Alabama Department of Transportation

Coliseum Boulevard Plume Analysis of TCE Trends Over Time Through January 2007

March 2007

4808-001

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1. Introduction

Groundwater samples have been collected from monitoring wells and Continuous Multichannel Tubing (CMT) wells at the Coliseum Boulevard Plume (CBP) Site from 2001 through 2006. Sufficient analyses have been completed that the data can be evaluated by visual and statistical methods to determine:

- Temporal changes in TCE concentrations throughout the CBP Site.
- Groundwater movement and TCE migration throughout the CBP Site.
- Occurrences and distributions of compounds that result from the degradation of the TCE.
- Extent of biodegradation at the CBP Site

These topics are discussed in the following sections. The first section provides the results of trend analyses to determine temporal changes in TCE concentrations at the CBP Site. The subsequent section, "Degradation Products of TCE," includes discussions of the limited occurrences and distributions of compounds that result from the degradation of TCE and the extent of biodegradation at the Site.

2. Temporal Changes in TCE Concentrations

2.1. Methodology

Time-series plots and intrawell Shewhart-Cumulative Sum (CUSUM) control charts were used to evaluate the trends in TCE concentrations. Trends were evaluated only for wells where TCE concentrations were above the detection limit for a sufficient number of sampling events to develop valid trends. Thus, trend analyses were completed for about 40 percent of the wells that are screened within the upper part of the water-table aquifer (upper WT) and for about 60 percent of the wells that are screened within the lower part of the water-table aquifer (lower WT).

2.1.1. Time-series Plots

Time-series plots provide for visual interpretations of trends. The TCE data were plotted for each well for which there were more than 4 sets of samples with TCE concentrations above detectable levels (Appendix A).

2.1.2. Shewhart-CUSUM Statistical Analysis:

The Shewhart-CUSUM statistical analysis provides two statistics that are based on comparison of recent monitoring results to results from the first year of sampling for each well (the first four events). The Shewhart statistic represents the "current" trend relative to baseline, whereas the CUSUM statistic represents the long-term trend relative to baseline (the CUSUM statistic retains a "memory" of previous values because it is a summed statistic). A statistically significant trend is indicated by a Shewhart statistic greater than 4.5 (or less than -4.5), or by a CUSUM statistic greater than 5 (or less than -5).

TCE trends for monitoring well MW-101 illustrate the difference between the Shewhart and the CUSUM measures (Figure 1). TCE concentrations for MW-101 have decreased from 133 ug/L to approximately 20 ug/L over the past 5 years with the majority of the decrease occurring within the first 3 years. In contrast, TCE concentrations at MW-101 over the past two years have been comparatively stable, varying only between 8 ug/L and 26 ug/L. The CUSUM statistic, representing the long term trend, is -36.3 (a significant decrease) and the Shewhart statistic, representing the short term trend is -1.3 (no significant trend).

2.2. RESULTS

Of the wells from which water samples contained detectable levels of TCE, approximately 60 percent are lower WT wells. Recharge from precipitation to the top of the aquifer causes this stratification of TCE such that the higher concentrations are near the base of the aquifer. The well locations used for the trend analysis are presented on Figure 2a and Figure 2b. Table 1 provides a comparison of the Shewart and CUSUM statistics for data from the upper WT and lower WT monitoring wells. For long-term trends (CUSUM statistic) and the most recent trends (Shewhart statistic), relatively few wells had increasing trends in TCE concentrations, with 86 percent of all monitoring wells exhibiting either no trend or a decreasing trend. Currently, no upper WT well and about 20 percent of the lower WT wells have increasing trends. The much higher percentage of wells with significantly decreasing long-term trends (72 percent for all wells) compared to recent trends (21 percent for all wells) largely reflects meterological effects.

TABLE 1
DISTRIBUTION OF TIME TRENDS BETWEEN
UPPER AND LOWER WATER TABLE MONITORING WELLS

Well Screen Interval	Shewhart Statistic				CUSUM Statistic			
	Increase	No Trend	Decrease	Total	Increase	No Trend	Decrease	Total
SITE WIDE								
Upper WT	0%	86%	14%	*100%*	4%	8%	88%	*100%*
Lower WT	19%	59%	22%	*100%*	20%	16%	64%	*100%*
All Wells	14%	65%	21%	*100%*	14%	14%	72%	*100%*
PH12 AREA								
All Wells	11%	70%	19%	*100%*	11%	15%	74%	*100%*

Notes: "Increase" and "decrease" are statistically significant trends.
Percentages are calculated within each trend direction. For the Shewhart test, 50 percent of the wells with significantly decreasing trends are upper WT wells and 50 percent of the wells with significantly decreasing trends are lower WT wells.

Spatial distributions of the trends are presented on Figures 3a and 3b. The recent trend for each well is presented on Figure 3a and the distribution of the CUSUM statistic for each well is presented in Figure 3b. The values for the Shewhart statistics and CUSUM statistics are provided in Appendix A. Most of the wells with increasing trends are along the southwest-northeast axis of the plume. This axis coincides with the dominant directions of groundwater flow. Wells with no trend or decreasing trends are principally found in the PH12 area and in areas around open fields where recharge is greater.

The following summaries are based on whether the trends were increasing, decreasing, or exhibiting no significant trend. The TCE concentrations in samples collected from most

of the monitoring wells exhibited either no significant trend or a significant decreasing trend.

2.2.1. Increasing TCE Trends

Review of the plots and the statistical analyses of the data indicate that:

- Less than 15 percent of all the monitoring wells had significant increasing trends (Table 1).
- The majority of the wells with significantly increasing trends were lower WT wells. All of the wells with significantly increasing recent trends are lower WT wells.
- Only 4 percent of the upper WT wells had significantly long-term increasing trends.
- Wells with significant increasing trends are along the dominant northeast-southwest orientation of the plume; the primary directions of groundwater flow coincide with this orientation (Figures 4a, 4b).
- Based on the Conceptual CBP Model and the numeric Site Wide Model, wells with significantly increasing TCE concentrations are expected to be downgradient of areas where there are the higher TCE concentrations. Figure 5 illustrates the increasing trend at well MW-232, west of the PH12 area and immediately downgradient of the 0.1 mg/L TCE isopleth.
- Within the PH12 area:
  - Only 11 percent of the monitoring wells had significant increasing trends.
  - The monitoring wells with significant increasing trends are within the western side of the PH12 area.
  - A slightly steeper gradient on the southwestern side of the groundwater divide is responsible for the increasing trends in the monitoring wells on the western side of the PH12 area. This slight increase in the gradient is largely a result of borrow pit dewatering to the southwest and modifications to the West Kilby Ditch to the northeast.
- Only one well in the PH12 area exhibited a significant increasing trend. This well (MW-237C) is within 500 feet of the western side of the PH12 area and is where the Site Wide model predicts higher rates of TCE movement will occur due largely to pumping from the borrow pits. All other wells downgradient and within 500 feet of the PH12 area (MW-106, MW-107/207, MW-135A/235B/235C, MW-136A/236A, and MW-3A) all had either no significant trends or decreasing trends. These wells are on the eastern side of the PH12 area.

2.2.2. No Significant Trend or Decreasing TCE Trends

- The majority of the site wide wells, 86 percent, have either no significant trends or significantly decreasing trends (Table 1).
- Long-term trends for upper WT wells (96 percent) were more likely to exhibit no significant or decreasing trends (Table 1). The majority of the lower WT wells (approximately 80 percent) exhibit no significant or decreasing trends.
- Recent TCE trends for all upper WT wells were either not significant or decreasing.
- Wells with significant decreasing trends are commonly in or immediately adjacent to open fields or drainage ditches (see for example, Figures 6 A and B). TCE trends in these wells inversely correlate with localized rises in groundwater levels due to increased recharge (increased precipitation).
  - The inverse relationship between TCE trends and precipitation is more evident in the upper WT wells.
  - Groundwater levels rose markedly in early 2003 due to increased precipitation after an extended drought. TCE concentrations began to decrease at upper WT wells at approximately the same time, for example MW-128 and MW-130 (Appendix A).
  - Deeper wells were less susceptible to recharge-related decreases of TCE concentrations. Some lower WT wells showed evidence of recharge-induced dilution, for example MW-203 (Appendix A):
    - TCE concentrations increased until the end of the 2001/2002 drought decreased through 2004, and flattened to the present.
    - This well is in an area where the water-table aquifer is relatively thin and prone to respond to localized precipitation.
    - Screened interval (29-33 feet BLS) is relatively shallow for a lower WT well.
- Within PH12 Area:
  - Most (89 percent) of the monitoring wells within the PH12 area have either no significant trends or significantly decreasing trends.
  - Recent trends (Shewhart Statistic)
    - 70 percent of the sampling locations have no statistically significant trends
    - 19 percent of the sampling locations have significant decreasing trends.
  - Long term trends (CUSUM Statistic)
    - 15 percent of the sampling locations have no statistically significant trends

- 17 percent of the sampling locations have significantly decreasing trends

- Immediately downgradient (within 500 feet) of the PH12 area, all wells with the exception of MW-237C had no significant trend or decreasing trends. As discussed in the "Increasing TCE Trend" section, the significant increase at MW-237C is largely the result of a slightly steeper gradient on the western side of the PH12 area due to borrow pit dewatering.

3. Degradation Products of TCE

In addition to TCE, analyses for other volatile organic compounds typically found as impurities in TCE (e.g., 1,1-dichloroethene) or degradation products of TCE (e.g., cis 1,2-dichloroethene and vinyl chloride) have been completed. Indicators of biodegradation (e.g., methane) also have been routinely measured. Few TCE degradation products have been detected in groundwater samples from within the CBP; where detected, they are predominately from within the PH12 area of the plume. Cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and vinyl chloride are the principal TCE degradation products that have been detected in groundwater samples within the CBP Site. Vinyl chloride has been detected only since October 2005 (see time trend graphs in Appendix B). The occurrences of these degradation products are largely restricted to two CMT wells within the PH12 area and there is no evidence that significant biodegradation is occurring within the CBP (see Figures B-1 through B-6 in Appendix B).

Table 2 shows a comparison of analytical results for samples from well cluster MW-138A/238B/238C and from comparable screen intervals from CMT-4, which is approximately 20 feet away. Constituents indicative of biodegradation (for example; dehalococcoides, vinyl chloride, cis 1,2-DCE, and methane) were detected in samples collected from CMT-4 but below detectable levels in all samples collected from the immediately adjacent MW-138A/238B/238C well cluster.

TABLE 2
PRESENCE/ABSENCE OF DEHALOCOCCOIDES AND CONCENTRATIONS OF TCE AND DEGRADATION PRODUCTS IN WATER SAMPLES FROM WELL CMT 4 AND WELL CLUSTER 138A/238B/238C

	CMT 4-3	MW-138A	CMT 4-5	MW-238B	CMT 4-6	MW-238C
Distance Between Wells (ft)	35		20		15	
Screen Interval (ft BGS)	35 - 37	34 - 38.5	45 – 48	44 - 48	51 - 54	50 - 54.5
Trichloroethylene (max ug/L)	6,900	10,900	9,360	17,300	13,500	17,900
Vinyl Chloride (max ug/L)	30.6	10 ND	649	33 ND	367	50 ND
1,1-Dichloroethene (max ug/L)	156	486 J	826	1,070	700	1,020
Cis-1,2-Dichloroethene (max ug/L)	290	10 ND	1760	33 ND	625	50 ND
Methane (max ug/L)	240	2 ND	57	2 ND	17	2 ND
pH (average SI)	5.71	4.76	6.42	5.38	5.93	5.41
Dehalococcoides (present/absent)	Present	Absent	Present	Absent	Present	Absent

- Cis 1,2-dichloroethene (cis 1,2-DCE)
  - Only above detectable levels in the PH12 area, Kilby Ditch area, and Low Lying area.
  - Highest concentrations are in and immediately adjacent to the PH12 area.
  - Concentrations of cis 1,2-DCE do not correlate well with TCE concentrations. For example, cis 1,2-DCE was detected in samples from CMT 4-5 but was not detected in samples from a monitoring well MW-238B approximately 20 feet away (Table 2).
  - Concentrations of cis 1,2-DCE correlate well with presence of methane in samples.
  - Likely dominant source of cis 1,2-DCE is biodegradation of TCE.
- Vinyl Chloride
  - Vinyl chloride has been detected only in water samples from only four CMT wells within the PH12 area.
  - Highest concentrations are in samples from CMT-2 and CMT-4.
  - No detectable levels of vinyl chloride were present in CMT samples prior to October 2005.
  - Presence of vinyl chloride corresponds with the presence of dehalococcoides.
  - Likely dominant source of vinyl chloride is biodegradation of the cis 1,2-DCE.
- 1,1-dichloroethene (1,1-DCE)
  - Occurrence is more widespread than cis 1,2-DCE.
  - Highest concentrations are in samples from wells immediately adjacent to the PH12 area.
  - Concentrations of 1,1-DCE correlate well with TCE concentrations.
  - Likely dominant source of 1,1-DCE is impurities in the TCE used by the Materials Testing Laboratory.

Groundwater quality parameters that influence or are indicators of biodegradation also have been measured. Methane and pH are routinely measured in samples and dehalococcoides has been measured periodically.

- Methane
  - Above detectable levels in samples from the PH12, Kilby Ditch, and Low Lying areas.
  - Highest concentrations are in samples from CMT-2 and CMT-4 and directly correlate with vinyl chloride concentrations detected in samples from these wells.
  - Locally highly variable: Present at 240 ug/L in CMT 4-3 but below detectable levels in samples from MW-138A approximately 35 feet away (Table 2).
- Dehalococcoides
  - Present only in samples from CMT-2 and CMT-4 and absent in samples from all monitoring wells.
  - Absent in samples from well cluster MW-138A/238B/238C, which is approximately 20 feet from CMT-4.
- pH
  - Groundwater throughout the CBP is acidic (averaging less than pH 5).
  - pHs of samples from the CMT wells are significantly higher than the monitoring wells, averaging 6.25 (Table 3).

TABLE 3
pH DISTRIBUTION IN CMT AND MONITORING WELLS

Well Type	Average	5th Percentile	95th Percentile
CMT (all)	6.25	5.35	7.51
Monitoring Well (all)	4.82	4.00	5.84

Any localized biodegradation at CMT 2 and CMT 4 may result from the anomalously high pH at these wells. The pH of water samples from all the CMT wells at the CBP Site have been consistently higher than for the monitoring wells. Specifically, the pH values of the groundwater samples collected from well cluster MW-138A/238B/238C (approximately 20 feet away) have been about one pH unit lower than the water samples from nearby CMT 4 (Table 2). The higher pH at the CMT wells is more conducive to dehalococcoides growth and may be partly responsible for the dehalococcoides in water samples from the CMT wells. The source of this variation in pH between CMT and monitoring wells is not readily apparent; however, it may be related to the difference in construction and sampling methods for these two types of wells.

4. Summary and Conclusions

Visual evaluations of the trend plots and the quantitative Shewhart-CUSUM analyses led to similar conclusions:

- TCE concentrations for a majority of the wells (86 percent) in the CBP have no trends or significantly decreasing trends.
- In the PH12 area, 93 percent of the wells have no trends or significantly decreasing trends.
- Recent TCE concentrations for all upper WT wells have either no significant trends or decreasing trends largely due to recharge from precipitation.
- Wells for which there are significantly increasing trends are aligned along the northeast-southwest axis of the plume. The axis coincides with the dominant directions of groundwater flow.
- Wells for which there are increasing trends are screened near the base of the aquifer where the effects from recharge are less.

The TCE trends are consistent with the plume movement predicted by the Conceptual CBP Model and the numeric Site Wide Model. The CBP straddles a groundwater divide and is bounded by Three Mile Branch to the northeast and sand and gravel borrow pits to the southwest. The current configuration of the plume is close to its maximum aerial extent and the lack of any trend to decreasing trends in TCE concentrations for 86 percent of the monitoring wells are indicative of this largely stable, slowly dispersing plume.

Based on the Conceptual CBP Model and the numeric Site-Wide Model, TCE concentrations in the PH12 area will continue to decrease very slowly. Groundwater movement within the PH12 area is very low, less than 10 feet/year. Outside the PH12 area groundwater movement increases to over 100 feet/year near Three Mile Branch (northeast) and the borrow pits (southwest). Recharge along the flow path from the groundwater divide (PH12 area) to Three Mile Branch and the borrow pits is largely responsible for the low TCE concentrations at the distal ends of the plume.

The significant increases in TCE concentrations along the western edge of the PH12 area result from borrow pit dewatering to the southwest. The borrow pits have tripled in area over the past 10-years. Rerouting and piping or concrete lining parts of the West Kilby Ditch over this same period reduced groundwater flow to the Ditch. As predicted by the Site-Wide Model, expansion of the borrow-pit dewatering operations and modifications to the West Kilby Ditch result in a very slight shift of the groundwater divide to the east.

This shift, while sufficient to increase TCE concentrations in wells along the western border of the PH12 area, is not enough sufficient to significantly change TCE concentrations at the distal ends of the plume.

Degradation products in the water samples likely were impurities within the original TCE that was used for asphalt extraction in the Materials and Testing Laboratory or from highly localized biodegradation. Evidence of anaerobic biodegradation of TCE in the groundwater is restricted to samples of groundwater from only wells CMT 2 and CMT 4. With the exception of these two wells, there is no evidence that the rate of TCE degradation is sufficient to result in significant decreases in TCE concentrations within the CBP. The highly localized degradation of TCE at wells CMT 2 and CMT4 may result from elevation of the pH of the water due to the grouting of the wells. The pH of the water throughout the rest of the CBP, which averages less than 5, likely suppresses growth of dehalococcoides colonies and thereby is too low to support conditions needed for biodegradation of the TCE.

Time Series Plot - MW-101

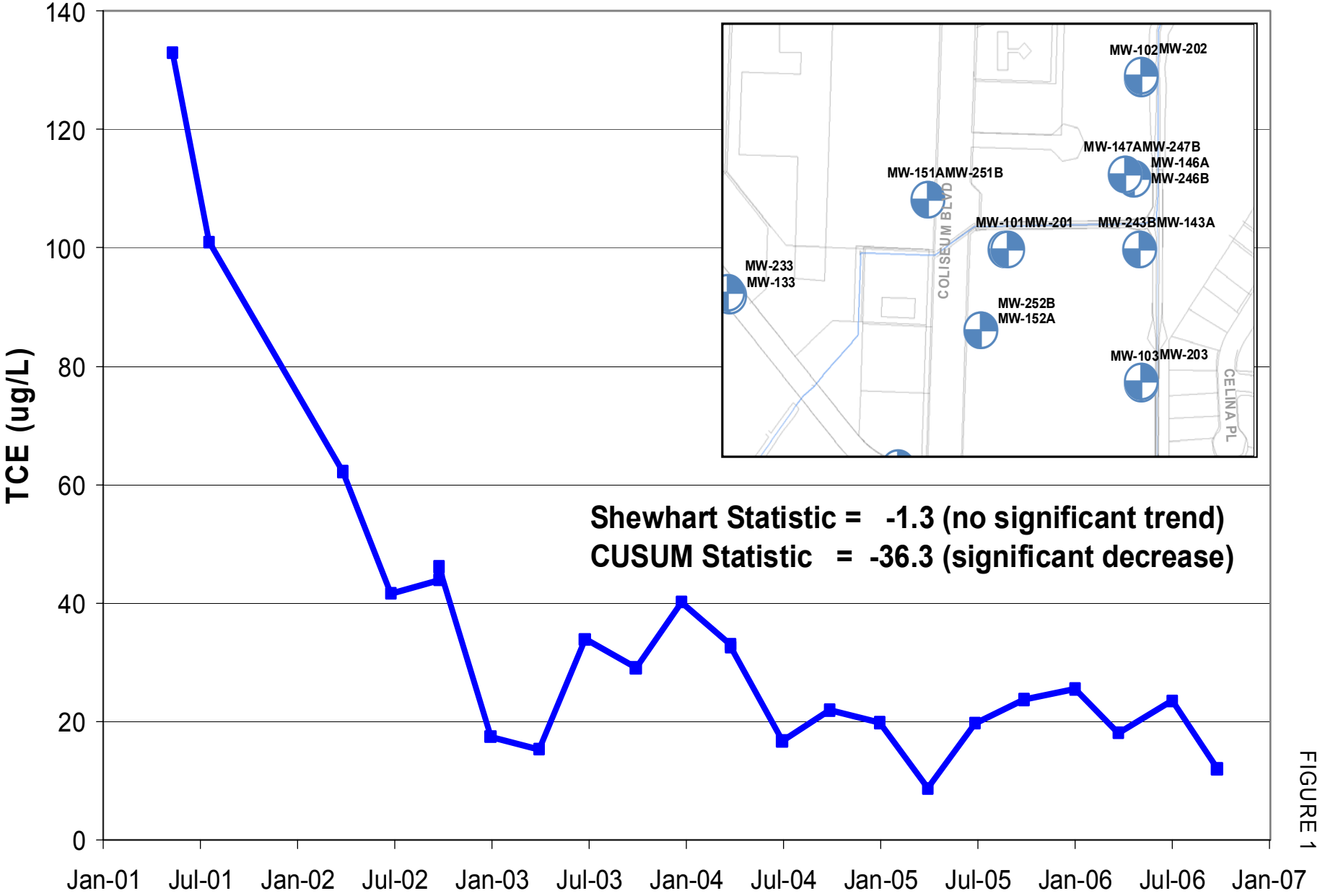
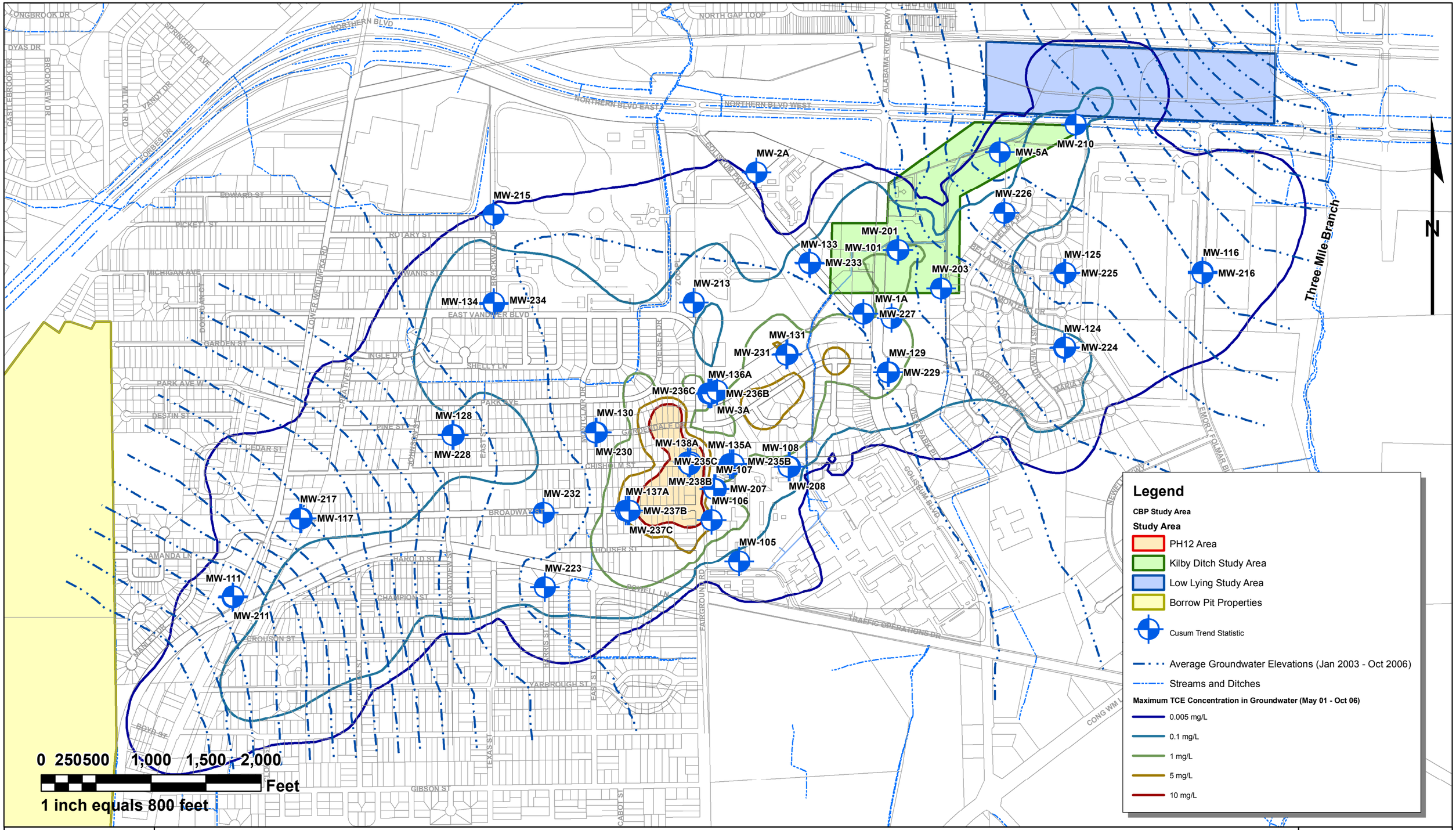


FIGURE 1



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Locations of Monitoring Wells Used in TCE Trend Assessment

