1 1-Trichloroethane	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Carbon tetrachloride	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Benzene	1	ug/L	---	1000	U	1000	U	1000	U	2000	U
1 2-Dichloroethane	0.6	ug/L	---	1000	U	1000	U	1000	U	2000	U
Trichloroethene	5	ug/L	**255**	**430**	J	**830**	J	**1800**		**1600**	J
1 2-Dichloropropane	1	ug/L	---	1000	U	1000	U	1000	U	2000	U
Bromodichloromethane		ug/L	---	1000	U	1000	U	1000	U	2000	U
cis-1 3-Dichloropropene	0.4	ug/L	---	1000	U	1000	U	1000	U	2000	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	2000	U	2000	U	2000	U	4000	U
Toluene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
trans-1 3-Dichloropropene	0.4	ug/L	---	1000	U	1000	U	1000	U	2000	U
1 1 2-Trichloroethane	1	ug/L	---	1000	U	1000	U	1000	U	2000	U
Tetrachloroethene	5	ug/L	**8700**	**100**		**25000**		**31000**		**28000**	
2-Hexanone		ug/L	---	2000	U	2000	U	2000	U	4000	U
Dibromochloromethane		ug/L	---	1000	U	1000	U	1000	U	2000	U
Chlorobenzene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Ethylbenzene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Styrene	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Bromoform		ug/L	---	1000	U	1000	U	1000	U	2000	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Xylenes (total)	5	ug/L	---	1000	U	1000	U	1000	U	2000	U
Total VOCs		ug/L	12675	2220		31960		38530		36900	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/26/2005		8/16/2005		12/1/2005	
Potassium		mg/L	15.45	15.7	E	15.3		23.9		23.3	
Sodium	200	mg/L	**302**	**352**		365		**477**		**595**	
Sulfate	250	mg/L	29	196		274		**829**		**970**	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-12a
MW-86R-1
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/25/2005		8/15/2005		12/1/2005	
Chloromethane	5	ug/L	---	50	U	25	U	25	U	25	U
Vinyl chloride	2	ug/L	**10.5**	**11**	J	**12**	J	**27**		**39**	
Bromomethane		ug/L	---	50	U	25	U	25	U	25	U
Chloroethane	5	ug/L	---	50	U	25	U	25	U	25	U
1 1-Dichloroethene	5	ug/L	---	50	U	25	U	25	U	25	U
Carbon disulfide		ug/L	---	50	U	25	U	25	U	25	UJ
Acetone		ug/L	---	100	U	50	U	25	U	50	UB
Methylene chloride	5	ug/L	---	50	UB	25	UB	25	UB	25	UB
trans-1 2-Dichloroethene	5	ug/L	---	50	U	25	U	25	UM	25	U
1 1-Dichloroethane	5	ug/L	---	50	U	25	U	25	U	25	U
cis-1 2-Dichloroethene	5	ug/L	**510**	**850**		**450**		**420**		**360**	
2-Butanone (MEK)		ug/L	---	100	U	25	U	U	UB	50	U
Chloroform	7	ug/L	---	50	U	25	U	25	U	25	U
1 1 1-Trichloroethane	5	ug/L	---	50	U	25	U	25	U	25	U
Carbon tetrachloride	5	ug/L	---	50	U	25	U	25	U	25	U
Benzene	1	ug/L	---	50	U	25	U	25	U	25	U
1 2-Dichloroethane	0.6	ug/L	---	50	U	25	U	25	U	25	U
Trichloroethene	5	ug/L	**305**	**10**	J	**5.4**	J	**59**		25	U
1 2-Dichloropropane	1	ug/L	---	50	U	25	U	25	U	25	U
Bromodichloromethane		ug/L	---	50	U	25	U	25	U	25	U
cis-1 3-Dichloropropene	0.4	ug/L	---	50	U	25	U	25	U	25	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	100	U	50	U	50	U	50	U
Toluene	5	ug/L	---	50	U	25	U	25	U	25	U
trans-1 3-Dichloropropene	0.4	ug/L	---	50	U	25	U	25	U	25	U
1 1 2-Trichloroethane	1	ug/L	---	50	U	25	U	25	U	25	U
Tetrachloroethene	5	ug/L	**1200**	**31**	J	**18**	J	**7.3**	J	**6.9**	J
2-Hexanone		ug/L	---	100	U	50	U	50	U	50	U
Dibromochloromethane		ug/L	---	50	U	25	U	25	U	25	U
Chlorobenzene	5	ug/L	---	50	U	25	U	25	U	25	U
Ethylbenzene	5	ug/L	---	50	U	25	U	25	U	25	U
Styrene	5	ug/L	---	50	U	25	U	25	U	25	U
Bromoform		ug/L	---	50	U	25	U	25	U	25	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	50	U	25	U	25	U	25	U
Xylenes (total)	5	ug/L	---	50	U	25	U	25	U	25	U
Total VOCs		ug/L	2026	952		535.4		538.3		430.9	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		8/15/2005		12/1/2005	
Potassium		mg/L	16.45	17.4	E	13.8		14.1		11.5	
Sodium	200	mg/L	**211.5**	**358**		262		**284**		**277**	
Sulfate	250	mg/L	69.25	28.6		31.7		27.3		12.1	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-12b
MW-86R-2
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/25/2005		8/17/2005		12/1/2005	
Chloromethane	5	ug/L	---	120	U	100	U	25	U	100	U
Vinyl chloride	2	ug/L	25.5	28	J	91	J	19	J	40	J
Bromomethane		ug/L	---	120	U	100	U	25	U	100	U
Chloroethane	5	ug/L	---	120	U	100	U	25	U	100	U
1 1-Dichloroethene	5	ug/L	---	120	U	100	U	25	U	100	U
Carbon disulfide		ug/L	---	120	U	100	U	25	U	100	UJ
Acetone		ug/L	---	250	U	200	UB	25	U	200	UB
Methylene chloride	5	ug/L	---	120	UB	100	UB	25	UB	100	UB
trans-1 2-Dichloroethene	5	ug/L	---	120	U	100	U	25	U	11	J
1 1-Dichloroethane	5	ug/L	---	120	U	100	U	25	U	100	U
cis-1 2-Dichloroethene	5	ug/L	1270	1400		1400		390		1100	
2-Butanone (MEK)		ug/L	---	250	U	100	U	50	U	200	U
Chloroform	7	ug/L	---	120	U	100	U	25	U	100	U
1 1 1-Trichloroethane	5	ug/L	---	120	U	100	U	25	U	100	U
Carbon tetrachloride	5	ug/L	---	120	U	100	U	25	U	100	U
Benzene	1	ug/L	---	120	U	100	U	25	U	100	U
1 2-Dichloroethane	0.6	ug/L	---	120	U	100	U	25	U	100	U
Trichloroethene	5	ug/L	315	440		430		160		190	
1 2-Dichloropropane	1	ug/L	---	120	U	100	U	25	U	100	U
Bromodichloromethane		ug/L	---	120	U	100	U	25	U	100	U
cis-1 3-Dichloropropene	0.4	ug/L	---	120	U	100	U	25	U	100	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	250	U	200	U	50	U	200	U
Toluene	5	ug/L	---	120	U	100	U	25	U	100	U
trans-1 3-Dichloropropene	0.4	ug/L	---	120	U	100	U	25	U	100	U
1 1 2-Trichloroethane	1	ug/L	---	120	U	100	U	25	U	100	U
Tetrachloroethene	5	ug/L	5350	3400		1900		520		870	
2-Hexanone		ug/L	---	250	U	200	U	50	U	200	U
Dibromochloromethane		ug/L	---	120	U	100	U	25	U	100	U
Chlorobenzene	5	ug/L	---	120	U	100	U	25	U	100	U
Ethylbenzene	5	ug/L	---	120	U	100	U	25	U	100	U
Styrene	5	ug/L	---	120	U	100	U	25	U	100	U
Bromoform		ug/L	---	120	U	100	U	25	U	100	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	120	U	100	U	25	U	100	U
Xylenes (total)	5	ug/L	---	120	U	100	U	25	U	100	U
Total VOCs		ug/L	6952.5	5388		4021		1139		2300	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		8/17/2005		12/1/2005	
Potassium		mg/L	25.25	39.9	E	25.1		9.49		33.3	
Sodium	200	mg/L	197	310		378		139		369	
Sulfate	250	mg/L	19.3	43.3		442		64		277	

Notes:

U: Not detected. Reporting limit provided.

B: Detected in blank.

J: Estimated.

Highlighted results exceed NYS Standards

Table B-12c
MW-86R-3
Baseline and Pre-Injection Sampling Results
Building 40
Watervliet Arsenal, Watervliet, New York

Volatile Organic Parameters Sample Date	NYS Standards	Units	9/30/2004	1/27/2005		4/25/2005		8/17/2005		12/1/2005	
Chloromethane	5	ug/L	---	120	U	250	U	250	U	500	U
Vinyl chloride	2	ug/L	---	28	J	220	J	640		650	
Bromomethane		ug/L	---	120	U	250	U	250	U	500	U
Chloroethane	5	ug/L	---	120	U	250	U	250	U	500	U
1 1-Dichloroethene	5	ug/L	---	120	U	250	U	250	U	500	U
Carbon disulfide		ug/L	---	120	U	250	U	250	U	500	UJ
Acetone		ug/L	---	250	U	500	U	250	U	1000	UB
Methylene chloride	5	ug/L	---	120	UB	250	UB	250	UB	500	UB
trans-1 2-Dichloroethene	5	ug/L	---	120	U	250	U	250	U	56	J
1 1-Dichloroethane	5	ug/L	---	120	U	250	U	250	U	500	U
cis-1 2-Dichloroethene	5	ug/L	2150 J	3100		6400		4000		5400	
2-Butanone (MEK)		ug/L	---	250	U	250	U	500	UB	1000	U
Chloroform	7	ug/L	---	120	U	250	U	250	U	500	U
1 1 1-Trichloroethane	5	ug/L	---	120	U	250	U	250	U	500	U
Carbon tetrachloride	5	ug/L	---	120	U	250	U	250	U	500	U
Benzene	1	ug/L	---	120	U	250	U	250	U	500	U
1 2-Dichloroethane	0.6	ug/L	---	120	U	250	U	250	U	500	U
Trichloroethene	5	ug/L	720 J	370		1800		470		240	J
1 2-Dichloropropane	1	ug/L	---	120	U	250	U	250	U	500	U
Bromodichloromethane		ug/L	---	120	U	250	U	250	U	500	U
cis-1 3-Dichloropropene	0.4	ug/L	---	120	U	250	U	250	U	500	U
4-Methyl-2-pentanone (MIBK)		ug/L	---	250	U	500	U	500	U	1000	U
Toluene	5	ug/L	---	120	U	250	U	250	U	31	J
trans-1 3-Dichloropropene	0.4	ug/L	---	120	U	250	U	250	U	500	U
1 1 2-Trichloroethane	1	ug/L	---	120	U	250	U	250	U	500	U
Tetrachloroethene	5	ug/L	6900 J	770		3800		1400		410	J
2-Hexanone		ug/L	---	250	U	500	U	500	U	1000	U
Dibromochloromethane		ug/L	---	120	U	250	U	250	U	500	U
Chlorobenzene	5	ug/L	---	120	U	250	U	250	U	500	U
Ethylbenzene	5	ug/L	---	120	U	250	U	250	U	500	U
Styrene	5	ug/L	---	120	U	250	U	250	U	500	U
Bromoform		ug/L	---	120	U	250	U	250	U	500	U
1 1 2 2-Tetrachloroethane	5	ug/L	---	120	U	250	U	250	U	500	U
Xylenes (total)	5	ug/L	---	120	U	250	U	250	U	500	U
Total VOCs		ug/L	9786	4388		12720		7010		7256	

Analyte	NYS Standards	Units	Baseline	1/25/2005		4/25/2005		8/17/2005		12/1/2005	
Potassium		mg/L	14.95	10.4	E	19.4		13.9		12.6	
Sodium	200	mg/L	398	431		546		504		537	
Sulfate	250	mg/L	9.845	79.6		975		532		366	

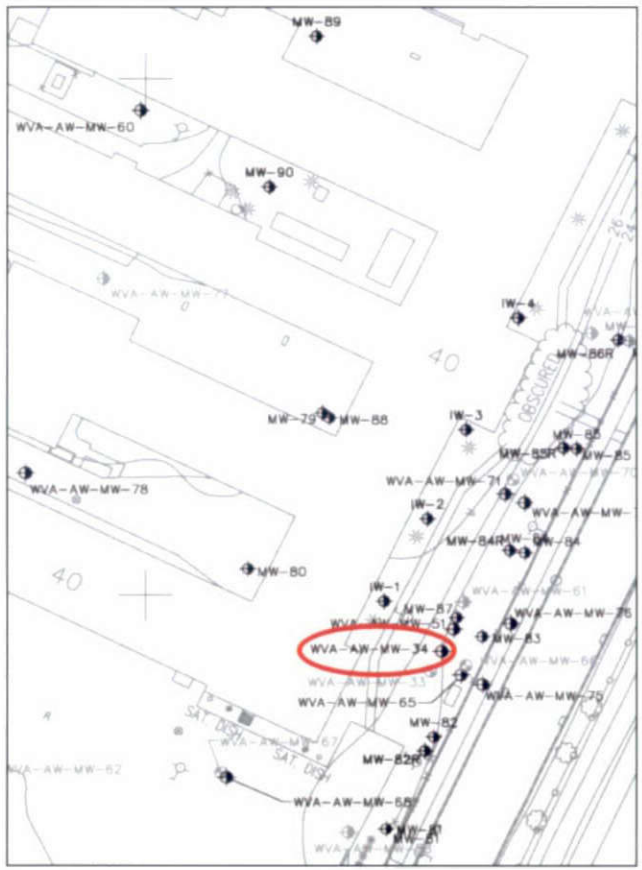
Notes:

U: Not detected. Reporting limit provided.

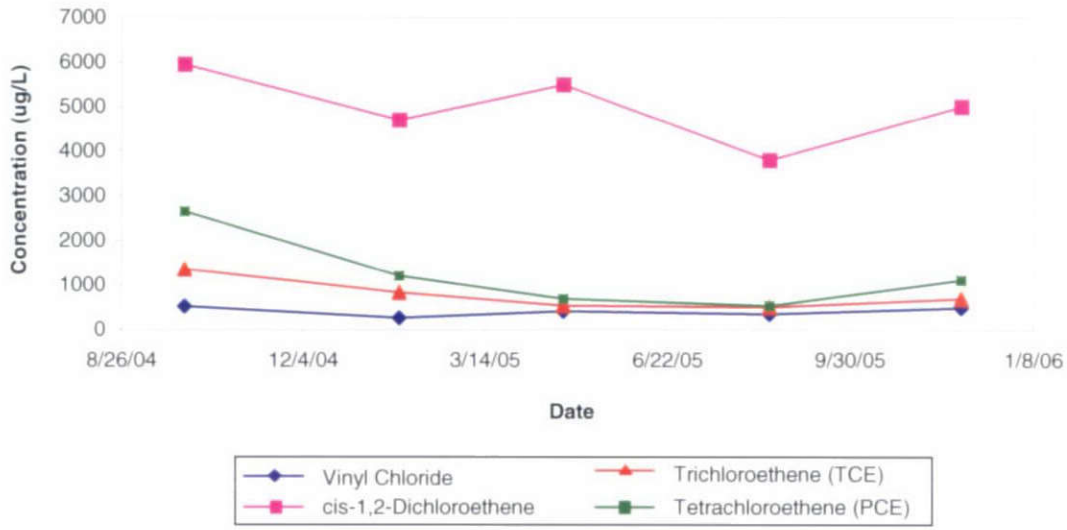
B: Detected in blank.

J: Estimated.

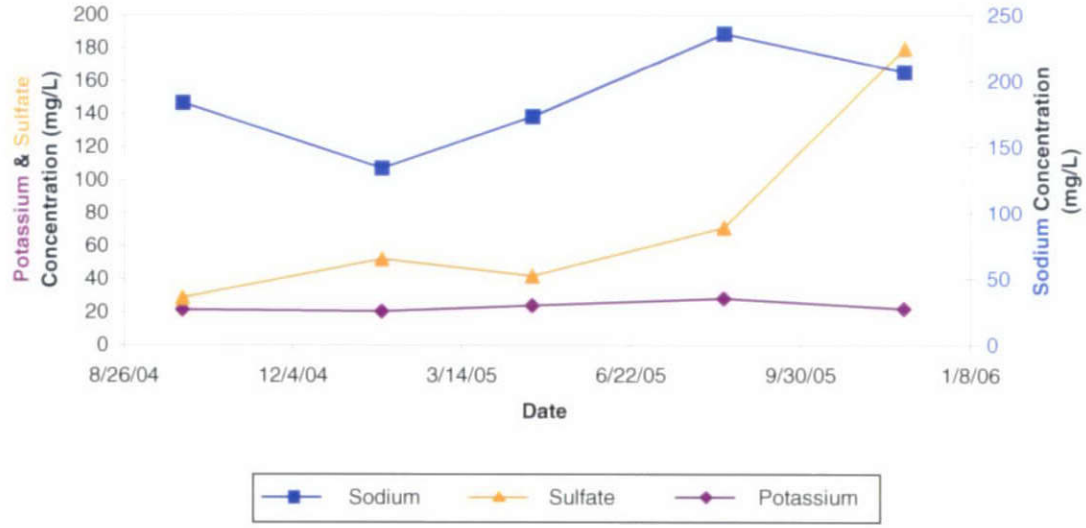
Highlighted results exceed NYS Standards



TARGET CHLORINATED ORGANIC COMPOUNDS



INORGANICS



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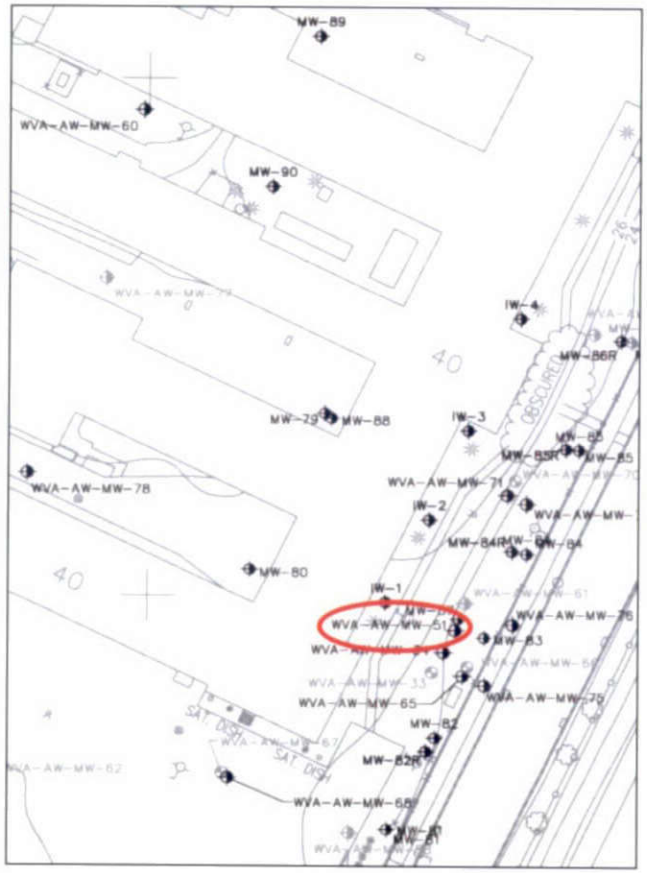
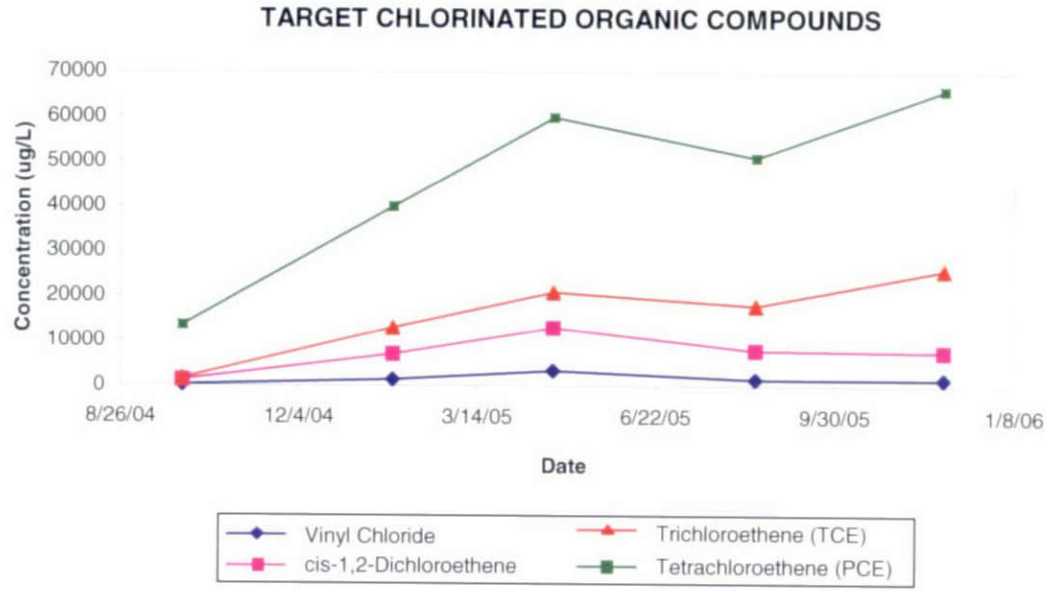
CORRECTIVE MEASURES STUDY

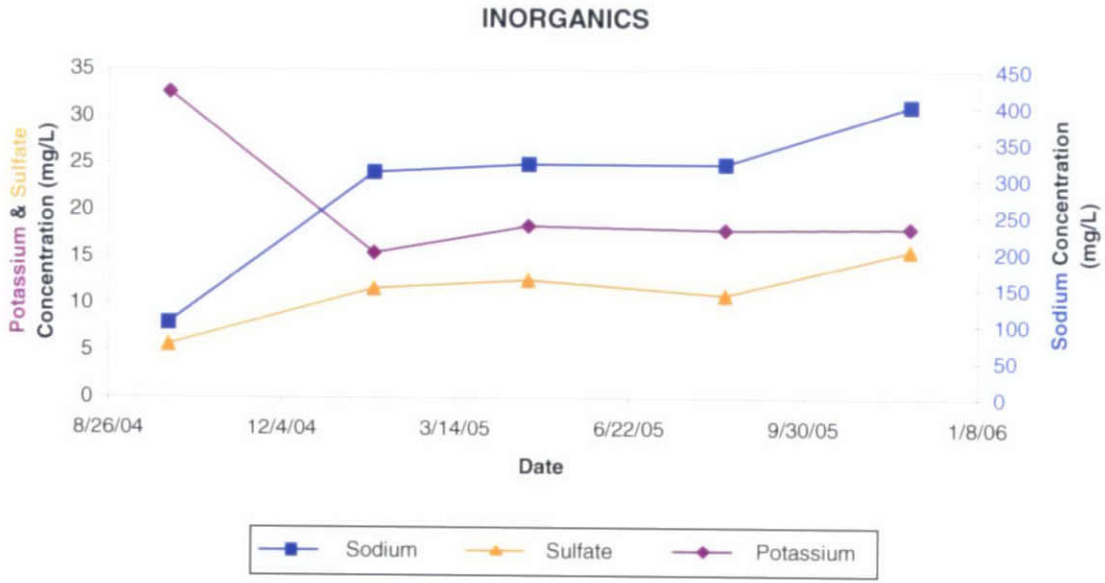
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-34

