
**2017 ANNUAL MONITORING PROGRESS REPORT FOR THE
NPBA EXTRACTION SYSTEM SHUTDOWN
Former York Naval Ordnance Plant
1425 Eden Road, Springettsbury Township
York, Pennsylvania**

Prepared for:

Former York Naval Ordnance Plant Remediation Team

April 2018

Prepared by:

Groundwater Sciences Corporation

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LIST OF ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
bgs	below ground surface
cis12DCE	cis-1,2-dichloroethene
COC	chemicals of concern
FSP	Field Sampling Plan
fYNOP	former York Naval Ordnance Plant
GSC	Groundwater Sciences Corporation
Harley-Davidson	Harley-Davidson Motor Company Operations, Inc.
mg/L	milligrams per liter
µg/L	micrograms per liter
MSC	Medium-Specific Concentration
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NETT	North End of Test Track
NPBA	Northern Property Boundary Area
PADEP	Pennsylvania Department of Environmental Protection
Part 2 SRI	Part 2 Supplemental Groundwater Remedial Investigation
PCE	tetrachloroethene
RUA	Residential Used Aquifer
TCE	trichloroethene
U	undetected
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

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1 INTRODUCTION

Groundwater Sciences Corporation (GSC) has prepared this progress report of the results of the 2017 annual groundwater monitoring of the Northern Property Boundary Area (NPBA) groundwater extraction system shutdown on June 19, 2013 at the former York Naval Ordnance Plant (fYNOP or Site) located at 1425 Eden Road, Springettsbury Township, York, Pennsylvania (**Figure 1**). The Site is divided into the East Campus, owned by Harley-Davidson Motor Operations, Inc. (Harley-Davidson), and the West Campus, owned by NP York 58, LLC. This fourth year progress report includes the annual monitoring data for 2017. Results are described in Section 2, the work plan for 2018 is described in Section 3, and references are provided in Section 4.

The rationale and plan for deactivation and evaluation of the NPBA groundwater extraction system are described in Section 8.7.5 of the Supplemental Remedial Investigation (SRI) Groundwater Report (Part 1) (GSC, 2011) and Section 4.3.4 of the Field Sampling Plan (FSP) for the Part 2 SRI Groundwater Report (GSC, 2012) and Addendum #6 to the FSP (GSC, 2013). Results of the monitored shutdown test were included in a report titled “Results of NPBA Extraction System and Bldg3 Footer Drain Monitored Shutdown Tests for Part 2 of the Supplemental Groundwater Remedial Investigation” (GSC, 2014). The report was submitted to the United States Environmental Protection Agency (USEPA) and the Pennsylvania Department of Environmental Protection (PADEP) on April 11, 2014 and included recommendations for monitoring of the groundwater in the NPBA area. The USEPA approved the shutdown of active pumping of the NPBA groundwater extraction system and annual monitoring in an email reply to Mr. Stephen Snyder of GSC (USEPA, 2014).

The approved monitoring plan involves the monitoring and reporting of groundwater levels and chemistry on an annual basis for a period of five years from 26 locations in and north of the NPBA. Monitoring results from seven additional on-Site wells located down-gradient of the NPBA (wells MW-3, MW-82, MW-77, MW-102S&D and MW-103S&D) are included in this 2017 annual NPBA report to track the potential migration of chemicals of concern (COCs) in the down-gradient direction on-Site. After five years of monitoring (through the end of 2018), long-term shutdown of the NPBA groundwater extraction system will be re-evaluated.

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The results of the first three years of annual groundwater monitoring (2014, 2015 and 2016) were submitted previously to the USEPA and PADEP (GSC, 2015, 2016 and 2017, respectively). Groundwater levels and chemical analyses from the first three years of long-term monitoring of the NPBA area indicated stable (unchanged) conditions from the initial post-shutdown conditions.

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2 2017 ANNUAL MONITORING PROGRESS

Fourth year (2017) monitoring results are discussed in this section, followed by a discussion of the potential for off-Site migration of Site-related COCs. Groundwater locations monitored in 2017 are shown on **Figure 2** and are summarized below:

NPBA and Off-Site Locations				Additional Locations Downgradient of NPBA
CW-1	CW-7	MW-18S	MW-143S	MW-3
CW-1A	CW-7A	MW-18D	MW-143D	MW-82
CW-2	MW-9	MW-20S	RW-2	MW-77
CW-3	MW-11	MW-20M	RW-4 (Folk)	MW-102S
CW-4	MW-12	MW-20D	Tate (S-6)	MW-102D
CW-5	MW-16S	MW-142S		MW-103S
CW-6	MW-16D	MW-142D		MW-103D

2.1 Groundwater Elevations and Gradient

Groundwater elevation measurements at the NPBA were collected on October 16, 2017 by Hydro-Terra Group and GSC personnel as part of the 2017 Site-wide water level monitoring round. Elevation measurements collected in 2017, plus elevations from prior to and during the NPBA groundwater extraction system shutdown testing period are listed in **Table 1**. In the 2017 monitoring event, the groundwater elevations, excluding wells under artesian pressure, ranged from a high of approximately 543 feet above mean sea level (amsl) in the northeast to approximately 344 feet amsl in the southwest (**Figure 3**).

Wells MW-16D and MW-18S&D exhibit artesian conditions and contain packers to seal the flow of groundwater to the surface. Wells MW-20M&D do not contain packers, but the water elevations are high in these wells indicating that the groundwater is under pressure at those locations. Note that the water level in private non-potable well RW-4 (Folk) was measured on October 14, 2017 when the homeowner allowed access (2 days prior to the comprehensive round of water levels). In addition, RW-1 no longer exists, RW-3 is not accessible for monitoring and the property owners have denied access to spring Herman (S-7) (**Figure 2**).

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Groundwater elevation contours from October 16, 2017 are shown on **Figure 3**. These contours represent the shallow groundwater elevations under natural flow conditions (non-pumping conditions) and show a lateral gradient that slopes toward the southwest.

Groundwater elevations and potentiometric contours from October 16, 2017 are shown in the cross section on **Figure 4**. Vertical groundwater gradients can be observed on the figure for nested wells MW-16S&D, MW-18S&D; MW-20S, M, & D; MW-142S&D; and MW-143S&D. In each of these wells except MW-142S&D, the groundwater elevation of the deeper well is higher than the elevation in the shallower well pair. This indicates that vertical groundwater flow is upward at these well locations under non-pumping conditions. Given this vertically upward flow gradient, dissolved COCs would not migrate deeper into the aquifer under natural (non-pumping) conditions.

Comparing the October 2017 groundwater elevations and potentiometric contours to the previous post-shutdown elevations and contours from 2013 through 2016 indicates there is essentially no change in the lateral and vertical groundwater gradients in the NPBA area.

2.2 Groundwater Chemistry

Groundwater sampling was completed from October 16 through November 1, 2017, coincident with the annual comprehensive well sampling across the Site. Samples were submitted to TestAmerica Pittsburgh for analysis of volatile organic compounds (VOCs) by Method 8260C. Recent chemistry data for the NPBA wells are summarized in **Table 2**. Isoconcentration contours for trichloroethene (TCE), the most common COC at the NPBA, are shown on **Figure 5** for wells screened or open to the top 110 feet below ground surface (bgs). **Figure 5** illustrates that the highest TCE concentrations in 2017 were centered on wells CW-1A, CW-7A and MW-12, and that TCE concentrations of 5 micrograms per liter ($\mu\text{g/L}$) or more were interpreted to exist in the groundwater beneath most of the NPBA. Note that the source of the elevated TCE and tetrachloroethene (PCE) concentrations to the southwest (downgradient) of the NPBA in the area of MW-102S&D and MW-103S&D is from former waste disposal, handling and storage activities at the North End of Test Track (NETT) area.

Historical chemistry data are shown on the graphs in **Appendix A**. **Figure 5** (plan view) and **Figure 6** (cross sectional view) show TCE and PCE chemistry data from pre-shutdown and post-

shutdown in 2013 through 2017 for these primary COCs. Minor concentration fluctuations in the post-shutdown samples were observed at most of the sample locations, with the majority of the COC concentrations in the samples decreasing or remaining about the same. Locations that exhibited increases in PCE concentrations compared to the pre-shutdown concentrations were at inactive collection wells CW-5 and CW-7A, where pumping had likely caused dilution while the extraction system was operating (see graphs in **Appendix A**). The COC trends in these wells are summarized as follows:

- Prior to system shutdown, detections of PCE in CW-5 showed a declining trend with a pre-shutdown concentration of 2.5 µg/L in 2013. After pumping ceased, PCE concentration have ranged from 7.4 µg/L in 2013 to 41 µg/L in 2016, and the concentration in 2017 was 31 µg/L.
- PCE concentrations were on a declining trend prior to the shutdown of CW-7A, which had a pre-shutdown concentration of 1.4 J µg/L in 2013. Post system shutdown concentrations have ranged from 4.3 J µg/L in 2013 to 8.6 µg/L in 2015. Concentrations of PCE in 2016 decreased to 5.6 µg/L and then again to 3.4 µg/L in 2017. Note that “J” refers to results that are less than the laboratory’s reporting limit, but greater than or equal to the method detection limit; the concentration is an approximate value.

In addition to the 26 annual NPBA monitoring locations, groundwater chemistry data from MW-3, MW-77, MW-82, MW-102S&D and MW-103S&D were also compared to historical data. These wells are located downgradient of the inactive collection wells in the NPBA, theoretically receiving groundwater flow from the NPBA (**Figure 5**). Note that well clusters MW-102S&D and MW-103S&D reflect the groundwater quality in the NETT area, and due to their distance downgradient of the NPBA, were sampled to assess long-term concentration trends associated with the shutdown of the NPBA groundwater extraction system.

TCE, PCE and cis-1,2-dichloroethene (cis12DCE) concentrations were similar or declined slightly compared to the historical groundwater data in MW-3 and MW-82. As shown on the graphs in **Appendix A**, TCE concentrations in MW-103D have shown a steady decline from 79 µg/L in 2013 to 2.2 µg/L in 2017, and the TCE concentration at MW-102D in 2017 was much lower than the previous concentrations (2.9 µg/L versus 140 µg/L).

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An additional downgradient well, MW-77, was sampled in 2013 and 2014 (non-detect COC concentrations), but was not sampled in 2015 or 2016 because it is located in an area of a hydrocarbon release and was part of a PADEP study. Access to sample this location was also prohibited in 2016 due to construction on the West Campus property. In 2017, MW-77 was sampled and showed undetected (U) concentrations of TCE, PCE and cis12DCE (**Table 2**).

The following bulleted text is taken from the monitored shutdown report (GSC, 2014), which explains the chemistry trends observed 12 weeks (September 2013) after extraction system shutdown. Added to that text is a brief summary of observations of changes from 2014 through 2017. The added text for 2017 is included in *italics*. Refer to **Figures 5** and **6** for plan view and cross section maps, to **Table 2** for a summary of chemistry data, and to chemistry concentration graphs included in **Appendix A**.

- Five wells are located in the eastern-most extent of the NPBA. MW-20S, M, D and CW-7 and CW-7A are within 20 feet of each other, and sample different depths in the aquifer, from 28 feet – 61 feet (MW-20S) to 153 feet – 165 feet (MW-20D). CW-7 is open to the bedrock aquifer from 61 feet – 150 feet, while CW-7A screens residuum and saprolite (decomposed bedrock maintaining the structural features of the bedrock) from 34 feet – 66 feet bgs. Concentrations of TCE are highest near the surface, and decrease with depth, with groundwater from MW-20S showing the highest concentrations during pumping. MW-20S concentrations dropped after cessation of pumping, suggesting TCE was being pulled through that well by pumping, and potentially indicating the location of higher concentrations of TCE to be to the east of MW-20S. CW-7A concentrations increased after cessation of pumping, indicating portions of the flow drawn in by pumping most likely had been diluting the concentrations. CW-7 TCE concentrations dropped after pumping ceased, indicating pumping of that well was likely drawing mass from the shallow portion of the aquifer.

The 2014 sample results indicate no significant changes from the description above. Concentrations of TCE in CW-7A decreased to a level closer to the pre-shutdown concentration.

The 2015 sample results are similar to the descriptions above with the exception that the PCE concentration in CW-7A increased to a high of 8.6 µg/L.

The 2016 sample results are similar to the descriptions above with the exception that the PCE concentration in CW-7A decreased slightly from 8.6 µg/L in 2015 to 5.6 µg/L after several years of slightly increasing concentrations. The TCE concentration in CW-7A (86 µg/L) represents the lowest concentration detected since shutdown. Concentrations of TCE in MW-20S continue to decline with a detection 48 µg/L representing the lowest concentration detected since shutdown.

The 2017 sample results continue to be similar to the descriptions above with the exception that both PCE and TCE concentrations in CW-7A and MW-20S represent the lowest concentrations detected since shutdown. Concentrations in MW-20D remain undetected (U); however, TCE in MW-20M has fluctuated with concentrations ranging from 0.85 J µg/L in 2014 to 32 J µg/L in 2017. Concentrations of TCE in MW-20S continue to decline with a concentration of 32 µg/L representing the lowest concentration detected since shutdown.

- Collection wells CW-1 and CW-1A are open to a depth of 68 feet – 175 feet and 29 feet – 74 feet, respectively. TCE concentrations in these wells prior to cessation of pumping were nearly the same at 33 µg/L and 35 µg/L, respectively. With the pumps off, concentrations in both wells dropped to 9.4 µg/L in CW-1 and 26 µg/L in CW-1A.

One year later, the TCE concentration in CW-1 reduced to 1.8 µg/L, while the TCE concentration in CW-1A remained nearly unchanged (31 µg/L).

Two years later, the TCE concentration in CW-1 reduced to 1.1 µg/L, while the TCE concentration in CW-1A remained nearly unchanged (28 µg/L).

Three years later, the TCE concentration in CW-1 remained relatively unchanged (1.6 µg/L). The TCE concentration in CW-1A increased from 28 µg/L to 56 µg/L, which represents the highest detection since it was shut down.

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Four years later, the TCE concentration in CW-1 has decreased to its lowest concentration since shutdown (0.79 J $\mu\text{g/L}$) and the TCE concentrations in CW-1A remained nearly unchanged (53 $\mu\text{g/L}$).

- Monitoring well MW-11, which is west of CW-1 and CW-1A and east of CW-2 showed no change in pre- and post-shutdown TCE concentrations (pre-shutdown of 4.5 $\mu\text{g/L}$ versus post-shutdown of 4.9 $\mu\text{g/L}$). The water level in this well is higher than wells on either side of it; and there was no apparent recovery (rise) in water level when the collection wells were shut down. The lack of response in both chemistry and water level, combined with the higher water level than in adjacent wells indicates that water from well MW-11 is not sufficiently hydraulically connected to the pumped portion of the aquifer or that it is being supported by an artesian condition below the pumping wells (deeper water sourced from the elevated area to the east).

The 2014 sample results indicate no significant changes from the description above. Monitoring well MW-3, located down-gradient and about 600 feet southwest of MW-11, showed no change in concentrations compared to 2013 data.

The 2015 sample results show no significant changes from the descriptions above.

The 2016 sample results for MW-11 show no significant changes from the above descriptions, and the detected TCE concentration of 2.4 $\mu\text{g/L}$ represents the lowest detection since the shutdown of the collection wells.

The 2017 sample results for MW-11 show no significant changes from the above descriptions for TCE and PCE.

- Collection well CW-2 and adjacent monitoring well MW-9 decreased in TCE concentrations after cessation of pumping. Since the groundwater flow direction at MW-9 while pumping was toward the northwest, and that flow direction changed to southwestward when CW-2 stopped pumping, the change in chemistry indicates higher concentrations of TCE in groundwater being pulled from the southeast of MW-9. With the cessation of pumping, the concentration of PCE in CW-2 went from undetected (U) to 3 $\mu\text{g/L}$. PCE was detected in

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this well prior to initiation of the extraction system at 2 µg/L to 4 µg/L. The reappearance suggests the concentration of PCE was being diluted by pulling groundwater from a greater distance away from CW-2. These pre- and post-shutdown results suggest that PCE is adsorbed onto the aquifer material at a location close to or discretely connected to CW-2.

The 2014 sample results indicate no significant changes from the description above. CW-2 TCE concentrations increased slightly to a level similar to pre-shutdown conditions.

The 2015 sample results show no significant changes from the description above; however, the TCE concentration in CW-2 decreased to the lowest level to date (4.9 µg/L).

The 2016 sample results for MW-9 show TCE at its lowest concentration since shutdown activities at 19 µg/L. TCE in CW-2 increased in concentration to 15 µg/L versus the previous maximum concentration of 14 µg/L in 2014, and the PCE concentration decreased to the lowest concentration to date (0.97 J µg/L).

The 2017 sample results for MW-9 show no significant changes from the above descriptions with a TCE concentration of 20 µg/L and an undetected (U) PCE concentration. PCE and TCE concentrations both decreased in CW-2 with PCE decreasing from 0.97 J µg/L to 0.91 J µg/L and TCE decreasing from 15 µg/L to 10 µg/L in 2016 and 2017, respectively.

- The TCE concentration in off-Site former residential supply well RW-2, located 150 feet northwest of CW-2 rose slightly between pre- (1.2 µg/L) and post- (1.9 µg/L) shutdown sampling. The change is within its normal range of TCE concentrations during pumping. This well has been below applicable PADEP Medium-Specific Concentrations (MSCs) for Residential Used Aquifers (RUA) with total dissolved solids less than or equal to 2,500 milligrams per liter (mg/L) for all Site-related COCs since 2003 and the TCE concentrations have ranged from 1.4 µg/L (in 2006) to 3.9 µg/L (in 2009) over the last seven years of annual sampling.

The 2014 sample results indicate no significant changes from the description above. The TCE concentration measured one year later was 3.1 µg/L.

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The 2015 sample results show no significant changes from the description above. The TCE concentration measured in 2015 was 3.8 µg/L. Concentrations of TCE and PCE continue to remain undetected (U) in the other former residential supply well, RW-4 (Folk), currently connected to an outdoor spigot, and not used as a potable supply.

The 2016 sample results for RW-2 suggest no significant changes from the descriptions above, and the TCE concentration in 2016 was 3.7 µg/L. RW-2 has not been used as a supply well since prior to the fYNOP investigations in 1986. Concentrations of TCE and PCE continue to remain undetected (U) in the other former residential supply well, RW-4 (Folk), currently connected to an outdoor spigot, and not used as a potable supply.

The 2017 sample results show no significant changes from the description above. The TCE concentration measured in 2017 was 3.4 µg/L. RW-2 is still not being used as a supply well since prior to fYNOP investigations in 1986. Concentrations of TCE and PCE continue to remain undetected (U) in the other former residential supply well, RW-4 (Folk), currently connected to an outdoor spigot, and not used as a potable supply.

- TCE and PCE concentrations decreased in collection well CW-4 after cessation of pumping. Adjacent monitoring well MW-12, southwest of CW-4, more than doubled in TCE and PCE concentrations after pumping stopped. This suggests that higher concentrations of these COCs may be located south or southeast of CW-4 and northeast of MW-12, in a position that is upgradient from MW-12 under the static post-shutdown groundwater potentiometric surface conditions.

The 2014 sample results indicate no significant changes from the description above. Concentrations of TCE and PCE in CW-4 continued to drop significantly, while MW-12 levels moderated.

The 2015 sample results show no significant changes from the description above. Concentrations of TCE and PCE continued to drop in CW-4, while the concentration of PCE in MW-12 slightly increased to 6.4 µg/L (an increase of 1 µg/L above the 2014 value).

The 2016 sample results indicate no significant changes from the descriptions above. Concentrations of TCE and PCE continued to drop in CW-4, while the concentrations of TCE and PCE in MW-12 decreased from 120 µg/L to 93 µg/L and 6.4 µg/L to 4.3 µg/L, respectively.

Concentrations in CW-4 have dropped to the lowest concentrations since pre- and post-shutdown sampling with both TCE and PCE results being undetected (U). TCE and PCE in MW-12 continue to decrease from 93 µg/L to 61 µg/L and 4.3 µg/L to 2.7 µg/L, in 2016 and 2017, respectively, with TCE detected at its lowest concentration since pre- and post-shutdown sampling.

- Collection well CW-3 and adjacent well pair MW-16S and MW-16D are located near the center of the row of collection wells along the NPBA. The groundwater chemistry in MW-16S is notable in that it shows the highest concentration of PCE in the NPBA, where TCE is the dominant COC. CW-3 concentrations of TCE increased slightly, with the cessation of pumping, but remained in single digits. A pre-shutdown sample of MW-16S could not be analyzed due to excessive turbidity. However, compared to previous samples collected during pumping, the concentration appears to have reduced significantly under post-shutdown conditions. MW-16D, screened at a depth bgs of 190 feet – 201 feet, is artesian, and groundwater quality is minimally influenced by the COCs in the shallower zones in the immediate vicinity, indicated by PCE concentrations being undetected (U).

The 2014 sample results show no significant changes from the description above.

In 2015, TCE and PCE both decreased significantly to below 10 µg/L in MW-16S, whereas concentrations in MW-16D have remained consistent. TCE and PCE were undetected (U) in CW-3 in 2015, compared to 1.4J and 0.41J µg/L in 2014. CW-3 also contained 460 µg/L of acetone, a common laboratory contaminant, and the laboratory had an issue with the recovery criteria for TCE and PCE in an associated Matrix Spike / Matrix Spike Duplicate (MS/MSD) sample, suggesting that the data at CW-3 may be suspect.

In 2016, TCE remained relatively unchanged (6.2 µg/L) in MW-16S, but the PCE concentration increased from 6.7 to 48 µg/L, which is well below the 2013 and 2014

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shutdown results. Concentrations in MW-16D have remained consistent with a slight decrease in TCE to 10 µg/L, which represents the lowest TCE concentration detected since shutdown. TCE and PCE remain undetected (U) in CW-3 in 2016.

In 2017, TCE remained stable (7.7 J µg/L) in MW-16S, and the PCE concentration decreased significantly from 48 µg/L in 2016 to 1.7 J µg/L in 2017, which represents the lowest detected since shutdown. TCE concentrations in MW-16D have continued to consistently decrease with the lowest post-shutdown concentration detected in 2017 (8.7 J µg/L). TCE and PCE remain undetected (U) in CW-3 in 2017.

- Collection wells CW-5 and CW-6 are west and down-gradient of the CW-3/MW-16 cluster of wells. After cessation of pumping, TCE and PCE concentrations in CW-6 dropped, suggesting during pumping this well was pulling COCs sourced some distance away from the pumping well. Since the reduction in PCE concentrations was disproportionately high, CW-6 was probably pulling in groundwater with PCE from the MW-16S area. After cessation of pumping, TCE and PCE concentrations in CW-5 increased slightly.

The 2014 sample results indicate no significant changes from the description above. After one year, CW-6 concentrations continued to drop, while CW-5 concentrations continued to increase slightly.

The 2015 sample results show no significant changes from the descriptions above. CW-6 concentrations remained stable with respect to 2013 post-shutdown concentrations, and CW-5 concentrations remained stable compared to 2014.

In 2016, CW-6 concentrations increased slightly from 2015 concentrations for PCE (40 J µg/L to 46 µg/L) and TCE (7.5 J µg/L to 11 µg/L). CW-5 TCE concentrations increased slightly from 5.3 µg/L in 2015 to 12 µg/L in 2016, whereas PCE concentrations had a more significant increase from 15 µg/L in 2015 to 41 µg/L in 2016.

In 2017, concentrations in CW-6 and CW-5 decreased slightly for both TCE and PCE. In CW-6, concentrations of TCE decreased from 11 µg/L (2016) to 9.0 µg/L (2017) and concentrations of PCE decreased from 46 µg/L (2016) to 37 µg/L (2017). In CW-5,

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concentrations for TCE and PCE went down from 12 µg/L to 9.4 µg/L and 41 µg/L to 31 µg/L, in 2016 and 2017, respectively.

- Well pair MW-18S and MW-18D are open from 45 feet – 65 feet and 130 feet – 140 feet bgs, respectively. When sampled in 1988, MW-18S had a relatively low concentration of TCE at 50 µg/L, and MW-18D had no detections of VOCs. At the time, this data was considered an indication of the western limit of the plume. These wells were resampled in 2008, and showed concentrations of TCE exceeding 1,000 µg/L in both wells. It was assumed that VOCs were mobilized by the extraction system and pulled through these wells, suggesting a source to the west of this well pair, with VOCs transported by groundwater being pulled eastward toward CW-5 and the other groundwater extraction system wells. As indicated by time vs. concentration graphs in **Appendix A**, concentrations of VOCs in wells MW-18S and MW-18D have generally declined over the last four to six years. The pre-shutdown concentration of TCE in MW-18S was 220 µg/L while the post-shutdown concentration was 45 µg/L. The pre-shutdown concentration of TCE in MW-18D was 560 µg/L while the post-shutdown concentration was 42 µg/L. Changes that largely suggest the pumping of the collection wells was pulling VOCs through the MW-18 well pair from a source located west of the well pair.

The 2014 sample results indicate no significant changes from the description above. Continued reductions of TCE concentrations in MW-18S (5.5 µg/L) and MW-18D (8.1 µg/L) support the conclusion regarding the observed concentration changes. Wells MW-142S&D and MW-143S&D, located down-gradient of MW-18S&D, continued to exhibit undetected or very low COC concentrations (TCE concentration of 1.9 µg/L at MW-143S).

The 2015 sample results show no significant changes from the descriptions above, with concentrations slightly higher than in 2014 in wells MW-18D, MW-142S and MW-143S, but lower than the post-shutdown concentrations from 2013. The TCE concentration in MW-18S increased from 5.5 µg/L in 2014 to 11 µg/L in 2015, which is well below the pre- and post-shutdown concentrations detected in 2013.

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The 2016 sample results show no detections of TCE and PCE in MW-142S&D and MW-143D. TCE in MW-18S&D and MW-143S have all decreased to their lowest concentrations since shutdown.

The 2017 sample results again show no detections of TCE and PCE in MW-142S&D and MW-143D. TCE and PCE in MW-143S continue to decrease to their lowest concentrations since shutdown. TCE in MW-18S increased slightly from 1.2 µg/L in 2016 to 4.1 µg/L in 2017. The concentrations have generally decreased since pre-shutdown conditions (220 µg/L) and post shutdown conditions (45 µg/L). PCE in MW-18S and MW-18D remain undetected (U).

2.3 Potential for Off-Site Plume Migration in the NPBA

The two primary potential groundwater flow paths for off-Site plume migration in the NPBA are 1) migration to the north toward former residential water supply wells and, 2) migration to the west across the Site property line in the vicinity of monitoring well pair MW-18S&D.

2.3.1 Potential for Migration to the North

The monitored shutdown report (GSC, 2014) concluded that “natural migration of COCs northward from the NPBA appears to be unlikely” based on the groundwater level contours developed from water levels in wells under non-pumping conditions after shutdown.

The 2017 groundwater elevation contours in plan (**Figure 3**) and profile (**Figure 4**) views are essentially the same as the post-shutdown conditions in 2013, 2014, 2015 and 2016. No modification to the previous evaluation is warranted based on the 2017 water level data. Similarly, the 2017 groundwater chemistry results are consistent with the previous post-shutdown results, and show no indications of northward migration. Specifically, Site-related COCs continue to remain undetected or detected at concentrations below the PADEP groundwater MSCs in off-Site monitoring locations to the north of the NPBA at RW-2, RW-4 and Tate (S-6).

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2.3.2 Potential for Migration to the West

The monitored shutdown report (GSC, 2014) described the existence of a natural (non-pumping) gradient to the south-southwest in the area of MW-18S&D. This gradient is essentially parallel to the western Site property line where well pairs MW-18S&D, MW-142S&D and MW-143S&D are located (see groundwater flow path illustrated on **Figure 3**). With elevated TCE concentrations in the pre- and post-shutdown concentrations at MW-18S&D and anisotropic groundwater flow (preferential permeability) along bedding/cleavage planes, there was a potential for the western margin of the groundwater plume to extend across the property line to the west onto the adjacent property and migrate to the southwest beneath the property for a lateral distance of approximately 1,000 feet, and then back onto the FYNOP Site where the property line changes to a northwest-southeast orientation just west of MW-143S&D.

As discussed in Section 2.2, the TCE concentrations in MW-18S&D declined sharply compared to the pre and post-shutdown concentrations and have remained relatively stable during the last four years of monitoring (2014 through 2017). These results, along with the consistent lateral gradient from the area of MW-18S&D to the southwest and the undetected to very low COC concentrations in downgradient well pairs MW-142S&D and MW-143S&D, is why the western edge of the 5 µg/L to 50 µg/L TCE plume is shown approximately 100 to 200 feet to the east of the property line downgradient of MW-18S&D (plume shown in gray on **Figure 5**). The groundwater plume shows no indication that it extends across the property boundary to the west under natural (non-pumping) conditions.

3 SUMMARY

Groundwater levels and VOC sample analytical results from the fourth year of planned shutdown monitoring (2017) in the NPBA indicate stable conditions compared to the initial post-shutdown conditions.

A comparison of the pre- and post-shutdown TCE and PCE concentrations indicate they are generally stable or declining in 24 of the 26 SPBA wells being monitored. A gradual increase in TCE concentrations at collection well CW-1A was observed following shutdown through 2016 and then leveled off in 2017. CW-5 had an upward trend in TCE and PCE concentrations; however, the concentrations in 2017 were lower than the concentrations in 2016. Concentration fluctuations at CW-1A and CW-5 are expected to continue in the future due to desorption of VOCs from the aquifer matrix in these localized source areas and the change in groundwater flow direction caused by the return to natural (non-pumping) conditions.

All data suggests that, while TCE and PCE concentrations exceed PADEP groundwater MSCs on Site in the NPBA, migration of the COCs is inward (southwestward) toward the center of the Site where former manufacturing and waste handling activities have resulted in general degradation of the groundwater. Monitoring indicates that concentrations in off-Site former residential supply wells (north of Paradise Road) remain below PADEP groundwater MSCs.

The work plan for the fifth and final year of planned shutdown monitoring (2018) is to continue the monitoring of the NPBA groundwater extraction system shutdown, with the annual collection of water level measurements and groundwater samples for analysis of VOCs. No changes to the plan are recommended. The annual groundwater level and sampling will coincide with the larger-scope 2018 comprehensive event which is planned for late summer or early fall.

The 2018 water levels and chemistry data will be analyzed and a progress report will be prepared during the first quarter of 2019. Analysis of the chemistry data will also include wells MW-3, MW-77, MW-82, MW-102S&D and MW-103S&D located southwest (downgradient) of the NPBA. The plan is to continue annual monitoring of the shutdown conditions in the NPBA for one more year for a total of five years. Recommendations regarding future system status will be made in early 2019.

April 2018

4 REFERENCES

- GSC, 2011. Supplemental Remedial Investigation Groundwater Report (Part 1) Former York Naval Ordnance Plant, September.
- GSC, 2012. Field Sampling Plan For Part 2 of the Supplemental Groundwater Remedial Investigation at the former York Naval Ordnance Plant in York, Pennsylvania, April.
- GSC, 2013. Addendum #6, to Field Sampling Plan for Part 2 of the Supplemental Groundwater Remedial Investigation Former York Naval Ordnance Plant, March 20.
- GSC, 2014. Results of NPBA Extraction System and Bldg3 Footer Drain Monitored Shutdown Tests for Part 2 of the Supplemental Groundwater Remedial Investigation Former York Naval Ordnance Plant, April.
- GSC, 2015. 2014 Annual Monitoring Progress Report for the NPBA Extraction System Shutdown Former York Naval Ordnance Plant, April.
- GSC, 2016. 2015 Annual Monitoring Progress Report for the NPBA Extraction System Shutdown Former York Naval Ordnance Plant, April.
- GSC, 2017. 2016 Annual Monitoring Progress Report for the NPBA Extraction System Shutdown Former York Naval Ordnance Plant, April.
- USEPA, 2014. Email from Mr. Griff Miller of USEPA to Mr. Stephen Snyder of GSC. April 17.

April 2018

Tables

April 2018

Table 1
Former York Naval Ordnance Plant- York, PA
Groundwater Elevations
NPBA Extraction System Shutdown Monitoring

Location	6/6/13			6/11/13			6/12/13			6/17/13			6/27/13			7/5/13		
	NPBA Shutdown Test Pre-Shutdown			NPBA Shutdown Test Event 1			NPBA Shutdown Test Event 2			NPBA Shutdown Test Event 3			NPBA Shutdown Test Event 4			NPBA Shutdown Test Event 5		
	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev
Collection Wells																		
CW-1	570.07	72.12	497.95	NM	NM	NM	570.07	72.08	497.99	570.07	75.16	494.91	570.07	41.99	528.08	570.07	41.74	528.33
CW-1A	568.28	60.60	507.68	NM	NM	NM	568.28	61.53	506.75	568.28	61.12	507.16	568.28	38.17	530.11	568.28	38.72	529.56
CW-2	556.95	68.66	488.29	NM	NM	NM	556.95	71.17	485.78	556.95	75.50	481.45	556.95	31.54	525.41	556.95	31.02	525.93
CW-3	518.66	80.80	437.86	518.66	81.57	437.09	NM	NM	NM	518.66	81.33	437.33	518.66	21.68	496.98	518.66	20.81	497.85
CW-4	541.55	85.70	455.85	541.55	15.32 AN	526.23	NM	NM	NM	541.55	84.84	456.71	541.55	27.75	513.80	541.55	26.94	514.61
CW-5	470.34	NM	NM	NM	NM	NM	NM	NM	NM	470.34	47.49	422.85	470.34	19.49	450.85	470.34	19.38	450.96
CW-6	484.67	70.70	413.97	484.67	70.67	414.00	NM	NM	NM	484.67	73.48	411.19	484.67	10.33	474.34	484.67	9.30	475.37
CW-7	573.78	86.40	487.38	NM	NM	NM	573.78	86.66	487.12	573.78	81.60	492.18	573.78	40.08	533.70	573.78	39.98	533.80
CW-7A	573.91	48.90	525.01	NM	NM	NM	573.91	48.55	525.36	573.91	50.10	523.81	573.91	41.88	532.03	573.91	41.87	532.04
Monitoring Wells																		
MW-3	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-9	558.78	47.34	511.44	NM	NM	NM	558.78	47.22	511.56	558.78	46.32	512.46	558.78	34.23	524.55	558.78	33.45	525.33
MW-10	567.80	51.94	515.86	NM	NM	NM	NM	NM	NM	567.80	51.45	516.35	567.80	40.92	526.88	567.80	40.77	527.03
MW-11	563.08	27.84	535.24	NM	NM	NM	563.08	25.84	537.24	563.08	26.49	536.59	563.08	27.47	535.61	563.08	27.83	535.25
MW-12	535.93	37.43	498.50	535.93	37.32	498.61	NM	NM	NM	535.93	37.59	498.34	535.93	35.55	500.38	535.93	34.95	500.98
MW-16D	516.51	8.63	507.88	516.51	7.96	508.55	NM	NM	NM	516.51	7.73	508.78	521.59	4.00	517.59	521.59	1.85	519.74
MW-16S	516.60	35.87	480.73	516.60	37.90	478.70	NM	NM	NM	516.60	36.43	480.17	516.60	23.30	493.30	516.60	22.10	494.50
MW-18D	464.19	16.75	447.44	464.19	16.88	447.31	NM	NM	NM	464.19	16.56	447.63	469.20	A	A	469.20	0.75	468.45
MW-18S	464.12	16.98	447.14	464.12	26.70	437.42	NM	NM	NM	464.12	16.27	447.85	464.12	A	A	464.12	0.98	463.14
MW-20D	573.85	38.59	535.26	NM	NM	NM	573.85	38.12	535.73	573.85	38.21	535.64	573.85	31.76	542.09	573.85	31.86	541.99
MW-20M	574.19	46.59	527.60	NM	NM	NM	574.19	46.39	527.80	574.19	45.98	528.21	574.19	41.47	532.72	574.19	41.37	532.82
MW-20S	574.05	46.53	527.52	NM	NM	NM	574.05	46.10	527.95	574.05	46.08	527.97	574.05	42.24	531.81	574.05	42.13	531.92
MW-31D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-31S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-70D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-70S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-82	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-102D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-102S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-142D	437.78	16.20	421.58	437.78	15.58	422.20	NM	NM	NM	437.78	15.72	422.06	437.78	16.11	421.67	437.78	16.31	421.47
MW-142S	437.44	4.57	432.87	437.44	3.60	433.84	NM	NM	NM	437.44	3.95	433.49	437.44	3.89	433.55	437.44	3.75	433.69
MW-143D	403.71	9.44	394.27	403.71	8.65	395.06	NM	NM	NM	403.71	8.70	395.01	408.81	14.89	393.92	408.81	15.17	393.64
MW-143S	403.56	31.72	371.84	403.56	30.93	372.63	NM	NM	NM	403.56	30.77	372.79	403.56	31.57	371.99	403.56	32.04	371.52
Residential Wells																		
RW-4 (Folk)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
RW-2	NM	NM	NM	548.27	28.21	520.06	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Staff Gauge																		
TATE (S-6) Staff Gauge	NM	NM	NM	NM	NM	NM	488.86	1.10	488.96	488.86	0.90	488.76	488.86	1.05	488.91	488.86	1.30	489.16

MPE: Measuring Point Elevation
DTW: Depth to Water
WL Elev: Water level Elevation
NM: Not Measured
A: Artesian
D: Dry
*: RW-4 Measurement collected on 10/11/2014, 9/26/2015, 10/1/16, and 10/14/17. RW-2 Measurement collected on 9/16/2015.
AN: Anomalous Reading

Table 1
Former York Naval Ordnance Plant- York, PA
Groundwater Elevations
NPBA Extraction System Shutdown Monitoring

Location	7/12/13			7/16/13			7/25/13			7/31/13			8/8/13			8/28/13		
	NPBA Shutdown Test Event 6			NPBA Shutdown Test Event 7			NPBA Shutdown Test Event 8			NPBA Shutdown Test Event 9			NPBA Shutdown Test Event 10			August 2013 Site Wide Water Levels		
	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev
Collection Wells																		
CW-1	570.07	41.69	528.38	570.07	41.69	528.38	570.07	41.19	528.88	570.07	41.30	528.77	570.07	41.43	528.64	570.07	40.60	529.47
CW-1A	568.28	38.65	529.63	568.28	38.05	530.23	568.28	37.38	530.90	568.28	37.78	530.50	568.28	38.05	530.23	568.28	37.39	530.89
CW-2	556.95	29.80	527.15	NM	NM	NM	556.95	26.18	530.77	556.95	28.71	528.24	556.95	29.96	526.99	556.95	28.97	527.98
CW-3	518.66	20.39	498.27	518.66	20.28	498.38	518.66	19.79	498.87	518.66	19.74	498.92	518.66	19.65	499.01	518.66	19.23	499.43
CW-4	541.55	27.20	514.35	NM	NM	NM	541.55	26.30	515.25	541.55	26.34	515.21	541.55	26.28	515.27	541.55	25.50	516.05
CW-5	NM	NM	NM	470.34	19.60	450.74	470.34	19.35	450.99	470.34	19.50	450.84	470.34	19.42	450.92	470.34	19.42	450.92
CW-6	484.67	9.10	475.57	484.67	9.03	475.64	484.67	8.91	475.76	484.67	9.22	475.45	484.67	8.65	476.02	484.67	8.00	476.67
CW-7	573.78	42.02	531.76	573.78	40.10	533.68	573.78	39.80	533.98	573.78	39.85	533.93	573.78	39.95	533.83	573.78	39.06	534.72
CW-7A	573.91	41.85	532.06	573.91	41.88	532.03	573.91	41.60	532.31	573.91	41.74	532.17	573.91	41.98	531.93	573.91	41.28	532.63
Monitoring Wells																		
MW-3	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	541.10	65.30	475.80
MW-9	558.78	32.90	525.88	NM	NM	NM	558.78	32.20	526.58	558.78	32.49	526.29	558.78	32.66	526.12	558.78	31.82	526.96
MW-10	567.80	40.75	527.05	NM	NM	NM	567.80	40.21	527.59	567.80	40.35	527.45	567.80	40.42	527.38	567.80	39.60	528.20
MW-11	563.08	27.11	535.97	NM	NM	NM	563.08	24.64	538.44	563.08	25.83	537.25	563.08	26.73	536.35	563.08	26.75	536.33
MW-12	535.93	34.26	501.67	NM	NM	NM	535.93	34.04	501.89	535.93	34.20	501.73	535.93	34.29	501.64	535.93	34.12	501.81
MW-16D	521.59	1.11	520.48	521.59	1.13	520.46	521.59	0.84	520.75	521.59	0.86	520.73	521.59	0.89	520.70	516.51	0.00	516.51
MW-16S	516.60	21.39	495.21	516.60	21.22	495.38	516.60	21.02	495.58	516.60	21.08	495.52	516.60	21.07	495.53	516.60	20.85	495.75
MW-18D	469.20	0.81	468.39	469.20	0.70	468.50	469.20	0.88	468.32	469.20	A	A	479.46	8.14	471.32	479.46	8.91	470.55
MW-18S	469.14	0.90	468.24	469.14	0.85	468.29	469.14	1.90	467.24	469.14	3.18	465.96	469.14	0.77	468.37	469.14	NM	NM
MW-20D	573.85	32.00	541.85	573.85	32.10	541.75	573.85	31.36	542.49	573.85	31.53	542.32	573.85	31.80	542.05	573.85	30.43	543.42
MW-20M	574.19	41.32	532.87	574.19	41.35	532.84	574.19	41.33	532.86	574.19	41.22	532.97	574.19	41.33	532.86	574.19	40.62	533.57
MW-20S	574.05	42.19	531.86	574.05	42.25	531.80	574.05	41.93	532.12	574.05	42.10	531.95	574.05	42.30	531.75	574.05	41.65	532.40
MW-31D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	369.30	17.56	351.74	369.30
MW-31S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	369.28	17.20	352.08	369.28
MW-70D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	416.31	23.20	393.11	416.31
MW-70S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	416.21	23.20	393.01	416.21
MW-82	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	382.18	36.23	345.95	382.18
MW-102D	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	405.23	12.91	392.32	405.23
MW-102S	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	405.41	39.14	366.27	405.41
MW-142D	437.78	16.30	421.48	437.78	16.27	421.51	437.78	15.78	422.00	437.78	16.09	421.69	437.78	16.36	421.42	437.78	16.30	421.48
MW-142S	437.44	3.84	433.60	437.44	3.55	433.89	437.44	2.74	434.70	437.44	3.29	434.15	437.44	3.38	434.06	437.44	3.52	433.92
MW-143D	408.81	15.24	393.57	408.81	15.29	393.52	408.81	14.88	393.93	408.81	14.79	393.92	408.81	10.25	393.46	408.81	10.01	393.70
MW-143S	403.56	32.05	371.51	403.56	32.05	371.51	403.56	31.99	371.57	403.56	31.85	371.71	403.56	32.25	371.31	403.56	34.57	368.99
Residential Wells																		
RW-4 (Folk)	NM	NM	NM	NM	NM	NM	575.93	43.47	532.46	575.93	43.58	532.35	575.93	43.74	532.19	575.93	NM	NM
RW-2	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	548.46	21.79	526.67	548.46	21.13	527.33
Staff Gauge																		
TATE (S-6) Staff Gauge	488.86	1.40	489.26	488.86	1.40	489.26	488.86	1.09	488.95	488.86	1.04	488.90	488.86	1.05	488.91	488.86	NM	NM

MPE: Measuring Point Elevation
DTW: Depth to Water
WL Elev: Water level Elevation
NM: Not Measured
A: Artesian
D: Dry
*: RW-4 Measurement collected on 10/11/2014, 9/26/2015, 10/1/16, and 10/14/17. RW-2 Measurement collected on 9/16/2015.
AN: Anomalous Reading

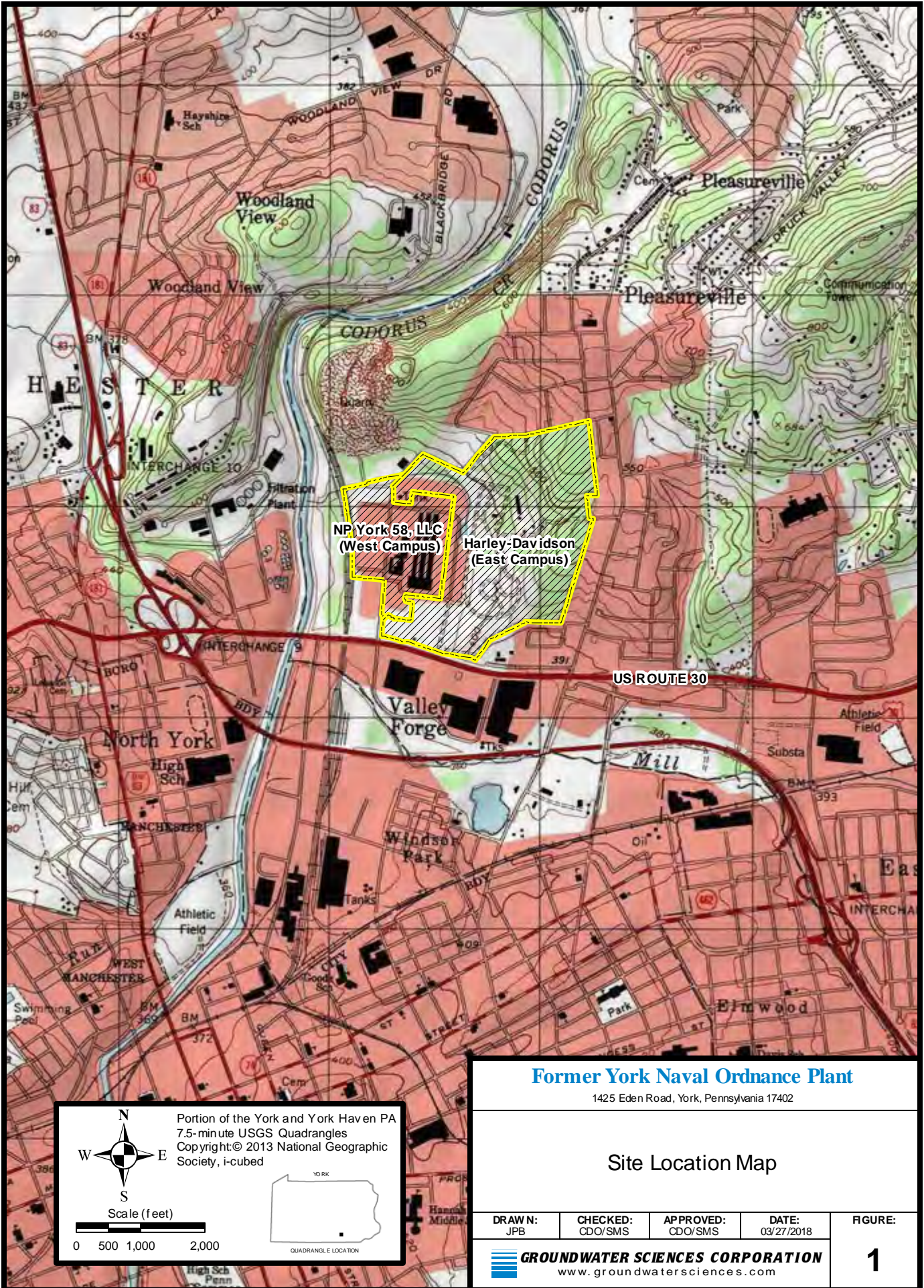
Table 1
Former York Naval Ordnance Plant- York, PA
Groundwater Elevations
NPBA Extraction System Shutdown Monitoring

Location	11/22/13			1/16/14			5/5/14			10/7/14			9/3/15			10/3/16			10/16/17		
	November 2013 Site Wide Water Levels			January 2014 Site Wide Water Levels			May 2014 Site Wide Water Levels			October 2014 Site Wide Water Levels			September 2015 Site Wide Water Levels			October 2016 Site Wide Water Levels			October 2017 Site Wide Water Levels		
	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev	MPE	DTW	WL Elev
Collection Wells																					
CW-1	570.07	40.80	529.27	570.07	36.71	533.36	570.07	32.90	537.17	570.07	43.15	526.92	570.07	40.90	529.17	570.07	42.72	527.35	570.07	40.28	529.79
CW-1A	568.28	37.90	530.38	568.28	30.52	537.76	568.28	26.83	541.45	568.28	40.21	528.07	568.28	28.23	540.05	568.28	39	529.28	568.28	36.93	531.35
CW-2	556.95	30.75	526.20	556.95	16.28	540.67	556.95	16.81	540.14	556.95	32.32	524.63	556.95	30.20	526.75	556.95	29.3	527.65	556.95	27.49	529.46
CW-3	518.66	19.90	498.76	518.66	17.11	501.55	518.66	15.58	503.08	518.66	18.92	499.74	518.66	16.60	502.06	518.66	16.93	501.73	518.66	16.22	502.44
CW-4	541.55	25.25	516.30	541.55	21.93	519.62	541.55	28.47	513.08	541.55	26.50	515.05	541.55	24.80	516.75	541.55	25.2	516.35	541.55	23.97	517.58
CW-5	470.34		NM	470.34	16.70	453.64	470.34	15.30	455.04	470.34	19.47	450.87	470.34	18.73	451.61	470.34	19.4	450.94	470.34	18.70	451.64
CW-6	484.67	8.00	476.67	484.67	5.33	479.34	484.67	4.46	480.21	484.67	8.51	476.16	484.67	7.75	476.92	484.67	8.15	476.52	484.67	7.63	477.04
CW-7	573.78	39.20	534.58	573.78	32.61	541.17	573.78	20.58	553.20	573.78	41.77	532.01	573.78	39.05	534.73	573.78	41.55	532.23	573.78	38.19	535.59
CW-7A	573.91	41.55	532.36	573.91	35.25	538.66	573.91	31.44	542.47	573.91	44.15	529.76	573.91	42.07	531.84	573.91	44	529.91	573.91	41.38	532.53
Monitoring Wells																					
MW-3	541.10	65.74	475.36	541.10	58.91	482.19	541.10	53.75	487.35	541.10	67.75	473.35	541.10	66.03	475.07	541.10	68.08	473.02	541.10	66.25	474.85
MW-9	558.78	32.32	526.46	558.78	26.93	531.85	558.78	24.44	534.34	558.78	33.66	525.12	558.78	31.74	527.04	558.78	32.57	526.21	558.78	30.74	528.04
MW-10	567.80	39.77	528.03	567.80	34.52	533.28	567.80	31.61	536.19	567.80	42.03	525.77	567.80	39.85	527.95	567.80	41.43	526.37	567.80	39.03	528.77
MW-11	563.08	28.50	534.58	563.08	18.70	544.38	563.08	19.08	544.00	563.08	30.18	532.90	563.08	27.55	535.53	563.08	26.1	536.98	563.08	24.57	538.51
MW-12	535.93	34.98	500.95	535.93	29.34	506.59	535.93	25.47	510.46	535.93	35.72	500.21	535.93	34.93	501.00	535.93	35.55	500.38	535.93	35.10	500.83
MW-16D	516.51	A	A	516.51	NM	NM	516.51	NM	NM	516.51	NM	NM	516.74	-4.86A	521.60A	516.73	-3.7A	520.43A	516.73	-6.52	523.25A
MW-16S	516.60	19.25	497.35	516.60	16.65	499.95	516.60	15.31	501.29	516.60	20.83	495.77	516.60	18.75	497.85	516.60	20.05	496.55	516.60	16.83	499.77
MW-18D	464.19	NM	NM	464.19	NM	NM	464.19	NM	NM	464.19	0.53	463.66	464.57	-4.35A	468.92A	464.52	-5.06A	469.58A	464.52	-7.16	471.68A
MW-18S	464.12	NM	NM	464.12	NM	NM	464.12	NM	NM	464.12	A	A	464.58	-6.39A	470.97A	464.52	-0.38A	464.90A	464.52	-3.75	468.27A
MW-20D	573.85	31.10	542.75	573.85	23.18	550.67	573.85	18.87	554.98	573.85	34.43	539.42	573.85	30.45	543.40	573.85	33.76	540.09	573.85	30.21	543.64
MW-20M	574.19	40.80	533.39	574.19	35.00	539.19	574.19	39.40	534.79	574.19	43.59	530.60	574.19	41.86	532.33	574.19	42.53	531.66	574.19	41.24	532.95
MW-20S	574.05	42.08	531.97	574.05	35.30	538.75	574.05	31.39	542.66	574.05	44.55	529.50	574.05	42.38	531.67	574.05	44.27	529.78	574.05	41.68	532.37
MW-31D	369.30	19.27	350.03	369.30	12.86	356.44	369.30	10.43	358.87	369.30	19.53	349.77	369.30	17.94	351.36	369.30	19.04	350.26	369.30	18.65	350.65
MW-31S	369.28	18.98	350.30	369.28	12.52	356.76	369.28	10.41	358.87	369.28	19.26	350.02	369.28	17.56	351.72	369.28	18.65	350.63	369.28	18.09	351.19
MW-70D	416.31	23.87	392.44	416.31	16.45	399.86	416.31	11.40	404.91	416.31	26.24	390.07	416.31	24.28	392.03	416.31	26.97	389.34	416.31	24.81	391.50
MW-70S	416.21	23.50	392.71	416.21	16.70	399.51	416.21	11.64	404.57	416.21	25.75	390.46	416.21	23.97	392.24	416.21	26.4	389.81	416.21	24.41	391.80
MW-82	382.18	37.91	344.27	382.18	31.56	350.62	382.18	29.06	353.12	382.18	37.04	345.14	382.18	36.83	345.35	382.18	37.63	344.55	382.18	37.84	344.34
MW-102D	405.23	13.20	392.03	405.23	5.75	399.48	405.23	0.71	404.52	405.23	42.53	362.70	405.23	13.60	391.63	405.23	16.31	388.92	405.23	14.09	391.14
MW-102S	405.41	40.33	365.08	405.41	31.90	373.51	405.41	26.83	378.58	405.41	15.60	389.81	405.41	40.17	365.24	405.41	43.18	362.23	405.41	41.58	363.83
MW-142D	437.78	16.75	421.03	437.78	12.75	425.03	437.78	11.05	426.73	437.78	17.82	419.96	437.78	15.90	421.88	437.78	16.5	421.28	437.78	15.07	422.71
MW-142S	437.44	3.70	433.74	437.44	0.82	436.62	437.44	0.00	437.44	437.44	4.24	433.20	437.44	2.97	434.47	437.44	2.9	434.54	437.44	2.66	434.78
MW-143D	403.71	10.70	393.01	403.71	3.17	400.54	403.71	0.05	403.66	403.71	12.04	391.67	403.71	9.40	394.31	403.71	11.43	392.28	403.71	9.14	394.57
MW-143S	403.56	33.65	369.91	403.56	25.03	378.53	403.56	21.73	381.83	403.56	36.54	367.02	403.56	33.30	370.26	403.56	38.4	365.16	403.56	34.87	368.69
Residential Wells																					
RW-4 (Folk)	575.93	NM	NM	575.93	NM	NM	575.93	NM	NM	575.93	46.51*	529.42	575.93	44.58*	531.35	575.93	40.82*	535.11	575.93	37.93*	538.00
RW-2	548.46	NM	NM	548.46	NM	NM	548.46	14.44	534.02	548.46	22.54	525.92	548.46	21.47*	526.99	548.27	21.98	526.29	548.27	21.24	527.03
Staff Gauge																					
TATE (S-6) Staff Gauge	488.86	NM	NM	488.86	NM	NM	488.86	1.32	489.18	488.86	NM	NM	488.86	NM	NM	488.86	NM	NM	488.86	NM	NM

MPE: Measuring Point Elevation
DTW: Depth to Water
WL Elev: Water level Elevation
NM: Not Measured
A: Artesian
D: Dry
*: RW-4 Measurement collected on 10/11/2014, 9/26/2015, 10/1/16, and 10/14/17. RW-2 Measurement collected on 9/16/2015.
AN: Anomalous Reading

Figures

April 2018



Former York Naval Ordnance Plant

1425 Eden Road, York, Pennsylvania 17402

Site Location Map

DRAWN: JPB	CHECKED: CDO/SMS	APPROVED: CDO/SMS	DATE: 03/27/2018
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FIGURE:

1

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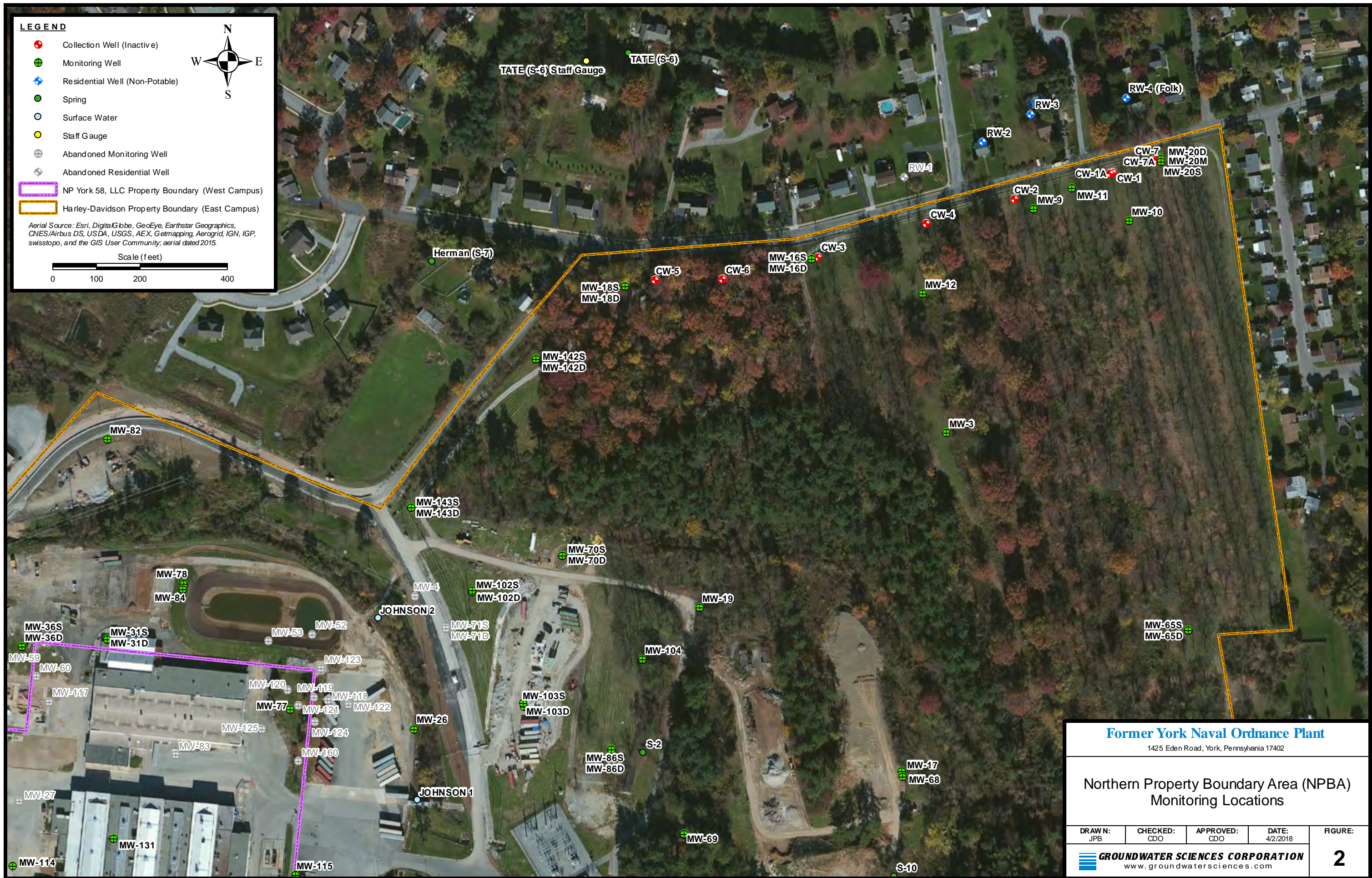
LEGEND

- Collection Well (Inactive)
- Monitoring Well
- Residential Well (Non-Potable)
- Spring
- Surface Water
- Staff Gauge
- ⊕ Abandoned Monitoring Well
- ⊕ Abandoned Residential Well
- ▭ NP York 58, LLC Property Boundary (West Campus)
- ▭ Harley-Davidson Property Boundary (East Campus)

Aerial Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community; aerial dated 2015.