FIGURE 2A

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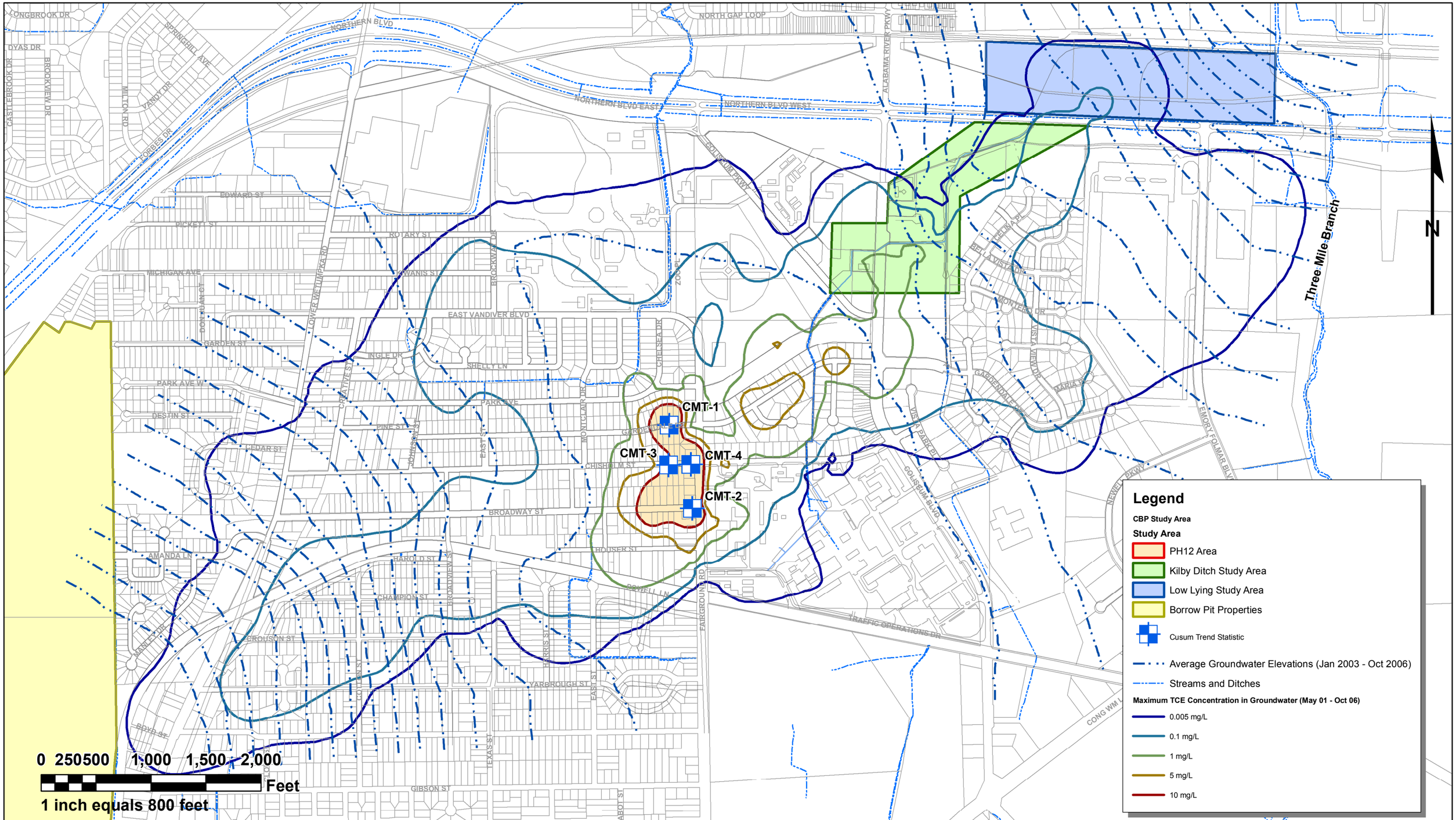

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Locations of CMT Wells Used in TCE Trend Assessment

FIGURE 2B

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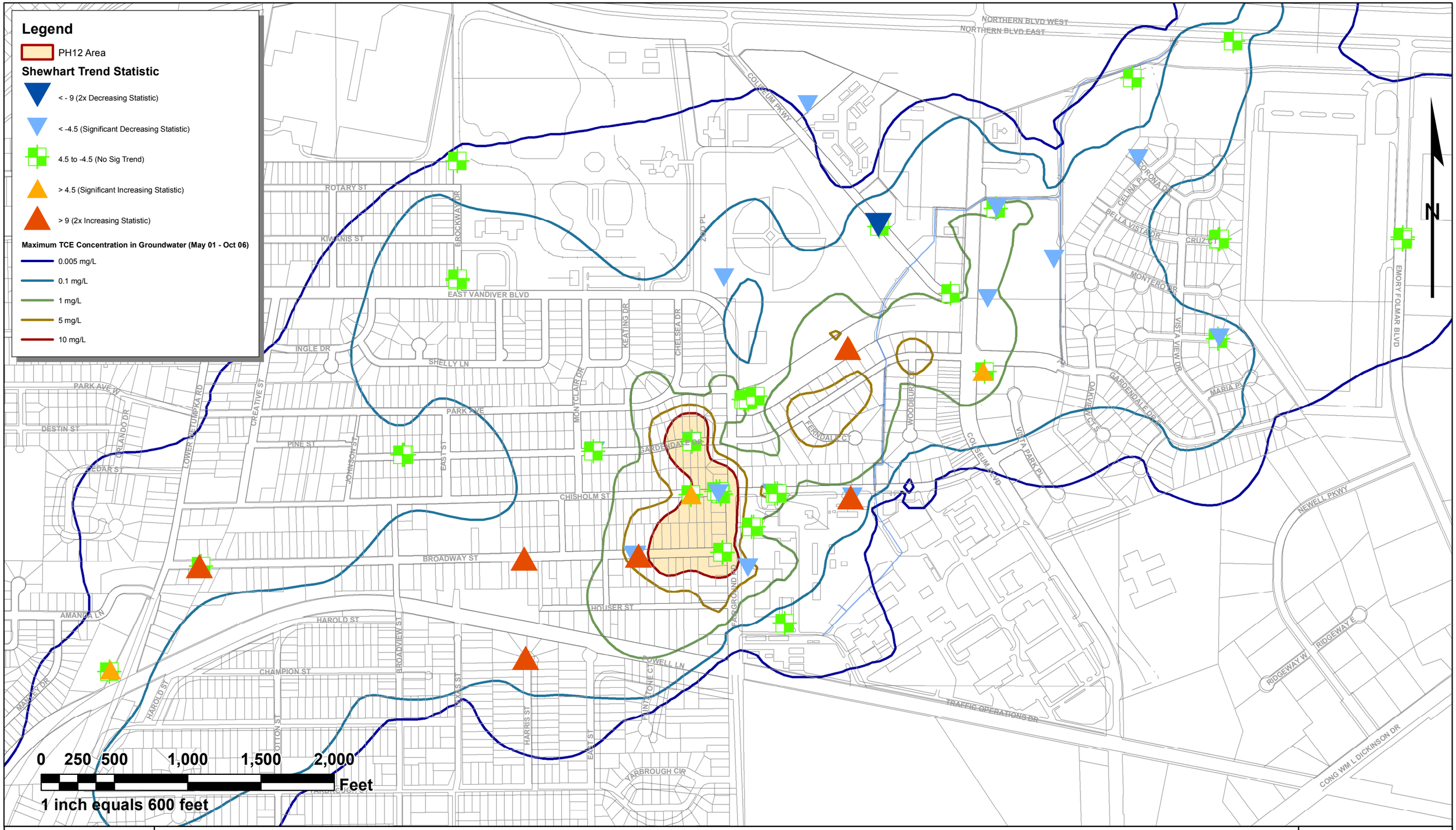

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Shewhart Trend Summary

FIGURE 3A

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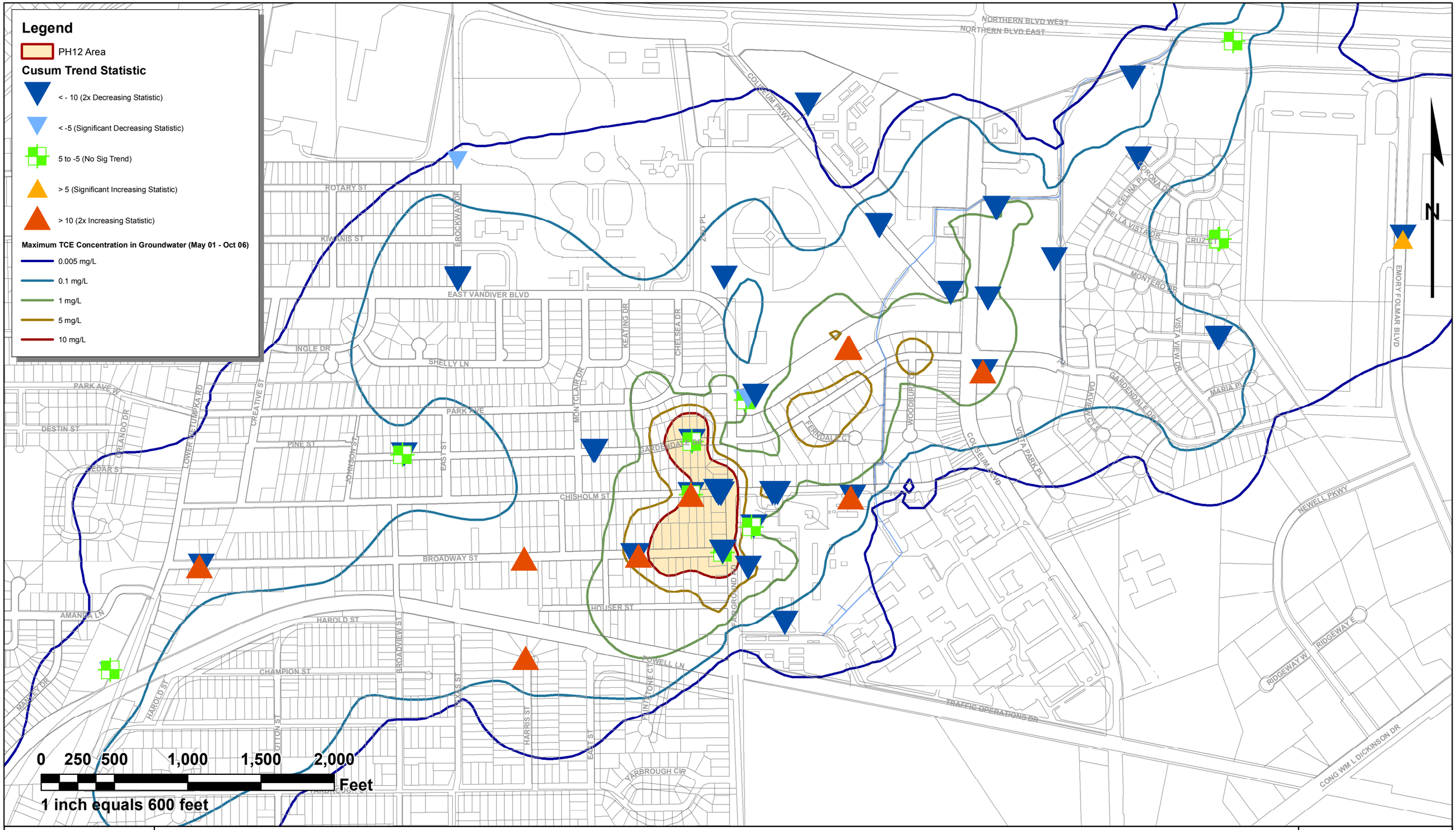

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CUSUM Trend Summary

FIGURE 3B

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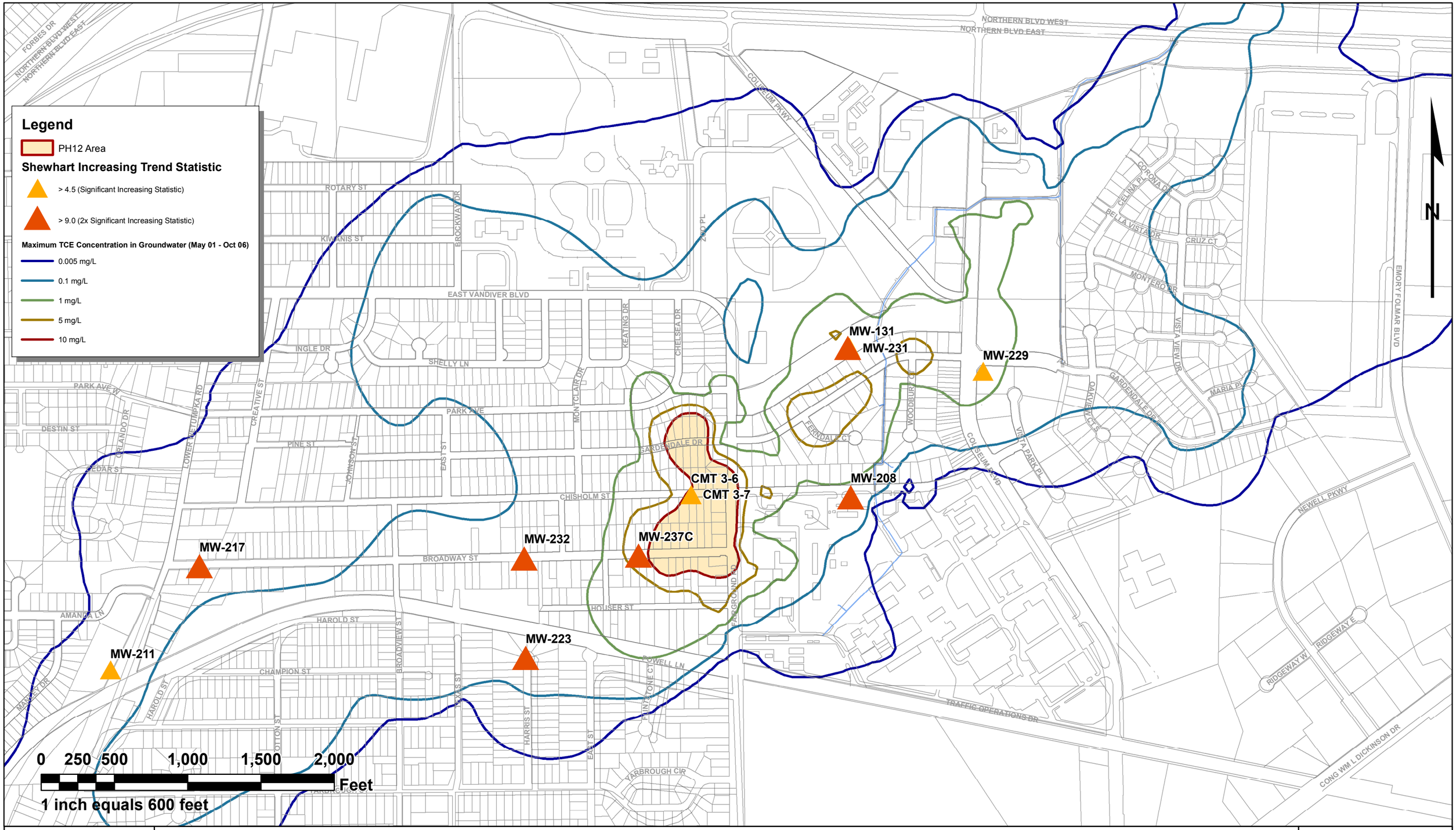

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Monitoring and CMT Wells with Increasing TCE Trends - Shewhart Statistic

FIGURE 4A

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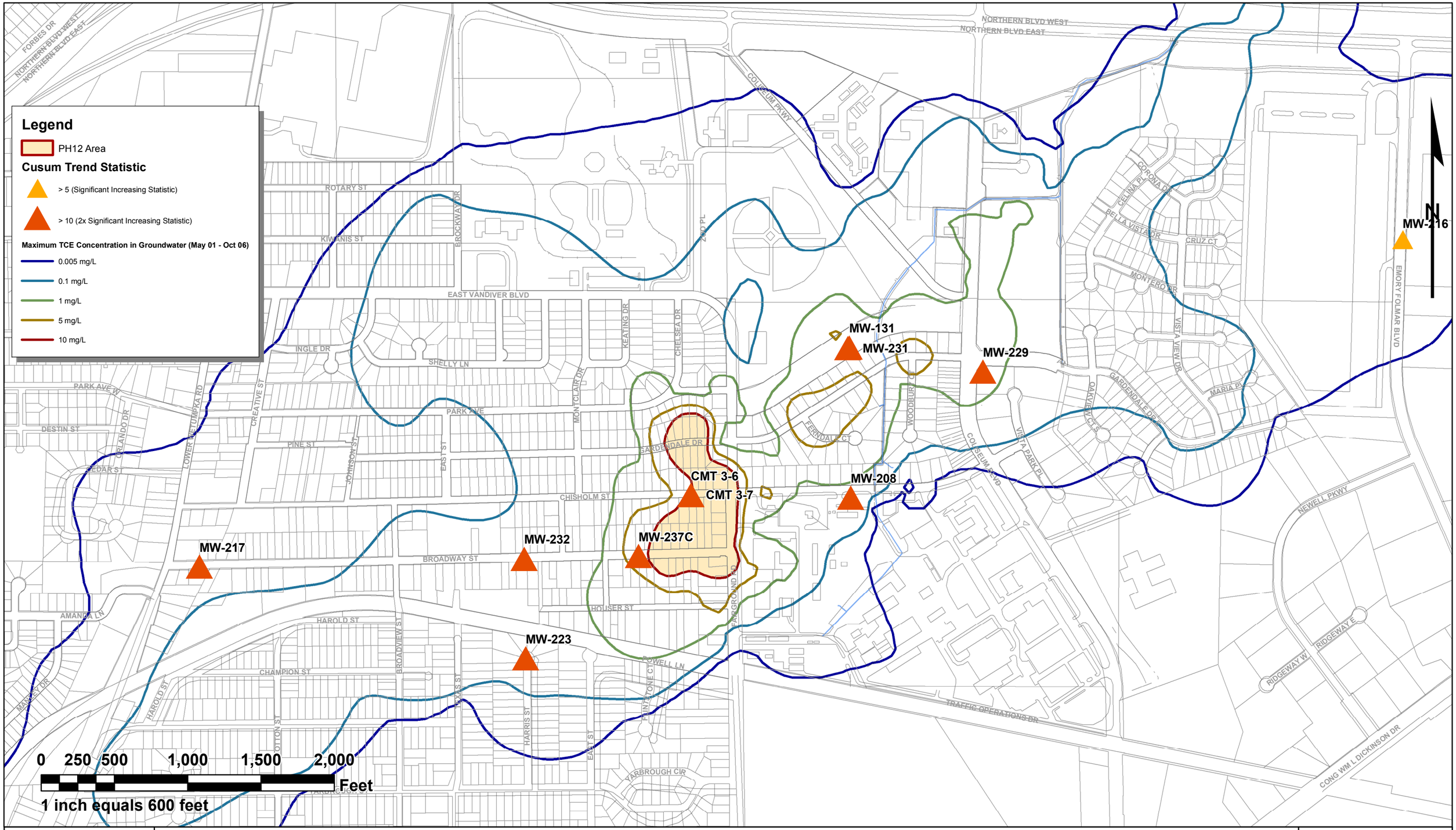

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Monitoring and CMT Wells with Increasing TCE Trends - CUSUM Statistic

FIGURE 4B

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Time Series Plots - MW-232

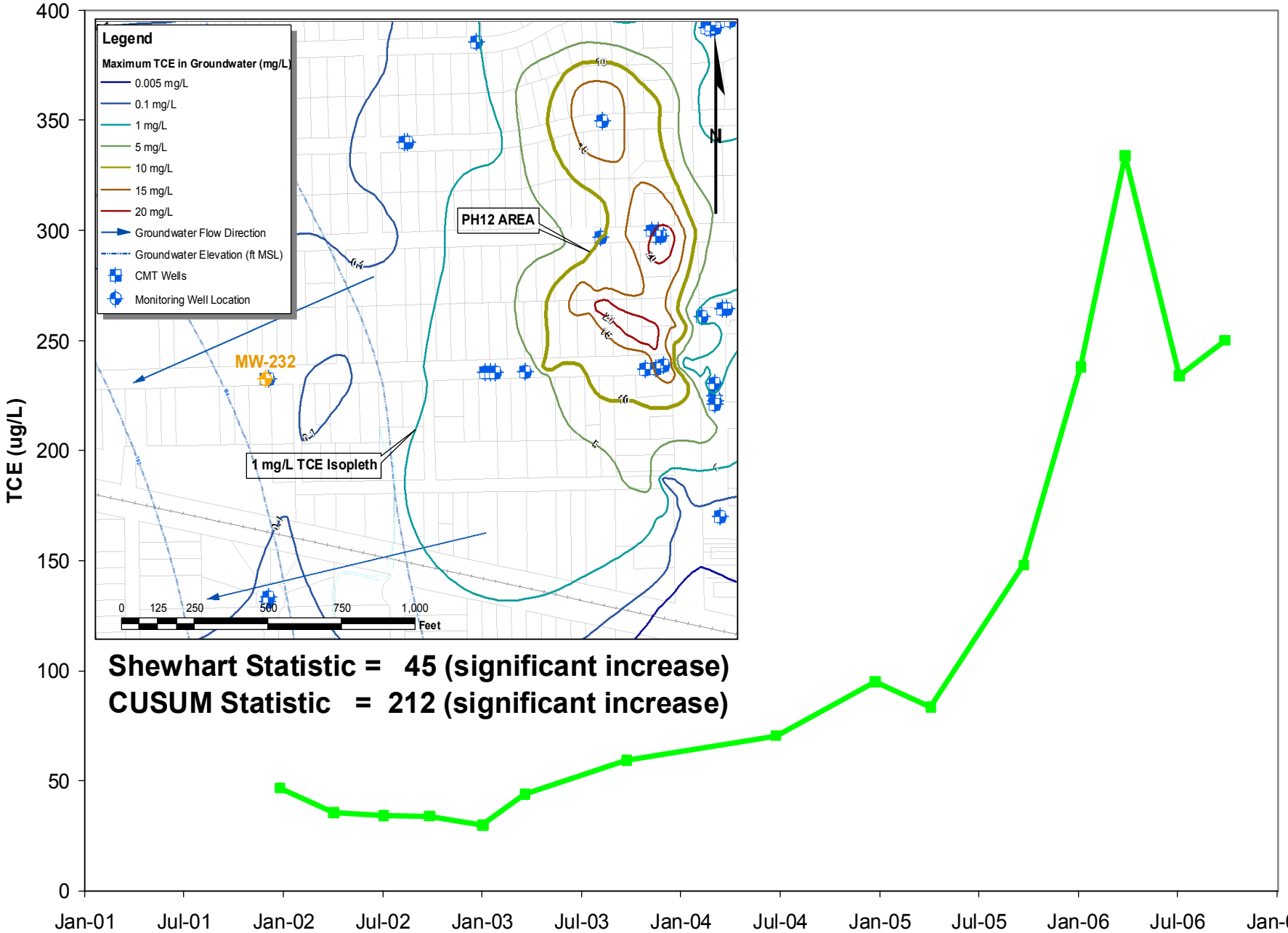
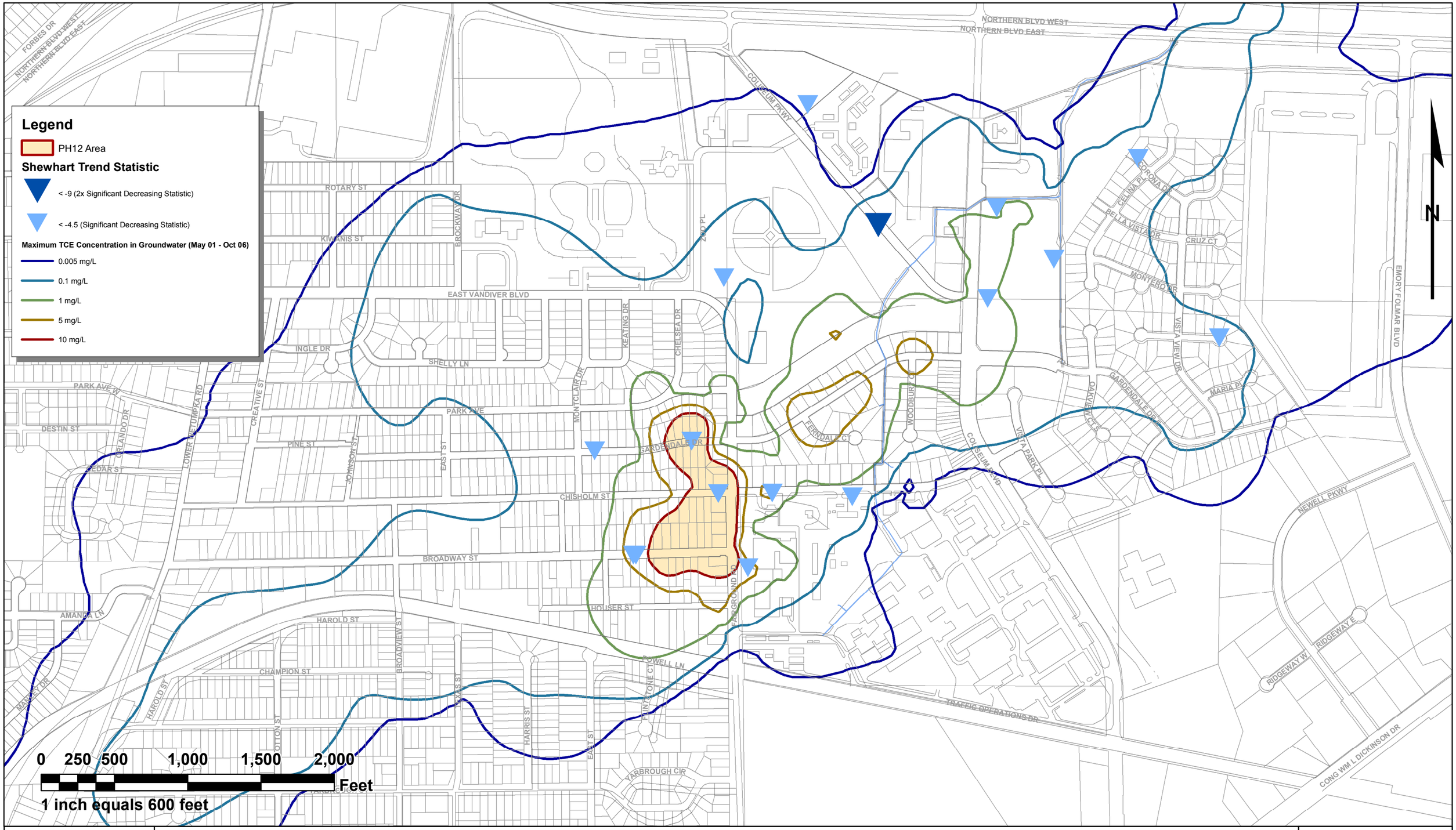