FIGURE B-1







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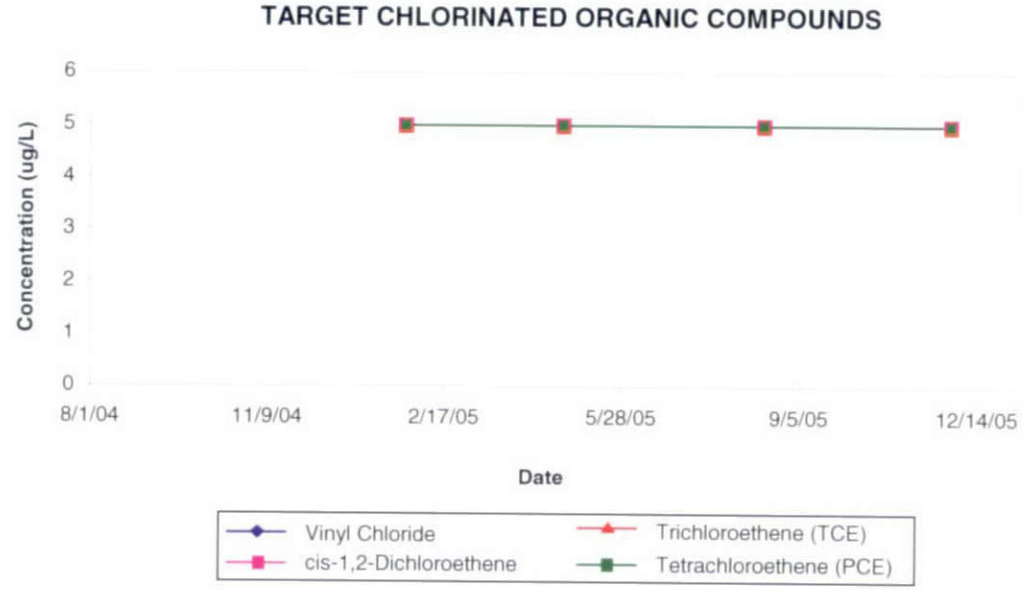
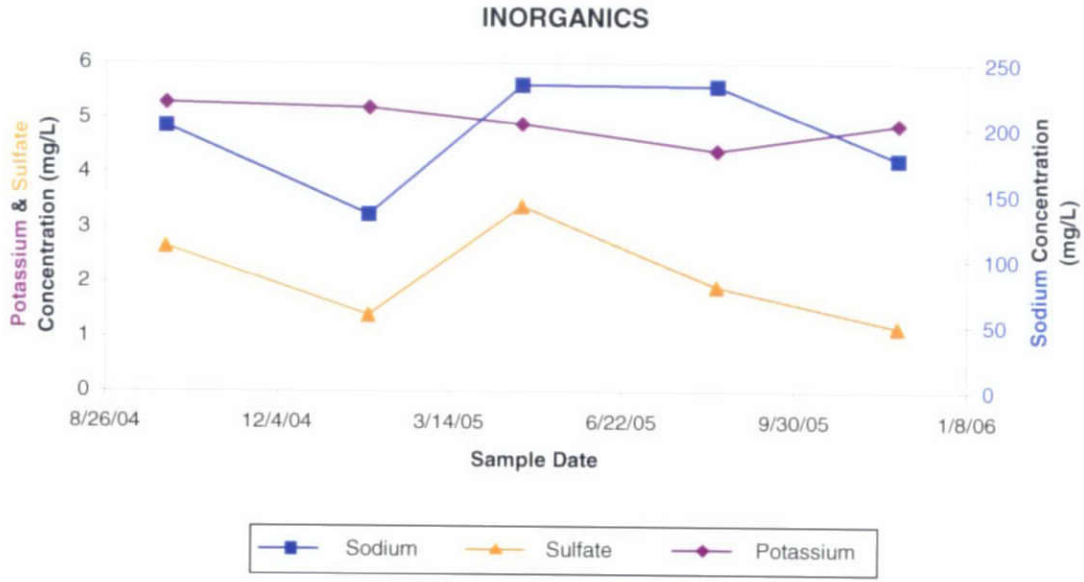
CORRECTIVE MEASURES STUDY

BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-51

FIGURE B-2





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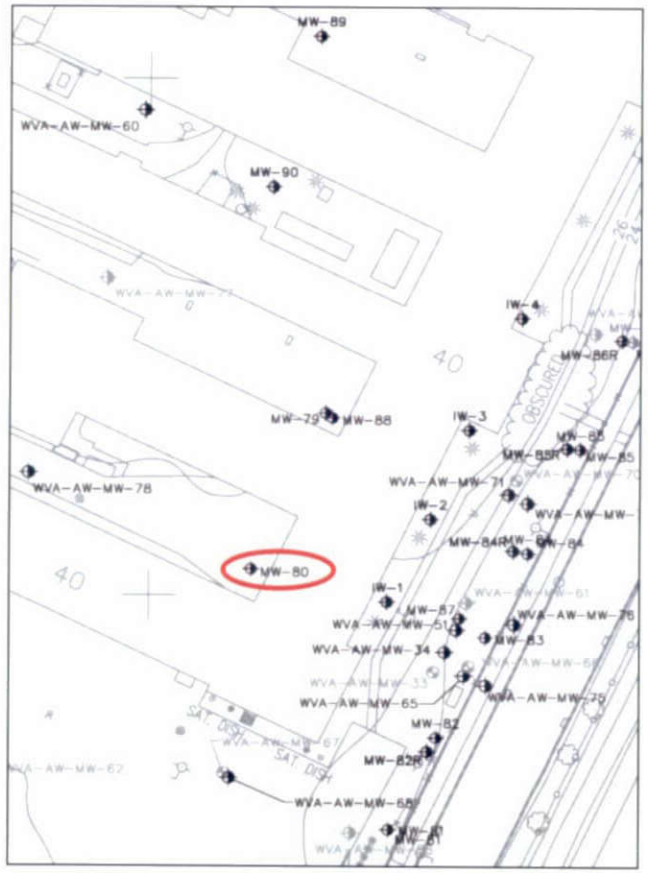
CORRECTIVE MEASURES STUDY

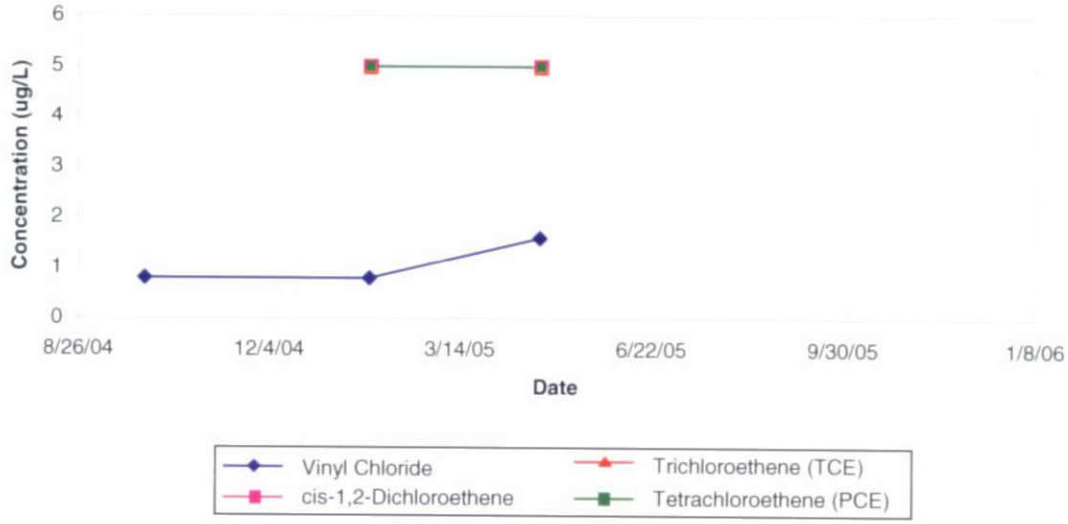
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-60

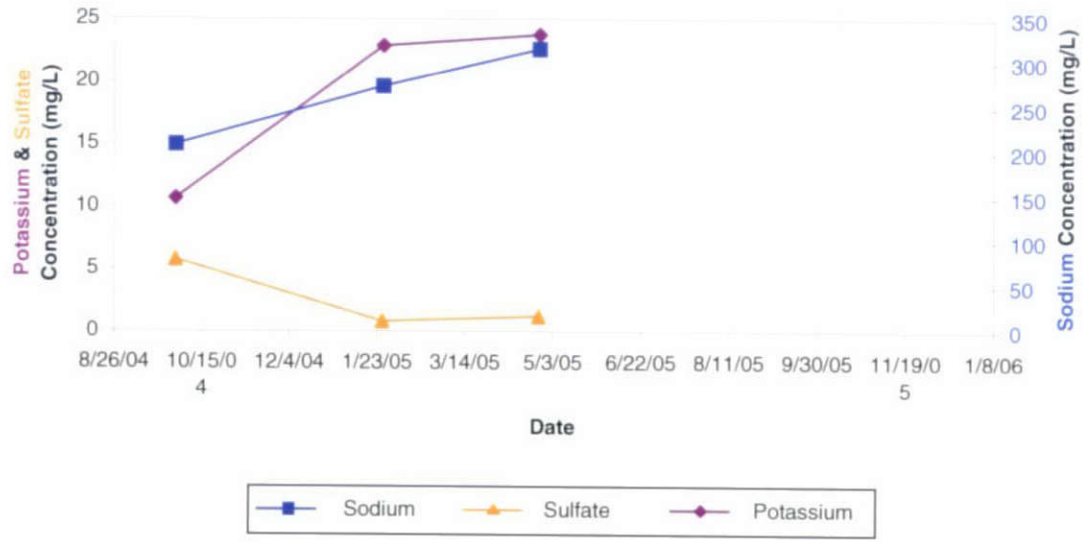
FIGURE B-3



TARGET CHLORINATED ORGANIC COMPOUNDS



INORGANICS



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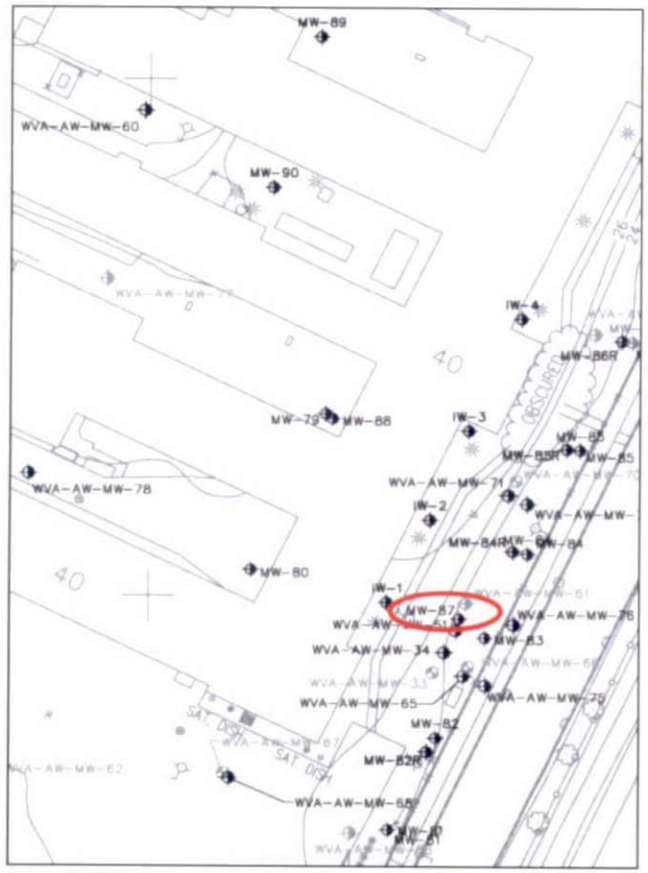
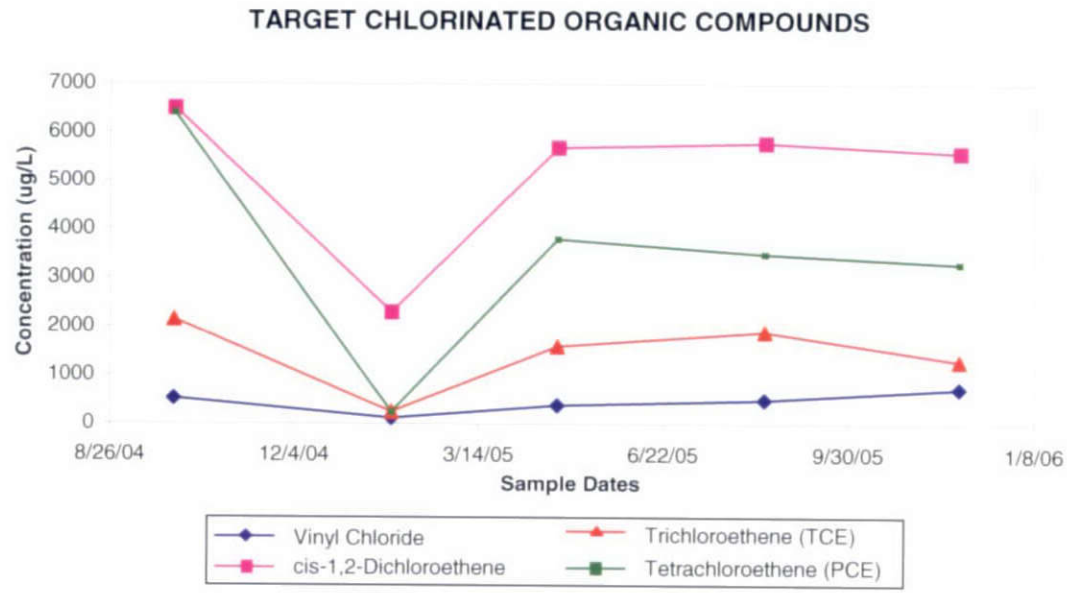
CORRECTIVE MEASURES STUDY

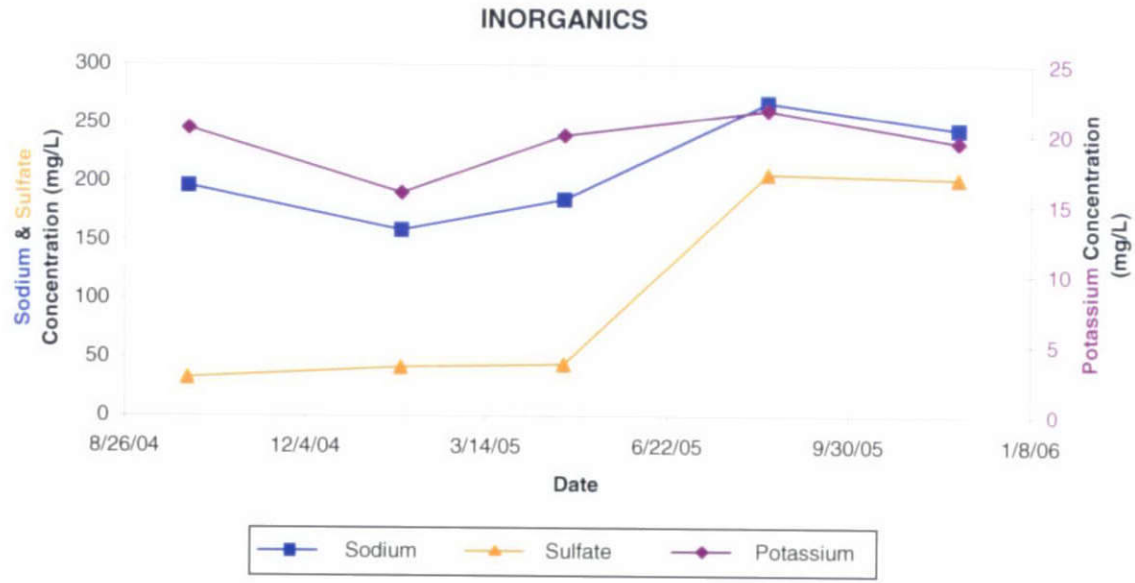
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-80

FIGURE B-4







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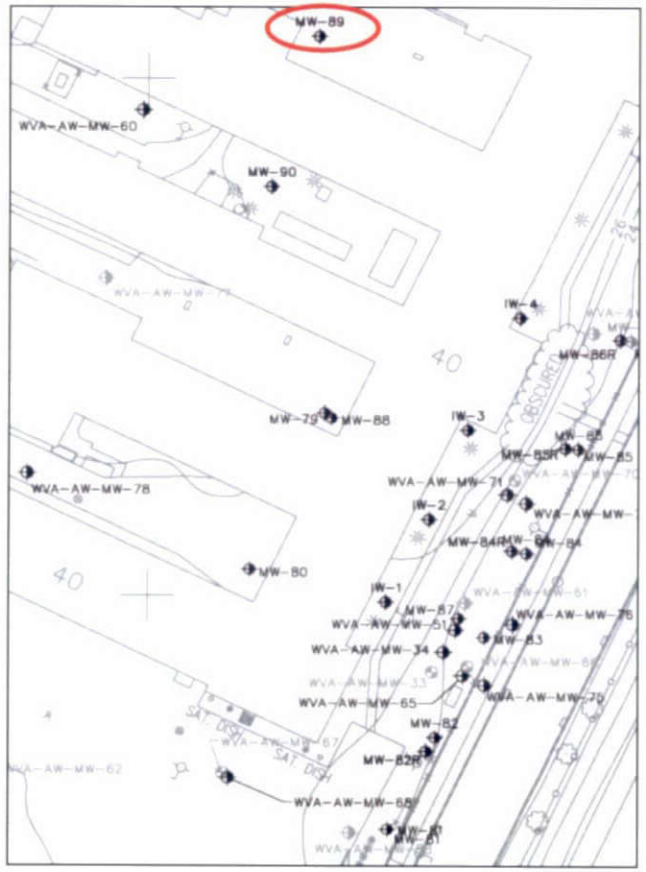
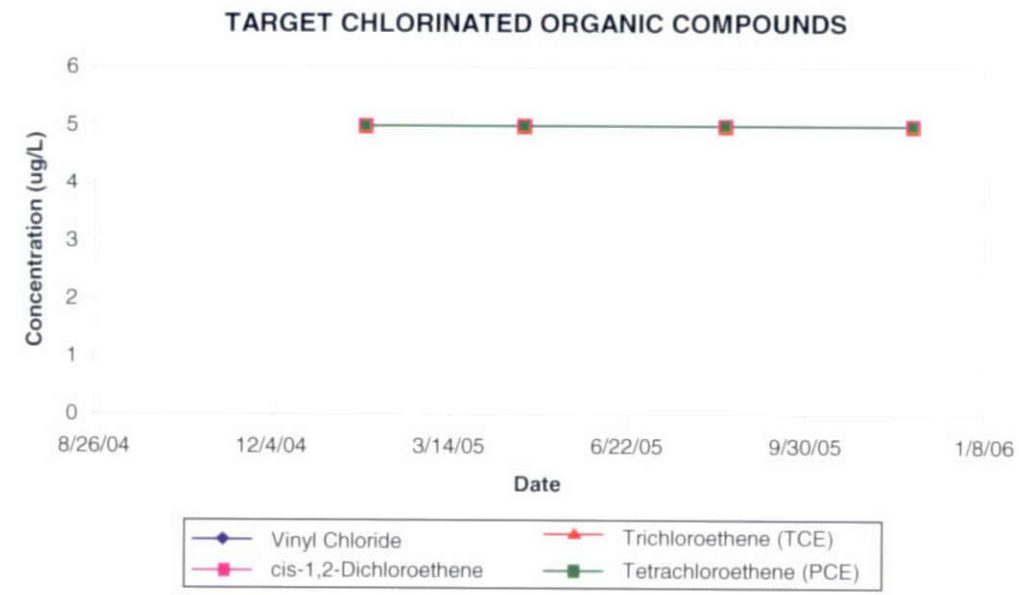
CORRECTIVE MEASURES STUDY

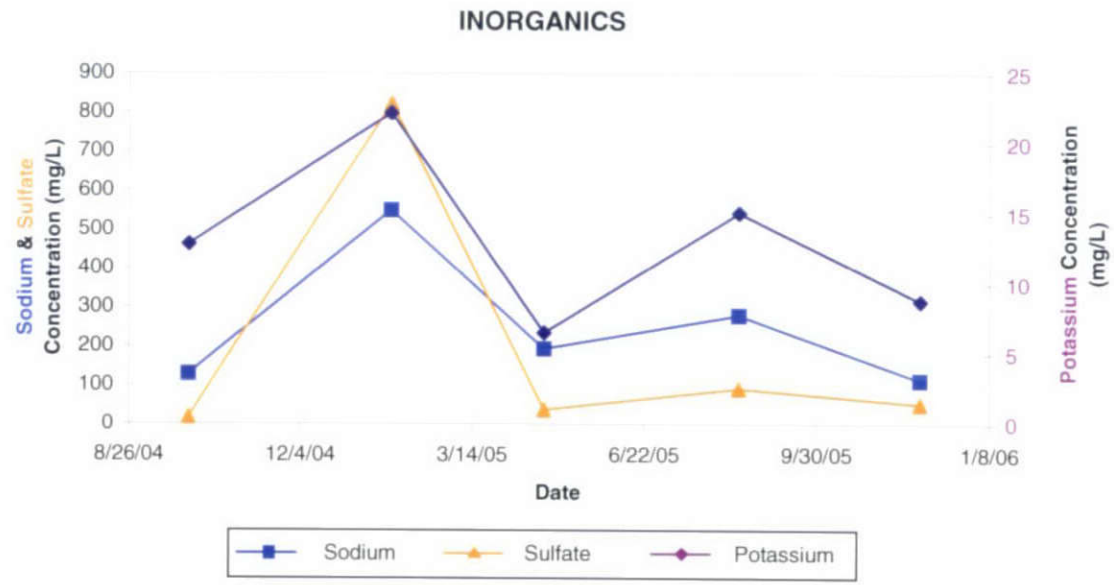
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-87

FIGURE B-5







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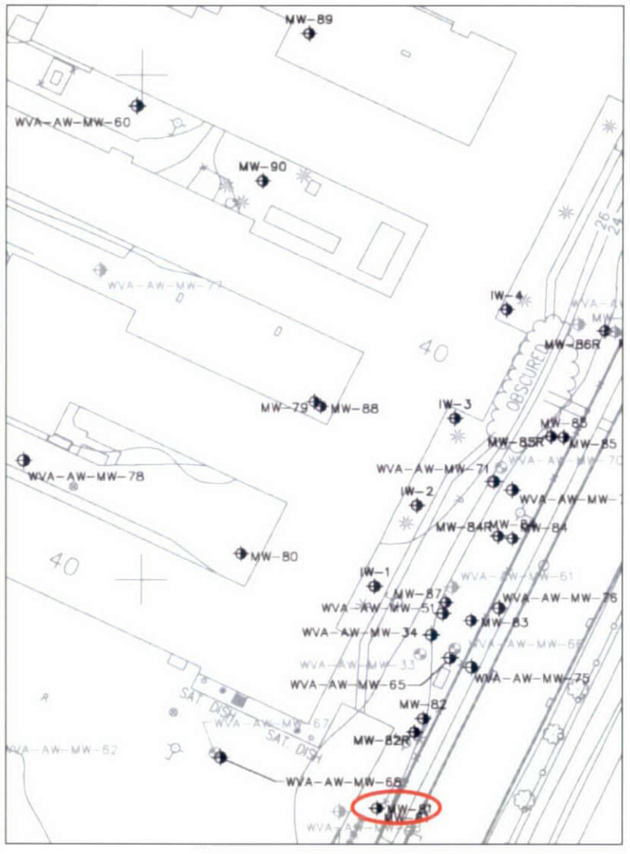
CORRECTIVE MEASURES STUDY

BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-89

FIGURE B-6

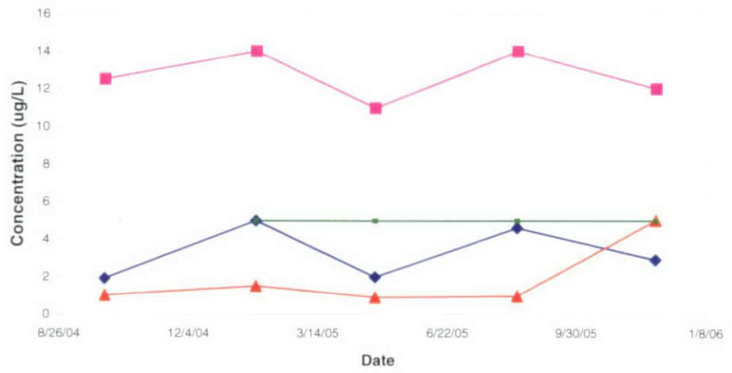


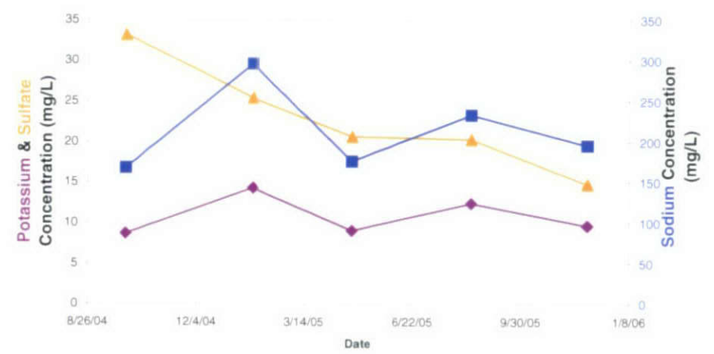
Note: Vertical scales are not the same.