Scale (feet)

0 100 200 400

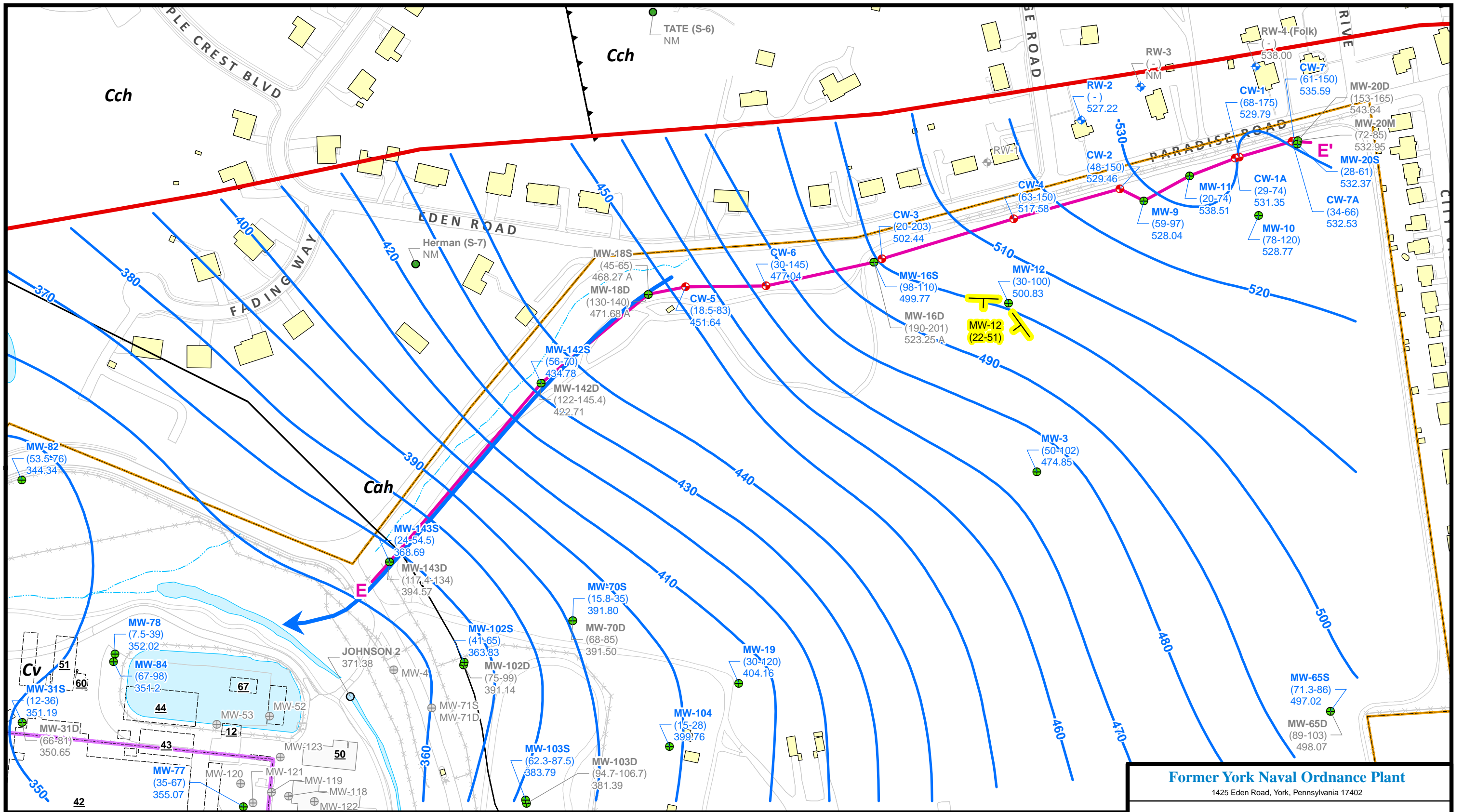


Former York Naval Ordnance Plant
1425 Eden Road, York, Pennsylvania 17402

**Northern Property Boundary Area (NPBA)
Monitoring Locations**

DRAWN: JPB	CHECKED: CDO	APPROVED: CDO	DATE: 4/2/2018	FIGURE:
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Q:\10000\10012\Projects\2017 NPBA Report\R2\Fig2_NPBAerial_20180327.mxd



Former York Naval Ordnance Plant

1425 Eden Road, York, Pennsylvania 17402

**Northern Property Boundary Area (NPBA)
Groundwater Elevation Contour Map
October 16, 2017**

DRAWN: JPB	CHECKED: CDO	APPROVED: CDO	DATE: 4/2/2018	FIGURE:
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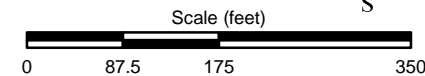
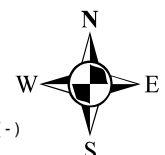
GROUNDWATER SCIENCES CORPORATION
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3

LEGEND

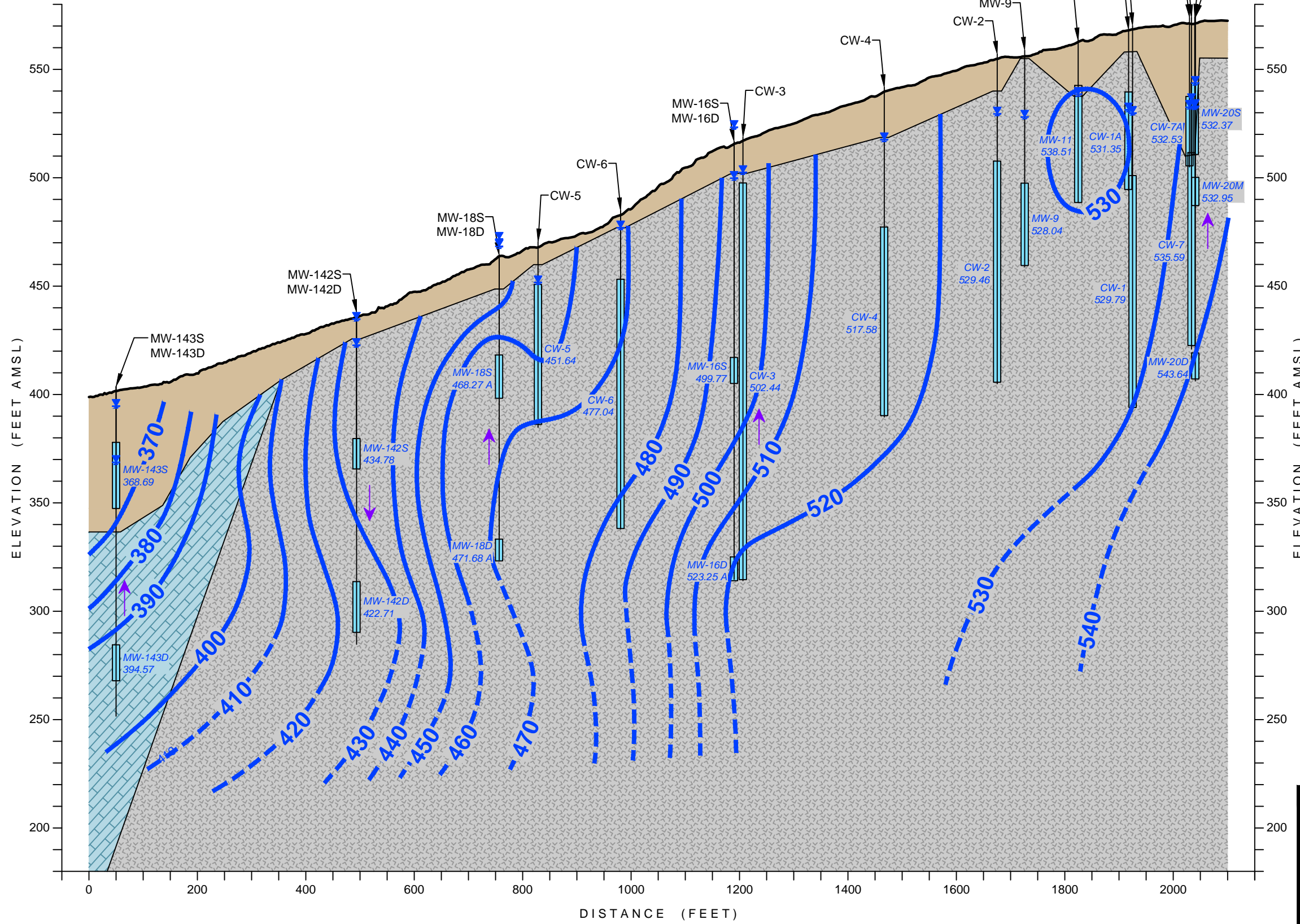
<ul style="list-style-type: none"> ● Collection Well (Inactive) ● Monitoring Well ● Residential Well (Non-Potable) ● Spring ○ Surface Water ⊕ Abandoned Monitoring Well ⊕ Abandoned Residential Well 	<ul style="list-style-type: none"> — Groundwater Contour (Feet AMSL) ← Groundwater Flow Path (Isotropic Aquifer) — Block Fault — Thrust Fault 	<ul style="list-style-type: none"> — (Cah) Antietam & Harpers Formation, undiv. — (Cch) Chickies Formation — (Cv) Vintage Formation — NP York 58, LLC Property Boundary (West Campus) — Harley-Davidson Property Boundary (East Campus) 	<ul style="list-style-type: none"> ■ Existing Building ■ Demolished ■ Demolished/Slab Removed — Road, Curb or Walkway — Fenceline — Existing Water Feature — Existing Stream 	<ul style="list-style-type: none"> — Cross Section Transect — Location ID Screened or Open Interval (Feet BGS) Groundwater Elevation (Feet AMSL) Used in Contouring — Location ID Screened or Open Interval (Feet BGS) Groundwater Elevation (Feet AMSL) Not Used in Contouring
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NOTES:
 AMSL - Above mean sea level
 BGS - Below Ground Surface
 A - Artesian
 NM - Groundwater Level Not Measured
 Well screen intervals for RW-2 and RW-4 shown as (-) are unknown.



E
West

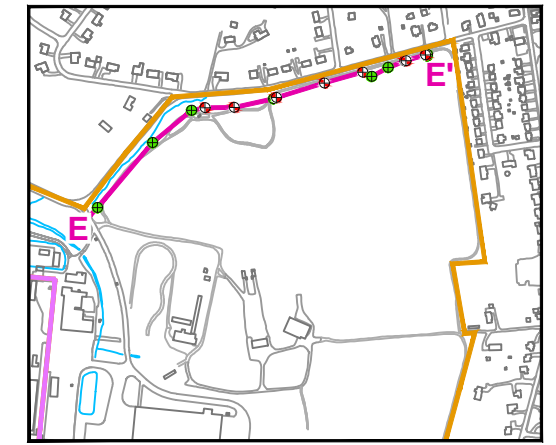
E'
East



LEGEND

- Existing Grade
- Collection or Monitoring Well
- Screened Interval
- Inferred Stratigraphy
- Piezometric Level on Oct. 16, 2017 (feet amsl) (A = Artesian Conditions) (NM = Not Measured)
- Groundwater Elevation (feet amsl) (Dashed Where Inferred)
- Vertical Gradient
- Overburden
- Limestone/Dolostone
- Sandstone/Quartzite

Approximate Horizontal Scale: 0 to 200'
Approximate Vertical Scale: 0 to 50'
Vertical Exaggeration 4X

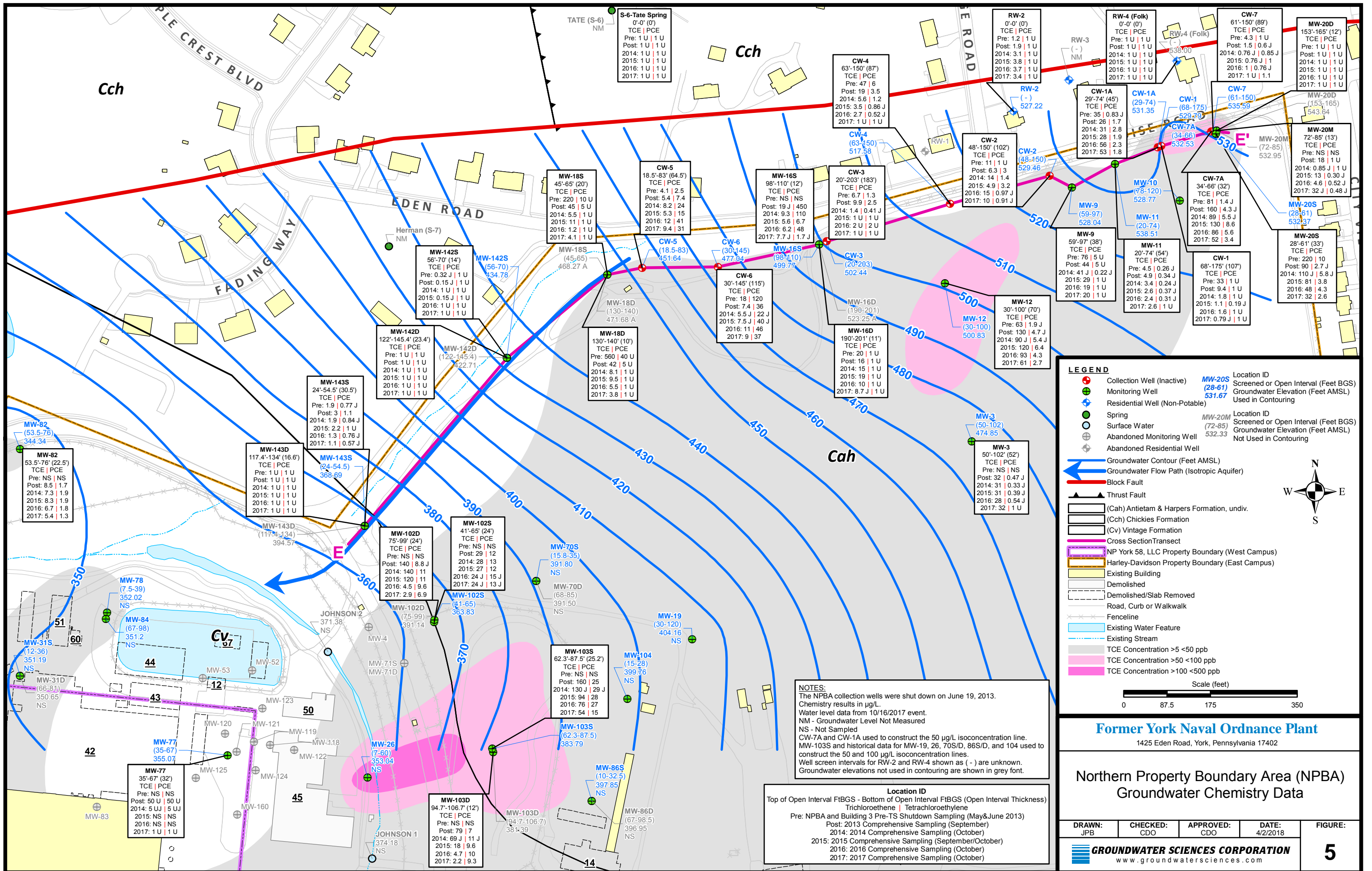


Former York Naval Ordnance Plant
1425 Eden Road, York, Pennsylvania 17402

Northern Property Boundary Area (NPBA)
Cross Section E-E'
Piezometric Levels on October 16, 2017

DRAWN: JPB	CHECKED: CDO	APPROVED: CDO	DATE: 3/27/2018	FIGURE: 4
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LEGEND

- Collection Well (Inactive)
- Monitoring Well
- Residential Well (Non-Potable)
- Spring
- Surface Water
- Abandoned Monitoring Well
- Abandoned Residential Well
- Groundwater Contour (Feet AMSL)
- Groundwater Flow Path (Isotropic Aquifer)
- Block Fault
- Thrust Fault
- (Cah) Antietam & Harpers Formation, undiv.
- (Cch) Chickies Formation
- (Cv) Vintage Formation
- Cross Section/Transect
- NP York 58, LLC Property Boundary (West Campus)
- Harley-Davidson Property Boundary (East Campus)
- Existing Building
- Demolished
- Demolished/Slab Removed
- Road, Curb or Walkway
- Fenceline
- Existing Water Feature
- Existing Stream
- TCE Concentration >50 <500 ppb
- TCE Concentration >50 <100 ppb
- TCE Concentration >100 <500 ppb

Location ID
Screened or Open Interval (Feet BGS)
Groundwater Elevation (Feet AMSL)
Used in Contouring

Location ID
Screened or Open Interval (Feet BGS)
Groundwater Elevation (Feet AMSL)
Not Used in Contouring

Scale (feet)
0 87.5 175 350

NOTES:
 The NPBA collection wells were shut down on June 19, 2013.
 Chemistry results in µg/L.
 Water level data from 10/16/2017 event.
 NM - Groundwater Level Not Measured
 NS - Not Sampled
 CW-7A and CW-1A used to construct the 50 µg/L isoconcentration line.
 MW-103S and historical data for MW-19, 26, 70S/D, 86S/D, and 104 used to construct the 50 and 100 µg/L isoconcentration lines.
 Well screen intervals for RW-2 and RW-4 shown as (-) are unknown.
 Groundwater elevations not used in contouring are shown in grey font.

Location ID	Top of Open Interval FtBGS - Bottom of Open Interval FtBGS (Open Interval Thickness)
Trichloroethylene	Tetrachloroethylene
Pre: NPBA and Building 3 Pre-TS Shutdown Sampling (May&June 2013)	Post: 2013 Comprehensive Sampling (September)
2014: 2014 Comprehensive Sampling (October)	2015: 2015 Comprehensive Sampling (September/October)
2016: 2016 Comprehensive Sampling (October)	2017: 2017 Comprehensive Sampling (October)

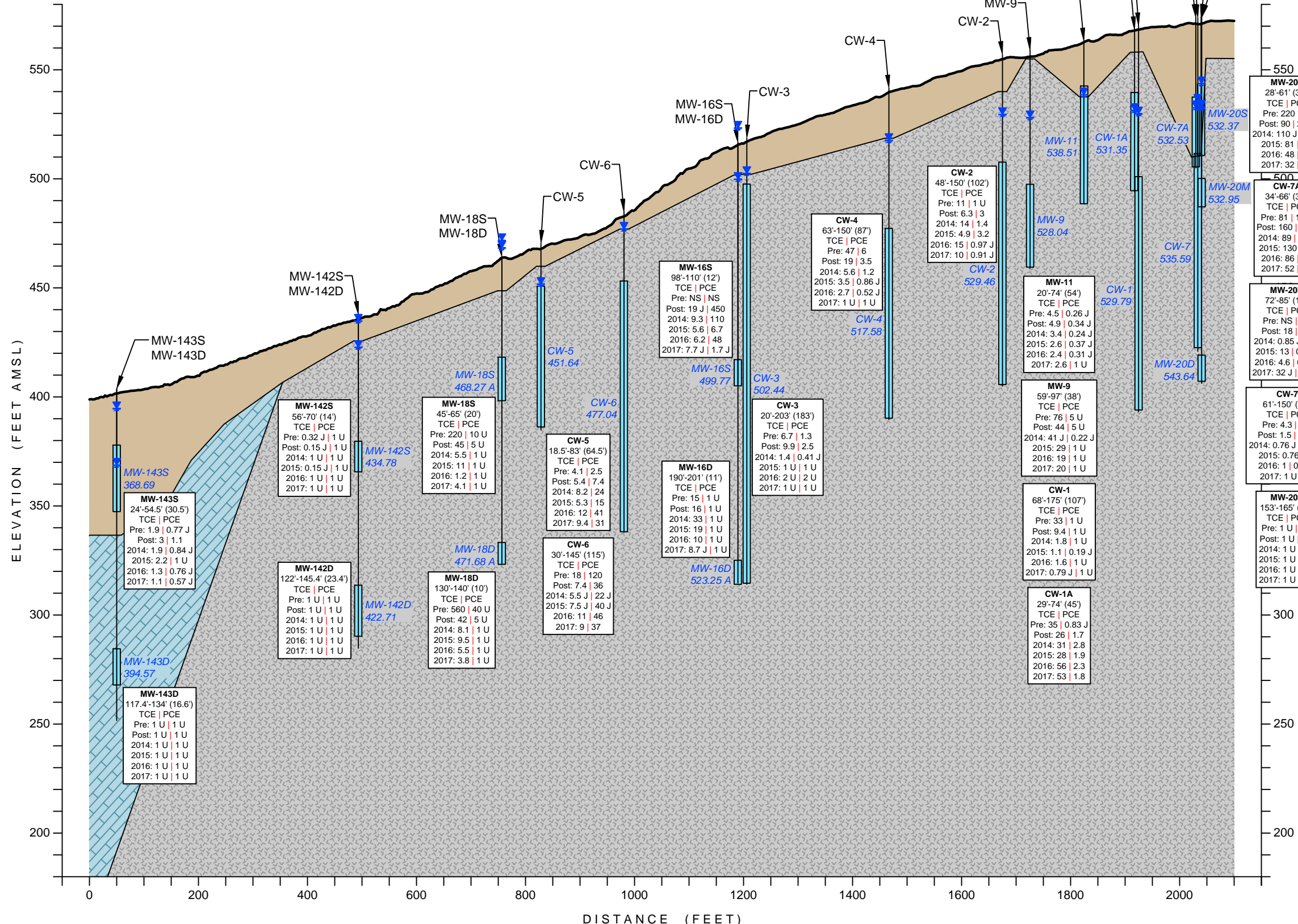
Former York Naval Ordnance Plant
 1425 Eden Road, York, Pennsylvania 17402

**Northern Property Boundary Area (NPBA)
 Groundwater Chemistry Data**

DRAWN: JPB **CHECKED:** CDO **APPROVED:** CDO **DATE:** 4/2/2018 **FIGURE:**

E
West

E'
East



LEGEND

- Existing Grade
- Collection or Monitoring Well
- Screened Interval
- Inferred Stratigraphy
- Piezometric Level (feet amsl; Oct. 16, 2017) (A = Artesian Conditions) (NM = Not Measured)
- Overburden
- Limestone/Dolostone
- Sandstone/Quartzite

Approximate Horizontal Scale: 0 200'

Approximate Vertical Scale: 0 50'

Vertical Exaggeration 4X

Location ID

Top of Open Interval FtBGS - Bottom of Open Interval FtBGS (Open Interval Thickness)

Trichloroethene | Tetrachloroethylene

Pre: NPBA and Building 3 Pre-TS Shutdown Sampling (May & June 2013)

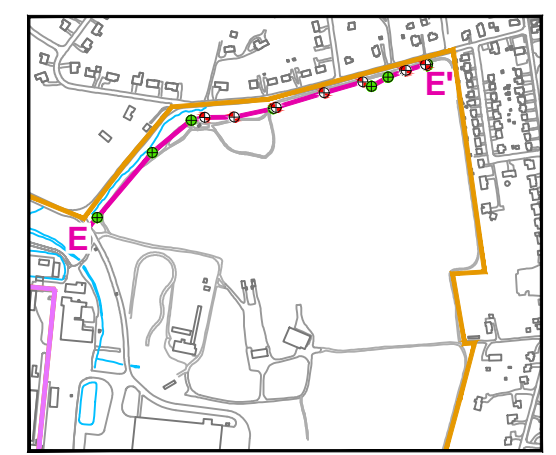
Post: 2013 Comprehensive Sampling (September)

2014: 2014 Comprehensive Sampling (October)

2015: 2015 Comprehensive Sampling (September/October)

2016: 2016 Comprehensive Sampling (October)

2017: 2017 Comprehensive Sampling (October)



Former York Naval Ordnance Plant
1425 Eden Road, York, Pennsylvania 17402

Northern Property Boundary Area (NPBA)
Cross Section E-E'
Pre- and Post-Shutdown Groundwater Chemistry

DRAWN: JPB	CHECKED: CDO	APPROVED: CDO	DATE: 3/27/2018	FIGURE: 6
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GROUNDWATER SCIENCES CORPORATION
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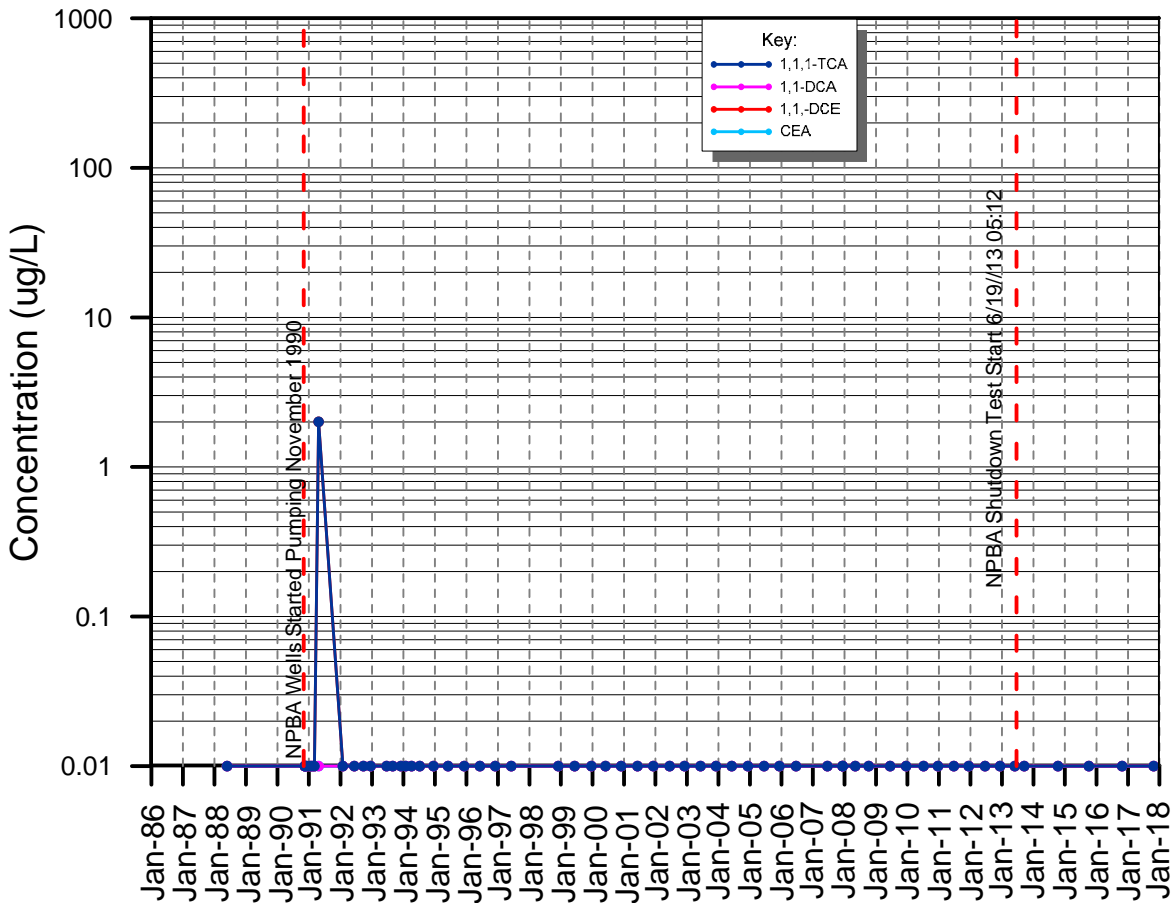
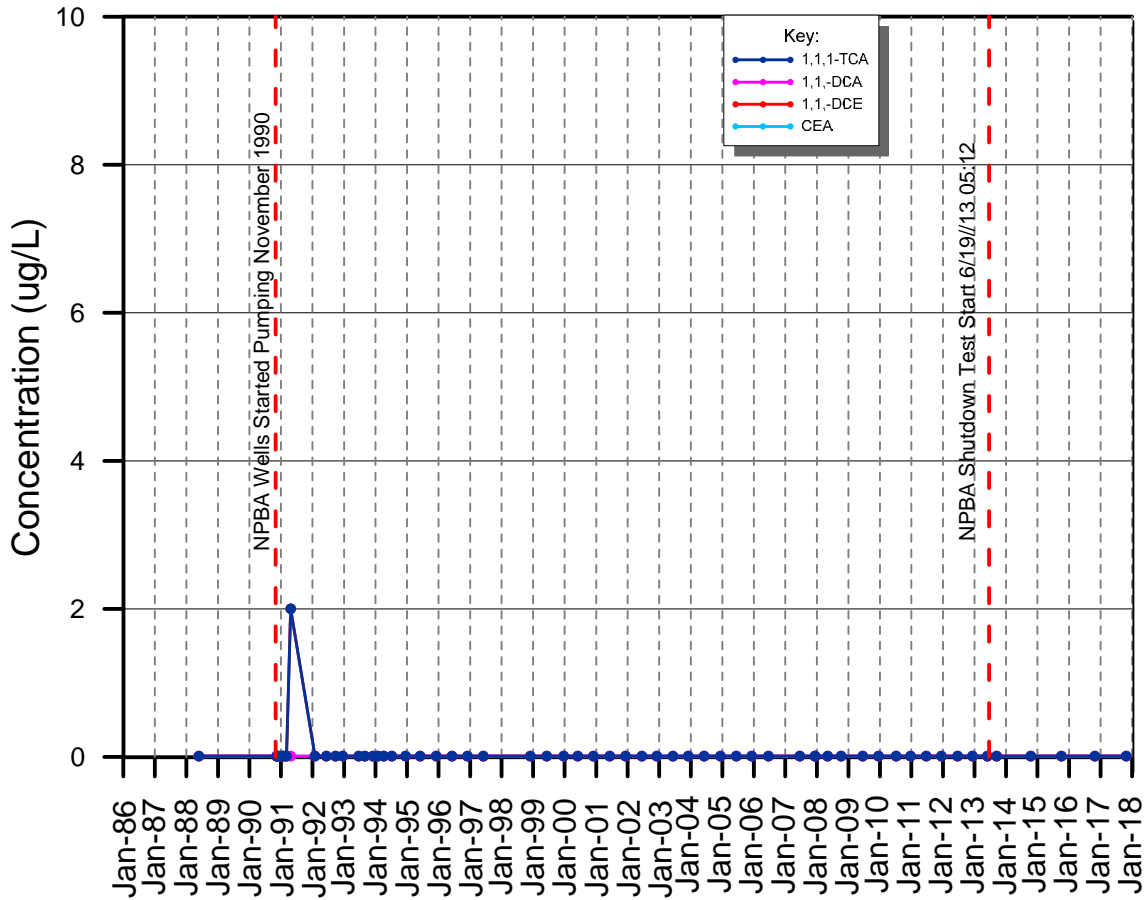
Appendix A

NPBA Shutdown Chemistry Graphs

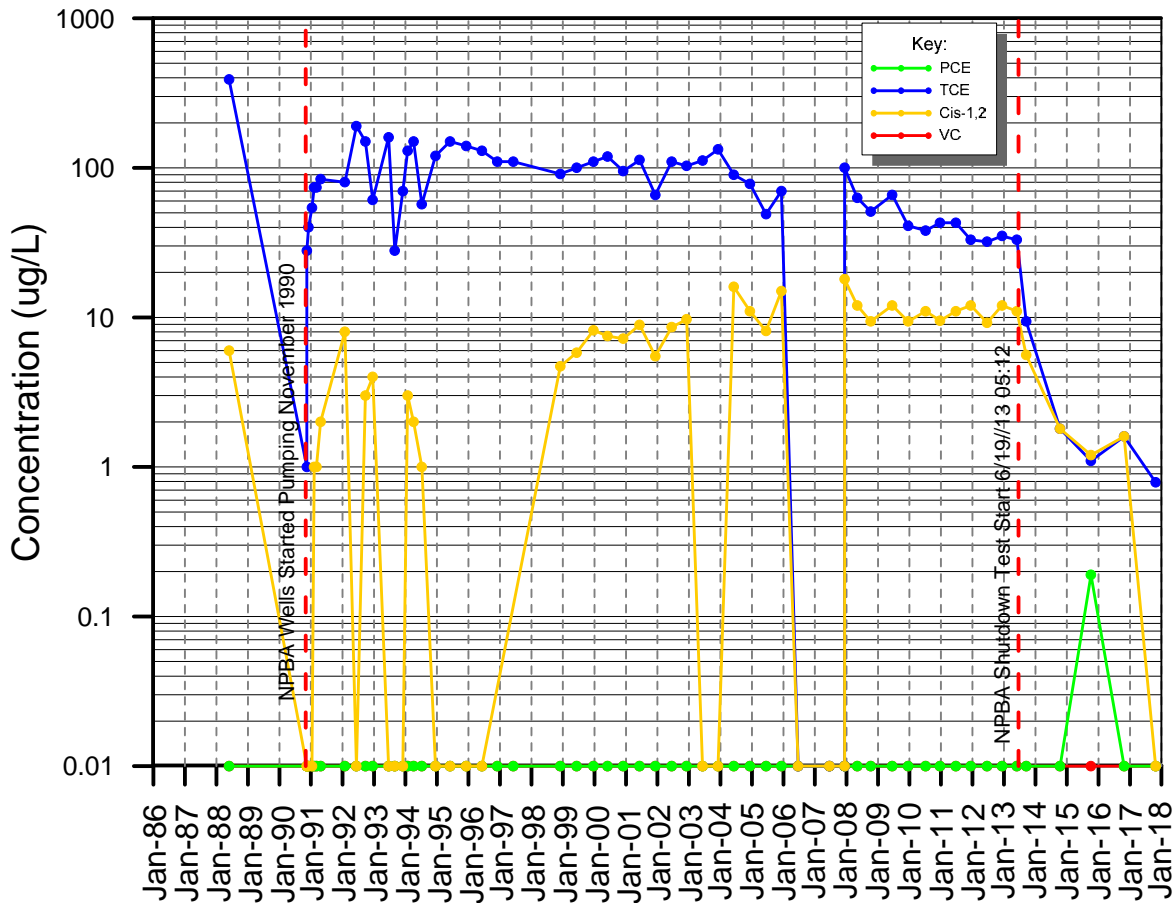
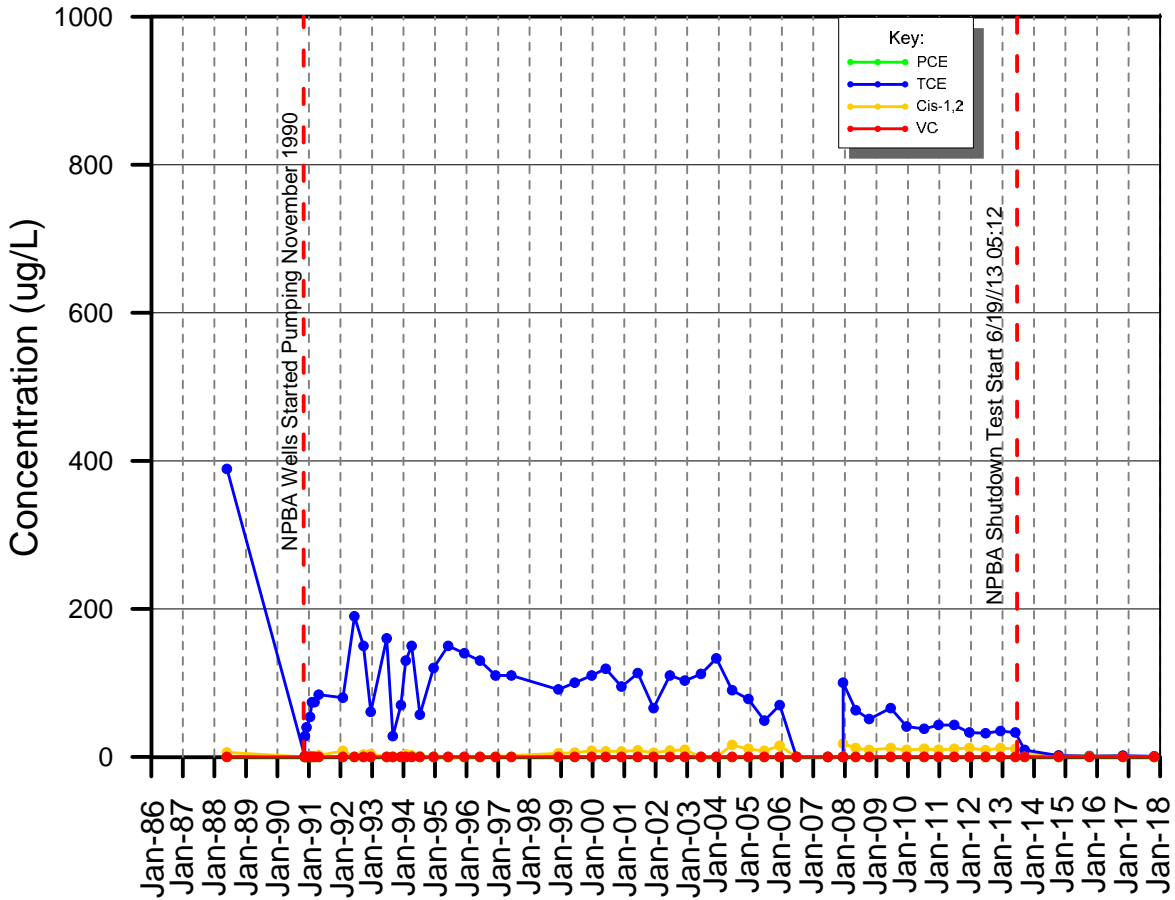
Undetected laboratory results are represented on the semi-log graphs as a concentration of 0.01 µg/L, regardless of method detection limit or laboratory reporting limit. “J” qualified (estimated) results were plotted as actual values.

April 2018

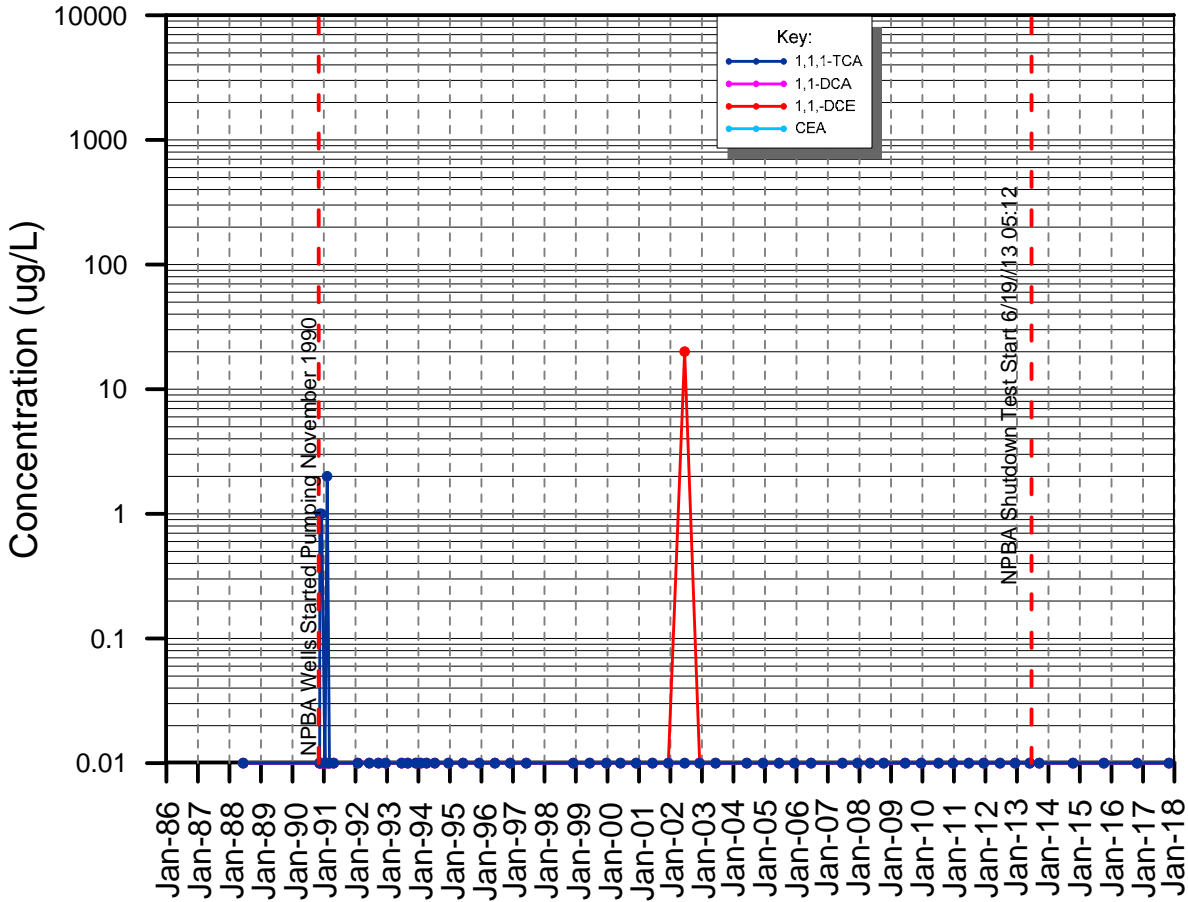
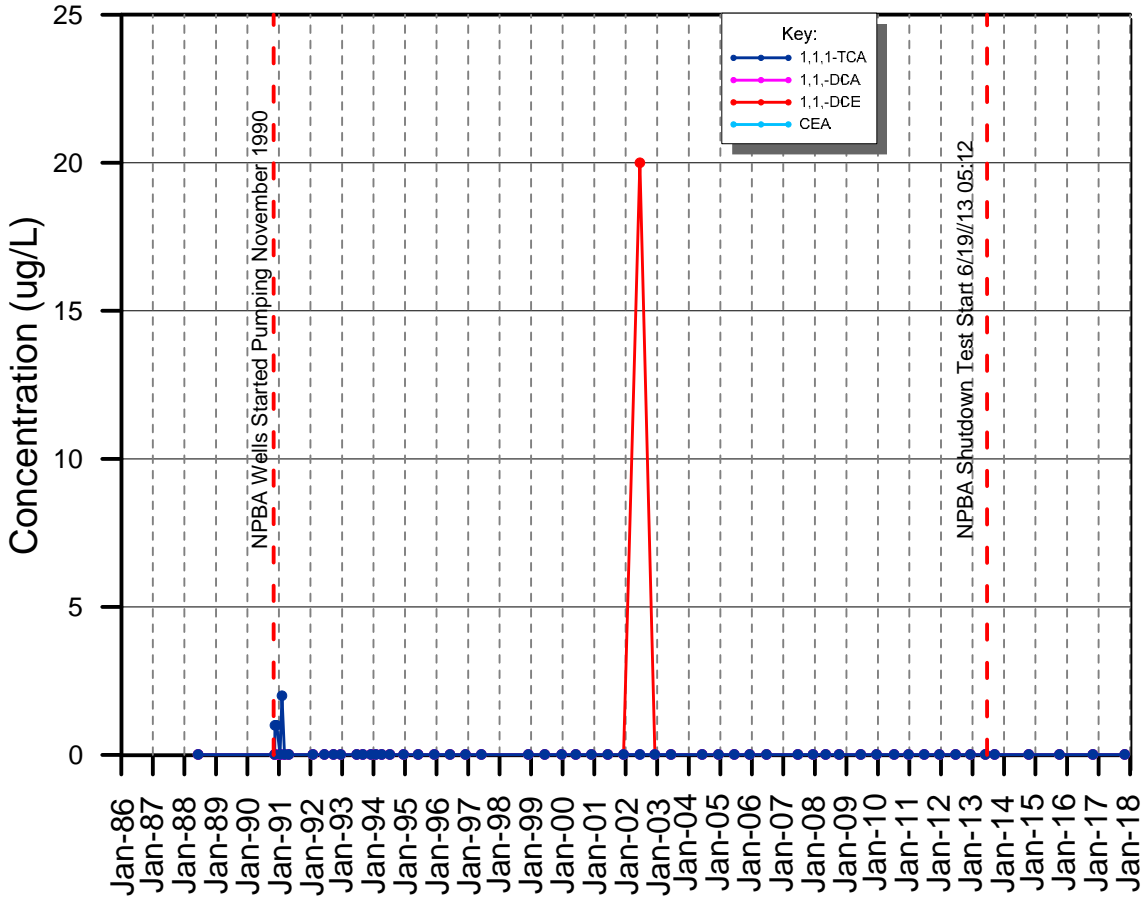
CW-1



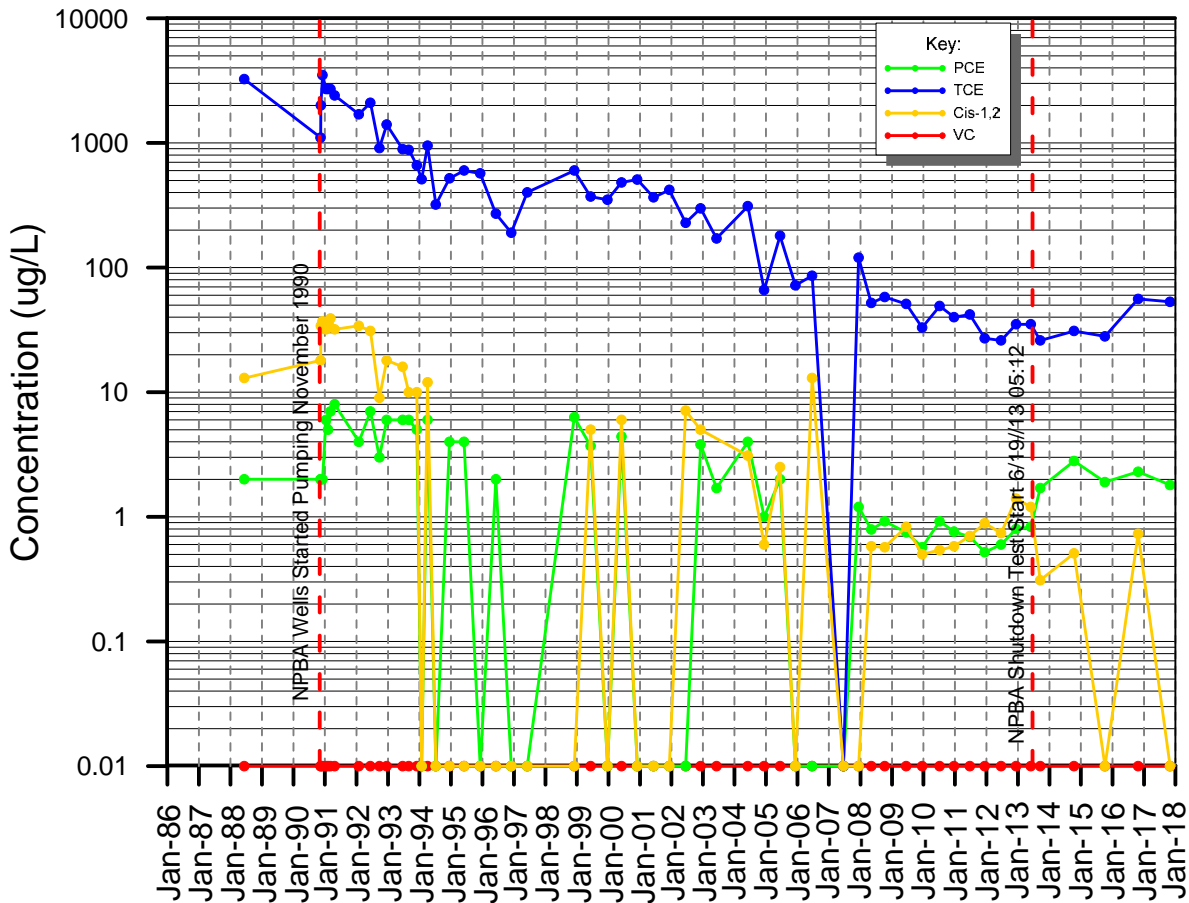
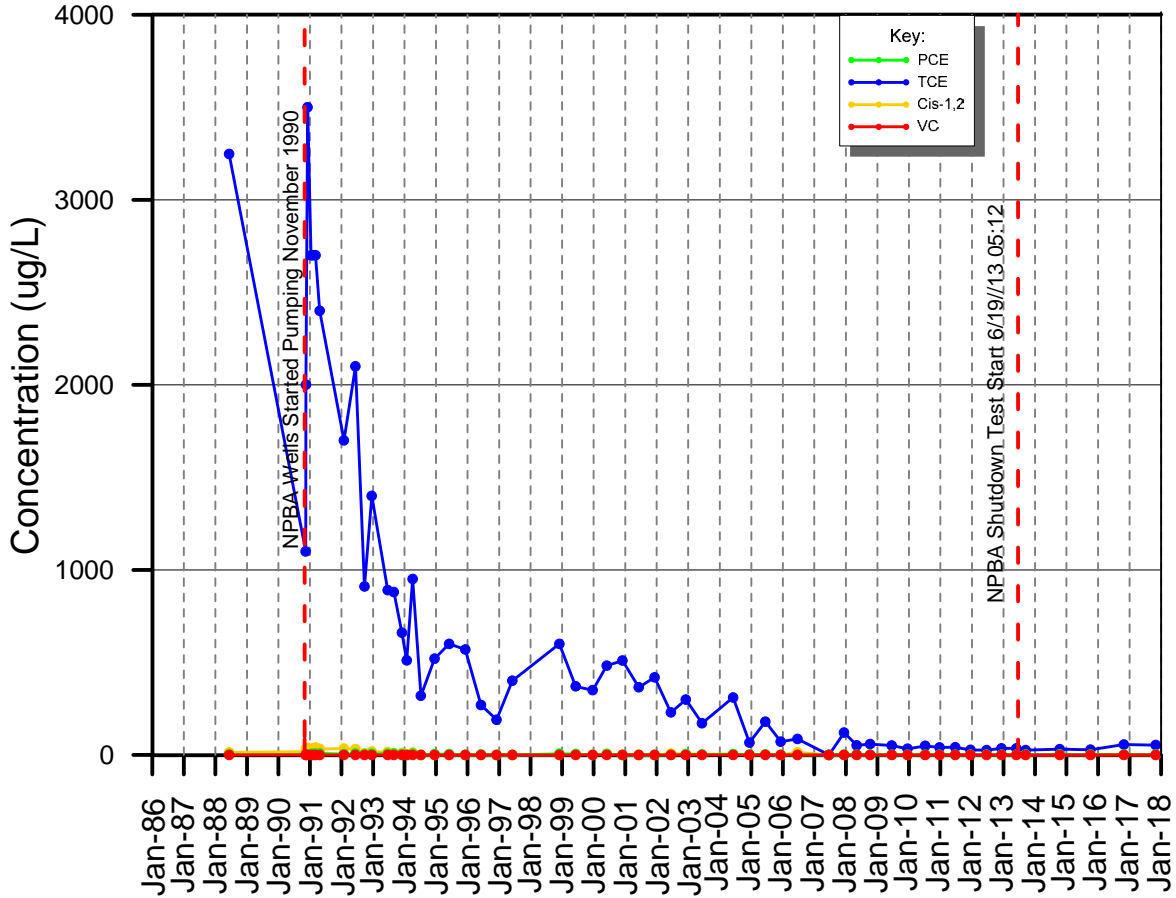
CW-1



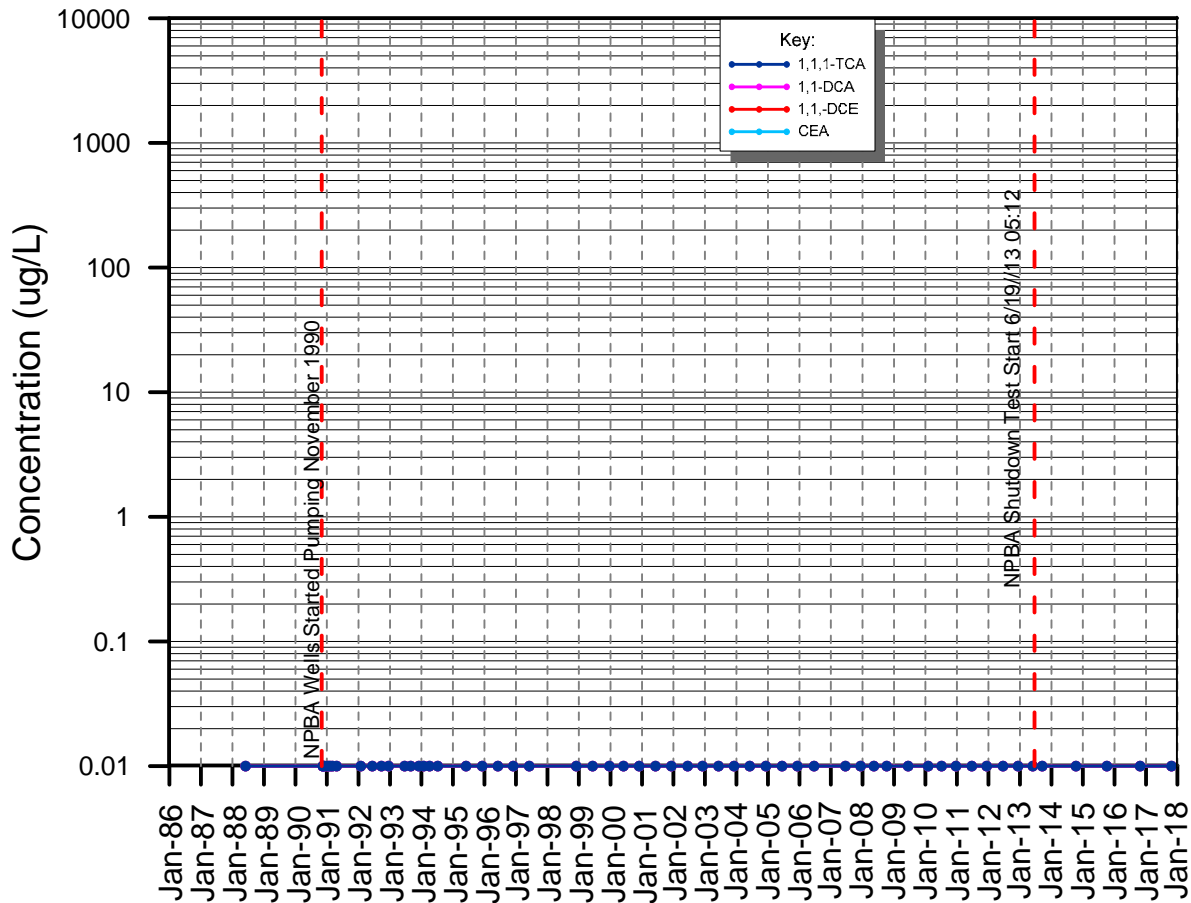
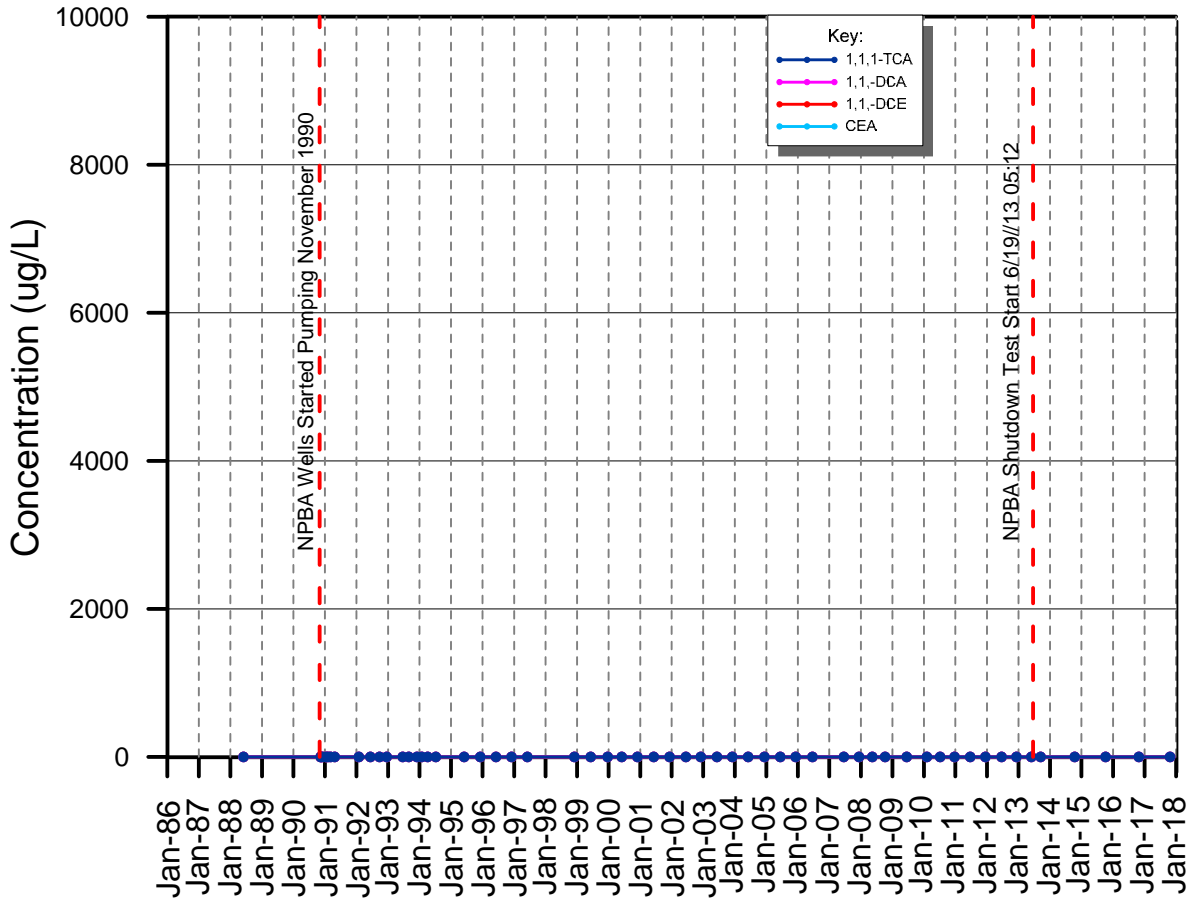
CW-1A



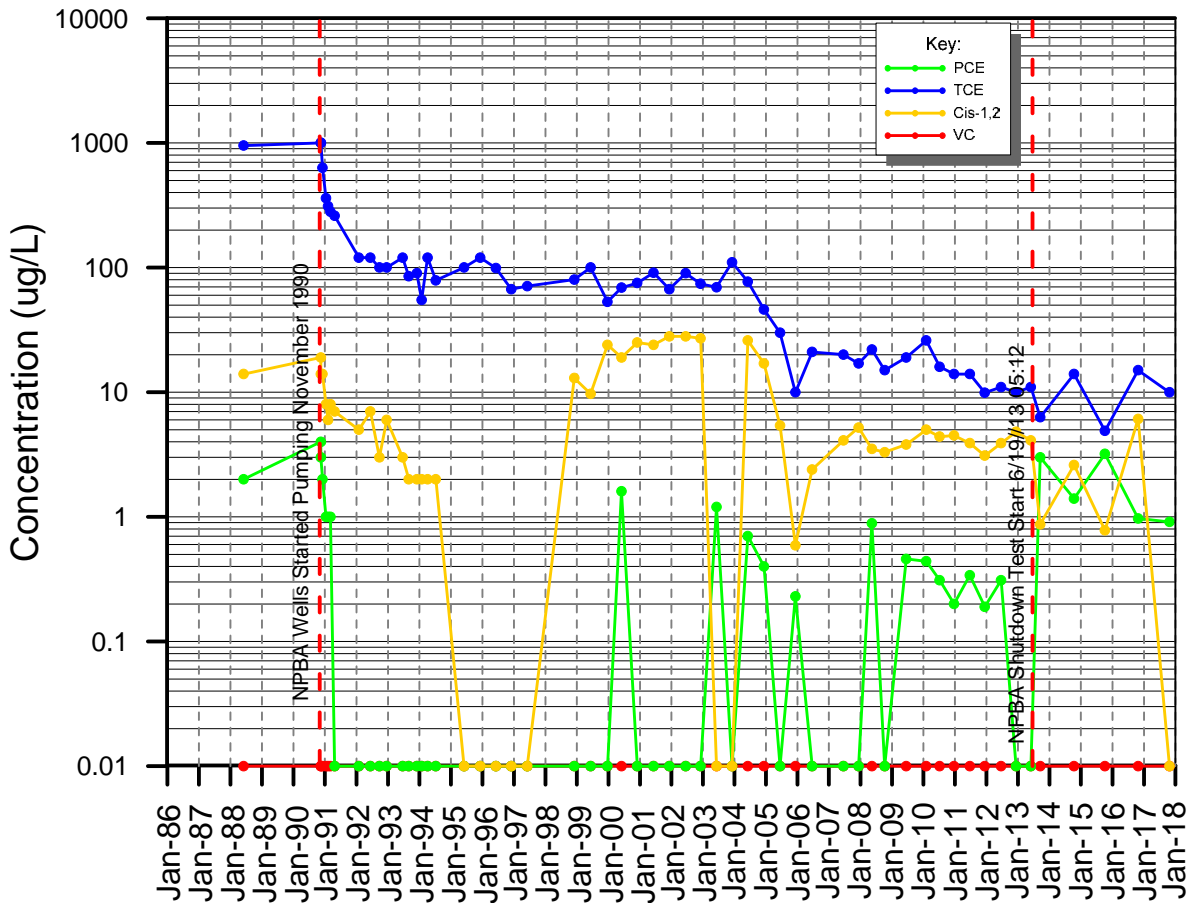
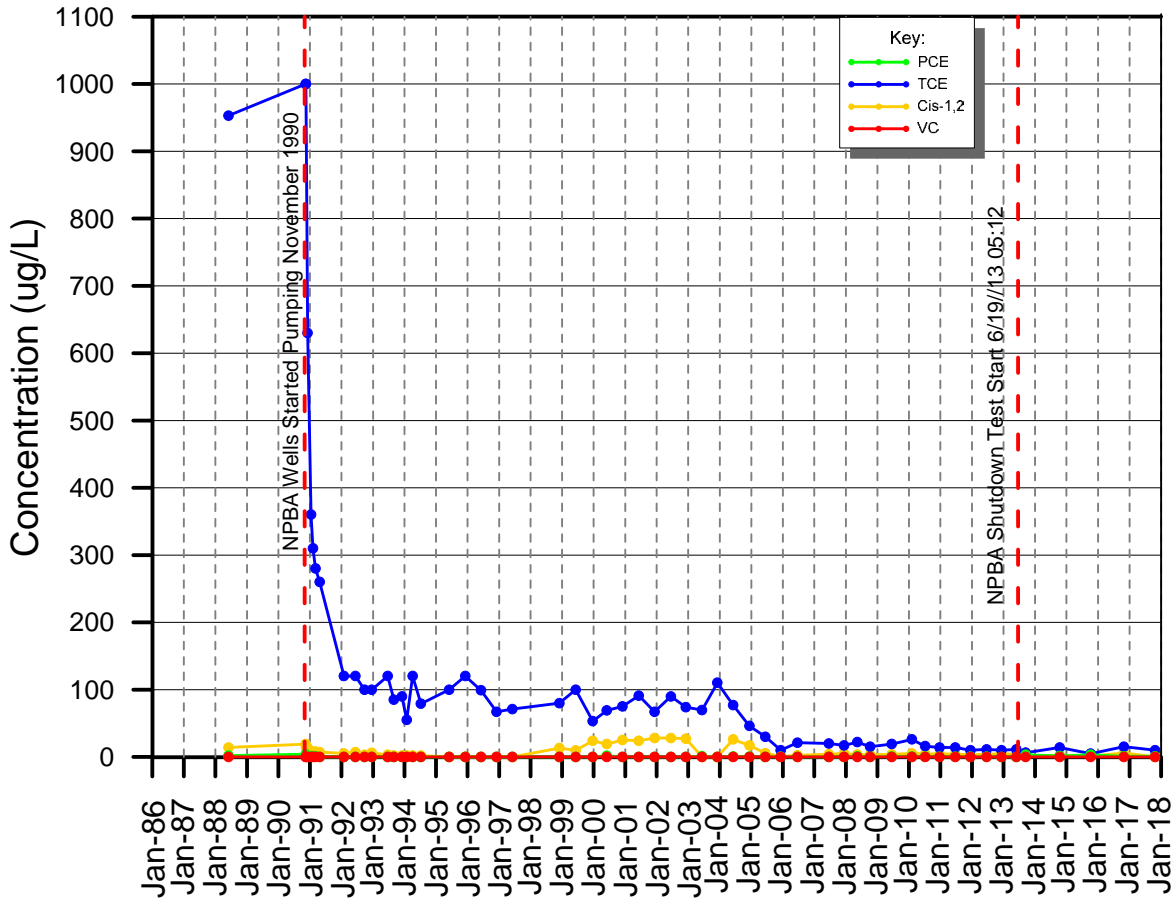
CW-1A