FIGURE 5



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Monitoring and CMT Wells with Decreasing TCE Trends - Shewhart Statistic

FIGURE 6A

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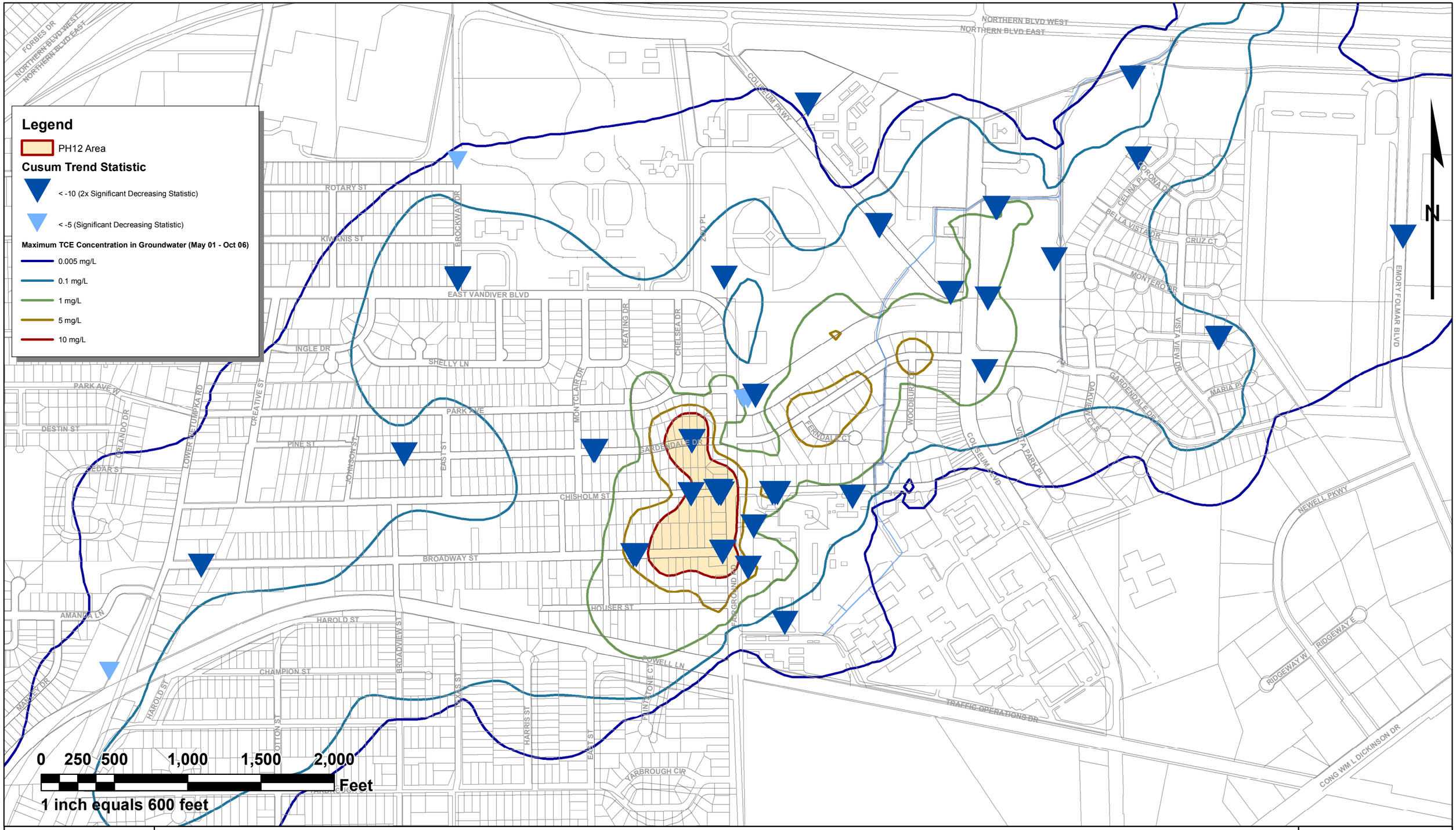

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Monitoring and CMT Wells with Decreasing TCE Trends - CUSUM Statistic

FIGURE 6B

March 2007

APPENDIX A

TIME TREND PLOTS FOR TCE CONCENTRATIONS

SUMMARY OF SHEWHART TREND ANALYSIS METRICS FOR TCE

Significant Increase		Non-Sig. Increase		Non-Sig. Decrease		Significant Decrease	
Well	Shewhart	Well	Shewhart	Well	Shewhart	Well	Shewhart
CMT 2-7	**28.32**	**CMT 3-6**	**1.48**	**CMT 1-1**	**-1.96**	**CMT 1-5**	**-4.73**
CMT 3-7	**40.78**	MW-125	2.29	**CMT 1-2**	**-1.52**	**CMT 2-4**	**-5.30**
MW-208	19.78	MW-131	1.89	**CMT 1-3**	**-3.71**	**CMT 4-4**	**-6.72**
MW-211	6.40	MW-207	3.05	**CMT 1-6**	**-2.91**	**CMT 4-7**	**-8.00**
MW-217	23.47	MW-225	4.09	**CMT 1-7**	**-1.43**	MW-106	-5.90
MW-223	36.32	MW-236C	0.46	**CMT 2-1**	**-3.09**	MW-135A	-5.95
MW-229	15.65	MW-3A	0.60	**CMT 2-2**	**-0.51**	MW-137A	-5.75
MW-231	10.17			**CMT 2-3**	**-3.55**	MW-1A	-6.36
MW-232	49.10			**CMT 2-5**	**-0.57**	MW-201	-7.85
MW-237C	10.40			**CMT 2-6**	**-0.46**	MW-213	-7.94
MW-238C	**6.28**			**CMT 3-3**	**-2.04**	MW-224	-8.21
				CMT 3-4	**-1.68**	MW-226	-6.05
				CMT 3-5	**-1.37**	MW-233	-9.53
				CMT 4-2	**-1.55**	MW-237B	-8.24
				CMT 4-3	**-1.28**	**MW-238B**	**-4.97**
				CMT 4-5	**-1.81**	MW-2A	-6.42
				CMT 4-6	**-1.78**		
				MW-101	-1.58		
				MW-105	-2.10		
				MW-107	-1.37		
				MW-108	-4.47		
				MW-111	-0.82		
				MW-116	-0.97		
				MW-117	-1.85		
				MW-124	-1.49		
				MW-128	-2.93		
				MW-129	-2.48		
				MW-130	-3.97		
				MW-133	-4.21		
				MW-134	-2.07		
				MW-136A	-0.74		
				MW-138A	**-1.67**		
				MW-203	-4.44		
				MW-210	-0.45		
				MW-215	-2.55		
				MW-216	-0.45		
				MW-227	-3.21		
				MW-228	-0.01		
				MW-230	-0.25		
				MW-234	-3.57		
				MW-235B	-0.94		
				MW-235C	-0.62		
				MW-236B	-0.28		
				MW-5A	-3.25		

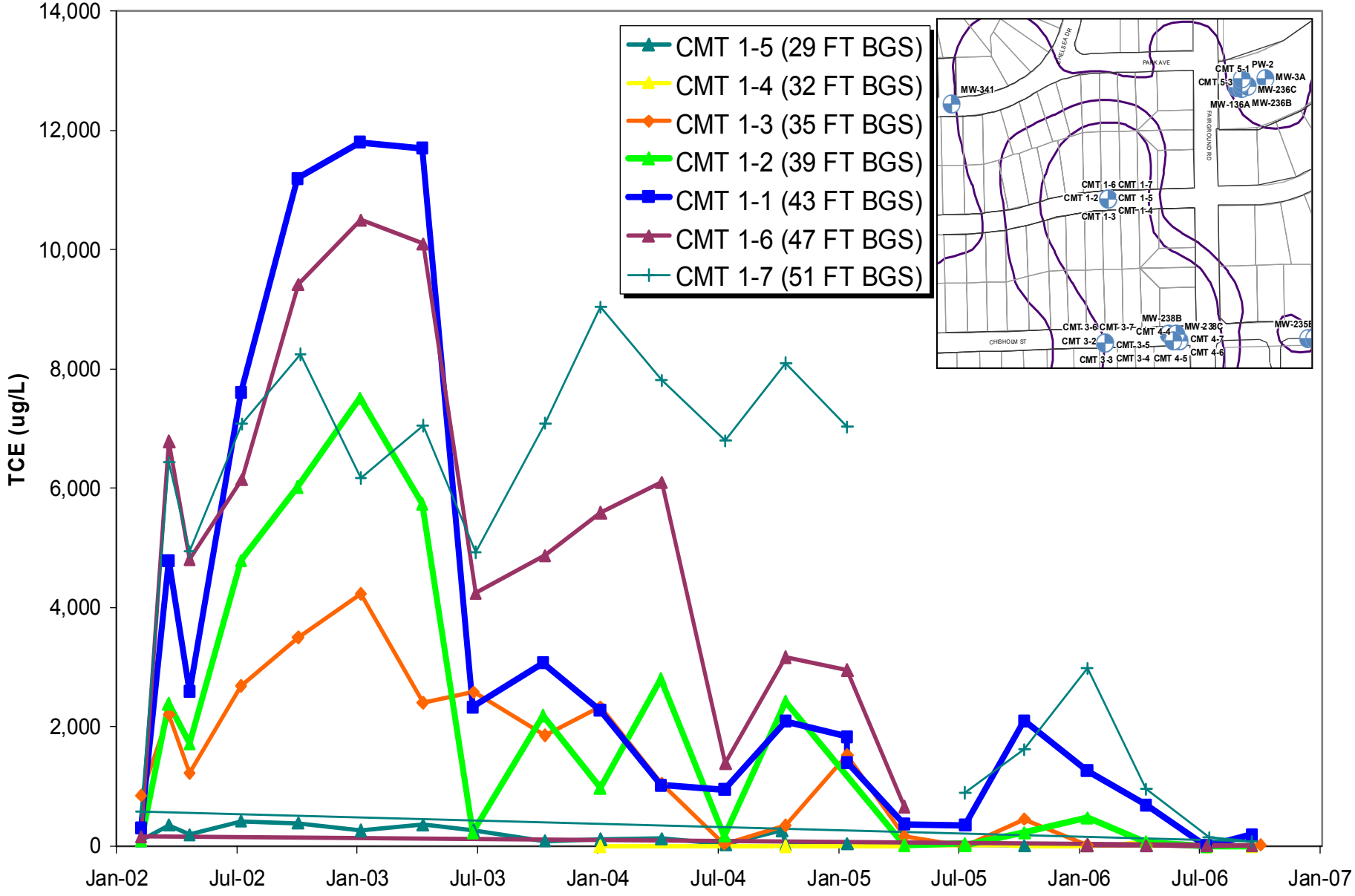
SUMMARY OF CUSUM TREND ANALYSIS METRICS FOR TCE

Significant Increase		Non-Sig. Increase		Non-Sig. Decrease		Significant Decrease	
Well	CUSUM	Well	CUSUM	Well	CUSUM	Well	CUSUM
CMT 2-7	**13.01**	**CMT 1-7**	**0.27**	**CMT 2-5**	**-1.62**	**CMT 1-1**	**-36.25**
CMT 3-6	**14.66**	MW-207	3.98	**CMT 2-6**	**-4.81**	**CMT 1-2**	**-28.00**
CMT 3-7	**76.27**	MW-211	2.53	**CMT 3-5**	**-0.47**	**CMT 1-3**	**-52.36**
MW-131	31.28	MW-225	2.31	MW-125	-3.81	**CMT 1-5**	**-57.10**
MW-208	71.25			MW-210	-2.87	**CMT 1-6**	**-40.40**
MW-216	6.35			MW-228	-4.63	**CMT 2-1**	**-16.28**
MW-217	154.48			MW-236B	-3.36	**CMT 2-2**	**-15.52**
MW-223	151.55					**CMT 2-3**	**-59.12**
MW-229	165.93					**CMT 2-4**	**-53.88**
MW-231	144.73					**CMT 3-3**	**-26.81**
MW-232	260.02					**CMT 3-4**	**-23.75**
MW-237C	29.35					**CMT 4-2**	**-19.84**
						CMT 4-3	**-22.40**
						CMT 4-4	**-49.60**
						CMT 4-5	**-27.20**
						CMT 4-6	**-18.18**
						CMT 4-7	**-86.25**
						MW-101	-38.88
						MW-105	-15.96
						MW-106	-132.35
						MW-107	-15.60
						MW-108	-50.09
						MW-111	-7.67
						MW-116	-40.53
						MW-117	-34.78
						MW-124	-29.35
						MW-128	-11.40
						MW-129	-17.28
						MW-130	-86.58
						MW-133	-48.79
						MW-134	-32.21
						MW-135A	-27.11
						MW-136A	-9.89
						MW-137A	-66.49
						MW-138A	**-29.08**
						MW-1A	-26.57
						MW-201	-67.11
						MW-203	-118.58
						MW-213	-49.03
						MW-215	-9.71
						MW-224	-72.92
						MW-226	-29.73
						MW-227	-16.31
						MW-230	-23.89
						MW-233	-86.36
						MW-234	-14.77

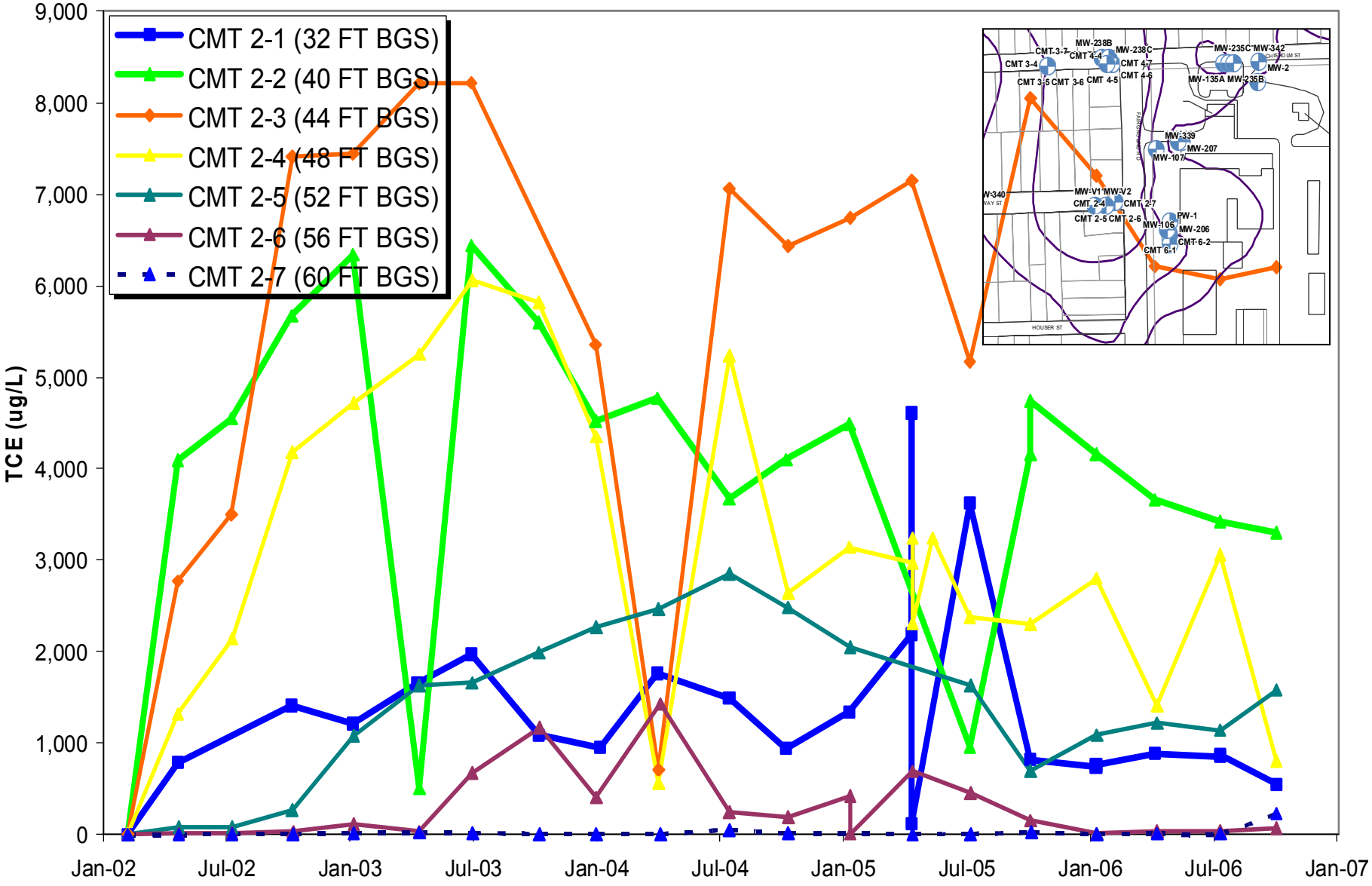
SUMMARY OF CUSUM TREND ANALYSIS METRICS FOR TCE

			MW-235B	-11.94
			MW-235C	-14.40
			MW-236C	-6.16
			MW-237B	-86.88
			MW-238B	**-53.13**
			MW-238C	**-55.54**
			MW-2A	-37.77
			MW-3A	-12.35
			MW-5A	-39.95