TARGET CHLORINATED ORGANC COMPOUNDS

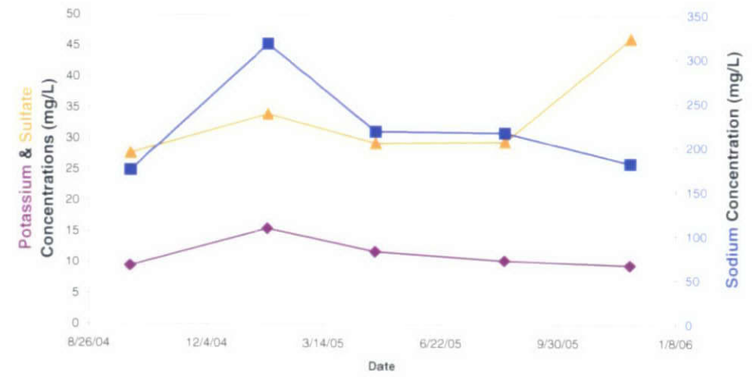
INORGANICS

MW-81-1

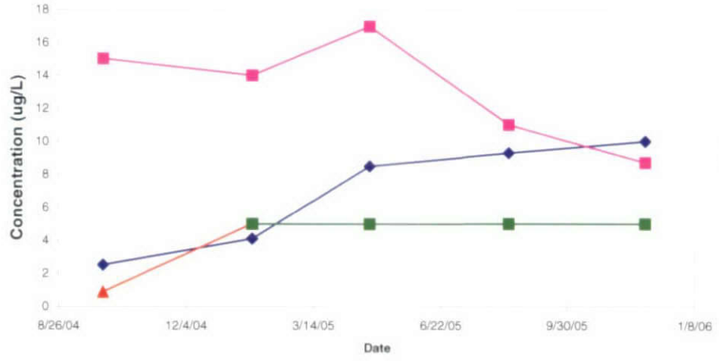


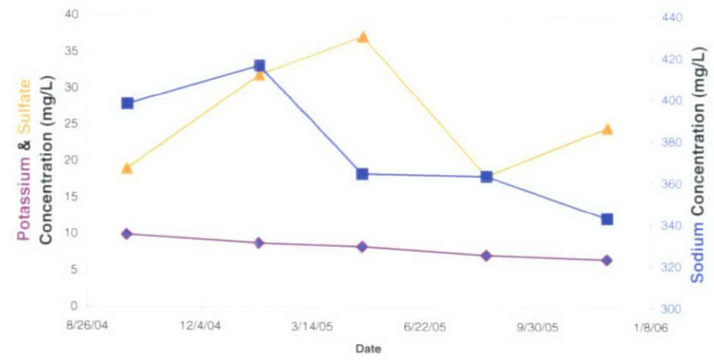


MW-81-2



MW-81-3





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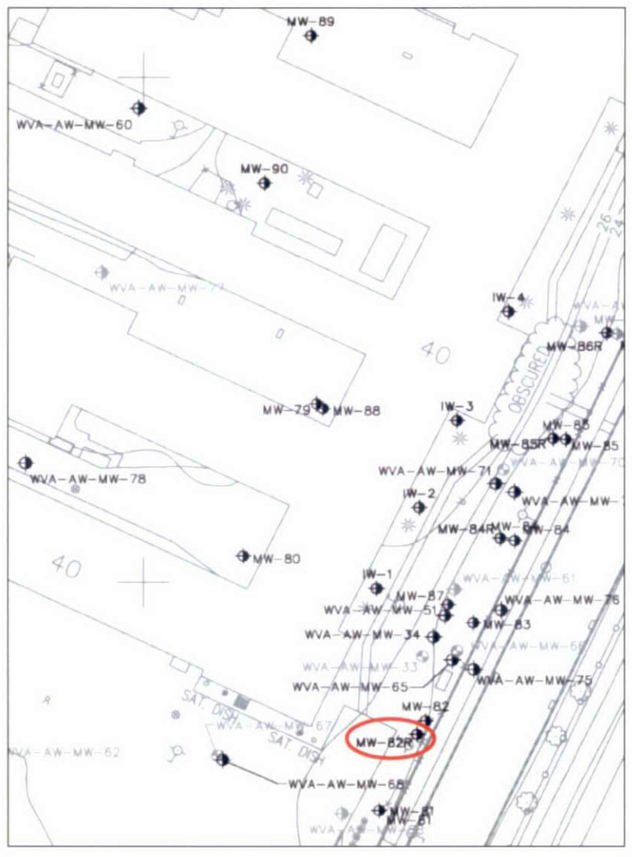
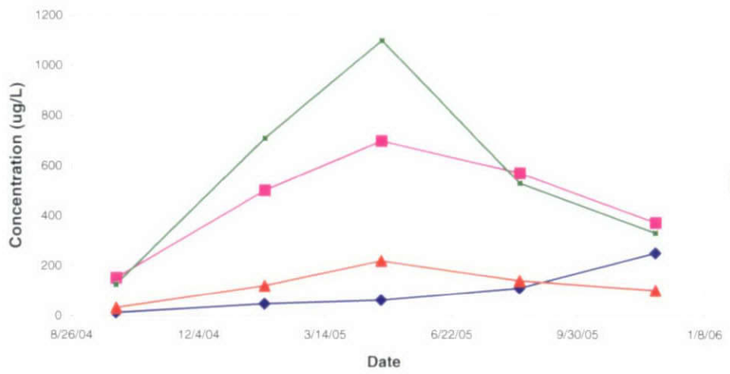
CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-81

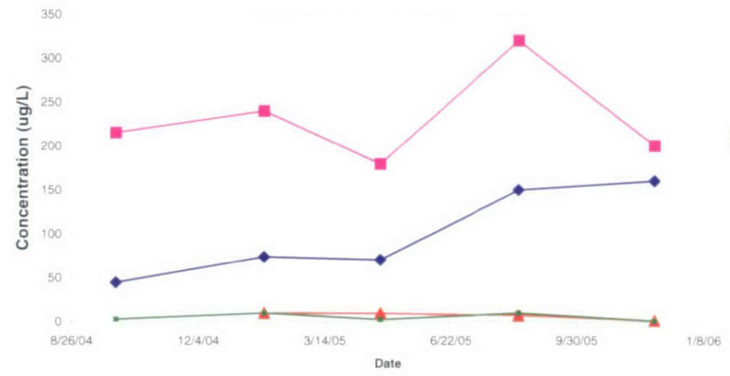
FIGURE B-7



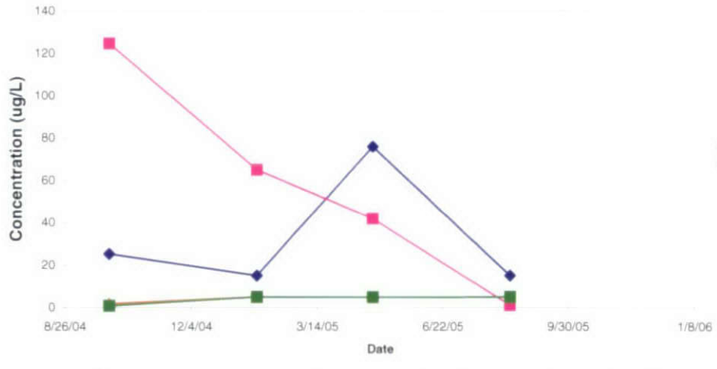
TARGET CHLORINATED ORGANC COMPOUNDS



MW-82R-1

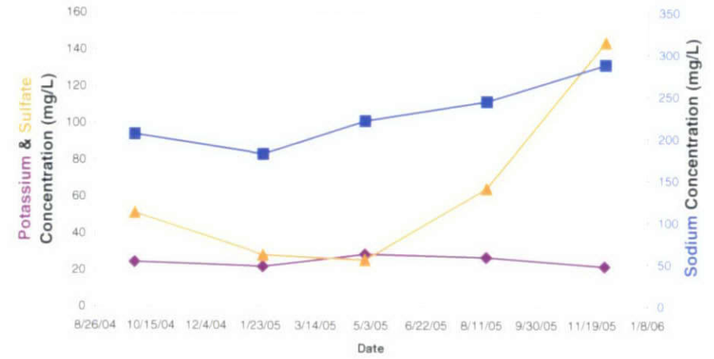


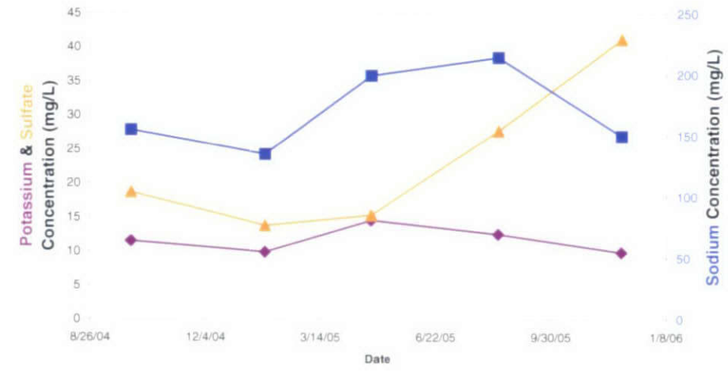
MW-82R-2

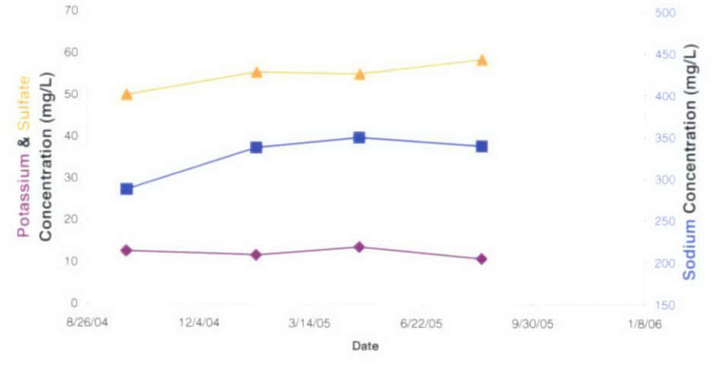


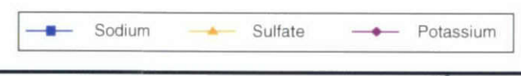
MW-82R-3

INORGANICS









Note: Vertical scales are not the same.

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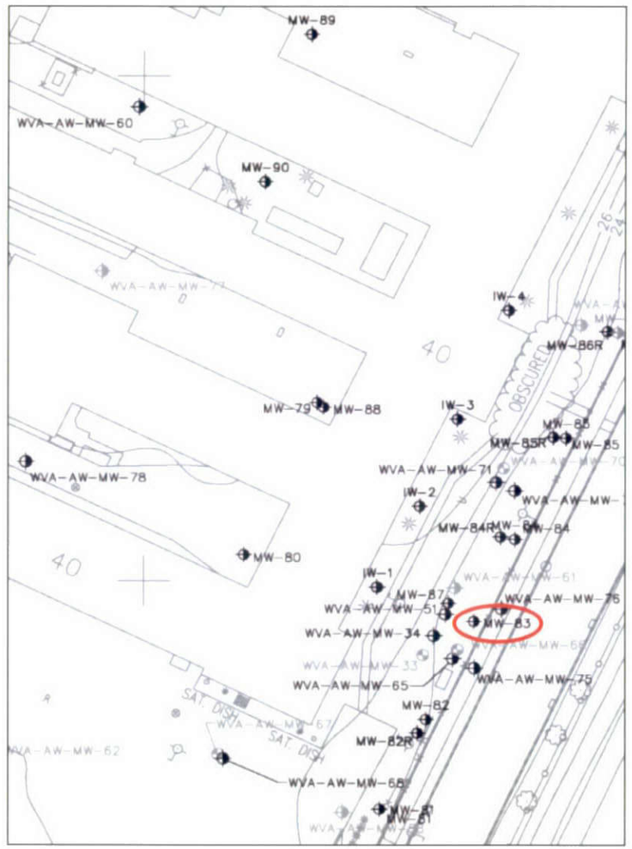
CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-82R

FIGURE B-8

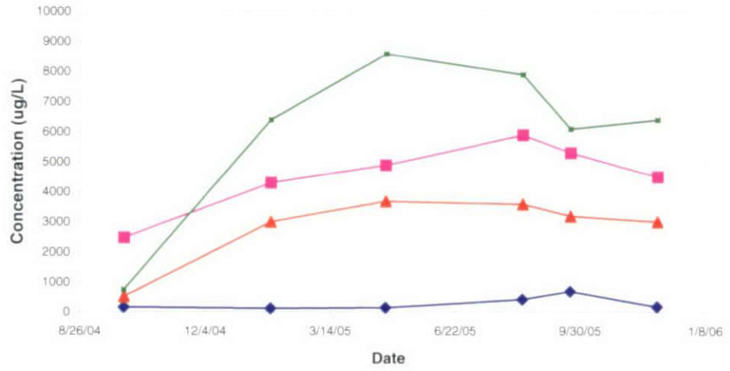


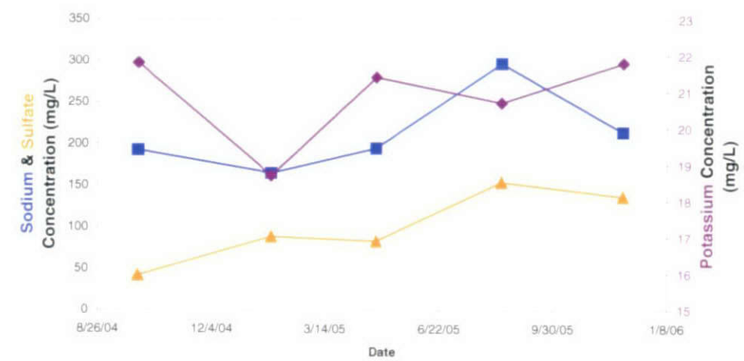
Note: Vertical scales are not the same.

TARGET CHLORINATED ORGANC COMPOUNDS

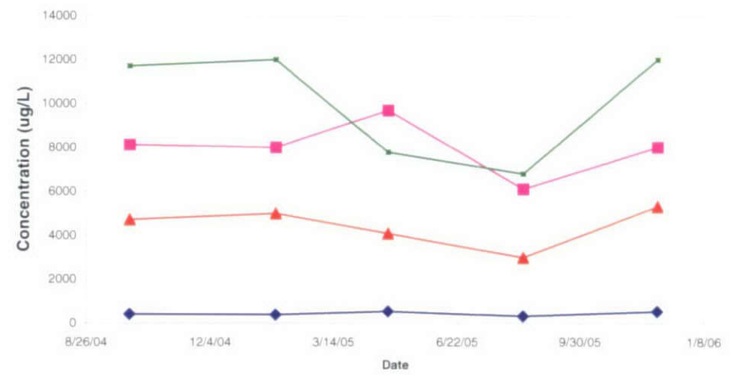
INORGANICS

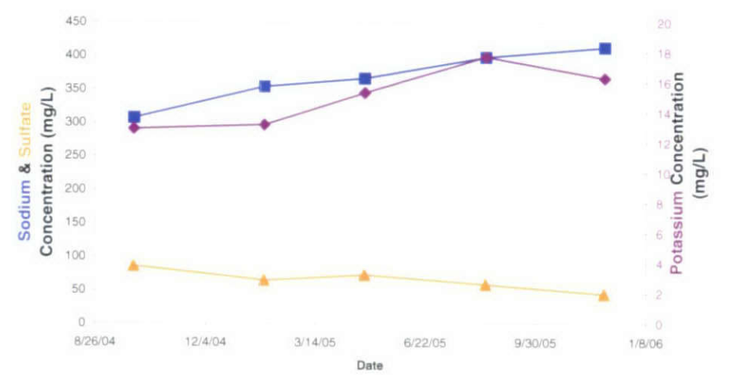
MW-83-1



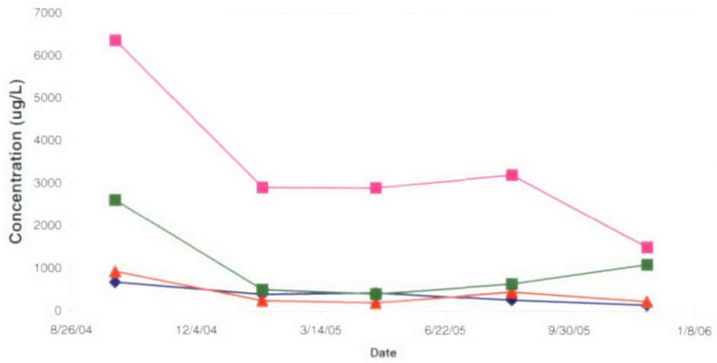


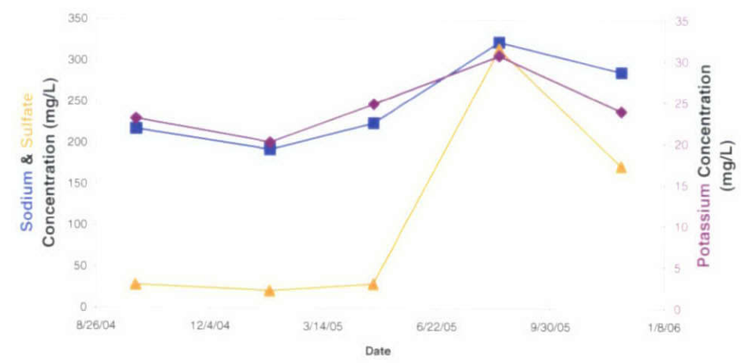
MW-83-2





MW-83-3



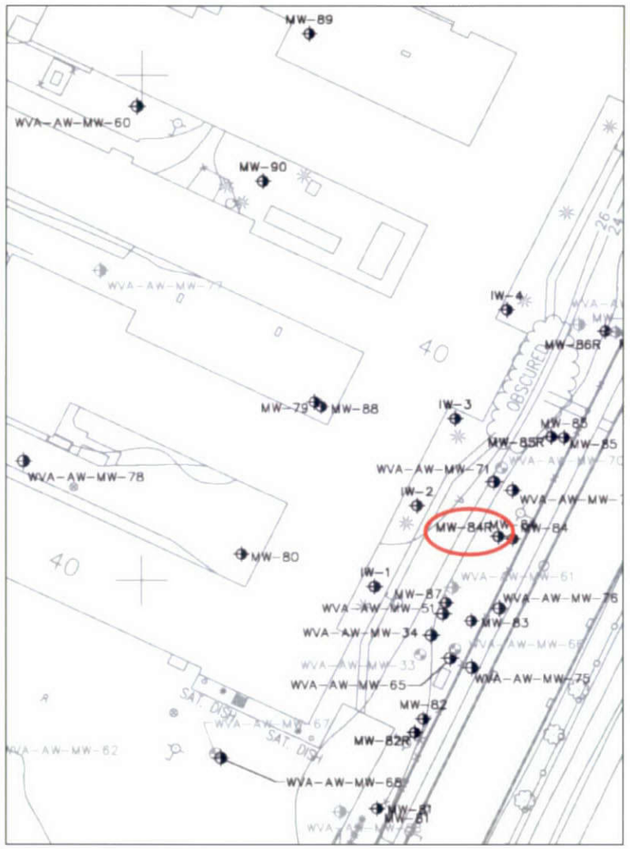


MALCOLM PIRNIE

CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-83

FIGURE B-9

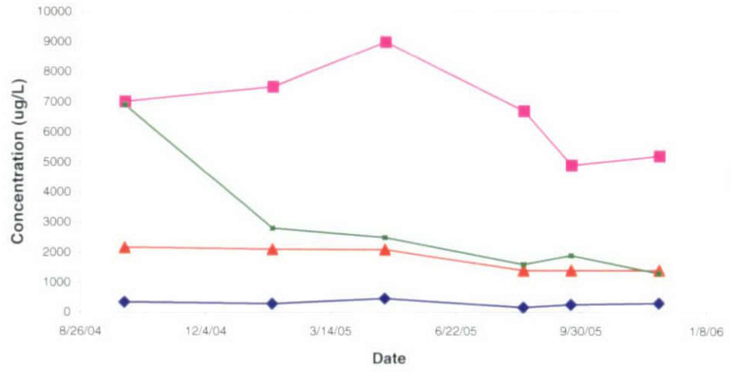


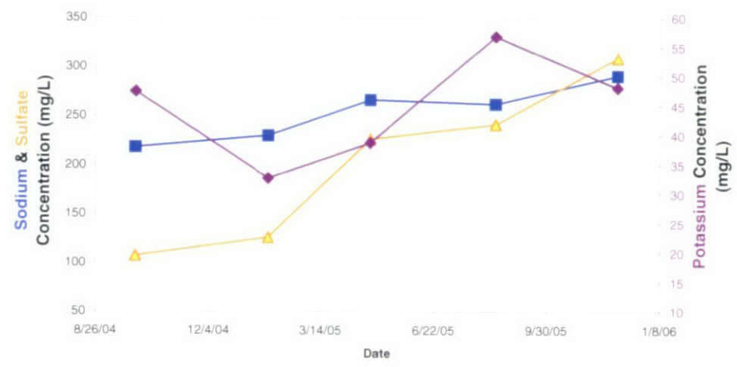
Note: Vertical scales are not the same.

TARGET CHLORINATED ORGANC COMPOUNDS

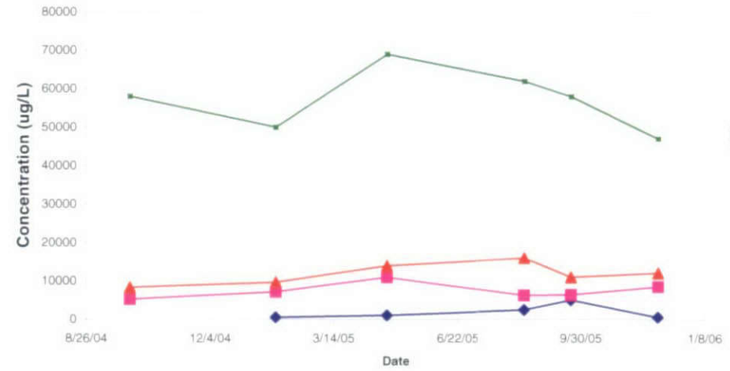
INORGANICS

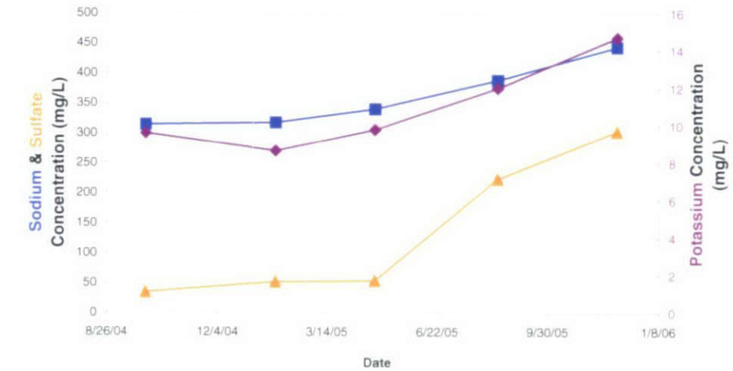
MW-84R-1



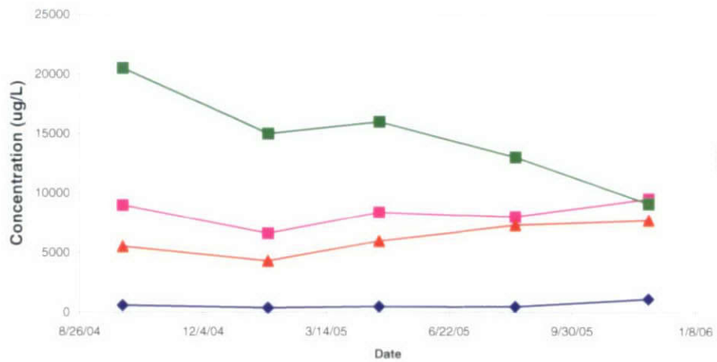


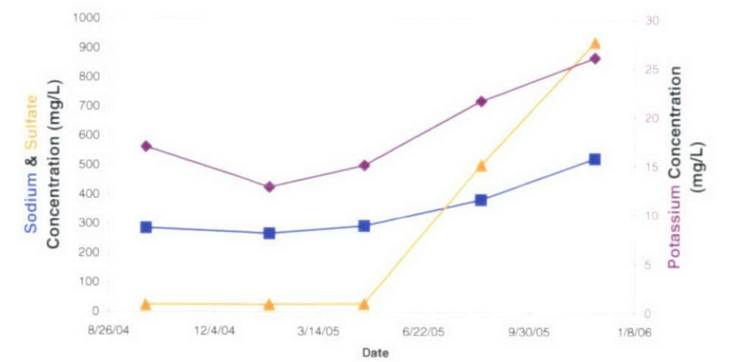
MW-84R-2





MW-84R-3



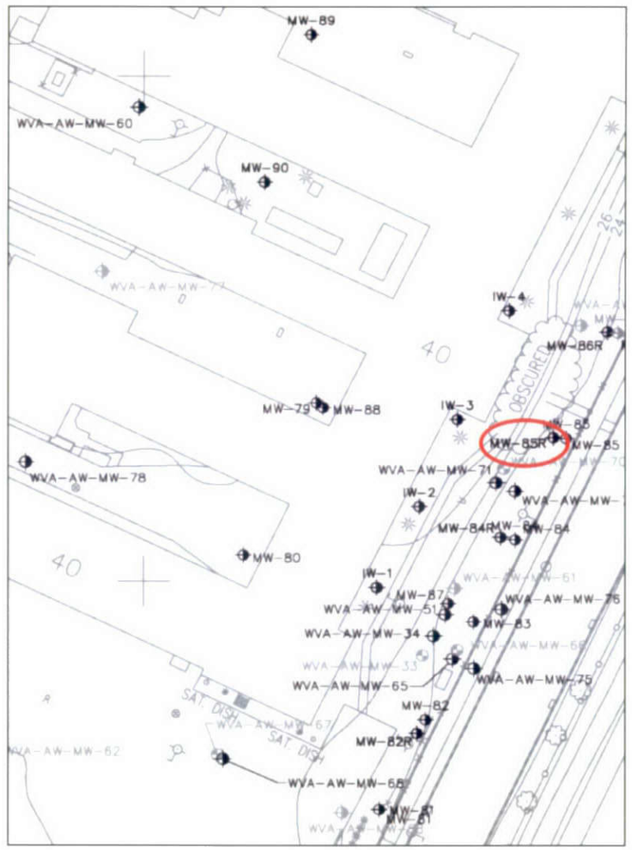


MALCOLM PIRNIE

CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-84R

FIGURE B-10

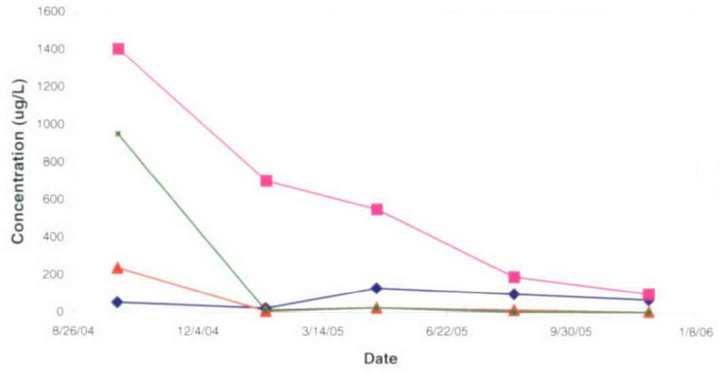


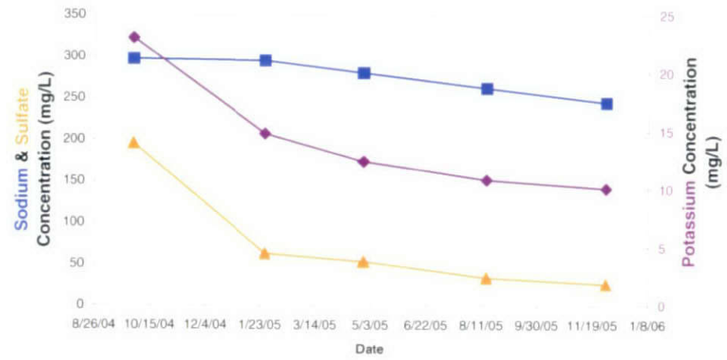
Note: Vertical scales are not the same.