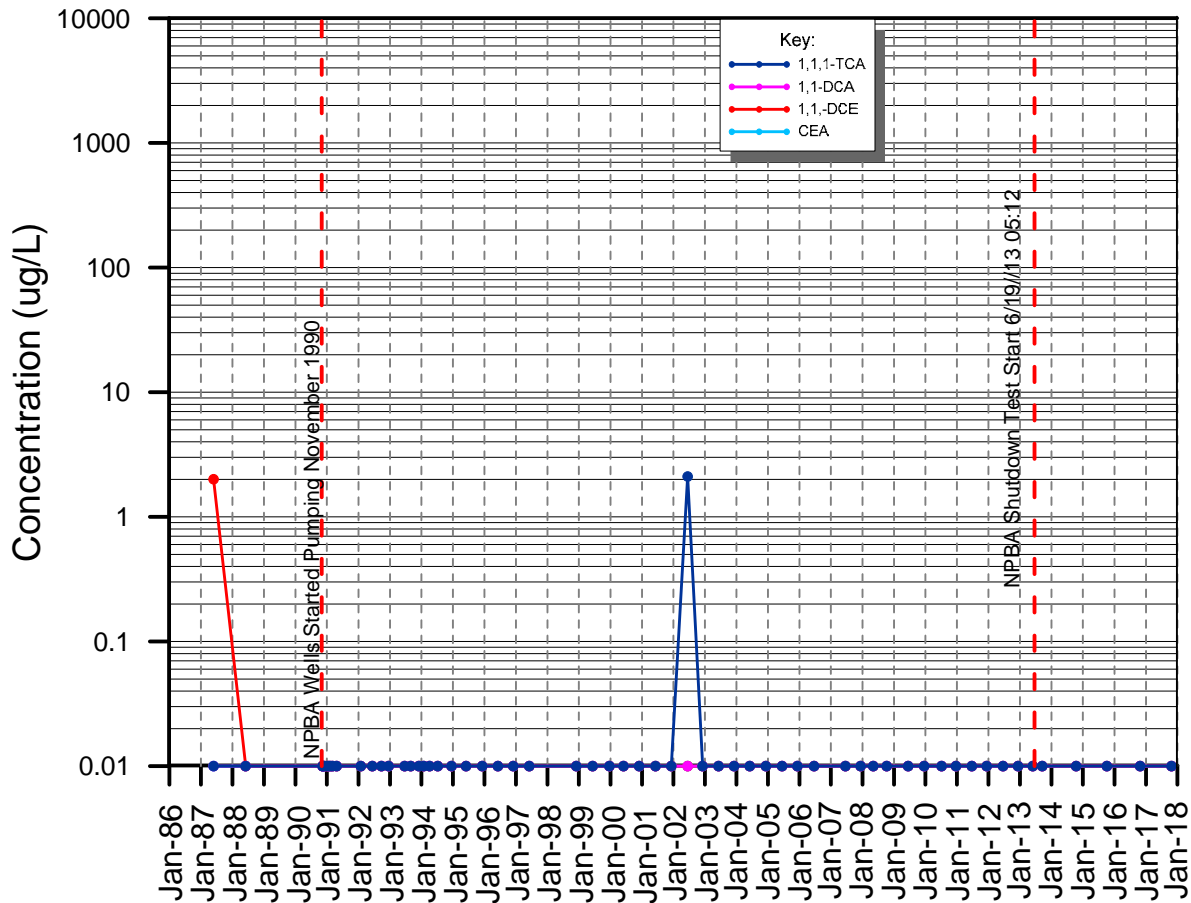
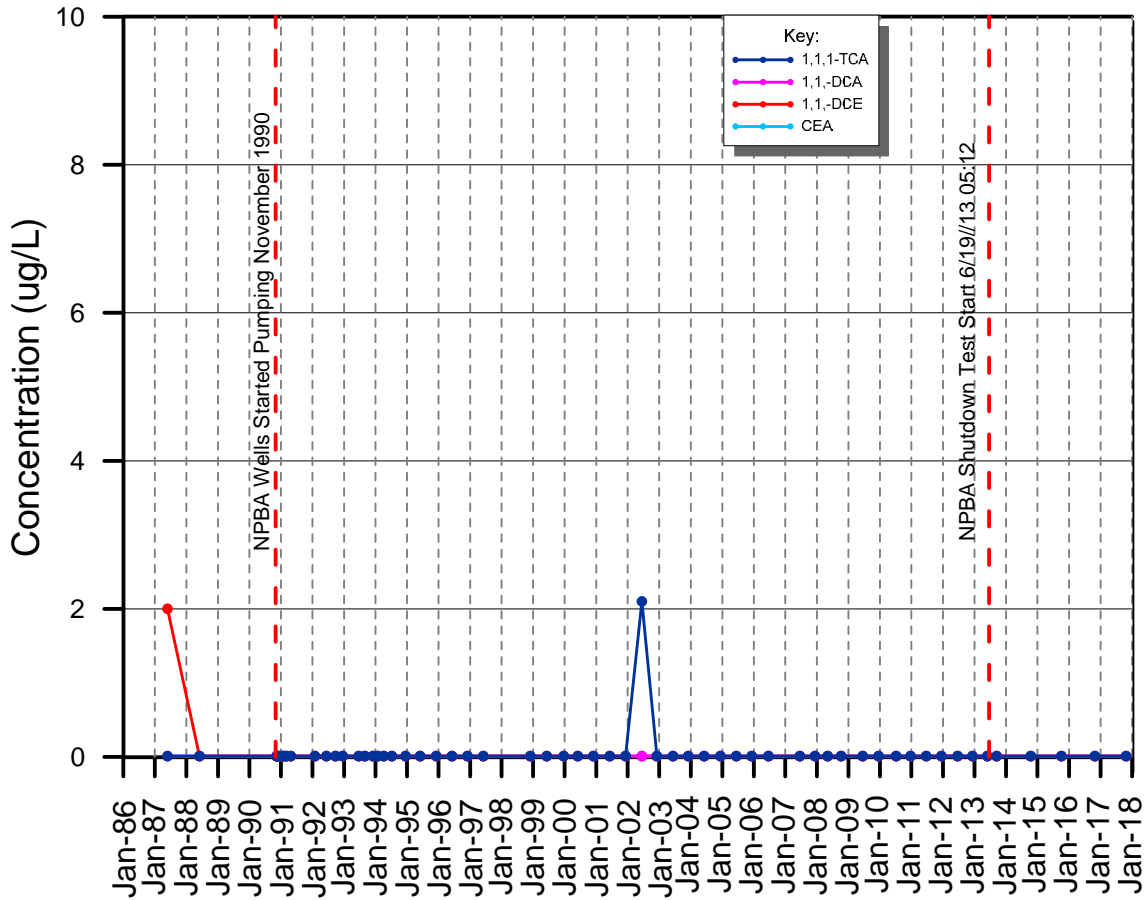
CW-2



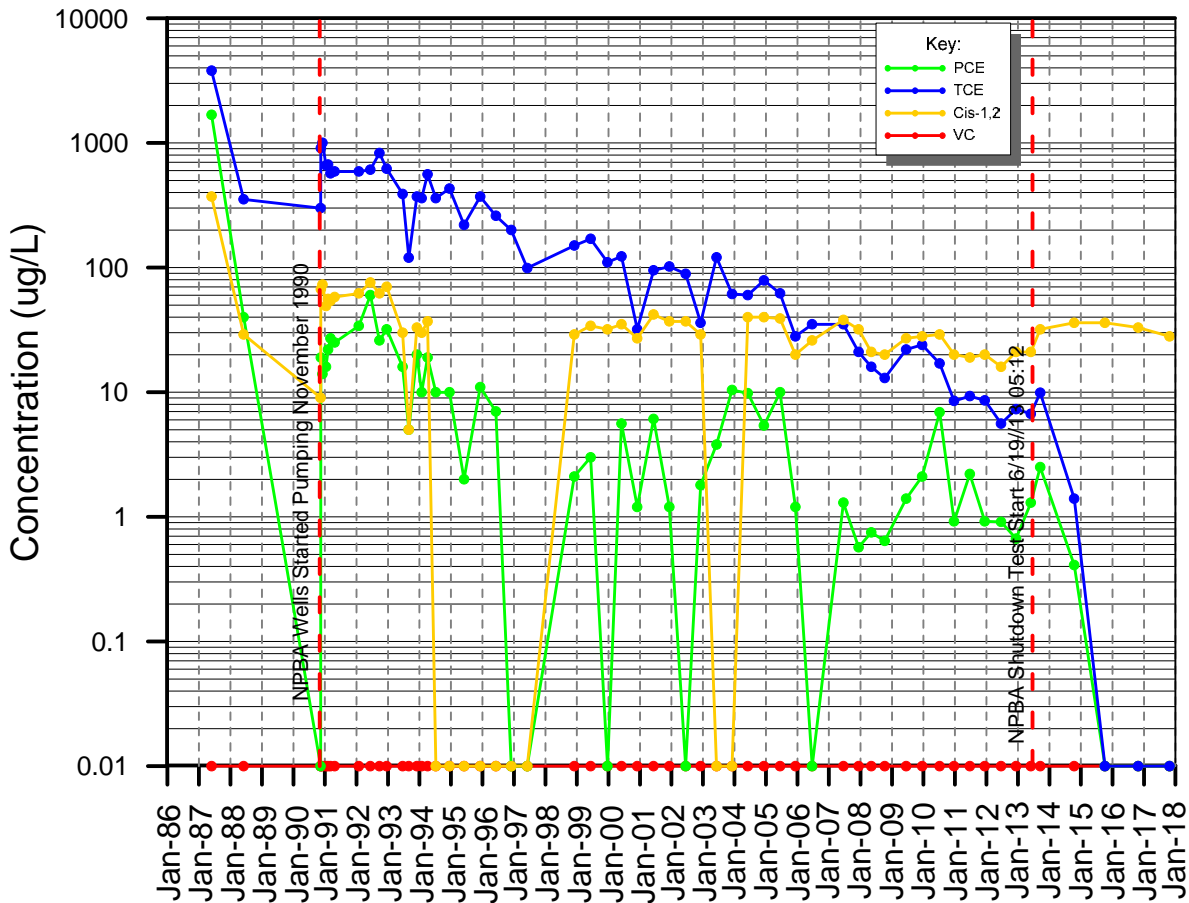
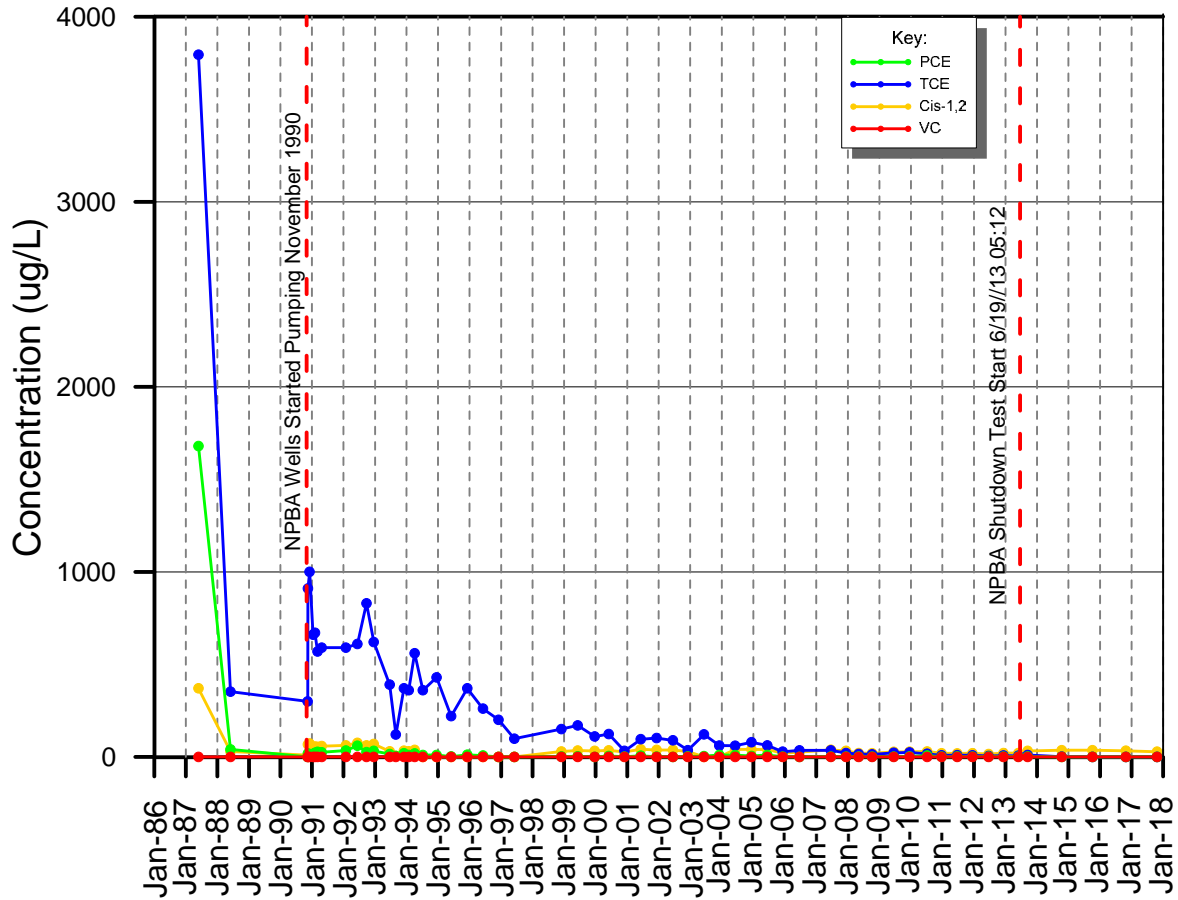
CW-2



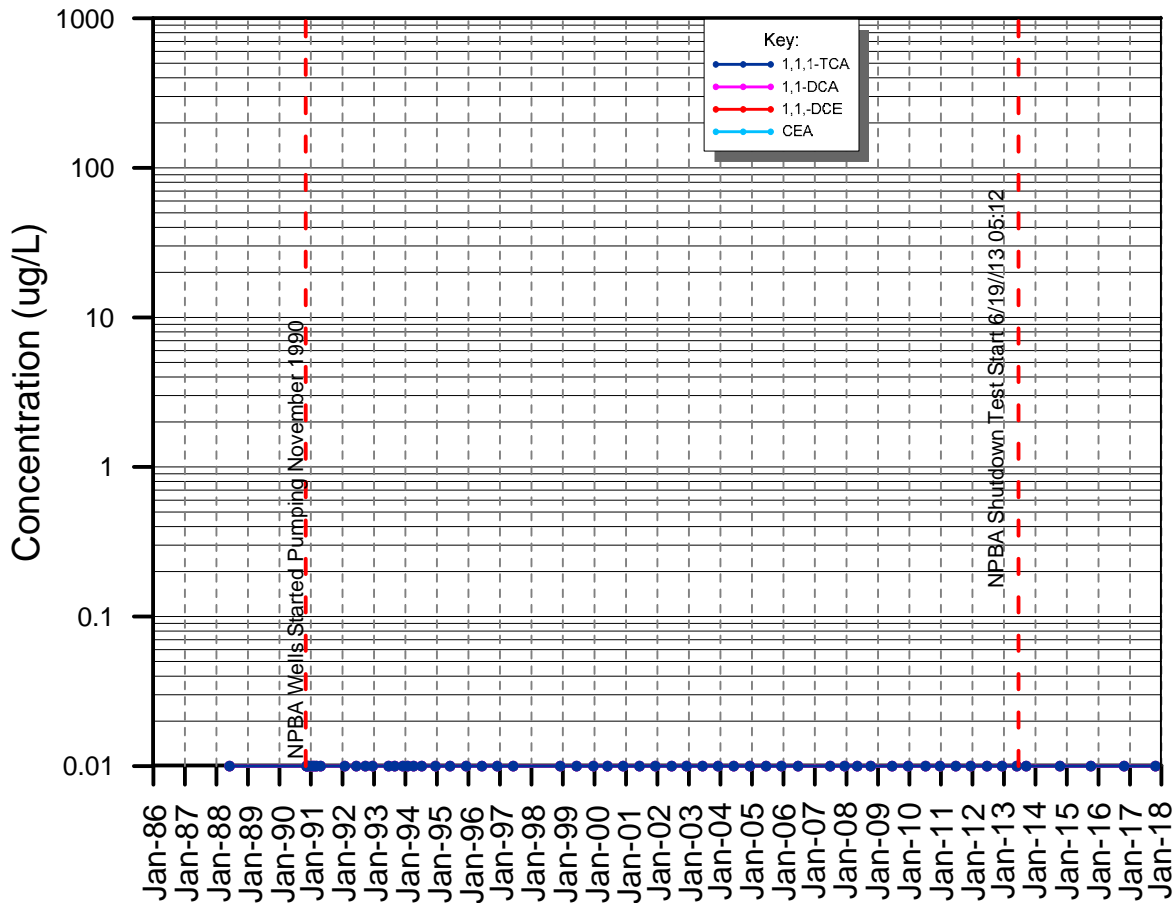
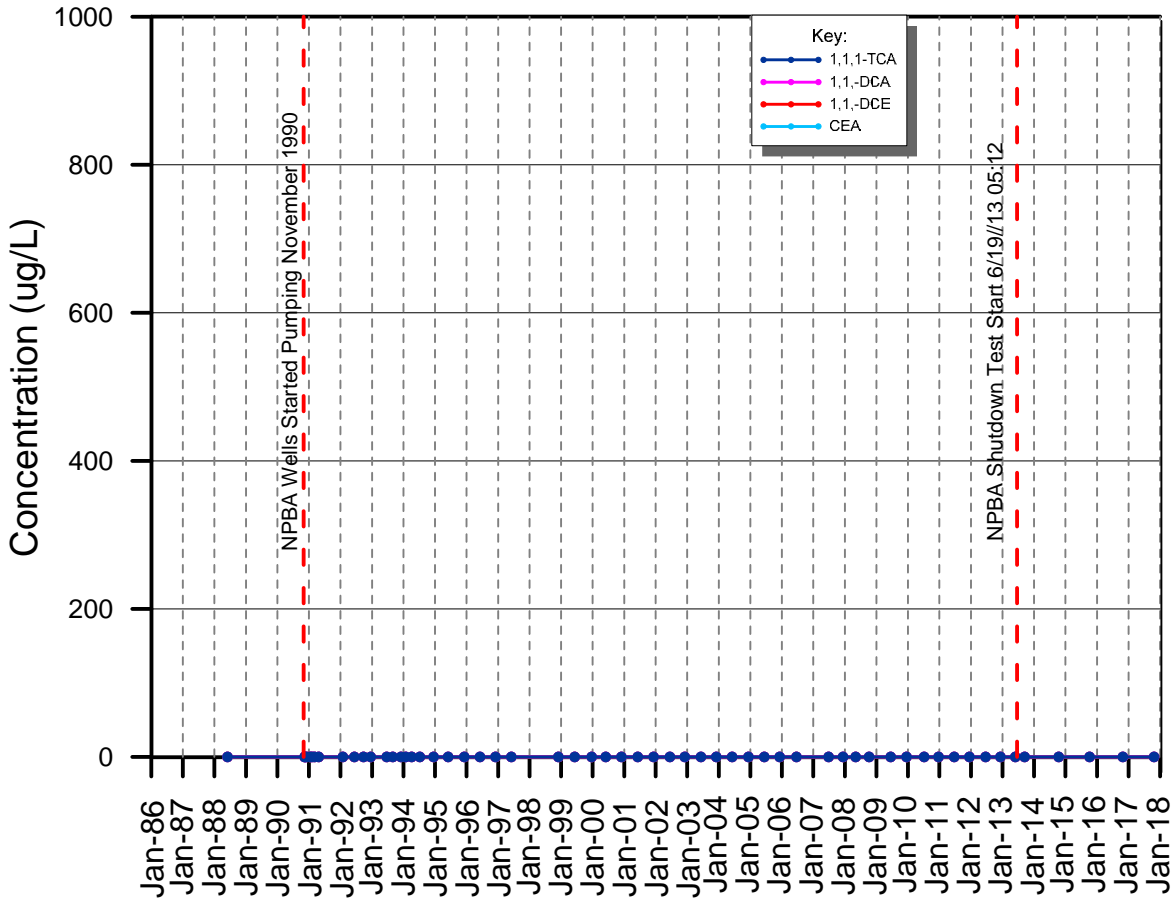
CW-3



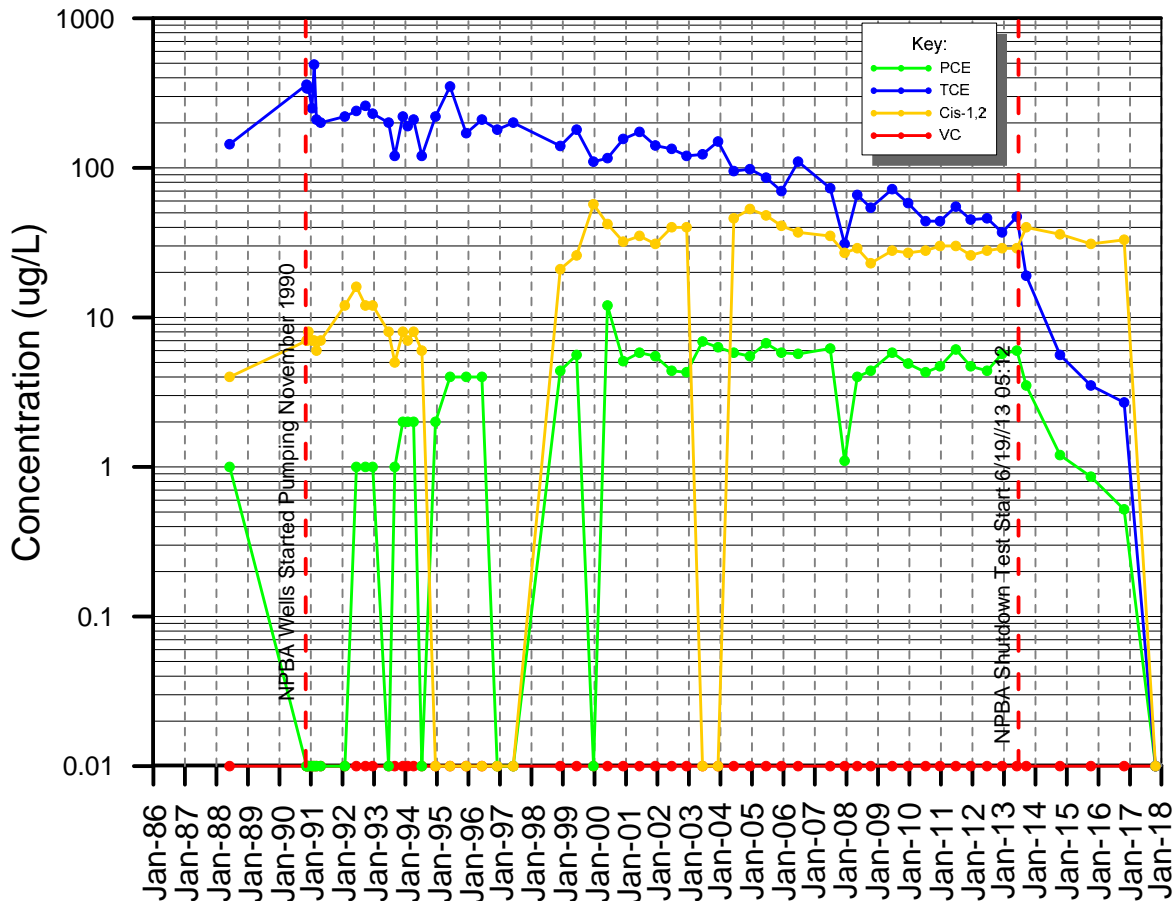
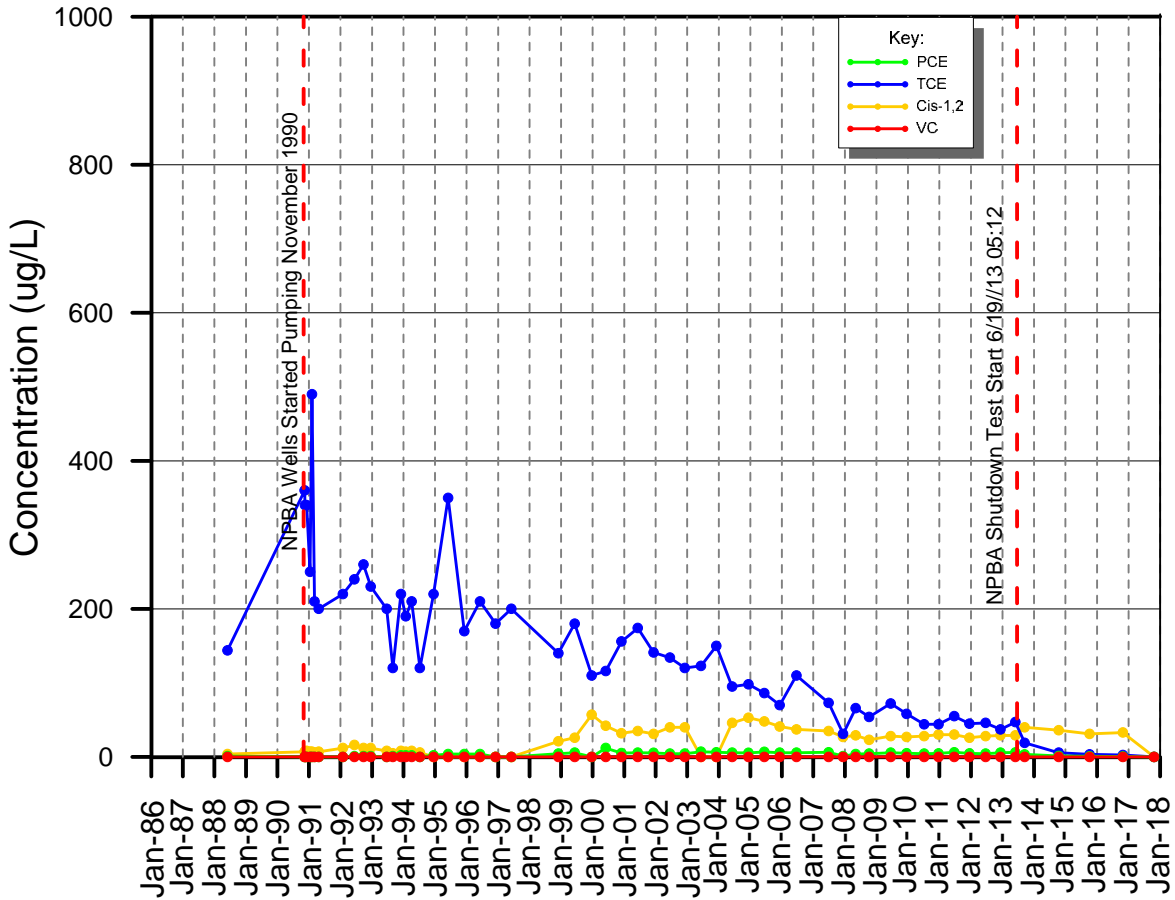
CW-3



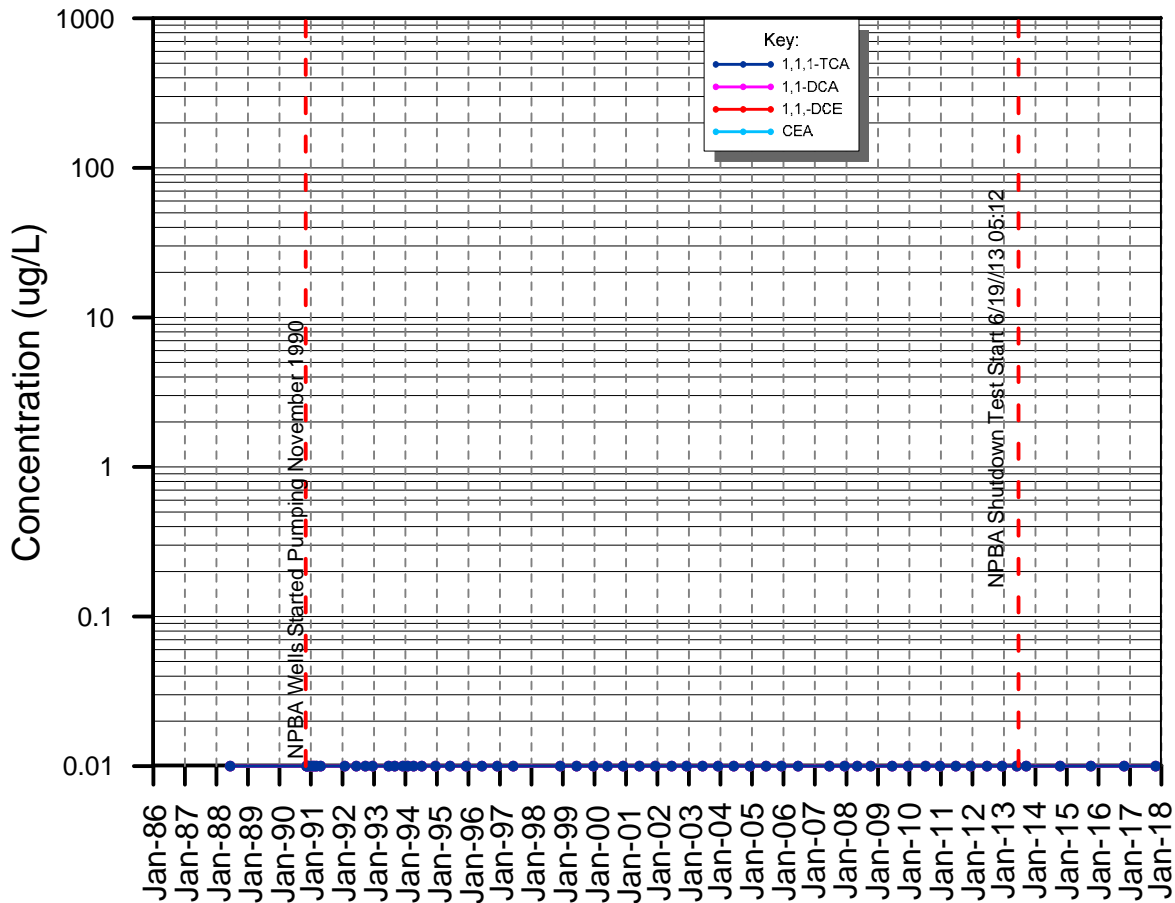
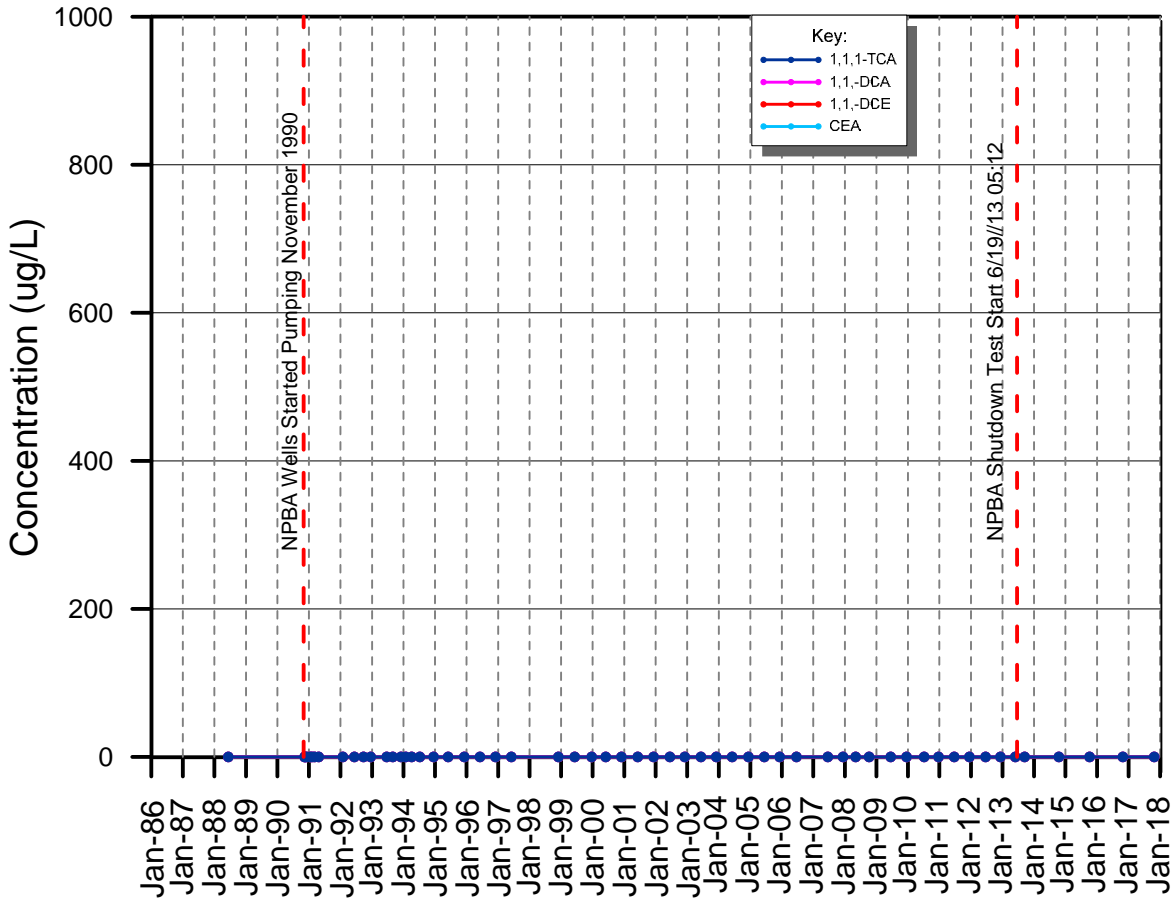
CW-4



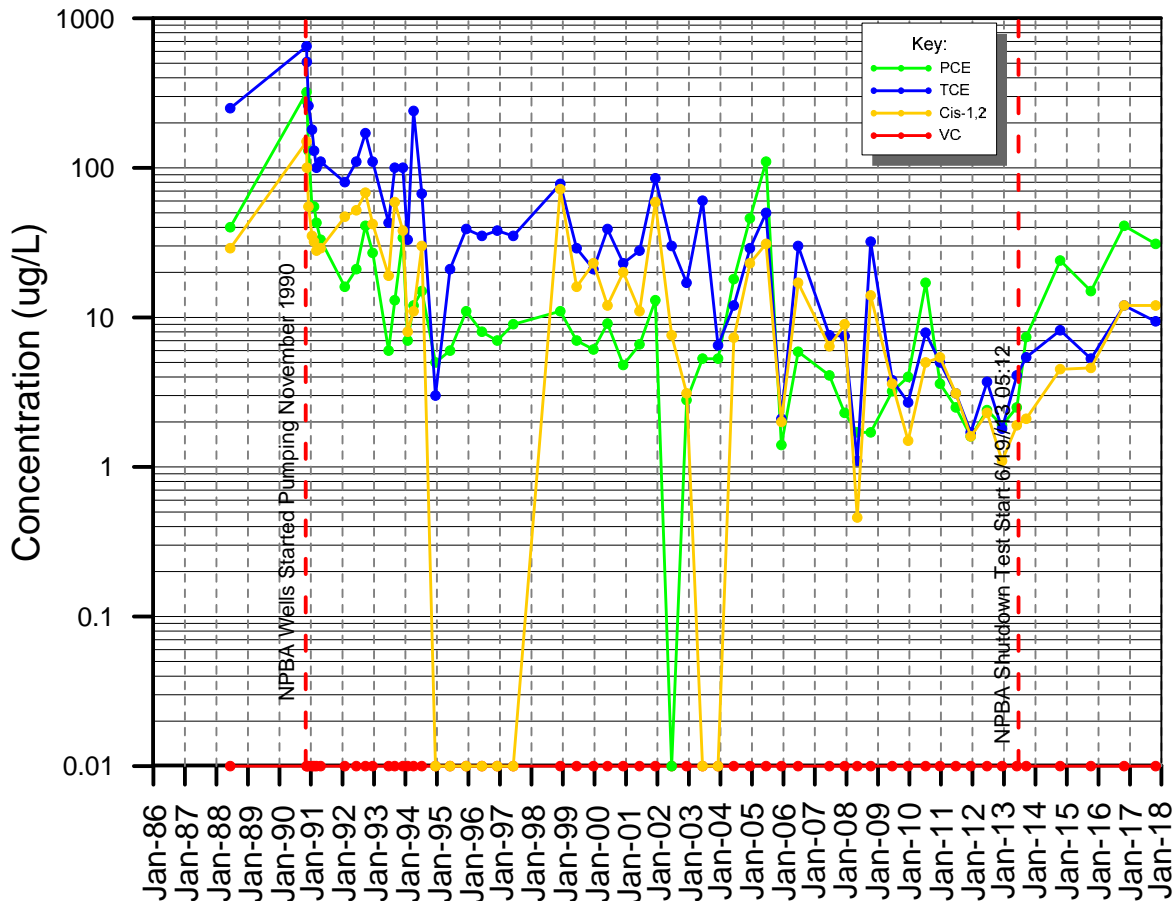
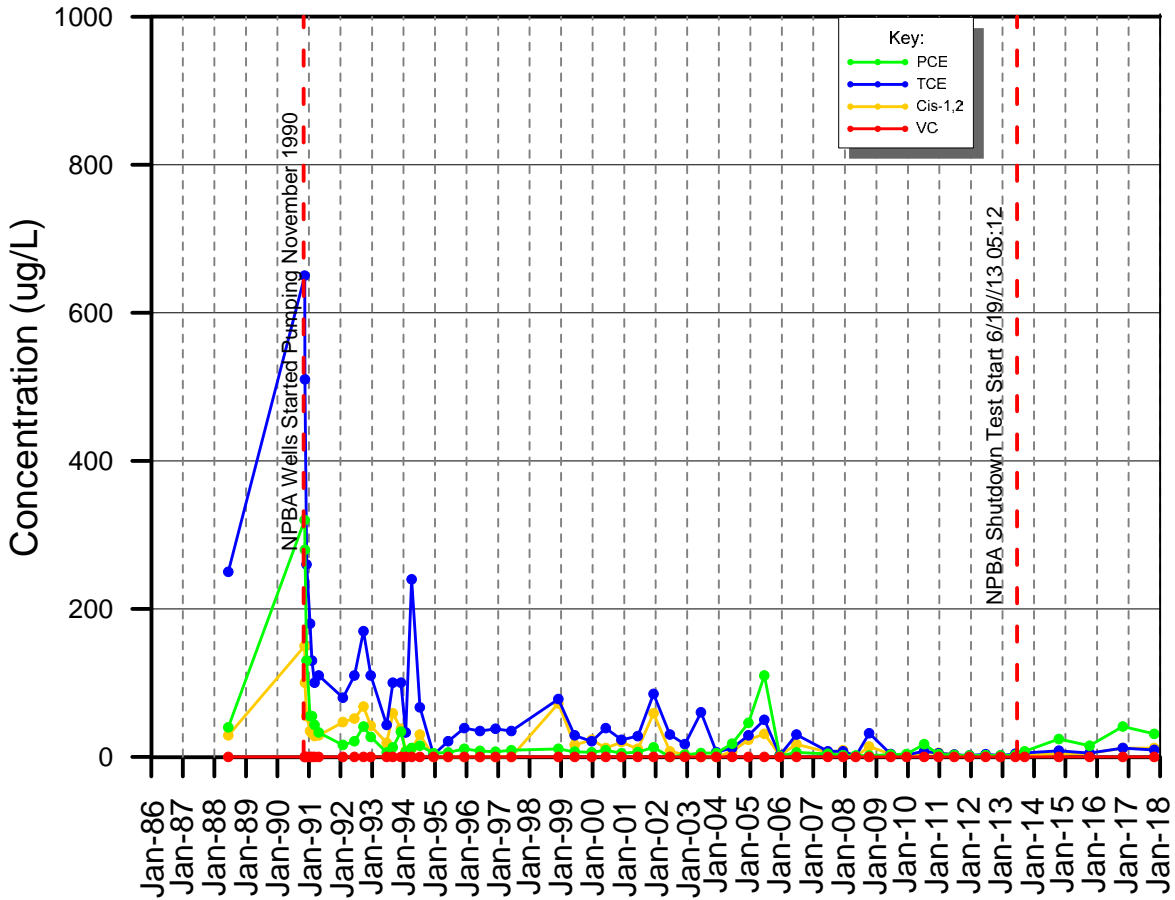
CW-4



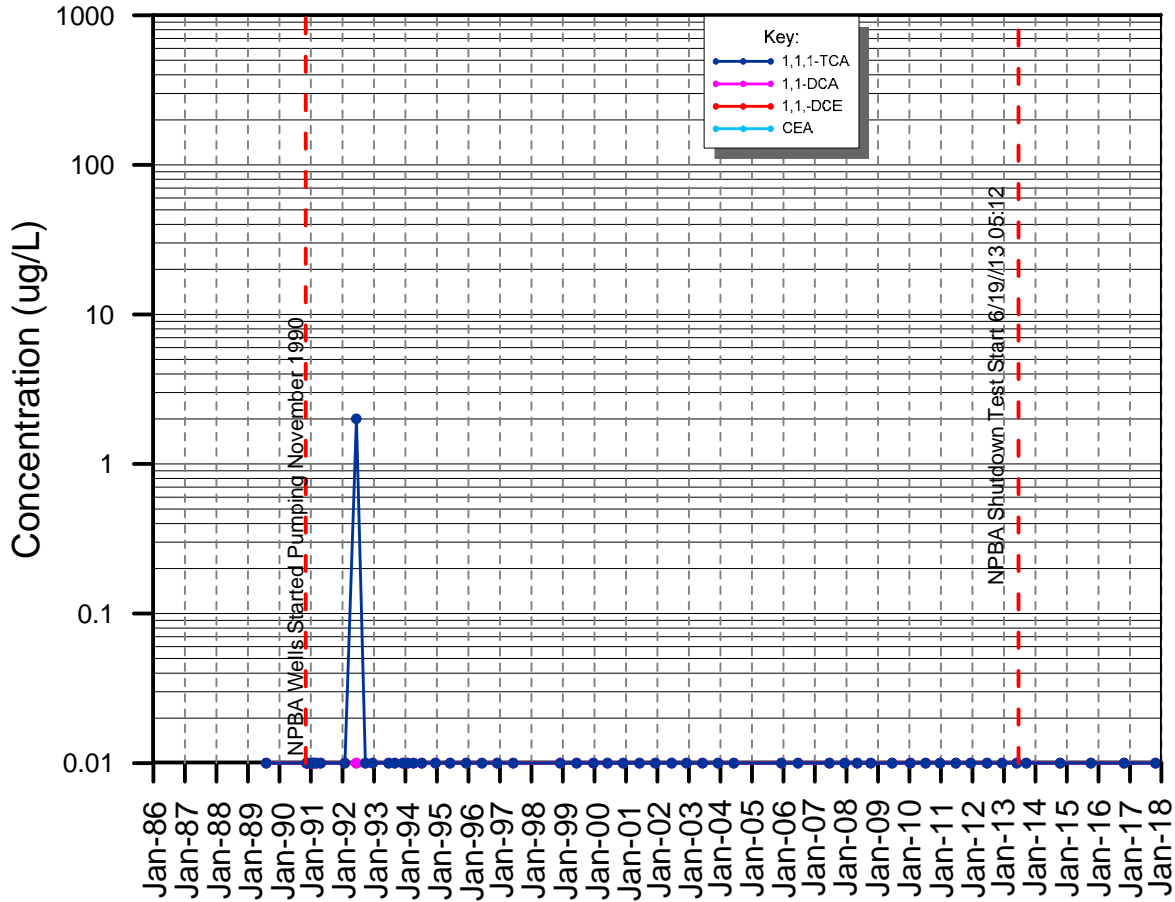
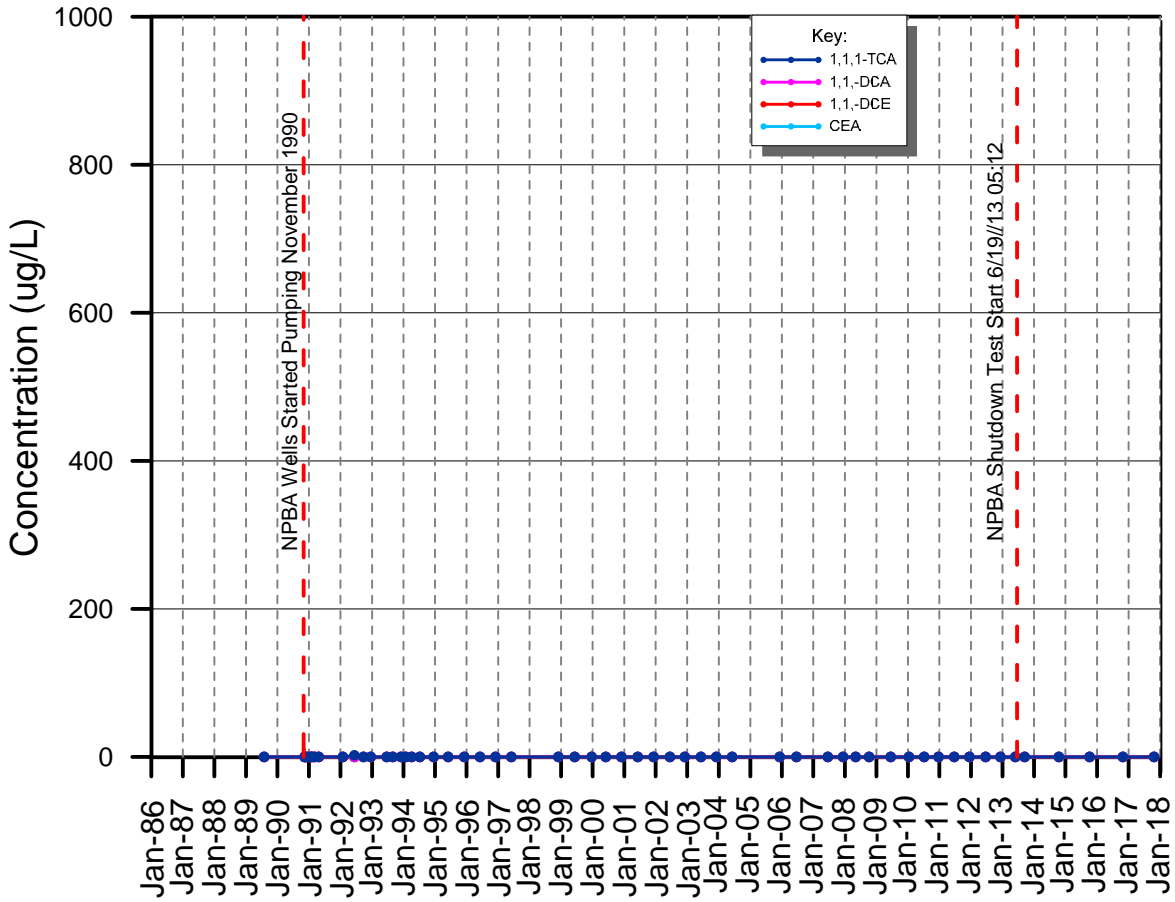
CW-5



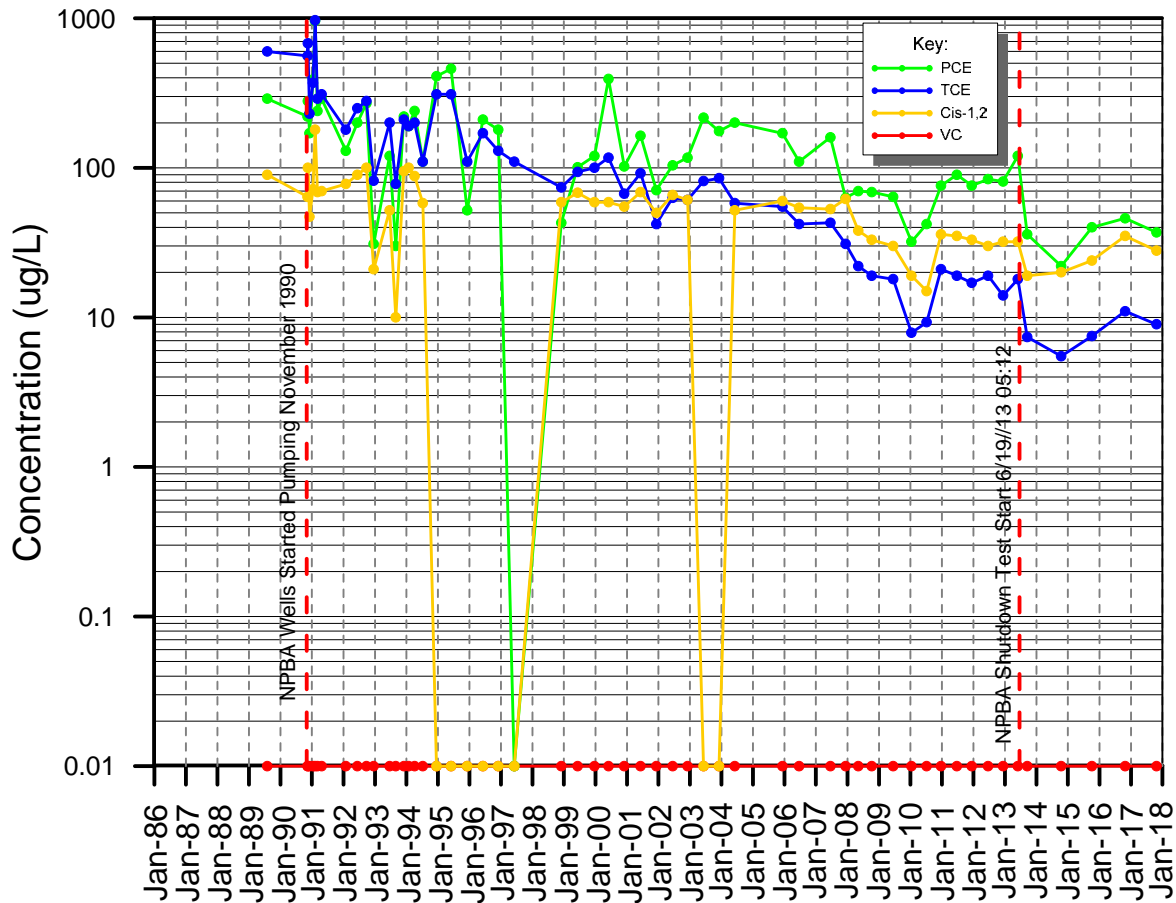
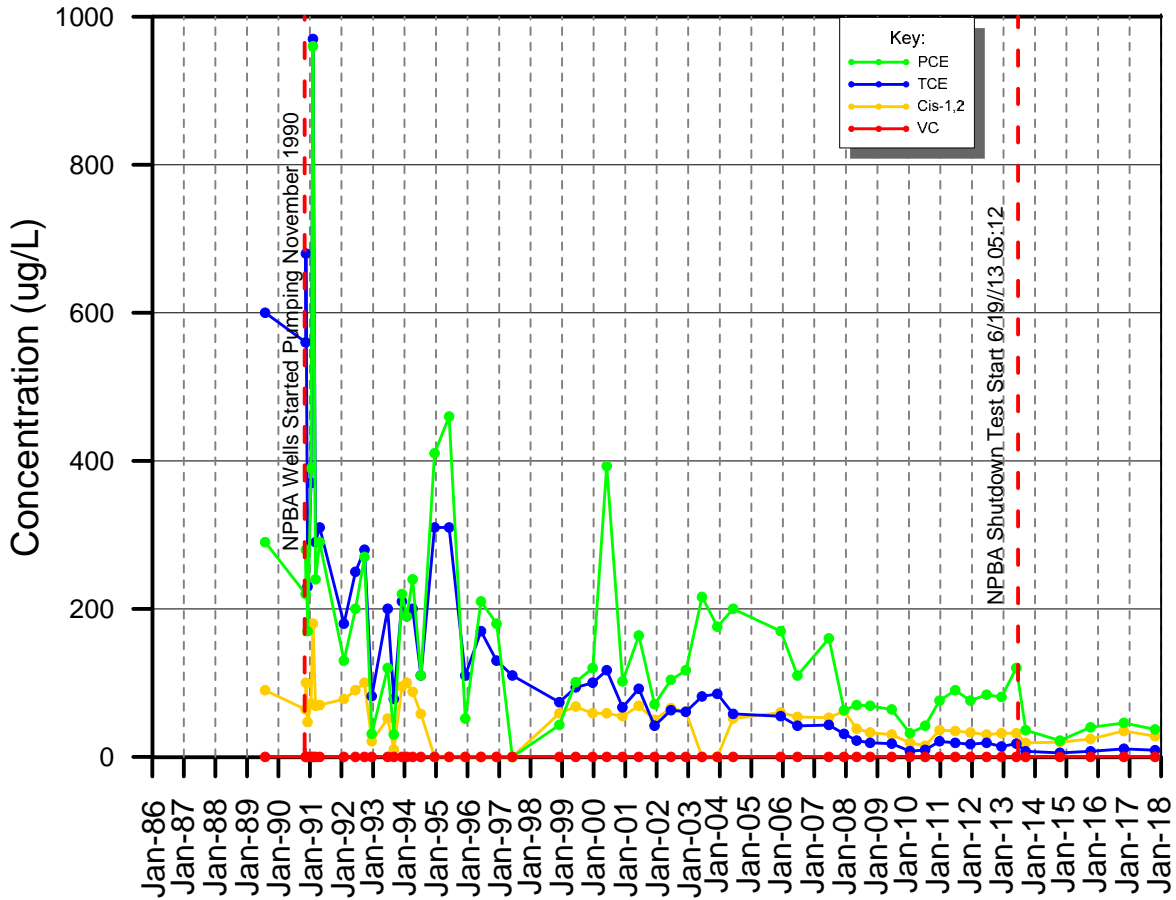
CW-5



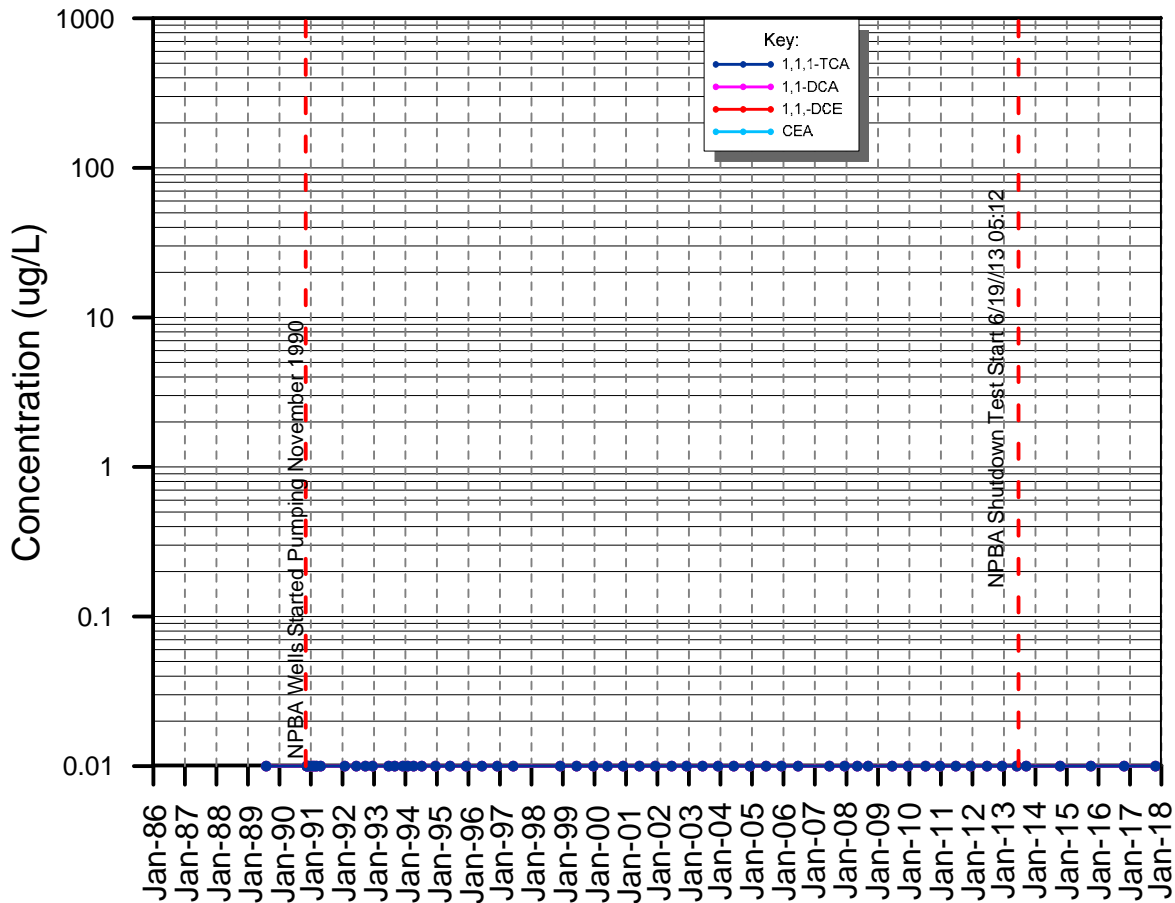
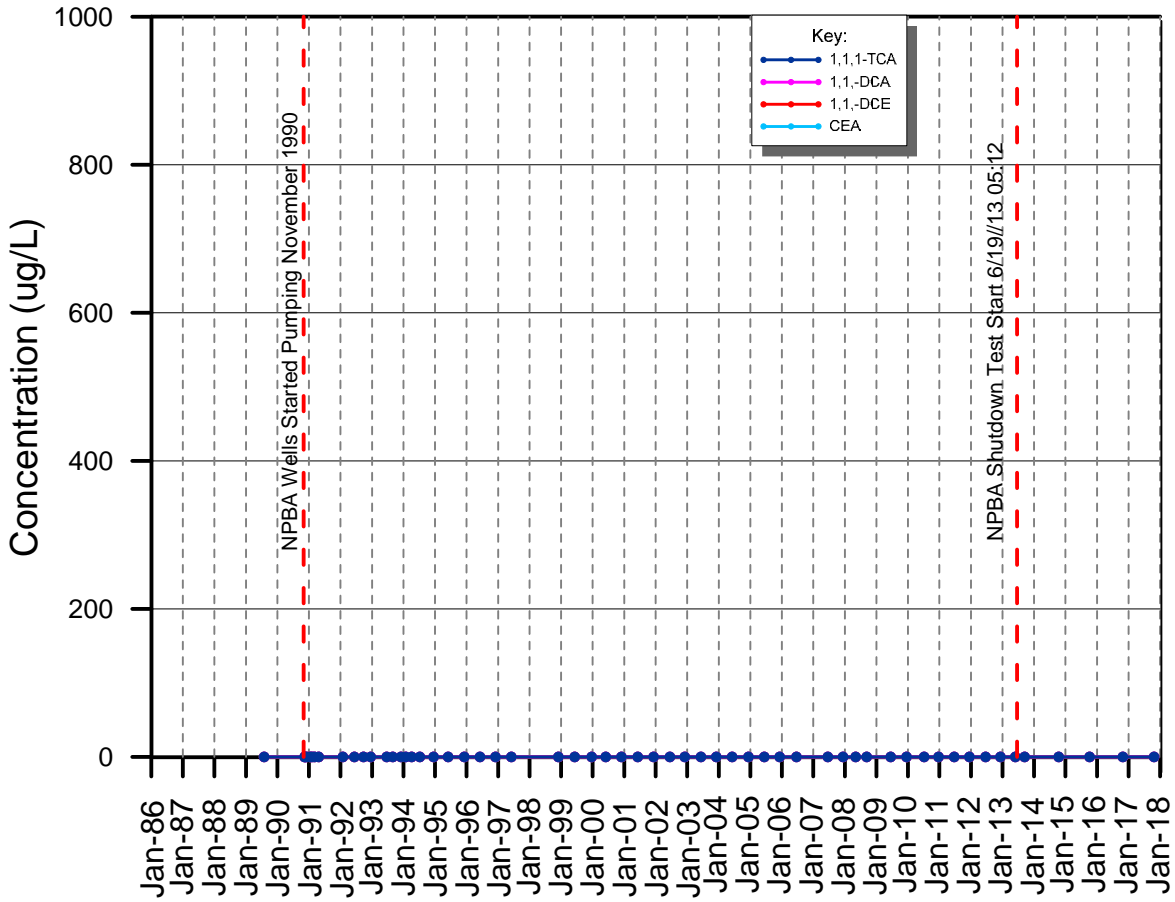
CW-6



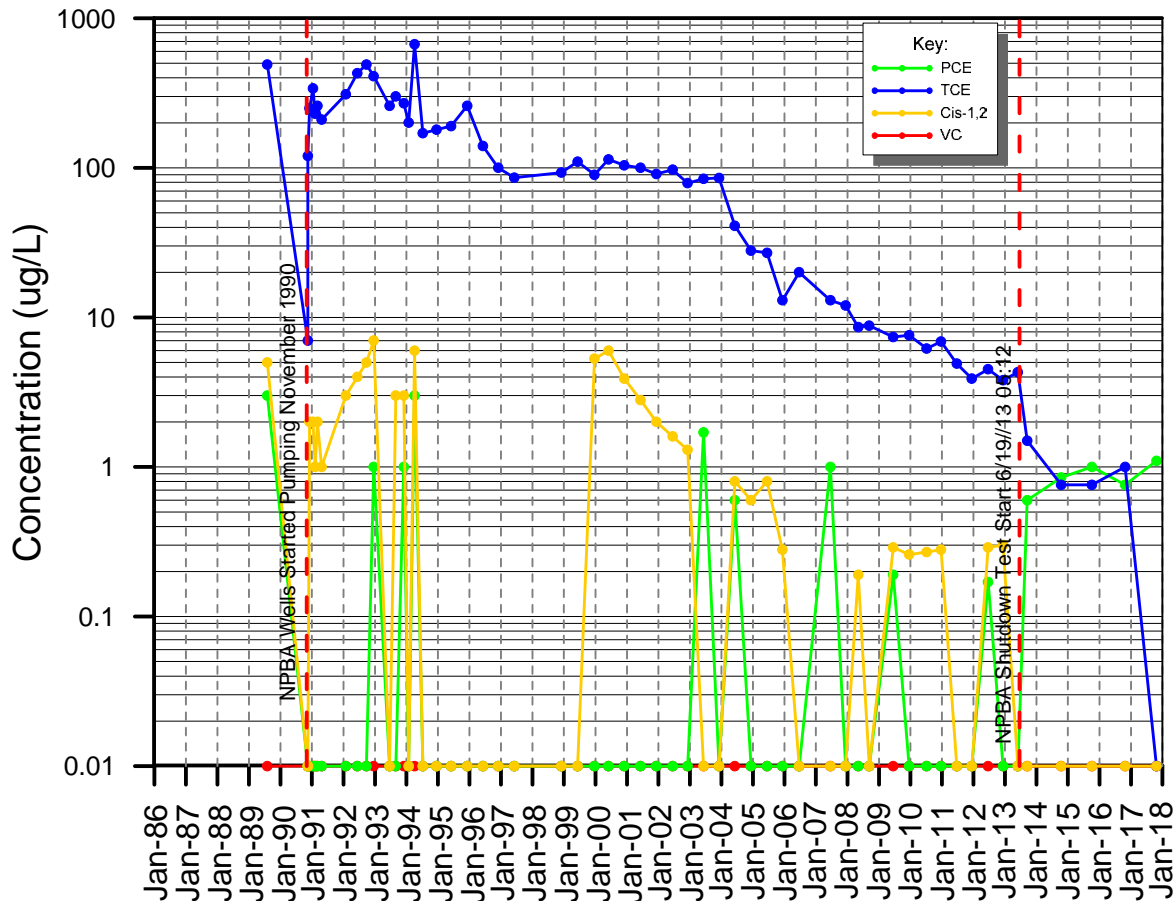
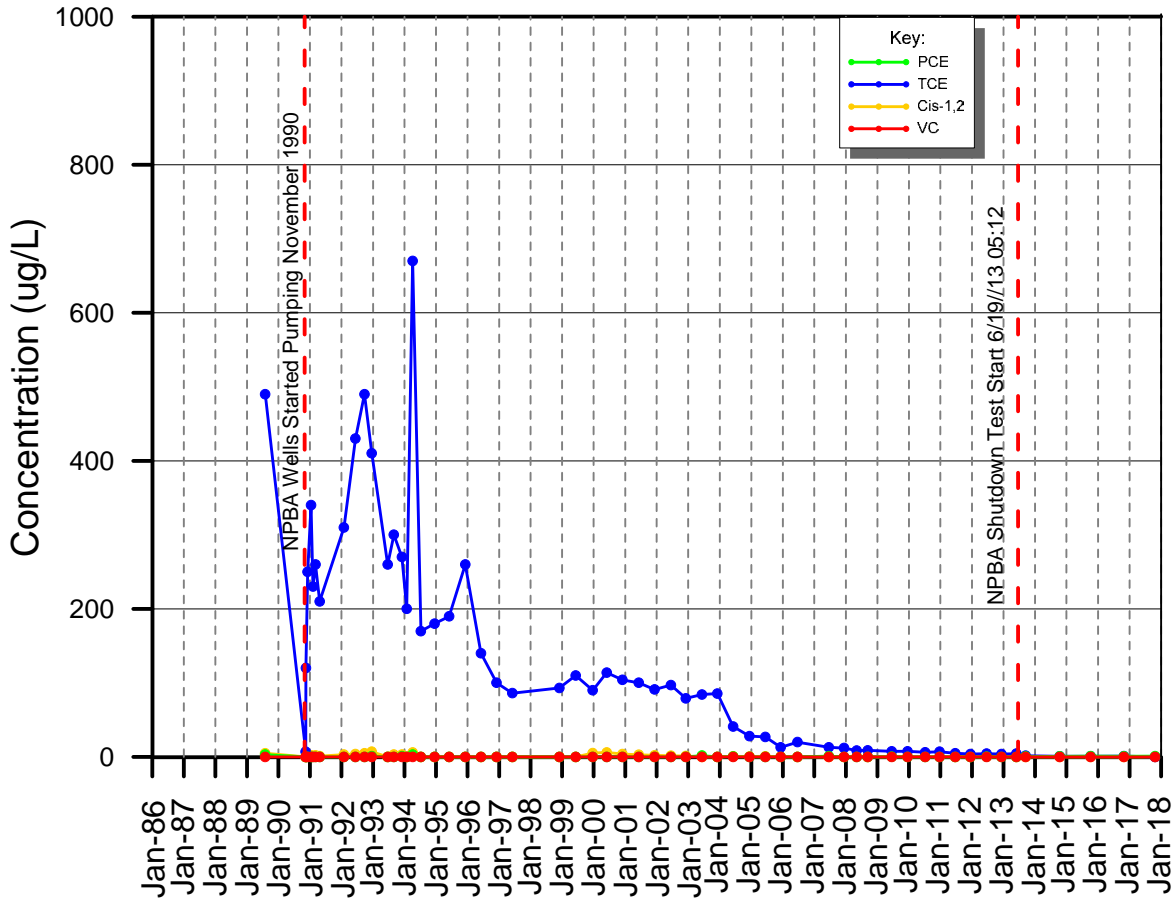
CW-6