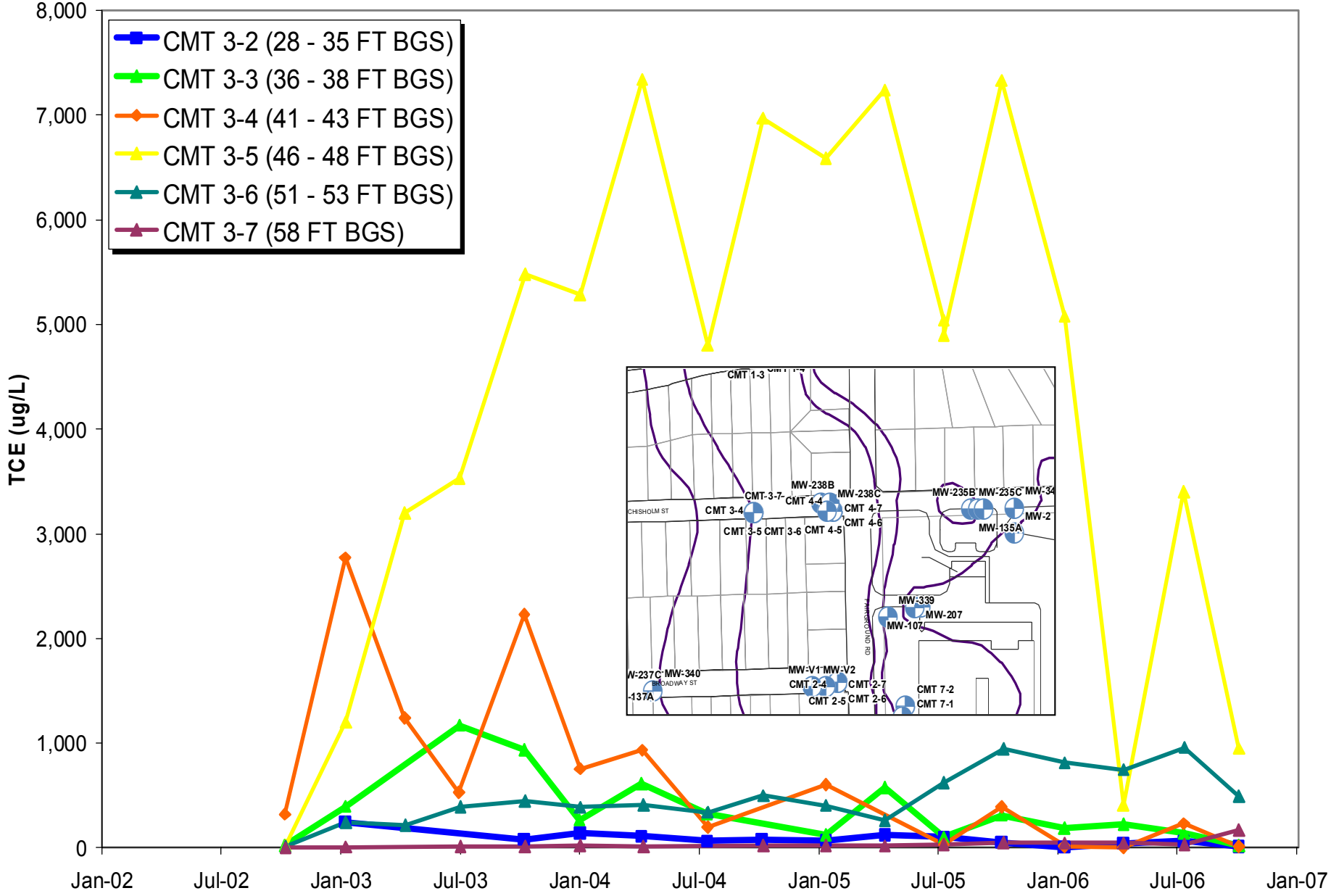
Time Series Plots
CMT 1-1 - CMT 1-7



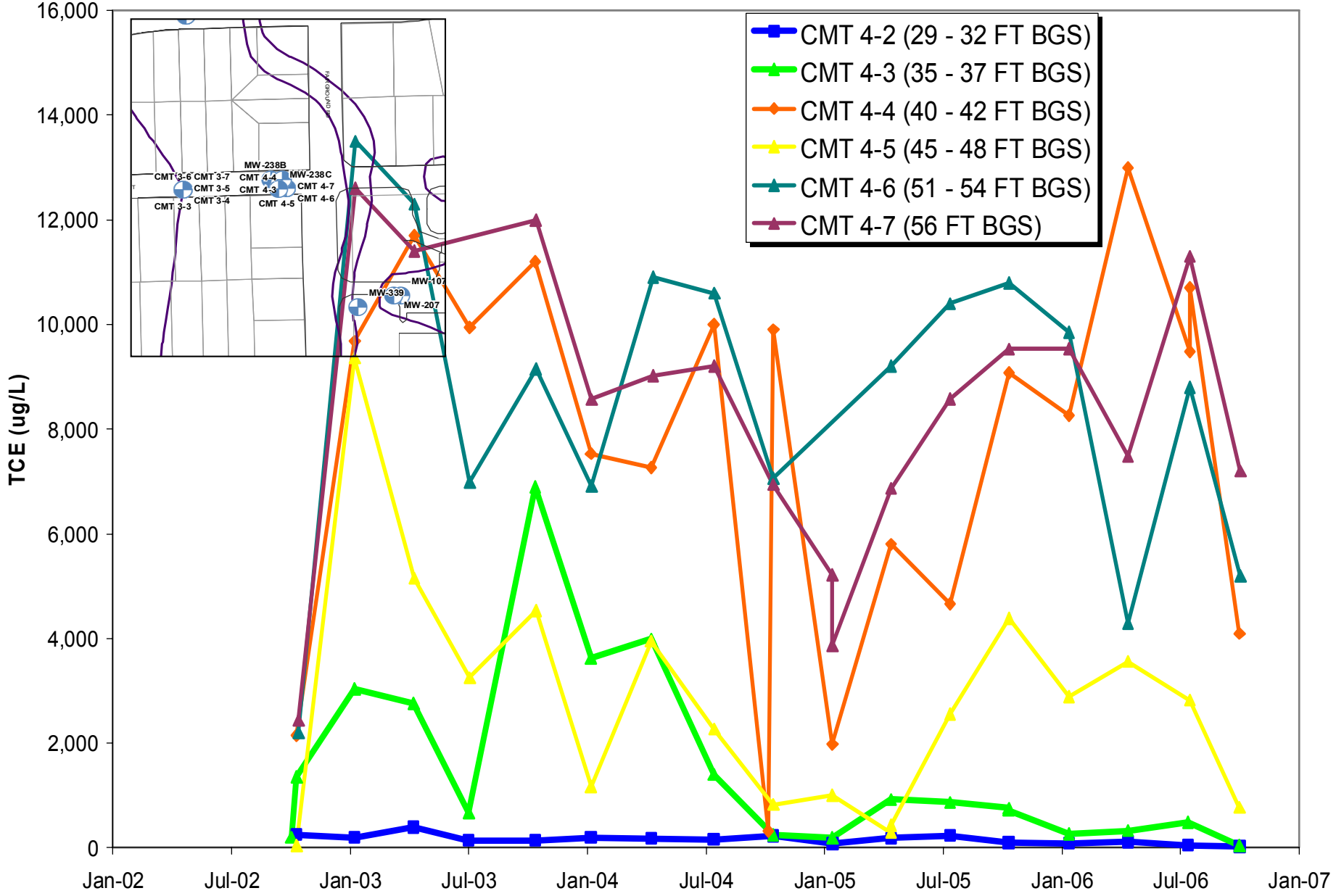
Time Series PLots
CMT 2-1 - CMT 2-7



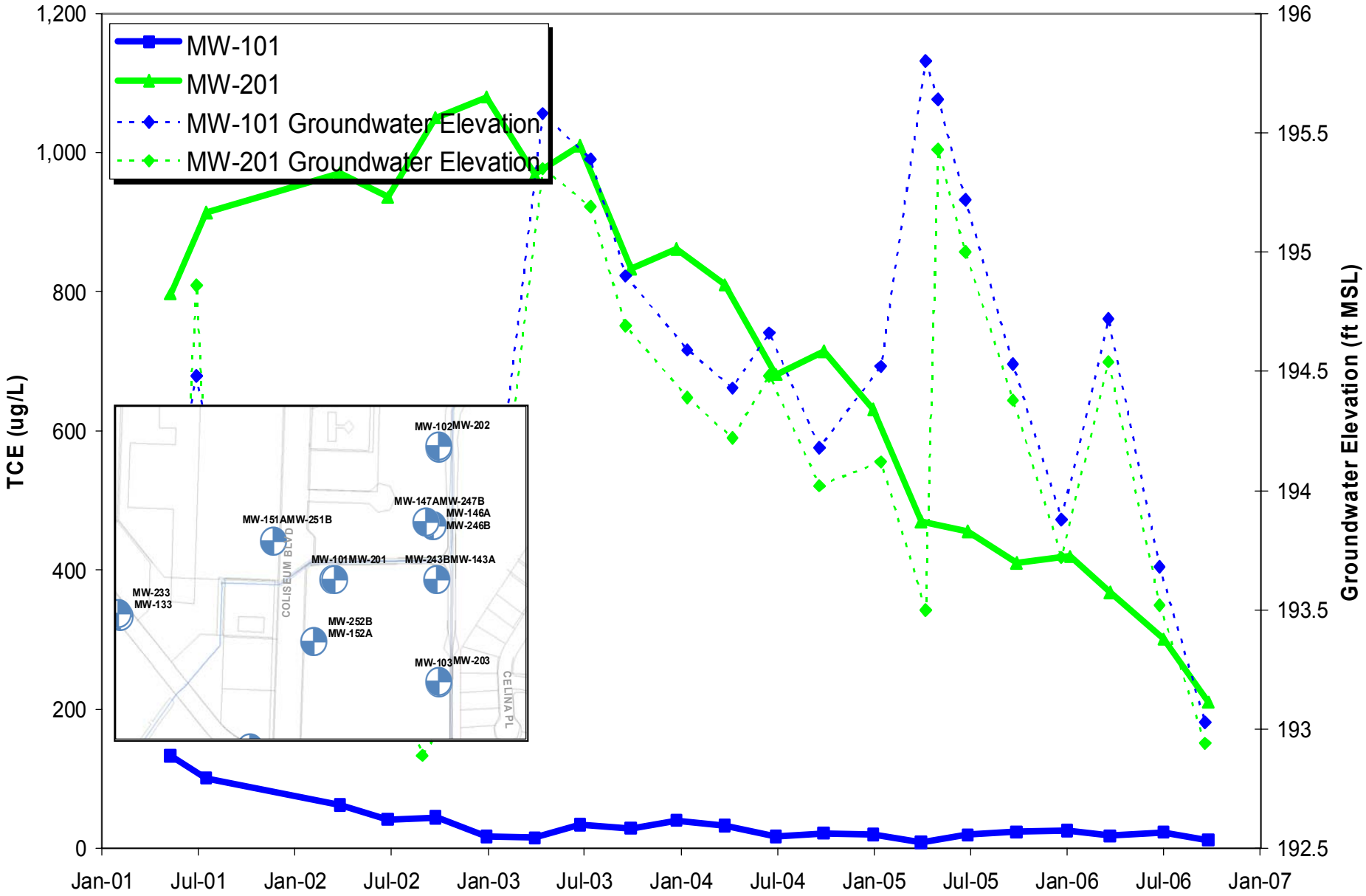
Time Series Plots
CMT 3-1 - CMT 3-7



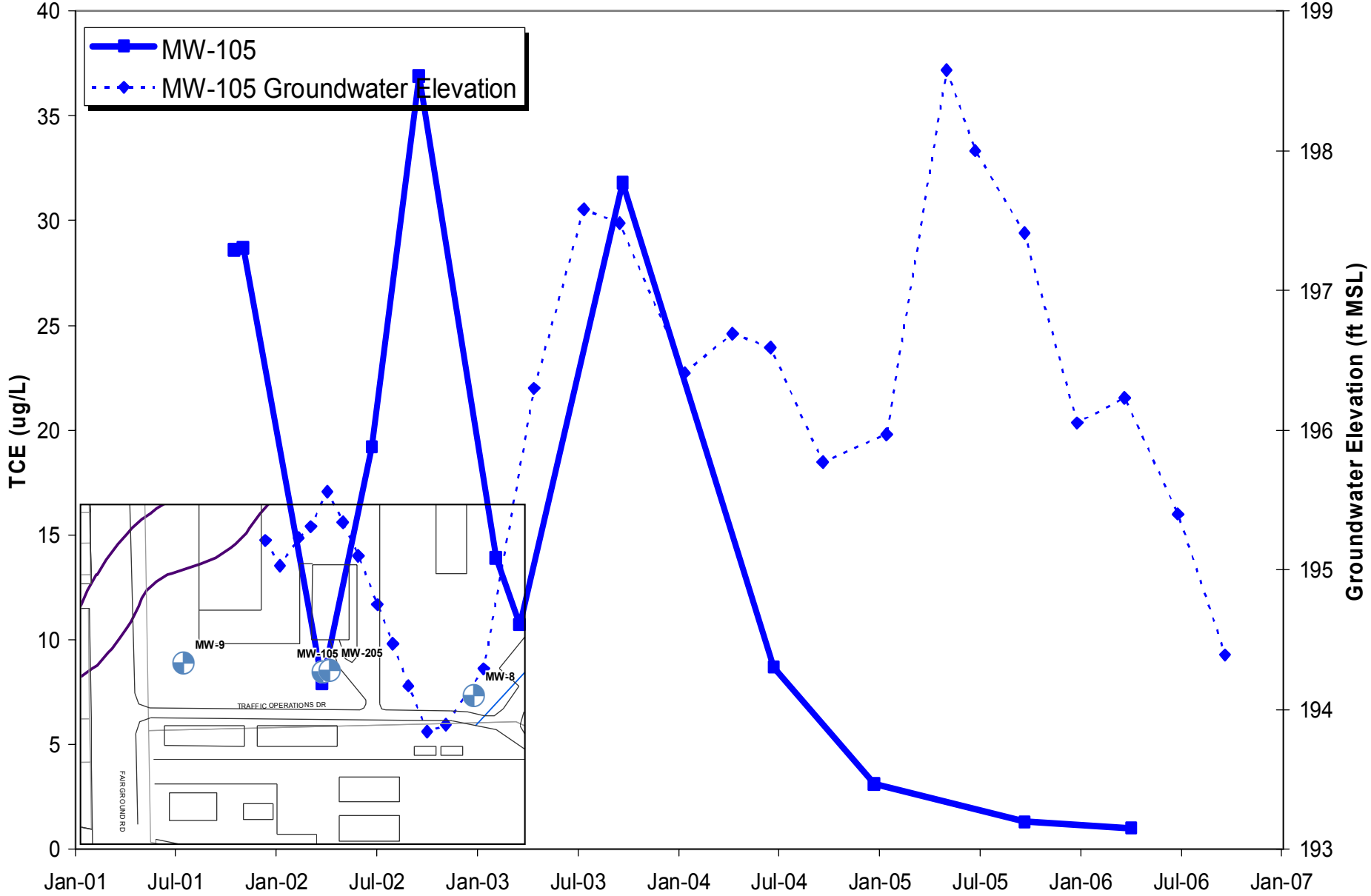
Time Series Plots
CMT 4-2 - CMT 4-7



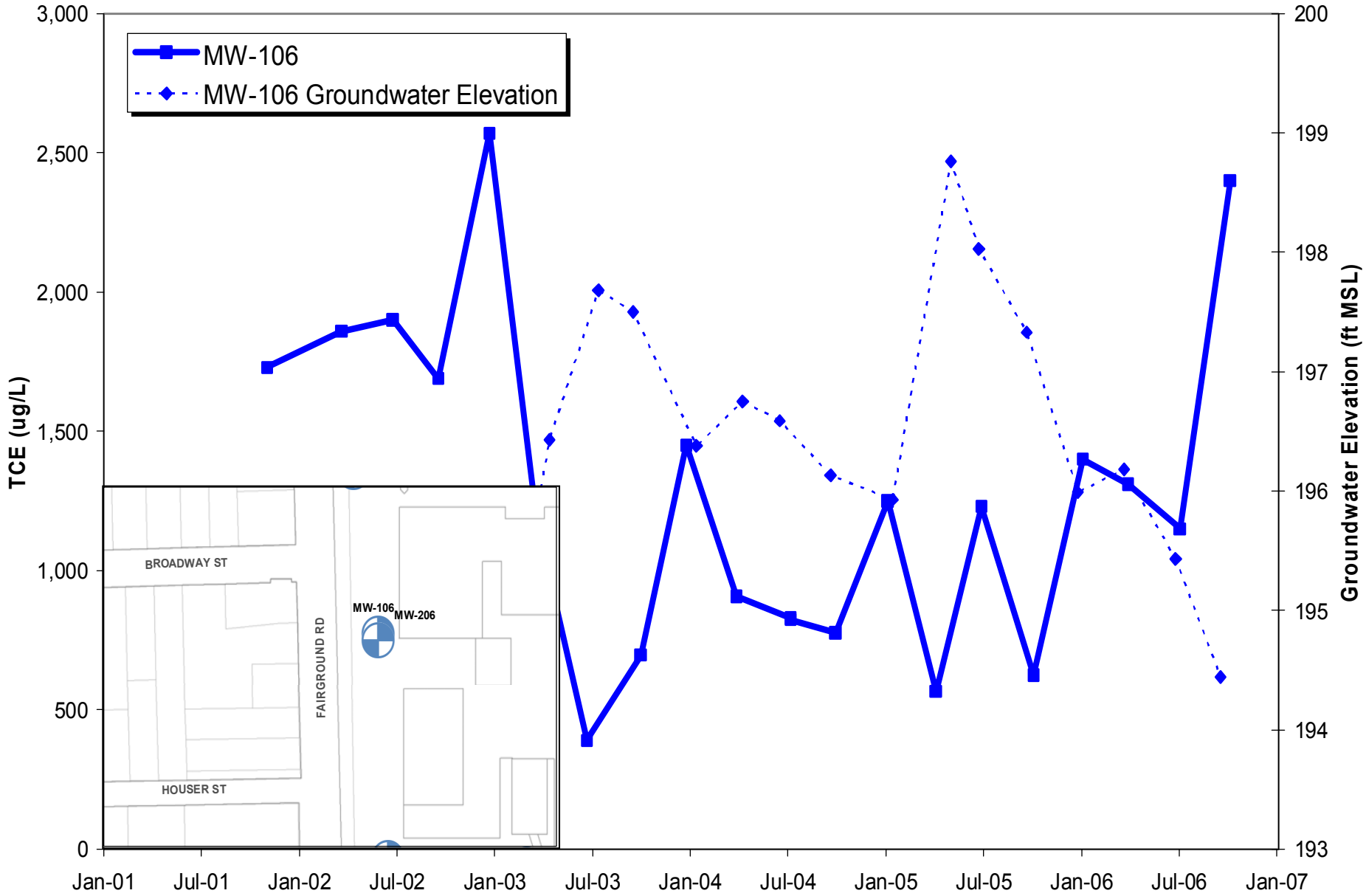
Time Series Plots
MW-101 - MW-201



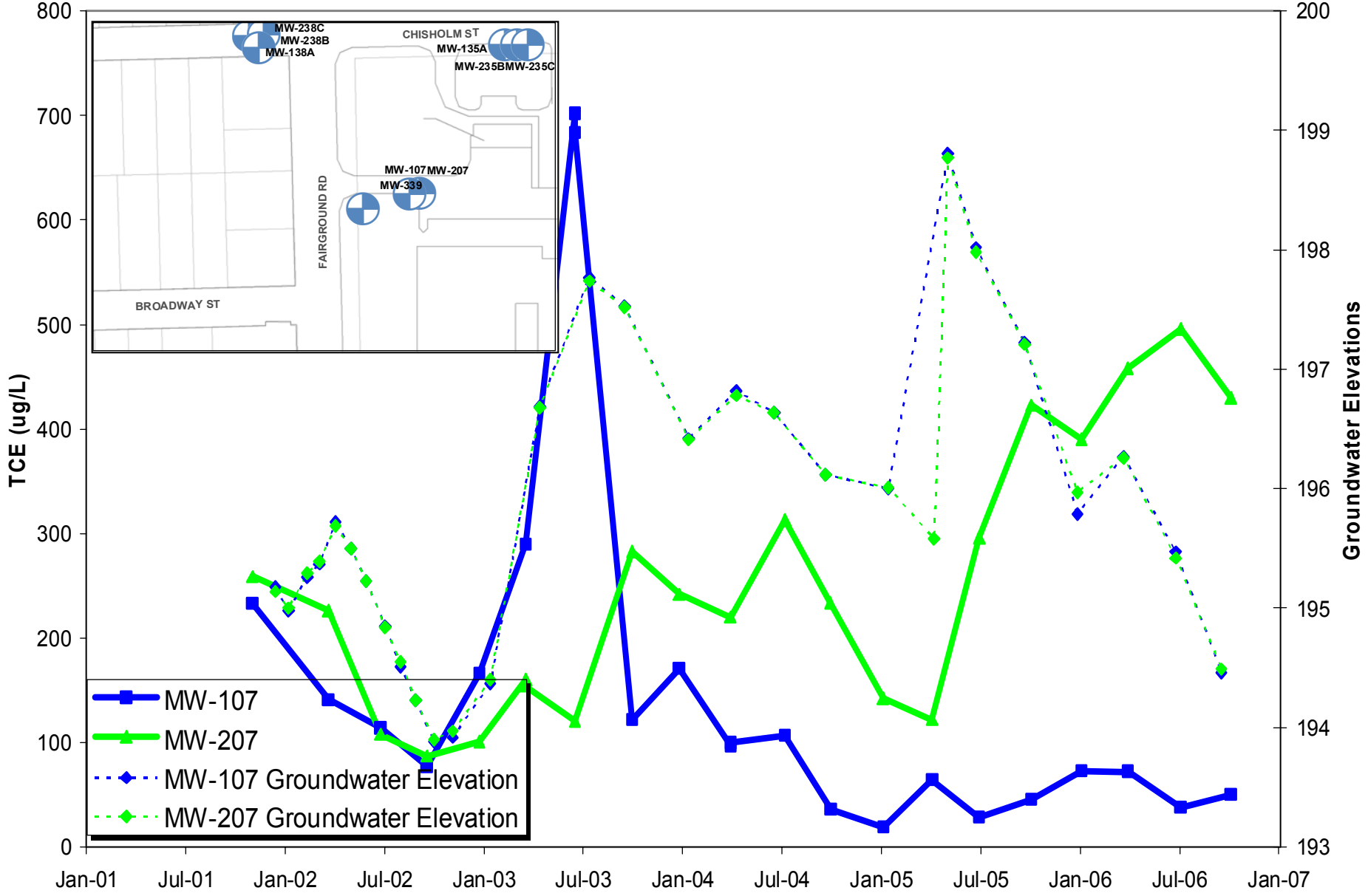
Time Series Plots
MW-105



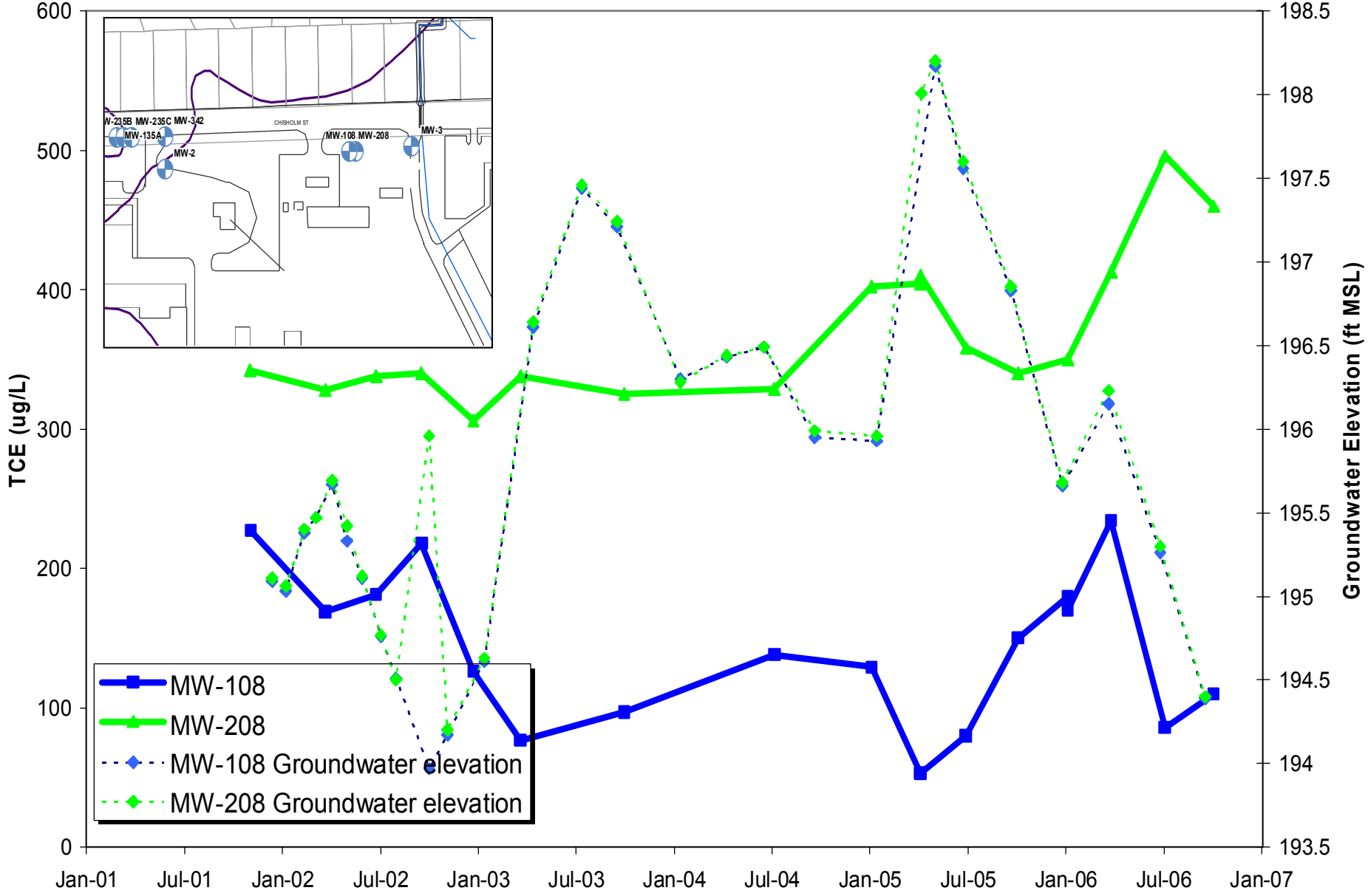
Time Series Plots
MW-106



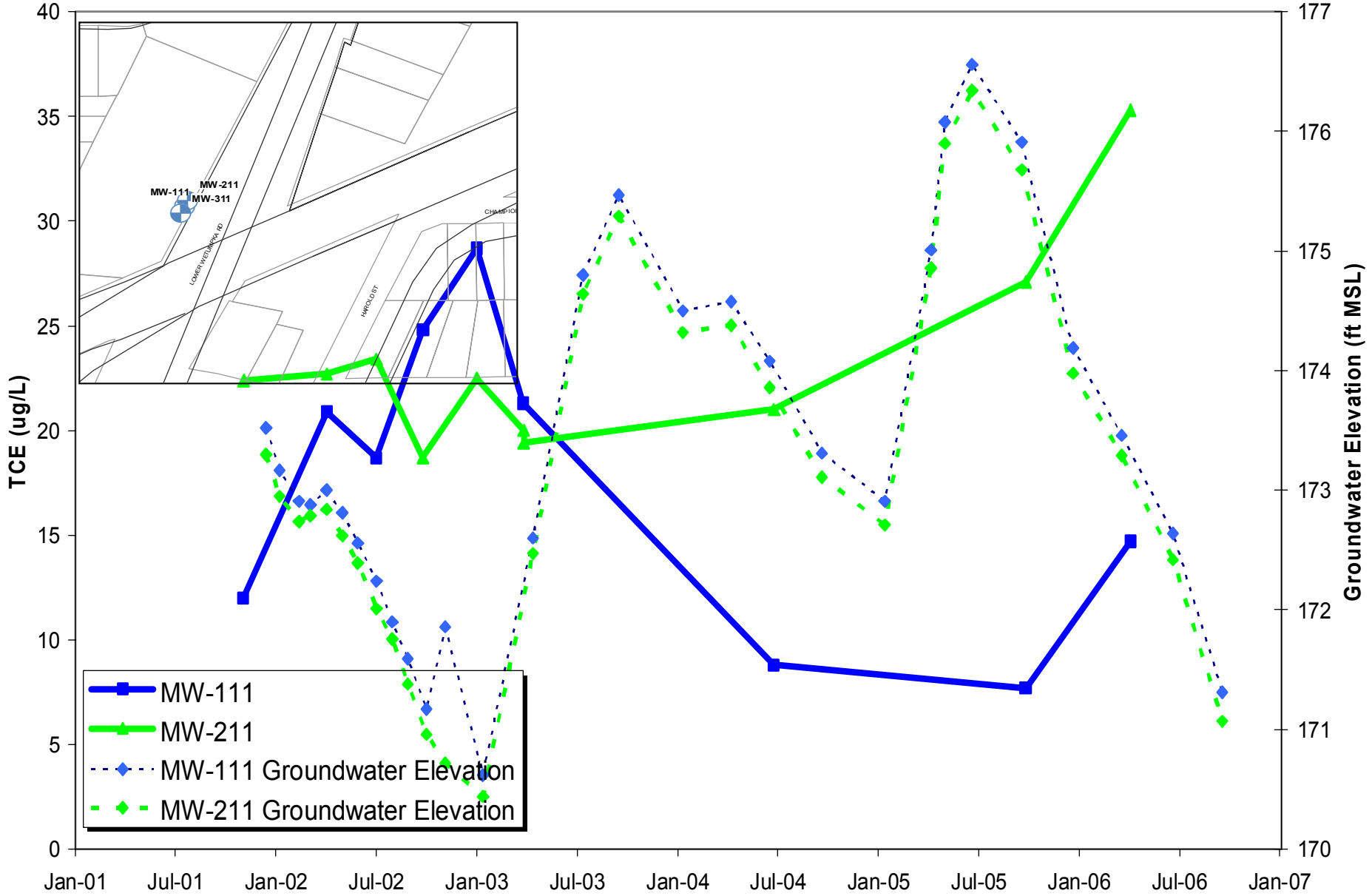