TARGET CHLORINATED ORGANC COMPOUNDS

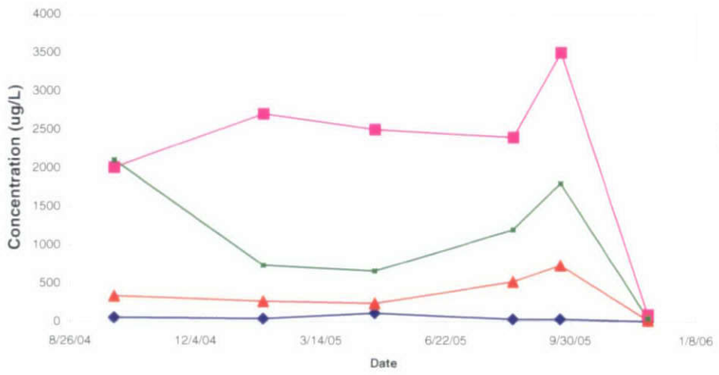
INORGANICS

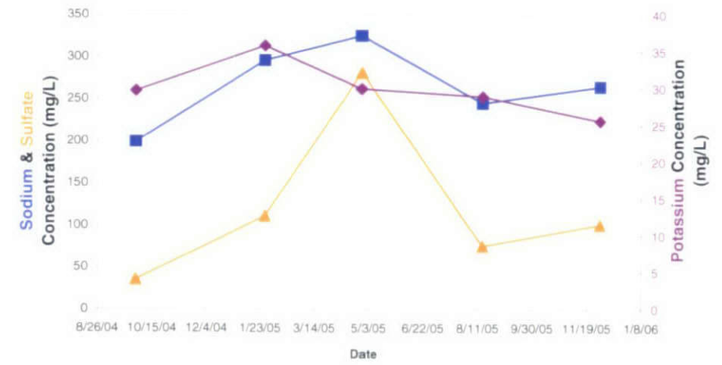
MW-85R-1



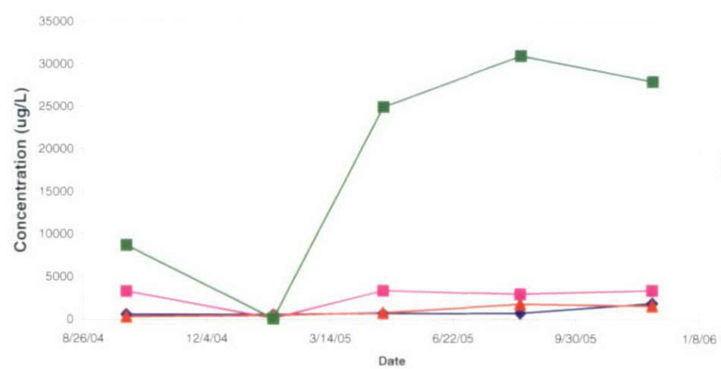


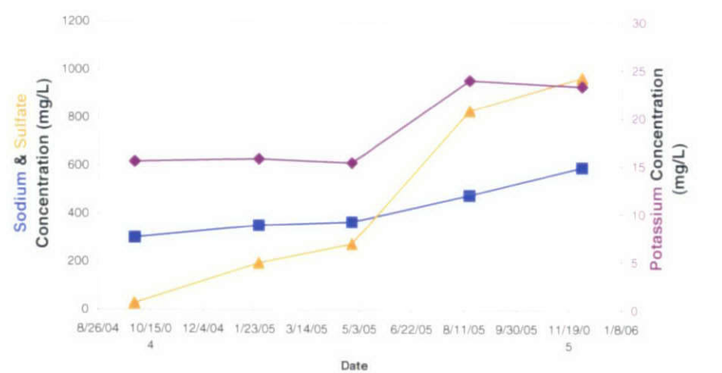
MW-85R-2





MW-85R-3



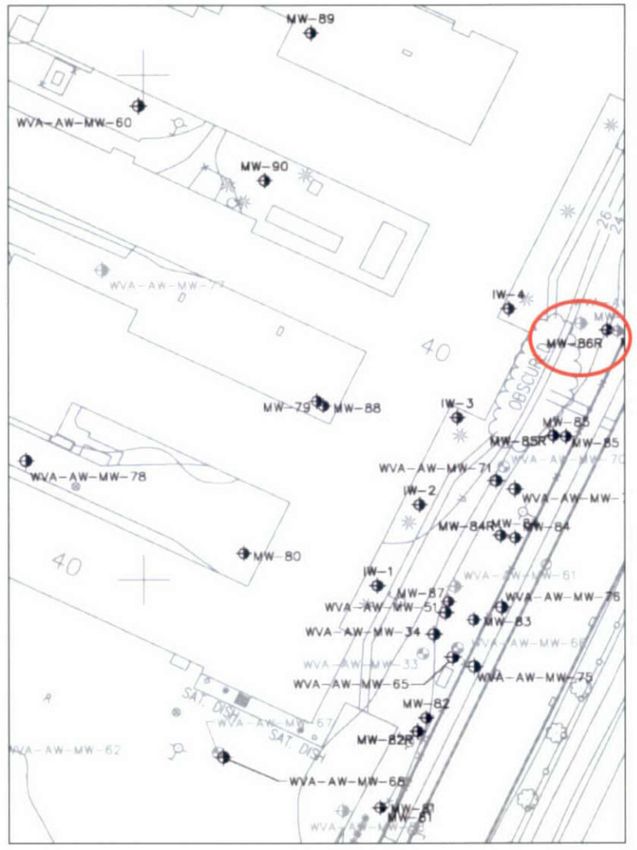


MALCOLM PIRNIE

CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

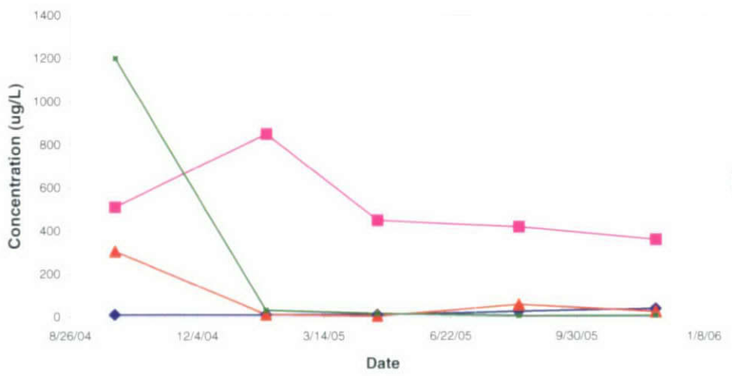
TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-85R

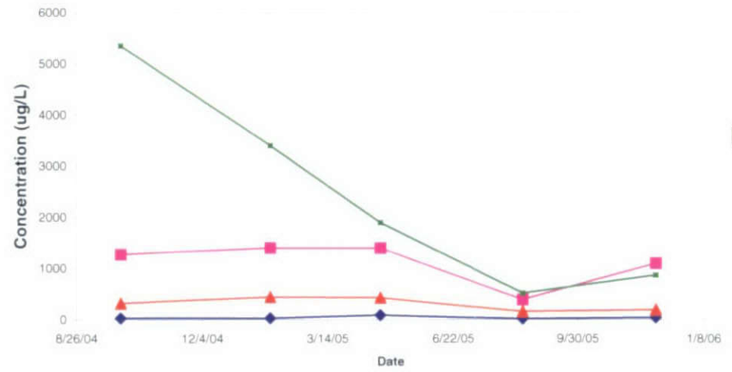
FIGURE B-11

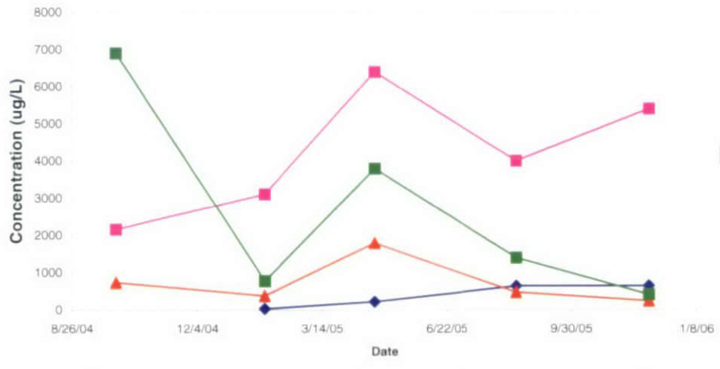


Note: Vertical scales are not the same.

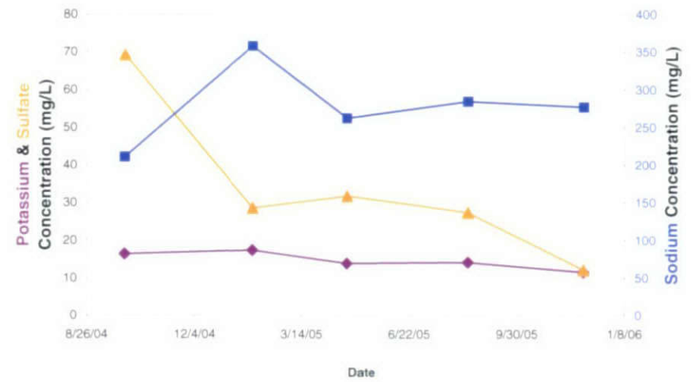
TARGET CHLORINATED ORGANC COMPOUNDS

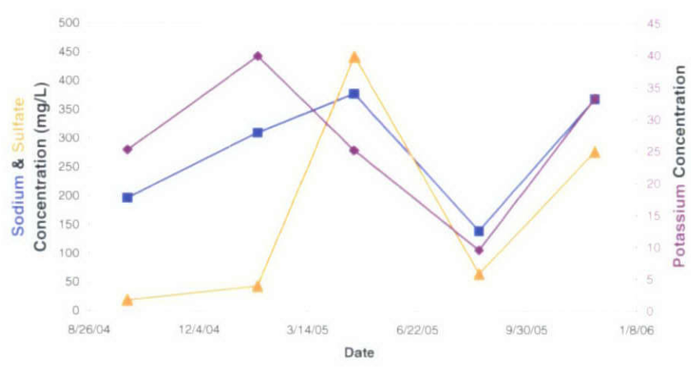


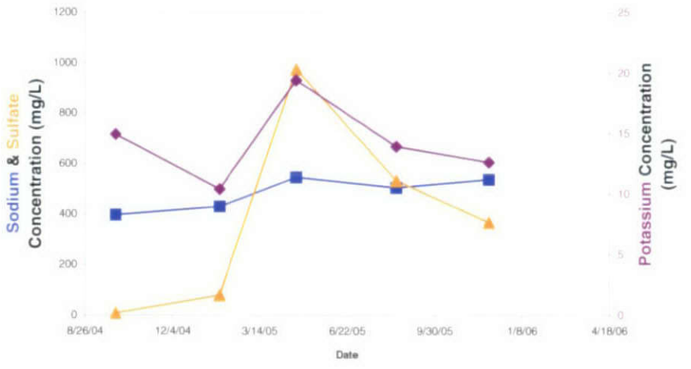




INORGANICS







MALCOLM PIRNIE

CORRECTIVE MEASURES STUDY
BUILDING 40, WATERVLIET ARSENAL, WATERVLIET, NEW YORK

TARGET CHLORINATED ORGANIC COMPOUNDS AND INORGANICS IN MONITORING WELL MW-86R

FIGURE B-12

APPENDIX C

Data Usability Summary Reports

Data Validation Services

120 Cobble Creek Road P. O. Box 208
North Creek, N. Y. 12853
Phone 518-251-4429
Facsimile 518-251-4428

June 16, 2006

Jeremy Wyckoff
Malcolm Pirnie, Inc.
43 British American Blvd.
Latham, NY 12110

RE: Validation of the Watervliet Arsenal site data packages –Aqueous samples
Building 40 Baseline and Pre-injection sampling events of August 2004 through December 2005
STL-CT SDG Nos.207425, 207439, 207546, 207573, 208638, 208660, 209339, 209369, 210491, 210521, 211476, and 211508

Dear Mr. Wyckoff:

Review has been completed for the data packages generated by Severn Trent Laboratories-CT that pertain to samples collected August 24, 2004 through December 01, 2005 at the Watervliet Arsenal Building 40 site. One hundred and fifty-seven aqueous field samples (including twelve field duplicates) were processed for TCL volatile analytes. The methodology utilized is the USEPA SW846 method EPA8260B.

Data validation was performed with guidance from the USEPA National and Regional validation guidelines and SOPs. For this project, a limited review scope is required. Although additional analytes were processed for the samples, validation is required only for data pertaining to the volatile fraction. All quality control parameters for that analytical fraction were reviewed, as provided on laboratory QC summary forms. Additionally, full validation was performed on 10% of the sample data. The following items were reviewed:

* Data Completeness
* Laboratory Case Narrative
* Custody Documentation
* Holding Times
* Surrogate Recoveries
* Matrix Spike Recoveries/Duplicate Correlations
* Field Duplicate Correlations
* Preparation/Calibration Blanks
* Control Spike/Laboratory Control Samples
* Calibration Standard
* Instrument IDLs
* Method Compliance
* Sample Result Verification

Those items showing deficiencies are discussed in the following sections of this report. All others were found to be acceptable as outlined in the above-mentioned validation procedures, and as applicable for the methodology. Unless noted specifically in the following text, reported results for the validated samples are substantiated by the raw data, and generated in compliance with protocol requirements.

Samples undergoing full validation review are the following: MW-83(2), MW-34, WVA-MW82R(3), IW-1, MW-81(1), WVA-MW-85R(1), MW-87, WVA-MW-81-1, WVA-MW-82R-II, WVA-MW-85R-III, WVA-MW-89(4/05), MW-85R-I, WVA-82R-I, MW-81-1, MW-83R-II, WVA-MW-51, MW-89(11/05), MW-85R(1), and WVA-MW-86-I.

In summary, sample processing was primarily conducted with compliance to protocol requirements and with adherence to quality criteria. Results for the volatile analytes are usable as reported, usable with qualification as estimated in value, or with edit of trace level detections to nondetection.

Copies of the laboratory case narratives, and the laboratory sample ID summaries are attached to this report, and should be reviewed in conjunction with this text. Because of replication of sample IDs in the various sampling events, collection dates have been entered parenthetically in this text for those requiring qualification.

General

Blind field duplicate correlations of volatile analytes in WVA-MW-86R-2 (8/04), WVA-MW-89 (8/04), WVA-MW-81-3 (9/04), WVA-MW-89 (9/04), WVA-MW-89 (1/05), WVA-MW-83-1 (1/05), WVA-MW-87, WVA-MW-83-2, WVA-MW-86R-2 (8/05), WVWA-MW-51, WVA-MW-81-3 (11/05), and WVA-MW-86R-1 were all acceptable (below +-CRDL or 50% RPD), with the exception of the reported concentrations of detected analytes in WVA-MW-83-1 (1/05). The concentrations in the parent sample exceed those of the duplicate by more than an order of magnitude (ex. trichloroethene at 3000 ppb and 240 ppb). The reason for this variance is not evident in the data package. Results for detected compounds in WVA-MW-83-1 and X-2 are therefore to be qualified as estimated, with a potential large bias.

Some of the bottle labels do not include the time of collection. Those entries are present on the custody forms. Discrepancies between bottle and custody sample IDs were resolved at sample receipt.

Volatile Analyses by EPA 8260B

Sample report forms show both MDL values and "RL" values for reporting limits. In compliance with the protocol, the "RL" values should be used as reporting limits for non-detected analytes.

Results for MW-86R(3) (9/04) and its associated trip blank, and for MW-80 (4/05) are to be qualified as estimated ("J" and "UJ") due to the presence of headspace in the vials. There may be a strong low bias to the results of the more volatile of the analytes.

Due to consistent low level presence in the associated trip and/or method blanks all detections of methylene chloride, 2-butanone, and acetone in the project samples are considered external contamination, and are to be edited to nondetection ("U") at either the CRDL or originally reported value, whichever is greater.

Additionally, detections of toluene in samples reported in SDG 207439 that are below the CRDL are also considered external contamination, and are to be edited to reflect non-detection ("U") at the CRDL.

Similarly, detections of tetrachloroethene up to 2 ppb in samples reported in SDG 207546 that are flagged as "B" are also to be edited to non-detection.

Calibration standard responses associated with validated samples are within laboratory and validation guidelines, with the following exceptions, results for which are to be qualified as estimated ("J" or "UJ") in the indicated samples:

- 2-butanone (32%D) in MW-81-1 (9/04)
- carbon tetrachloride (27%D) in MW-85R(1) (11/05)

Matrix spike/matrix spike duplicate evaluations of all analytes (except CEVE) were performed on MW-83(2), WVA-MW-80, MW-81(3), MW-87 (9/04), MW-60 (9/04), MW-87 (1/05), MW-60 (1/05), WVA-MW-80, WVA-MW-81-III, MW-87 (8/05), MW-83R-1, MW-60, and MW-34 All accuracy and precision values were acceptable, with the following exceptions, results for which are to be qualified as estimated ("J" or "UJ"):

- Tetrachloroethene (1% and 27%, below 62%) and cis-1,2-dichloroethene (52% and 36%, below 65% in MSs, and also 36% in LCS) in MW-87 (9/04)

Any detections of carbon disulfide in samples reported in SDGs 210491 and 210521 are to be qualified as estimated ("J"), with a possible high bias due to outlying LCS recoveries (163% to 185%, above 142%).

Results for carbon disulfide in samples reported in SDG 211476 are to be qualified as estimated ("UJ"/"J"), with a possible low bias due to outlying LCS recoveries (35% to 43%, below 44%).

The result for 2-hexanone in MW-87 (9/04) is to be qualified as estimated ("UJ") due to low recovery in the associated LCS (48%, below 54%).

Surrogate recoveries, internal standard responses, holding times, and instrument tune performance were compliant with protocol requirements.

Please do not hesitate to contact me if questions or comments arise during your review of this report.

Very truly yours,

Judy Harry

VALIDATION QUALIFIER DEFINITIONS

DATA QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the national qualifiers assigned to results in the data review process. If the Regions choose to use additional qualifiers, a complete explanation of those qualifiers should accompany the data review.

U - **The analyte was analyzed for, but was not detected above the reported sample quantitation limit.**

J - **The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.**

N - **The analysis indicates the present of an analyte for which there is presumptive evidence to make a "tentative identification."**

NJ - **The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.**

UJ - **The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.**

R - **The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.**

APPENDIX D

Water FLUTe™ VOC Monitoring Results

Table D-1
VOC Monitoring Results
IW-1 Water FLUTe
Building 40
Watervliet Arsenal, Watervliet, New York

Zone	Date	Chlorinated VOCs (ug/l)					
		PCE	TCE	c-DCE	t-DCE	1,1-DCE	CF
	9/29/04	915.3	735.8	5925.1			
	10/4/04	1259.0	995.5	7274.3			
	10/13/04	1001.4	843.6	8035.7			
1	11/16/04	641.6	551.3	6435.6		10.9	
	1/25/05	705.4	629.0	5878.3			
	2/11/05	688.3	722.8	6645.8			
	2/17/05	607.6	573.7	5975.2			
	9/29/04	**364.1**	**185.8**	**2043.3**			
	10/4/04	**683.1**	**304.6**	**2385.1**			
	10/13/04	**622.1**	**296.2**	**2482.6**			
2	**11/16/04**	**735.2**	**306.6**	**2895.7**		**6.9**	
	1/25/05	**1331.9**	**538.9**	**3042.3**			
	2/11/05	**1810.0**	**596.7**	**3421.7**			
	2/17/05	**1752.3**	**551.7**	**3132.9**			
	9/29/04	164.8	51.6	1017.8			
	10/4/04	76.3	56.5	1366.2			
	10/13/04	34.3	18.0	1258.2			
3	11/16/04	19.8	9.1	818.2		3.7	
	1/25/05	6.6	2.6	606.7			
	2/11/05	23.2	6.1	759.7			
	2/17/05	15.2	4.1	693.8			
	9/29/04	**495.7**	**52.1**	**515.5**			
	10/4/04	**3479.6**	**90.1**	**713.9**			
	10/13/04	**412.8**	**79.3**	**786.4**			
4	**11/16/04**	**209.2**	**30.4**	**492.9**		**3.7**	
	1/25/05	**102.2**	**16.1**	**473.9**			
	2/11/05	**112.8**	**13.0**	**459.4**			
	2/17/05	**121.1**	**15.6**	**576.9**			
	9/29/04	17.7	12.1	451.9			
	10/4/04	14.1	10.0	382.9			
	10/13/04	13.7	10.7	393.4			
5	11/16/04	6.2	7.5	354.0		4.0	
	1/25/05		1.9	247.4			
	2/11/05	2.4	2.7	257.1			
	2/17/05	1.7	2.4	332.8			
	9/29/04	**10.8**	**5.7**	**363.5**			
	10/4/04	**12.4**	**10.4**	**349.1**			
	10/13/04	**15.6**	**14.7**	**383.5**			
6	**11/16/04**	**4.7**	**6.8**	**480.7**		**3.7**	
	1/25/05		**1.8**	**265.0**			
	2/11/05	**1.8**	**1.9**	**336.2**			
	2/17/05		**1.5**	**411.6**			
	9/29/04	9.3	4.8	333.1			
	10/4/04	19.4	8.8	326.5			2.3
	10/13/04	17.7	15.7	299.9			
7	11/16/04	3.4	4.4	555.2		3.5	
	1/25/05		2.8	315.2			
	2/11/05	1.8		392.6			
	2/17/05	1.5		439.3			
	9/29/04	**12.3**	**5.5**	**389.5**			
	10/4/04	**24.1**	**8.5**	**327.2**			**3.6**
	10/13/04	**29.1**	**16.1**	**342.7**			
8	**11/16/04**	**2.8**	**4.0**	**631.8**		**4.2**	
	1/25/05		**2.8**	**384.4**			
	2/11/05	**2.1**	**1.6**	**442.9**			
	2/17/05	**1.6**		**468.1**			
	9/29/04	10.2	4.7	385.1			
	10/4/04	25.5	10.8	433.2			24.3
	10/13/04	32.8	14.1	330.0			
9	11/16/04	1.9	4.2	591.7		4.6	
	1/25/05	698.9	439.2	7344.8			
	2/11/05	1.7	1.5	477.9			
	2/17/05			431.5			

Notes:
Blank space: Compound not detected.
ug/l - micrograms per liter

Table D-2
VOC Monitoring Results
IW-2 Water FLUTe
Building 40
Watervliet Arsenal, Watervliet, New York