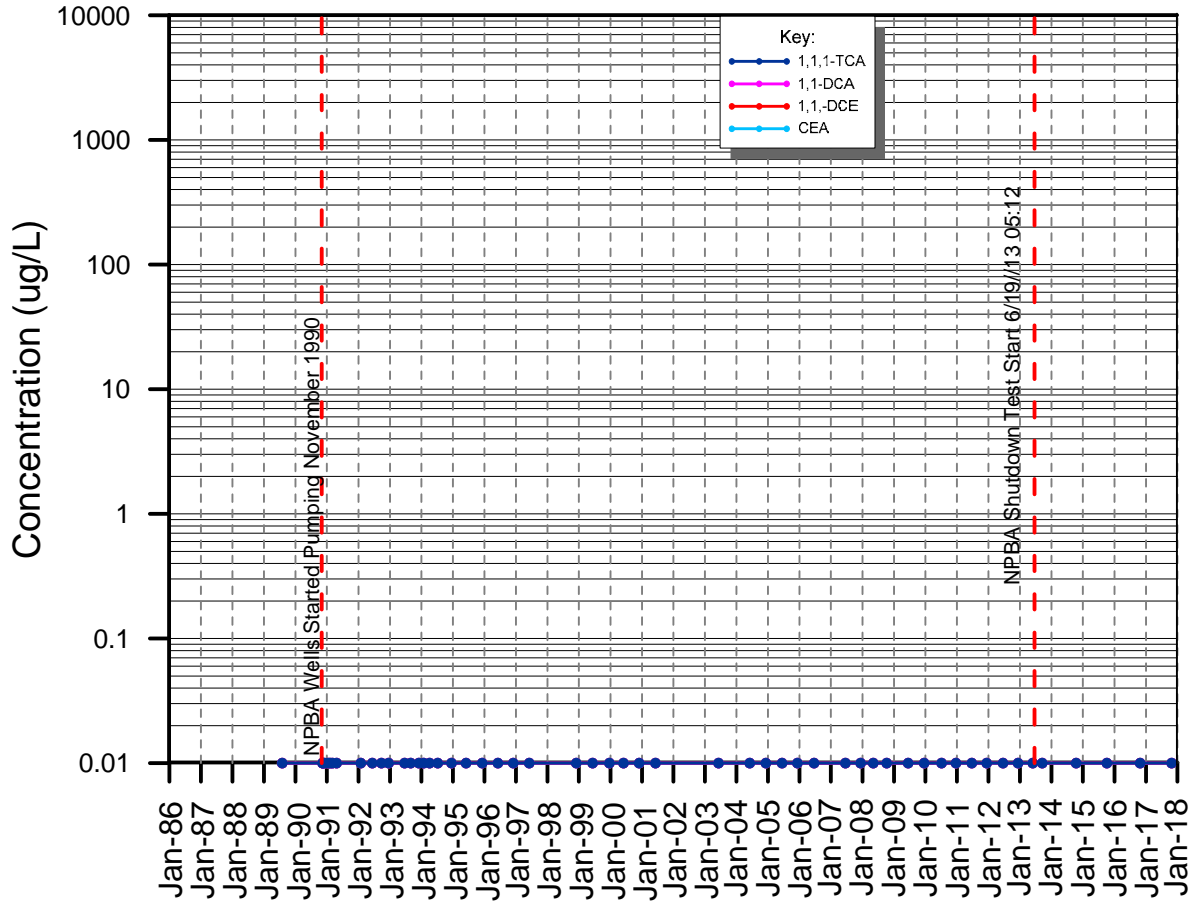
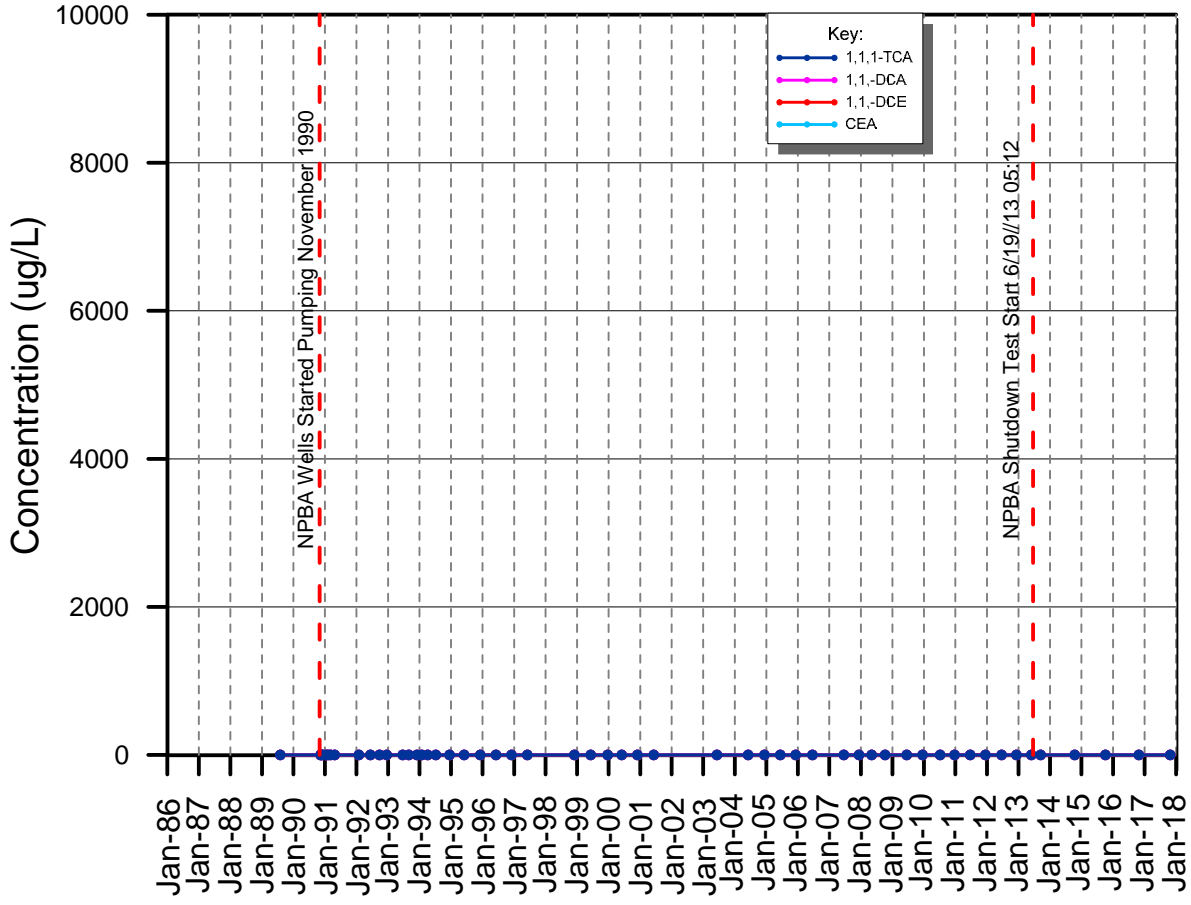
CW-7



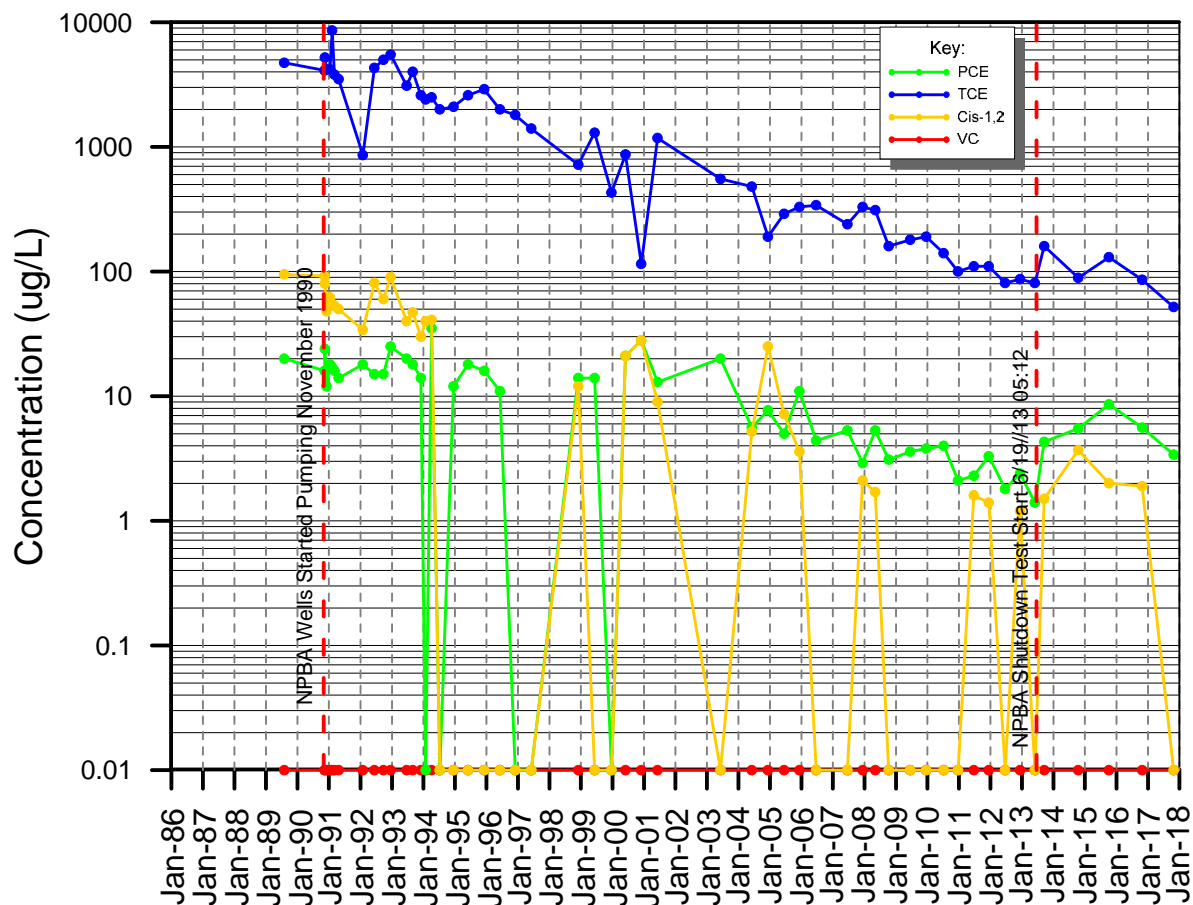
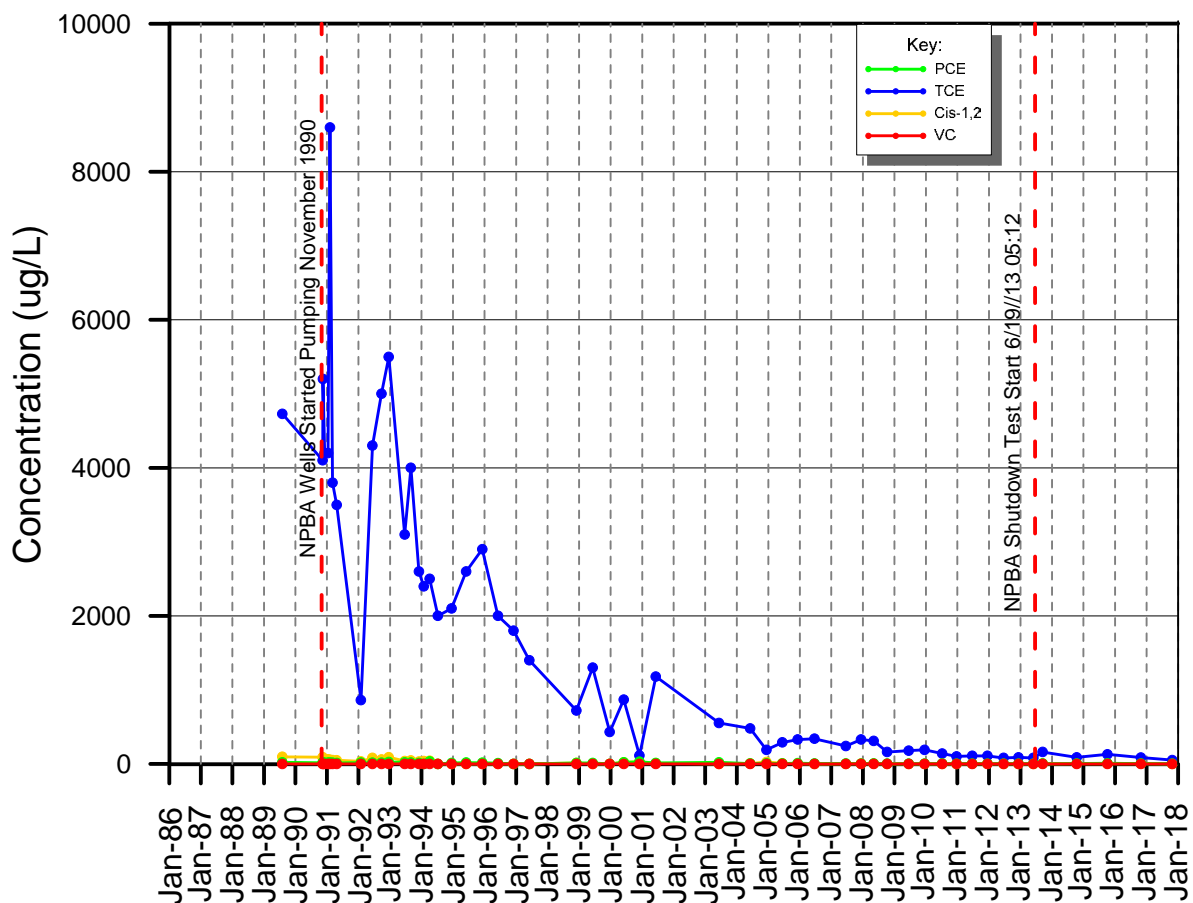
CW-7



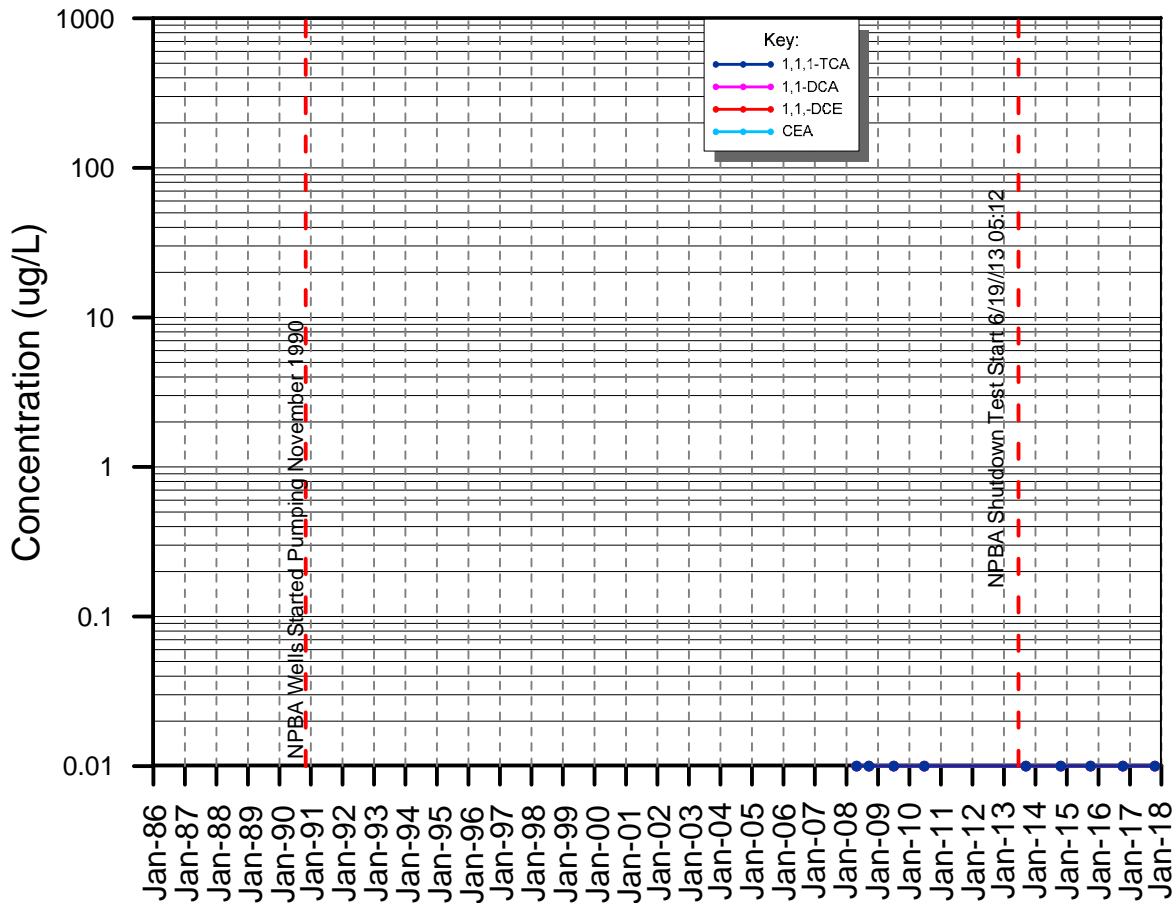
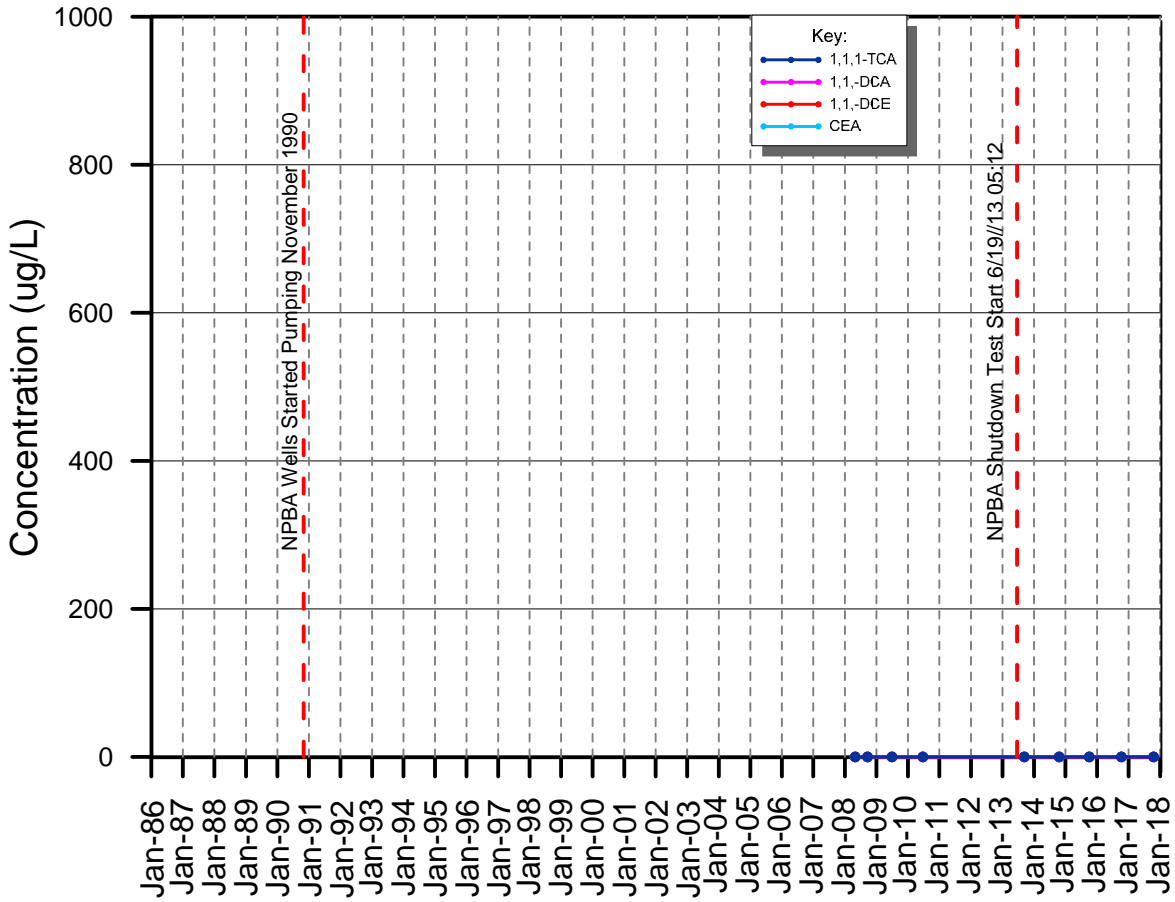
CW-7A



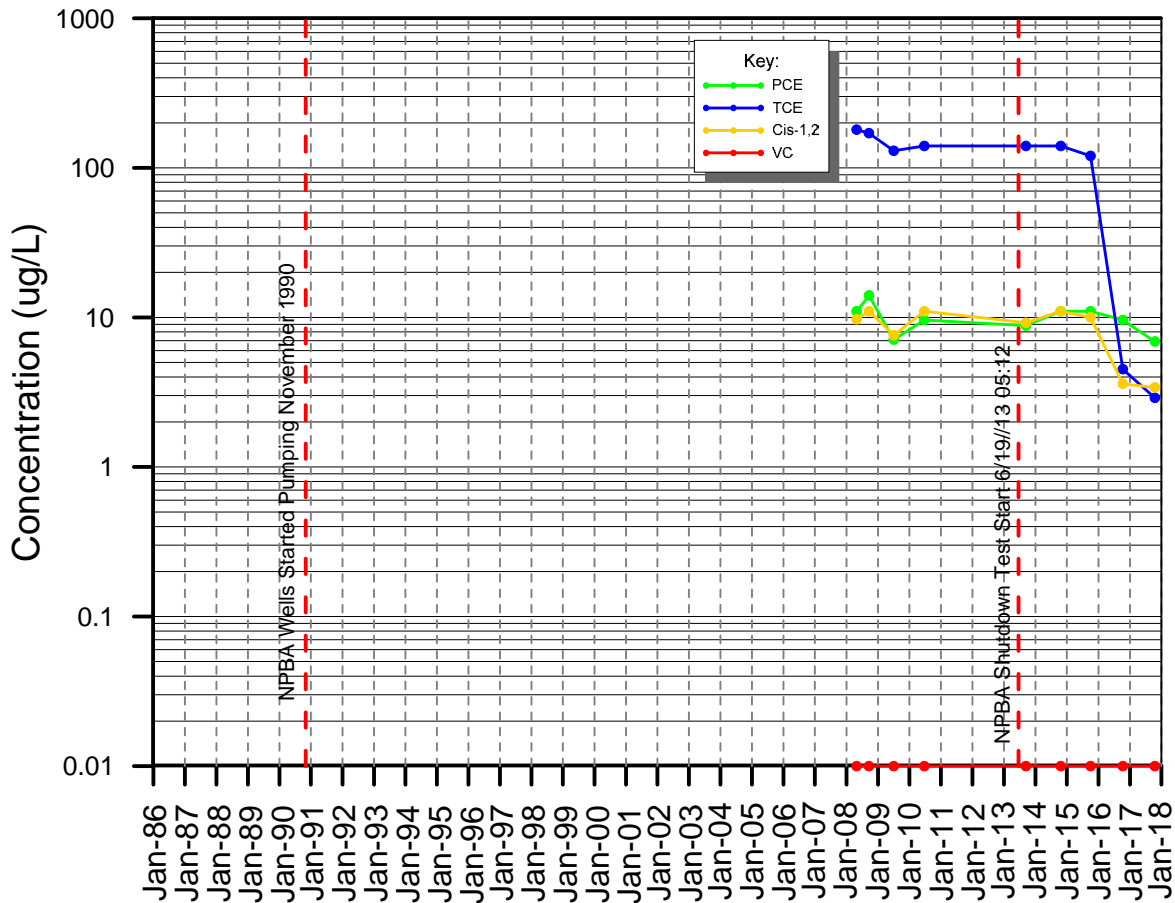
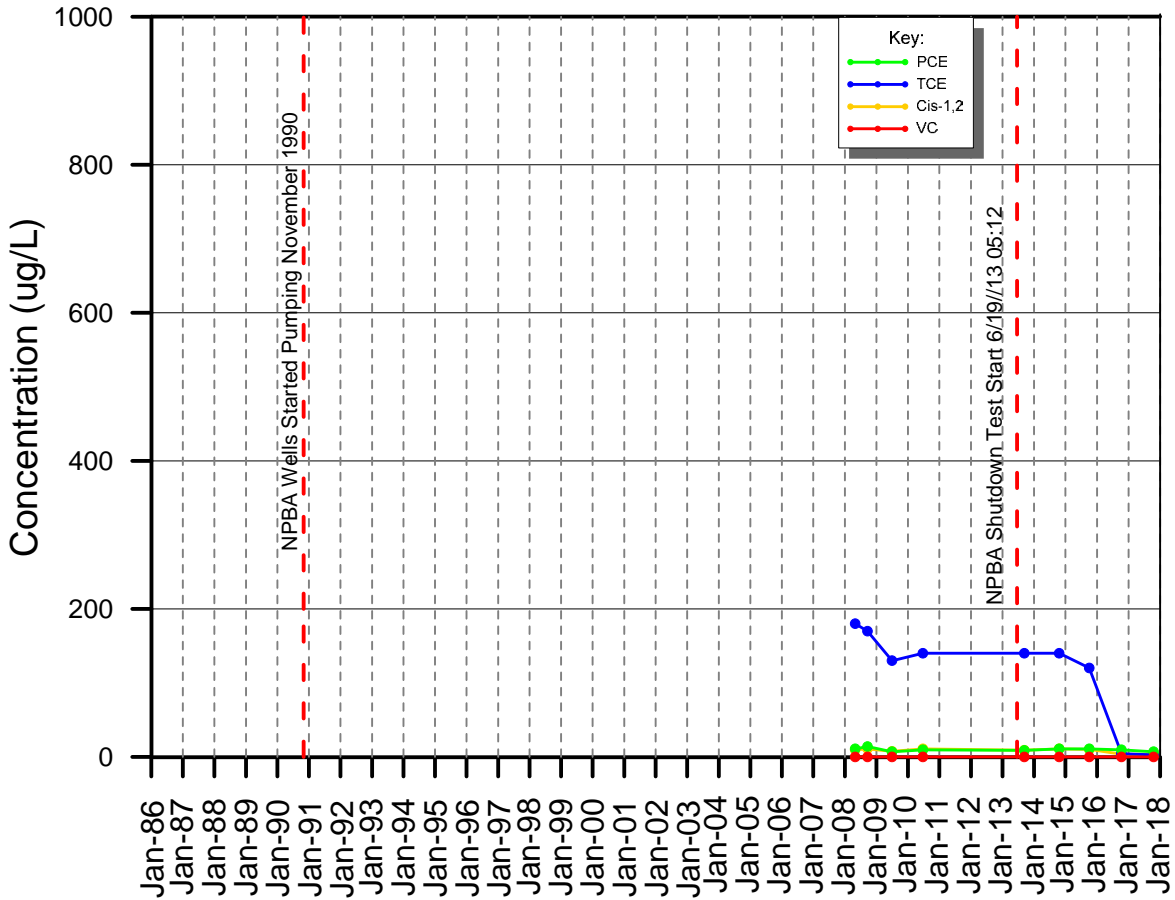
CW-7A



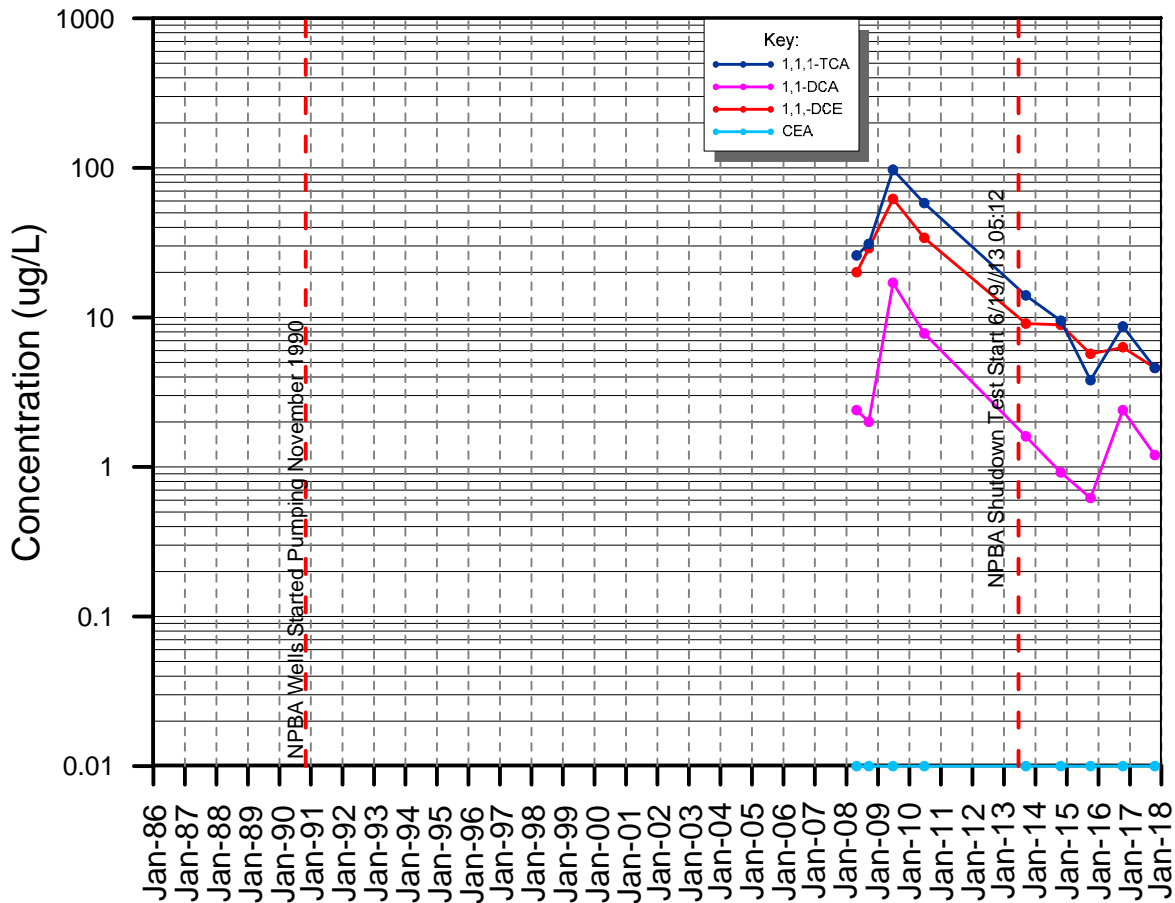
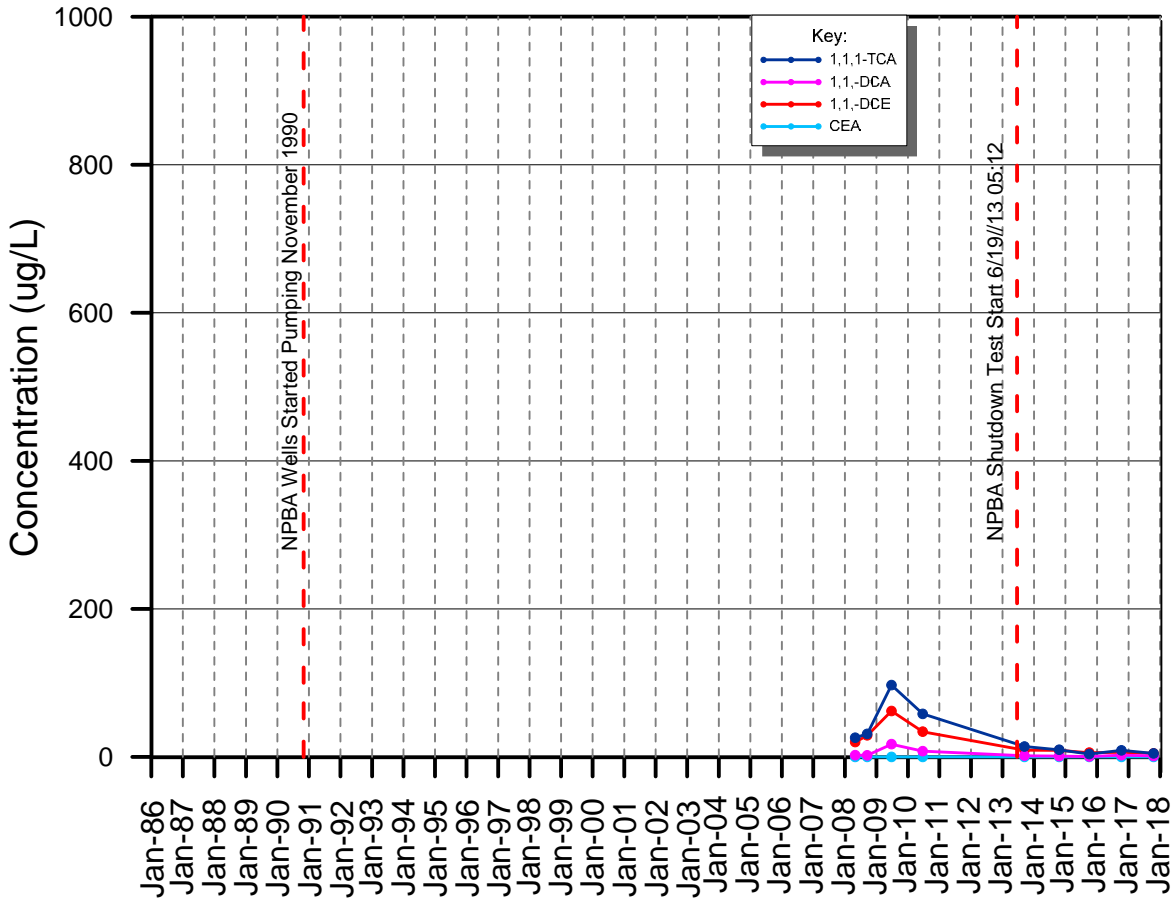
MW-102D



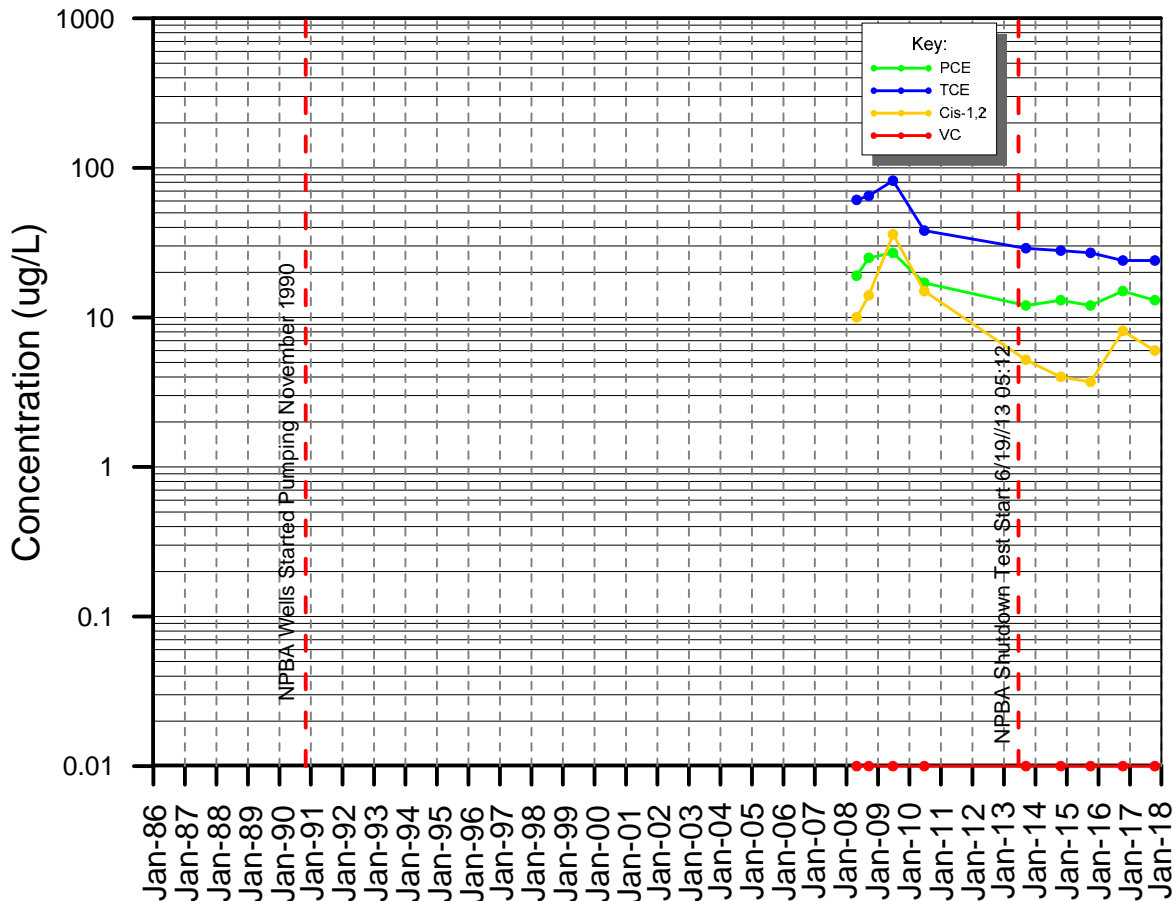
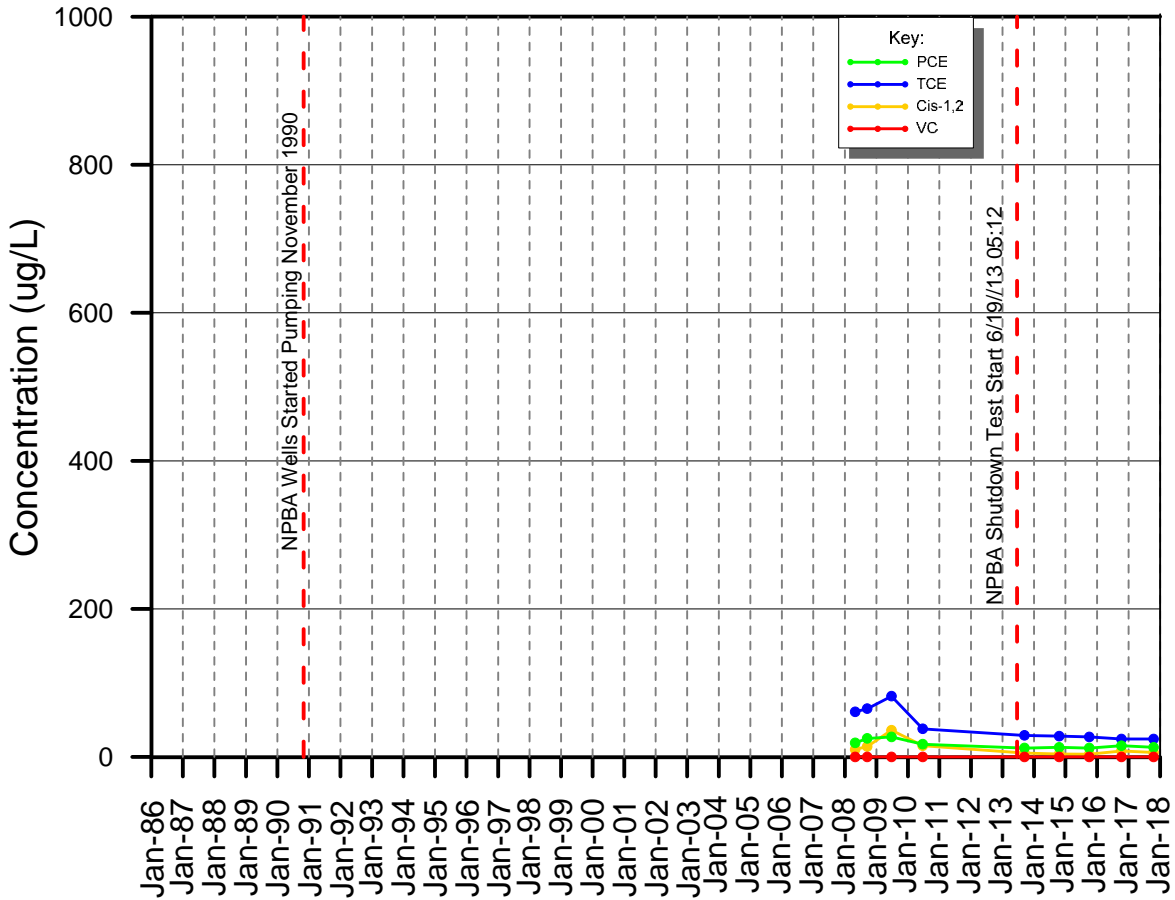
MW-102D



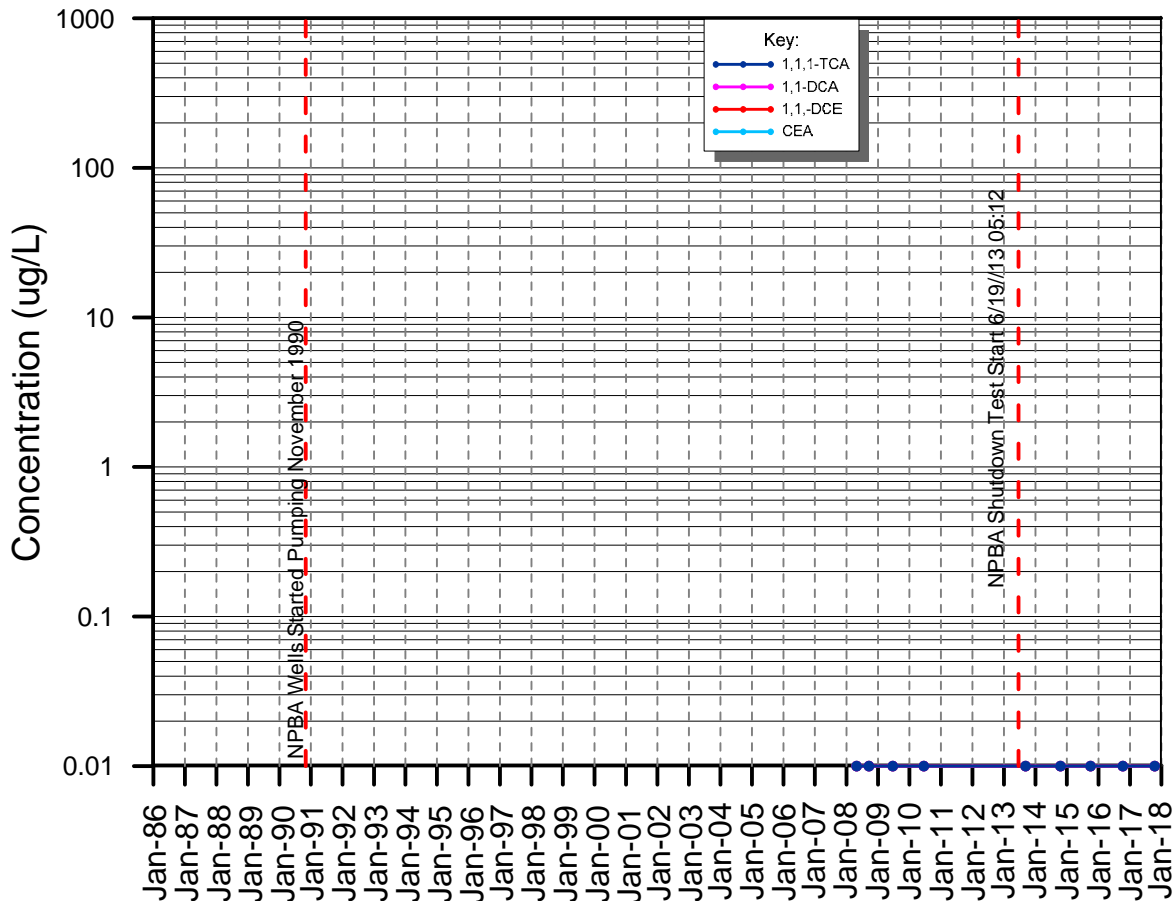
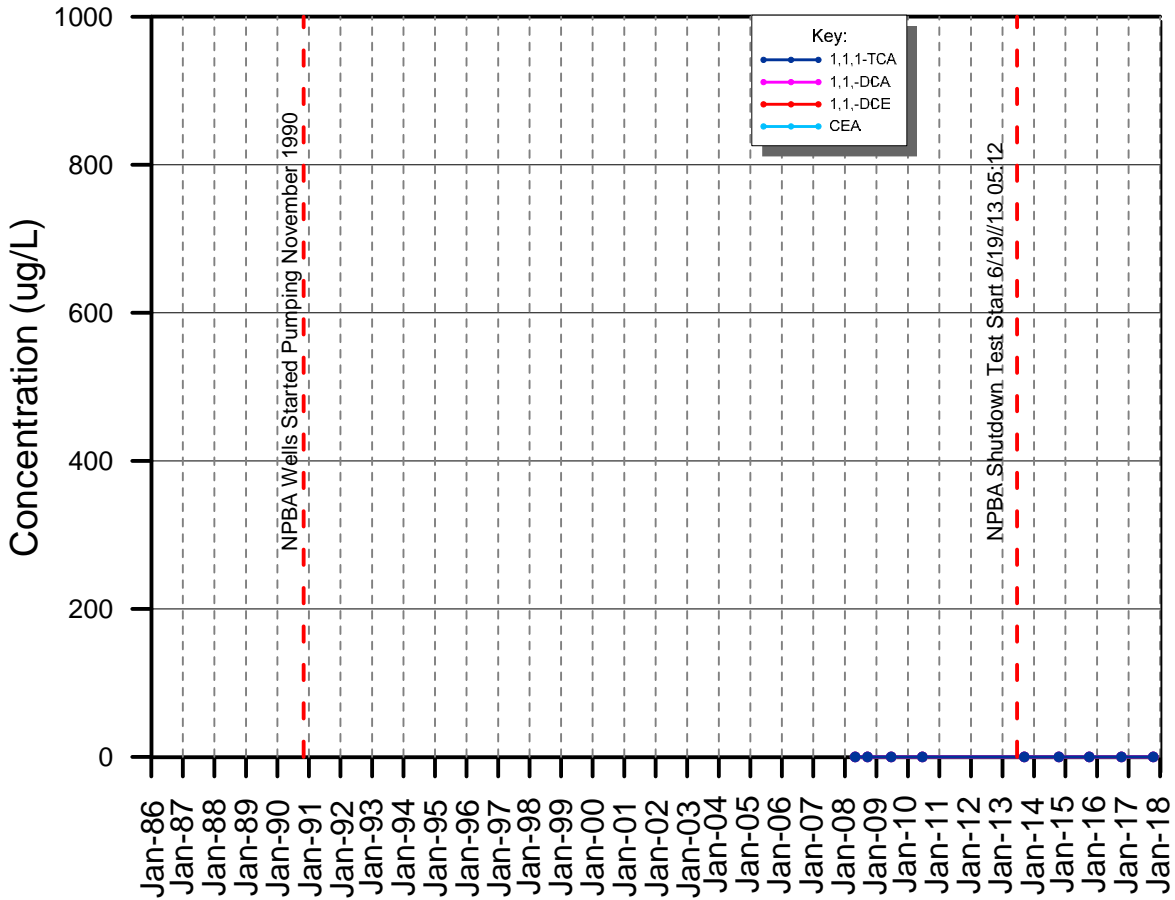
MW-102S



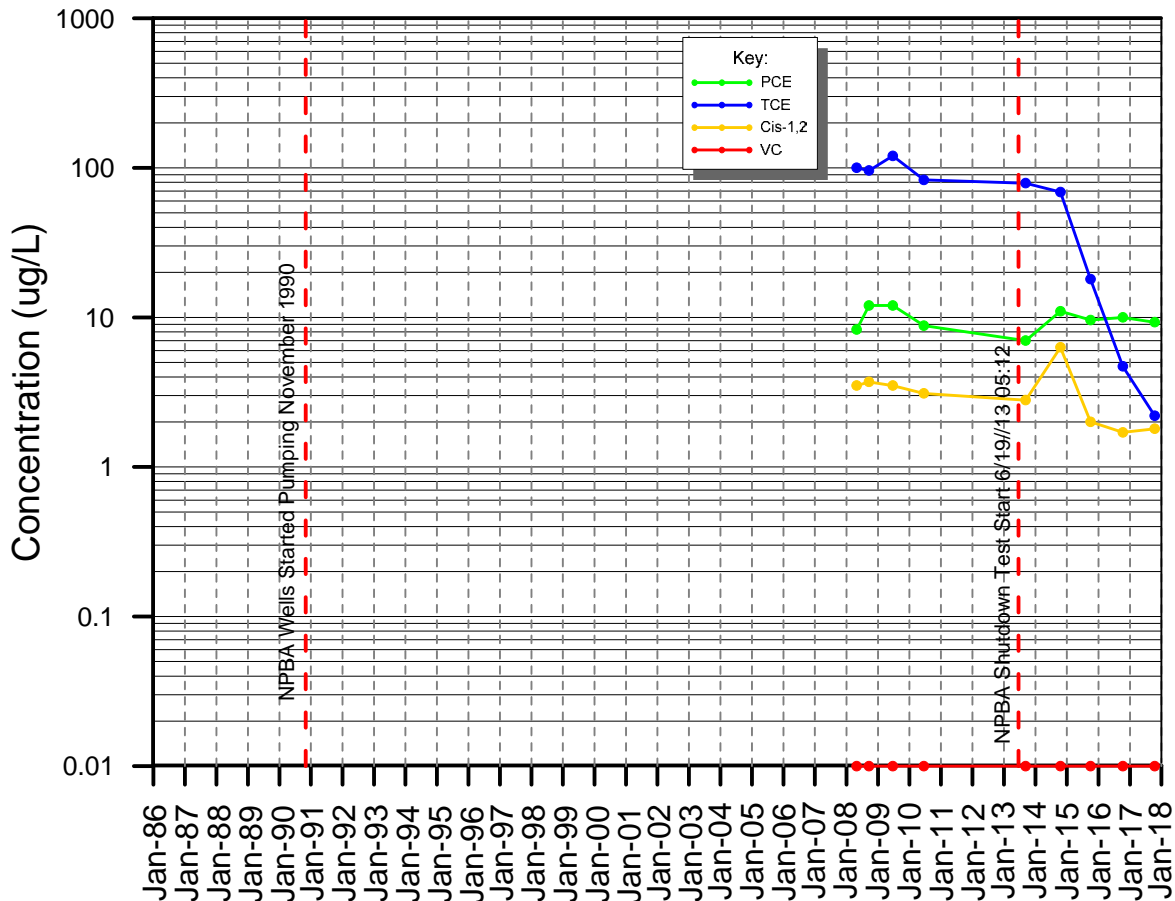
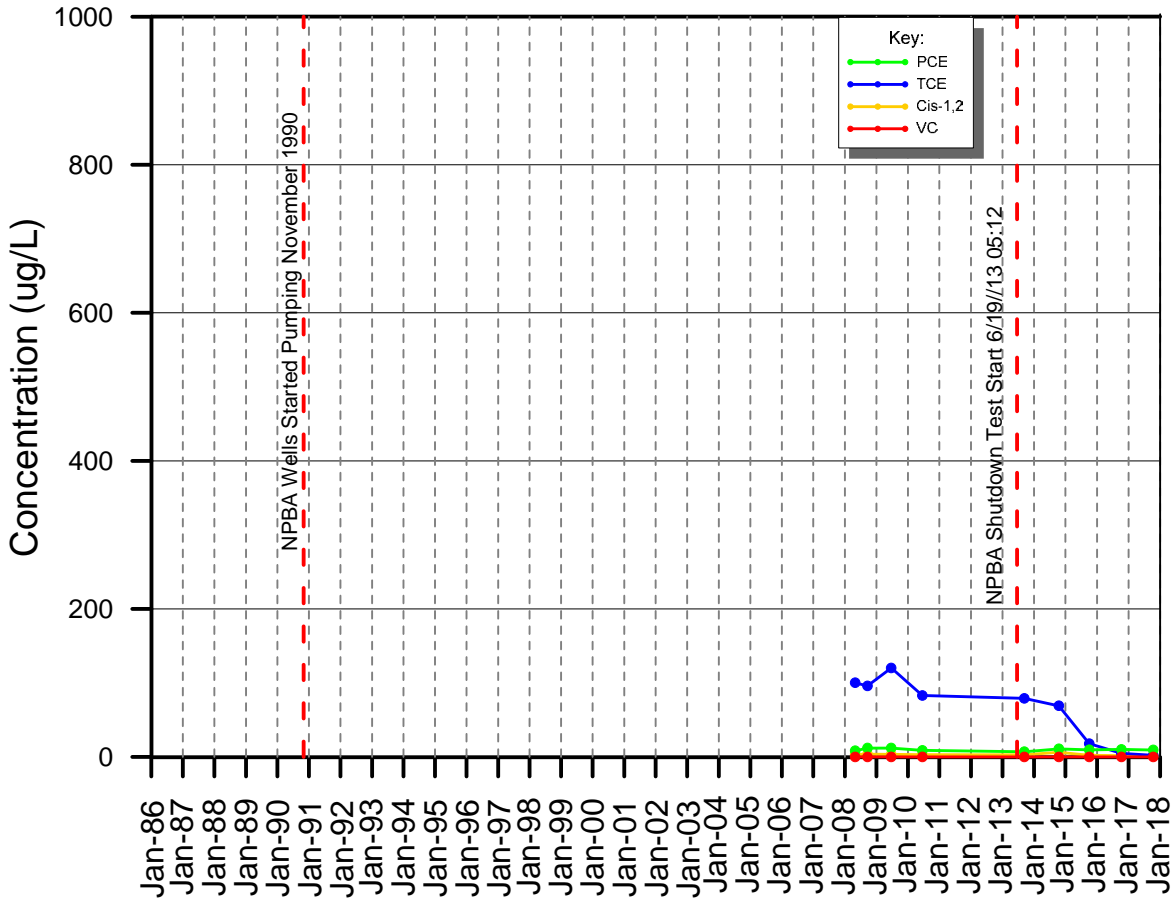
MW-102S



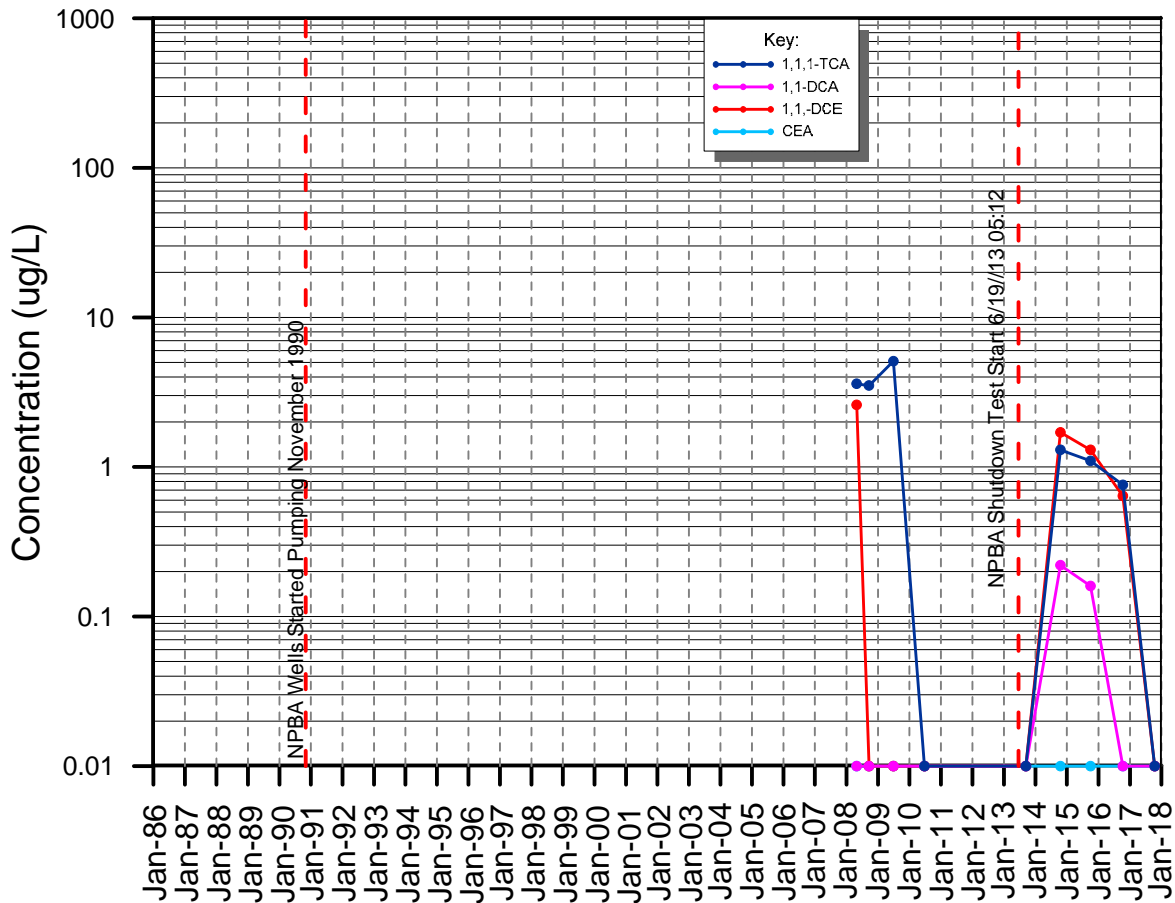
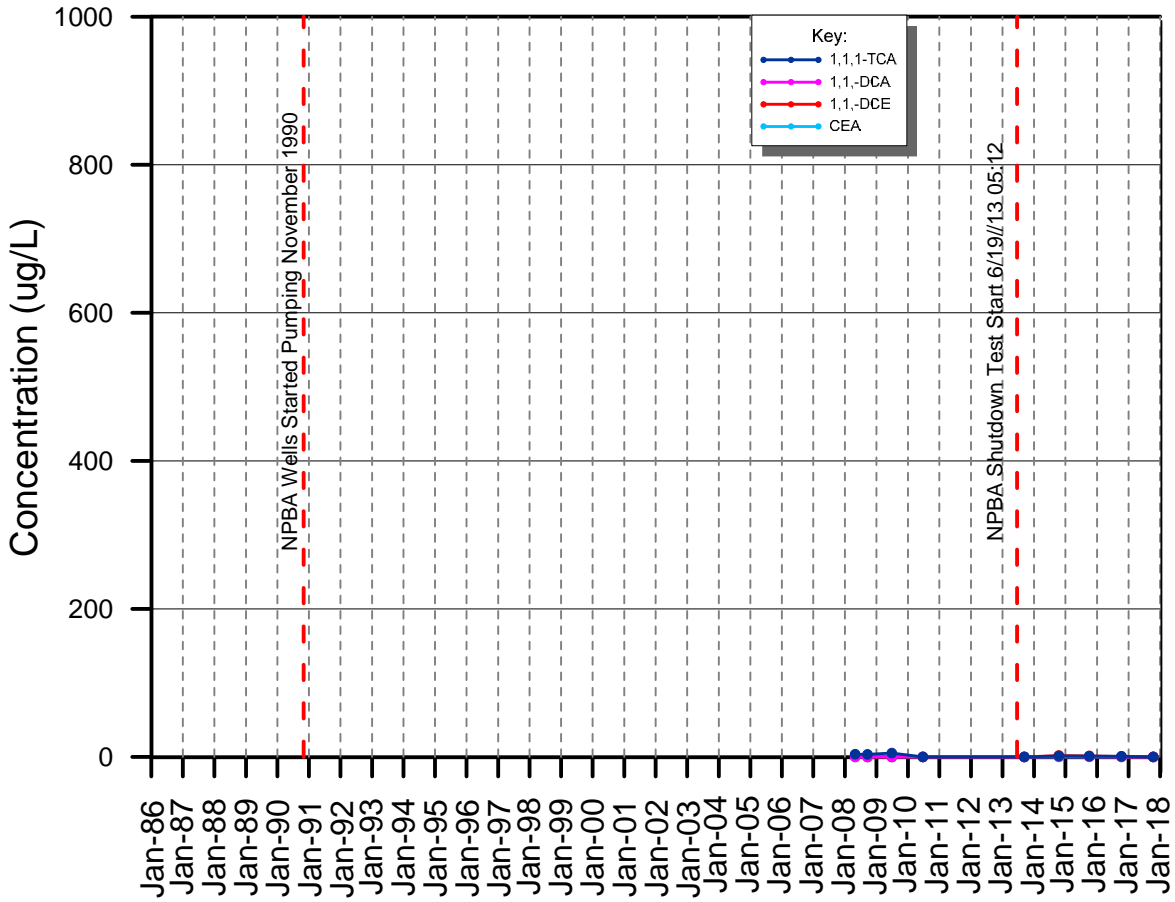
MW-103D