Time Series Plots
MW-107 - MW-207



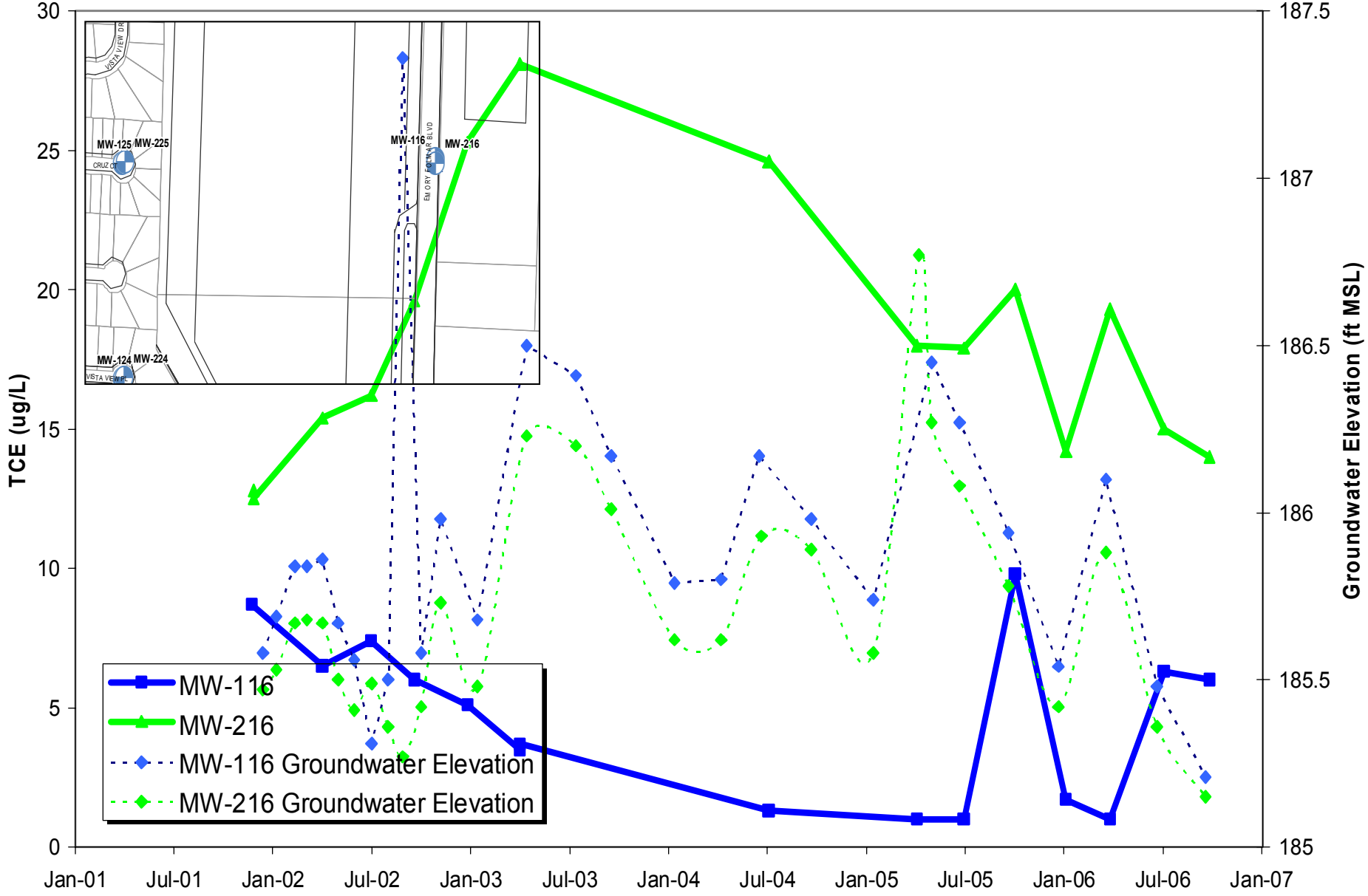
Time Series Plots
MW-108 - MW-208



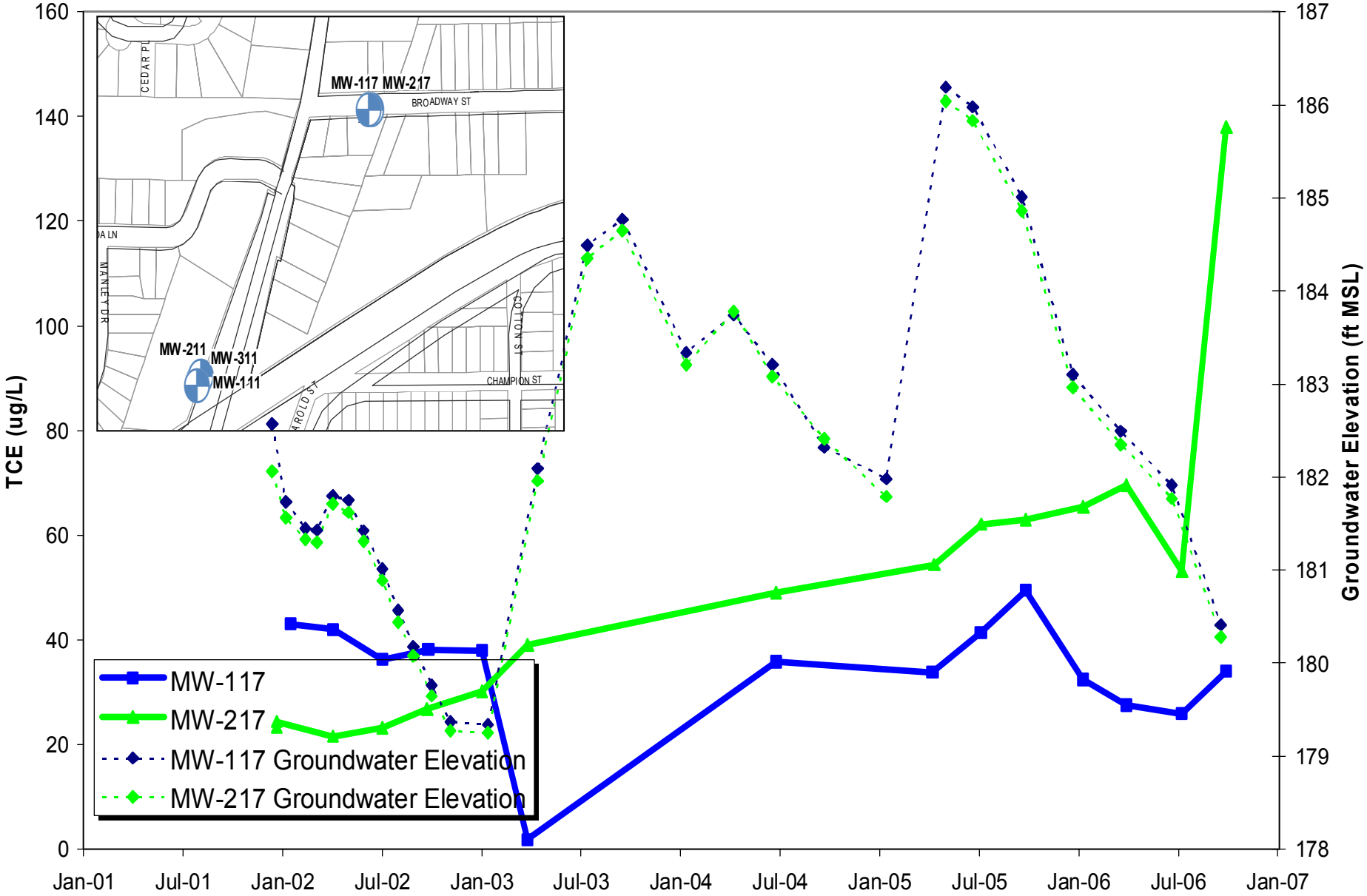
Time Series Plots
MW-111 - MW-211



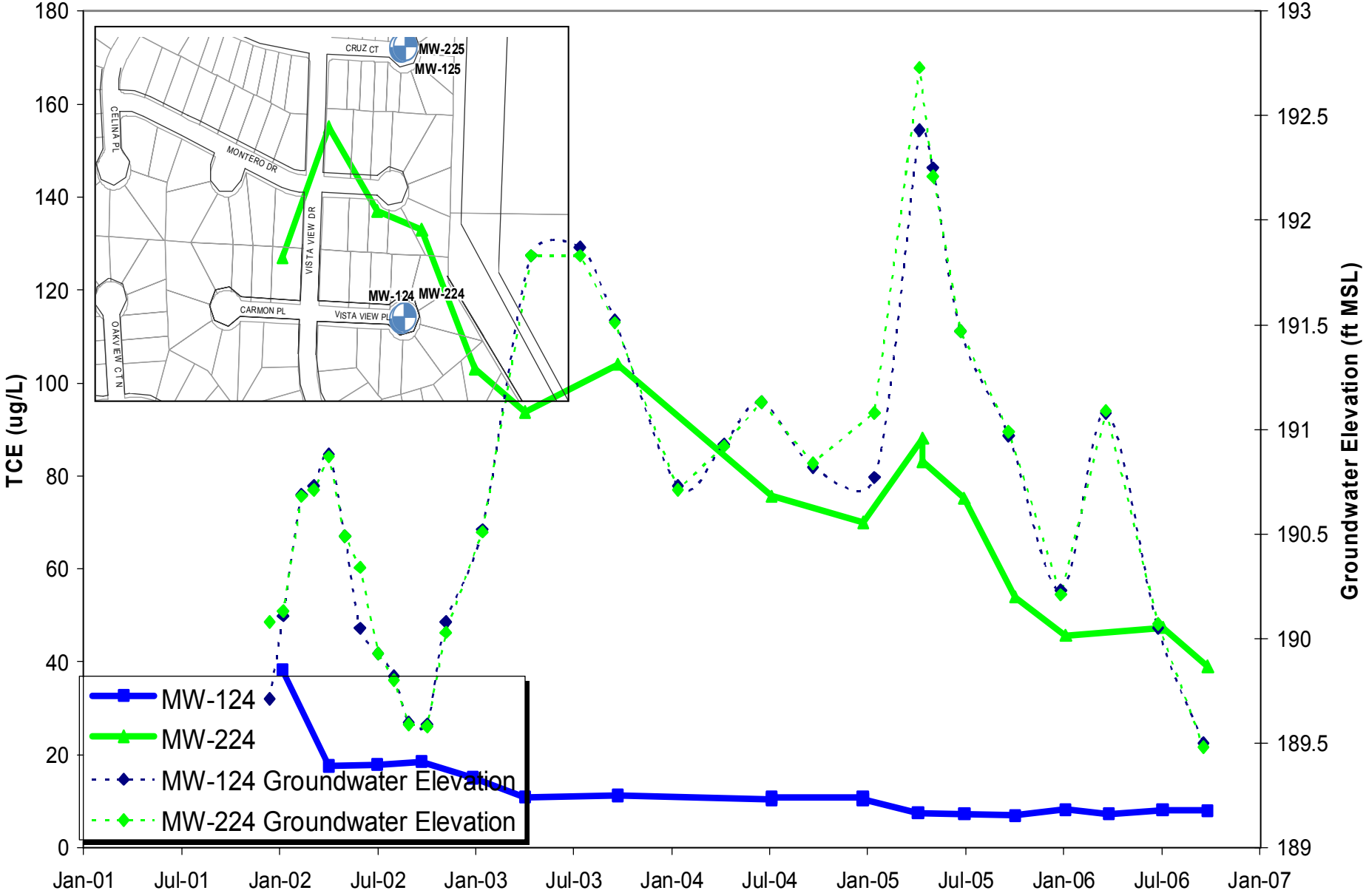
Time Series Plots
MW-116 - MW-216



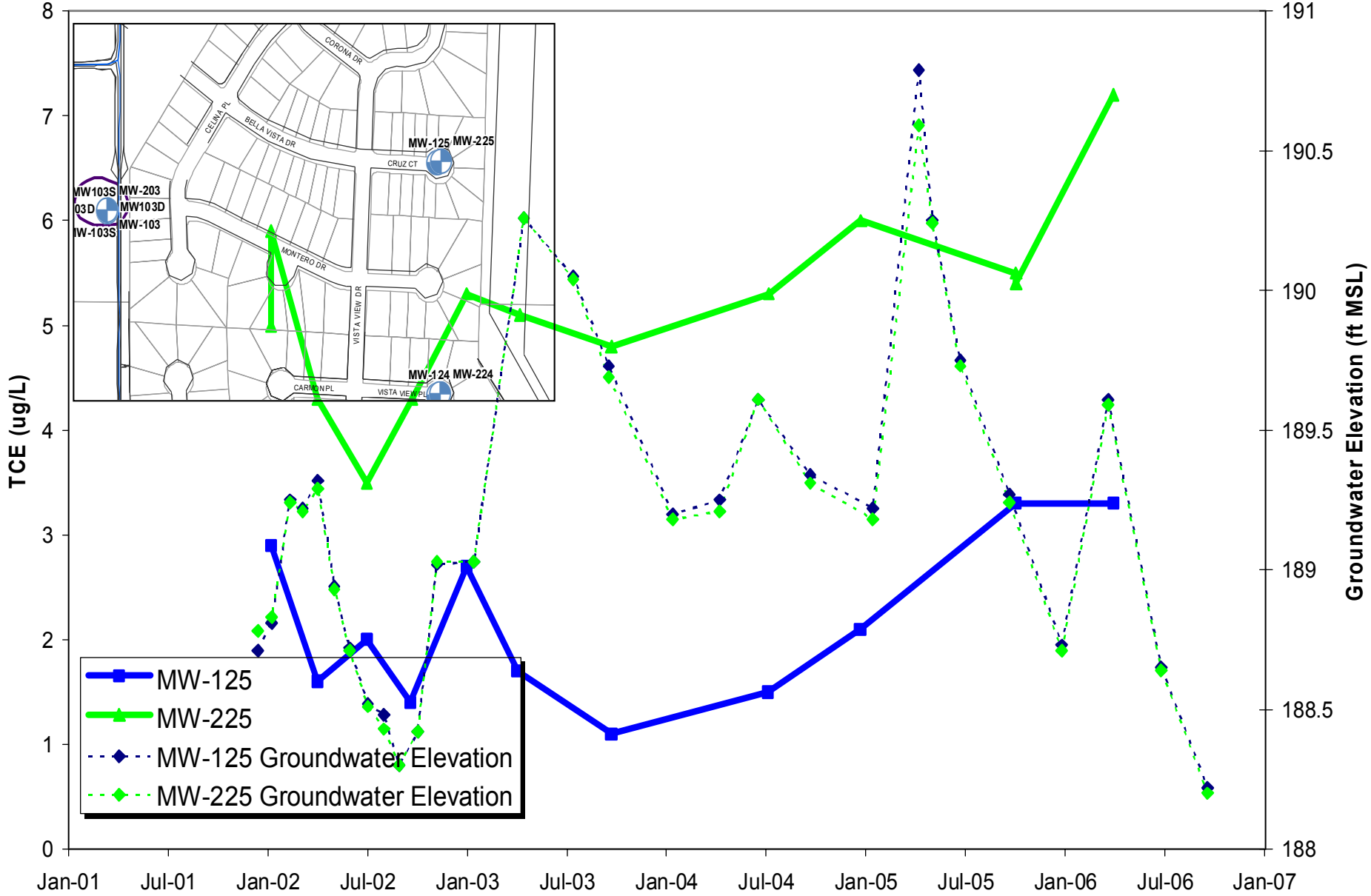
Time Series Plots
MW-117 - MW-217



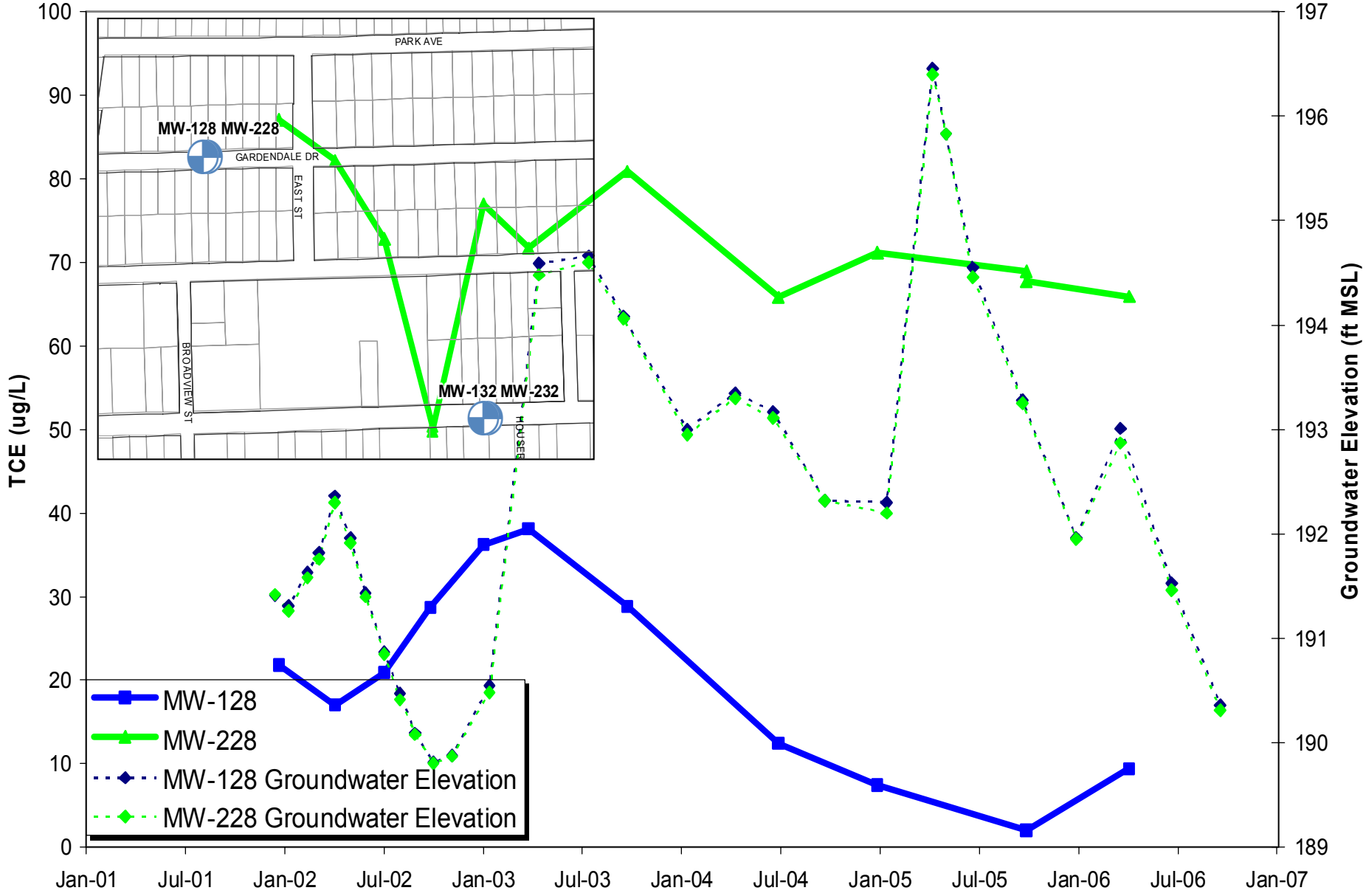
Time Series Plots
MW-124 - MW-224



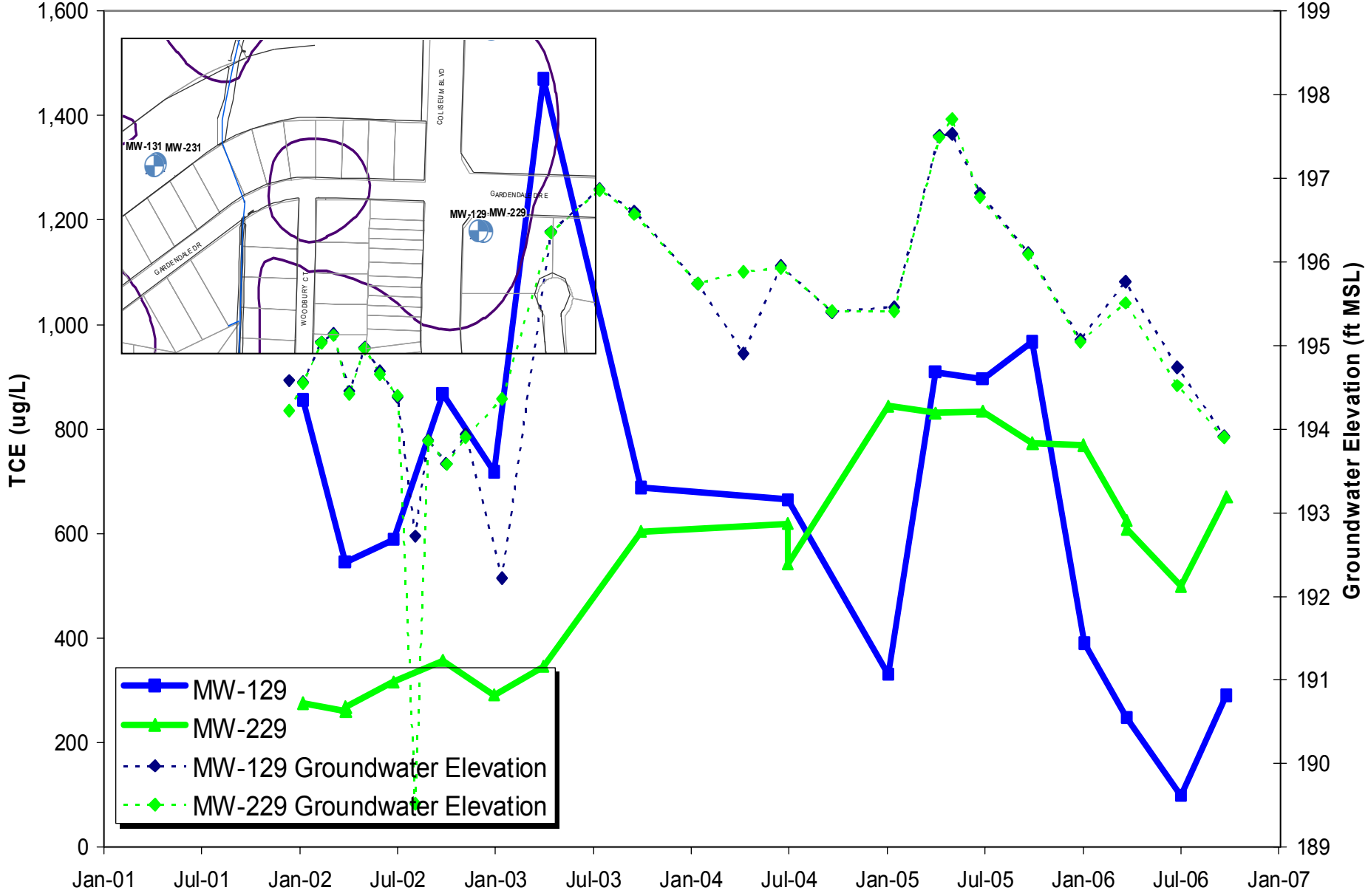
Time Series Plots
MW-125 - MW-225



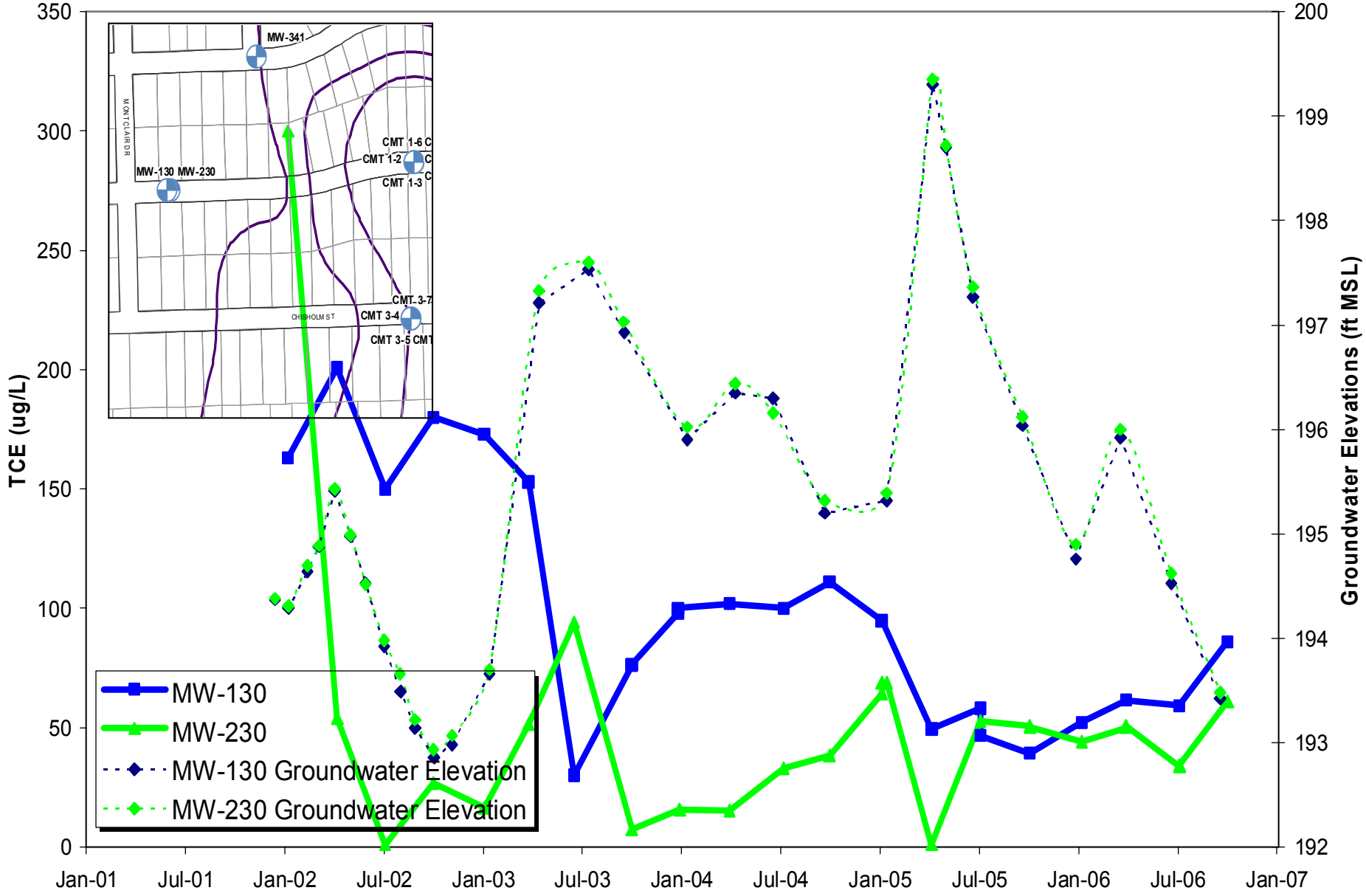