Zone	Date	Chlorinated VOCs (ug/l)					
		PCE	TCE	c-DCE	t-DCE	1,1-DCE	CF
	9/30/04	3330.4	473.0	2195.8			
	10/4/04	3451.3	730.8	2561.0			
	10/13/04	3376.3	789.5	2766.8			
1	11/16/04	282.6	292.3	7572.1		8.7	
	1/25/05		2.7	435.1			
	2/11/05	1324.1	654.2	7697.0			
	2/17/05	1254.5	703.4	8560.0			
	9/30/04	**7049.9**	**595.3**	**2676.8**			
	10/4/04	**11092.4**	**1012.7**	**3588.4**			
	10/13/04	**8844.0**	**1028.8**	**4078.8**			
2	**11/16/04**	**5243.9**	**1121.1**	**6265.3**		**8.2**	
	1/25/05	**5257.0**	**1222.5**	**7250.4**			
	2/11/05	**9610.0**	**1409.1**	**7687.8**			
	2/17/05	**7040.0**	**1578.3**	**7182.6**			
	9/30/04	5468.1	470.5	2452.0			
	10/4/04	4455.0	470.6	2594.2			1.5
	10/13/04	2390.7	412.6	2406.0			
3	11/16/04	2400.1	492.4	5618.5		6.8	
	1/25/05	2136.5	481.3	7553.2			
	2/11/05	247.4	76.5	7248.7			
	2/17/05	590.0	131.7	7360.0			
	9/30/04	**4860.9**	**385.0**	**2271.2**			
	10/4/04	**1367.8**	**189.4**	**2583.1**			
	10/13/04	**702.7**	**157.6**	**4018.1**			
4	**11/16/04**	**30.8**	**23.5**	**5974.0**		**9.5**	
	1/25/05	**152.1**	**79.1**	**6405.0**			
	2/11/05	**19.7**	**17.6**	**6611.1**			
	2/17/05	**35.3**	**25.1**	**7122.1**			
	9/30/04	5133.7	345.3	1883.7			
	10/4/04	3785.1	213.2	2500.1			
	10/13/04	3834.6	243.5	3027.6			
5	11/16/04	1529.3	1156.6	6763.5		7.3	
	1/25/05	1348.3	809.3	9210.0			
	2/11/05	667.4	238.2	7061.8			
	2/17/05	867.2	669.2	12573.0			
	9/30/04	**5812.4**	**317.6**	**1773.5**			
	10/4/04	**6889.3**	**284.9**	**1653.2**			**2.9**
	10/13/04	**7671.4**	**392.6**	**1795.9**			
6	**11/16/04**	**8491.5**	**1712.0**	**2996.5**		**6.6**	
	1/25/05	**2045.4**	**4677.0**	**12115.0**			
	2/11/05	**3046.8**	**1962.5**	**11403.0**			
	2/17/05	**3131.9**	**2330.9**	**12791.0**			
	9/30/04	11420.0	442.5	2160.2			
	10/4/04	50180.0	938.3	2375.1			
	10/13/04	46410.0	1380.8	3042.1			
7	11/16/04	13097.8	2202.3	3276.8		8.4	
	1/25/05	26497.0	7293.0	9165.0			
	2/11/05	27078.0	4745.0	9349.0			
	2/17/05	25302.0	6634.0	13269.0			
	9/30/04	**7353.5**	**345.5**	**1569.4**			
	10/4/04	**6840.9**	**275.5**	**1336.9**			**1.9**
	10/13/04	**5881.7**	**328.8**	**1490.1**			
8	**11/16/04**	**6269.4**	**603.8**	**1581.1**			
	1/25/05	**227.2**	**2914.4**	**16861.0**			
	2/11/05	**1497.4**	**2058.1**	**19002.0**			
	2/17/05	**1909.0**	**2024.4**	**21666.0**			
	9/30/04	21910.0	758.3	2300.4			
	10/4/04	2510.5	140.5	690.6			2.4
	10/13/04	2427.1	149.3	741.9			
9	11/16/04	2758.4	1838.5	1696.4		3.7	
	1/25/05	22.5	170.4	13229.0			
	2/11/05	178.0	343.9	16285.0			
	2/17/05	214.5	342.3	17816.0			

Notes:
Blank space: Compound not detected.
ug/l - micrograms per liter

Table D-3
VOC Monitoring Results
IW-3 Water FLUTe
Building 40
Watervliet Arsenal, Watervliet, New York

Zone	Date	Chlorinated VOCs (ug/l)					
		PCE	TCE	c-DCE	t-DCE	1,1-DCE	CF
	9/29/04	160.5	103.7	657.6			
	10/4/04	143.9	84.0	458.8			2.3
1	11/16/04	26.6	40.3	1411.6		5.6	
	1/25/05	2.6	1.9	1786.7			
	2/11/05	2.6	2.1	2237.8			
	2/17/05	2.6	1.9	2350.4			
	9/29/04	**198.6**	**141.6**	**940.8**			
	10/4/04	**223.0**	**134.7**	**914.0**			**2.9**
2	**10/13/04**	**175.2**	**122.8**	**1014.4**			
	11/16/04	**5.7**	**6.1**	**2429.1**		**4.9**	
	2/11/05	**2.0**	**1.9**	**2070.7**			
	2/17/05	**2.1**	**1.6**	**1894.1**			
	9/29/04	174.9	127.3	1358.0			1.7
	10/4/04	267.4	162.6	2280.7			25.6
	10/13/04	283.8	144.4	1785.9			
3	11/16/04	31.3	27.3	3871.7		7.4	
	1/25/05	7.0	6.8	3772.0			
	2/11/05	26.6	21.5	4419.5			
	2/17/05	28.5	23.4	4572.9			
	9/29/04	**578.1**	**267.5**	**2758.6**			
	10/4/04	**639.5**	**255.9**	**3138.3**			
4	**10/13/04**	**931.8**	**300.2**	**3544.0**			
	11/16/04	**344.5**	**144.9**	**5172.6**		**9.9**	
	2/11/05	**391.1**	**153.5**	**5319.9**			
	2/17/05	**318.7**	**143.1**	**5295.2**			
	9/29/04	3007.4	395.5	2291.1			
	10/4/04	5338.3	573.2	3001.0			
5	10/13/04	3227.1	628.1	4783.2			
	11/16/04	463.0	206.7	6574.7		10.1	
	2/11/05	423.0	157.1	7040.0			
	2/17/05	388.8	159.1	7763.0			
	9/29/04	**2424.0**	**294.7**	**2125.4**			
	10/4/04	**3079.7**	**435.3**	**2556.2**			
6	**10/13/04**	**3397.4**	**452.7**	**3251.9**			
	11/16/04	**2368.7**	**512.3**	**5266.0**		**9.1**	
	2/11/05	**1397.3**	**489.9**	**7345.0**			
	2/17/05	**1649.2**	**556.4**	**8009.0**			
	9/29/04	785.3	146.4	1627.7			
	10/4/04	1236.4	210.4	1802.7			
	10/13/04	1669.2	314.0	2737.1			
7	11/16/04	659.0	245.1	3513.4		6.8	
	1/25/05	794.7	249.1	4843.2			
	2/11/05	1012.2	293.6	7011.8			
	2/17/05	672.1	232.4	7366.9			
	9/29/04	**142.1**	**53.1**	**1343.9**			
	10/4/04	**240.5**	**72.6**	**1242.5**			**2.5**
	10/13/04	**393.7**	**127.5**	**1775.1**			
8	**11/16/04**	**77.9**	**63.7**	**2153.3**		**5.4**	
	1/25/05	**91.0**	**40.0**	**2073.5**			
	2/11/05	**163.2**	**71.5**	**4324.7**			
	2/17/05	**67.2**	**33.9**	**3730.2**			
	9/29/04	31.7	16.8	1395.3			
	10/4/04	57.2	27.7	968.8			
	10/13/04	85.5	36.6	1089.2			
9	11/16/04	5.0	15.2	1191.7		5.1	
	1/25/05	6.7	6.6	1157.3			
	2/11/05	9.4	7.3	1595.3			
	2/17/05	4.1	2.9	1046.0			

Notes:
Blank space: Compound not detected.
ug/l - micrograms per liter

Table D-4
VOC Monitoring Results
IW-4 Water FLUTe
Building 40
Watervliet Arsenal, Watervliet, New York

Zone	Date	Chlorinated VOCs (ug/l)					
		PCE	TCE	c-DCE	t-DCE	1,1-DCE	CF
	9/29/04	1.6					
	10/4/04						
	10/13/04						
1	11/16/04	3.7	0.9			3.9	
	1/25/05	4.4	3.5			21.1	2.1
	2/11/05	2.1	4.2				
	2/17/05	3.0	3.9				
	9/29/04	**3.3**					
	10/4/04	**3.3**					
2	**10/13/04**	**2.5**	**1.8**				
	11/16/04	**11.6**	**2.9**	**28.0**		**3.5**	
	1/25/05	**8.0**	**12.8**				**1.1**
	2/17/05	**3.3**	**5.2**				
	9/29/04	7.2	1.5				
	10/4/04	7.1					
	10/13/04	5.5	1.7				
3	11/16/04	25.9	6.3	62.3		3.6	
	1/25/05	6.8	59.6	277.5			3.7
	2/11/05		3.8	325.0			
	2/17/05		1.8	296.0			
	9/29/04	**4.6**					
	10/4/04	**10.9**					
	10/13/04	**12.8**	**2.6**				
4	**11/16/04**	**41.4**	**9.5**	**79.3**		**2.5**	
	1/25/05	**3.2**	**9.9**	**472.8**			**9.8**
	2/11/05		**2.0**	**749.6**			
	2/17/05			**849.0**			
	9/29/04	37.1	8.0				
	10/4/04	36.7	5.4				
	10/13/04	38.5	5.1				
5	11/16/04	59.0	11.2	87.8		3.7	
	1/25/05	2.2	2.7	377.9		21.0	4.4
	2/11/05	2.2		461.0			
	2/17/05	2.2		719.2			
	9/29/04	**79.9**	**12.5**				
	10/4/04	**74.6**	**8.6**				
	10/13/04	**70.4**	**7.2**				
6	**11/16/04**	**7.6**	**10.4**	**423.4**		**4.1**	
	1/25/05	**3.3**	**3.6**	**545.5**			**10.3**
	2/11/05	**6.9**	**2.3**	**187.1**			
	2/17/05	**622.0**	**7.6**	**840.2**			
	9/29/04	168.3	31.0	225.1			
	10/4/04	499.1	110.0	842.6			
	10/13/04	786.5	200.3	875.9			
7	11/16/04	203.0	154.6	1629.0		5.9	
	1/25/05	110.8	66.7	1726.7		21.0	3.3
	2/11/05	119.7	23.1	915.5			
	2/17/05	1004.9	91.6	2112.0			
	9/29/04	**212.0**	**17.1**				**3.7**
	10/4/04		**160.3**	**1148.3**			**3.7**
	10/13/04	**3907.2**	**201.9**	**967.2**			
8	**11/16/04**	**2410.1**	**350.4**	**1107.4**		**4.7**	
	1/25/05	**363.2**	**212.4**	**3370.9**		**22.9**	**10.1**
	2/11/05	**4370.0**	**820.4**	**3266.2**			
	2/17/05	**2546.8**	**617.8**	**4316.6**			
	9/29/04	705.2	29.9				
	10/4/04	1461.3	44.9	319.8			1.5
	10/13/04	822.4	57.9	519.8			
9	11/16/04	481.0	593.1	1063.9		3.9	
	1/25/05	4.5	3.8	3610.0		22.0	8.1
	2/11/05	59.3	29.6	3616.4			
	2/17/05	33.2	35.9	4294.3			

Notes:
Blank space: Compound not detected.
ug/l - micrograms per liter

Table D-5
VOC Monitoring Results
MW-79 Water FLUTe
Building 40
Watervliet Arsenal, Watervliet, New York

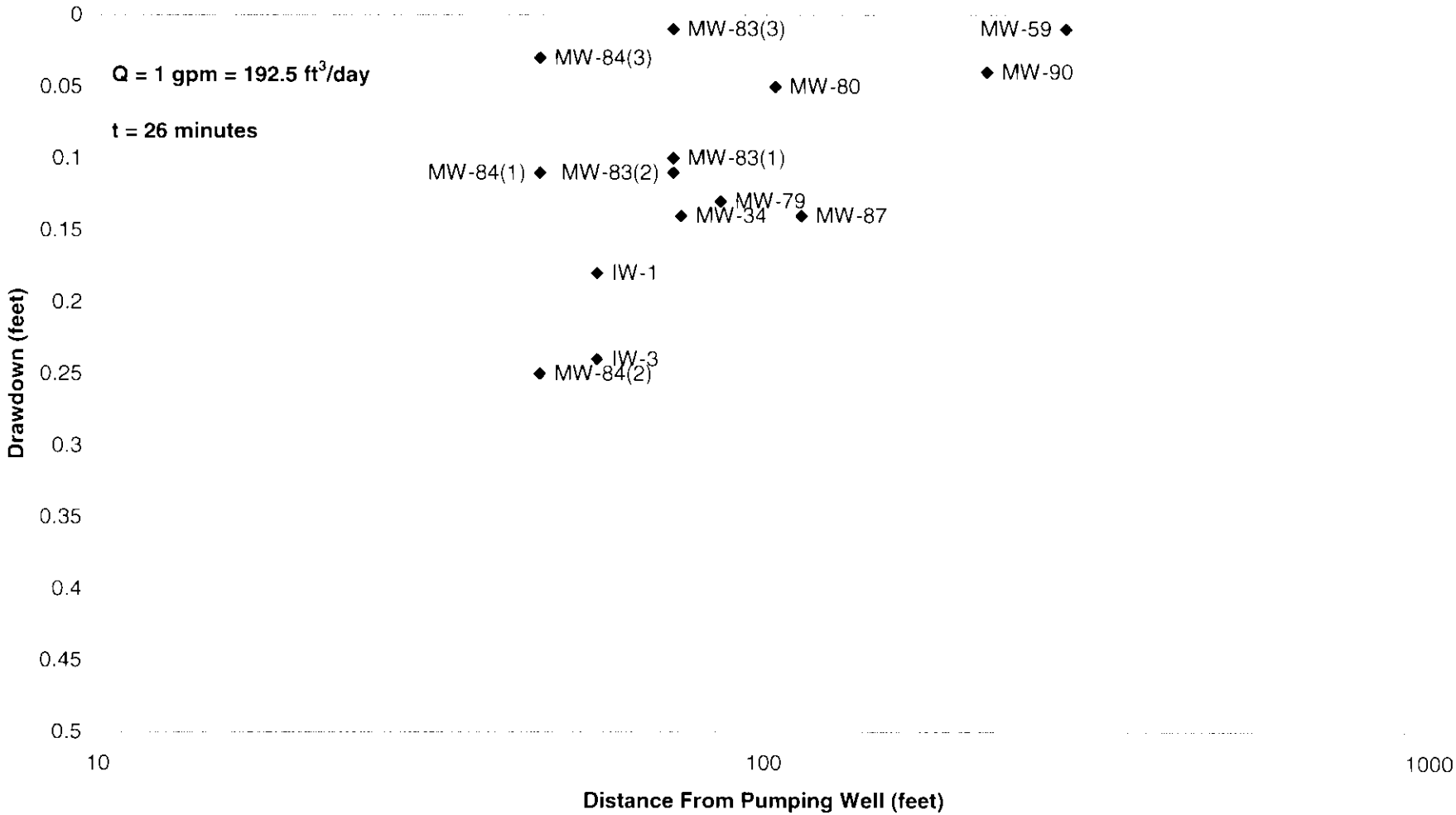
Zone	Date	Chlorinated VOCs (ug/l)					
		PCE	TCE	c-DCE	t-DCE	1,1-DCE	CF
	9/30/04	988.3	122.8	438.8			2.5
	10/4/04	15644.2	1443.2	1544.0			
	10/13/04	11374.0	1405.5	1222.1			
1	11/16/04	5158.0	1542.9	1177.3		4.5	
	1/24/05	6184.0	1828.8	1750.3		22.9	5.7
	2/11/05	6061.0	1454.2	1723.0			
	2/17/05	7730.0	3177.8	3736.5			
	9/30/04	**64.9**	**14.2**				**11.2**
	10/4/04	**25.4**	**10.9**				**7.9**
	10/13/04	**45.3**	**18.0**				
2	**11/16/04**	**1281.2**	**268.4**	**637.7**		**2.7**	
	1/24/05	**2898.4**	**1812.7**	**7093.2**		**25.5**	**4.7**
	2/11/05	**4330.0**	**2140.6**	**5152.2**			
	2/17/05	**4278.0**	**2319.0**	**5842.7**			
	9/30/04	357.4	83.1	645.3			
	10/4/04	16867.0	98.2	507.5			7.9
	10/13/04	7635.1	179.9	845.3			
3	11/16/04	14520.1	2161.1	2648.8		4.0	
	1/24/05	20286.1	3356.8	2661.1		24.1	7.7
	2/11/05	35610.0	4000.0	3790.6			
	2/17/05	33579.0	5910.0	4280.7			
	9/30/04	**509.4**	**166.2**	**1068.8**			
	10/4/04	**765.8**	**180.8**	**905.8**			
	10/13/04	**490.8**	**173.0**	**1297.4**			
4	**11/16/04**	**8382.6**	**4726.9**	**6717.8**		**8.5**	
	1/24/05	**11915.7**	**5131.5**	**5147.3**		**22.4**	**1.1**
	2/11/05	**7286.0**	**3349.0**	**4456.3**			
	2/17/05	**9427.0**	**4320.0**	**4817.3**			
	9/30/04	873.2	311.4	1593.9			
	10/4/04	1656.9	616.1	2790.3			
	10/13/04	1560.8	583.3	4055.8			
5	11/16/04	785.7	404.3	4518.7		8.1	
	1/24/05	3987.6	2103.9	5982.2		25.2	3.7
	2/11/05	2542.9	1256.3	6379.0			
	2/17/05	2826.2	1558.6	6931.6			
	9/30/04	**137.5**	**74.9**	**734.0**			
	10/4/04	**155.7**	**84.5**	**702.7**			
	10/13/04	**511.0**	**268.6**	**1828.0**			
6	**11/16/04**	**827.5**	**515.3**	**3319.6**		**5.9**	
	1/24/05	**5052.1**	**4112.6**	**6325.1**		**26.5**	**5.6**
	2/11/05	**4987.0**	**2880.1**	**6283.4**			
	2/17/05	**4495.0**	**2776.1**	**6278.0**			
	9/30/04	132.0	65.7	565.2			
	10/4/04	34.6	15.0				
	10/13/04	31.5	18.9	196.7			
7	11/16/04	122.6	137.9	1110.8		4.7	
	1/24/05	1333.7	1248.5	4533.5		21.8	1.1
	2/11/05	998.3	999.2	3584.7			
	2/17/05	1849.1	1889.5	6362.7			
	9/30/04	**69.1**	**31.3**	**328.7**			
	10/4/04	**19.7**	**11.4**				
	10/13/04	**15.0**	**8.5**				
8	**11/16/04**	**212.8**	**88.2**	**279.1**		**3.1**	
	1/24/05	**233.4**	**428.0**	**3185.0**		**24.0**	**6.4**
	2/11/05	**259.8**	**310.4**	**1555.8**			
	2/17/05	**351.6**	**306.5**	**2394.7**			
	9/30/04	101.8	67.5	585.6			
	10/4/04	44.1	30.4	207.2			
	10/13/04	37.7	27.2	226.6			
9	1/24/05	6.0	15.8	1156.2		0.0	7.5
	2/11/05	86.1	286.9	3654.1			
	2/17/05	92.4	353.3	5225.7			

Notes:
Blank space: Compound not detected.
ug/l - micrograms per liter

APPENDIX E

IW-2 Integrated VOC Mass Discharge Test Data and Type Curves

DISTANCE DRAWDOWN RELATIONSHIP
AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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Transmissivity Calculation
IW-2 Pump Test Analysis
Watervliet Arsenal, Building 40 Area
Watervliet, New York

Pumping rate = 1gpm = 192.5 ft^3/day

Neuman Method

Well ID	Γ	$W(U_A,\Gamma)$	$1/U_A$	h_0-h (ft)	t (min)	t (days)	T (ft^2/day)
MW-90	0.06	1.0	1.0	0.2	28	0.0194	77
MW-80	0.2	1.0	1.0	0.26	30	0.0208	59
MW-79	0.06	1.0	1.0	0.33	25	0.0174	46
MW-34	0.2	1.0	1.0	0.31	12	0.0083	49
IW-3	2.0	1.0	1.0	7.4	56	0.0389	2
IW-1	0.6	1.0	1.0	0.60	12	0.0083	26
MW-87	0.6	1.0	1.0	0.62	19	0.0132	25
MW-59	2.0	1.0	1.0	0.40	50	0.0347	38
MW-83R-1	1.0	1.0	1.0	0.90	26	0.0181	17
MW-83R-2	1.0	1.0	1.0	1.6	36	0.0250	10
MW-83R-3	2.0	1.0	1.0	1.4	51	0.0354	11
MW-84R-1	2.0	1.0	1.0	2.2	40	0.0278	7
MW-84R-2	0.2	1.0	1.0	0.61	11	0.0076	25
MW-84R-3	2.0	1.0	1.0	1.5	55	0.0382	10

Transmissivity Calculation
IW-2 Pump Test Analysis
Watervliet Arsenal, Building 40 Area
Watervliet, New York

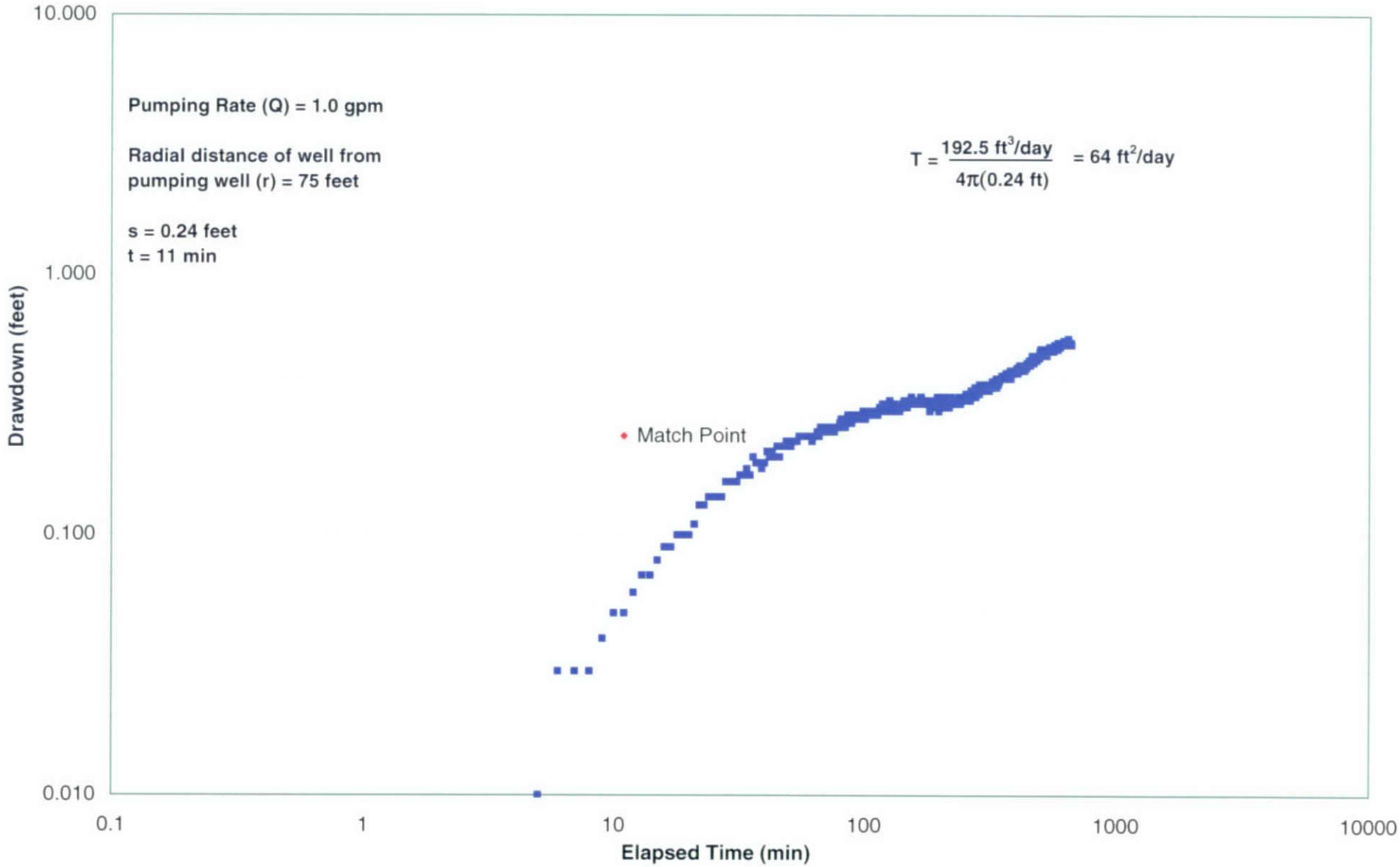
Pumping rate = 1gpm = 192.5 ft^3/day

Theis Method

Well ID	W(u)	1/u	h_0-h (ft)	t (min)	t (days)	T (ft^2/day)
MW-90	1.0	1.0	0.26	34	0.0236	59
MW-80	1.0	1.0	0.26	31	0.0215	59
MW-79	1.0	1.0	0.46	29	0.0201	33
MW-34	1.0	1.0	0.24	11	0.0076	64
IW-3	1.0	1.0	2.6	40	0.0278	6
IW-1	1.0	1.0	0.31	9.5	0.0066	49
MW-87	1.0	1.0	0.5	19	0.0132	31
MW-59	1.0	1.0	0.39	60	0.0417	39
MW-83R-1	1.0	1.0	0.43	26	0.0181	36
MW-83R-2	1.0	1.0	0.80	34	0.0236	19
MW-83R-3	1.0	1.0	0.5	56	0.0389	31
MW-84R-1	1.0	1.0	0.4	22	0.0153	38
MW-84R-2	1.0	1.0	0.7	17	0.0118	22
MW-84R-3	1.0	1.0	0.52	47	0.0326	29