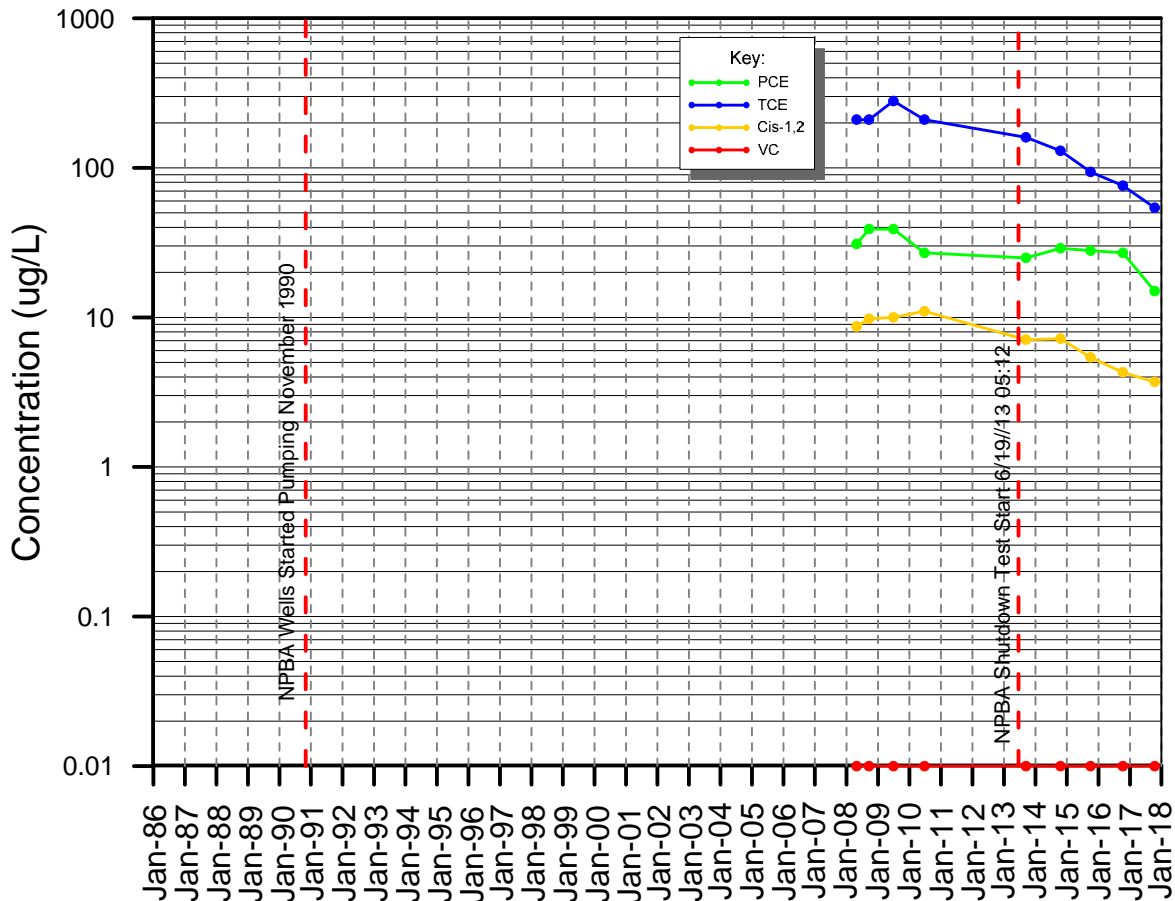
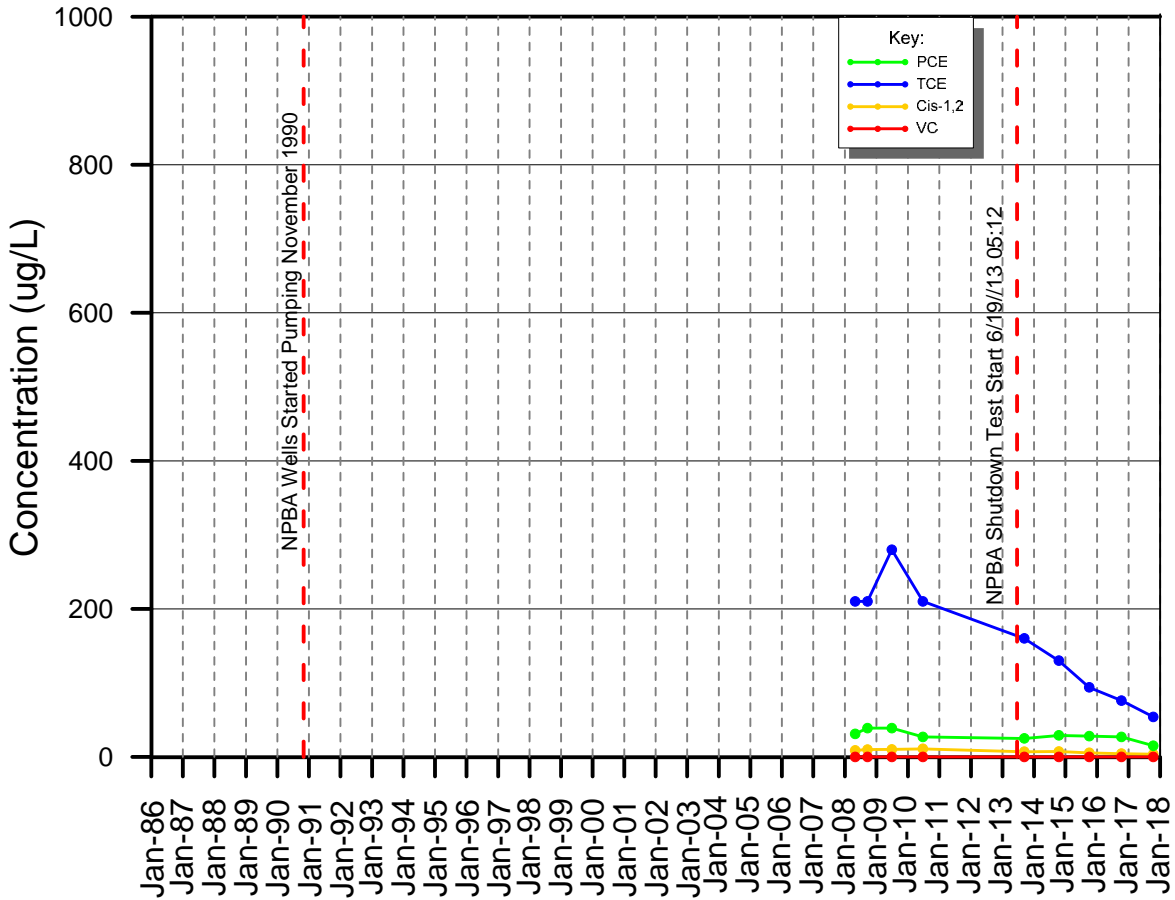
MW-103D



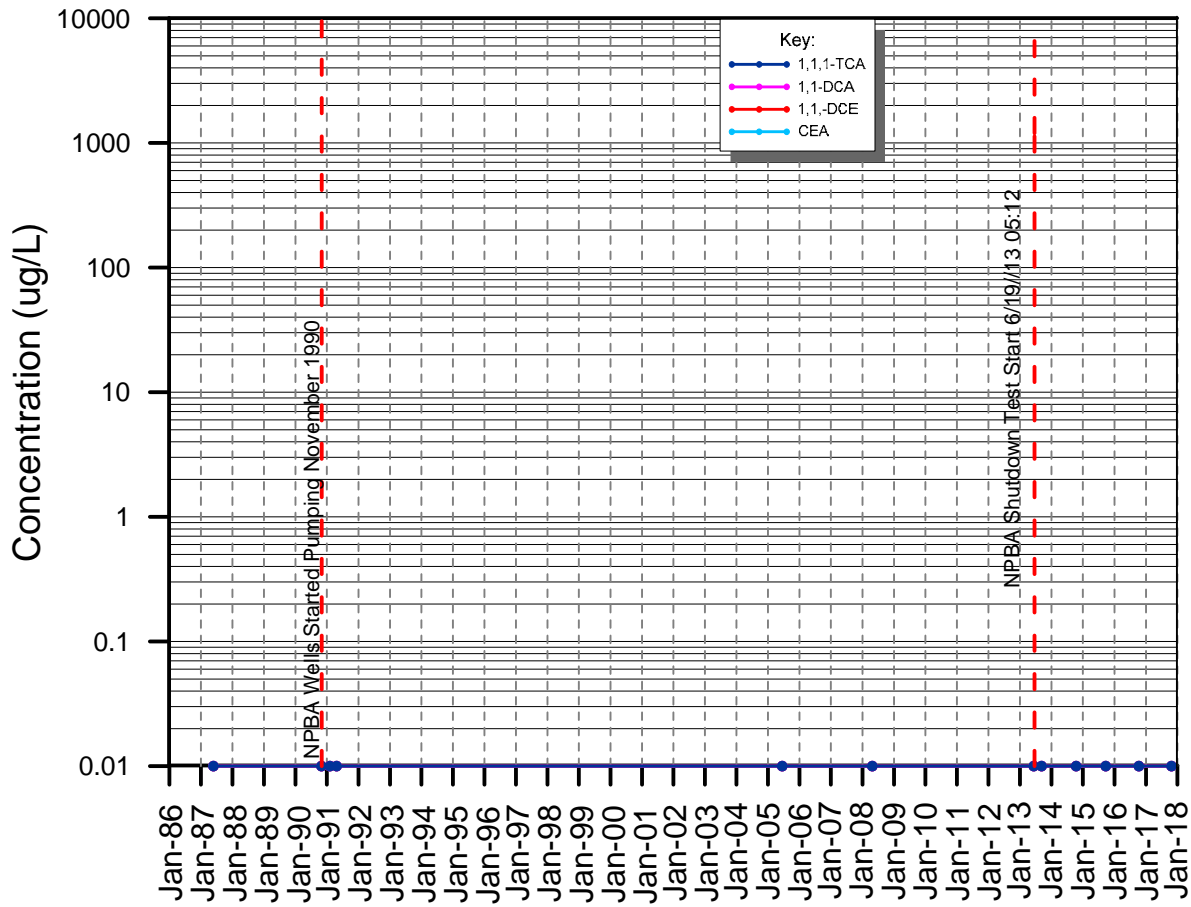
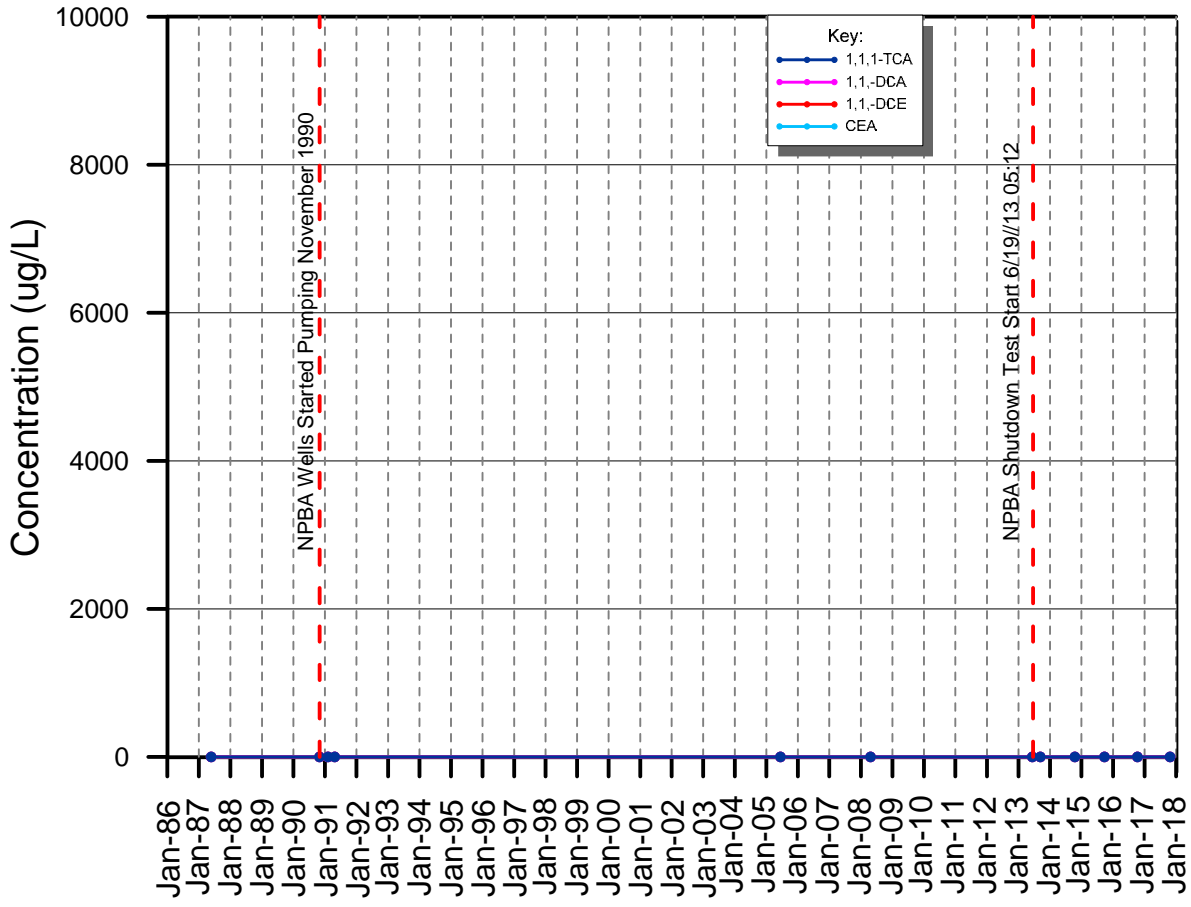
MW-103S



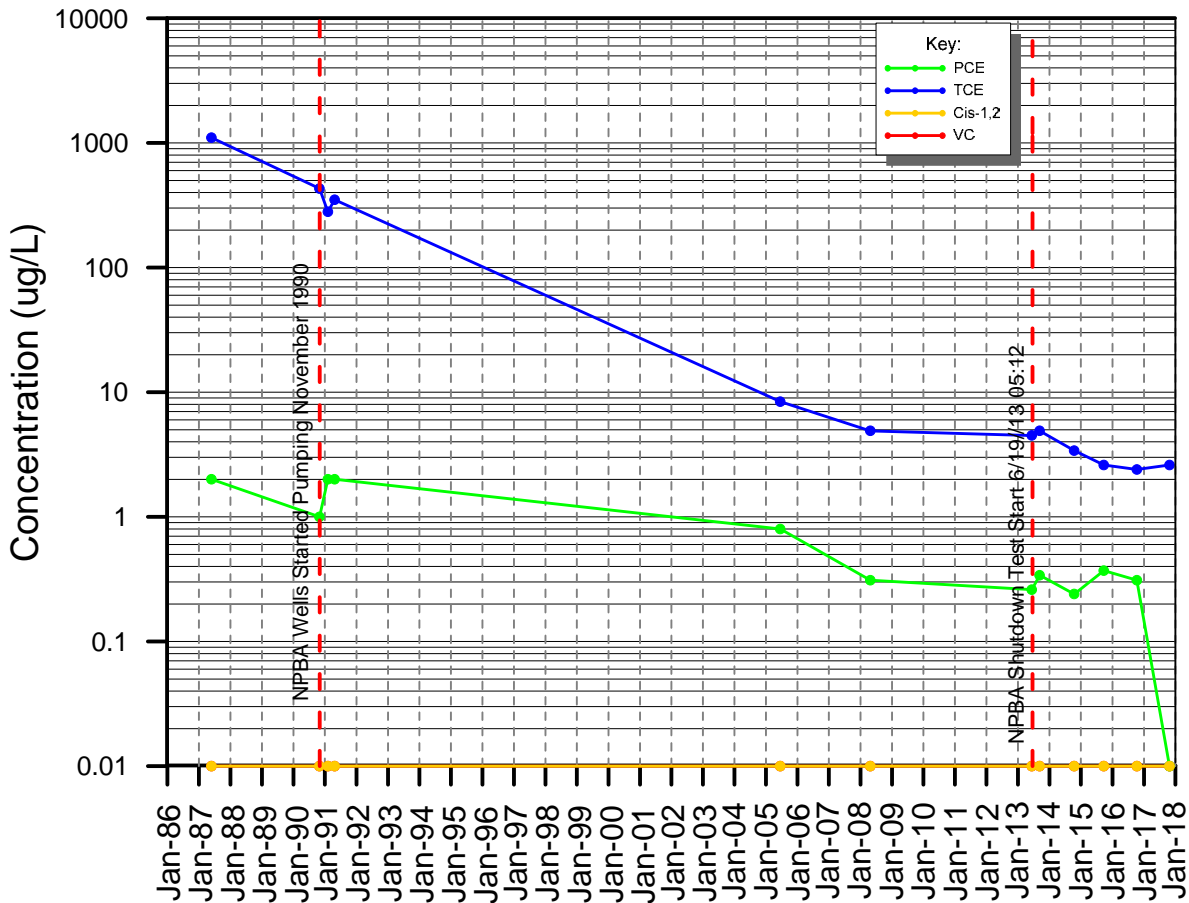
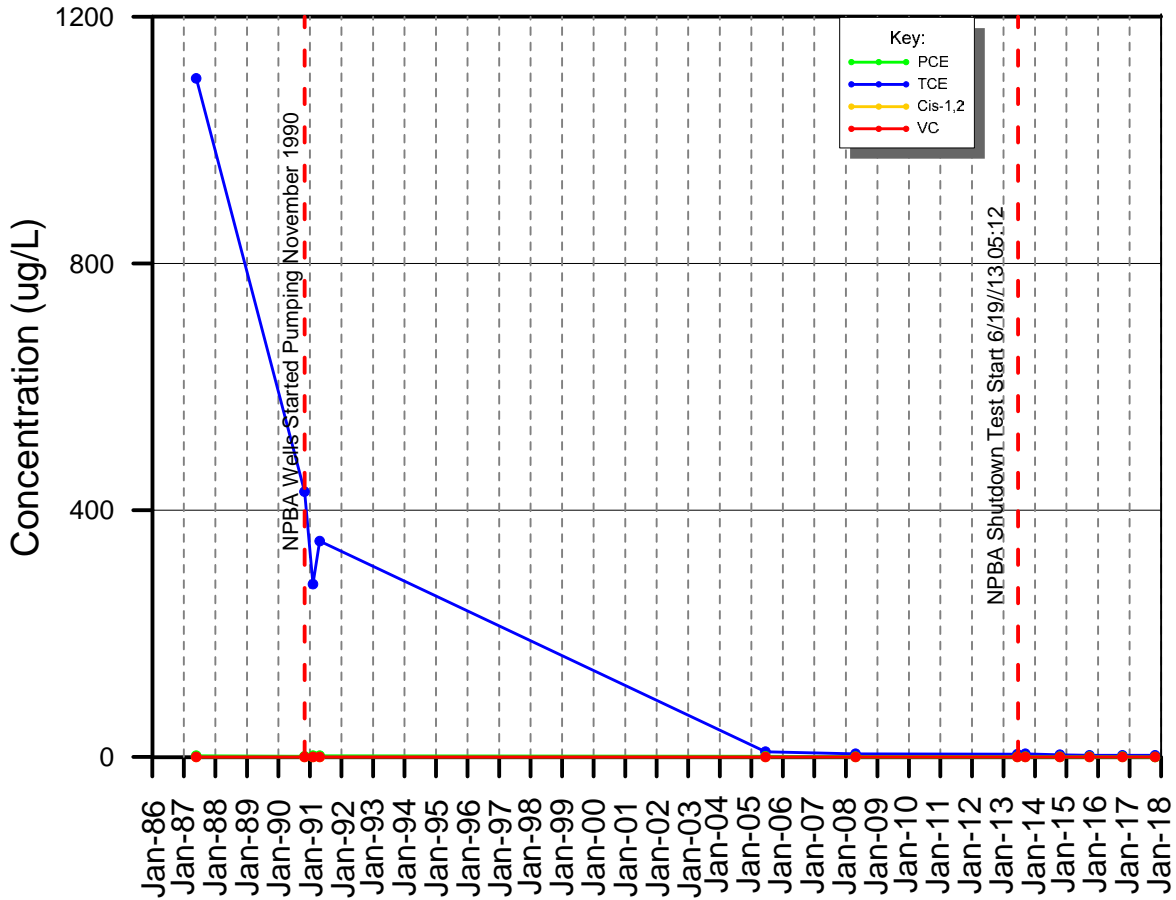
MW-103S



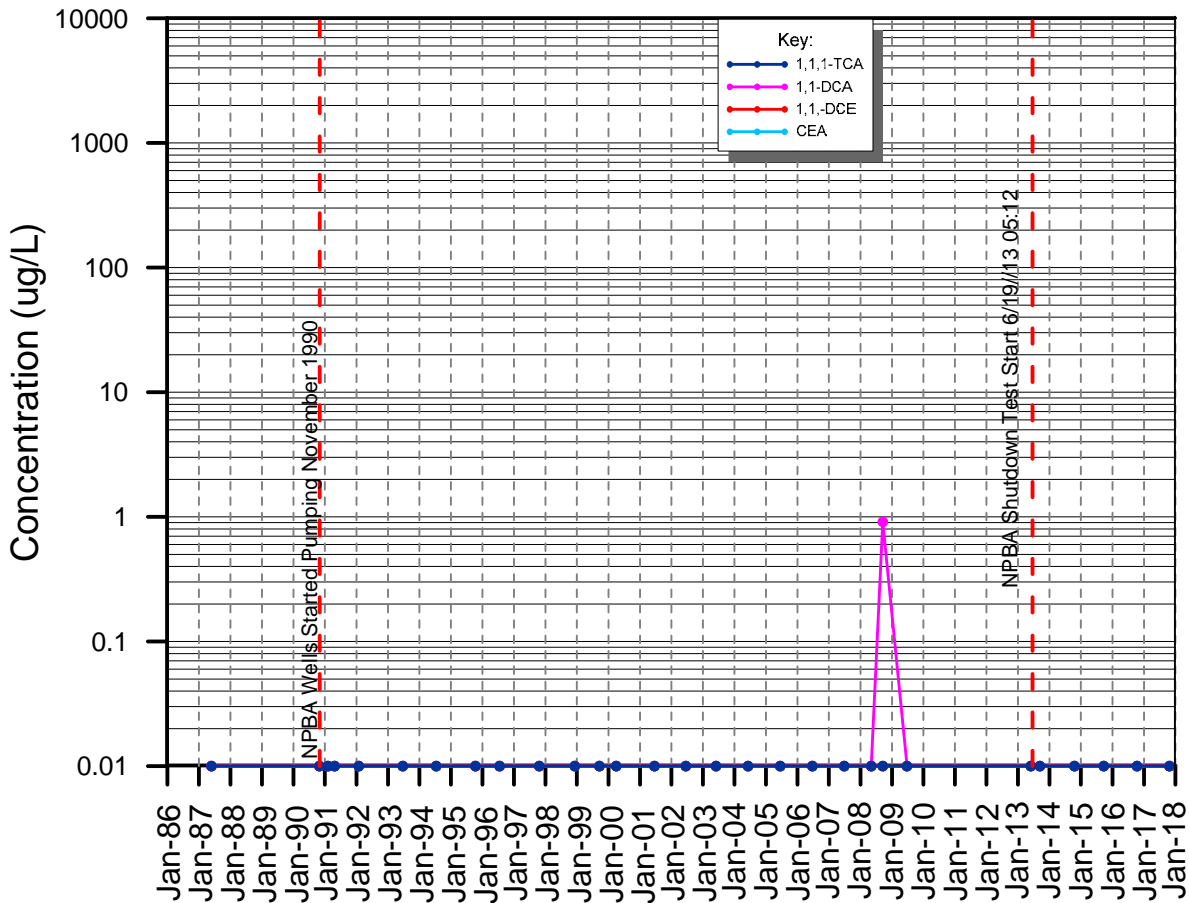
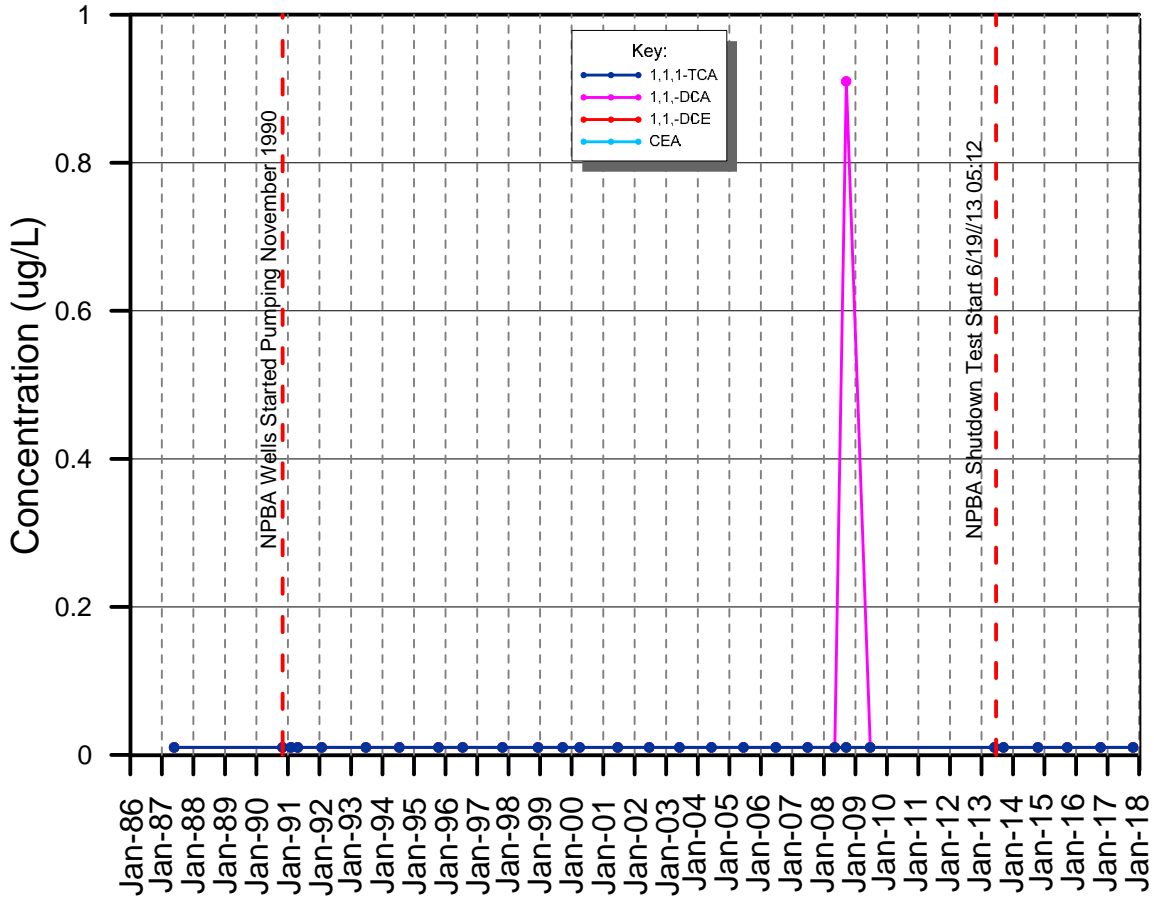
MW-11



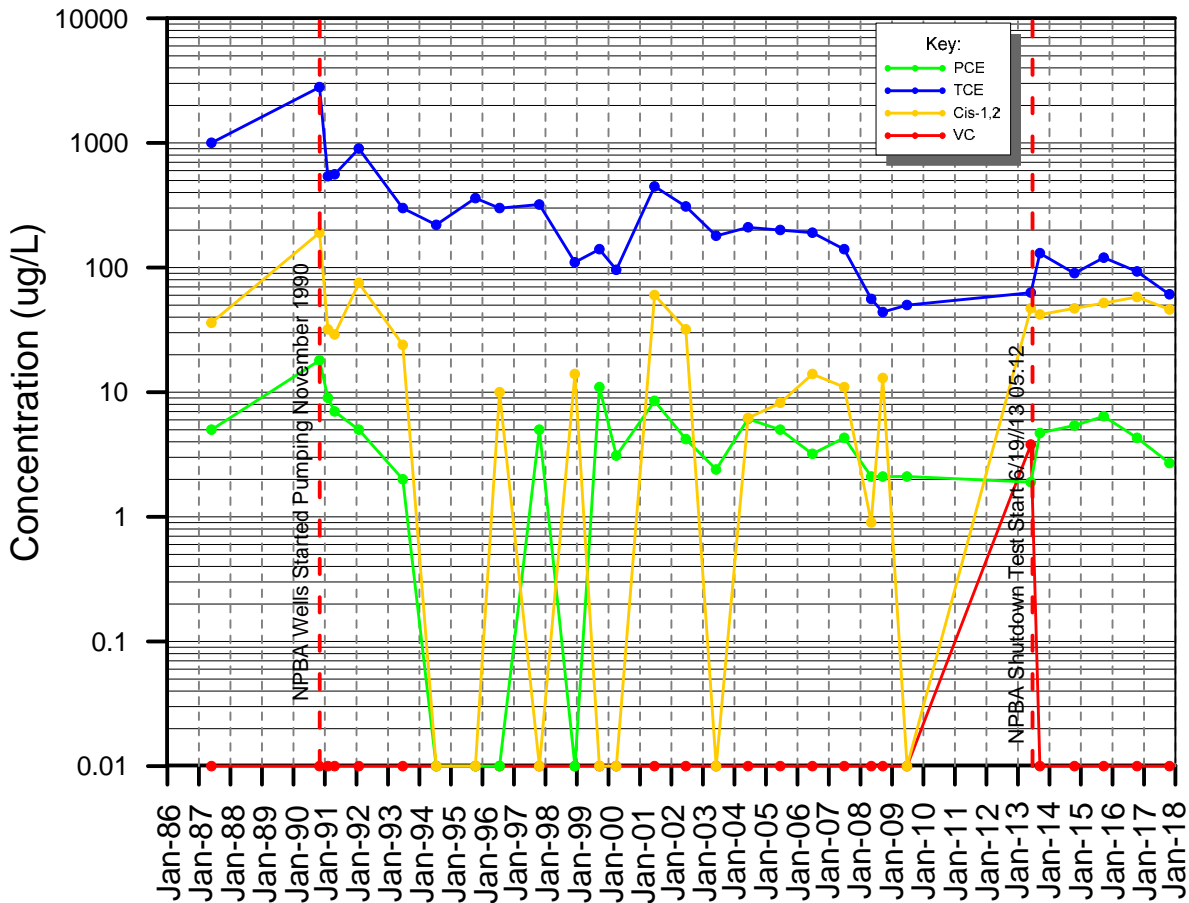
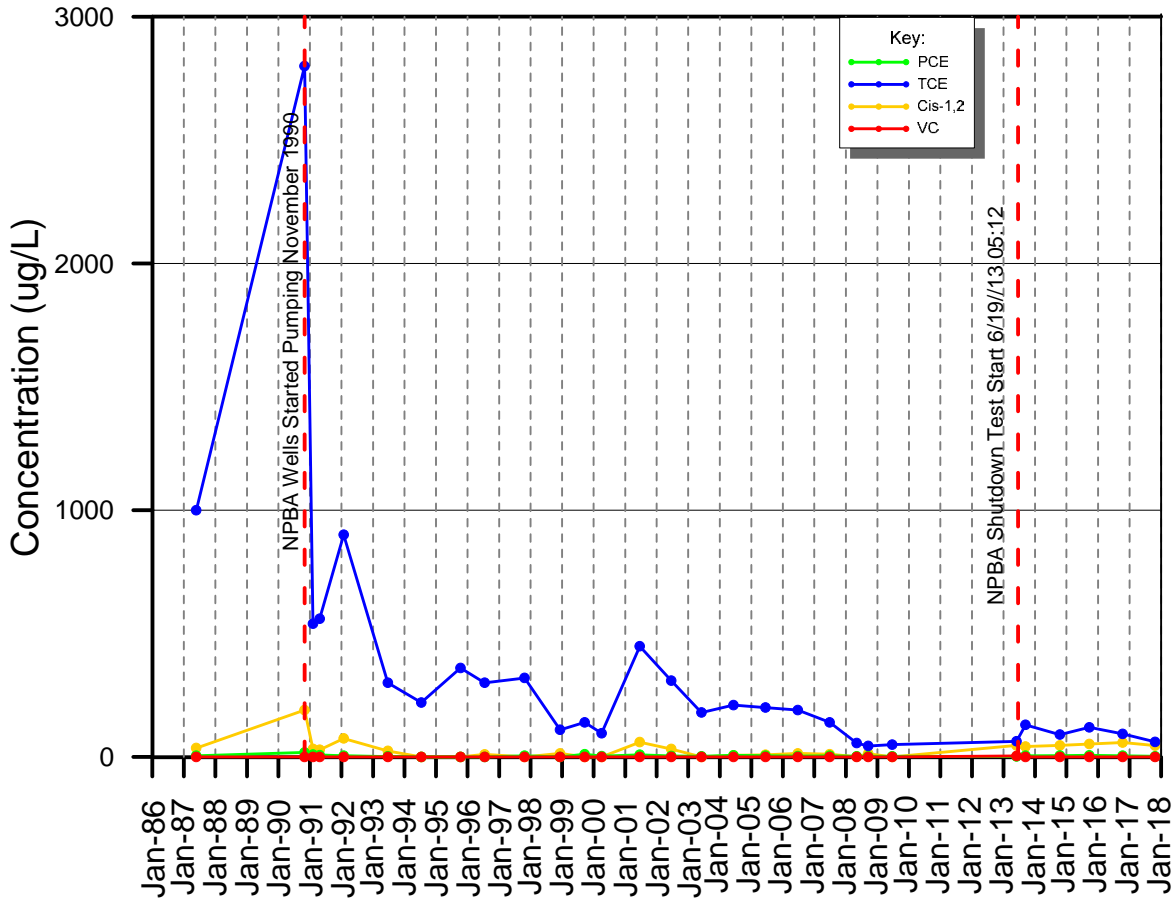
MW-11



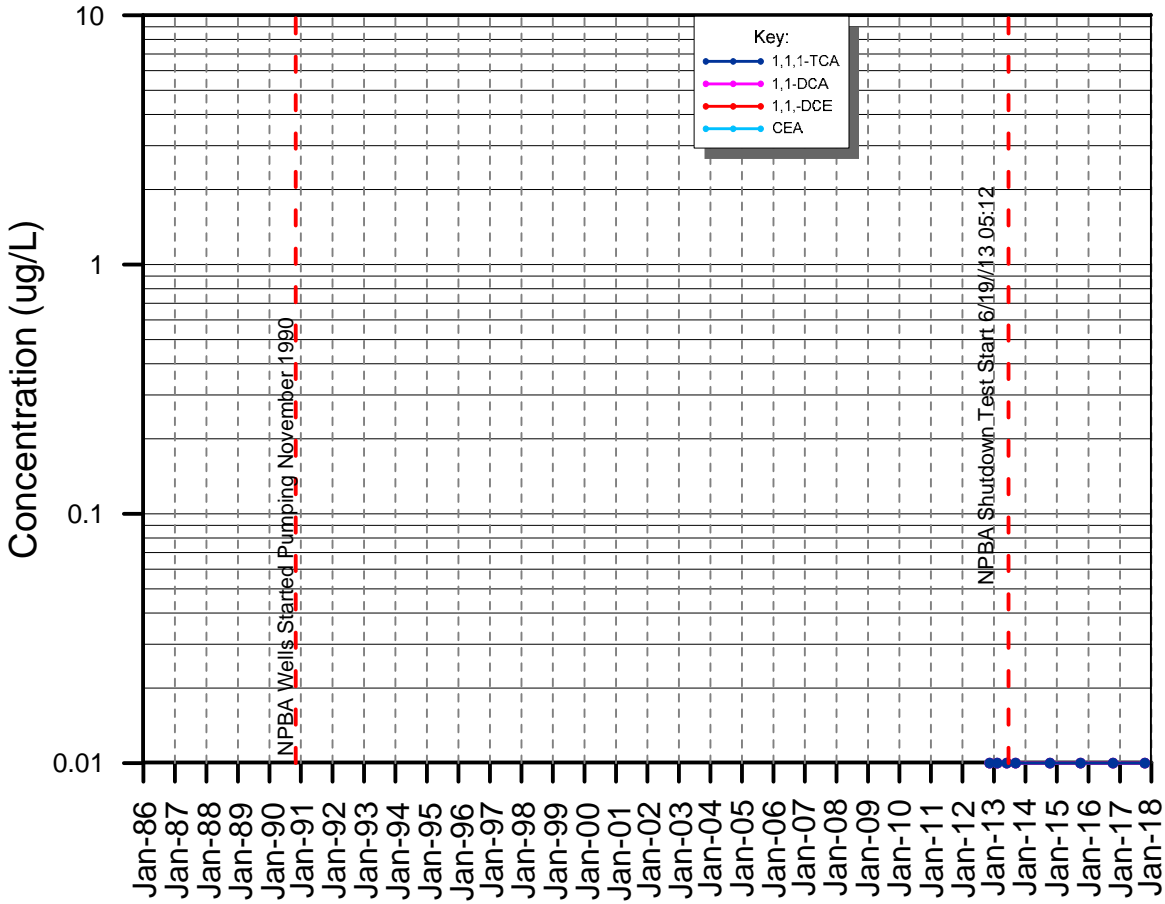
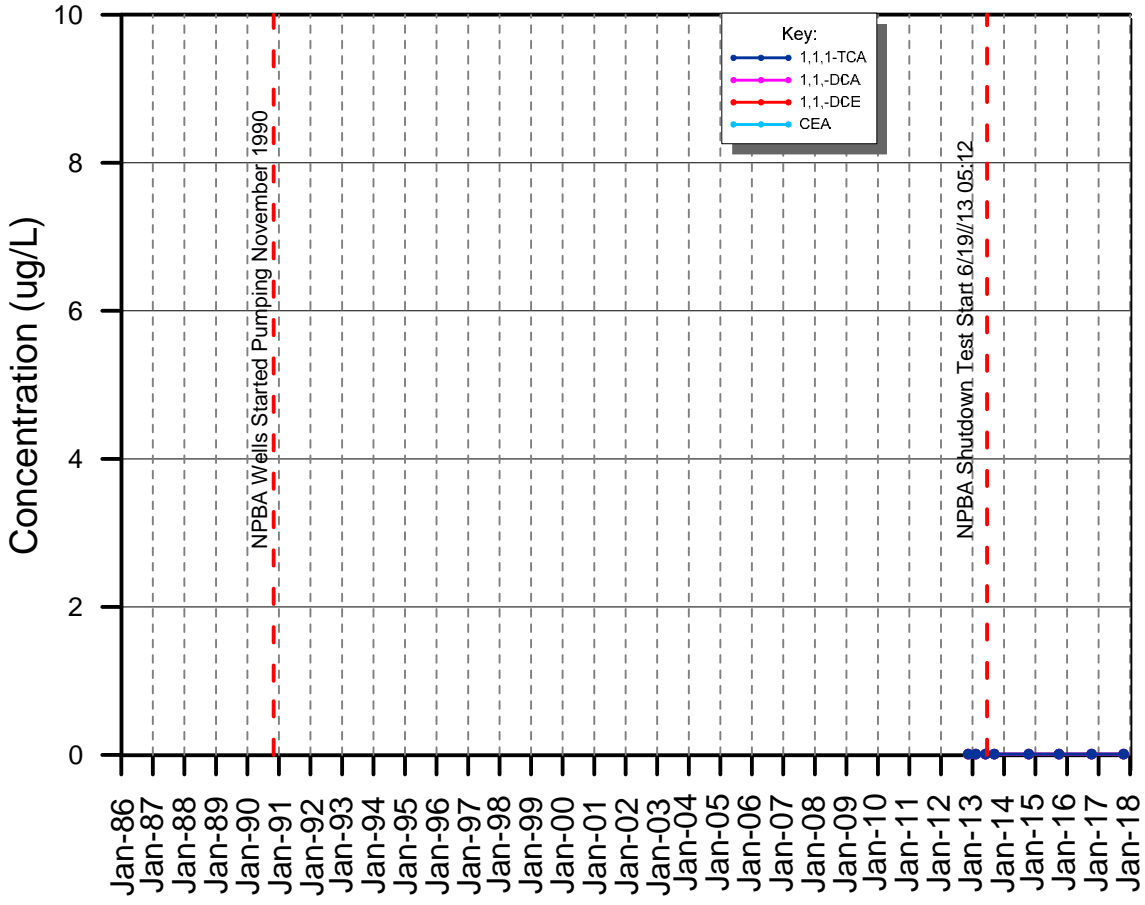
MW-12



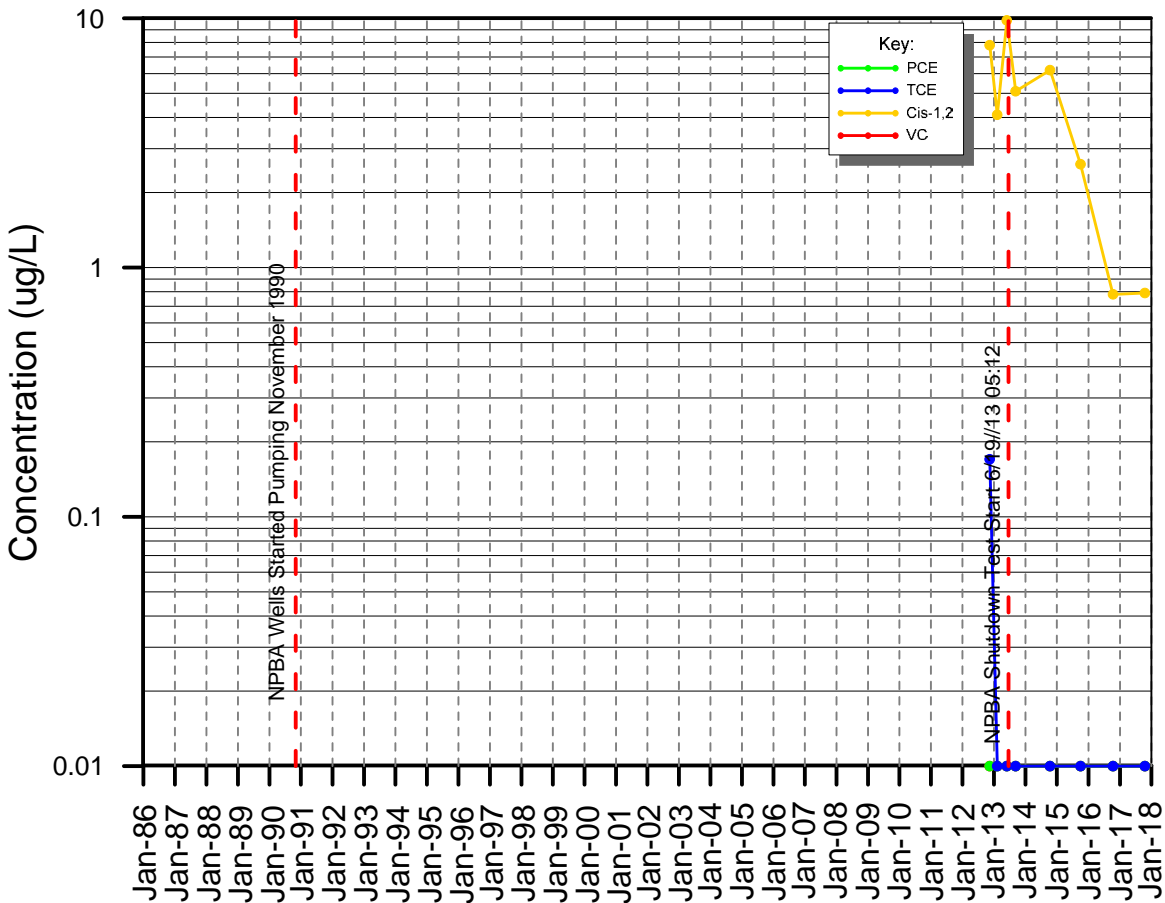
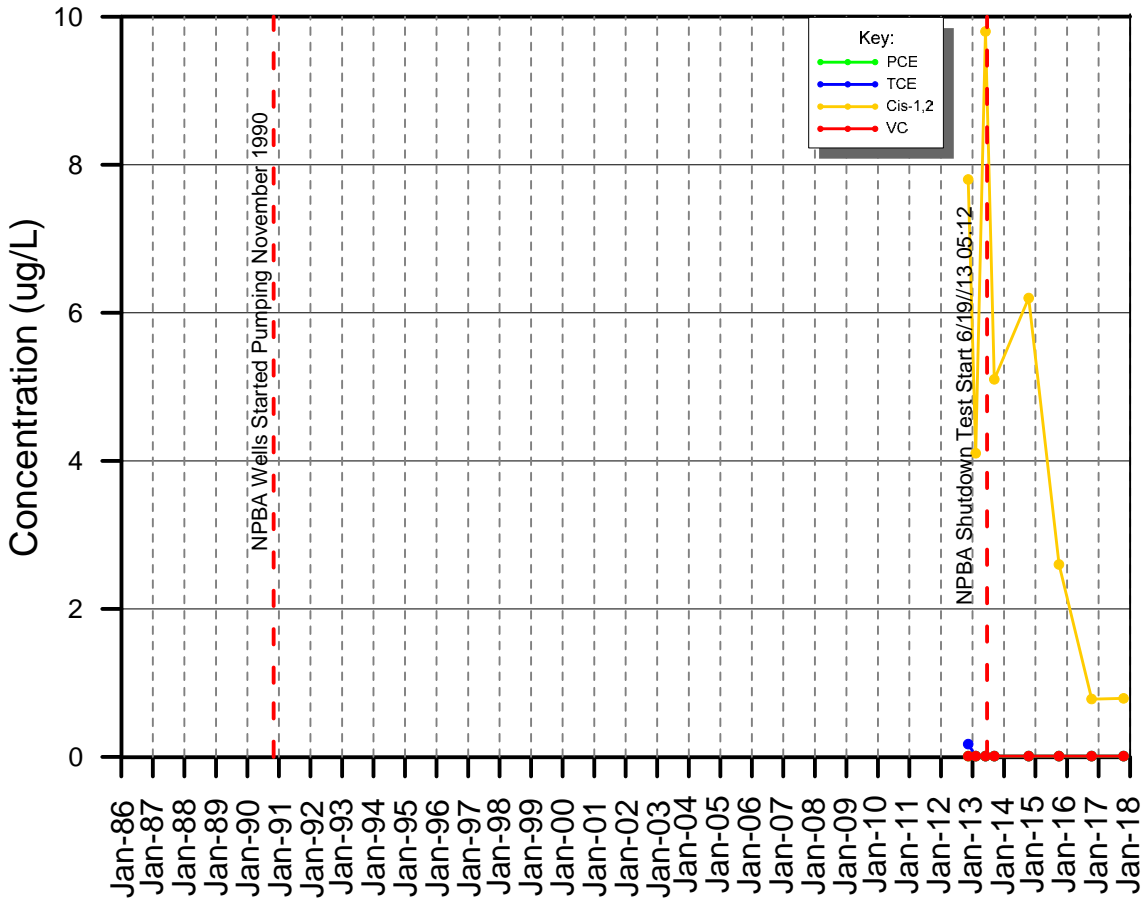
MW-12



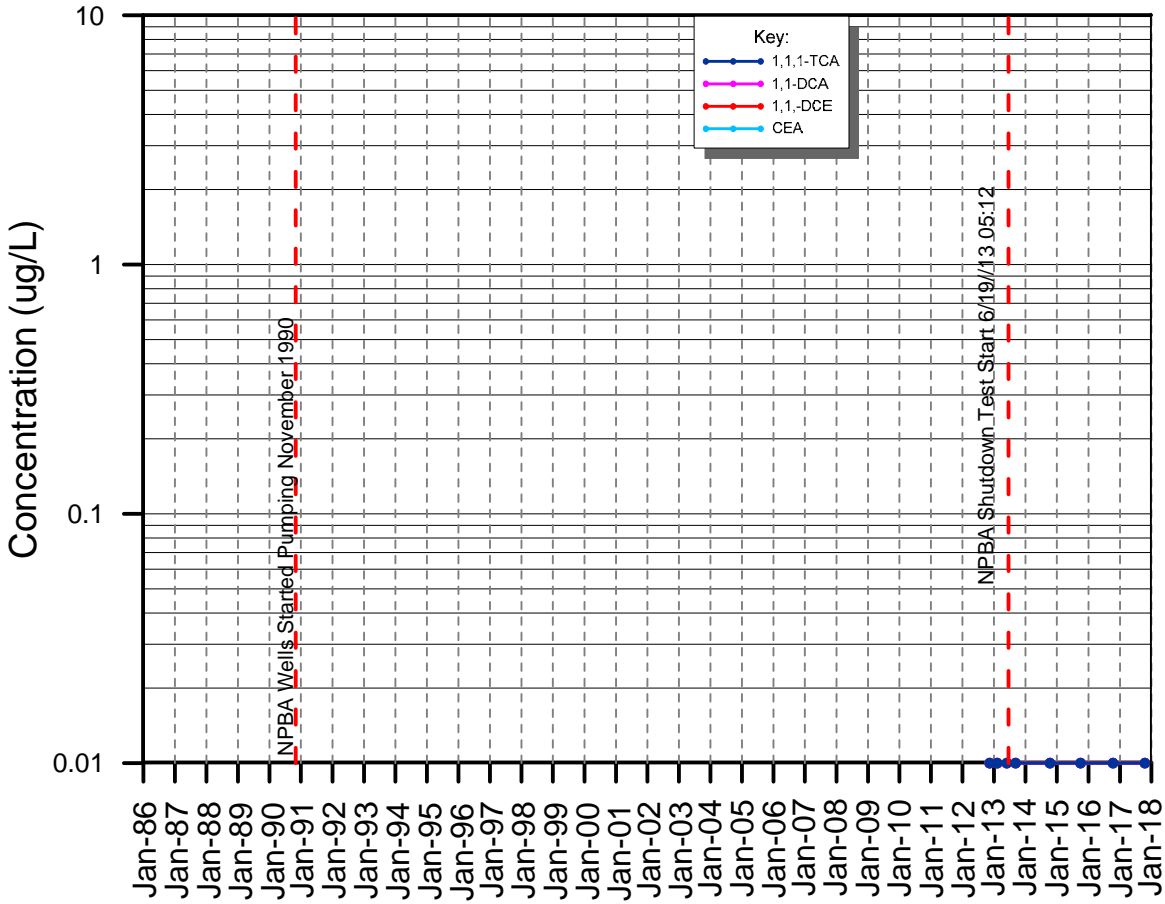
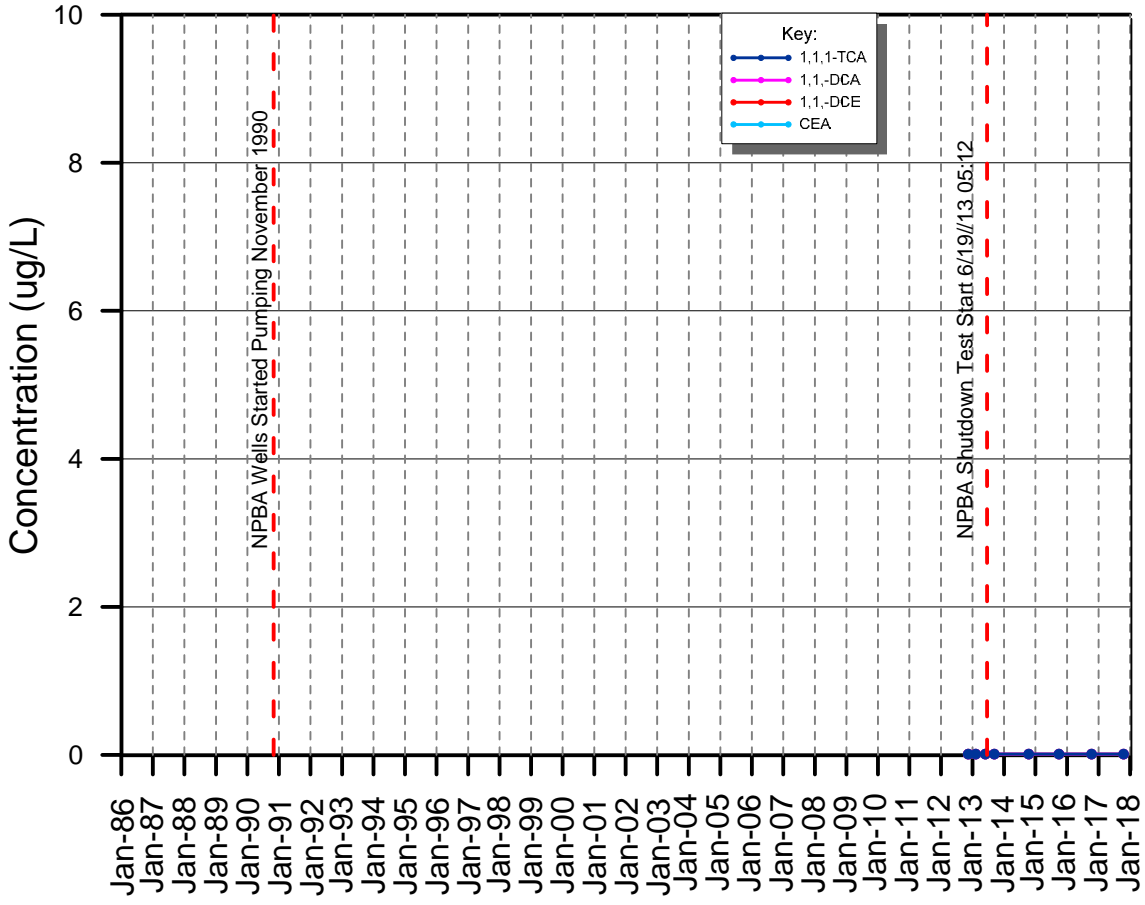
MW-142D



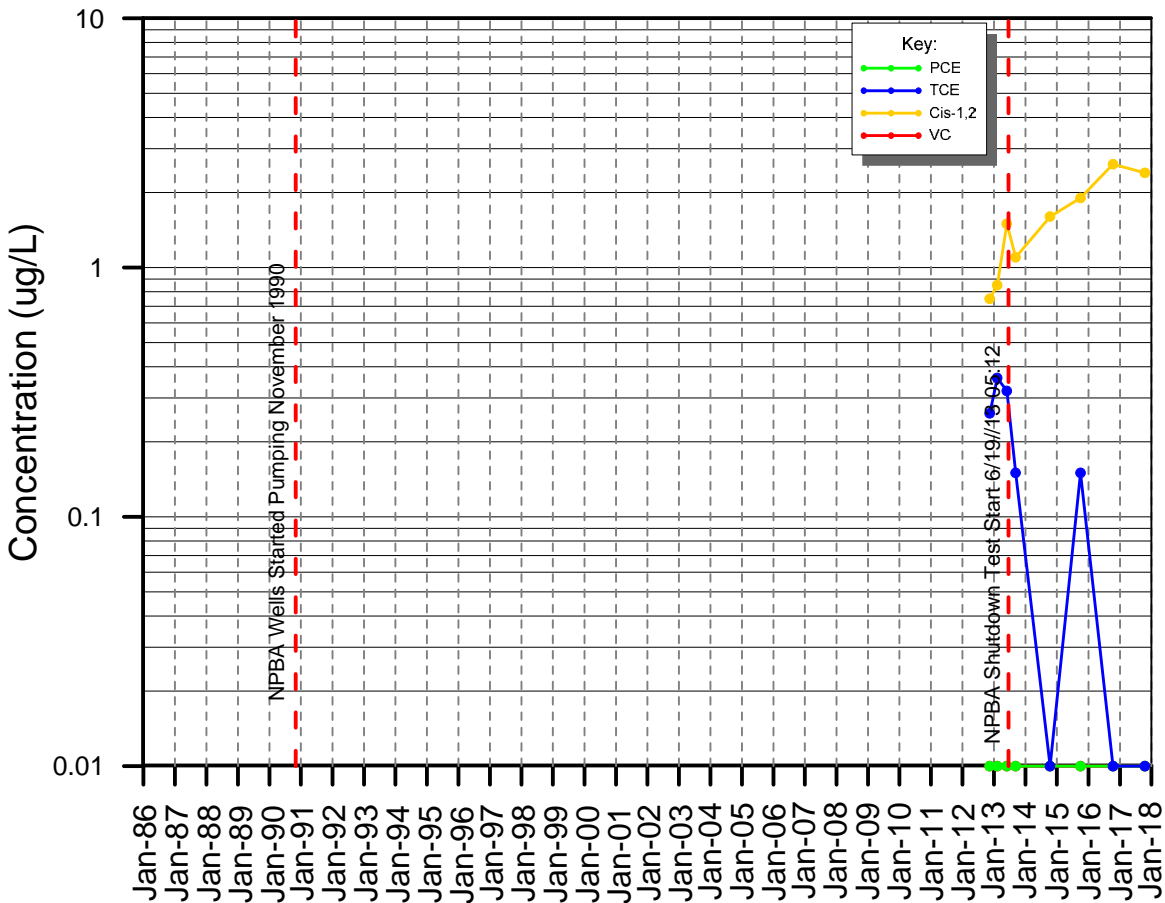
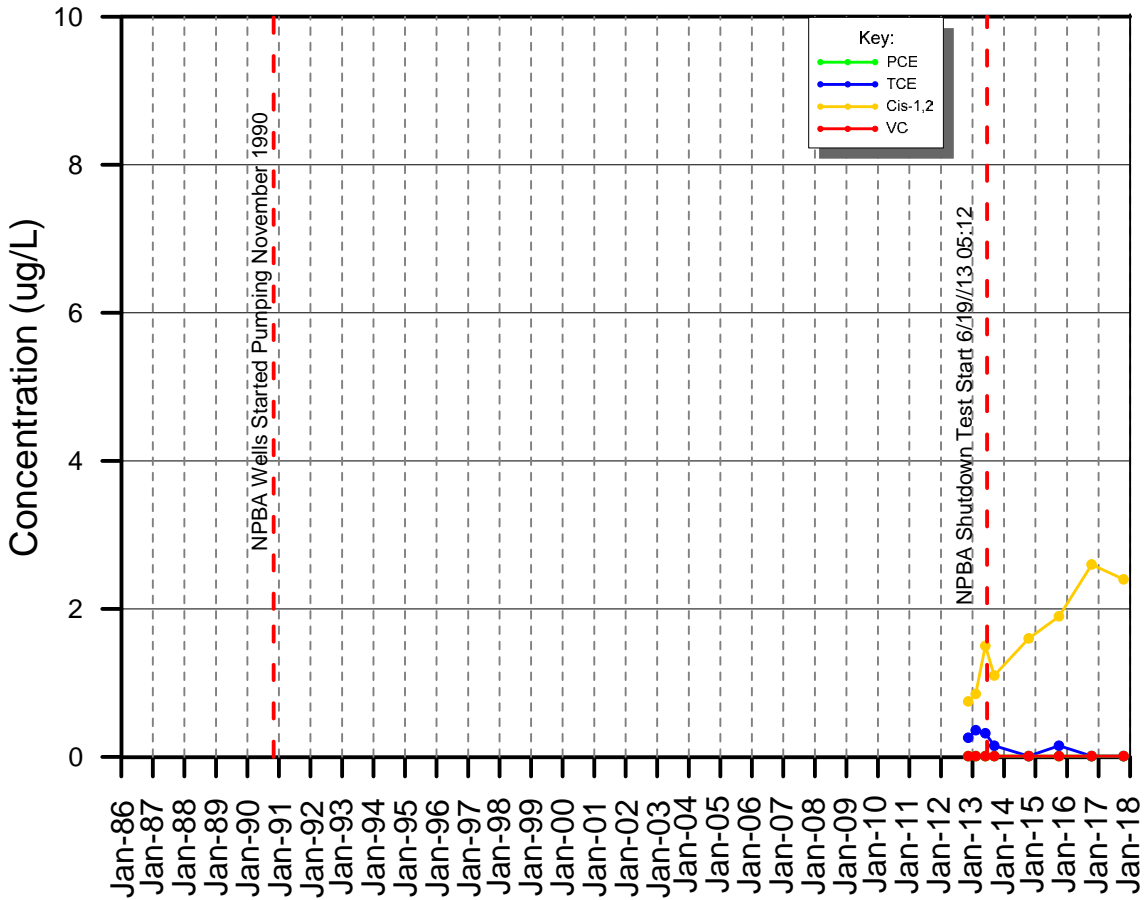
MW-142D



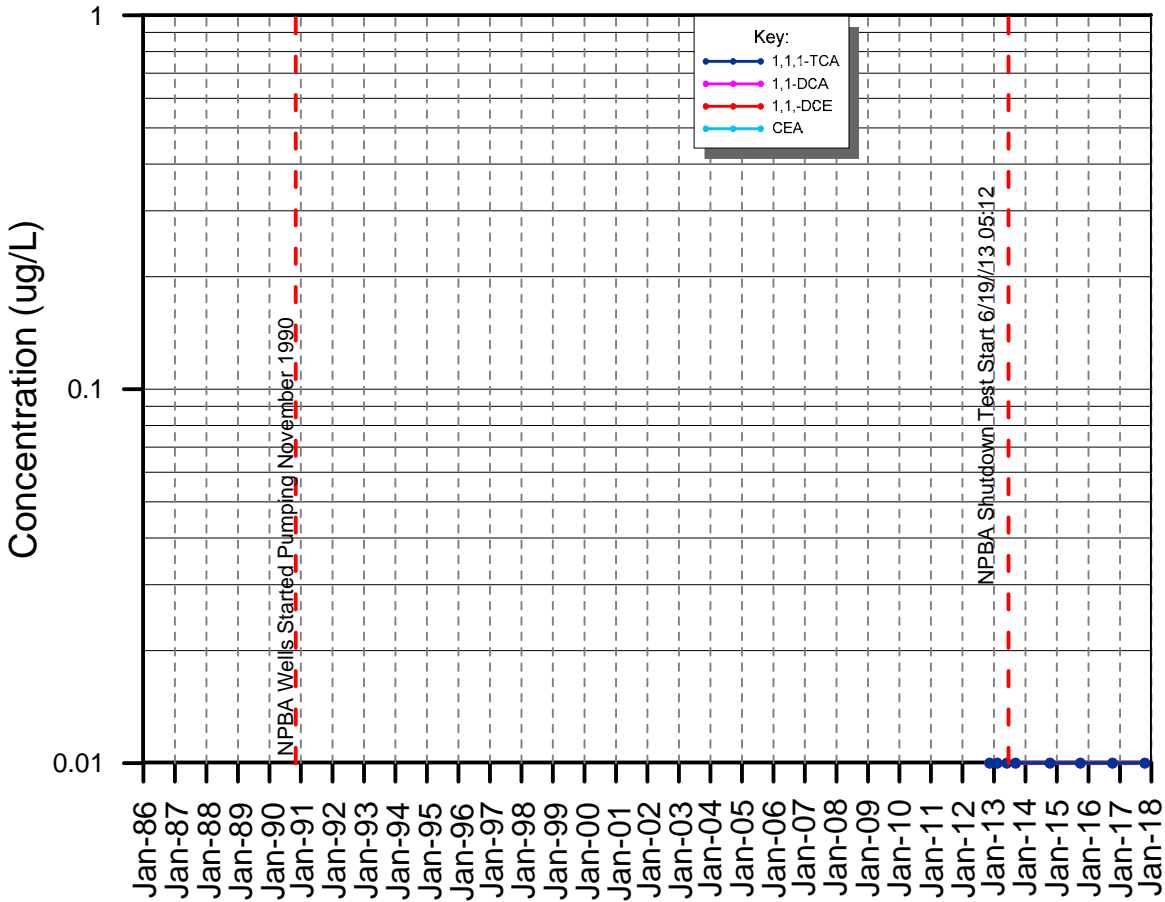
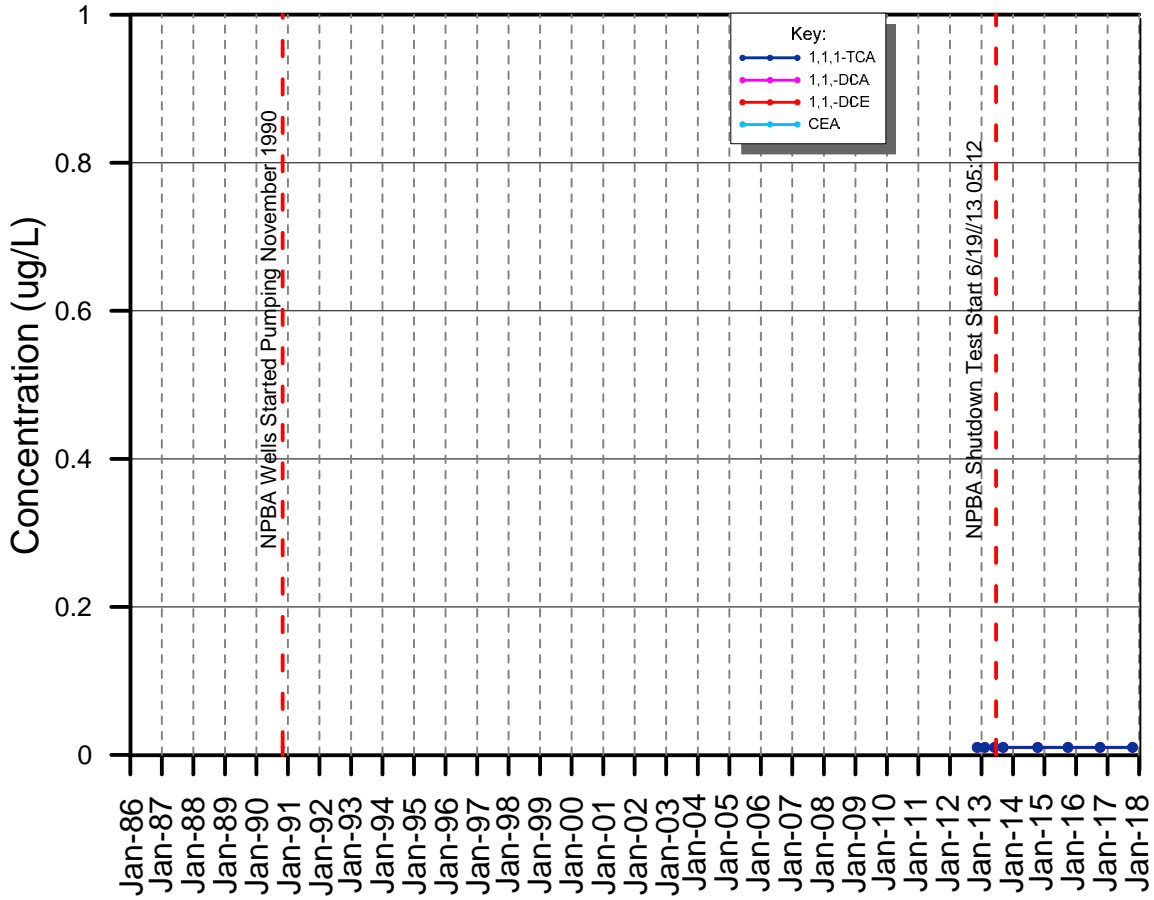
MW-142S