Time Series Plots
MW-128 - MW-228



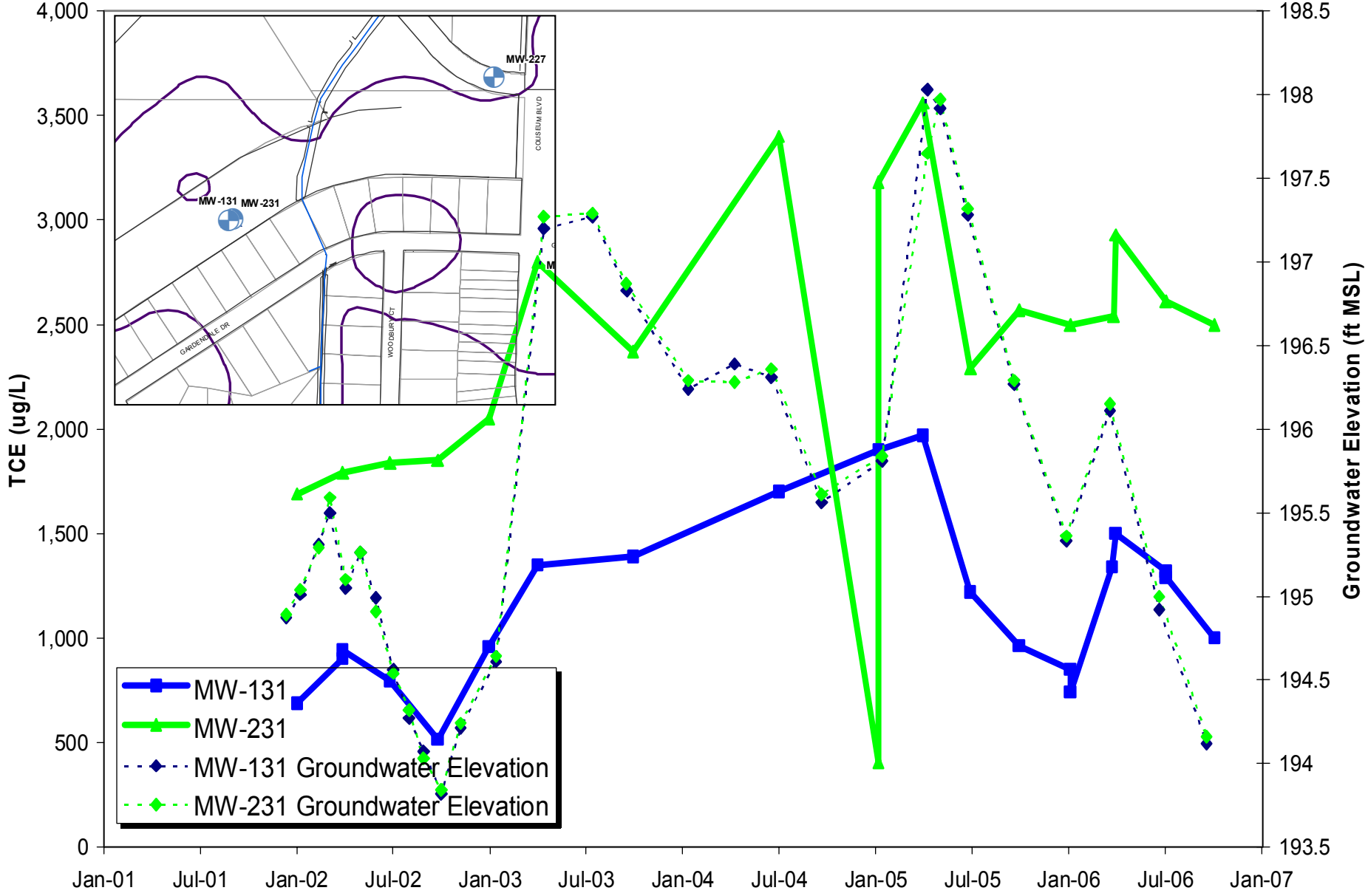
Time Series Plots
MW-129 - MW-229



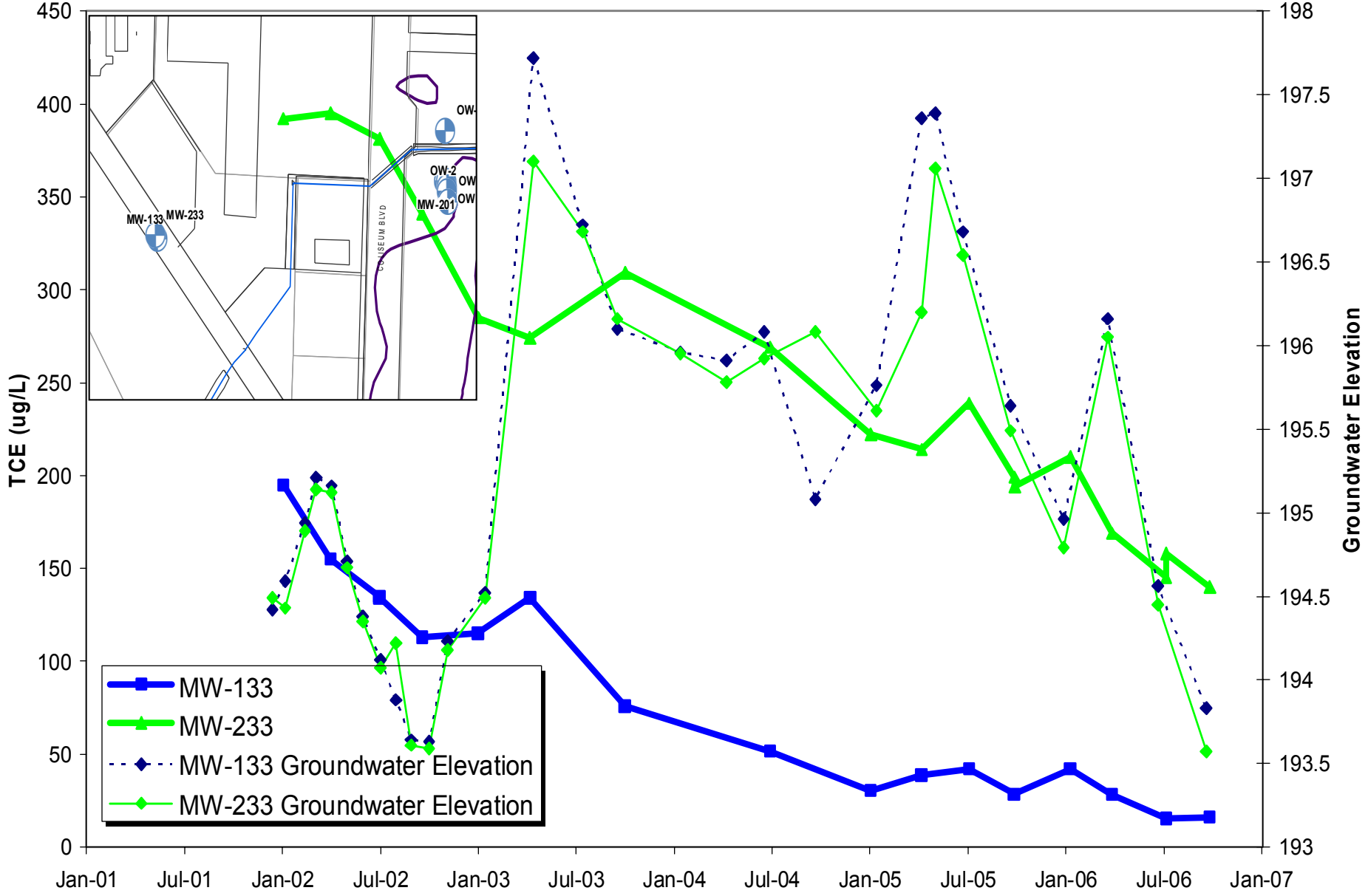
Time Series Plots
MW-130 - MW-230



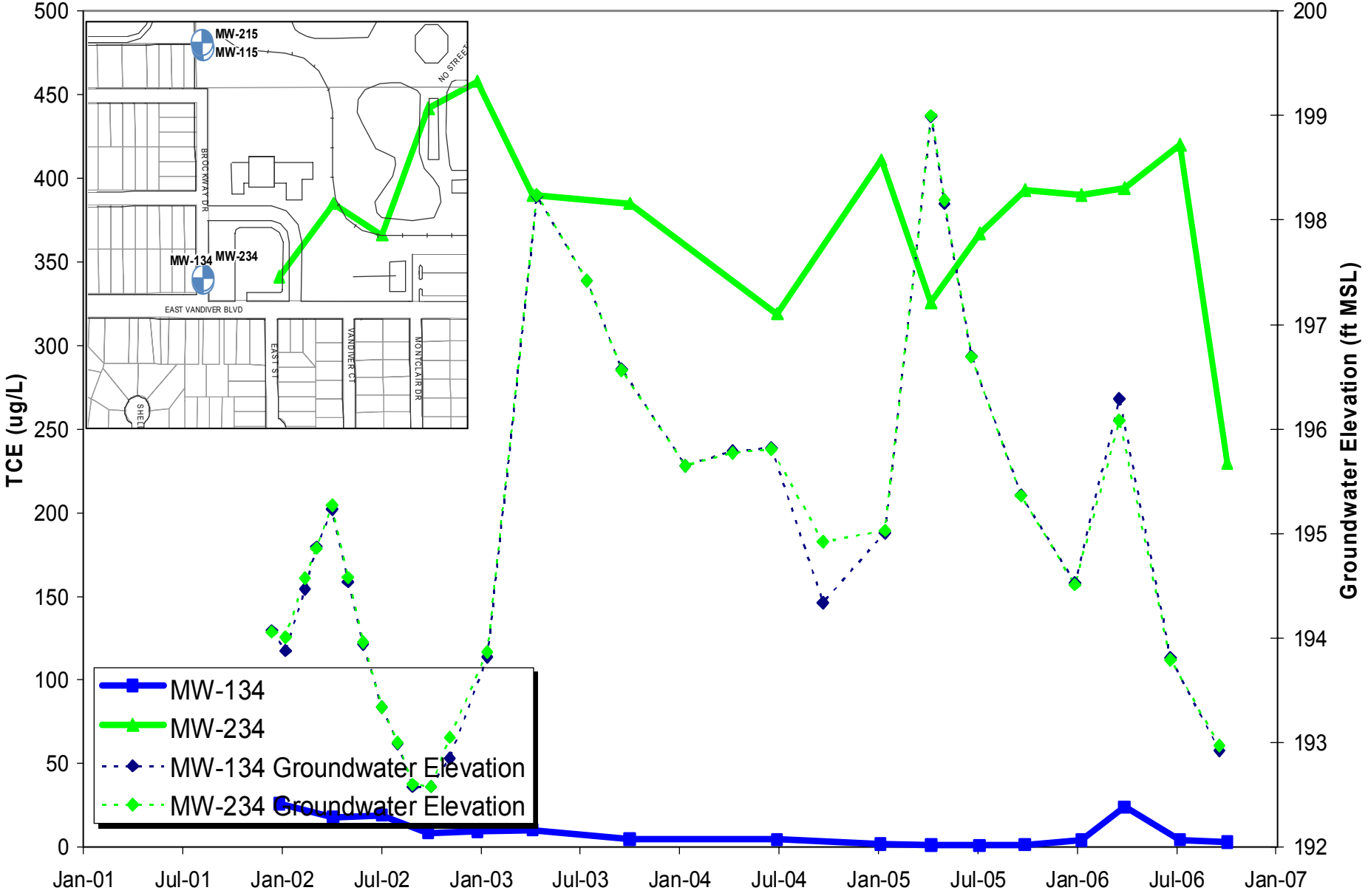
Time Series Plots
MW-131 - MW-231



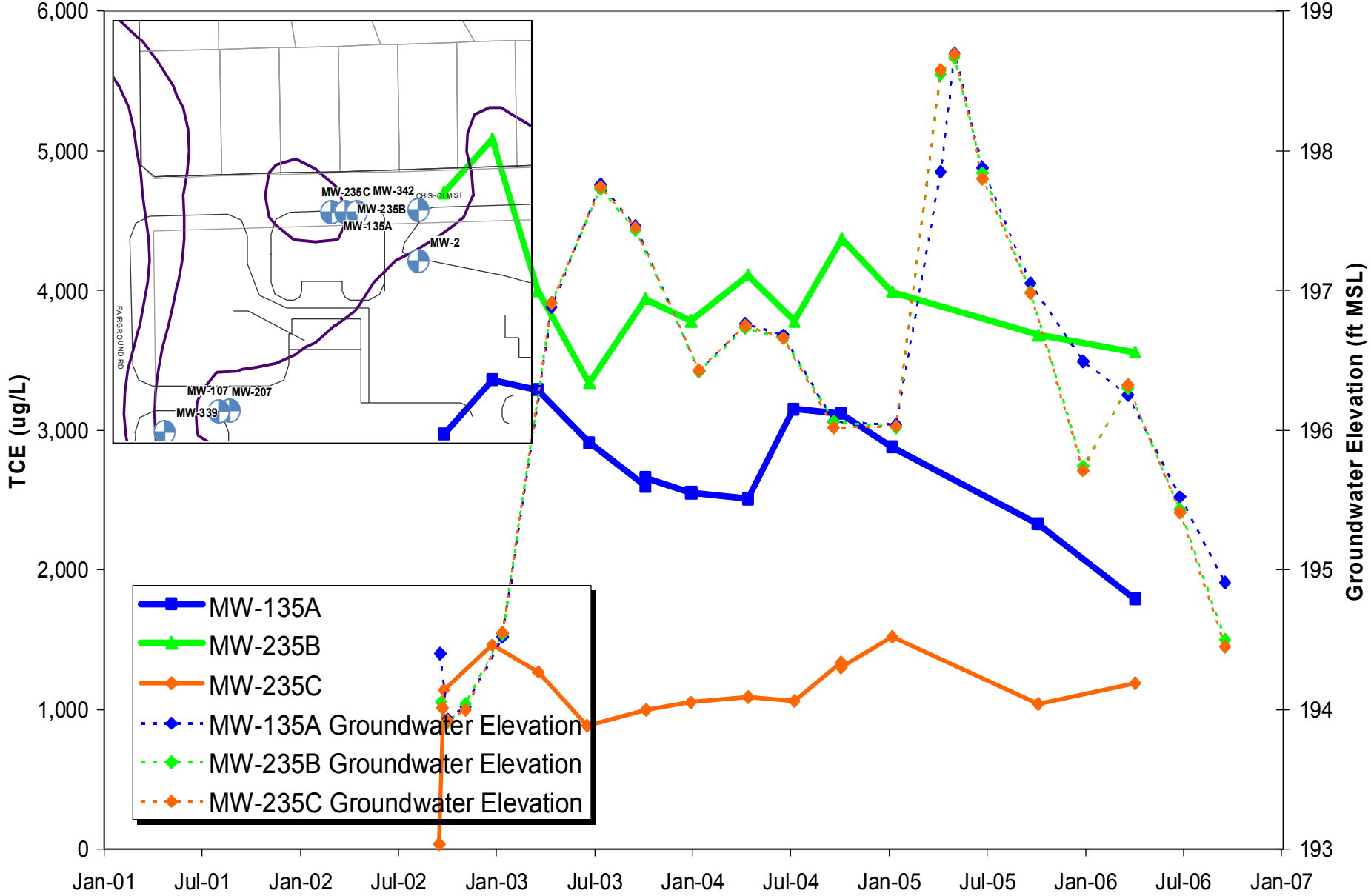
Time Series Plots
MW-133 - MW-233



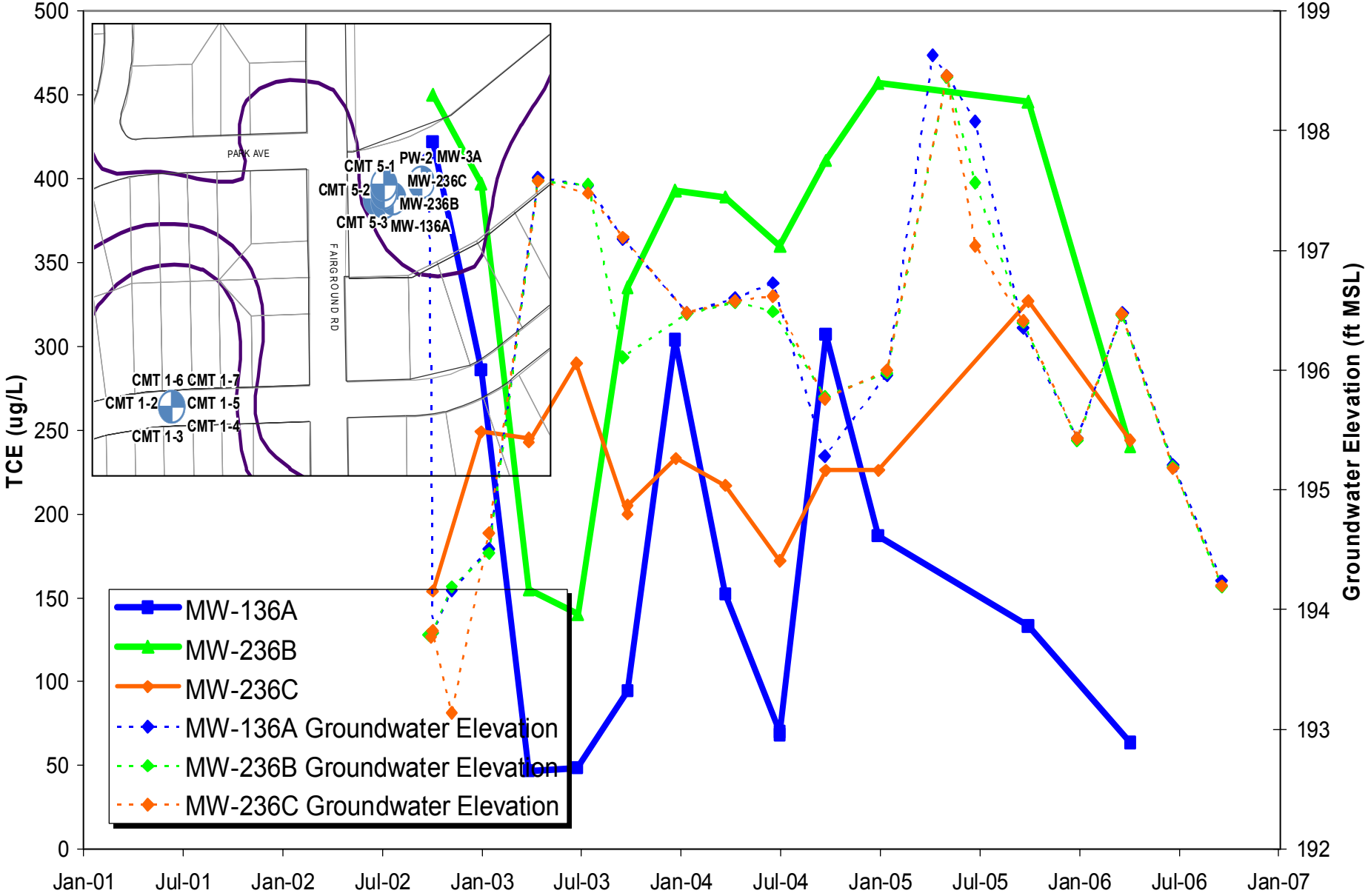
Time Series Plots
MW-134 - MW-234



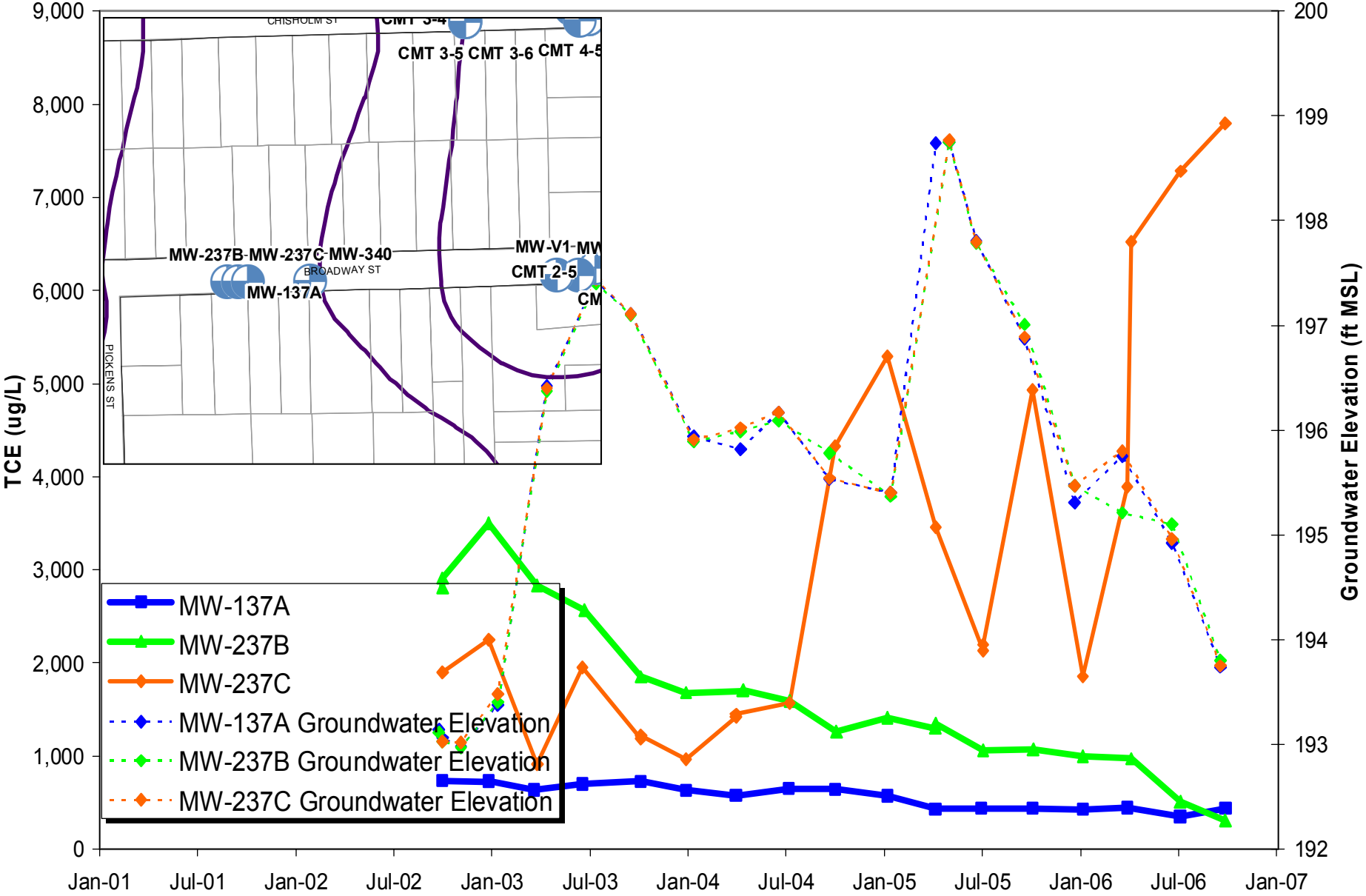
Time Series Plots
MW-135A - MW-235C



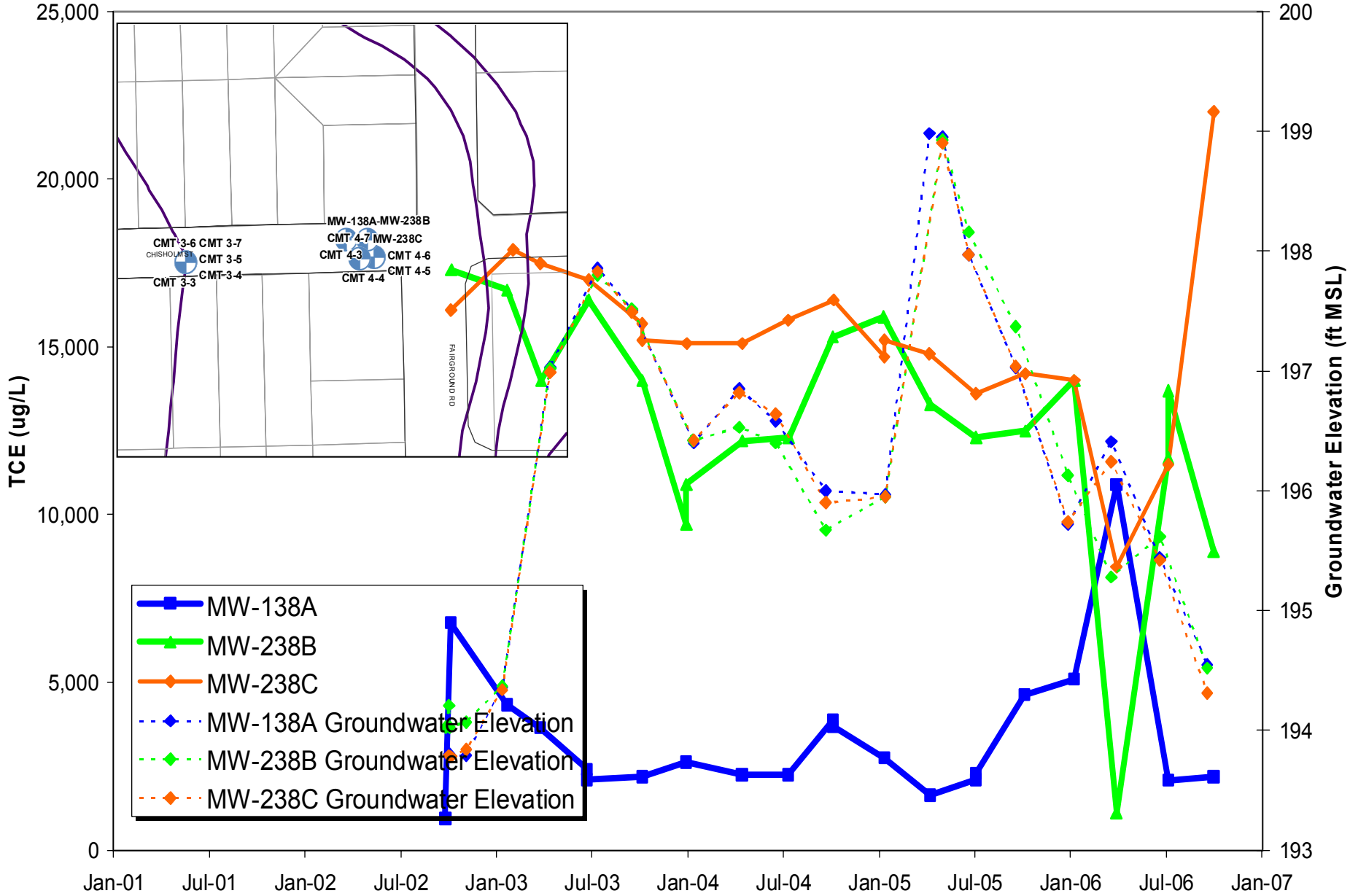
Time Series Plots