MONITORING WELL MW-34 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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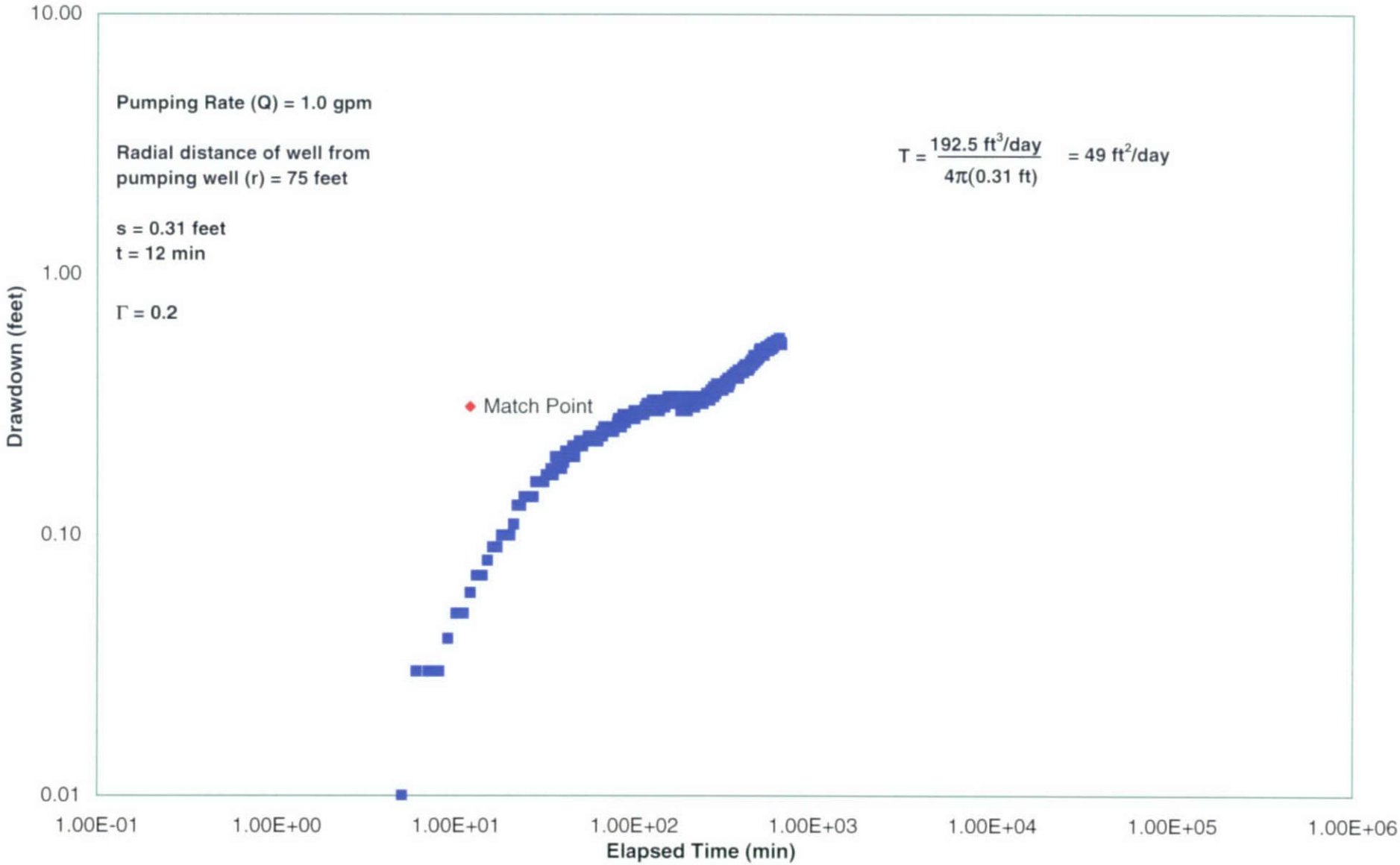
MONITORING WELL MW-34 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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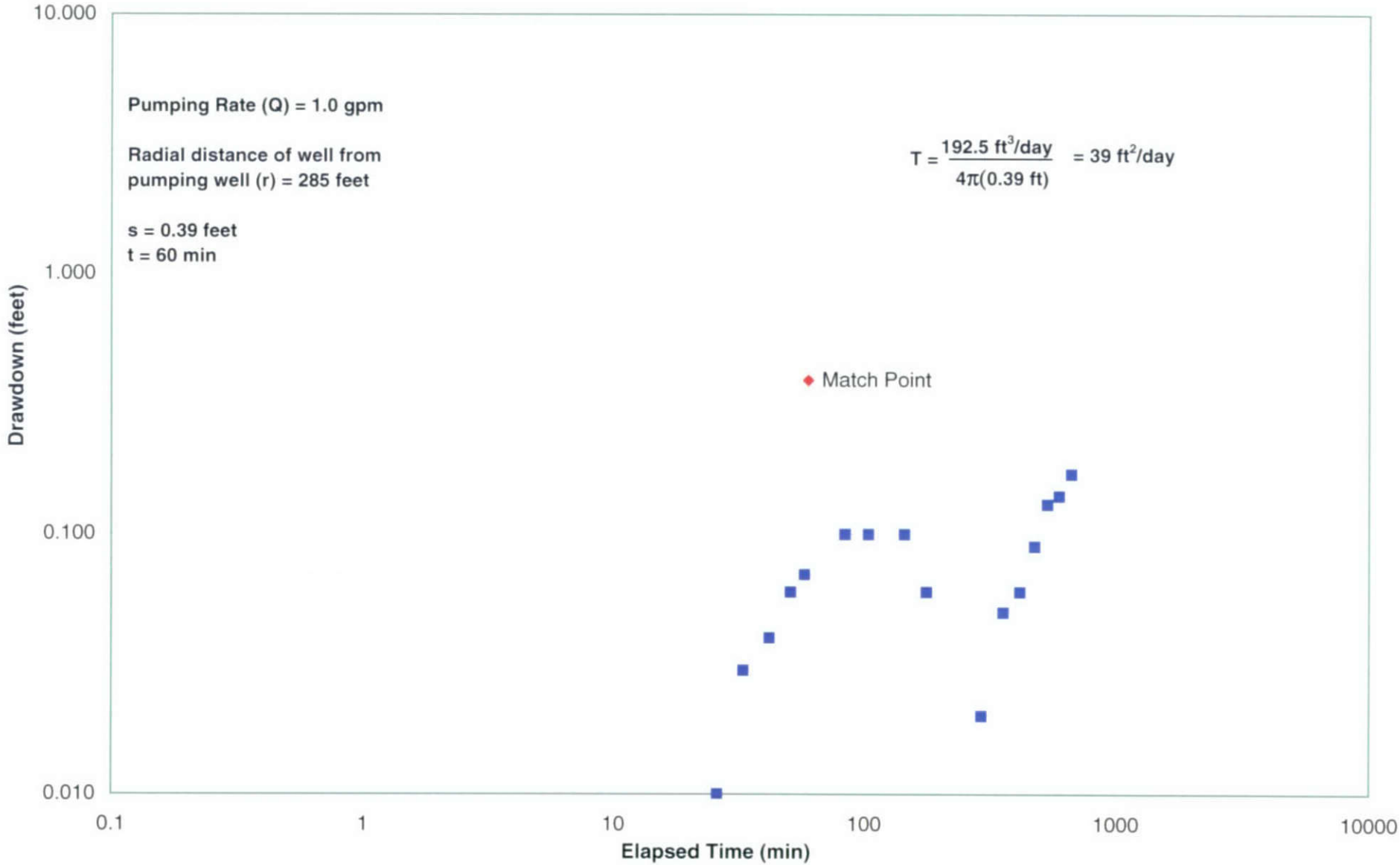
MONITORING WELL MW-59 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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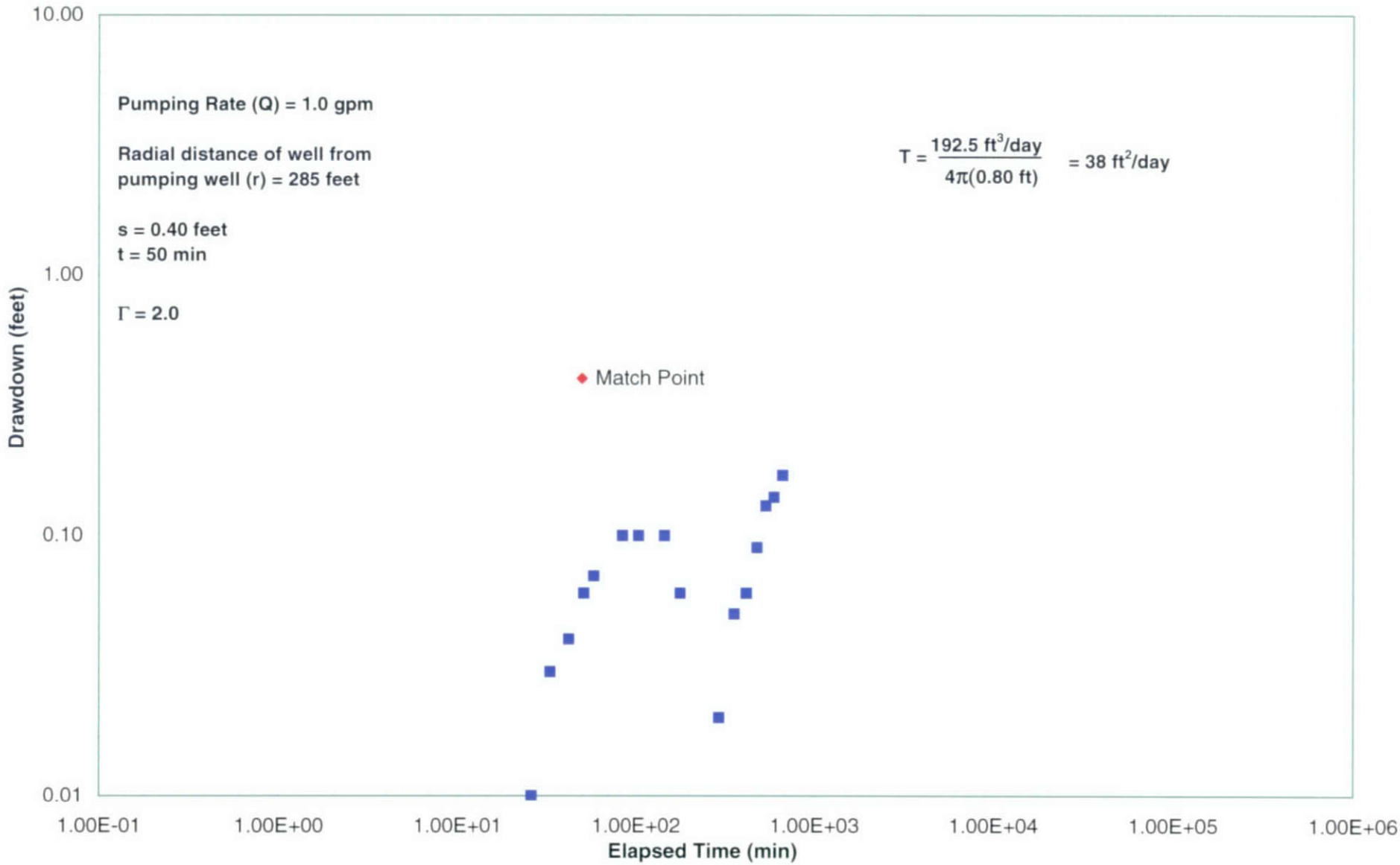
MONITORING WELL MW-59 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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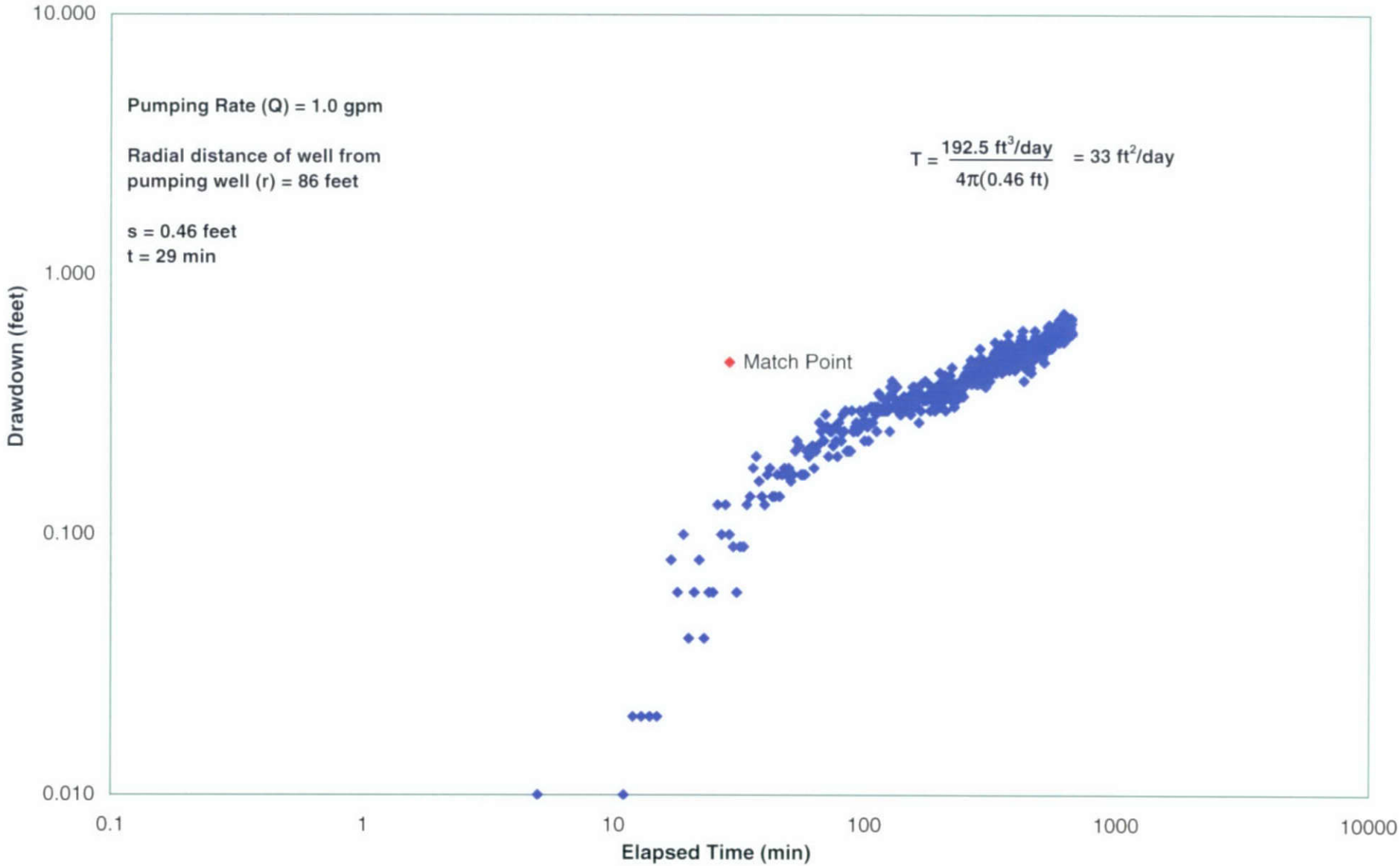
MONITORING WELL MW-79 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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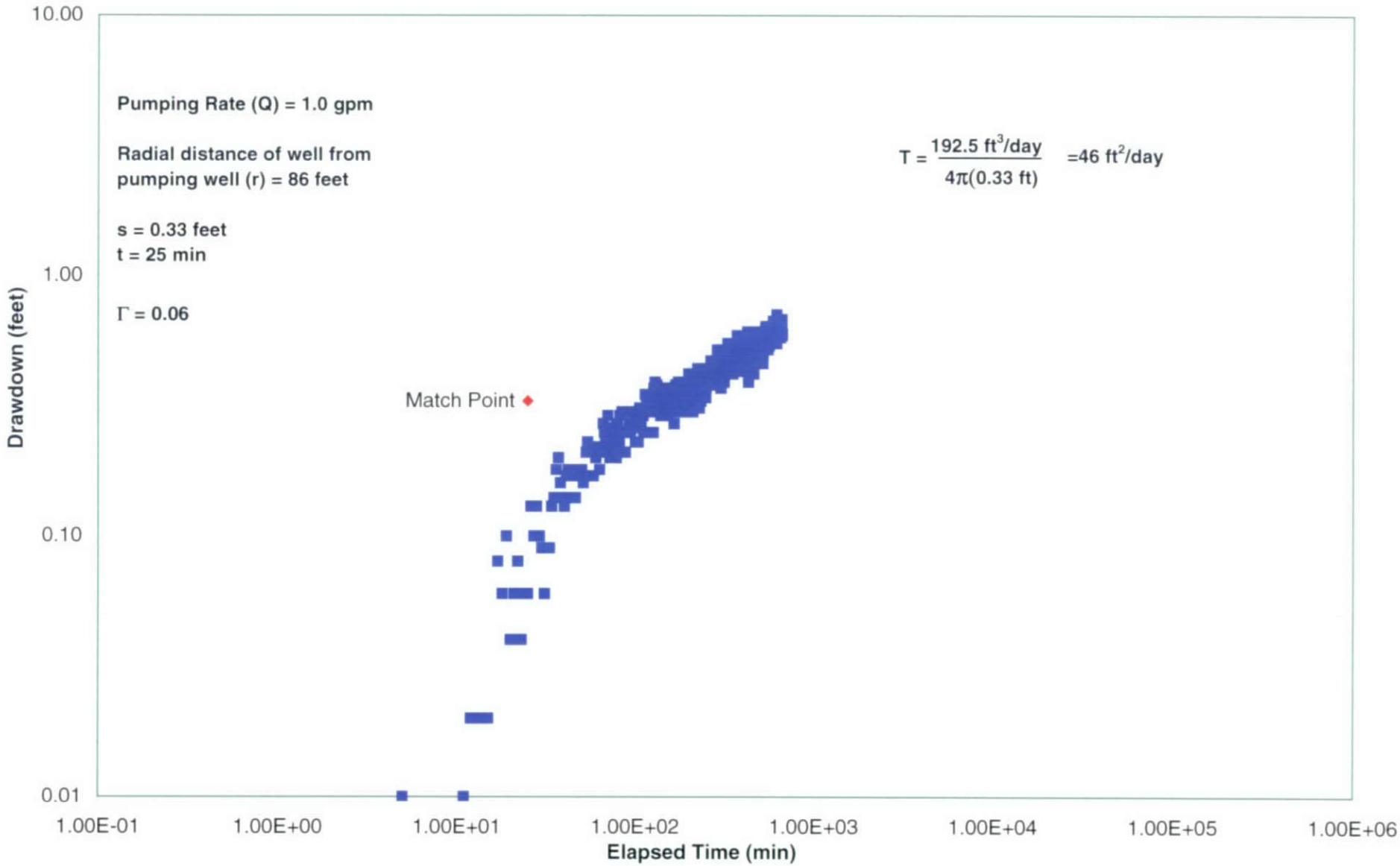
MONITORING WELL MW-79 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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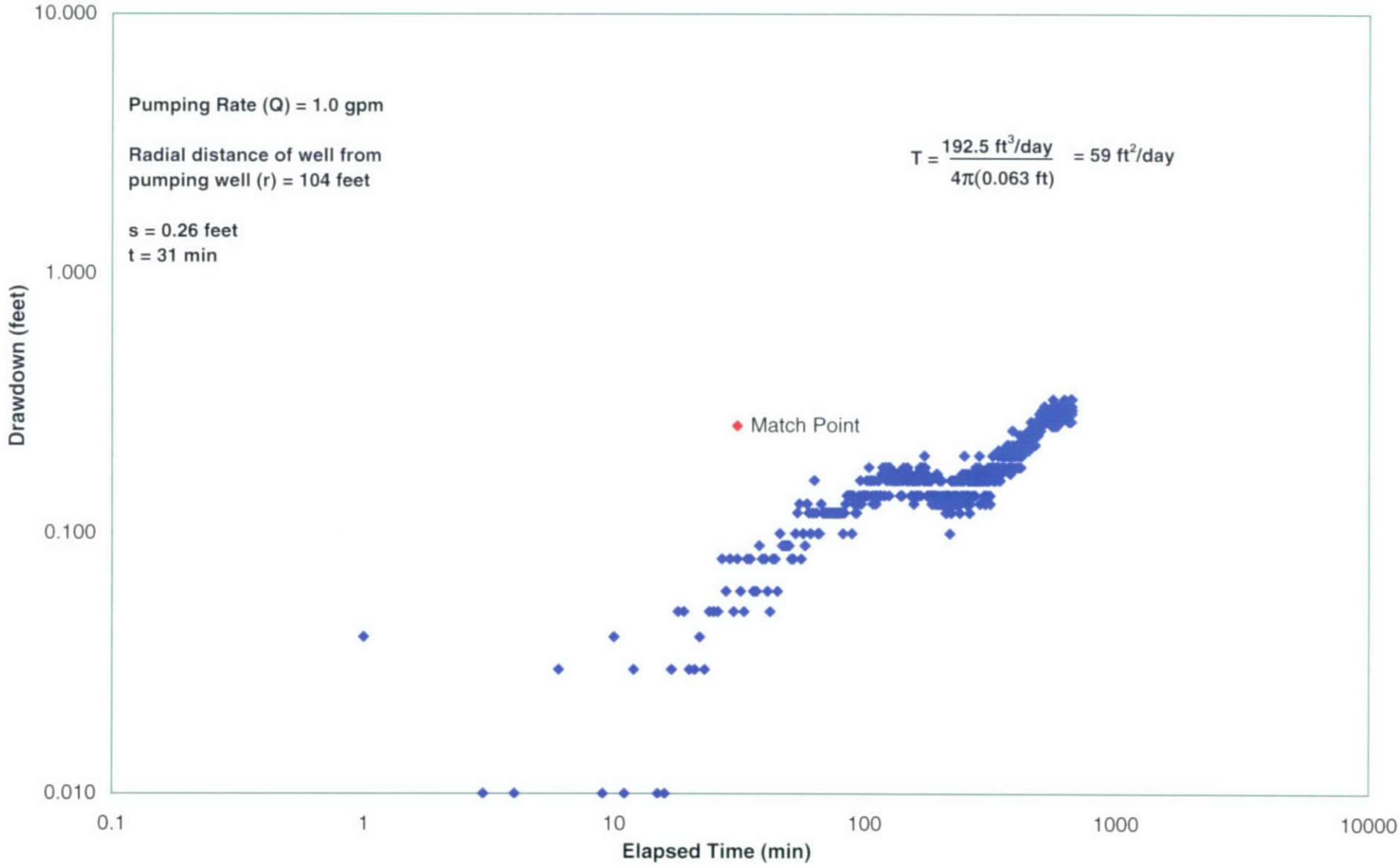
MONITORING WELL MW-80 DRAWDOWN -
THEIS PLOT
AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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MONITORING WELL MW-80 DRAWDOWN - NEUMAN PLOT