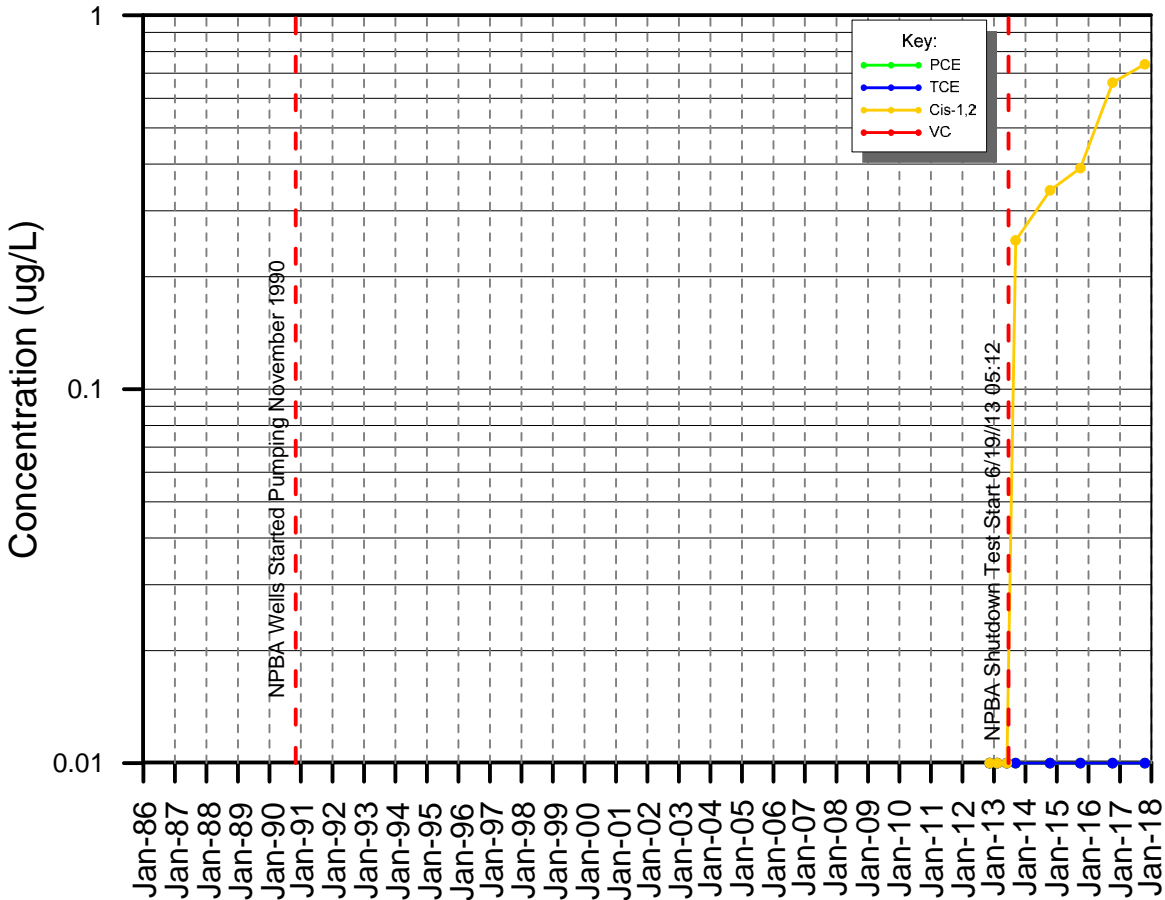
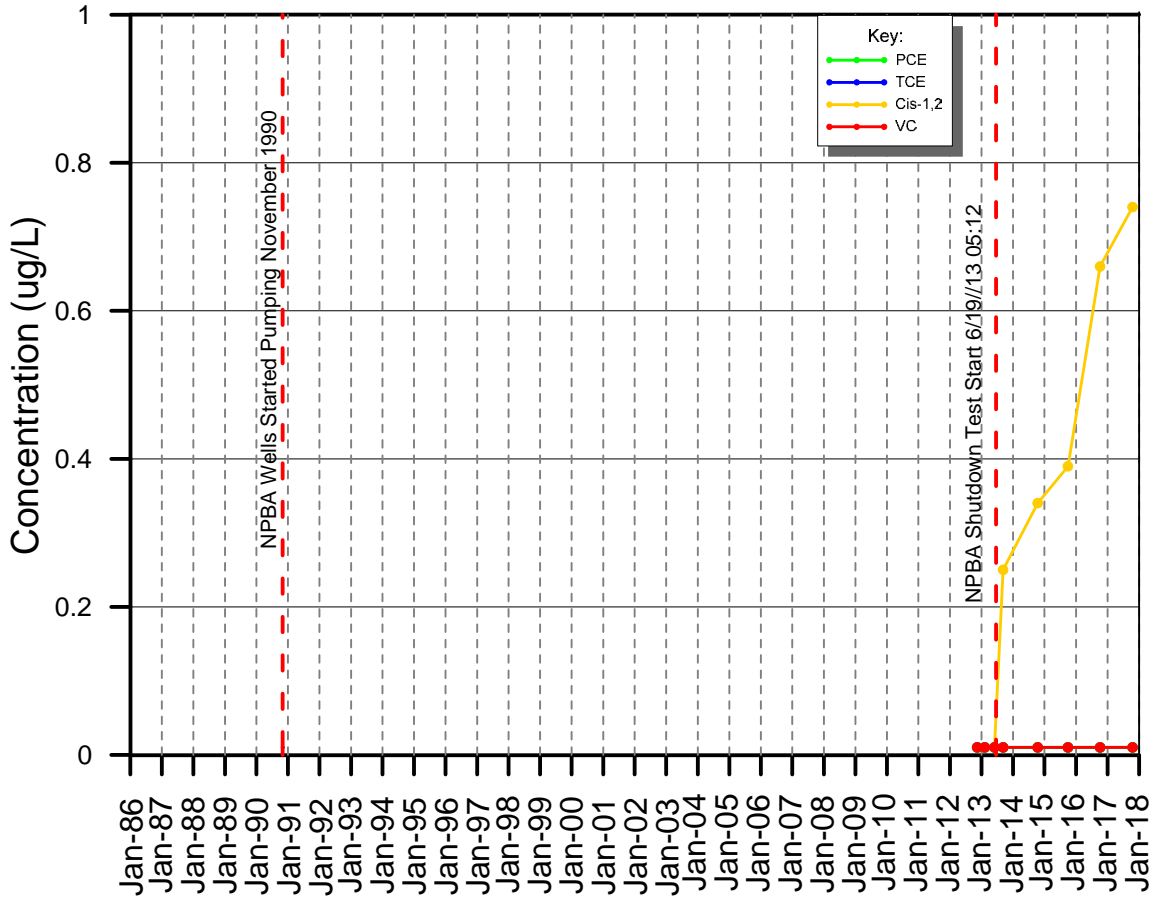
MW-142S



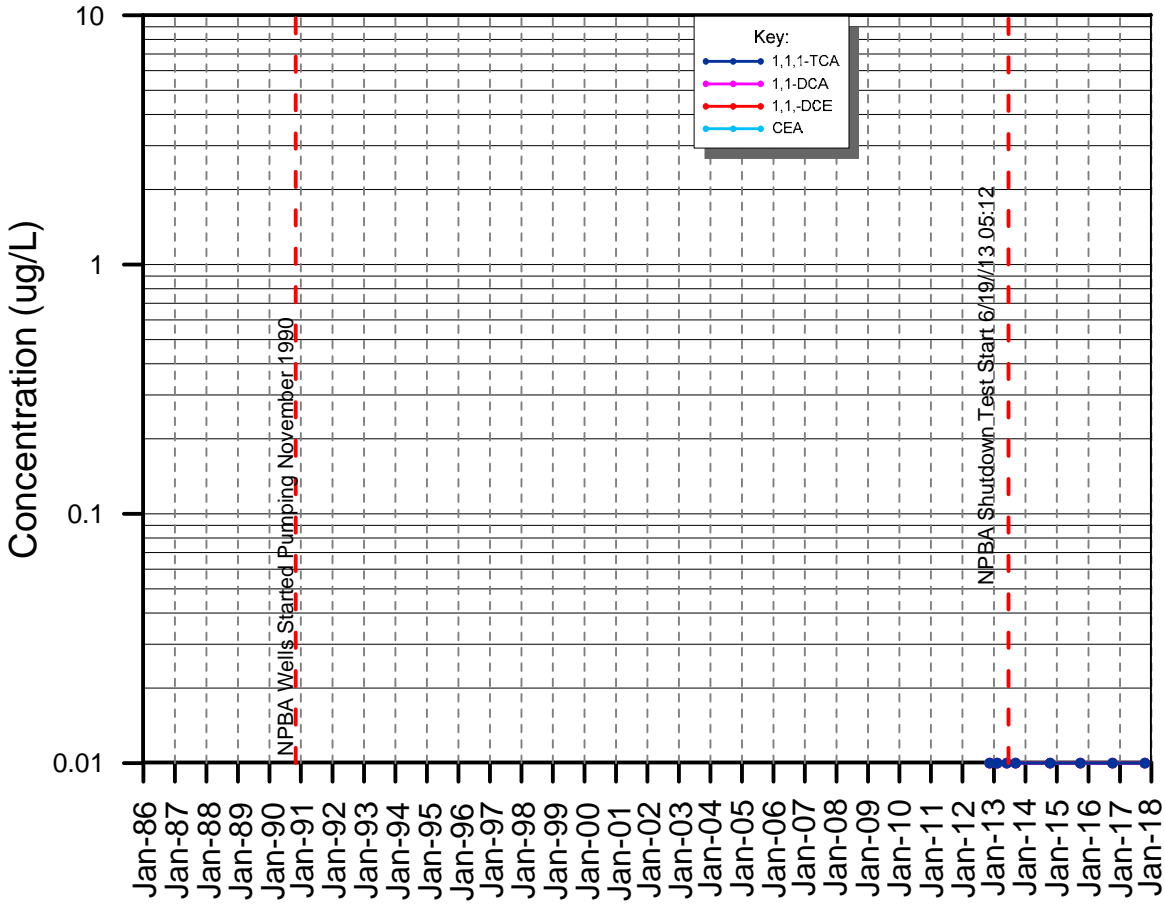
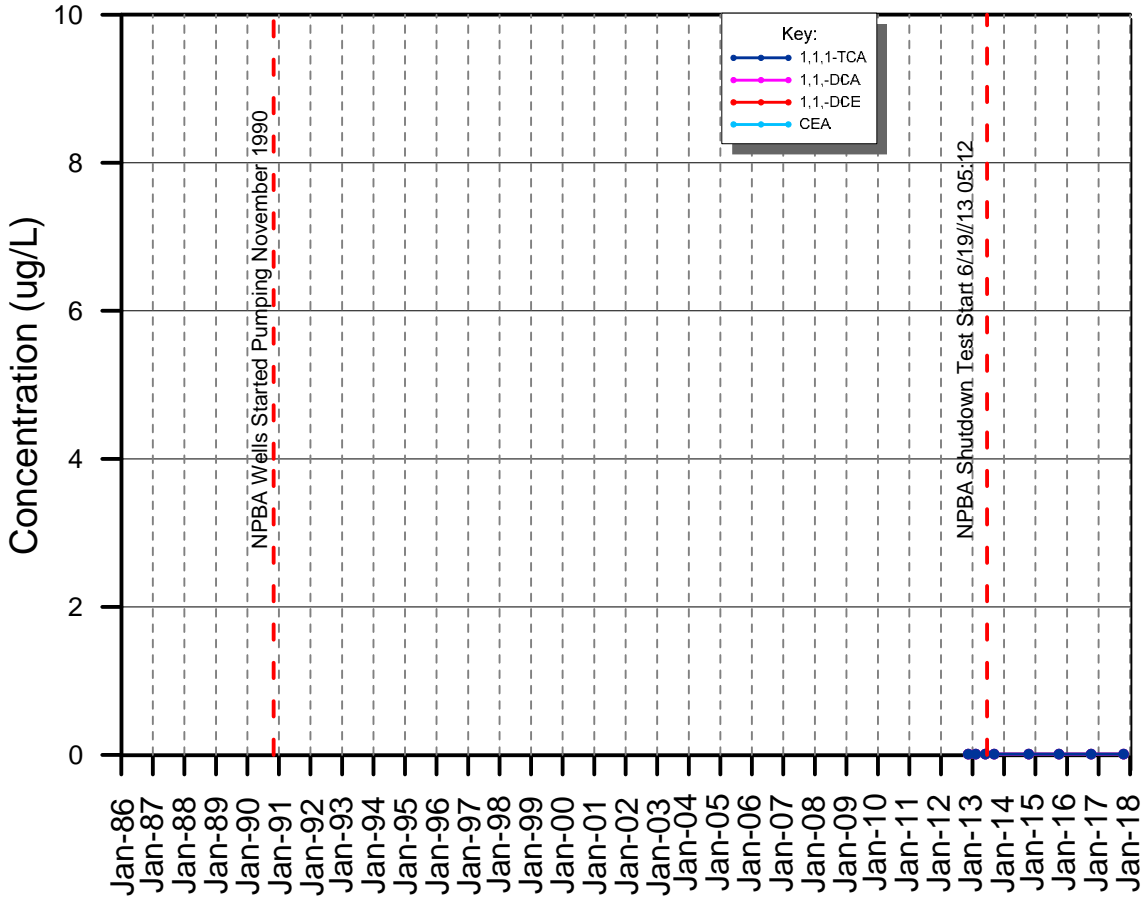
MW-143D



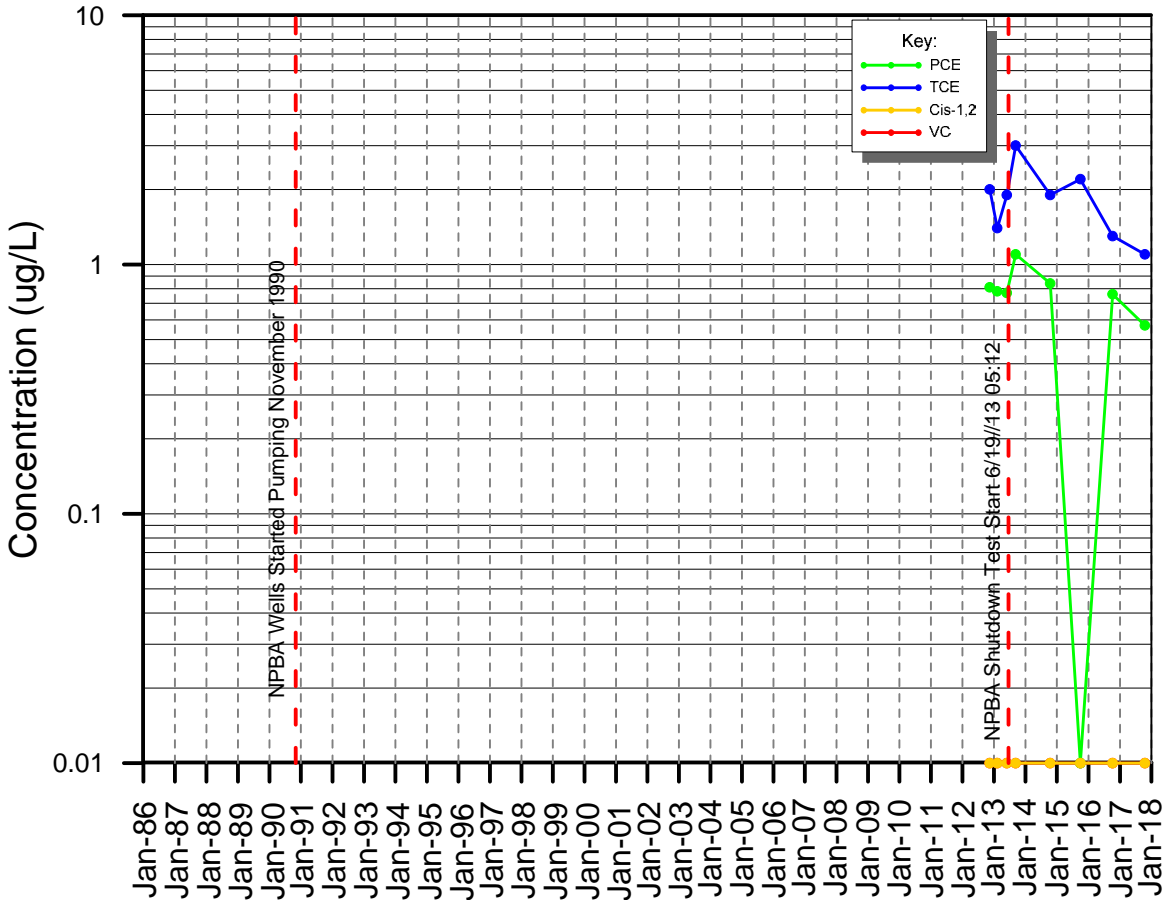
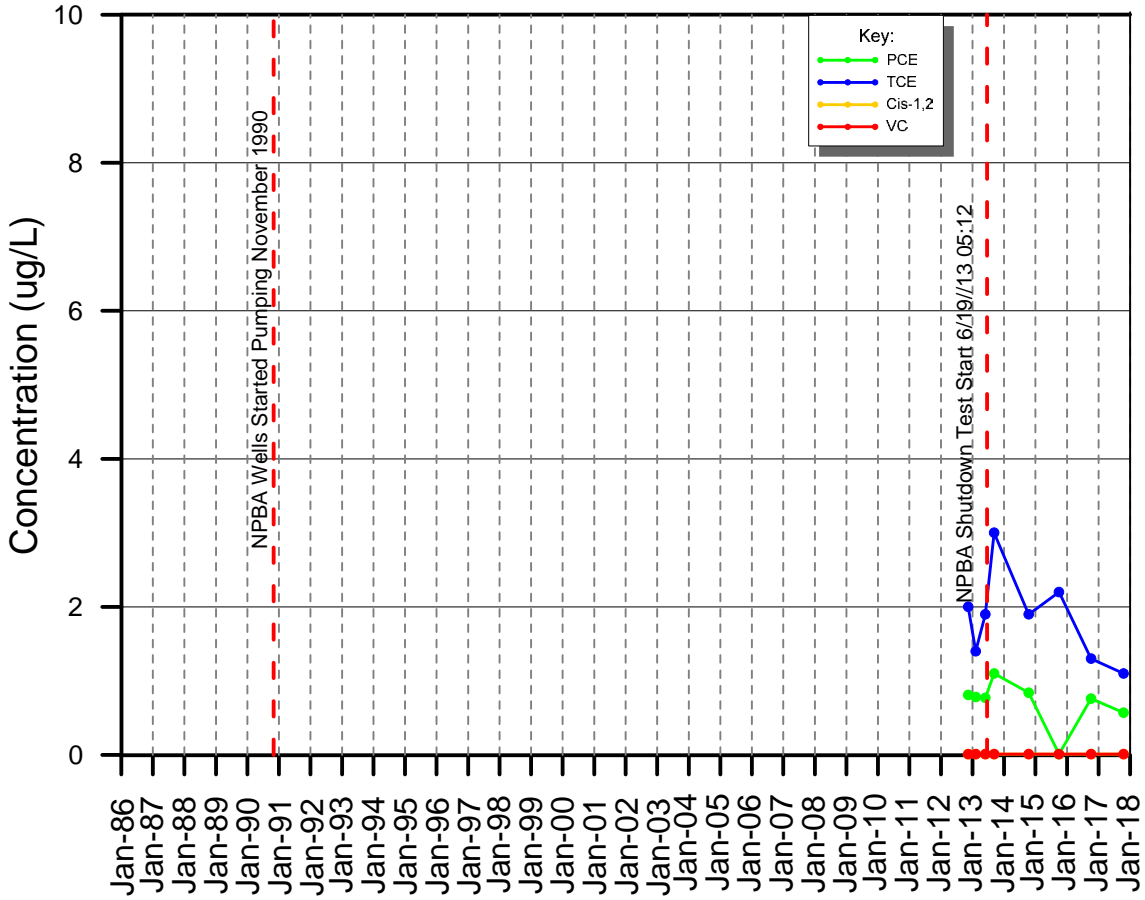
MW-143D



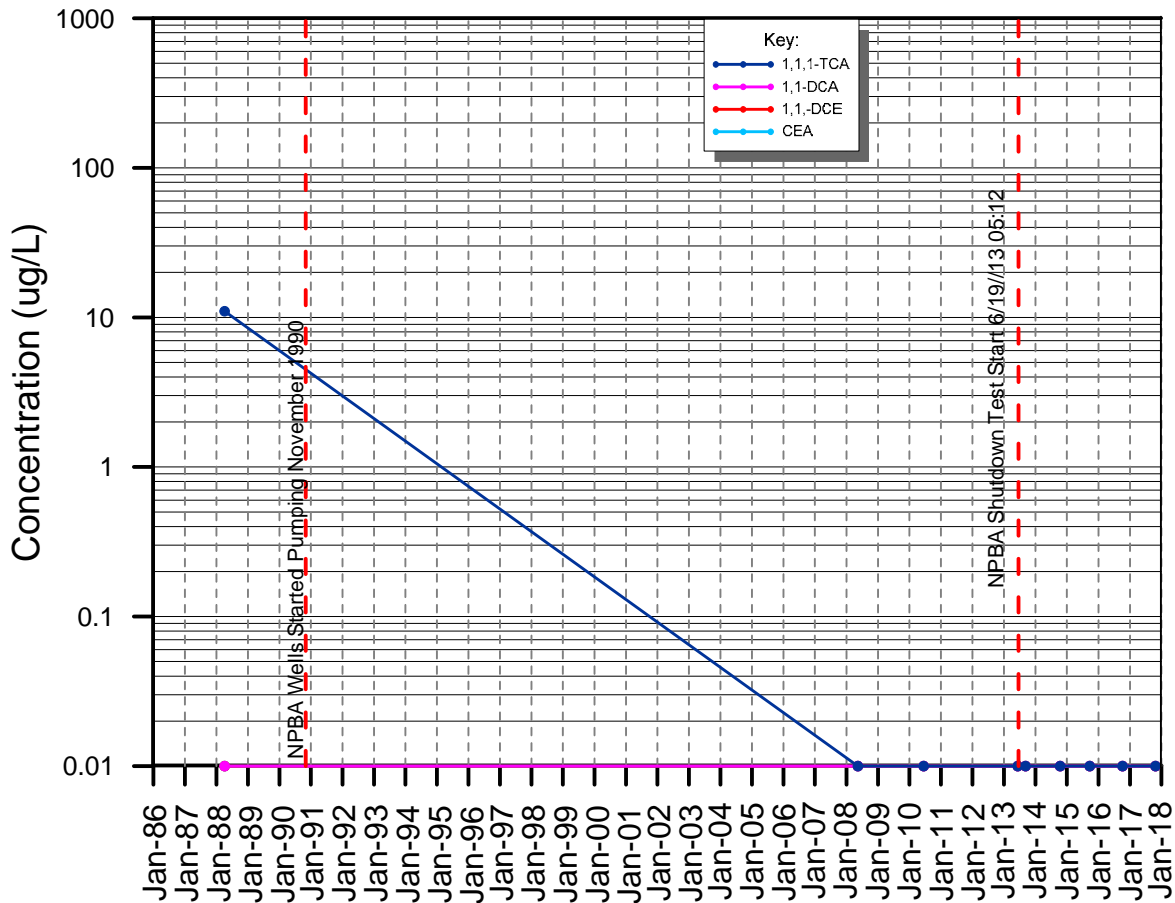
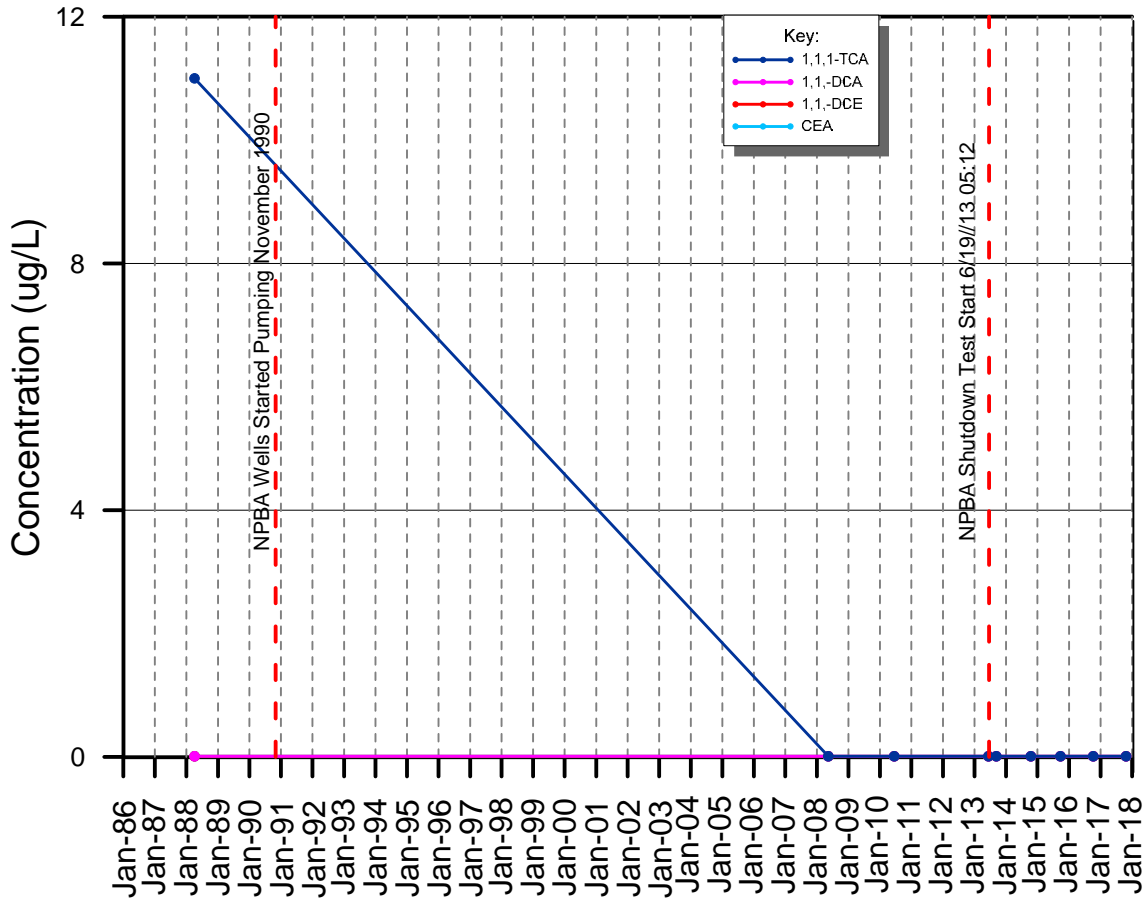
MW-143S



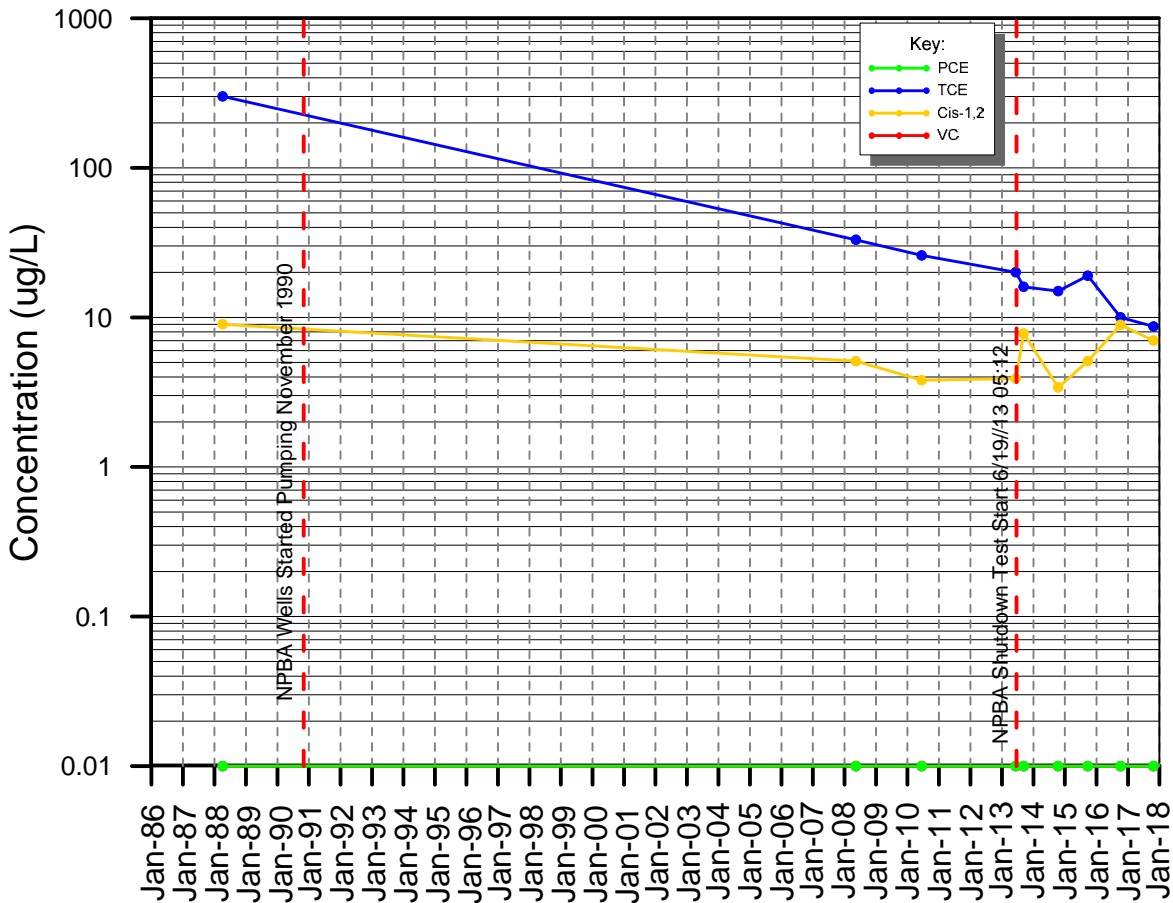
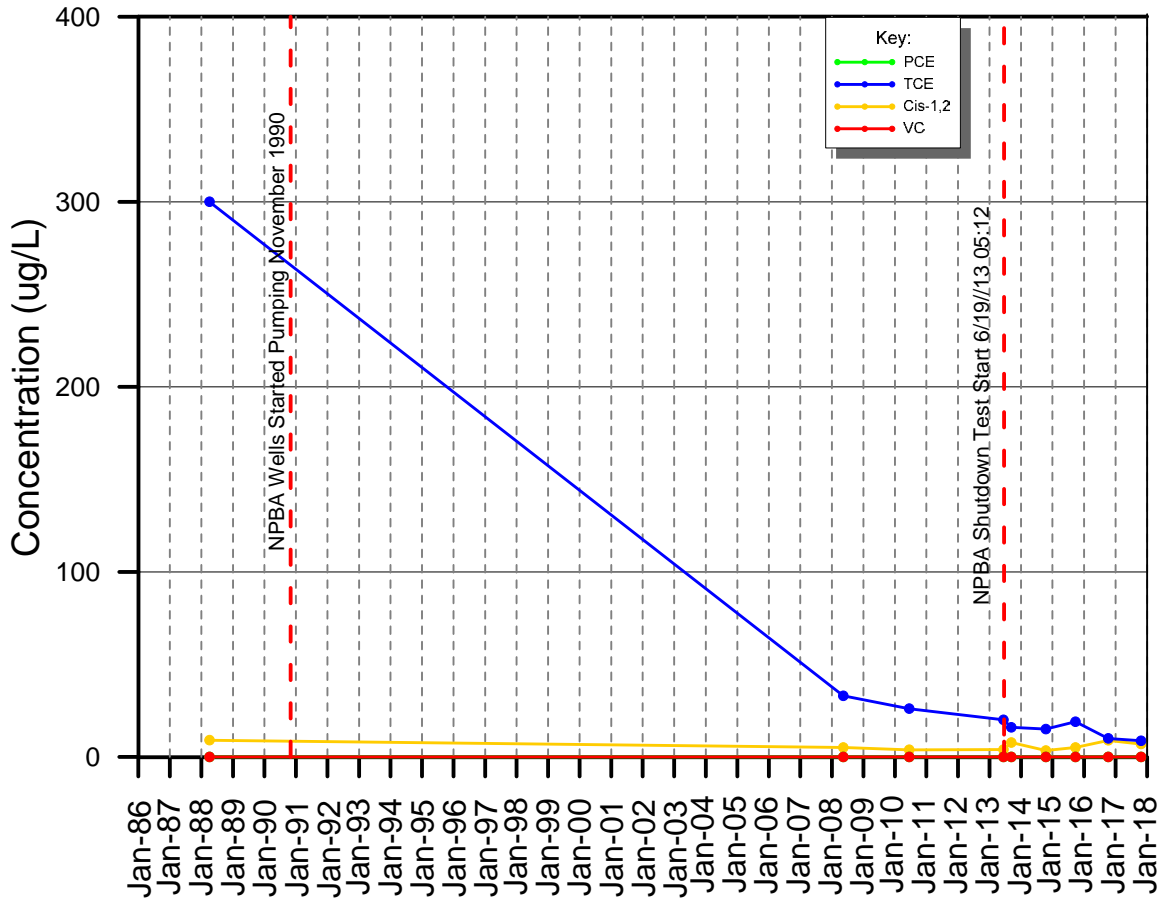
MW-143S



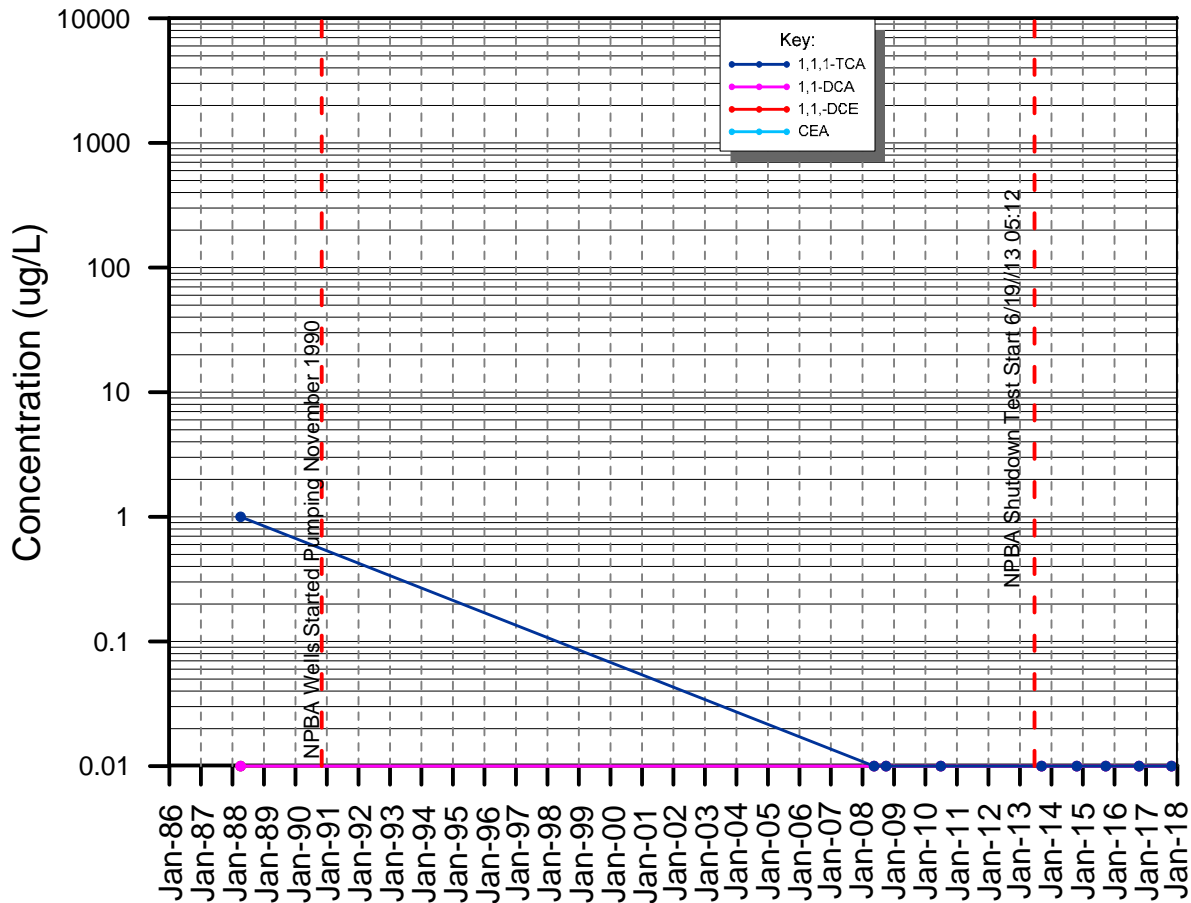
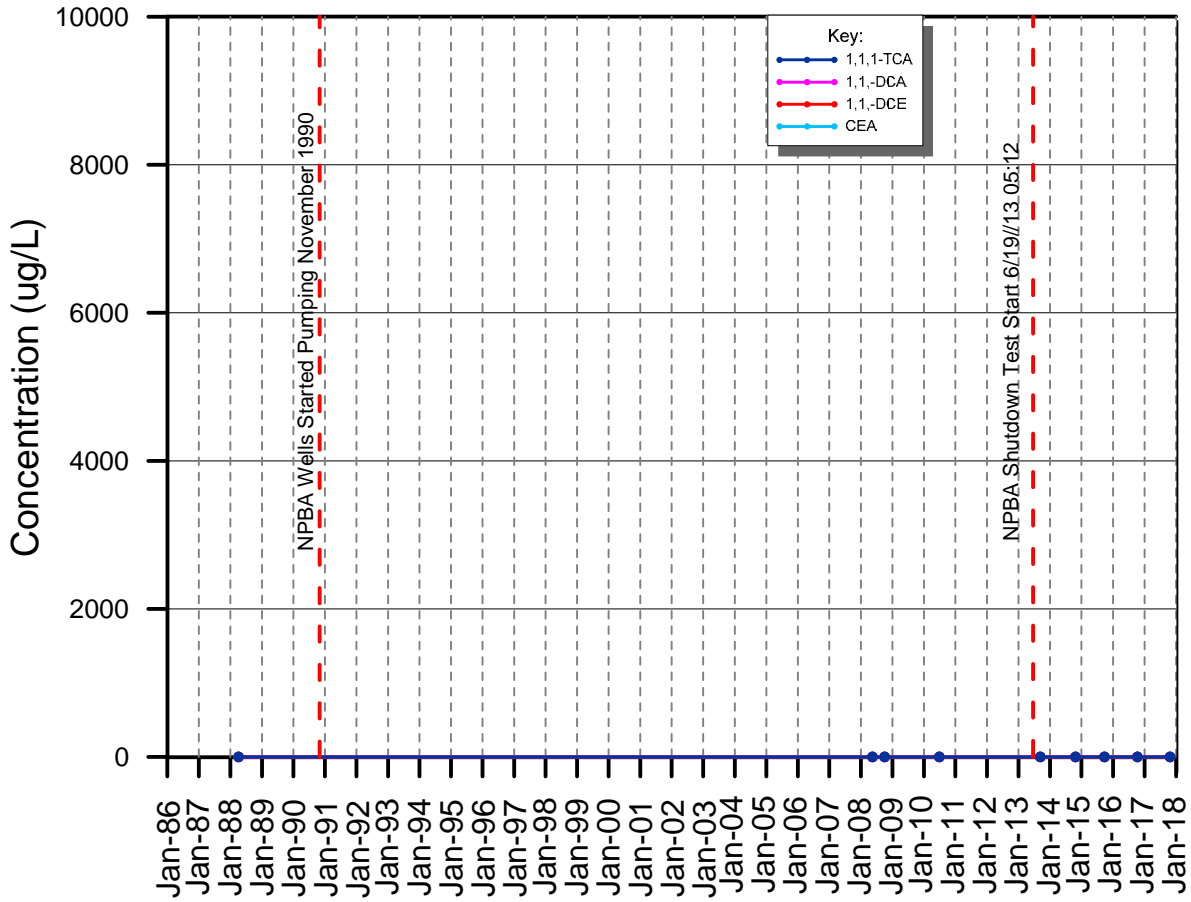
MW-16D



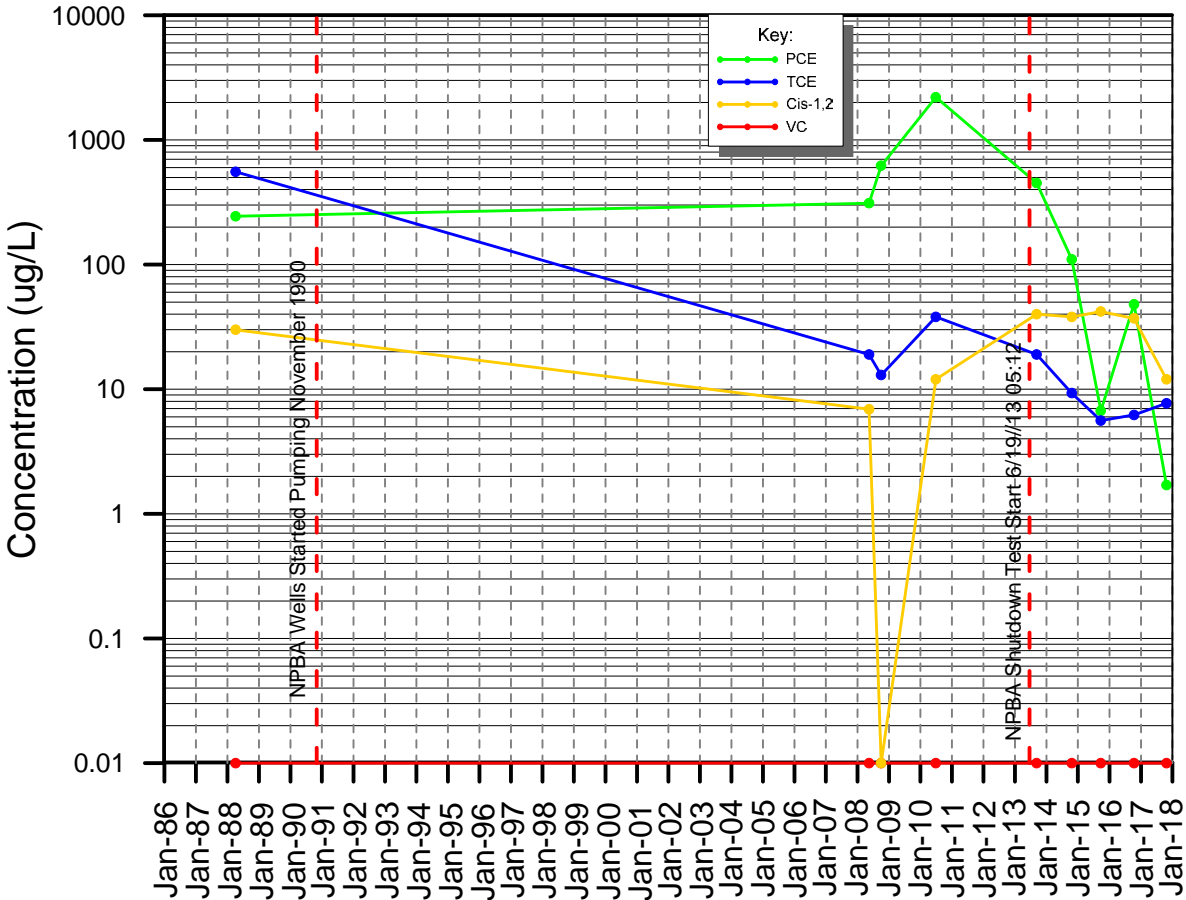
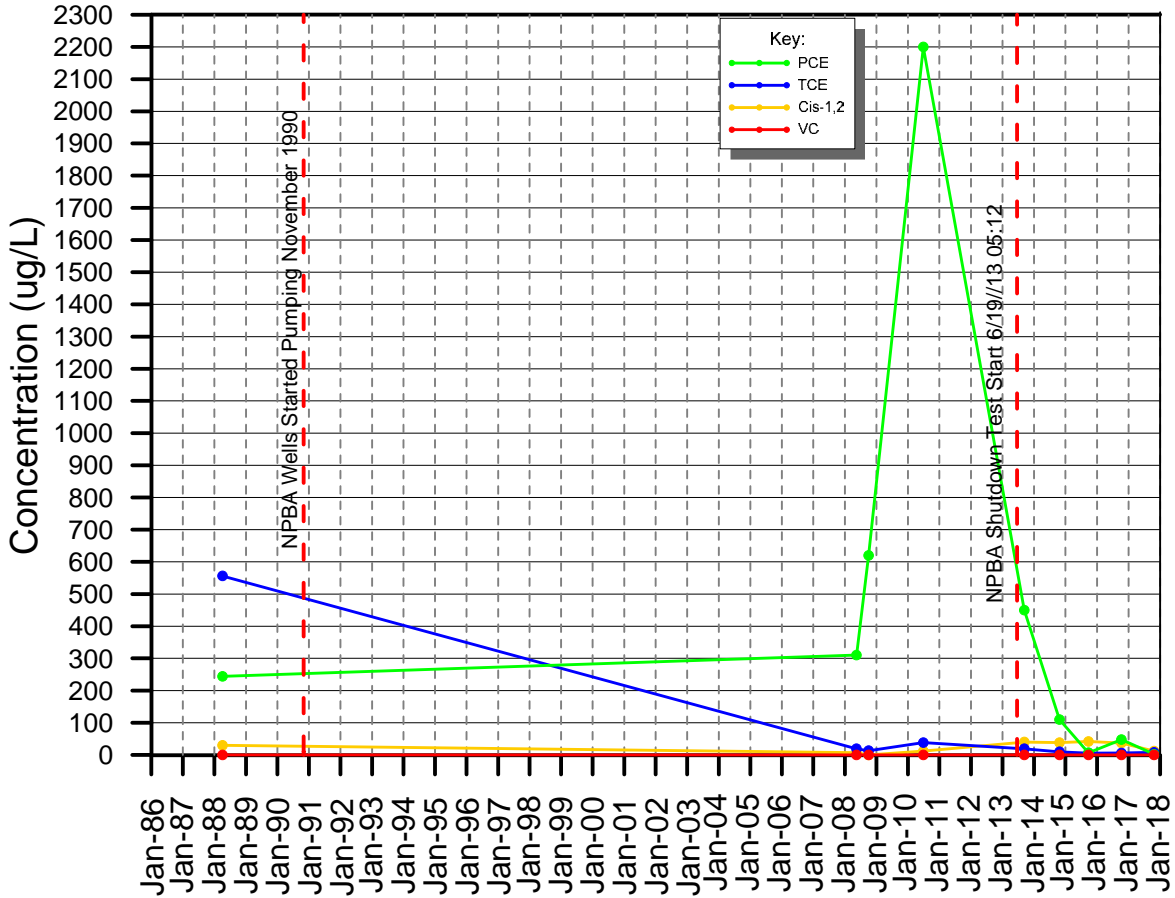
MW-16D



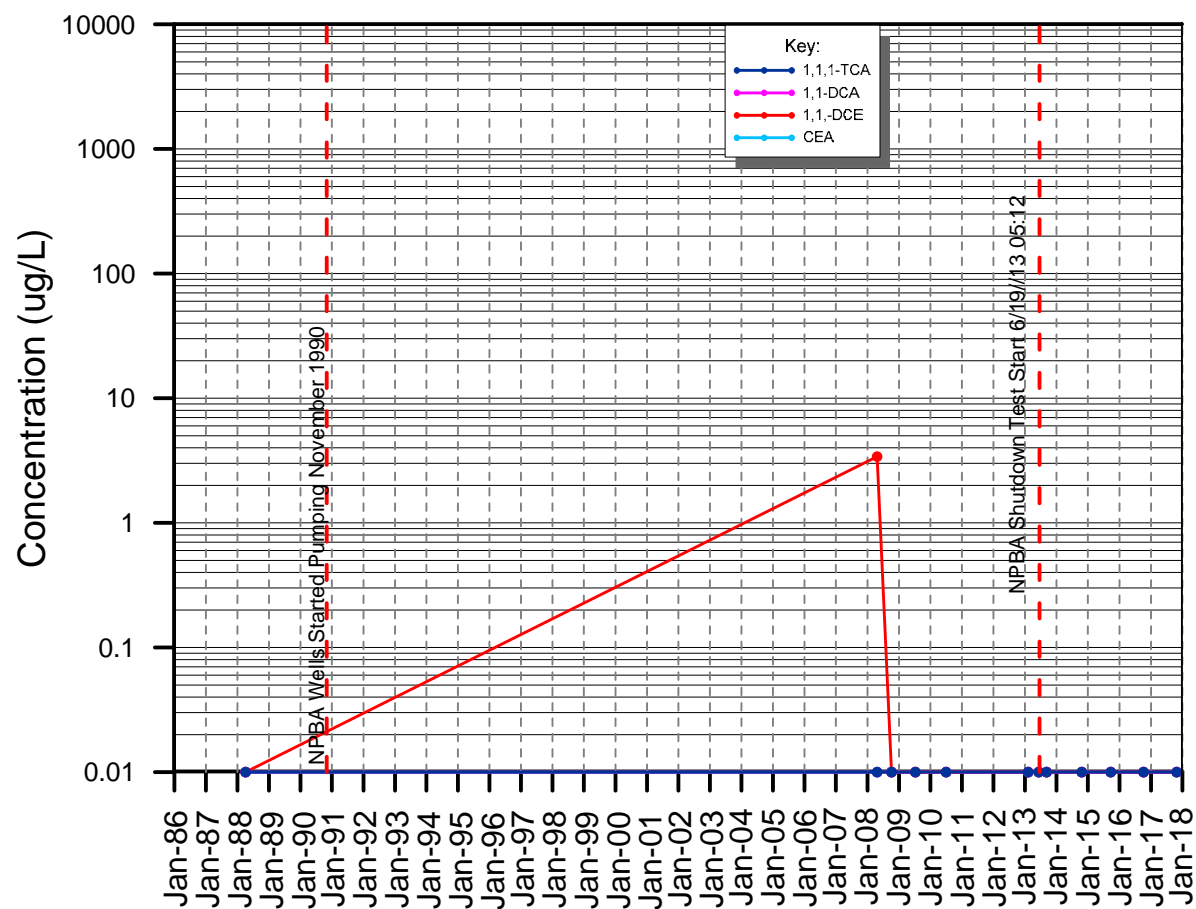
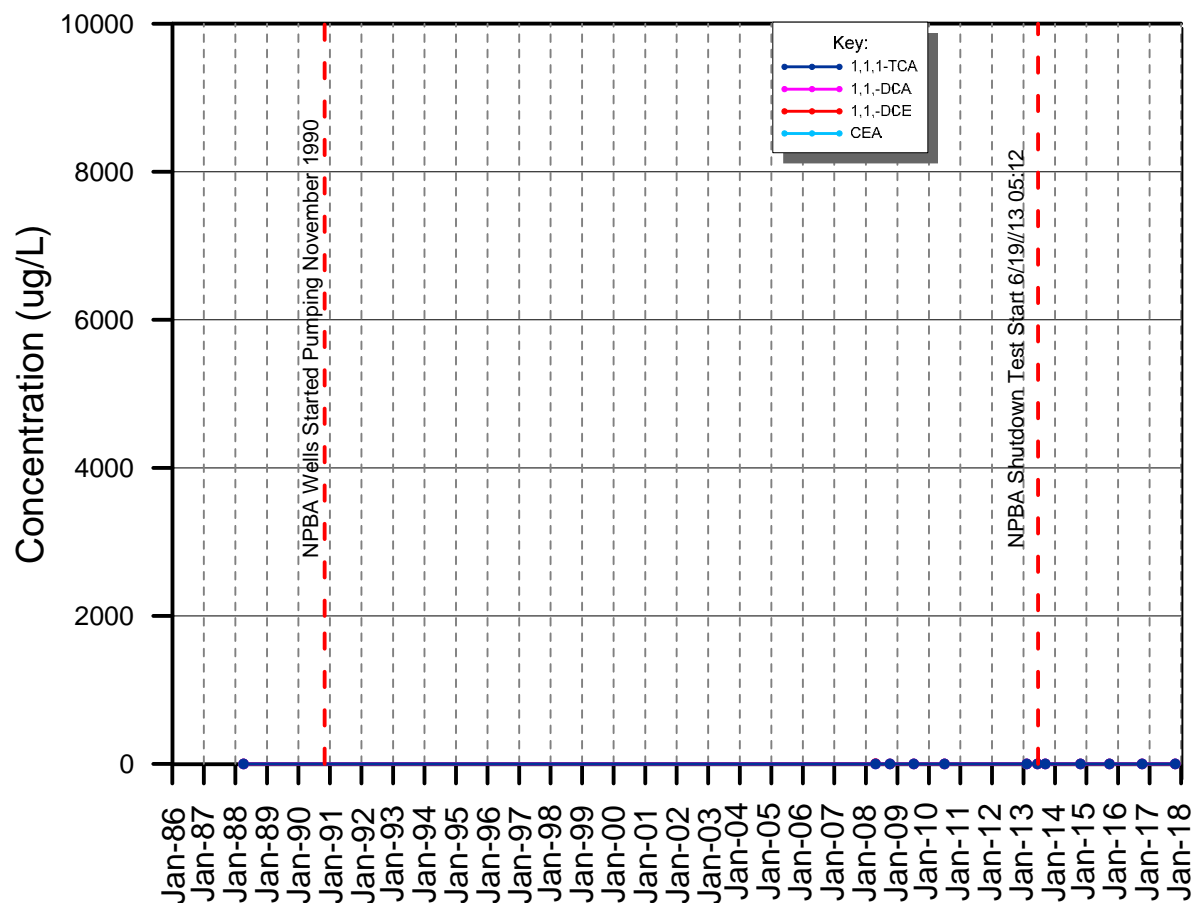
MW-16S



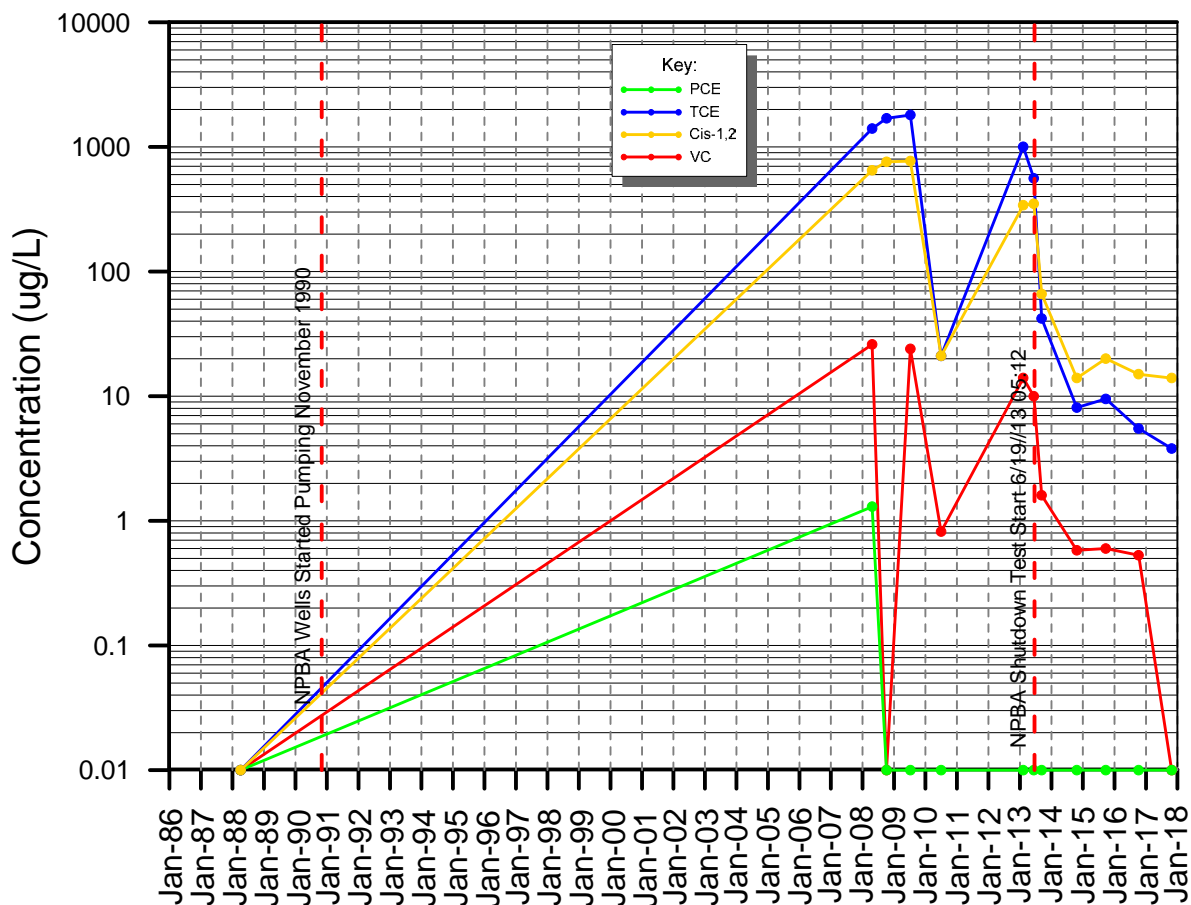
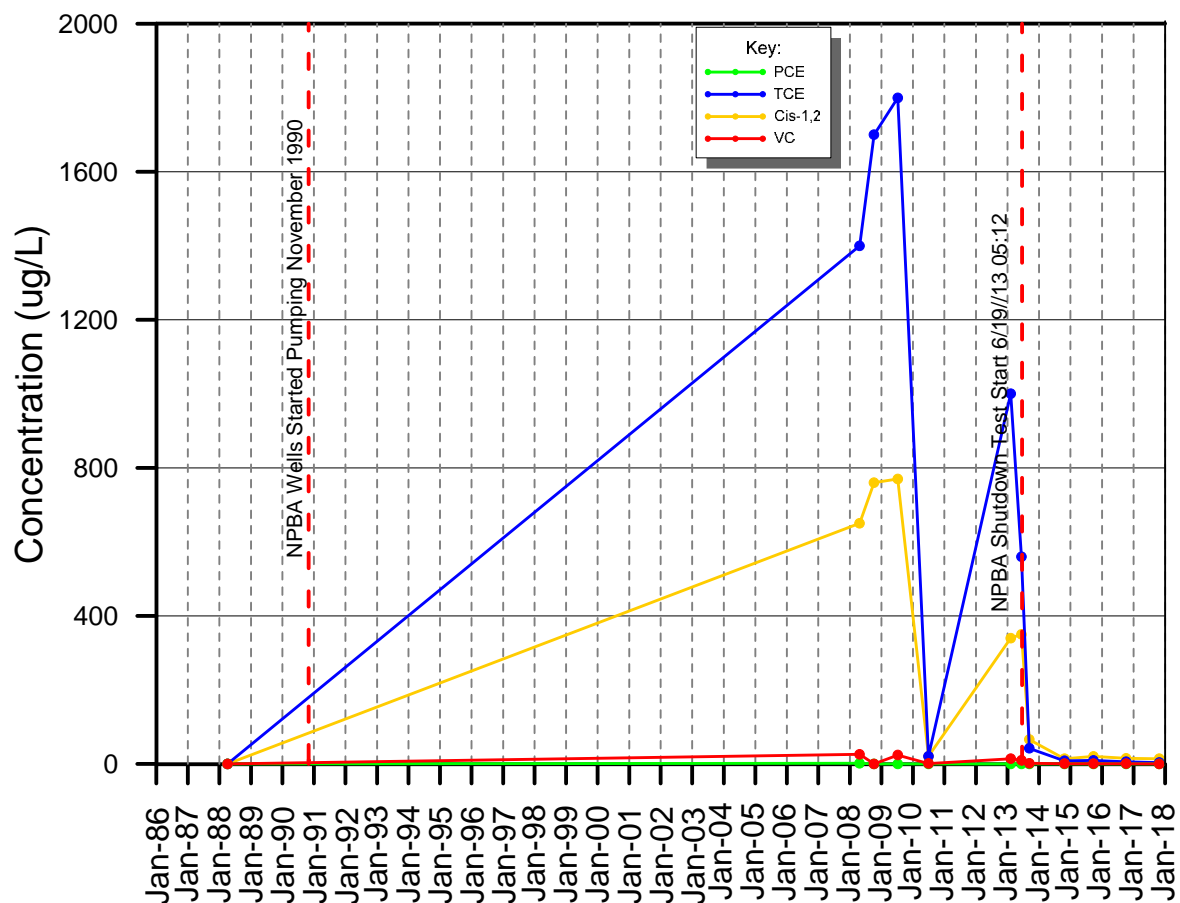
MW-16S