MW-136A - MW-236C



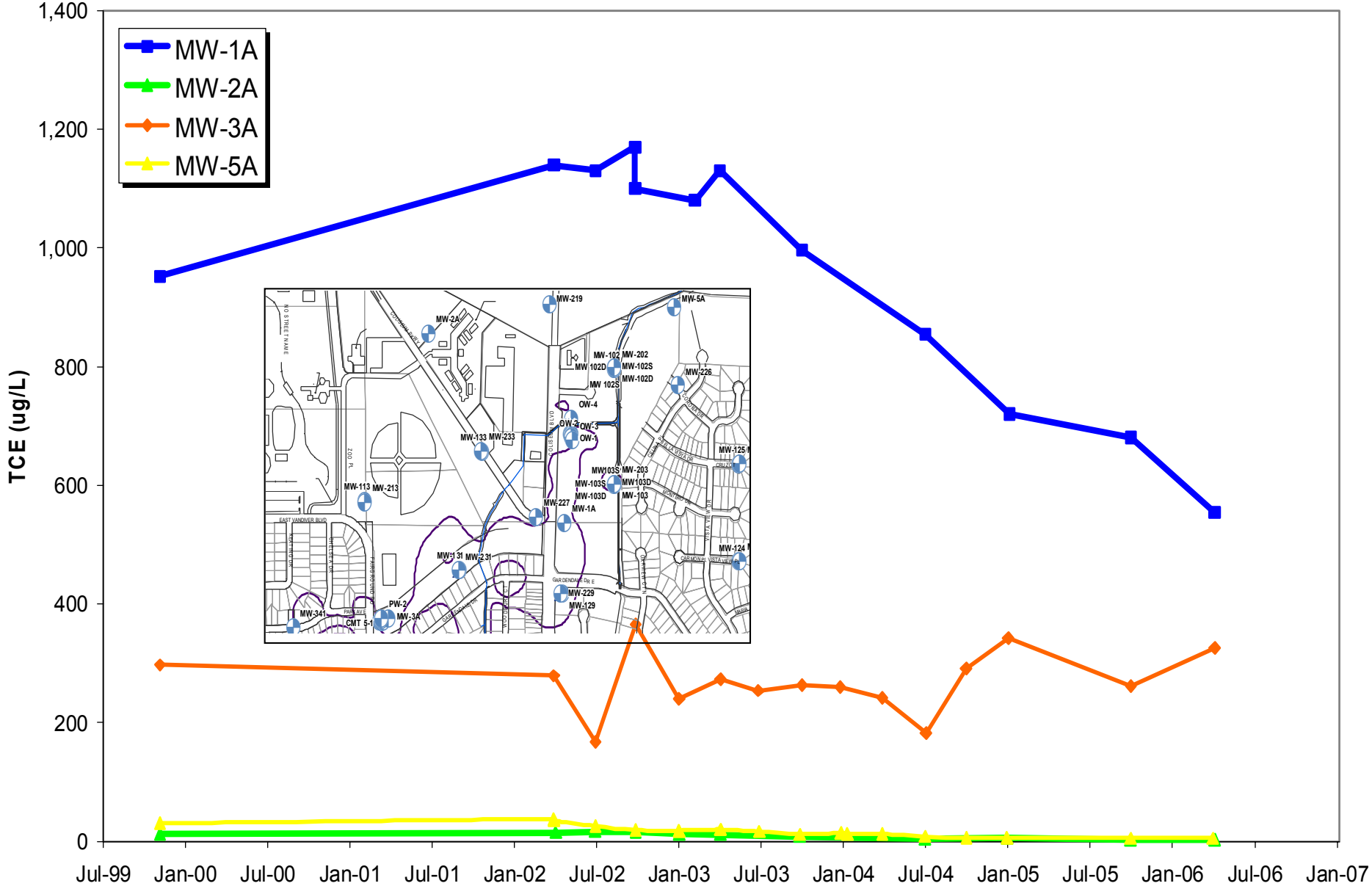
Time Series Plots
MW-137 - MW-237



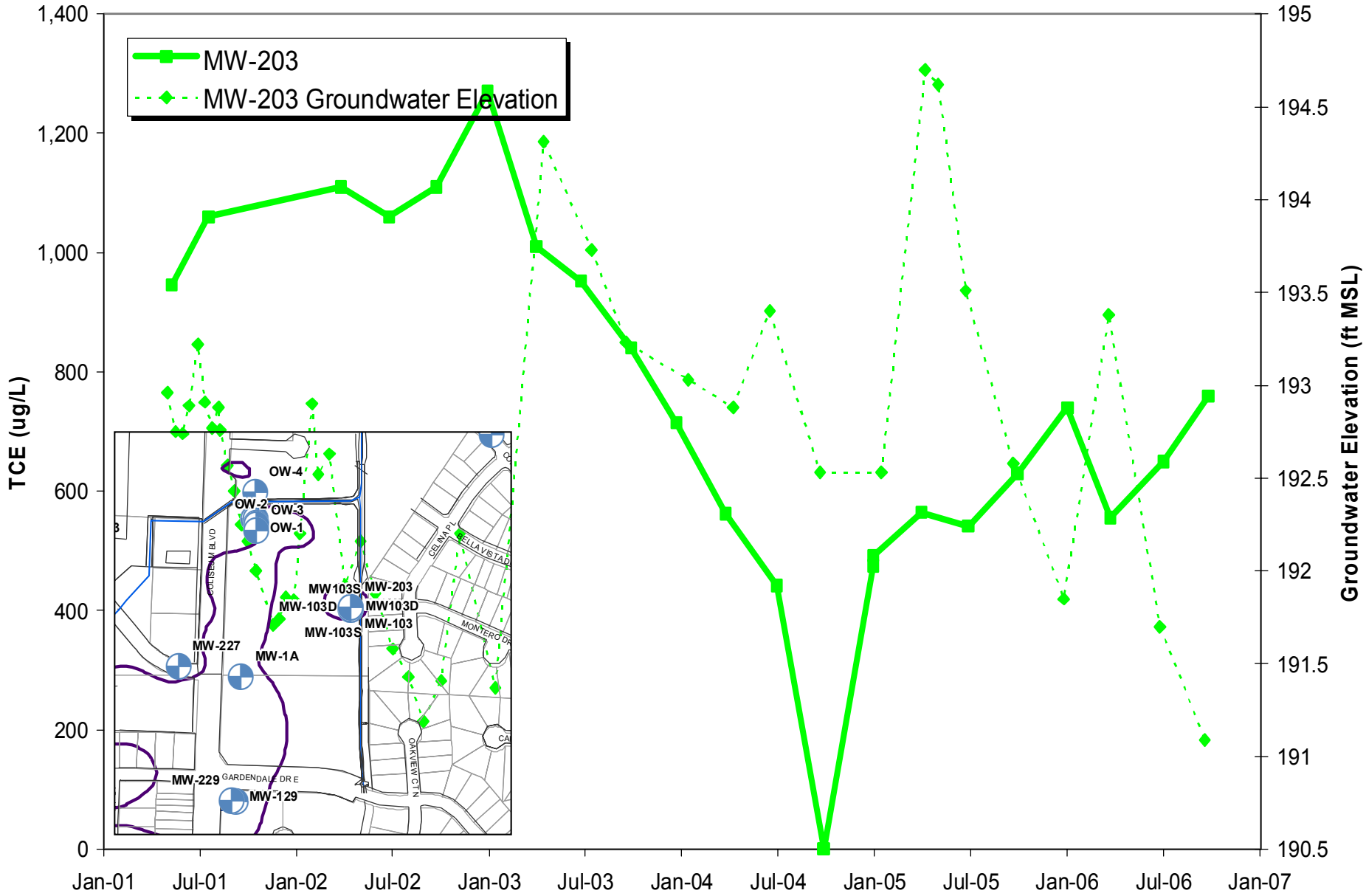
Time Series Plots MW-138A - MW-238C



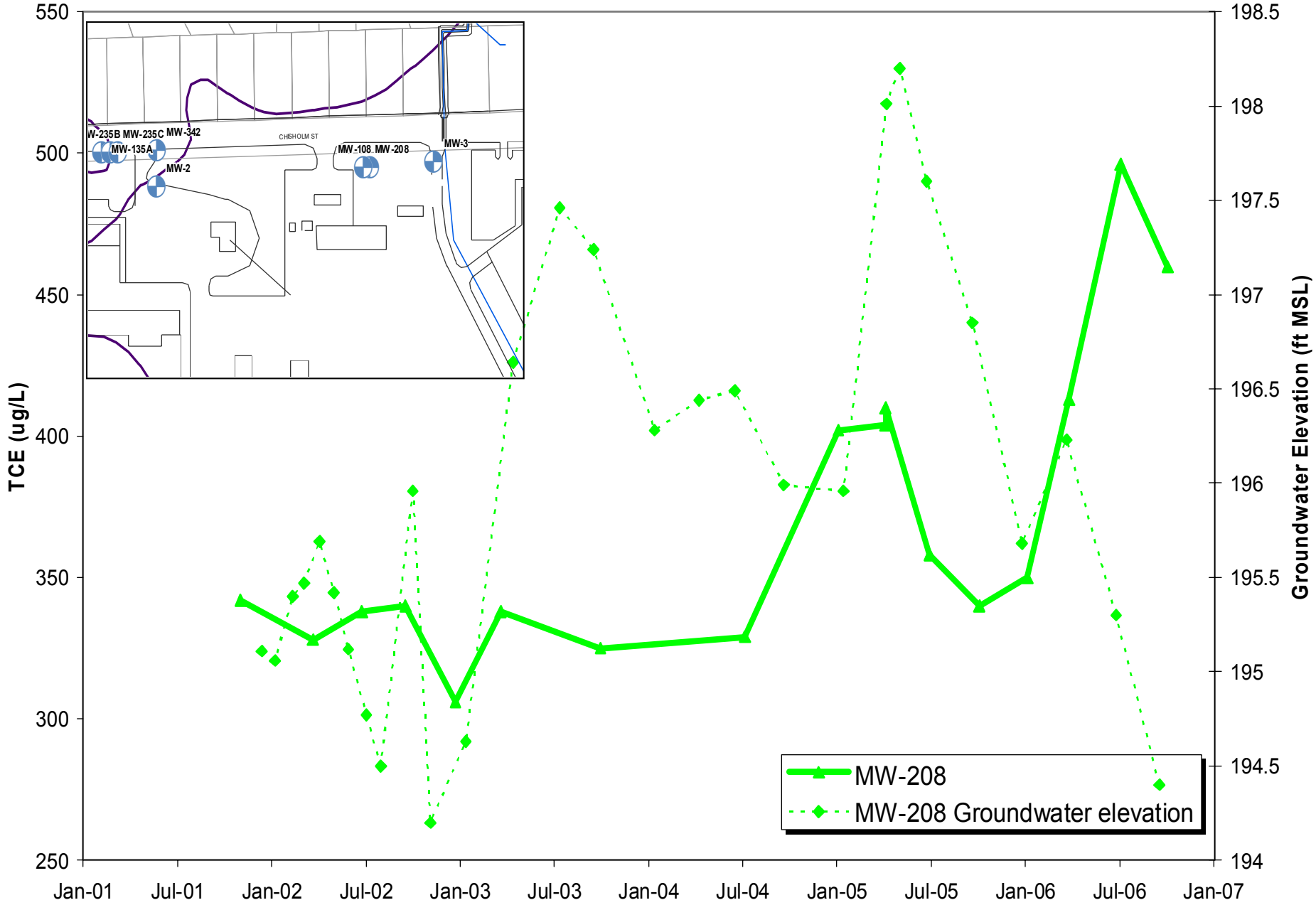
Time Series Plots
MW-1A - MW-5A



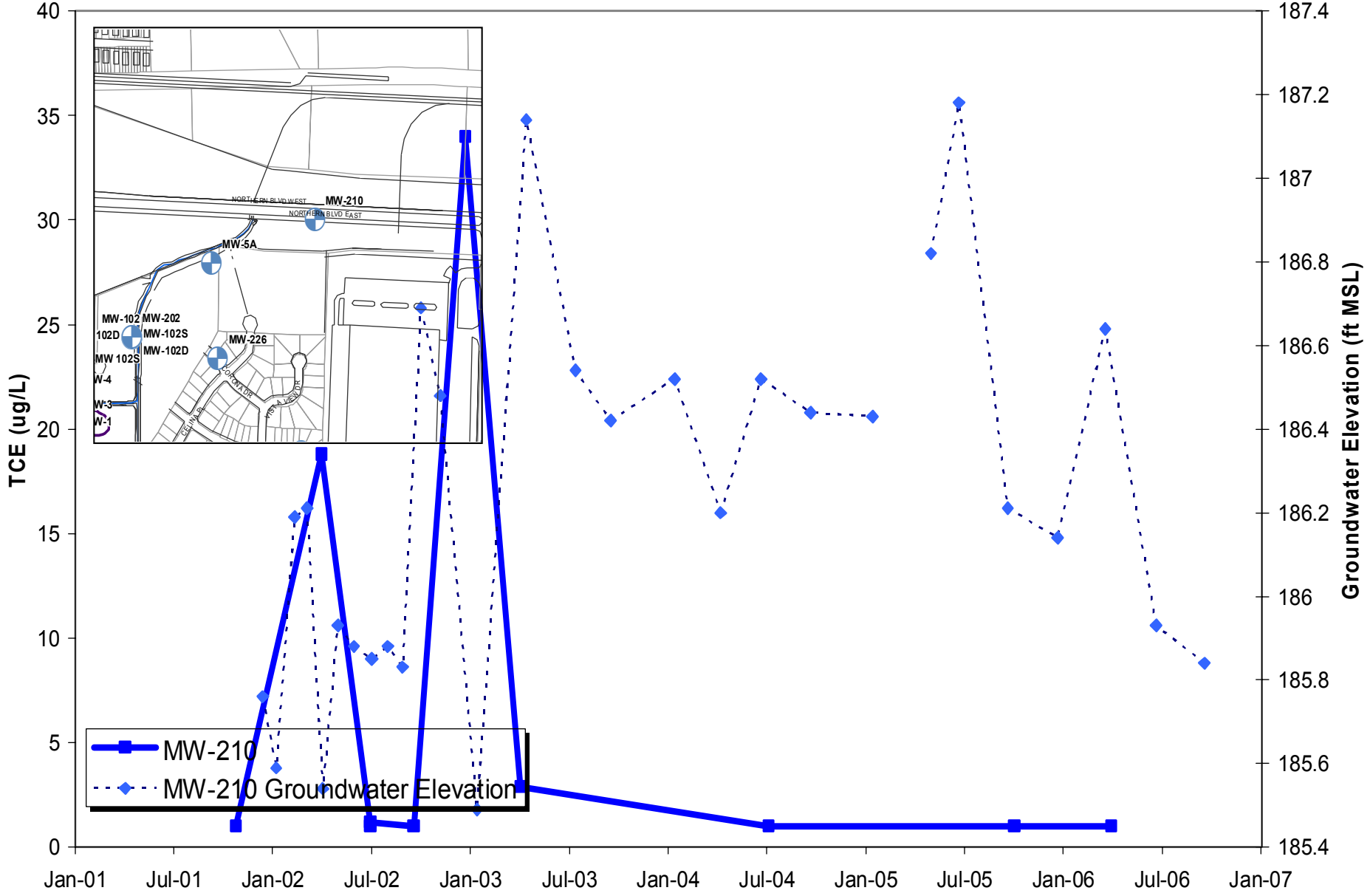
Time Series Plots
MW-203



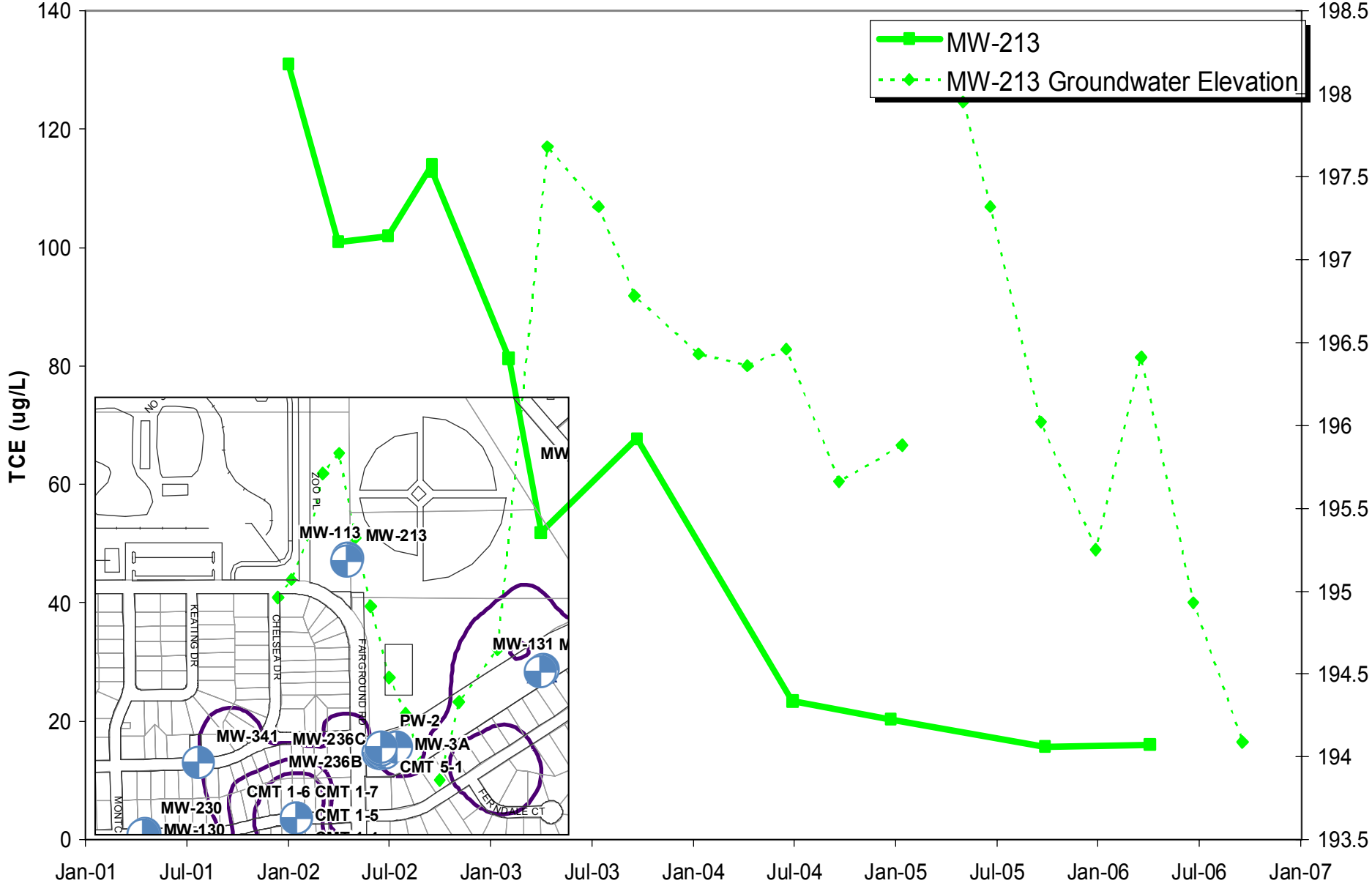
Time Series Plots MW-208



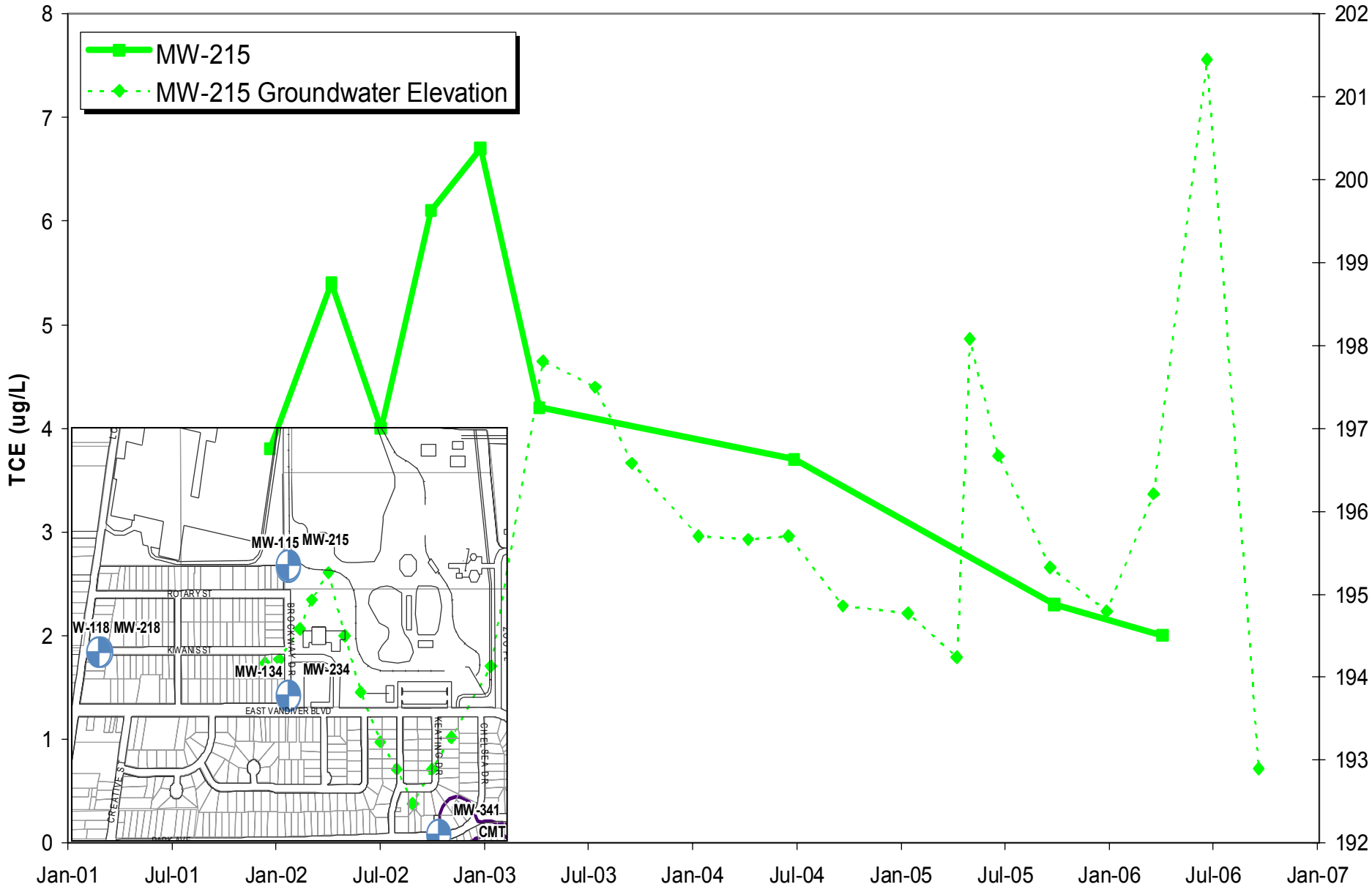
Time Series Plots
MW-210



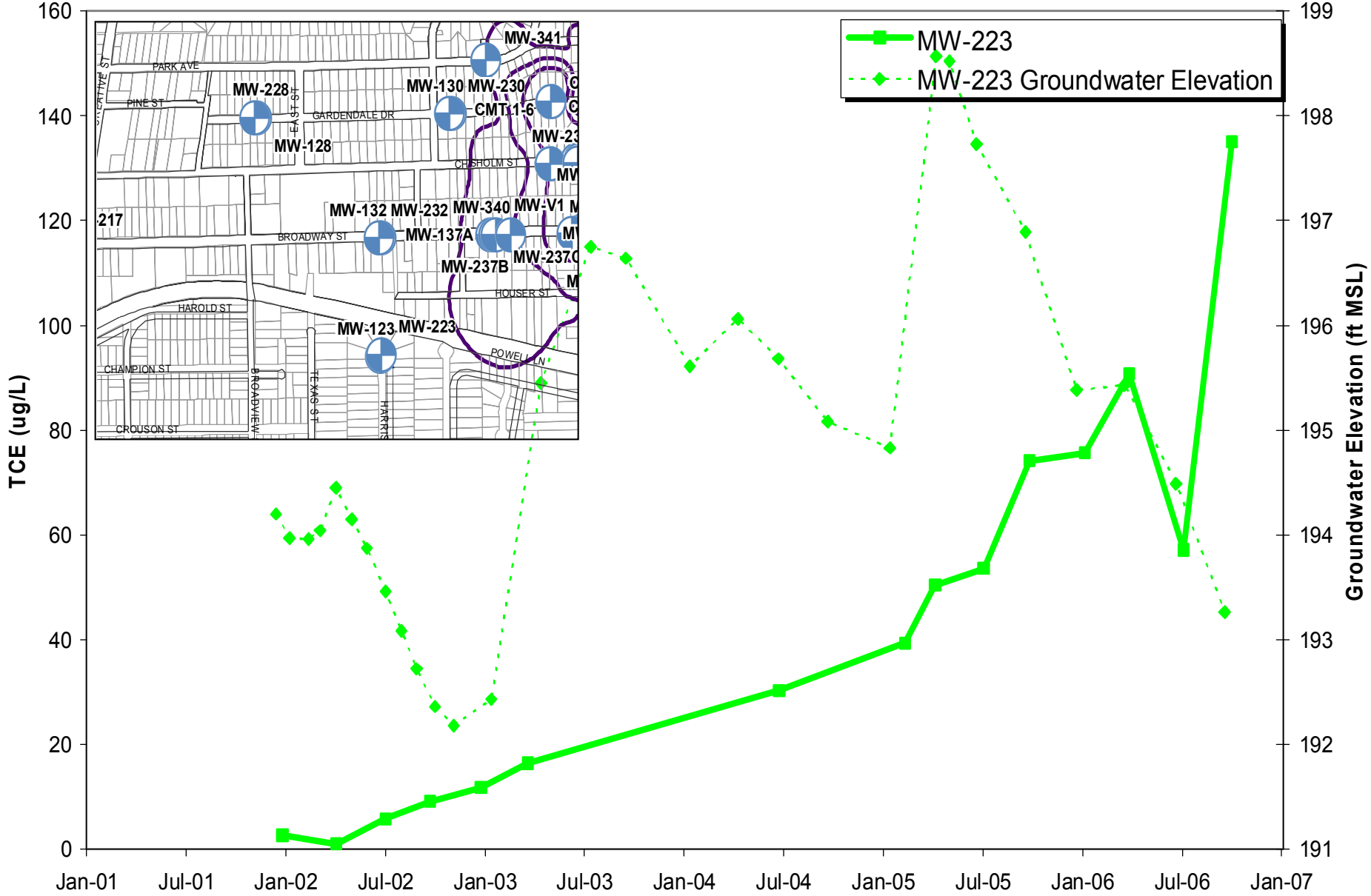
Time Series Plots
MW-213



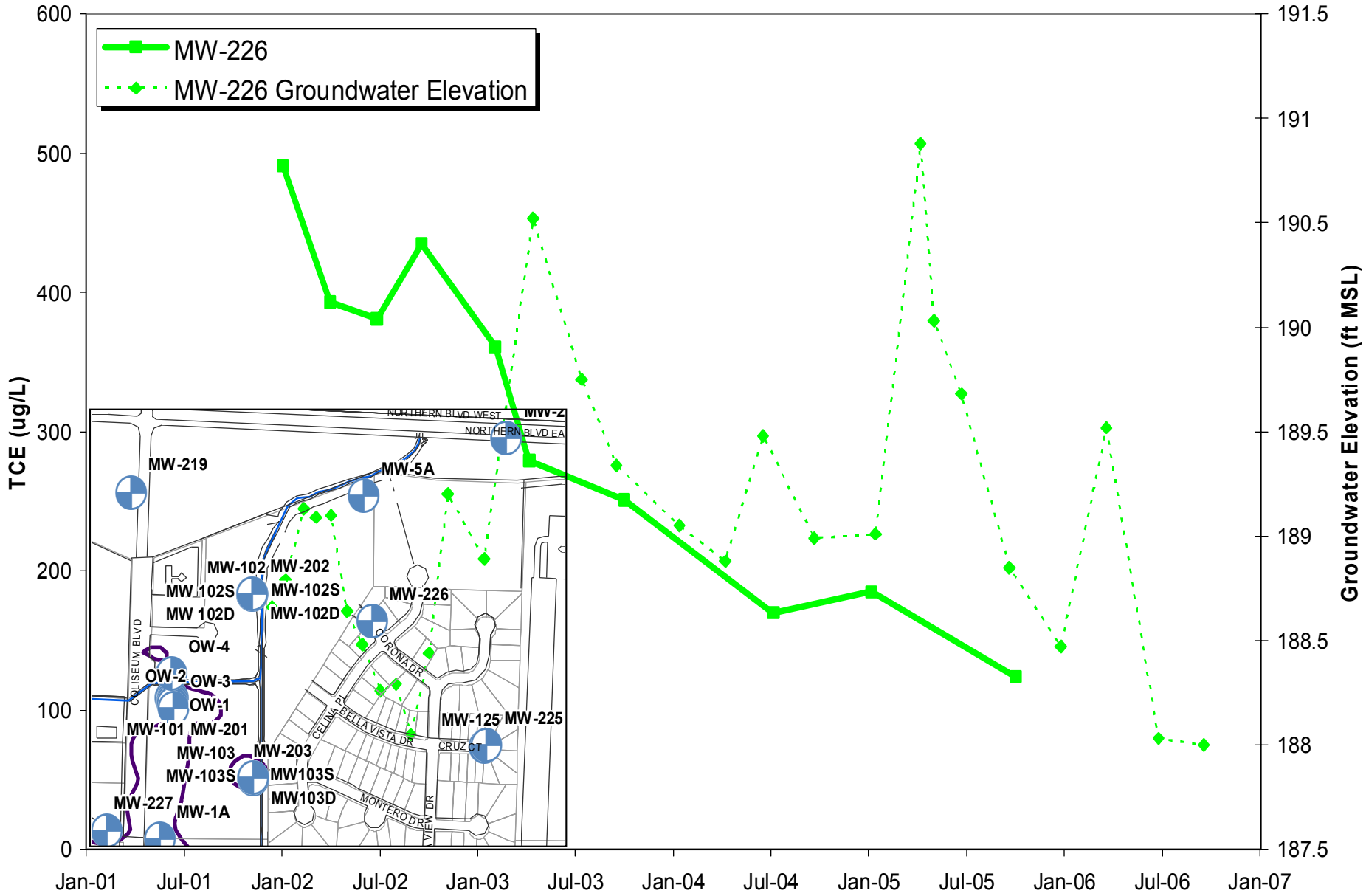