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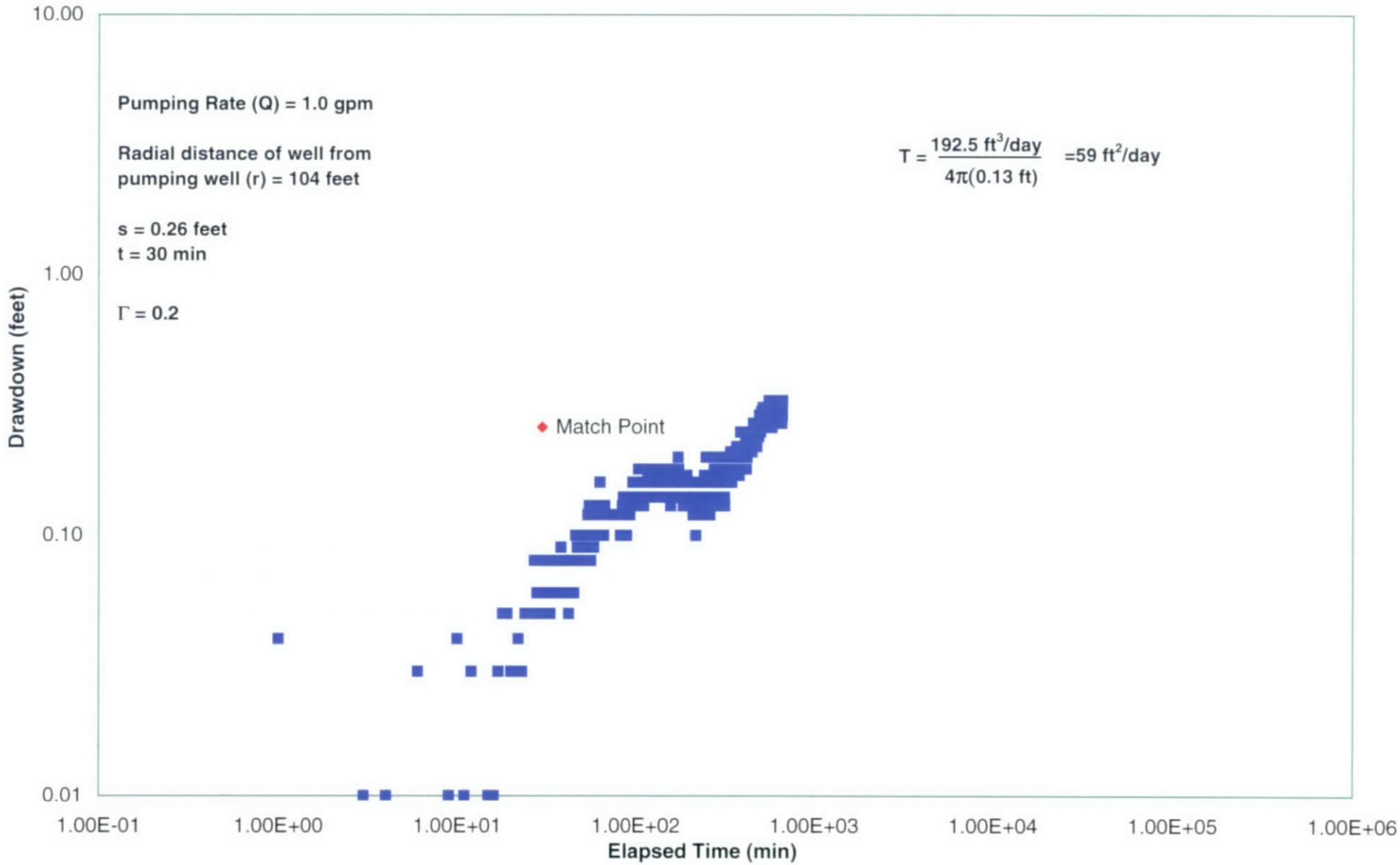
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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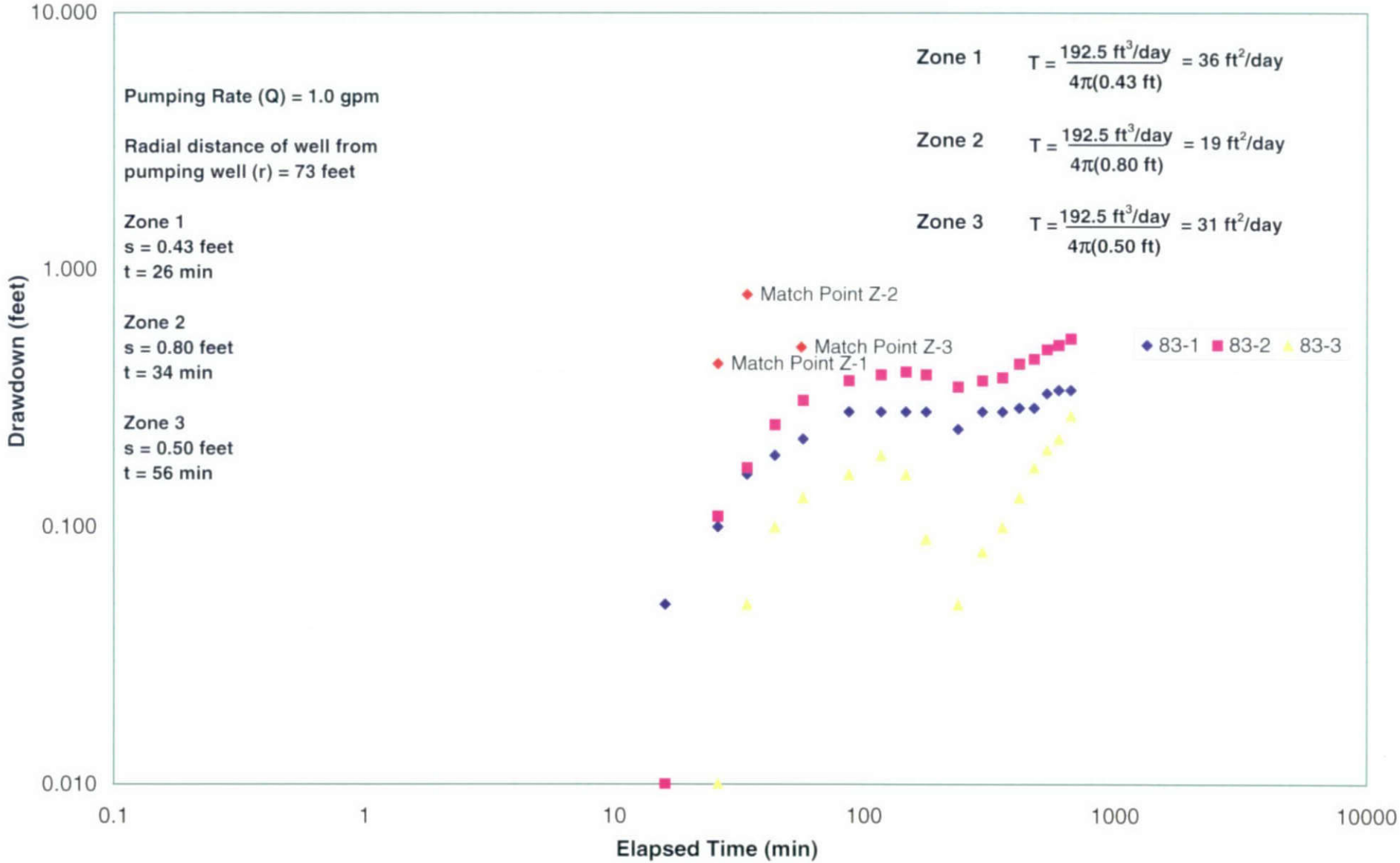
MONITORING WELL MW-83 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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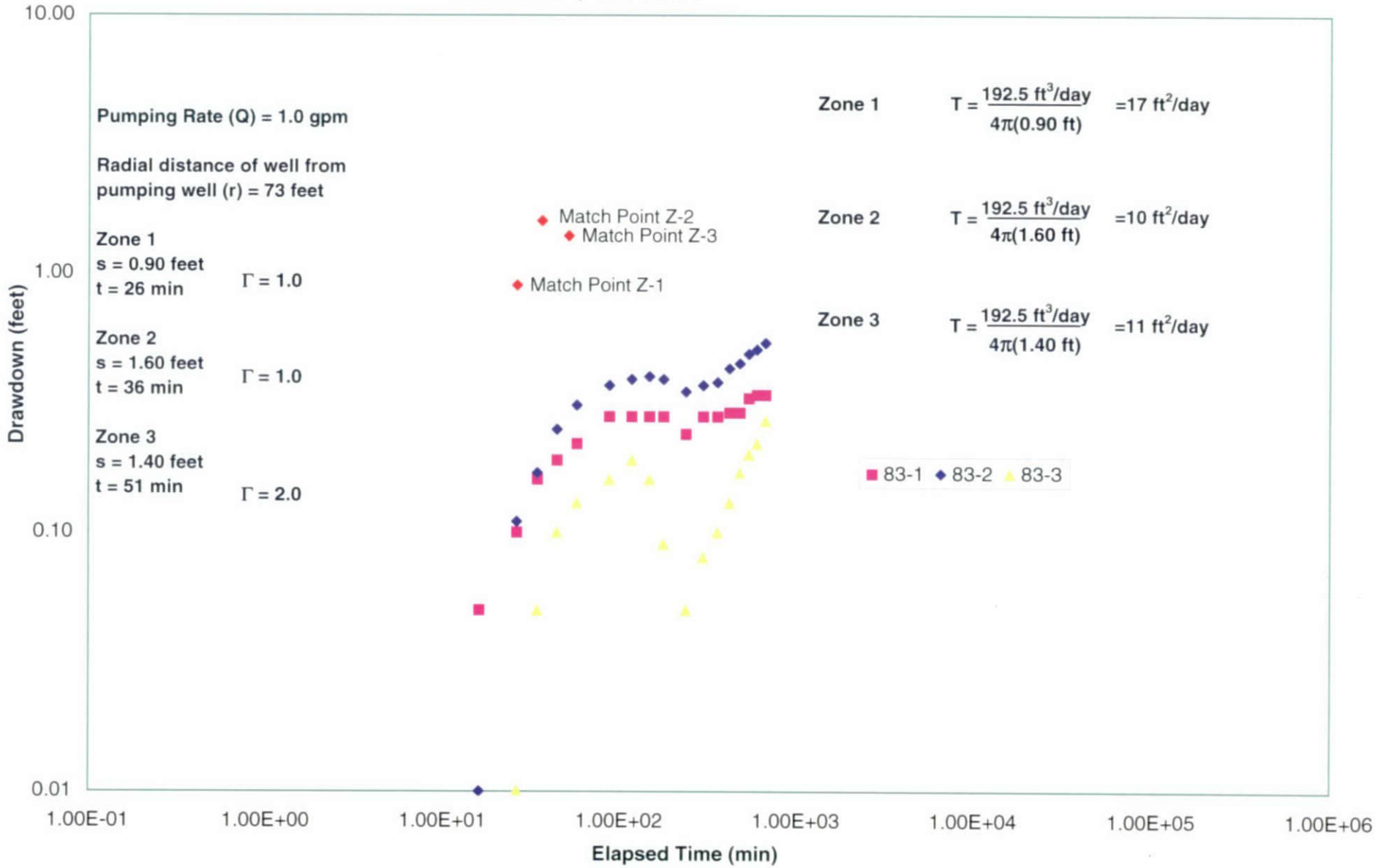
MONITORING WELL MW-83 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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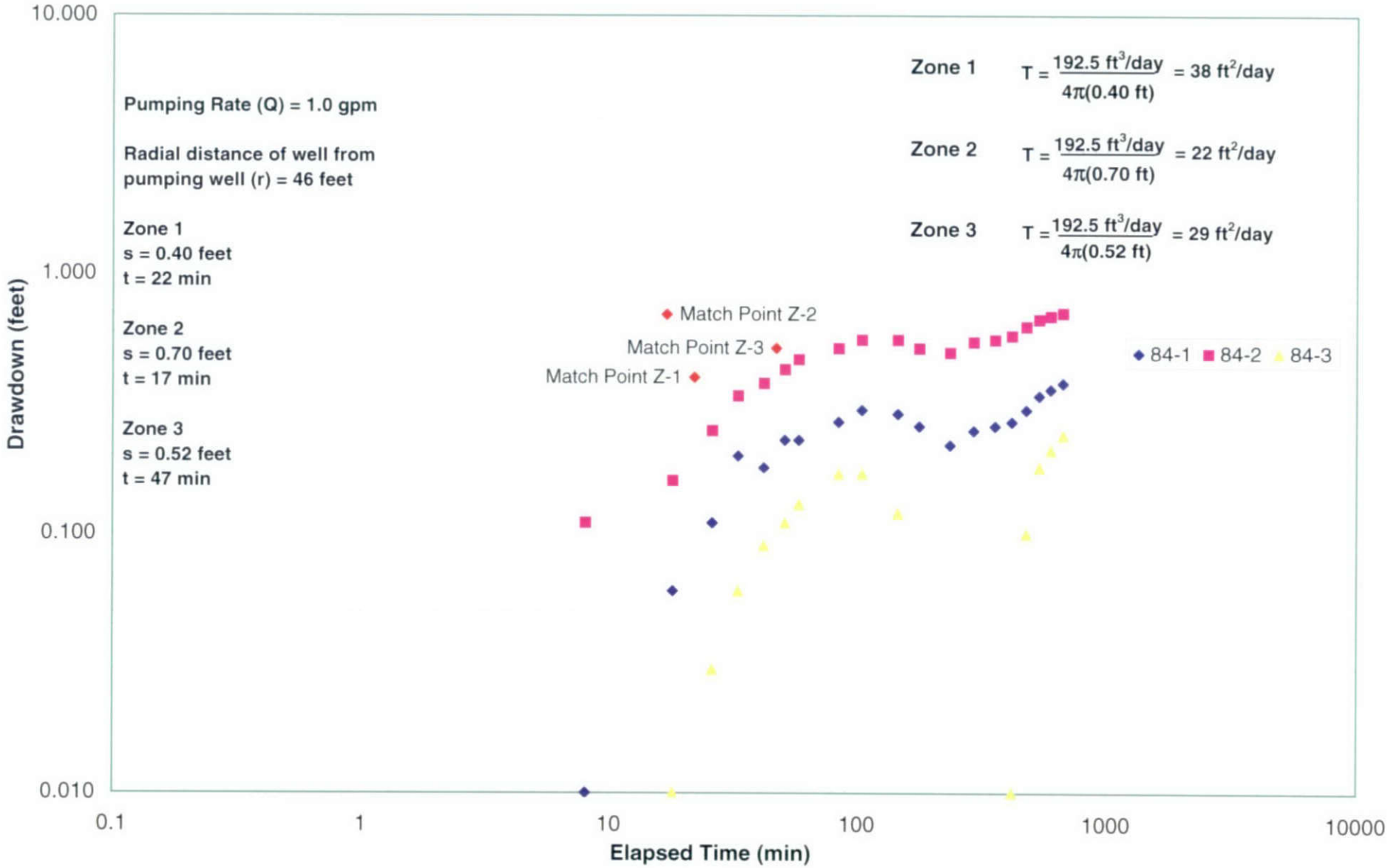
MONITORING WELL MW-84R DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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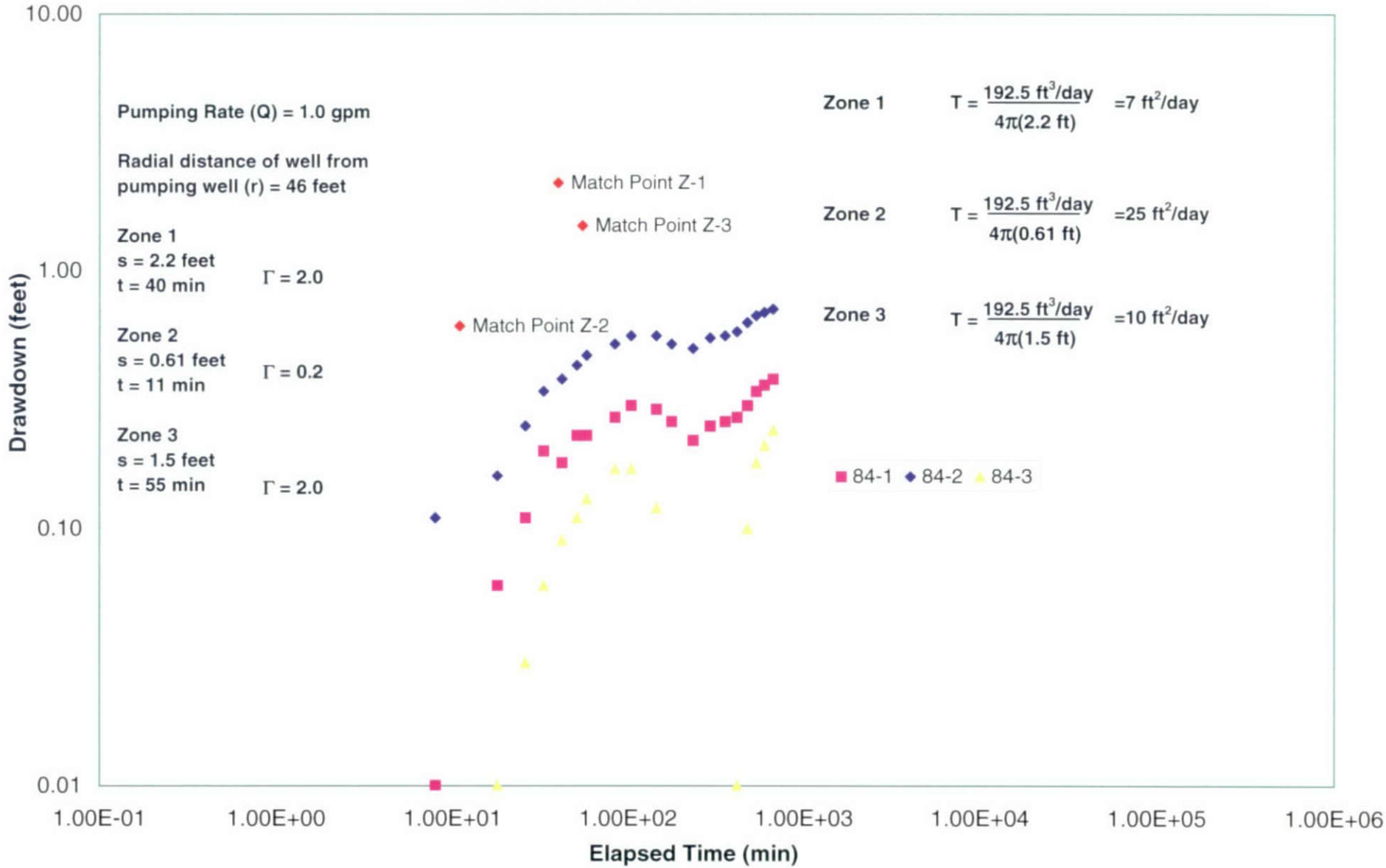
MONITORING WELL MW-84R DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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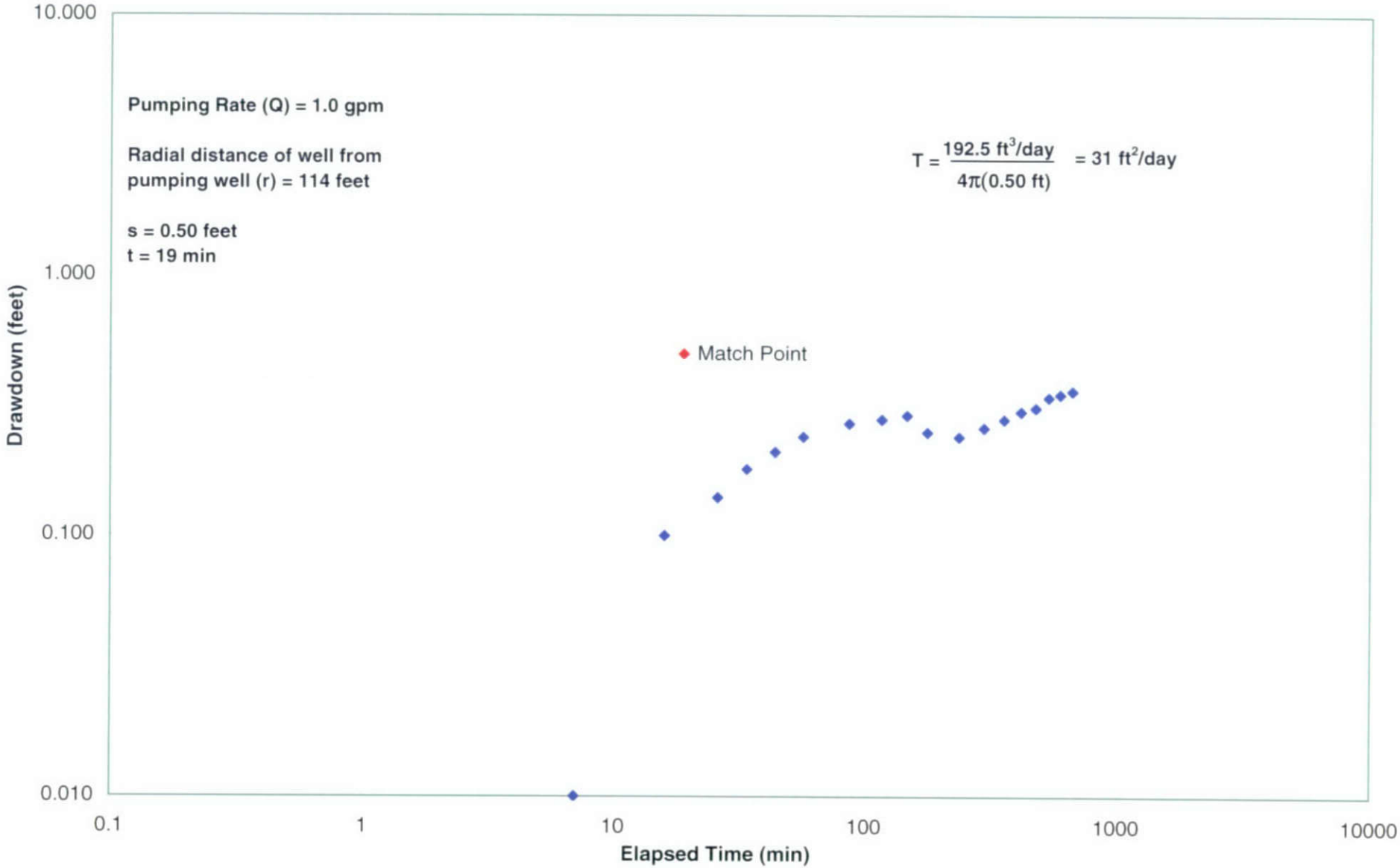
MONITORING WELL MW-87 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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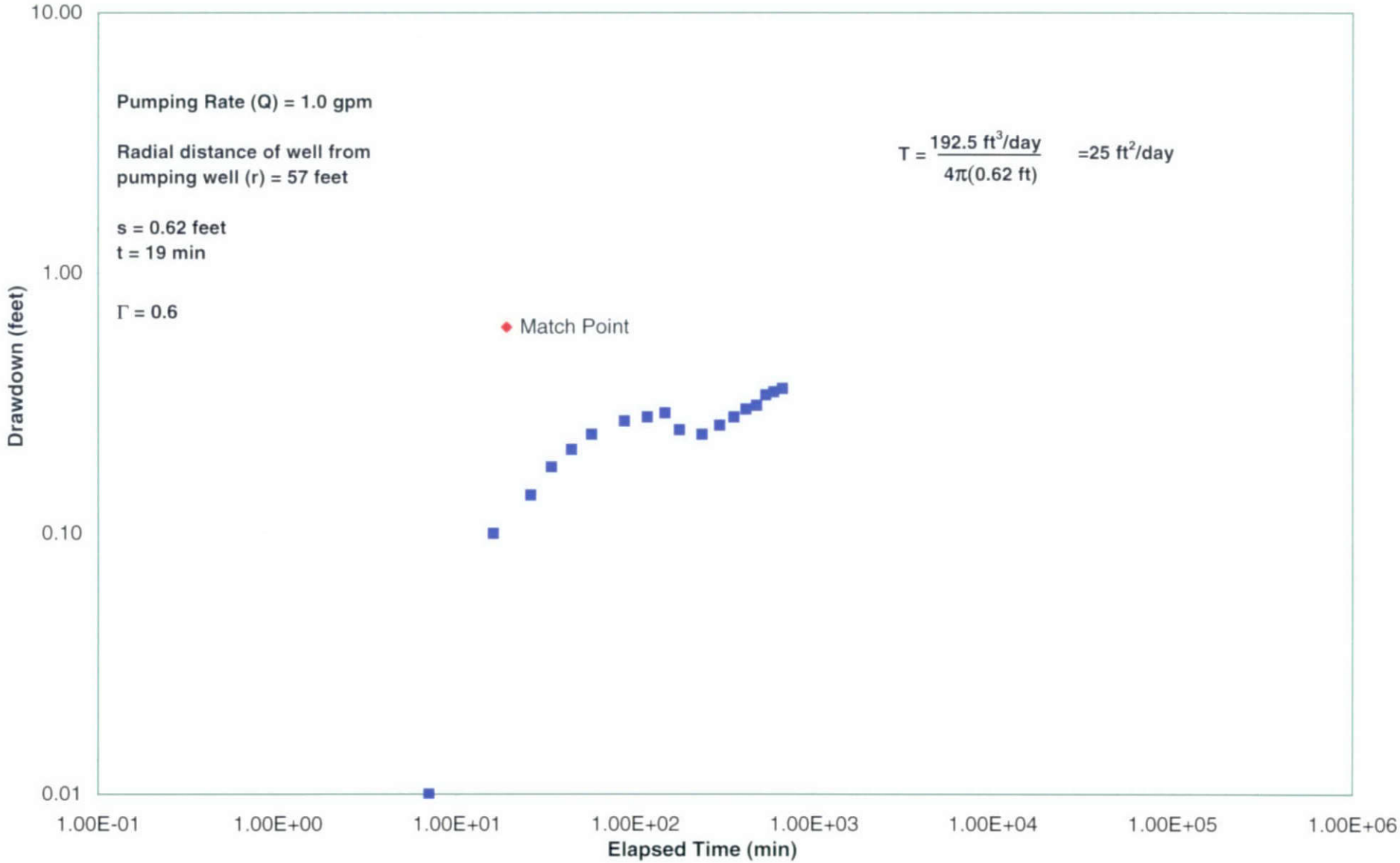
MONITORING WELL MW-87 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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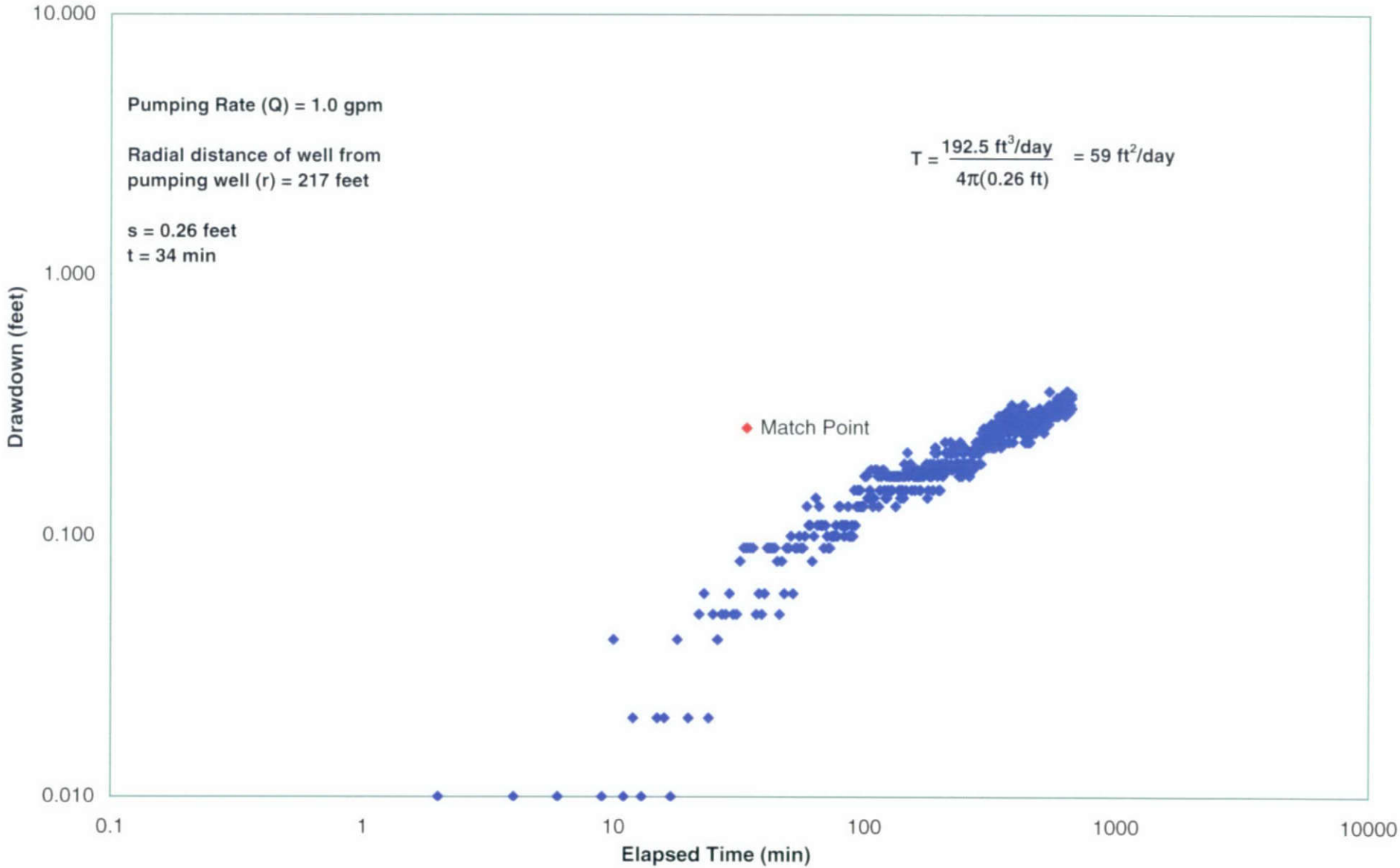
MONITORING WELL MW-90 DRAWDOWN - THEIS PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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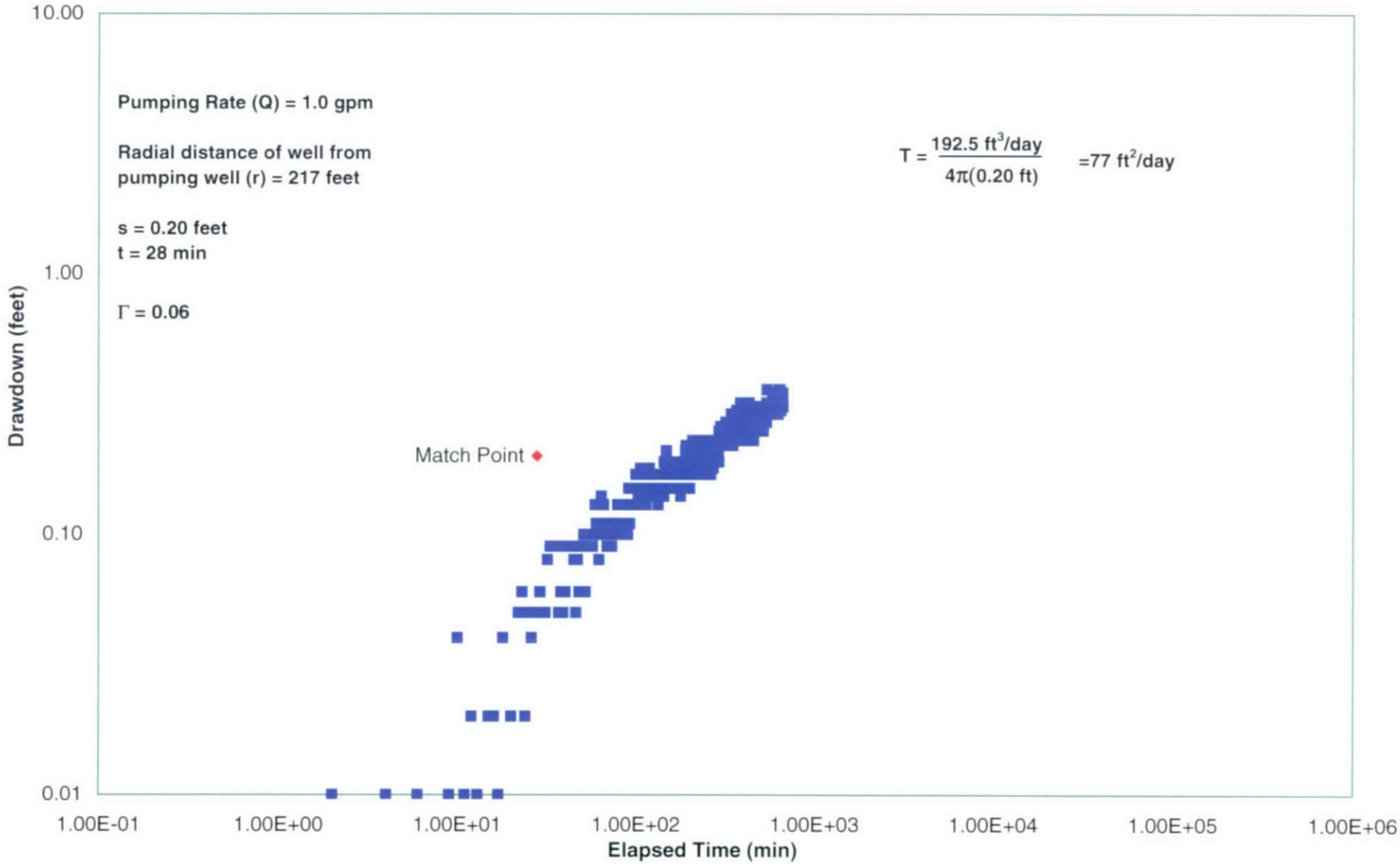
MONITORING WELL MW-90 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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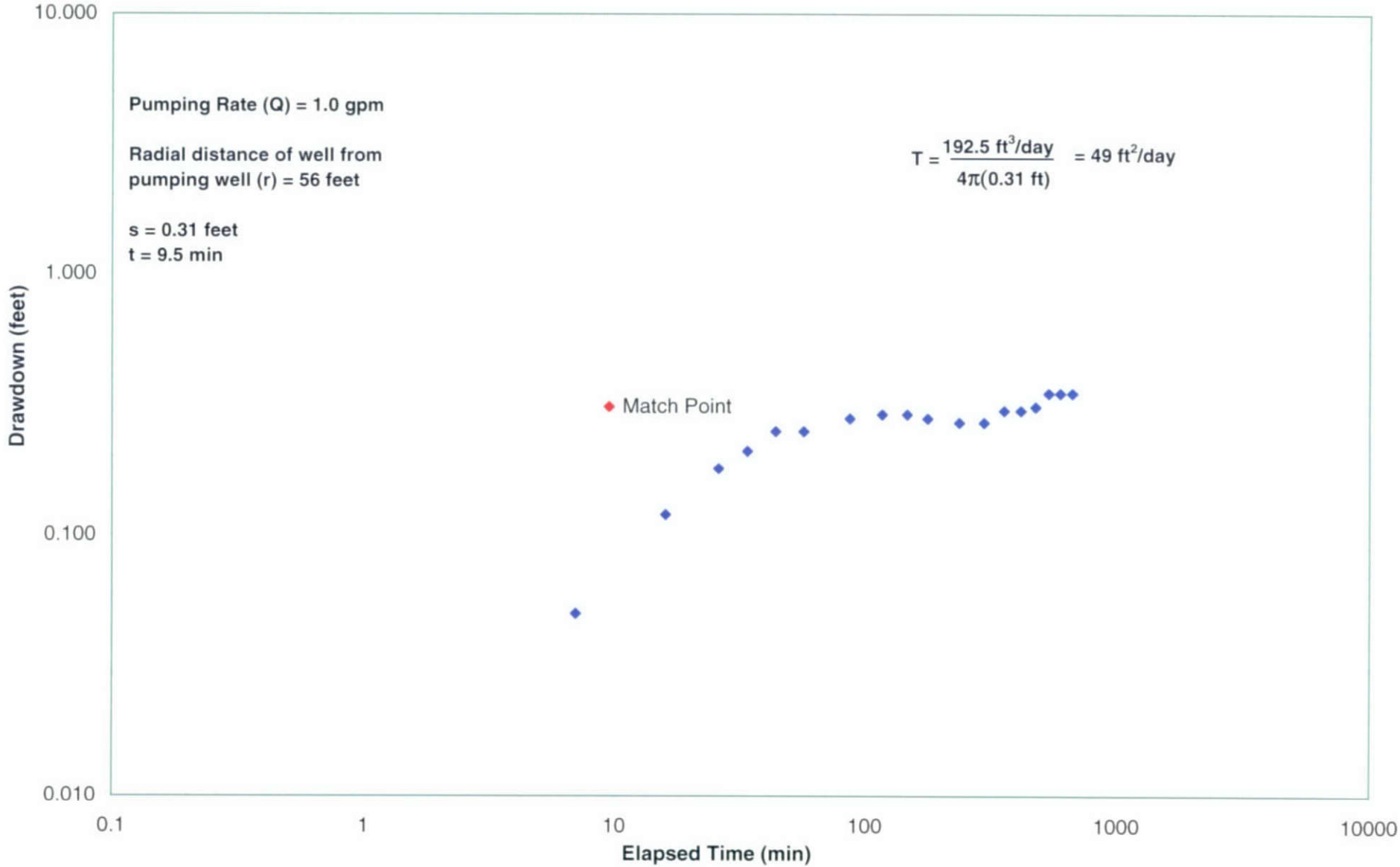
MONITORING WELL IW-1 DRAWDOWN -
THEIS PLOT
AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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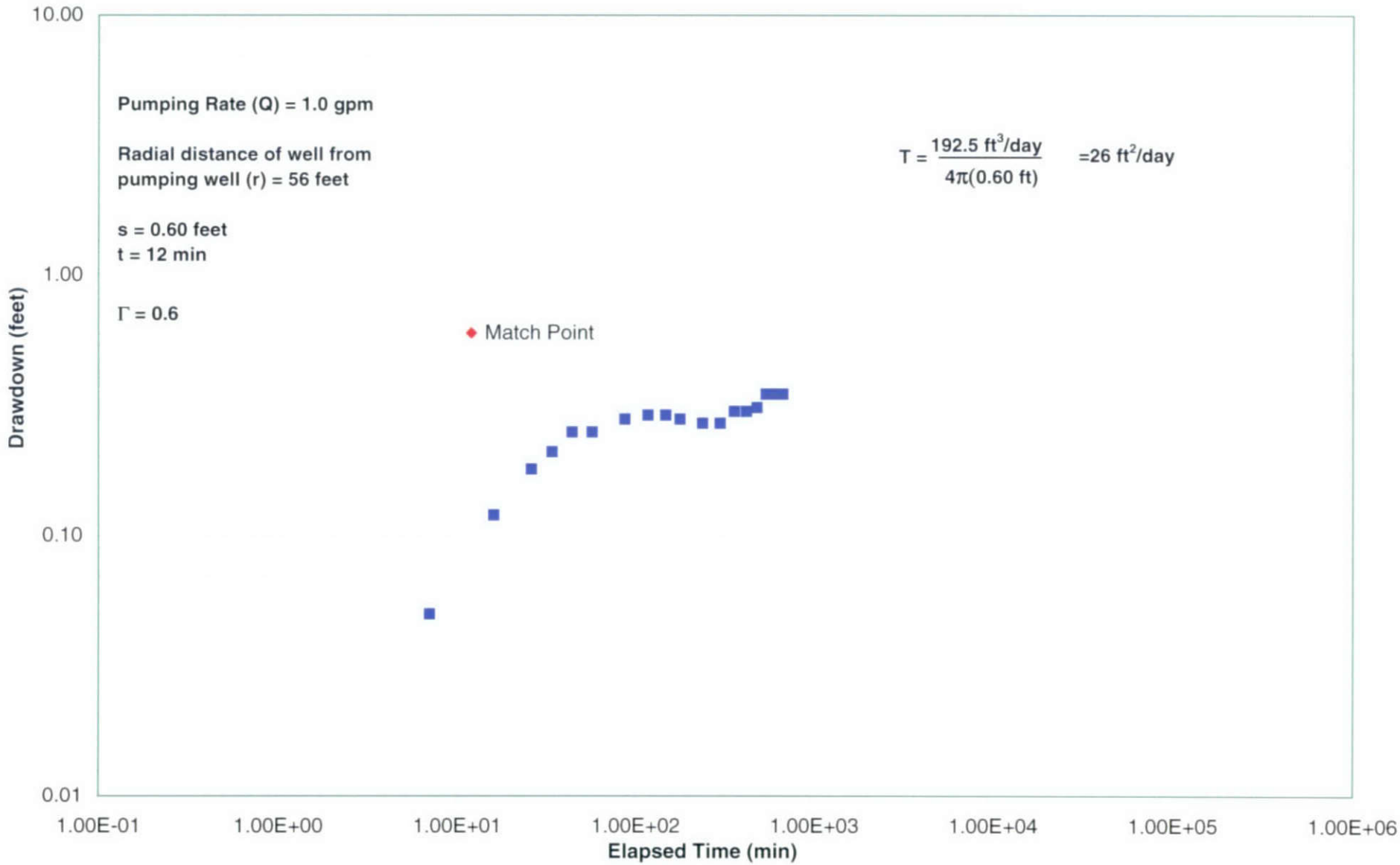
MONITORING WELL IW-1 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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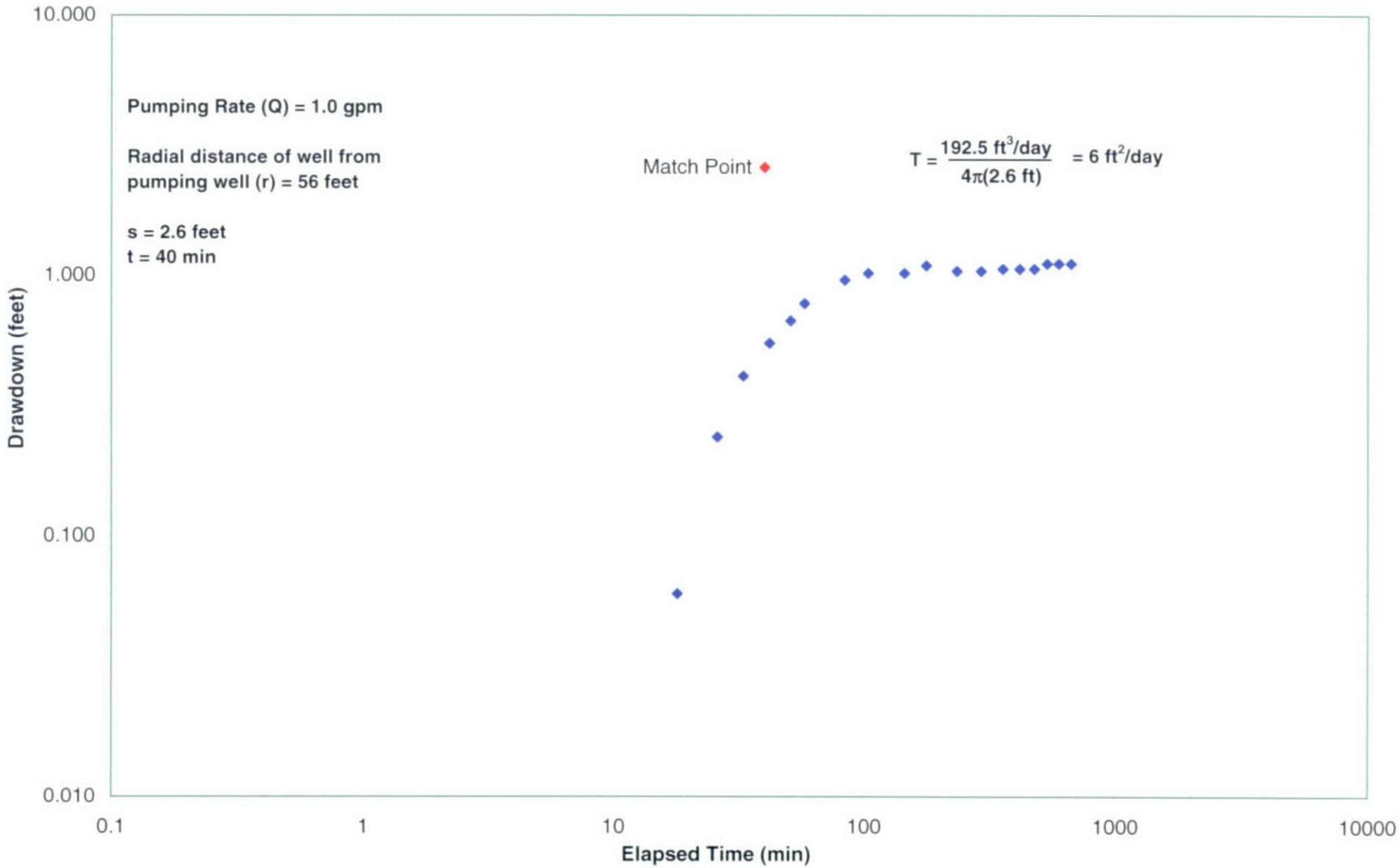
MONITORING WELL IW-3 DRAWDOWN -
THEIS PLOT
AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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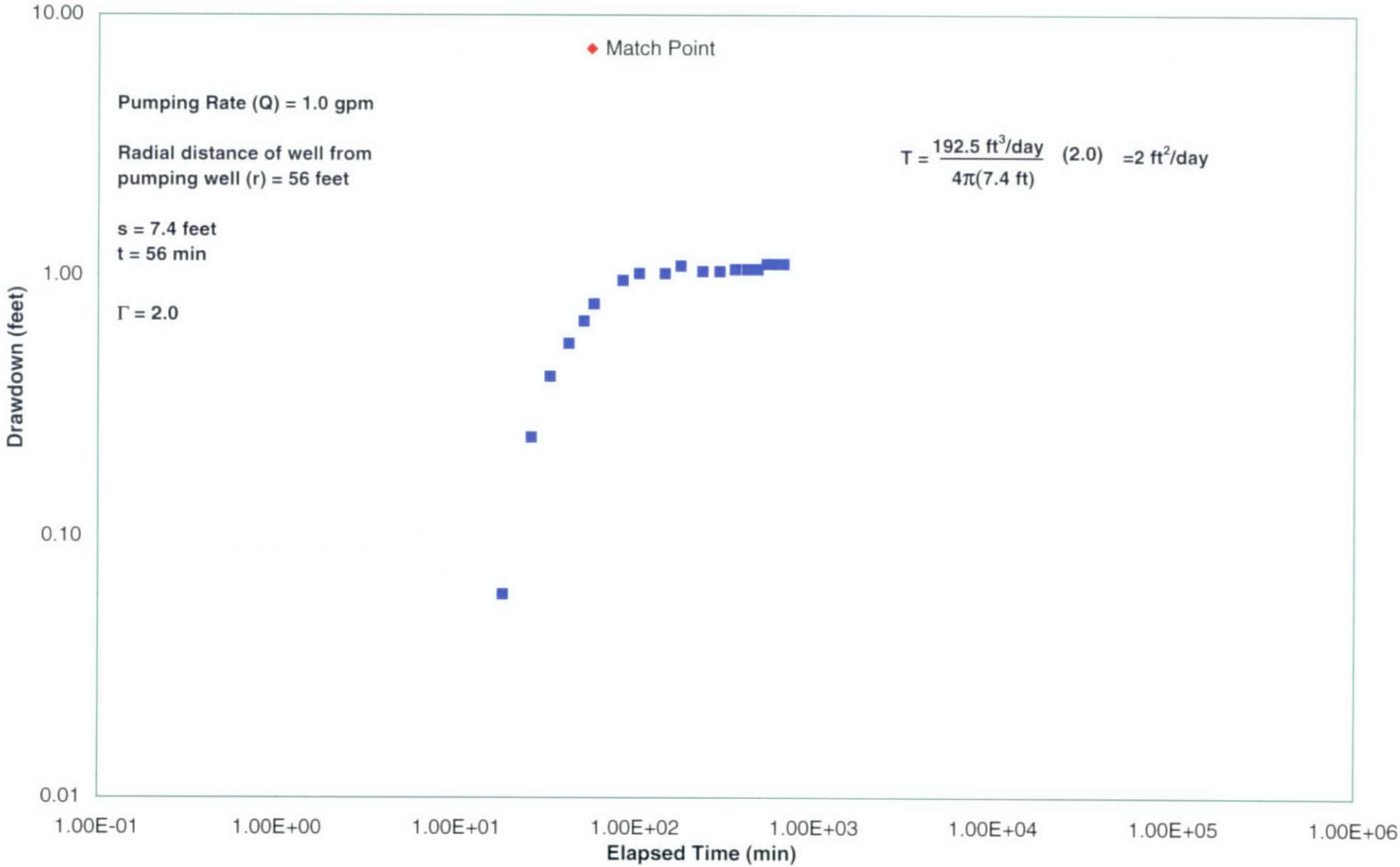
MONITORING WELL IW-3 DRAWDOWN - NEUMAN PLOT