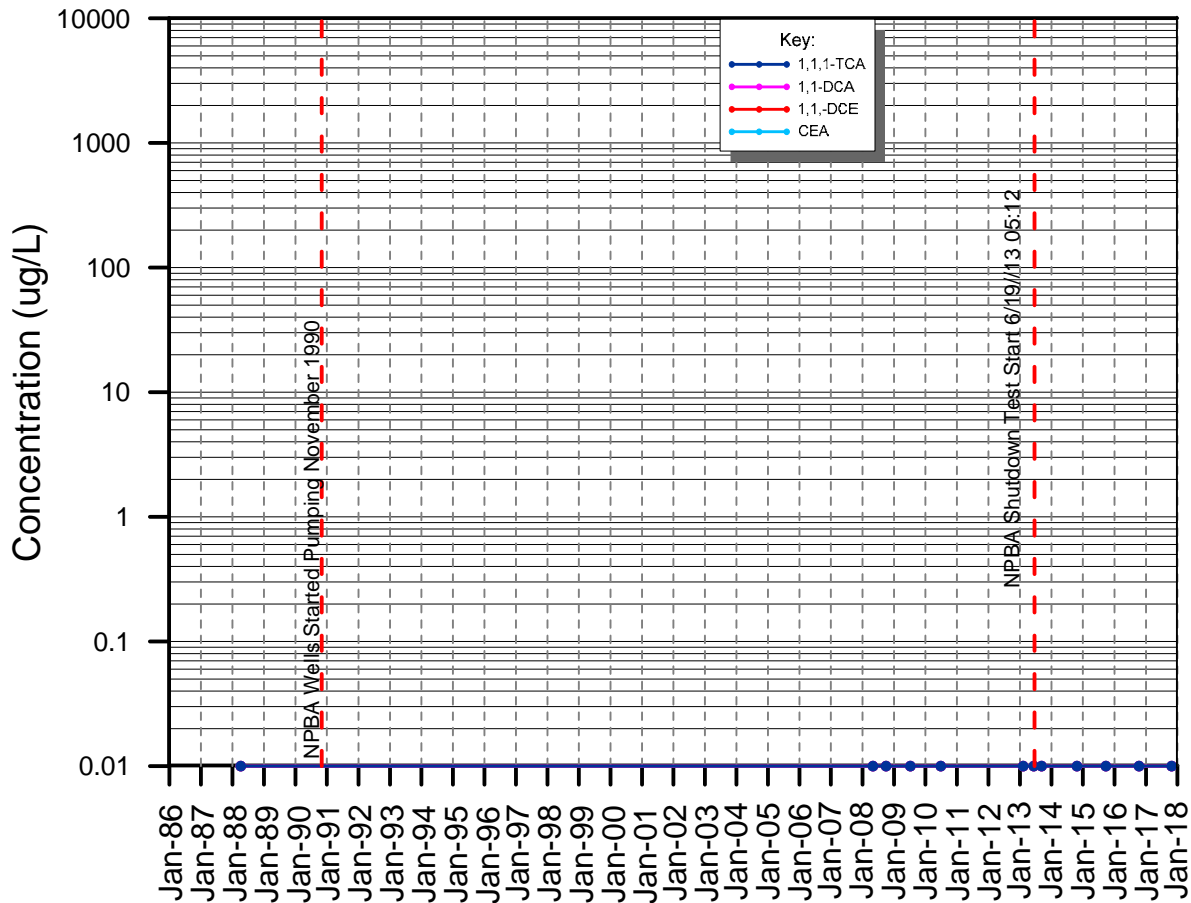
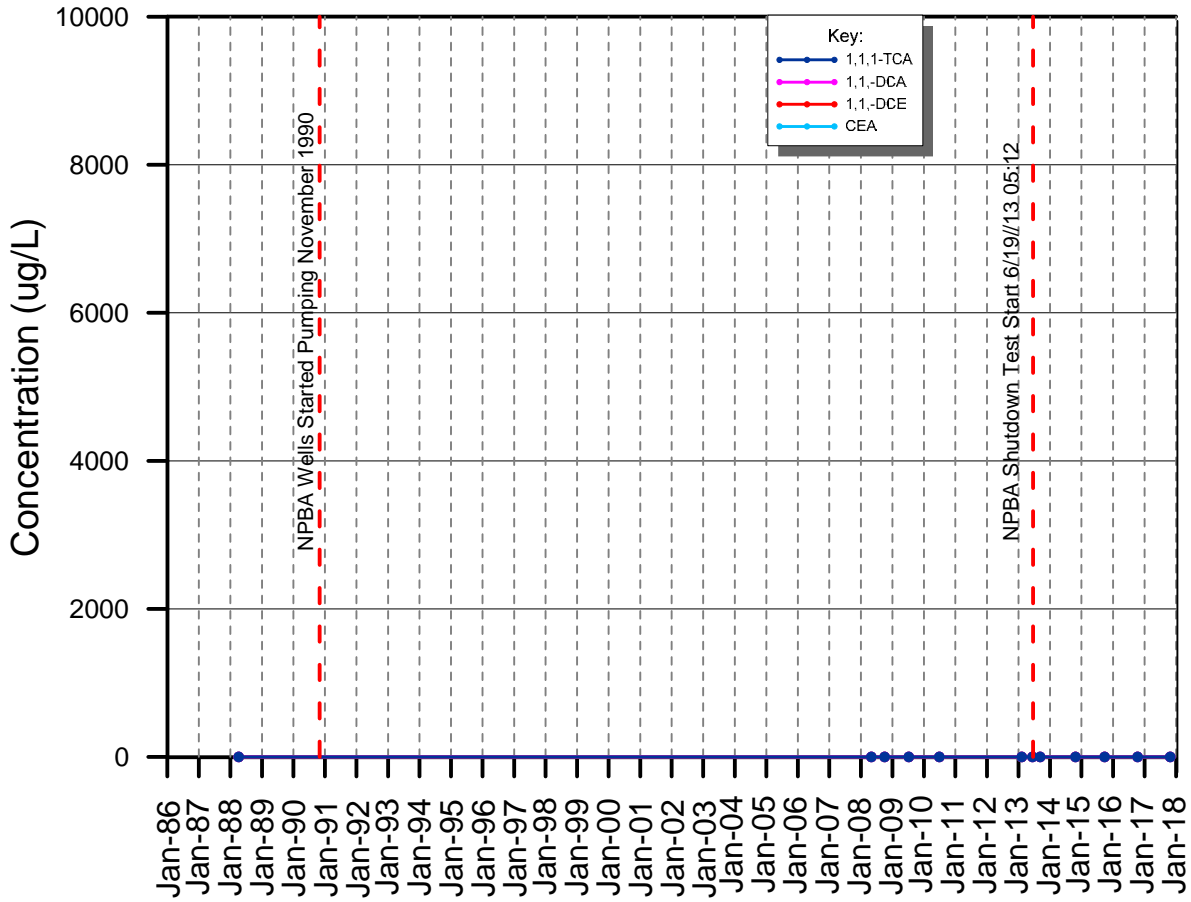
MW-18D



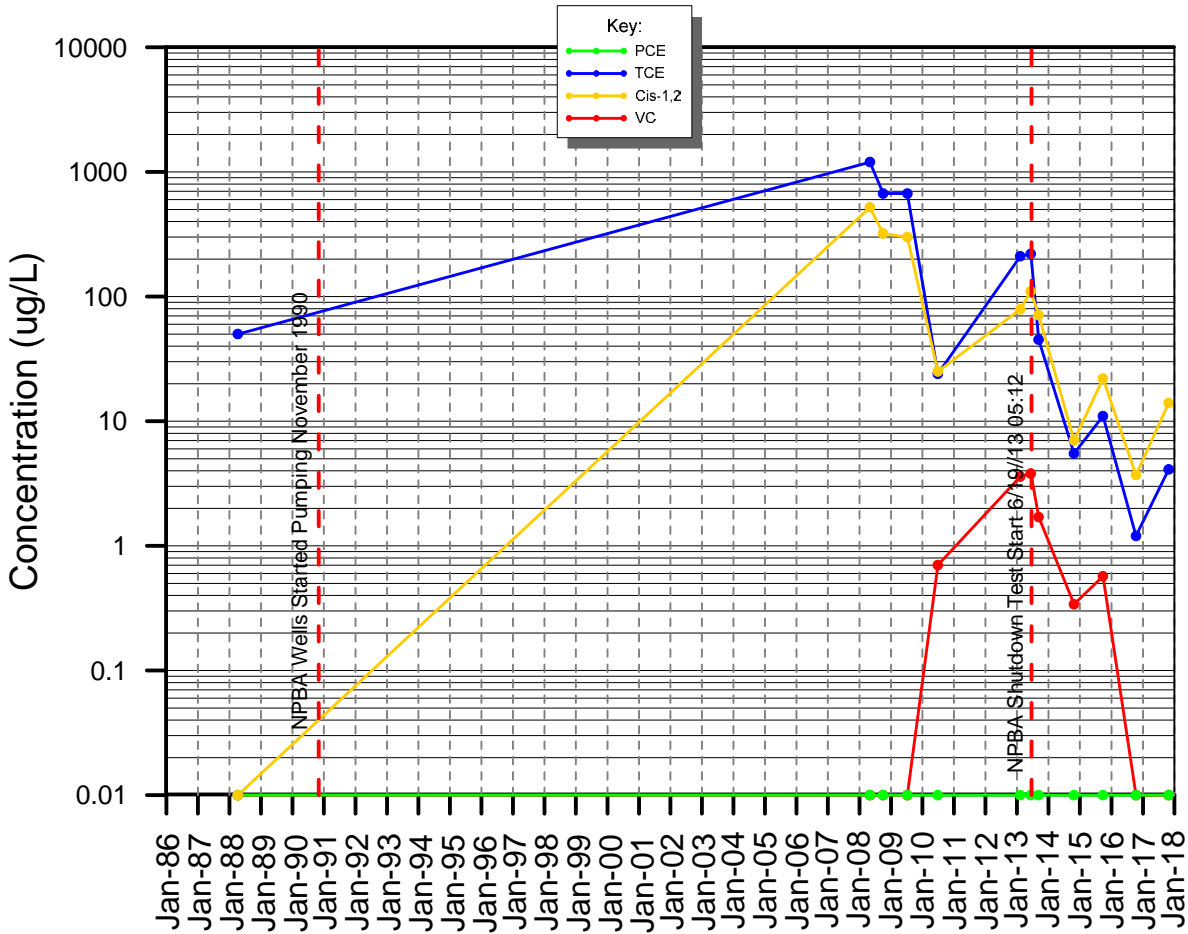
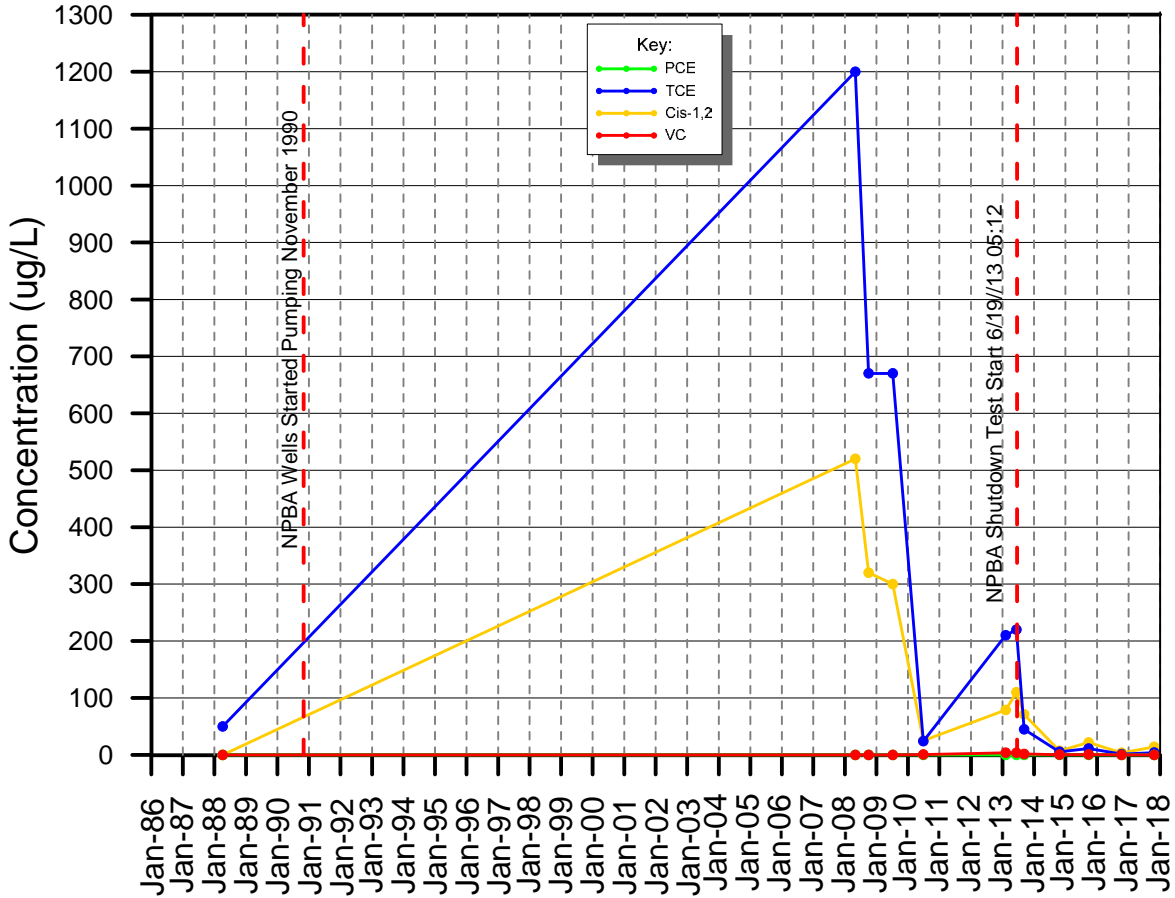
MW-18D



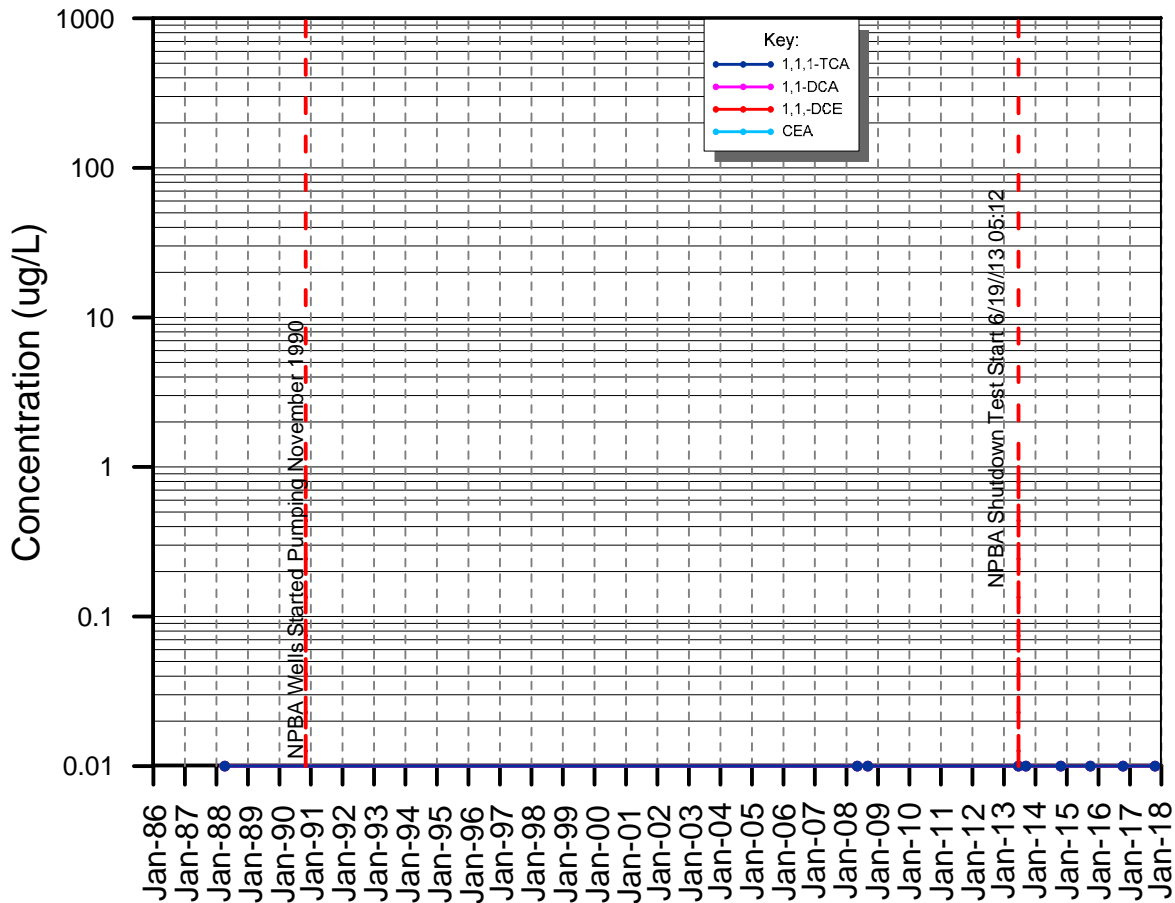
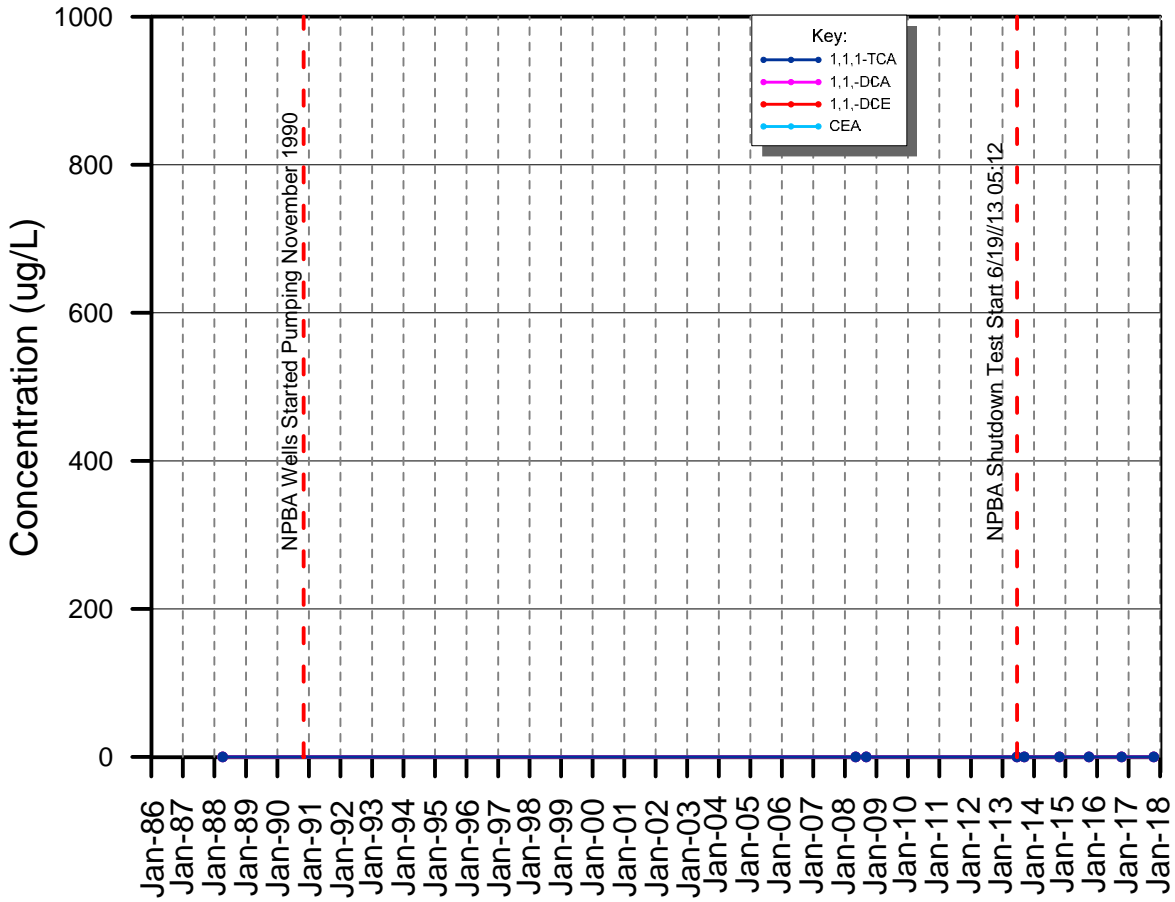
MW-18S



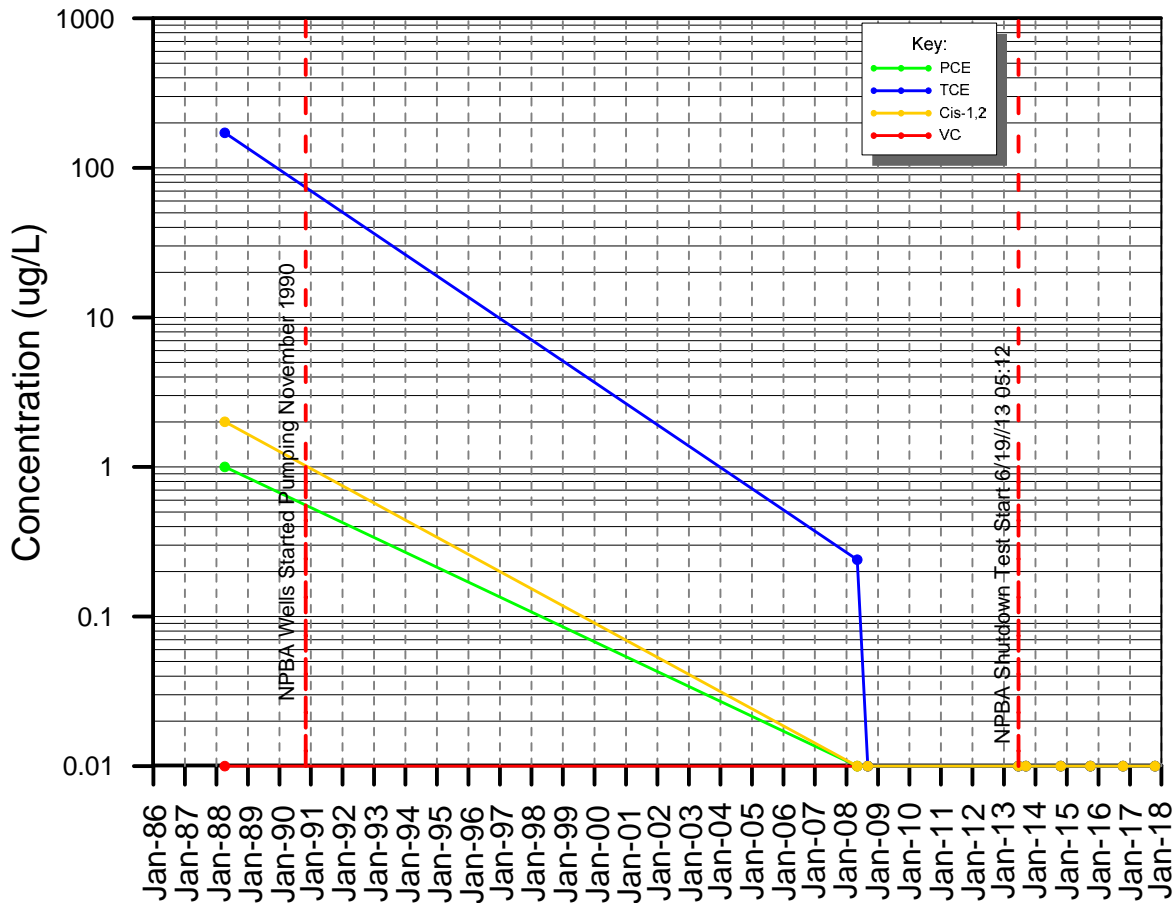
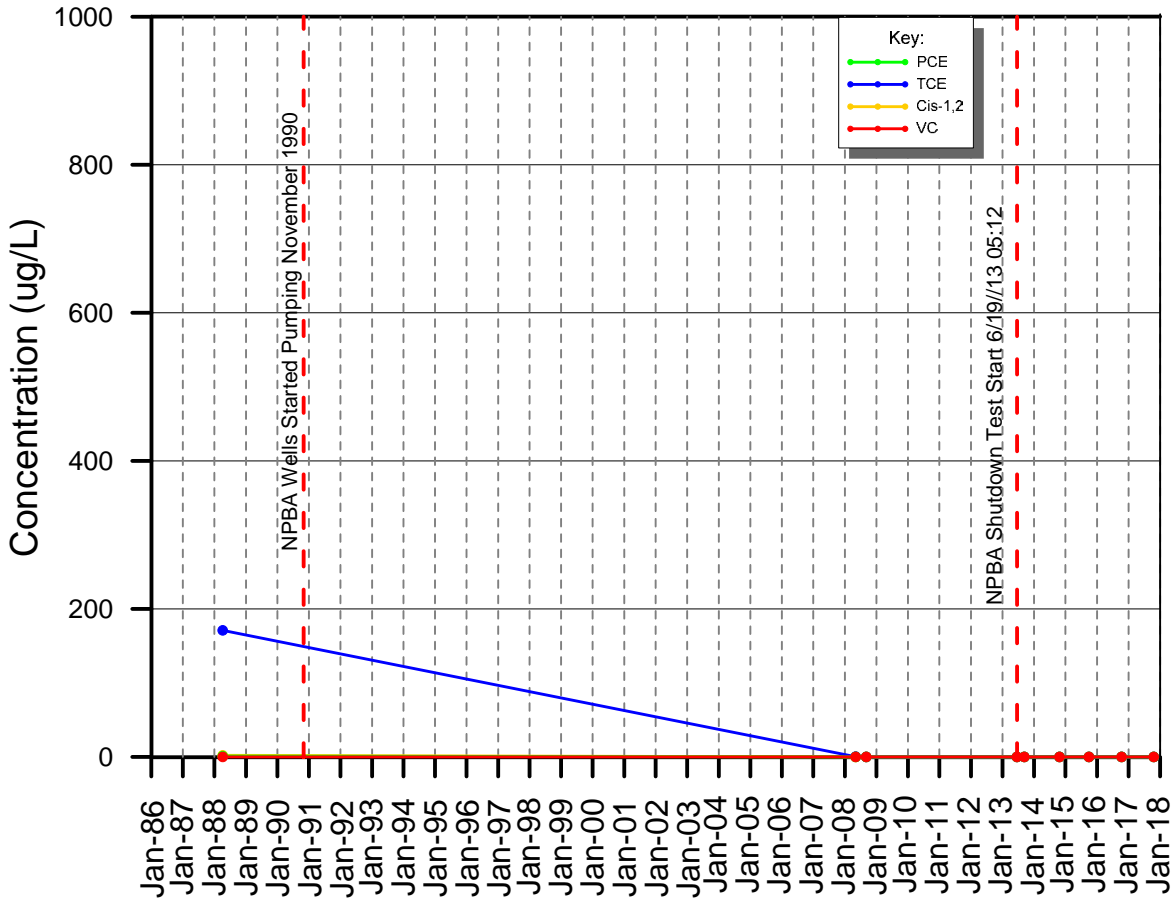
MW-18S



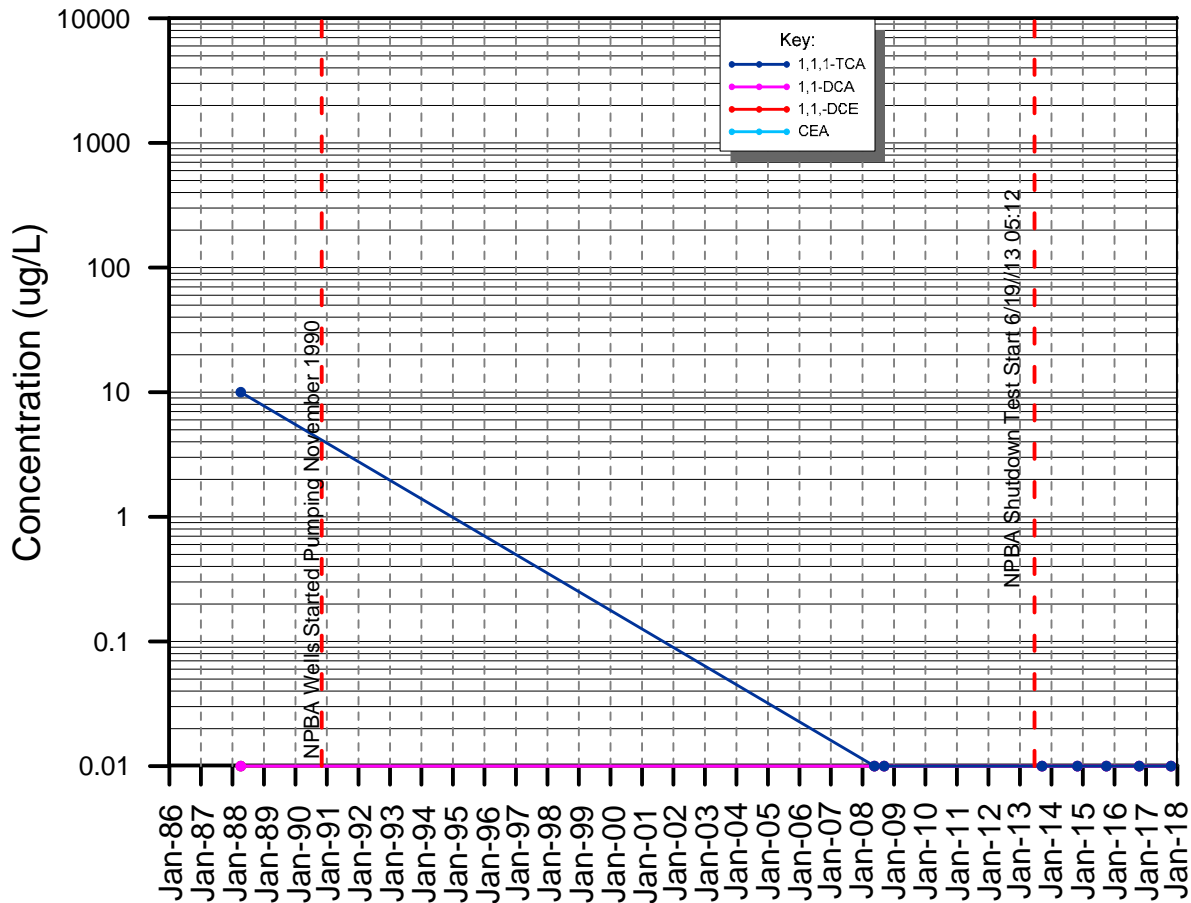
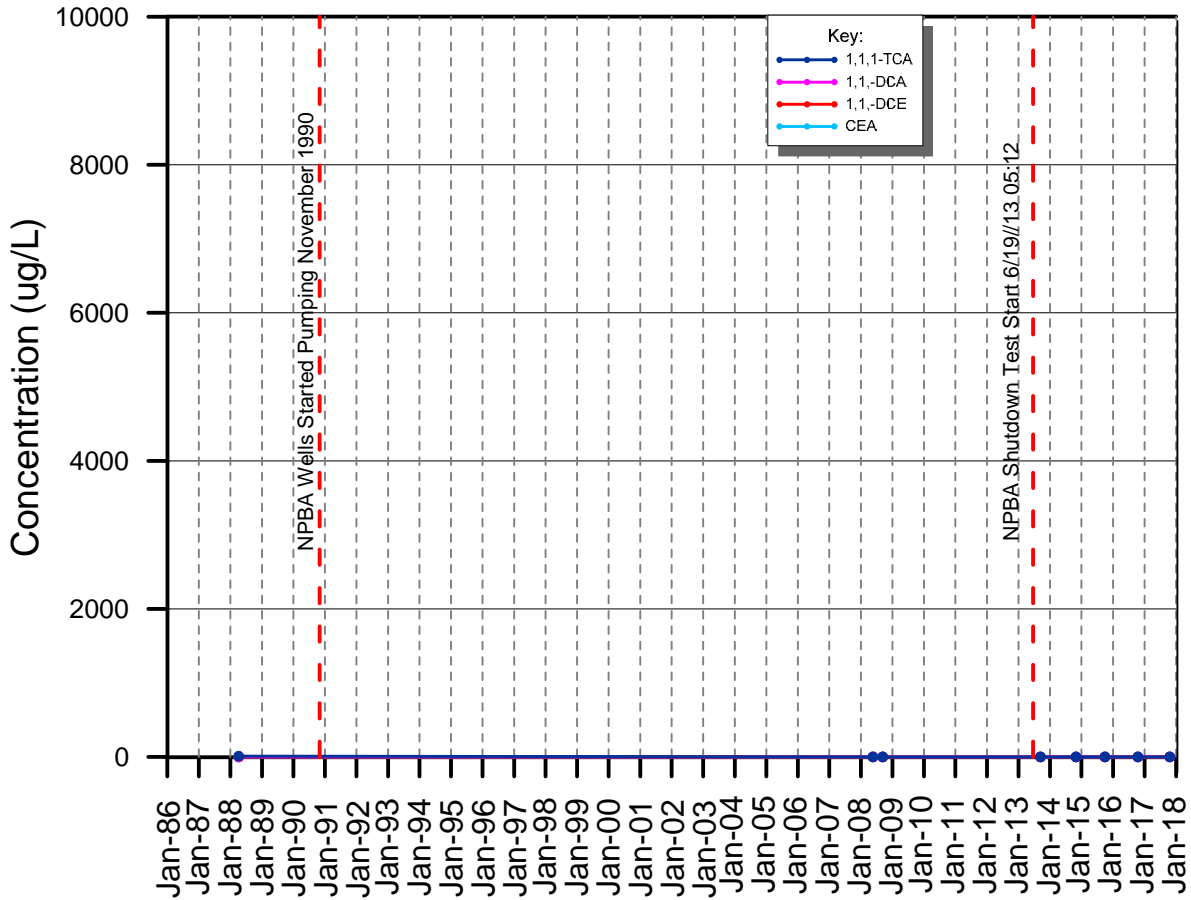
MW-20D



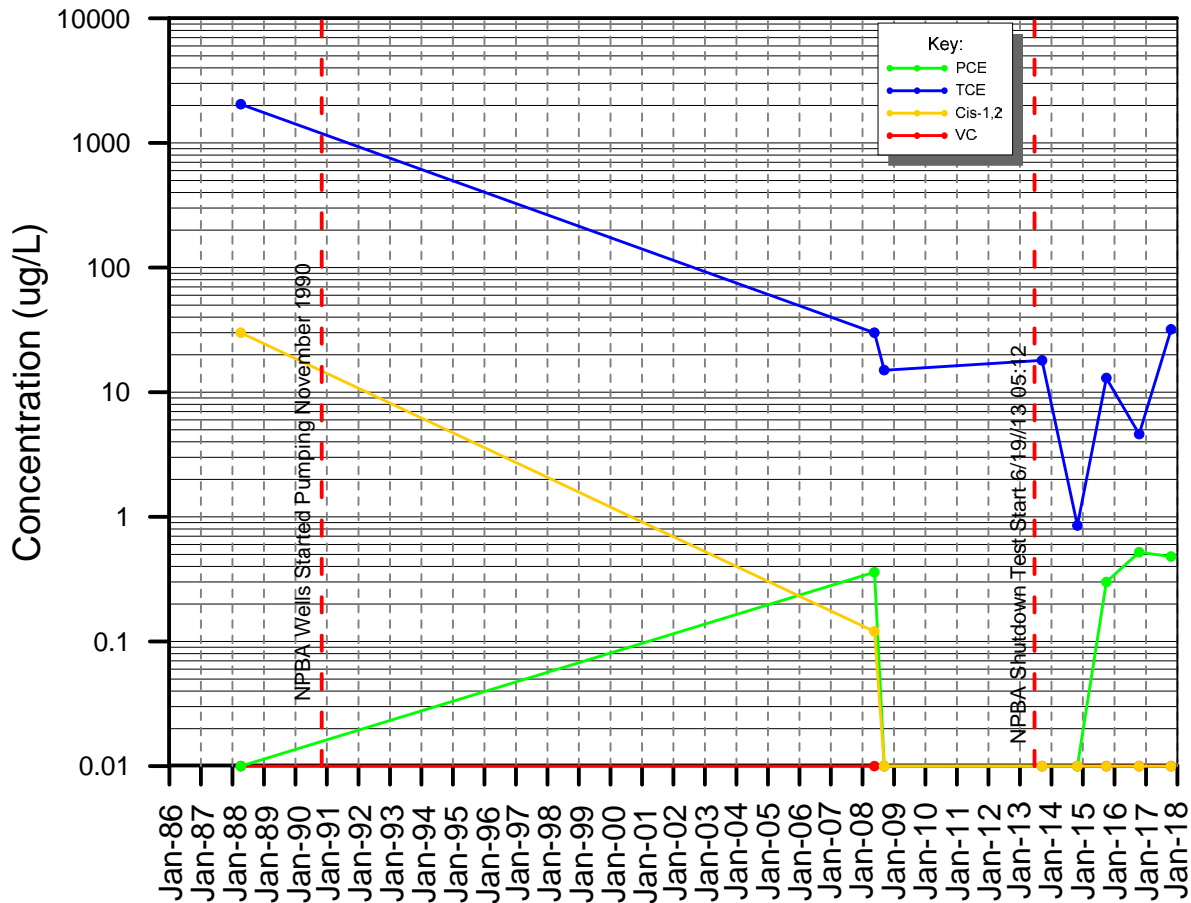
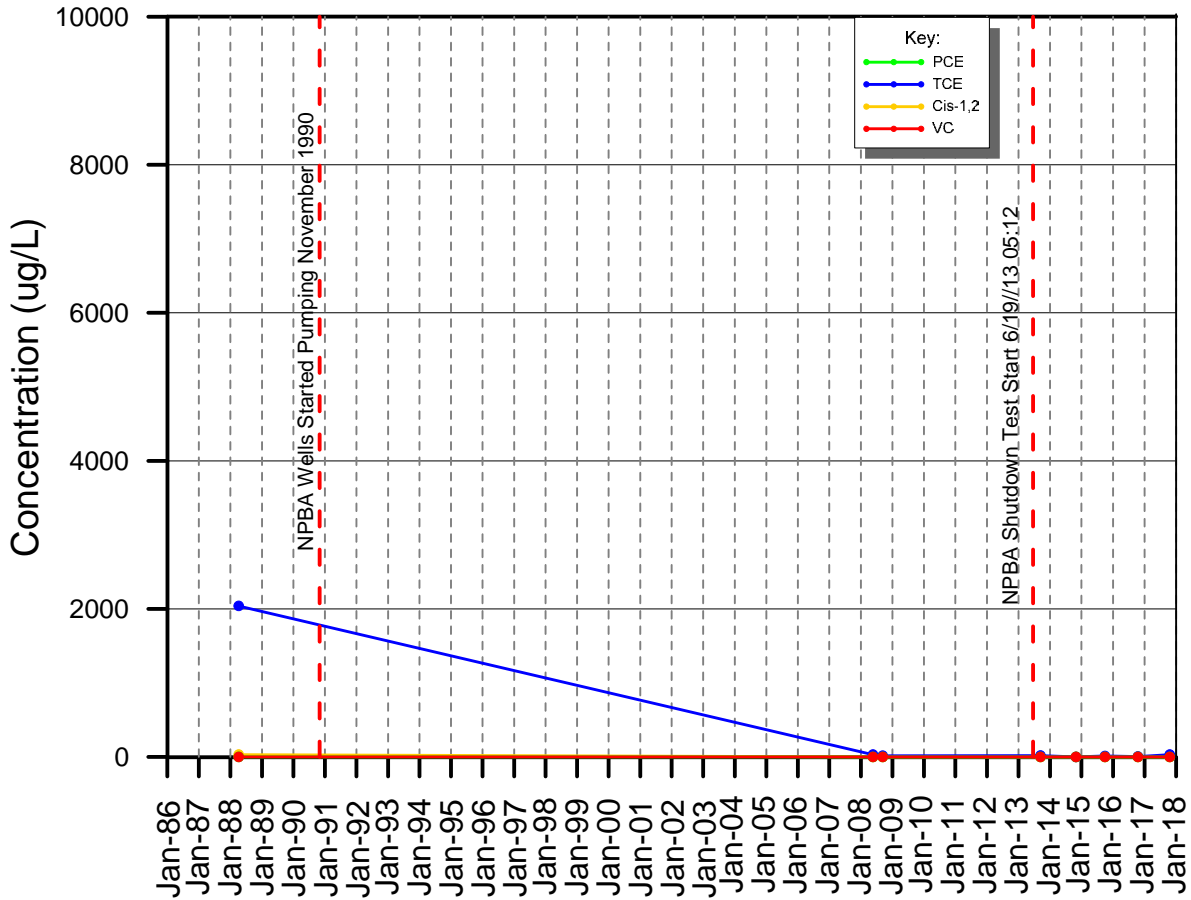
MW-20D



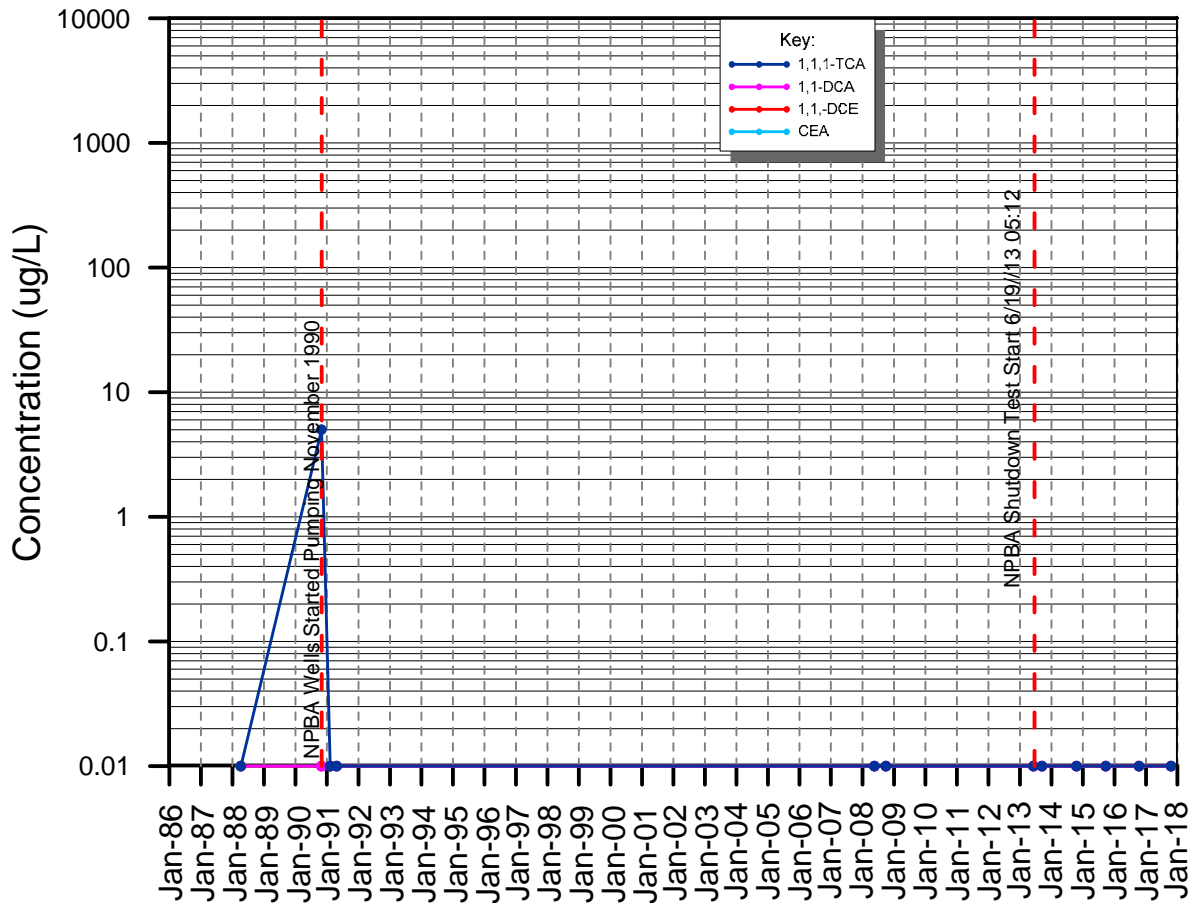
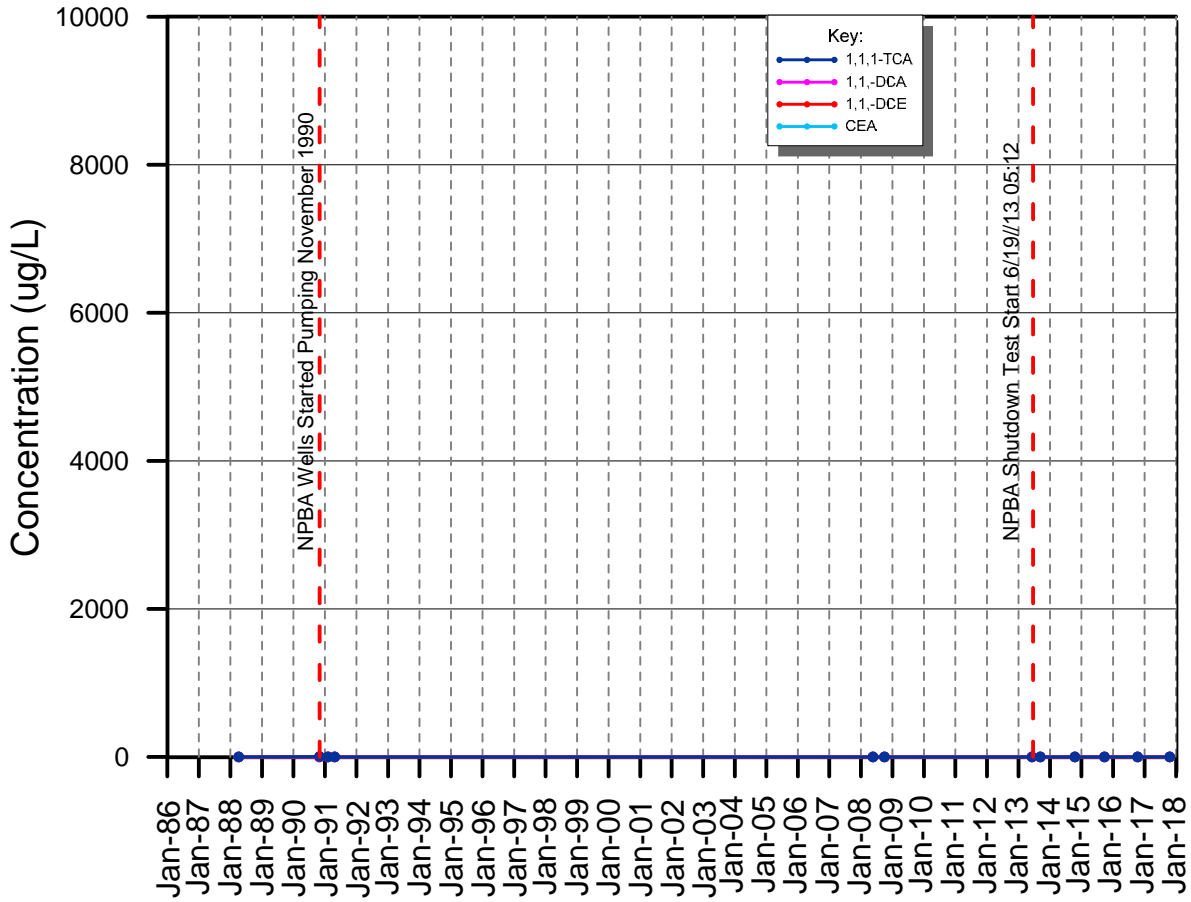
MW-20M



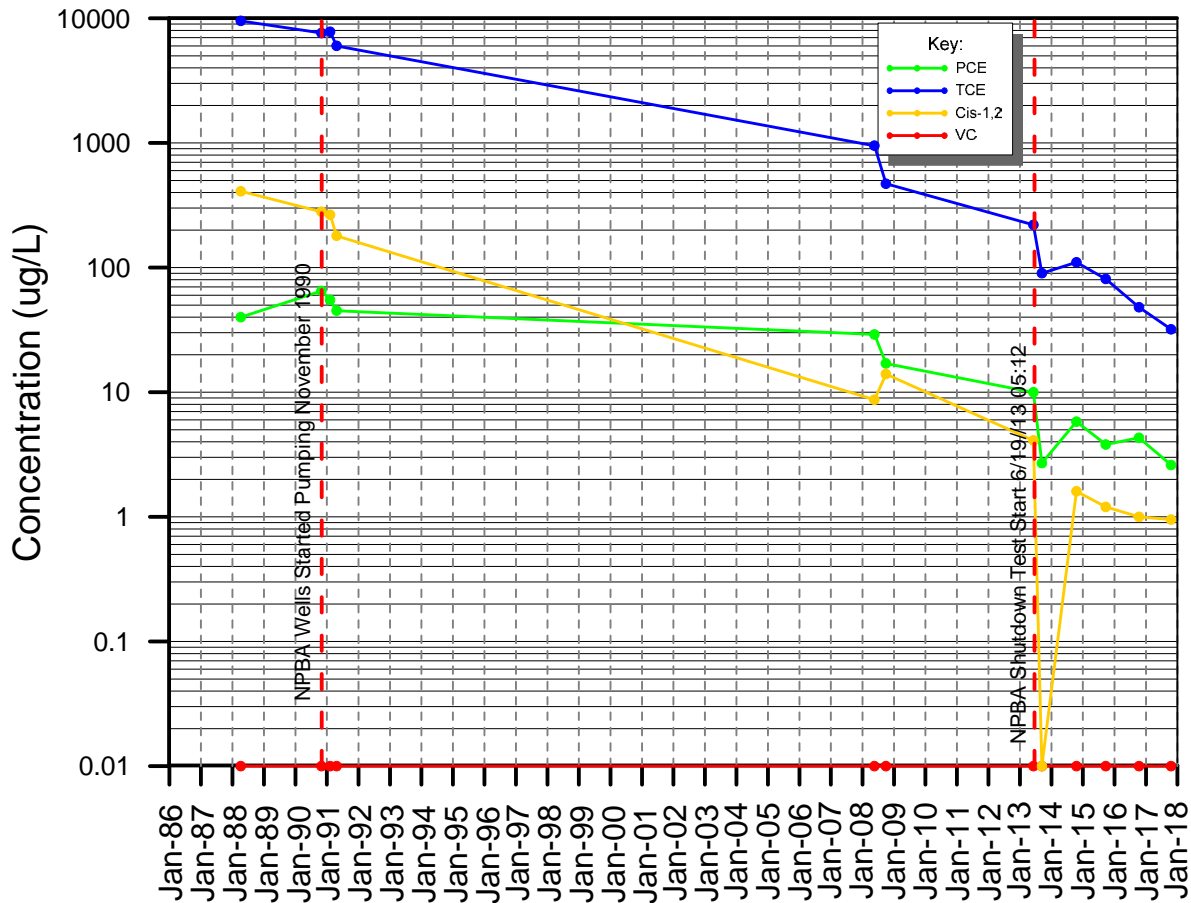
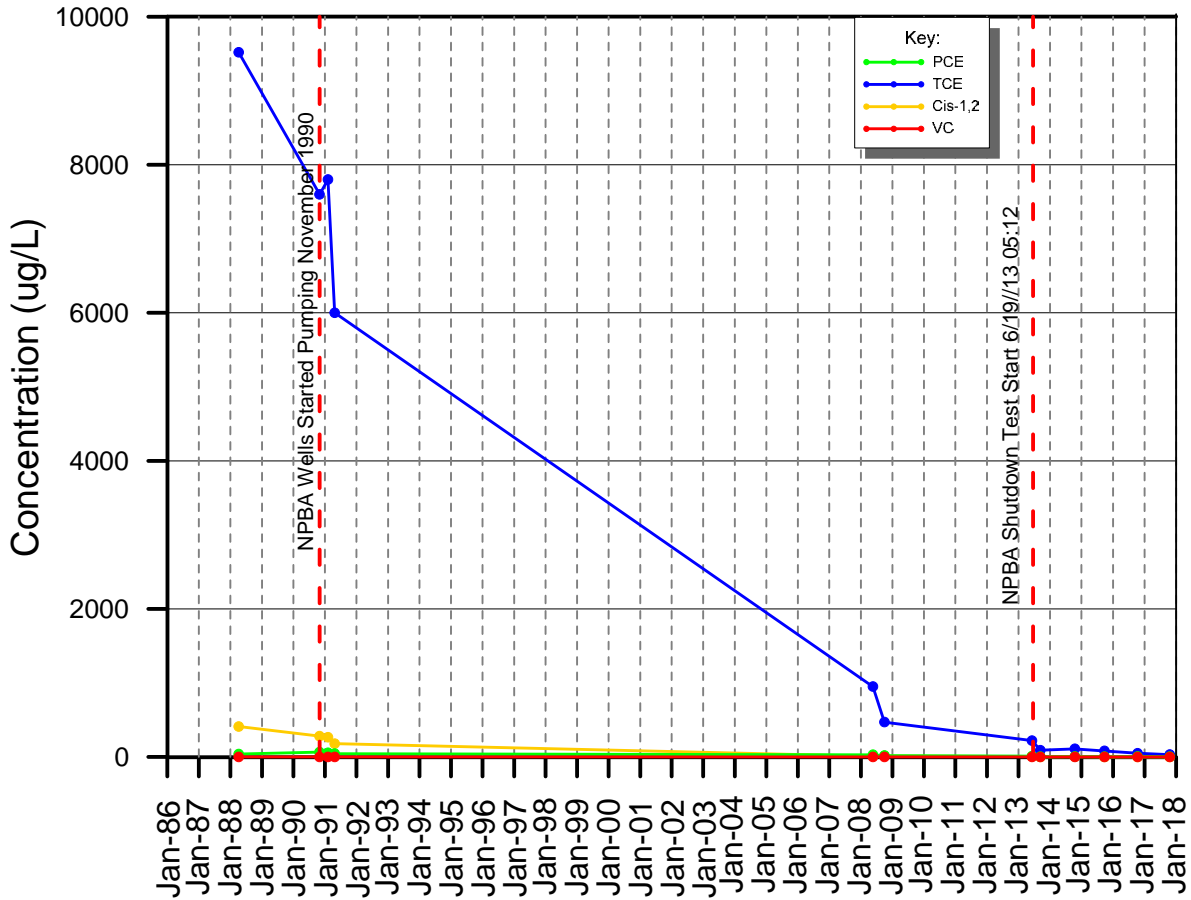
MW-20M



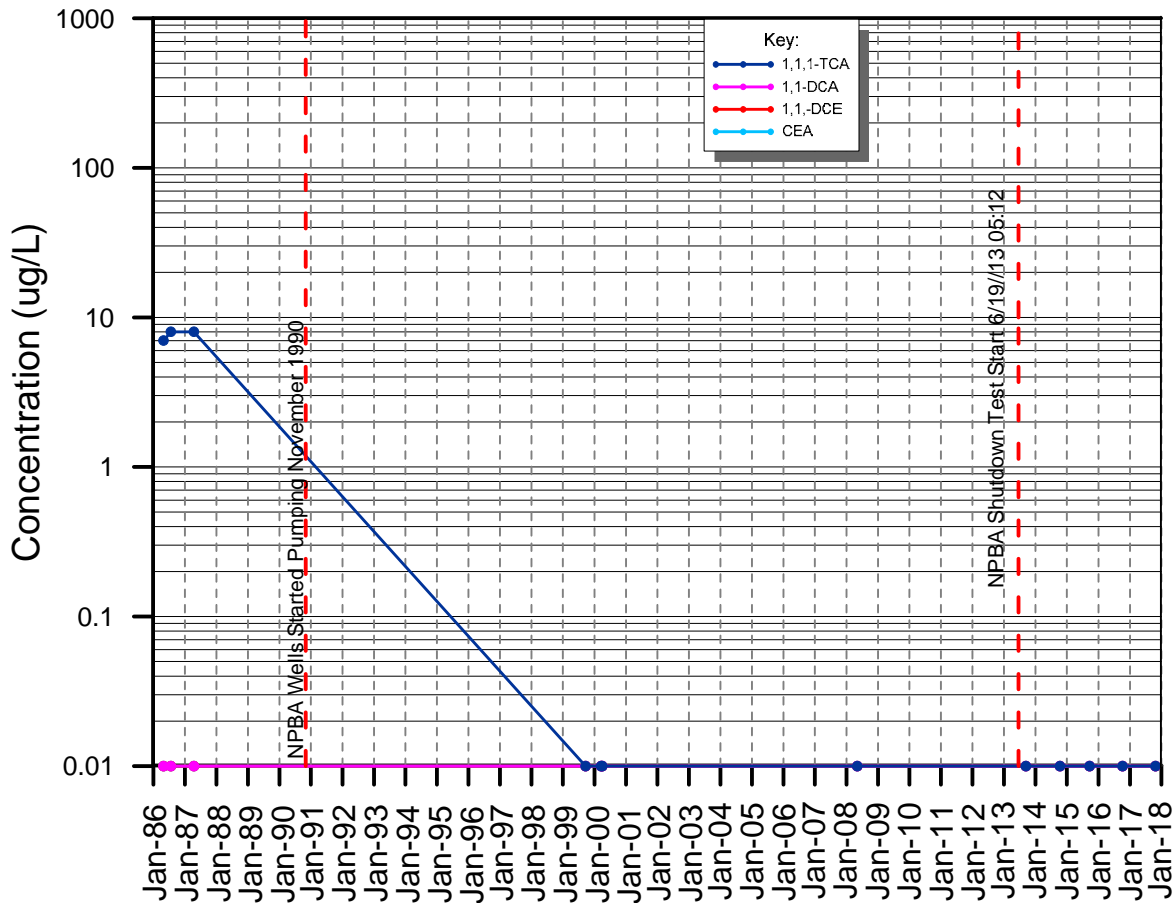
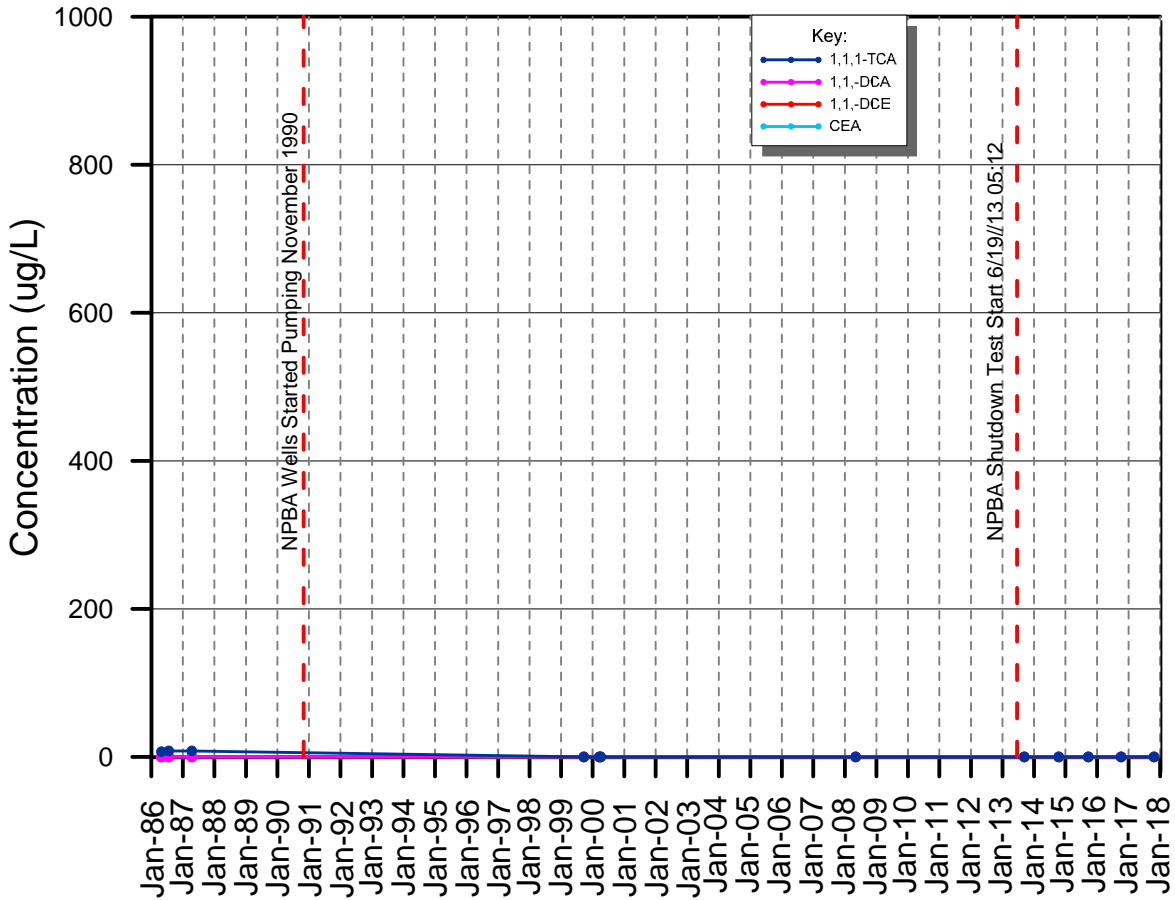
MW-20S



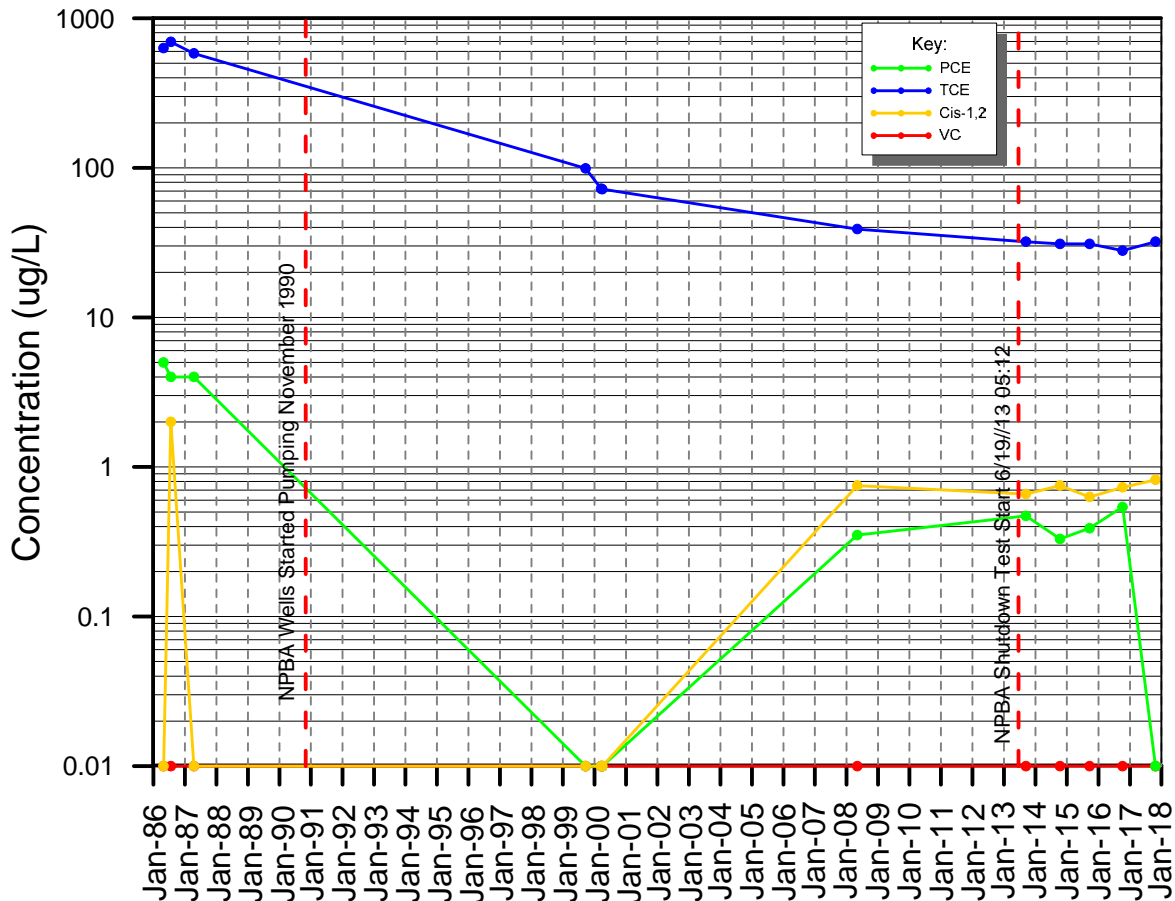
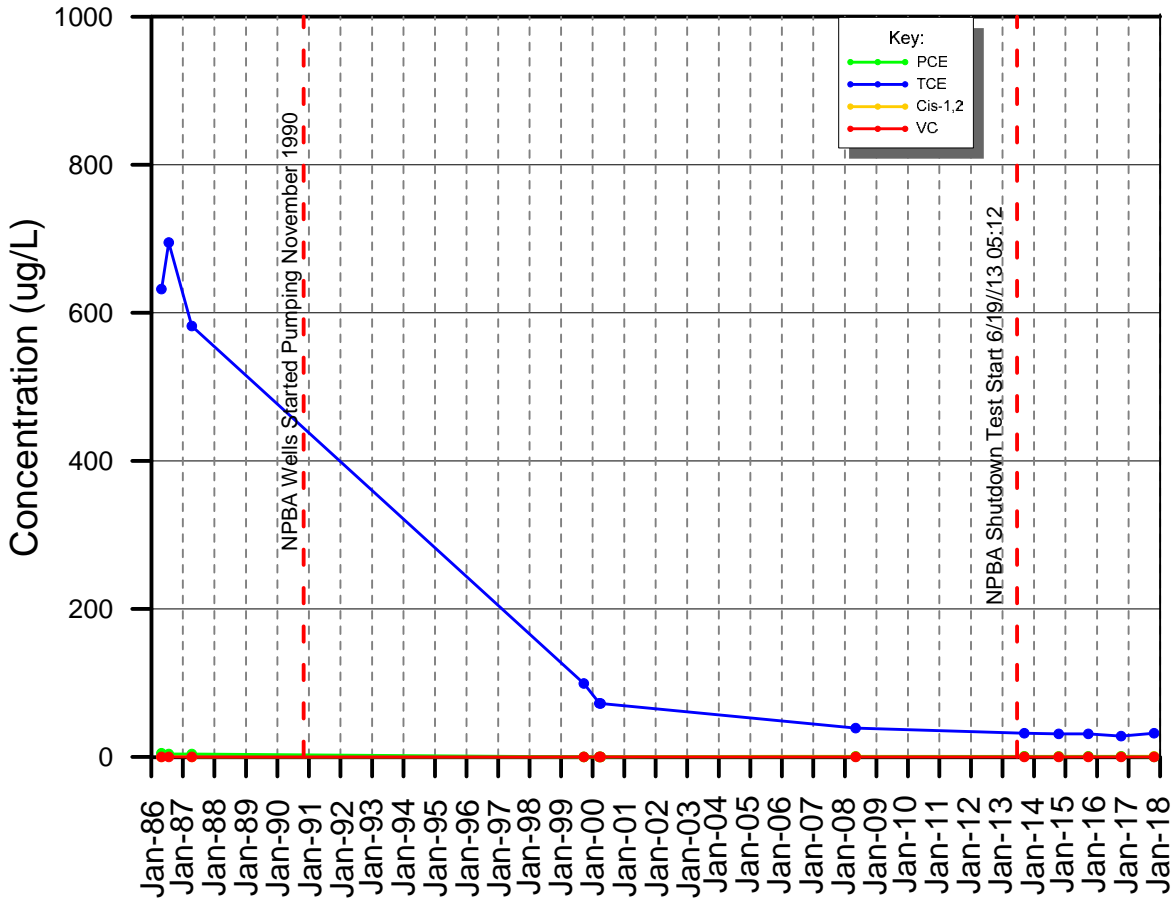
MW-20S