AQUIFER ANALYSIS OF BUILDING 40 AREA
IW-2 AQUIFER TEST
WATERVLIET, NEW YORK



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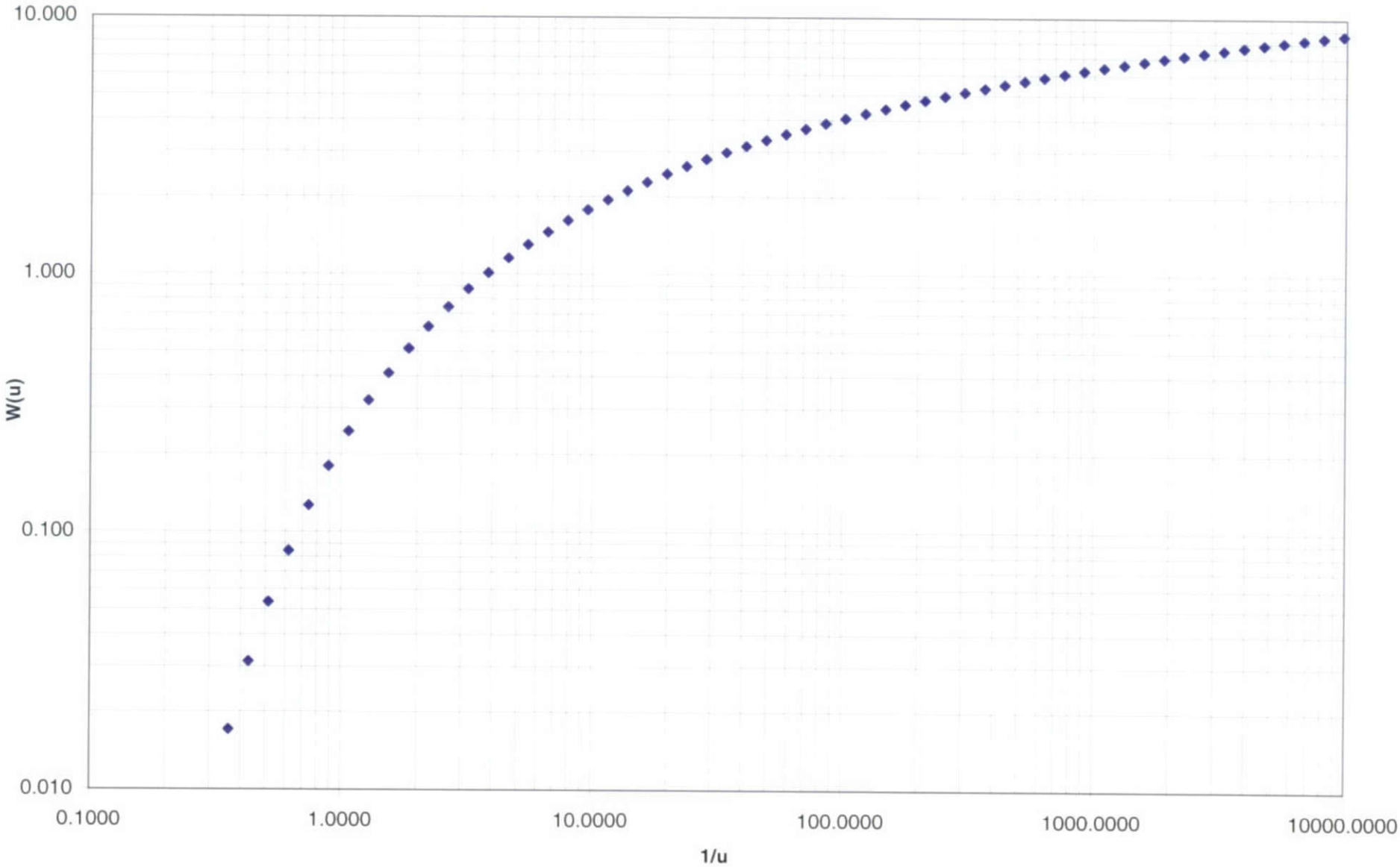
Theis Curve



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Theoretical Curves of $W(U_A, \Gamma)$ versus $1/U_A$ for an Unconfined Aquifer (after Neuman, 1975)