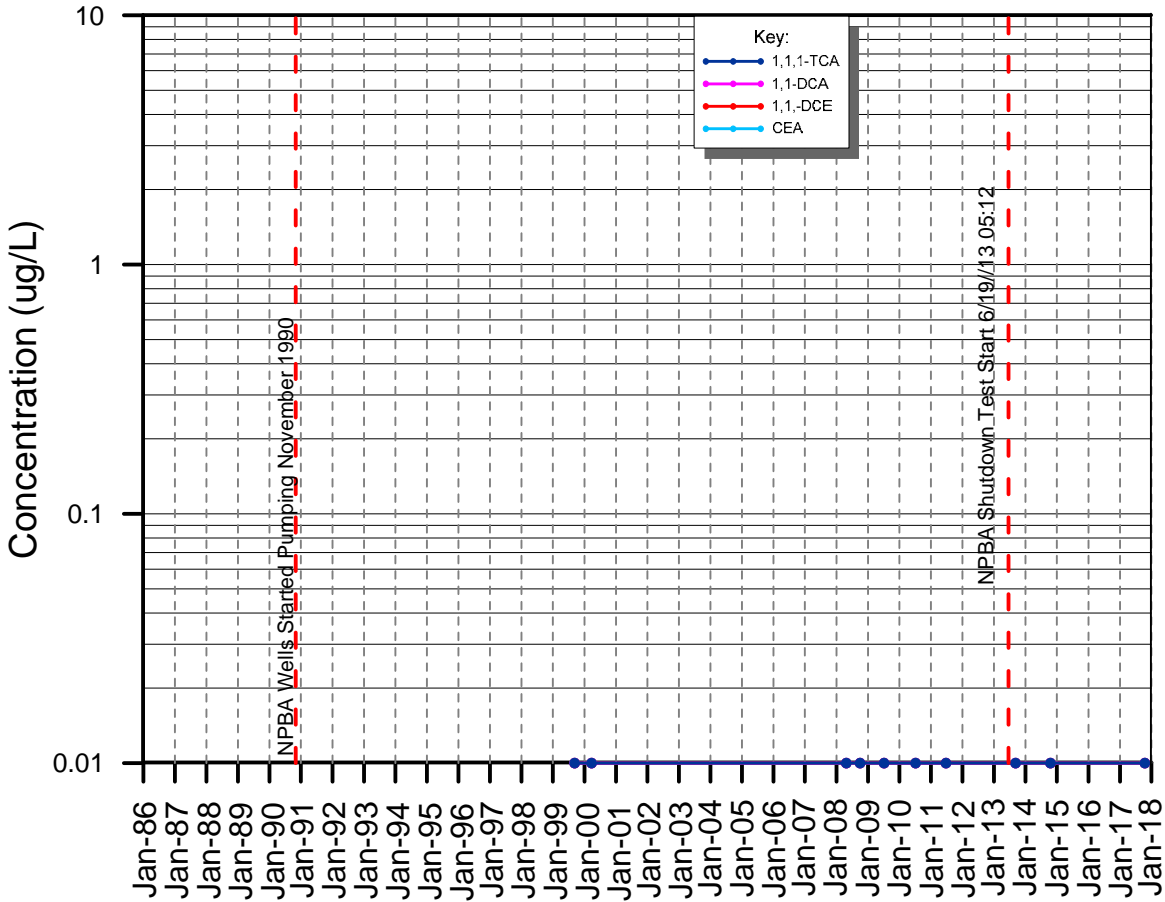
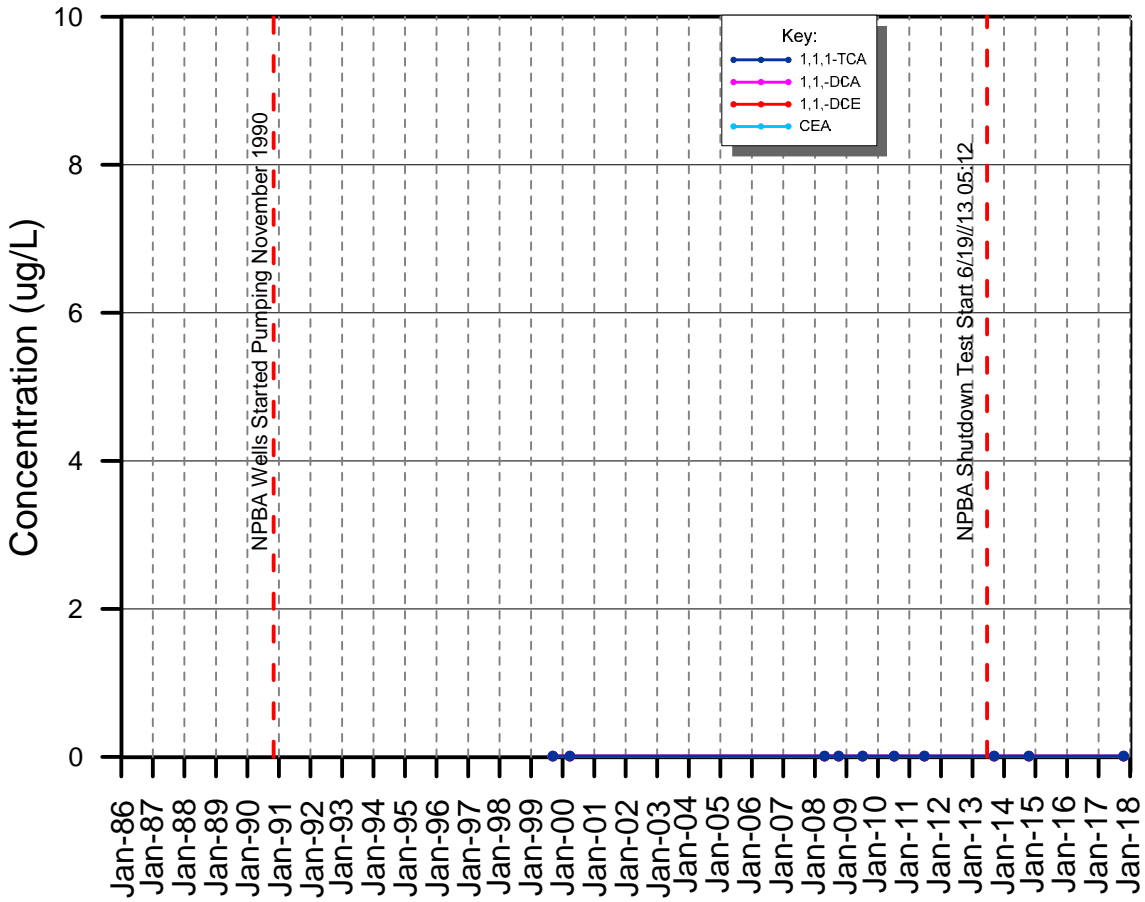
MW-3



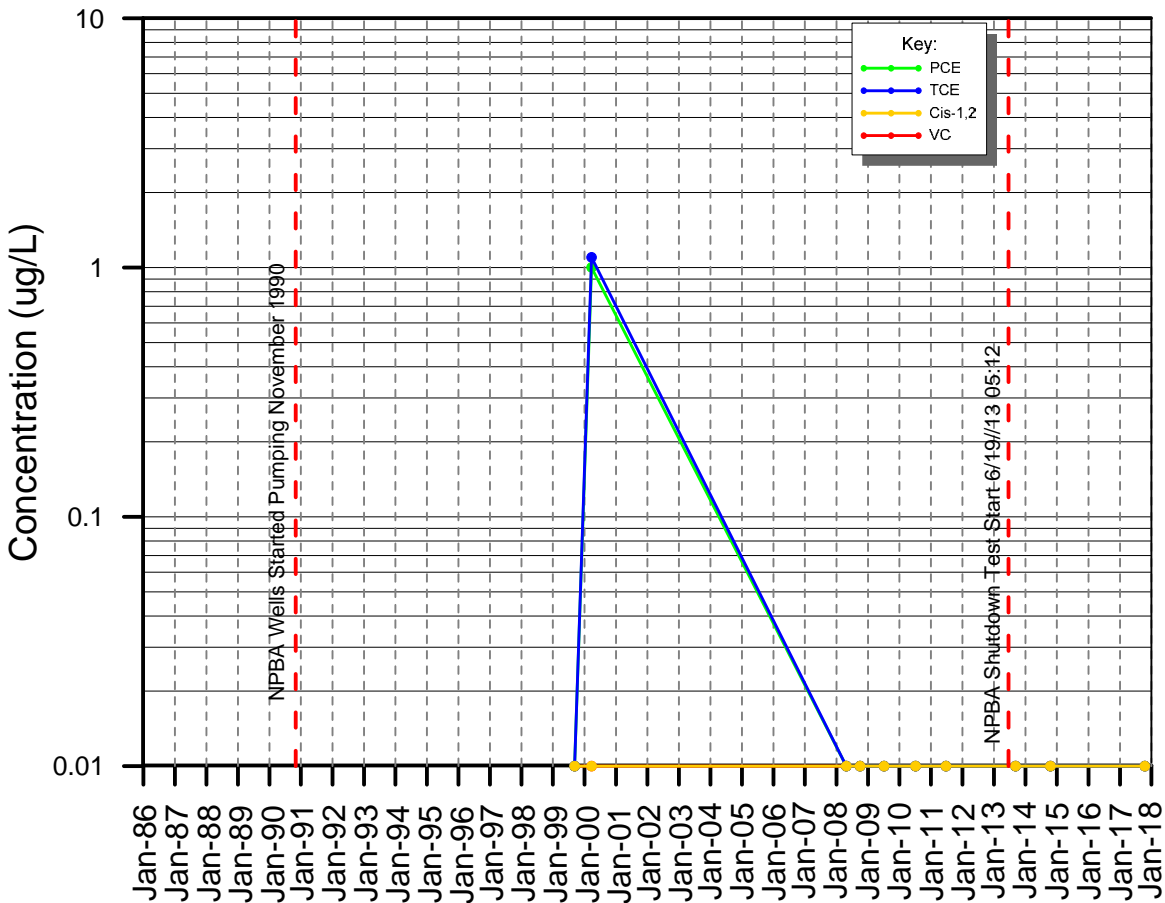
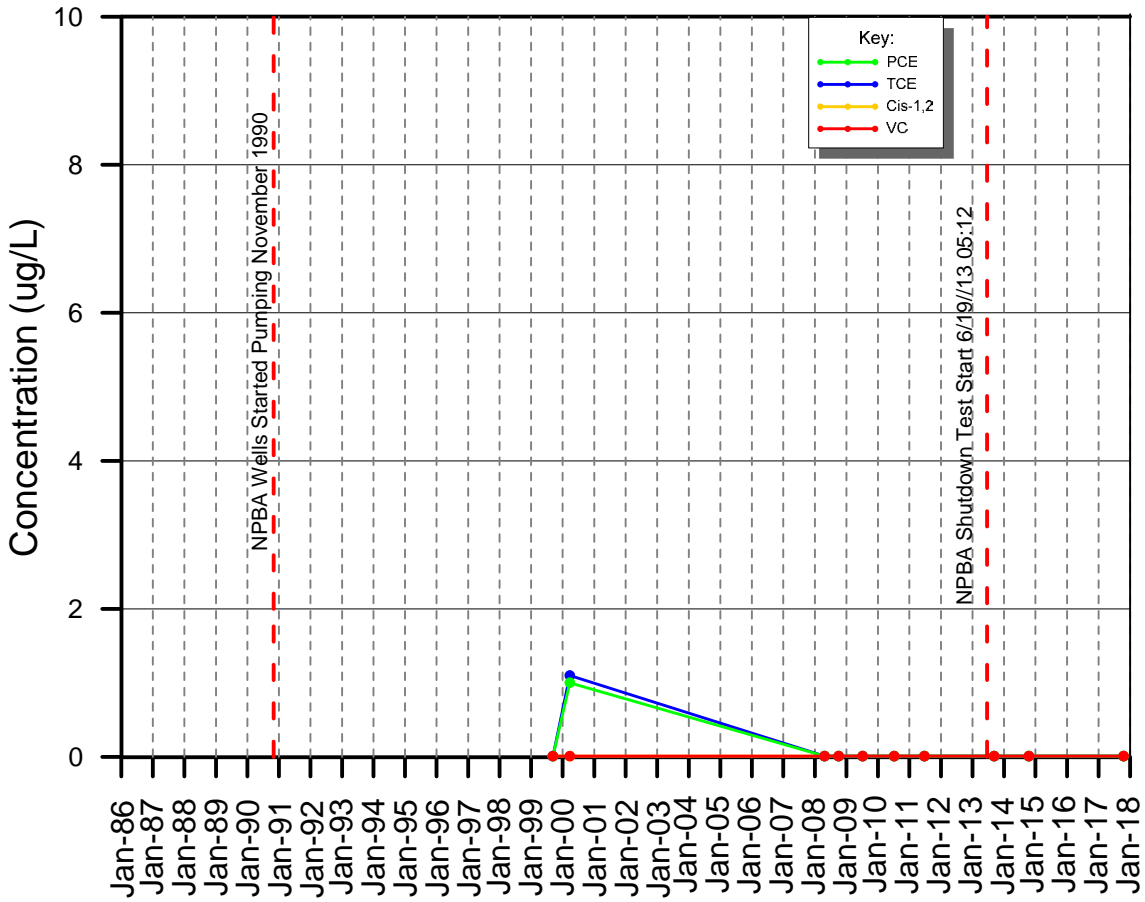
MW-3



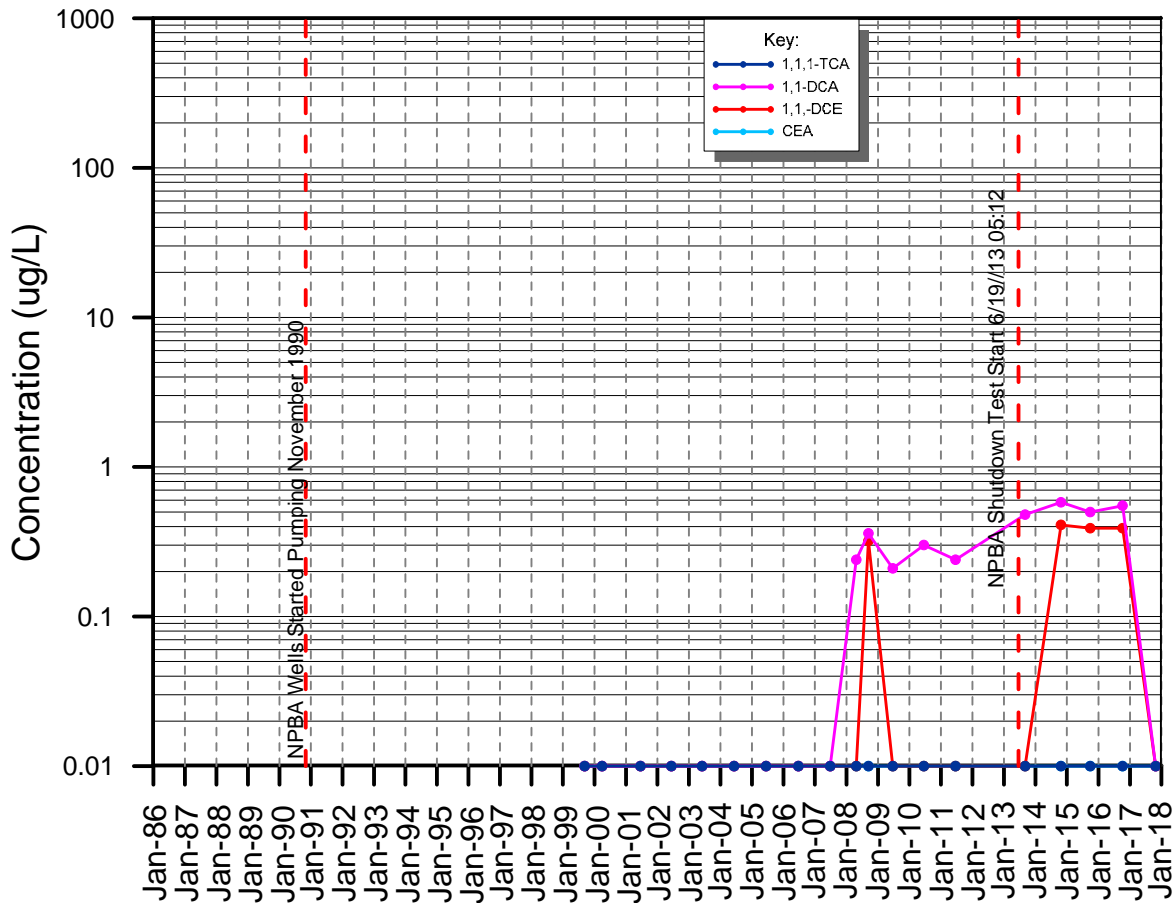
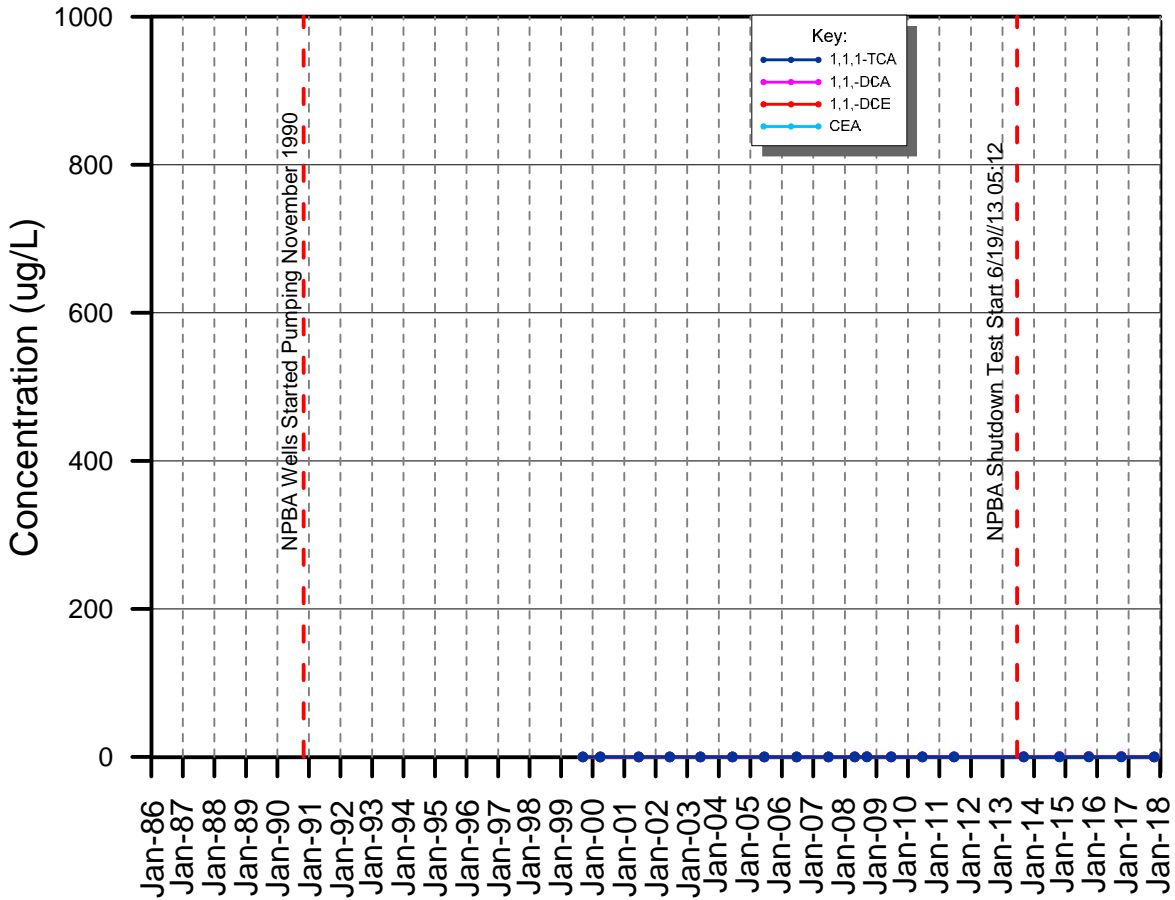
MW-77



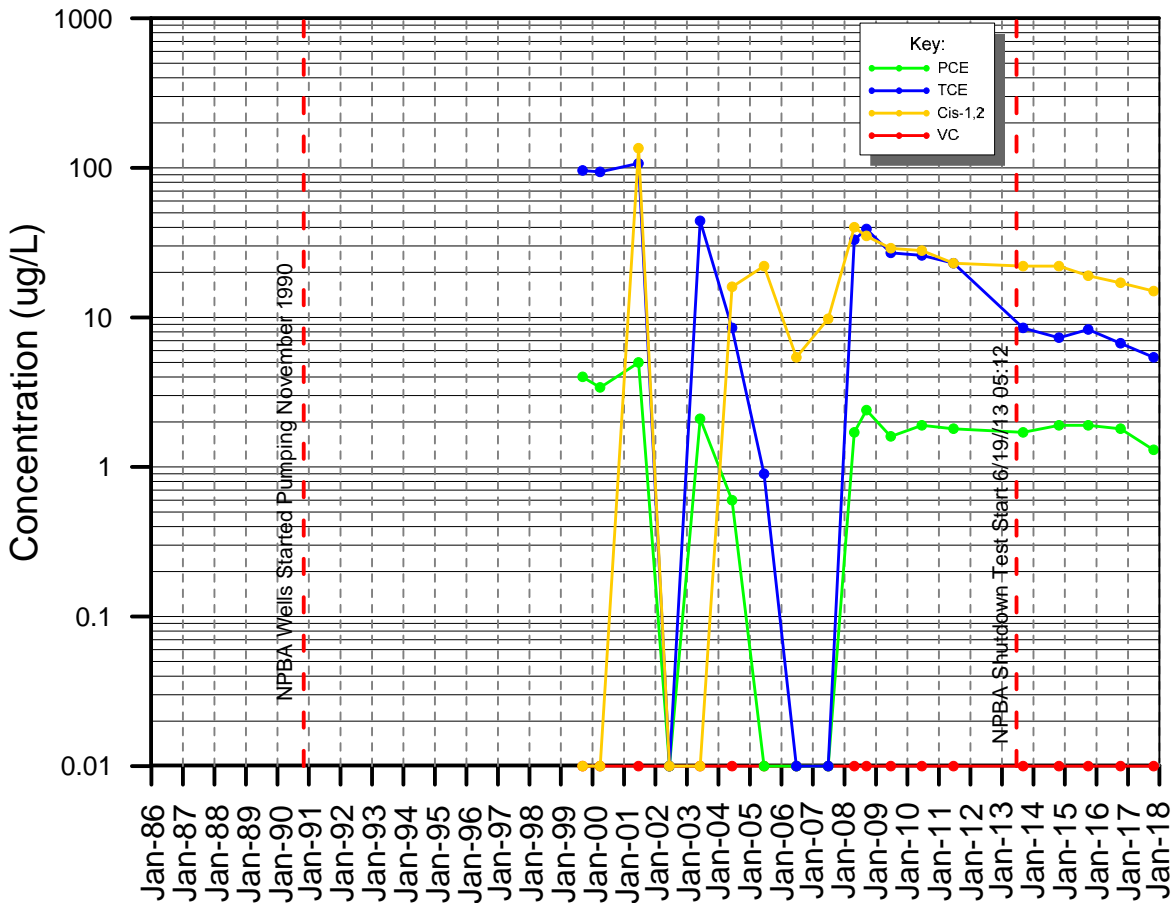
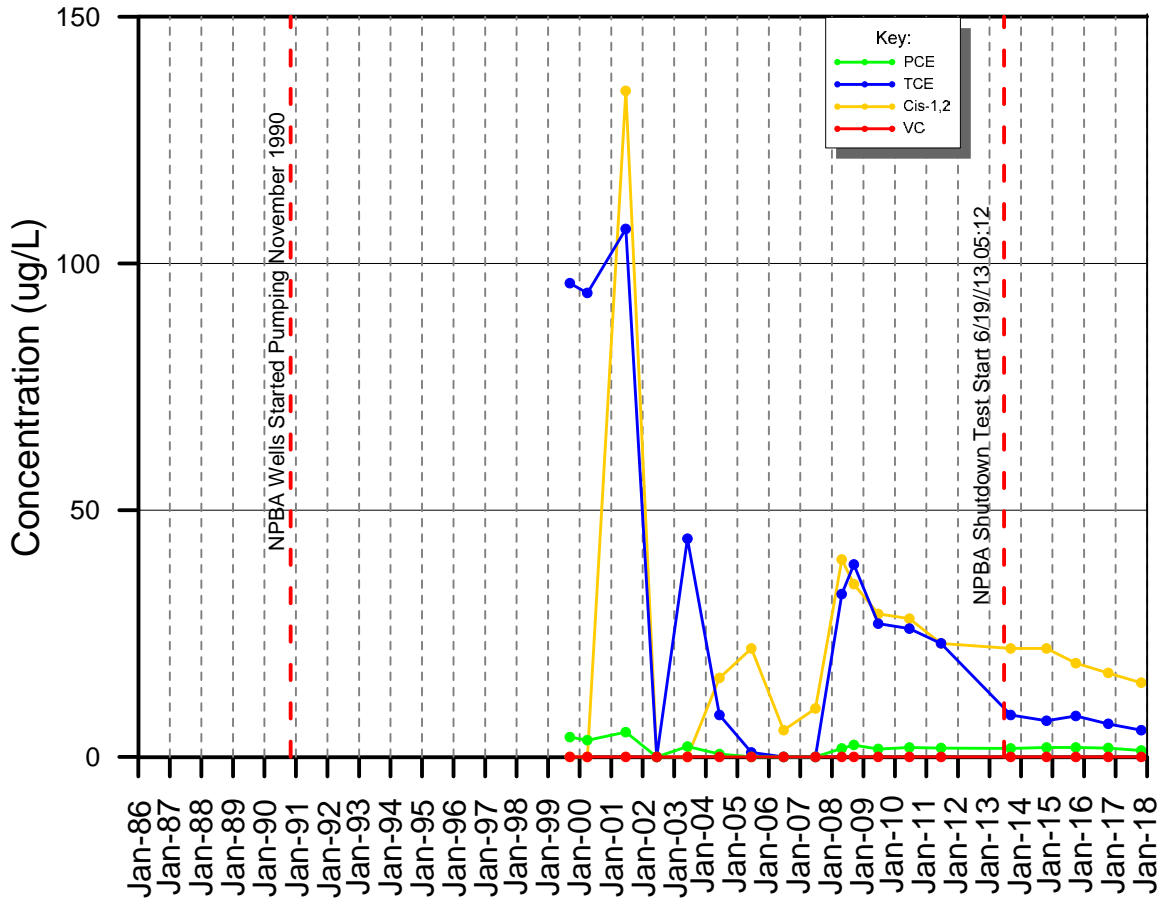
MW-77



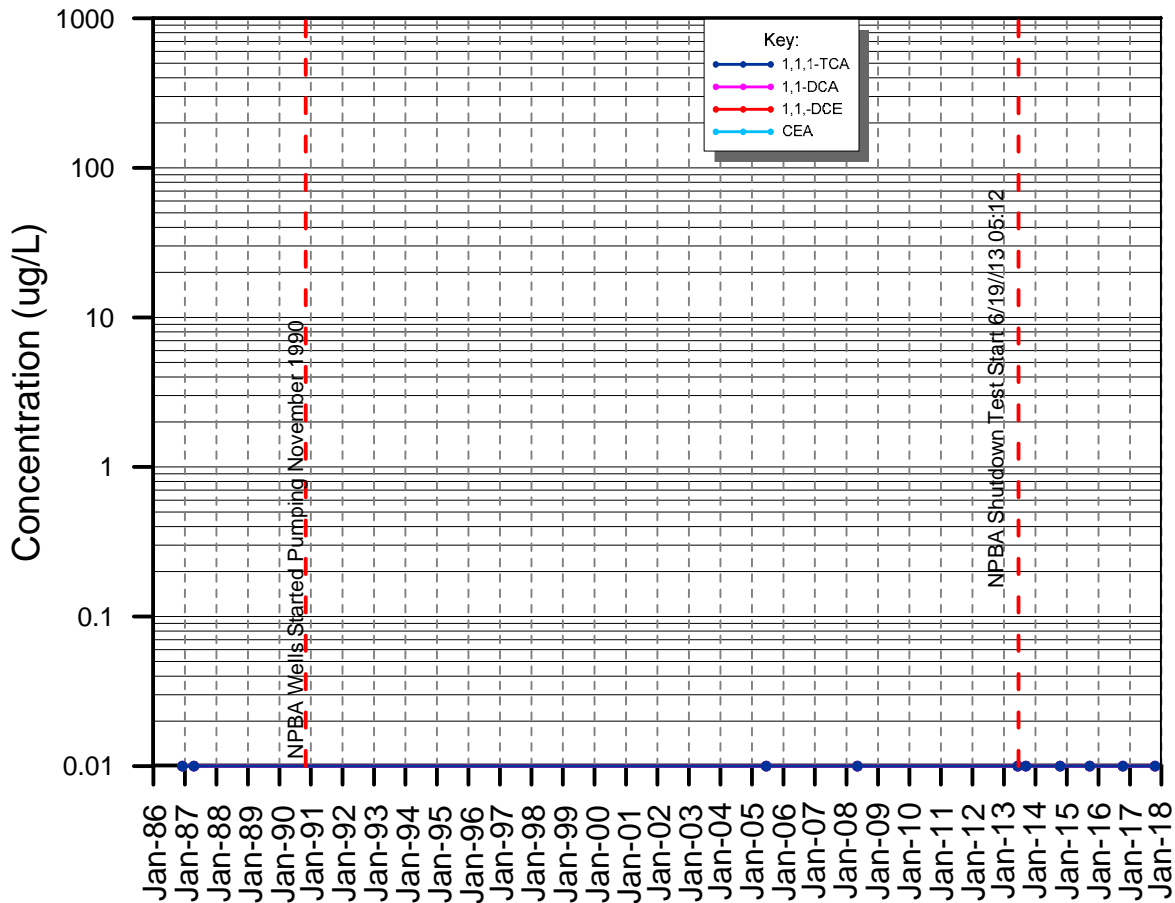
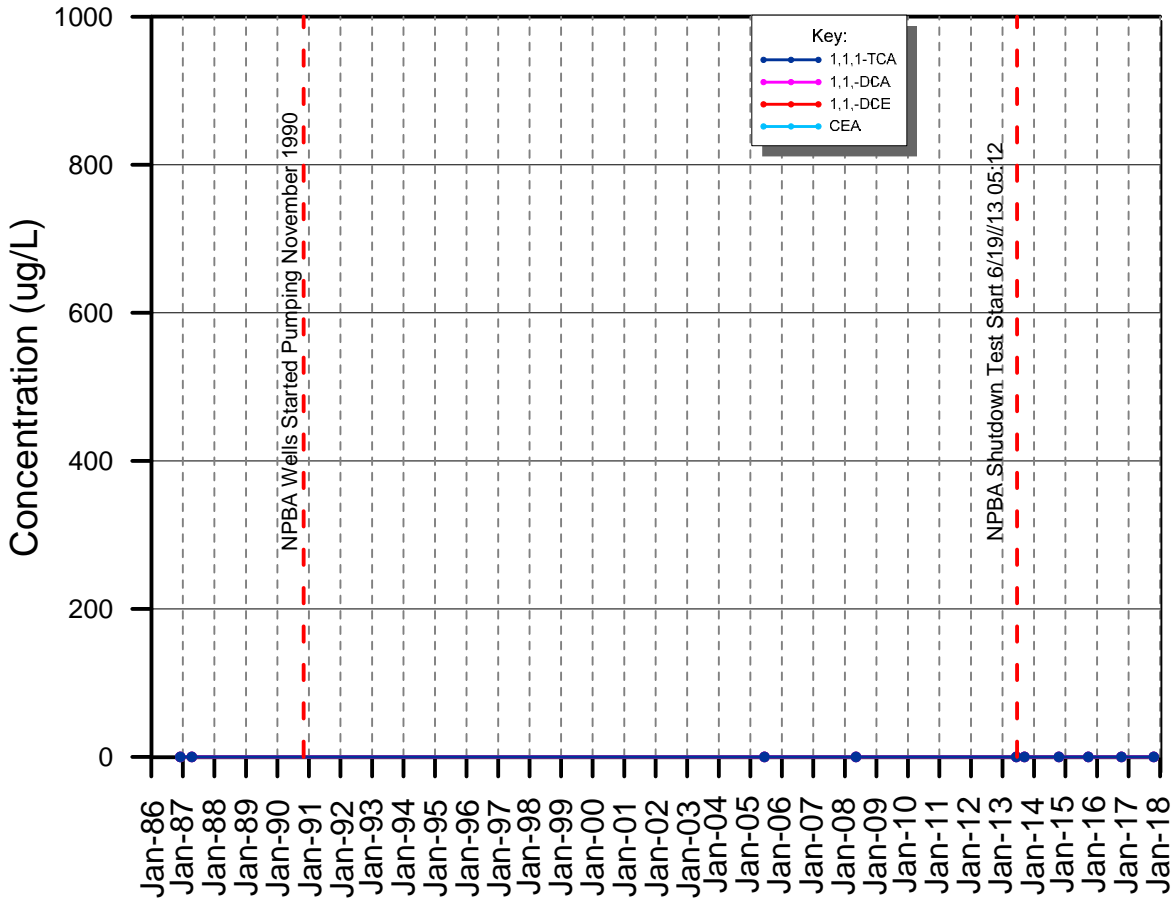
MW-82



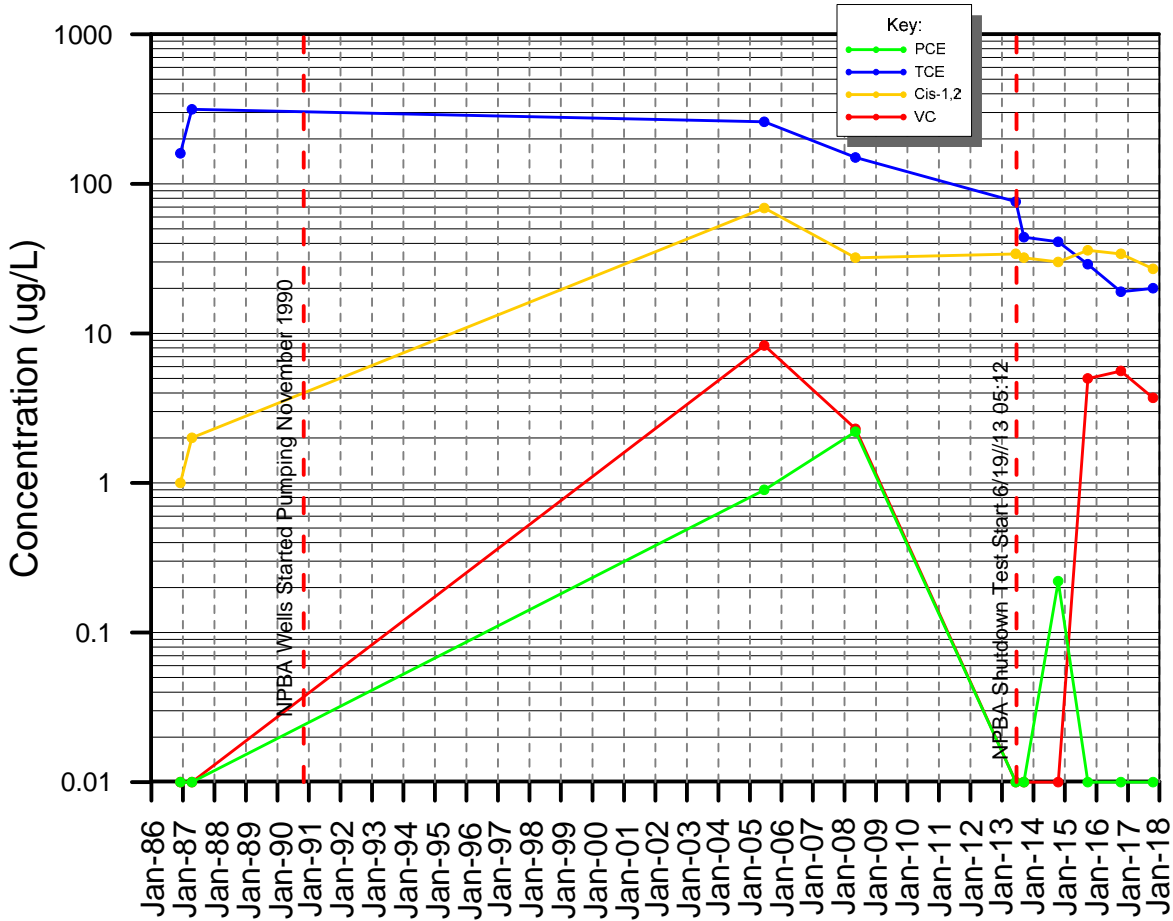
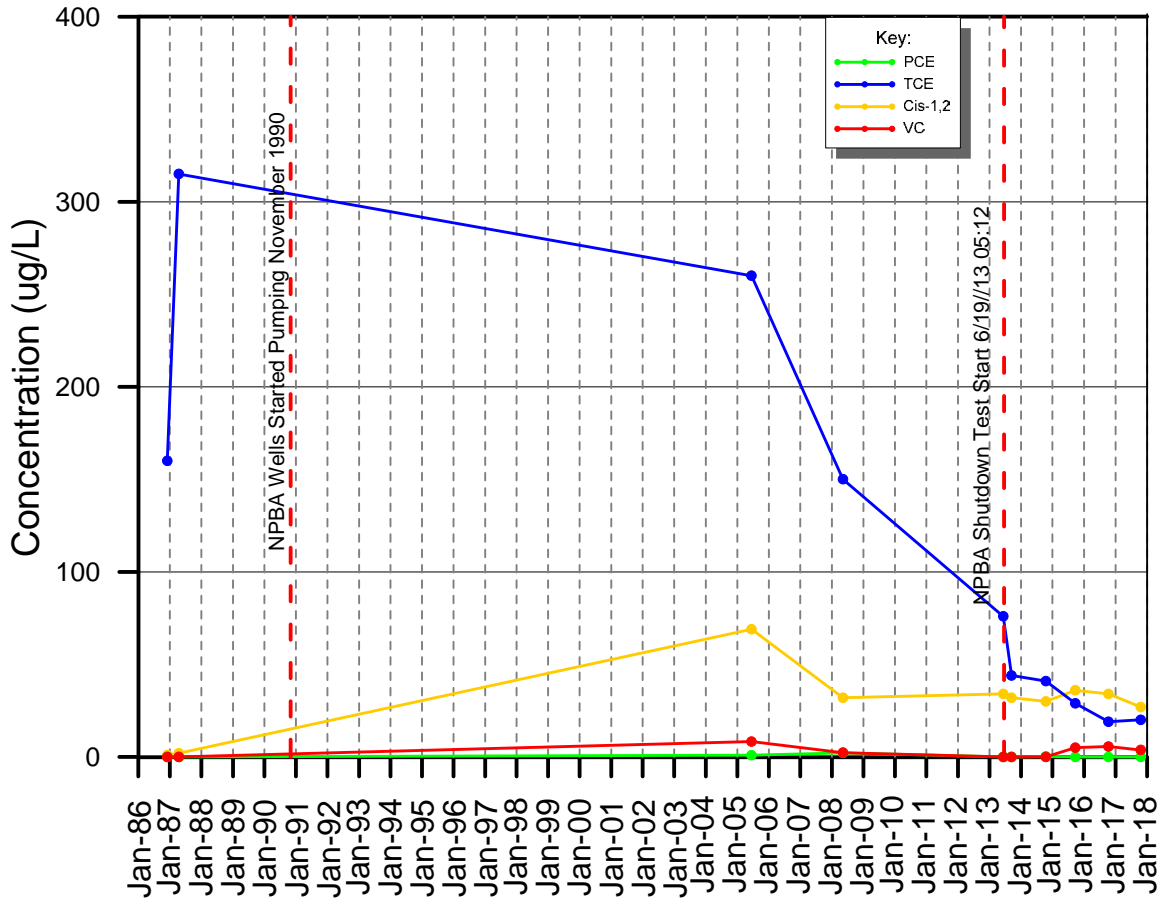
MW-82



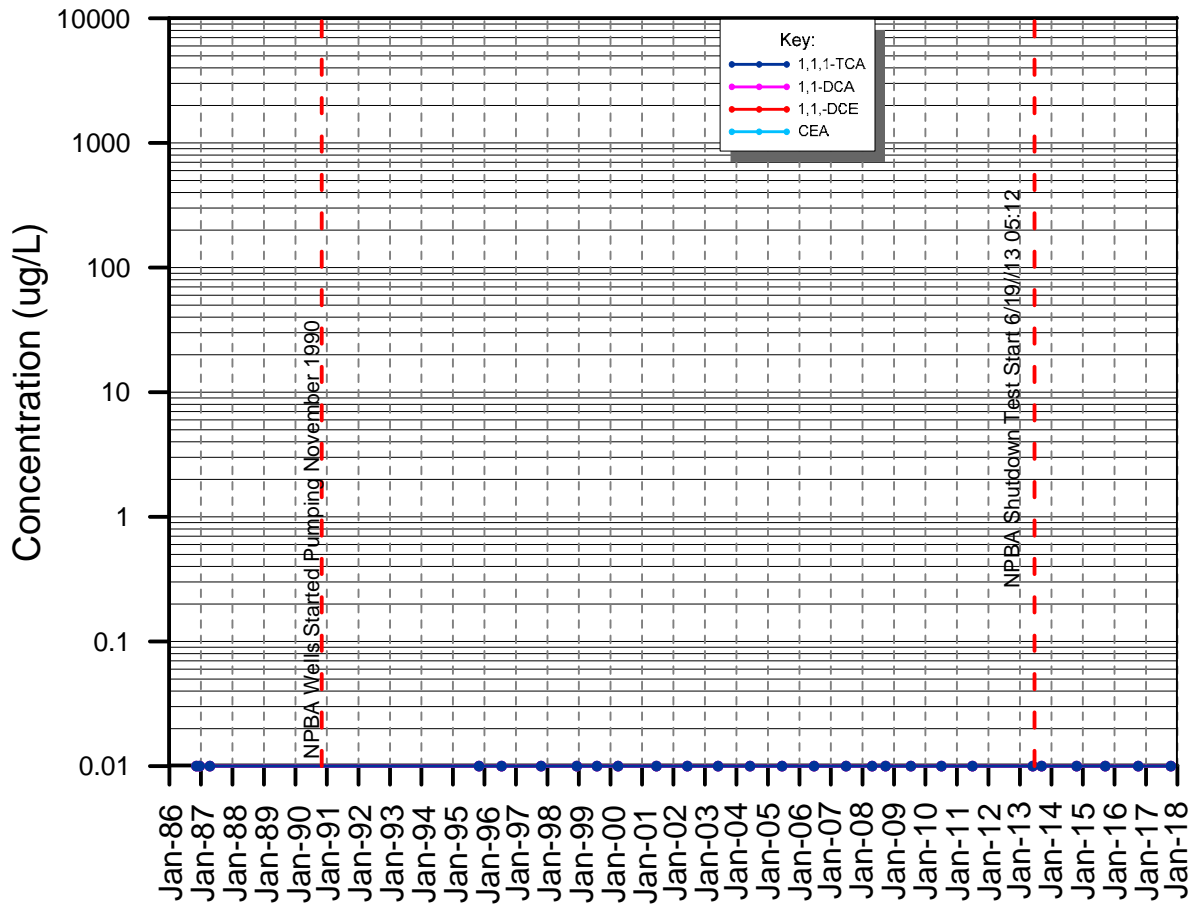
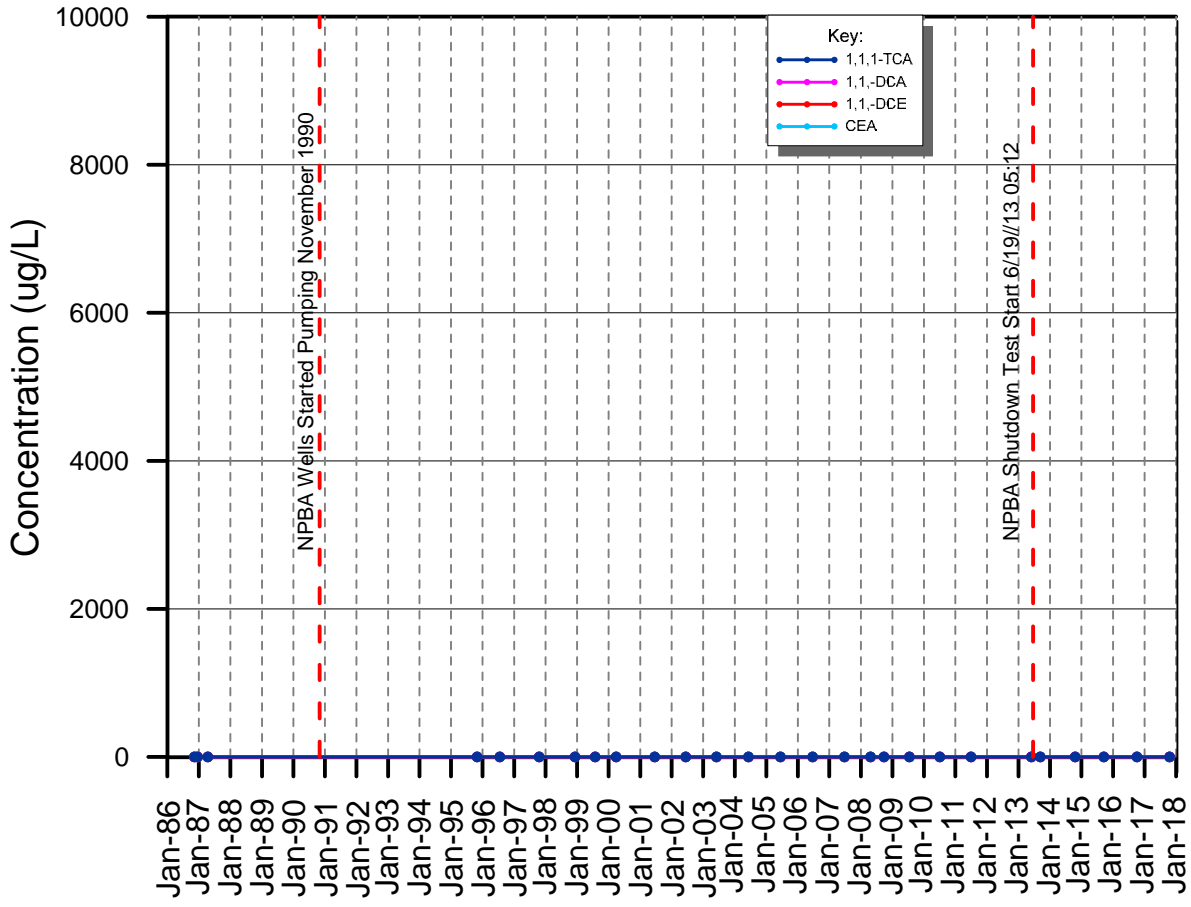
MW-9



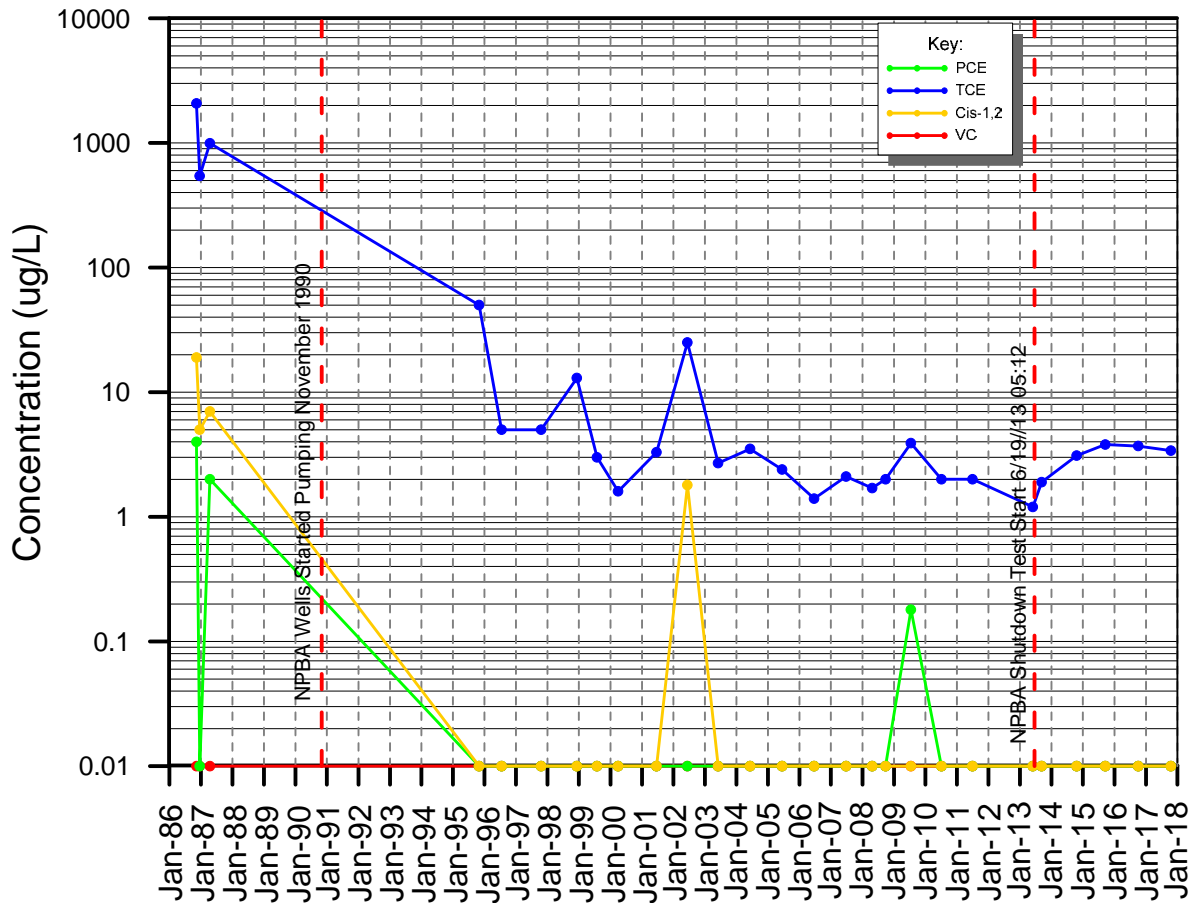
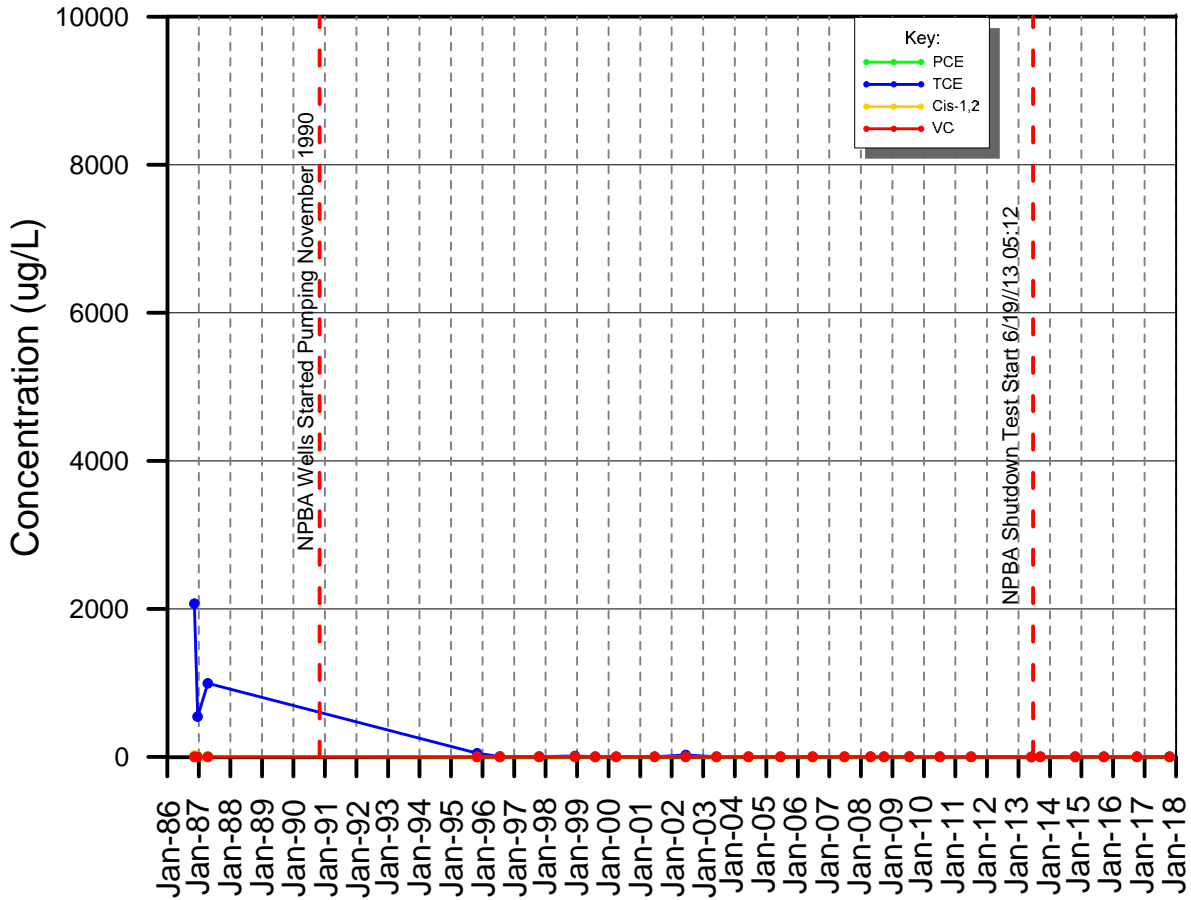
MW-9



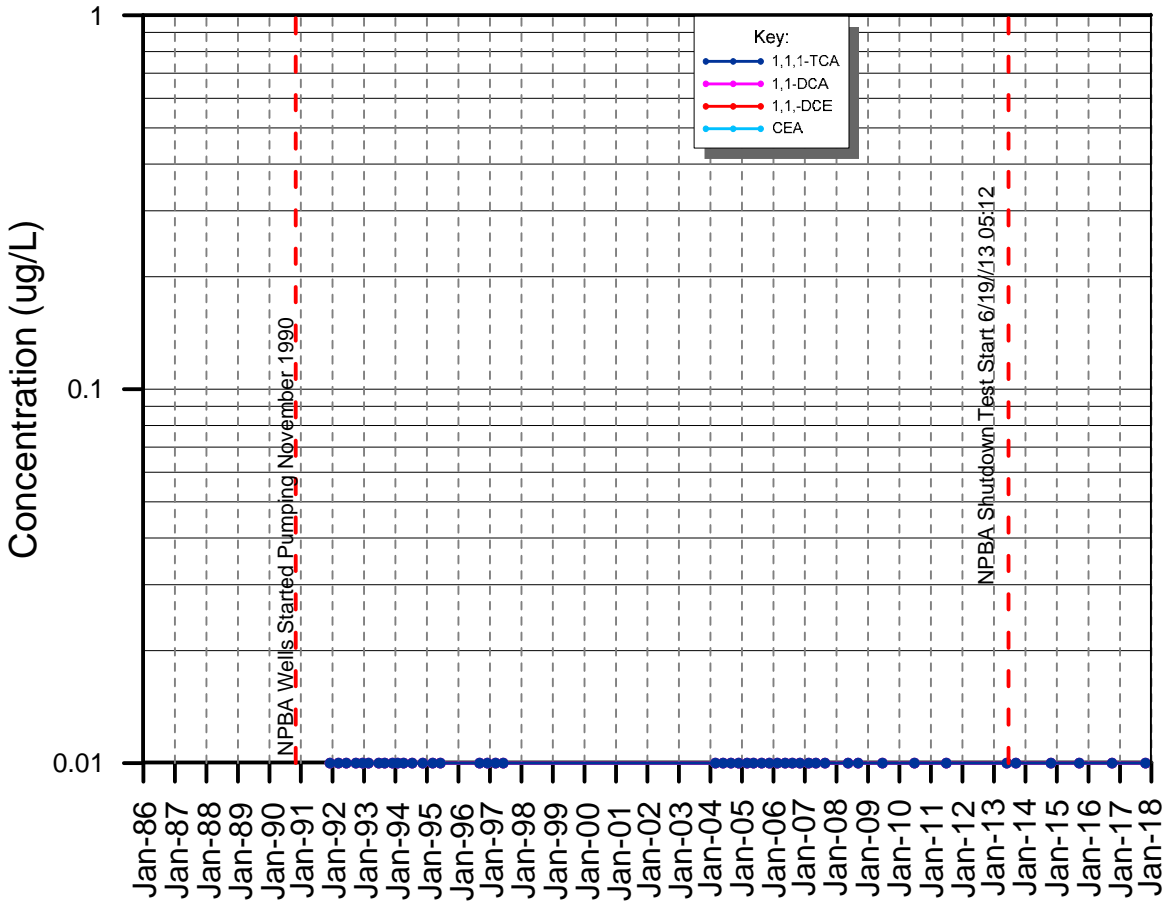
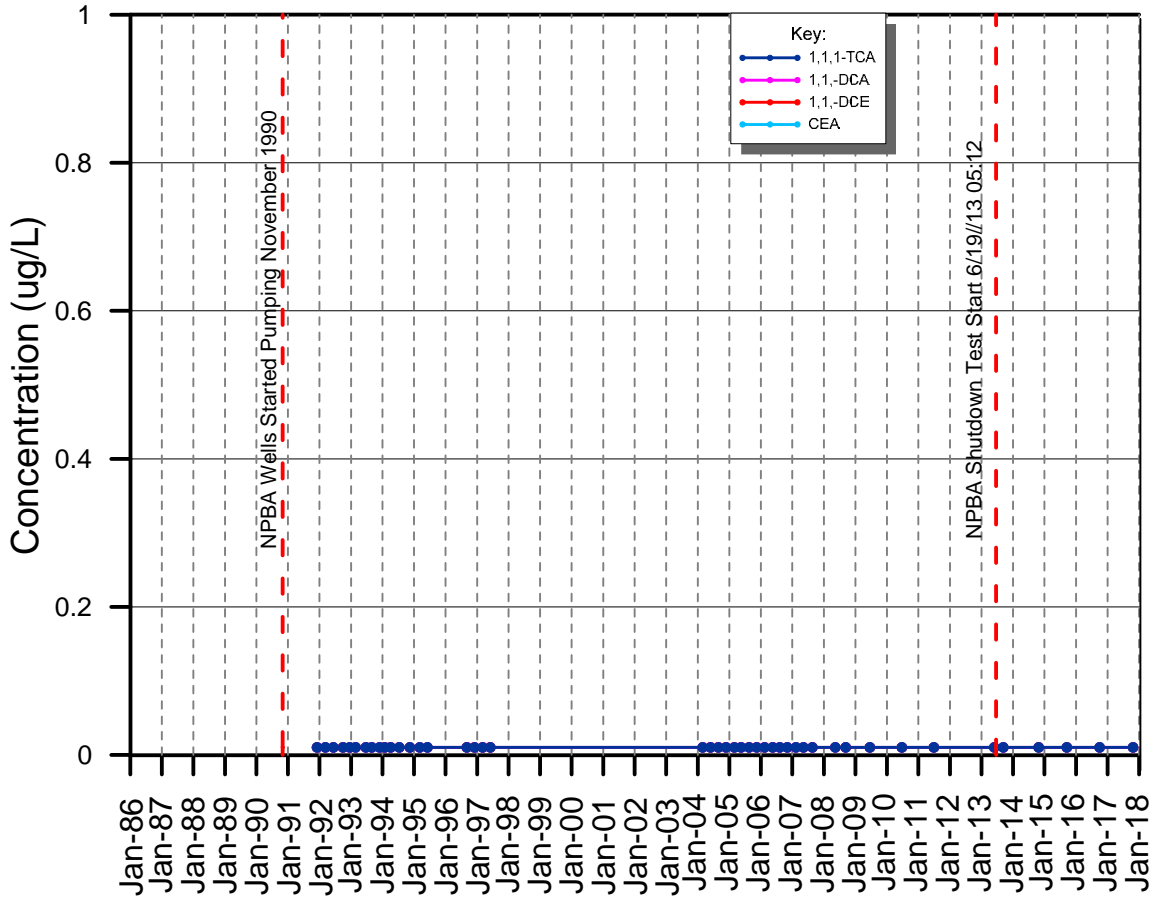
RW-2



RW-2



RW-4 (Folk)



RW-4 (Folk)