Time Series Plots MW-215



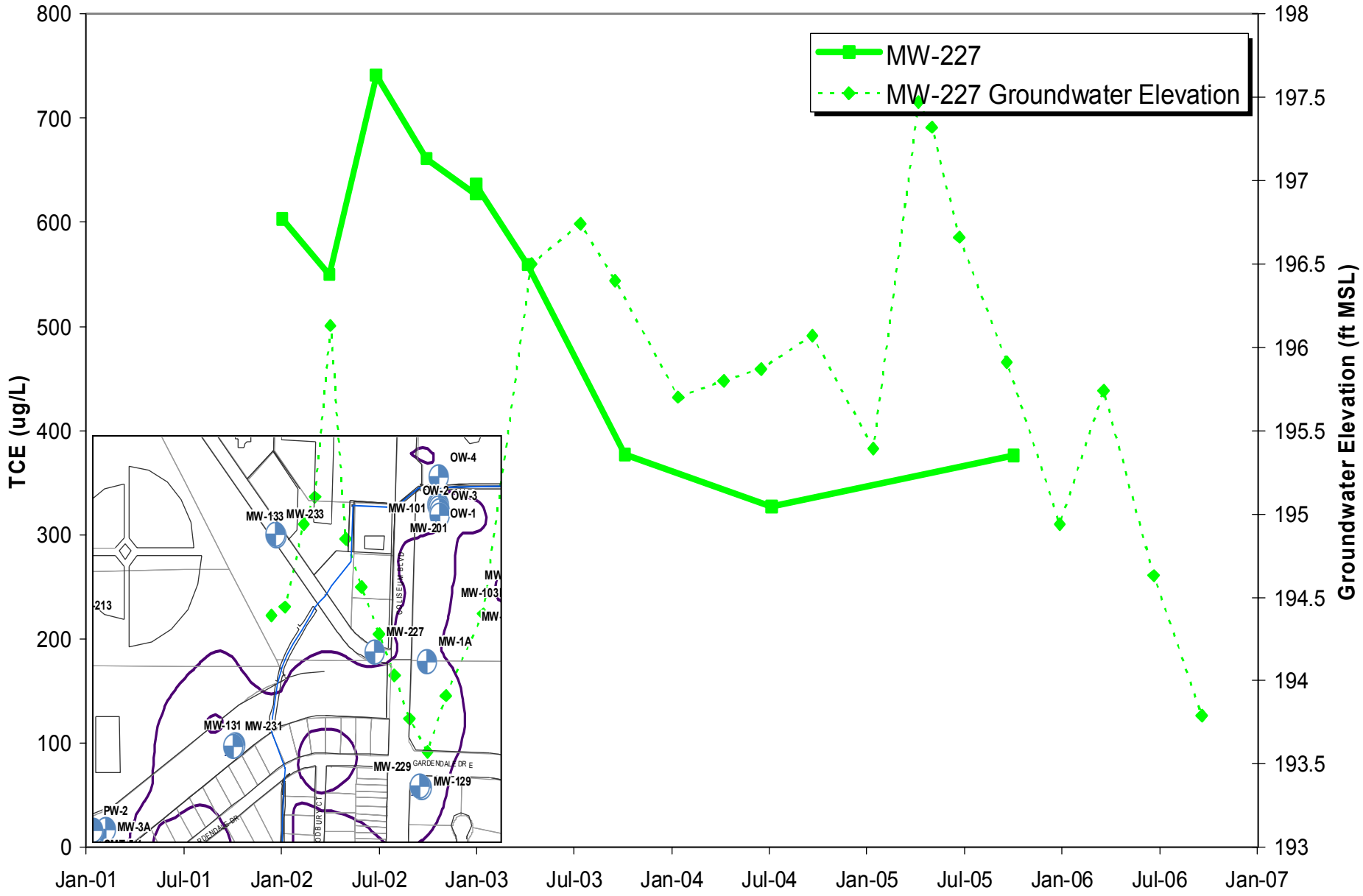
Time Series Plots
MW-223



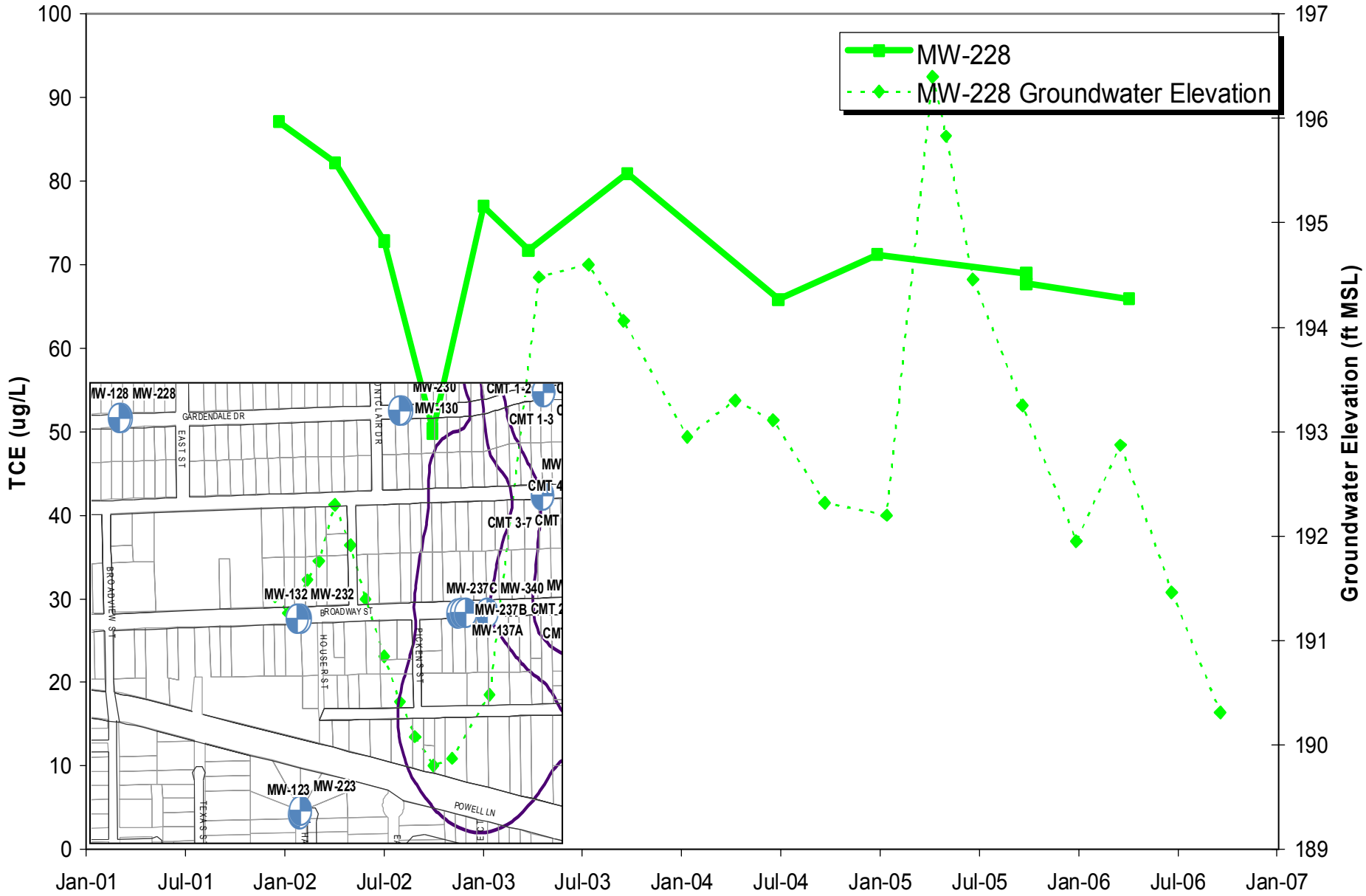
Time Series Plots
MW-226



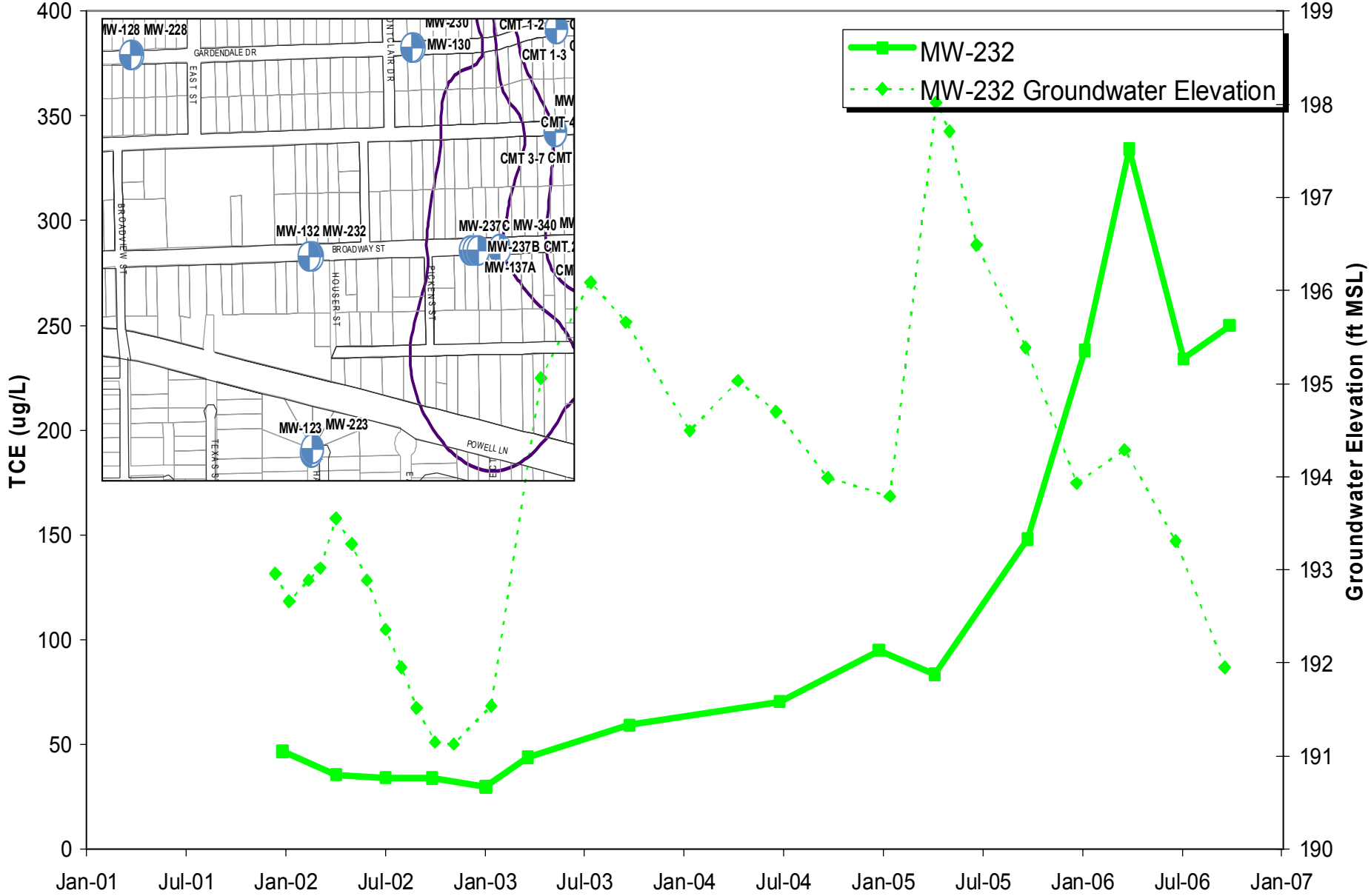
Time Series Plots
MW-227



Time Series Plots
MW-228



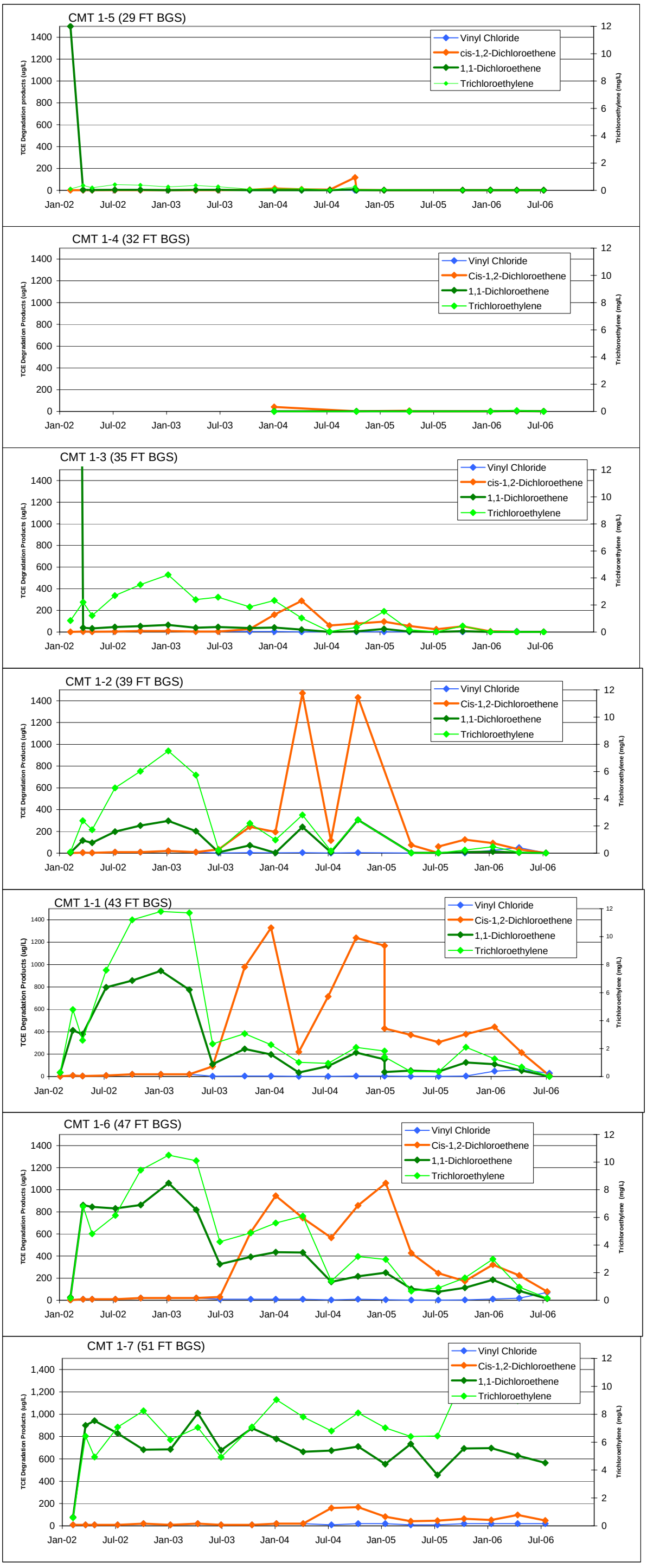
Time Series Plots
MW-232



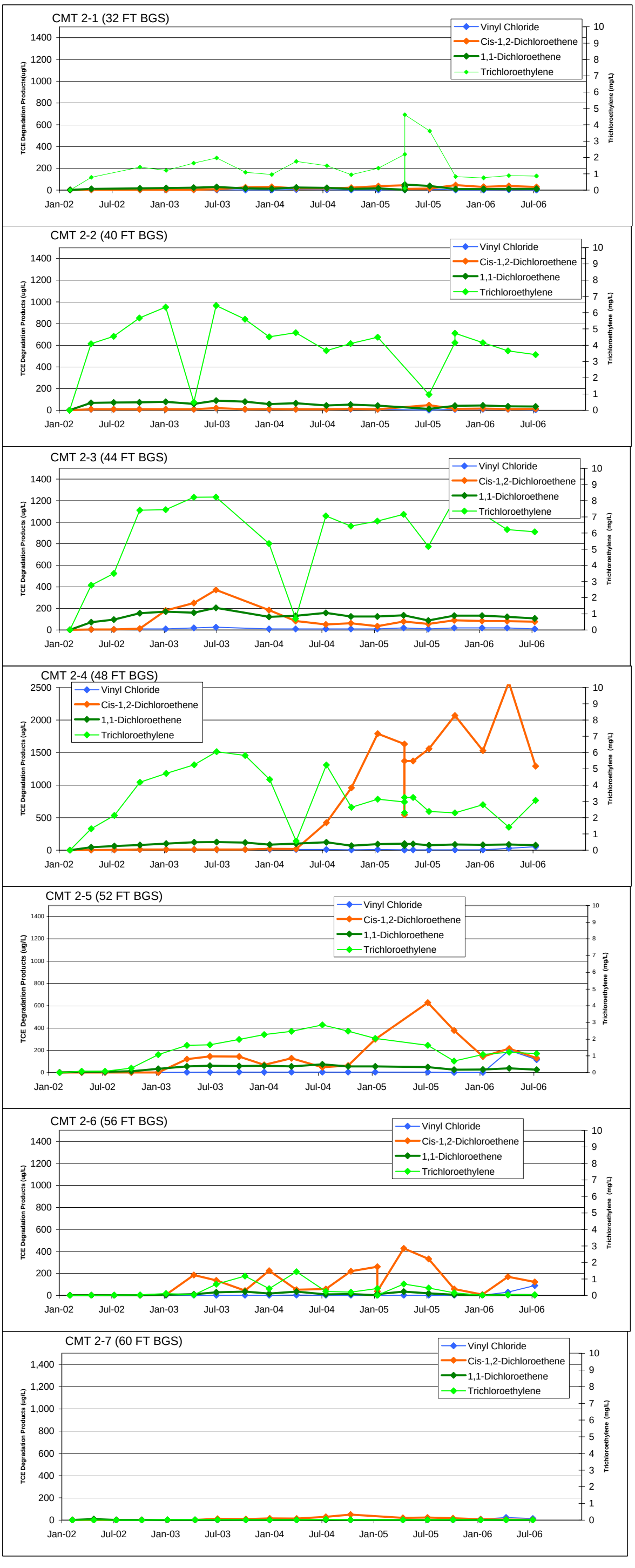
APPENDIX B

TIME SERIES PLOTS OF TCE DEGRADATION PRODUCTS

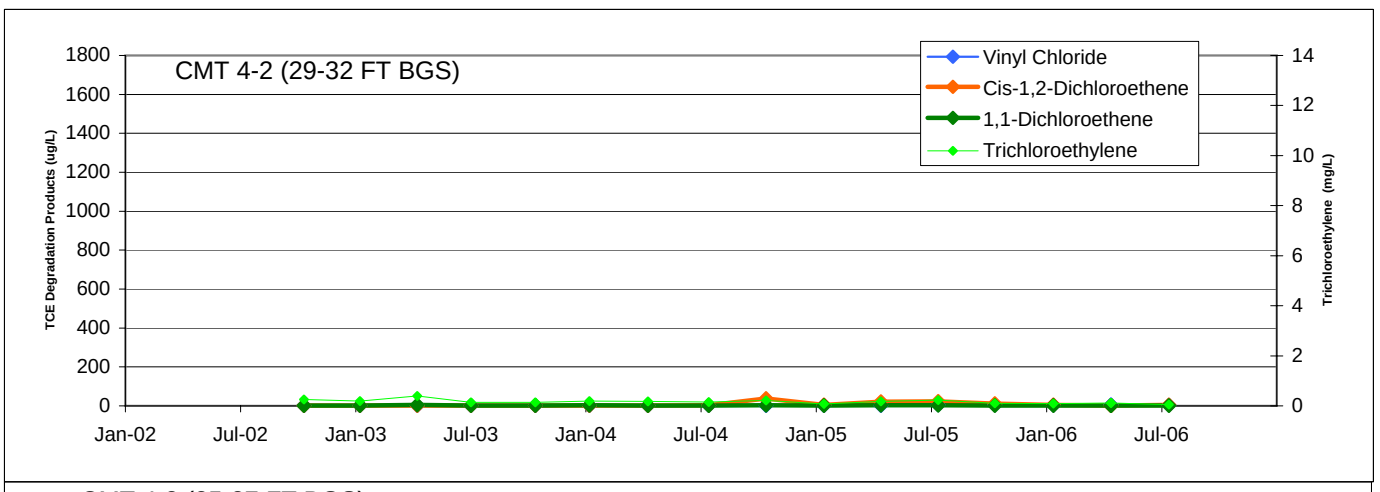
COLISEUM BOULEVARD PLUME
CMT 1 CONSTITUENT CONCENTRATION TIME SERIES PLOTS

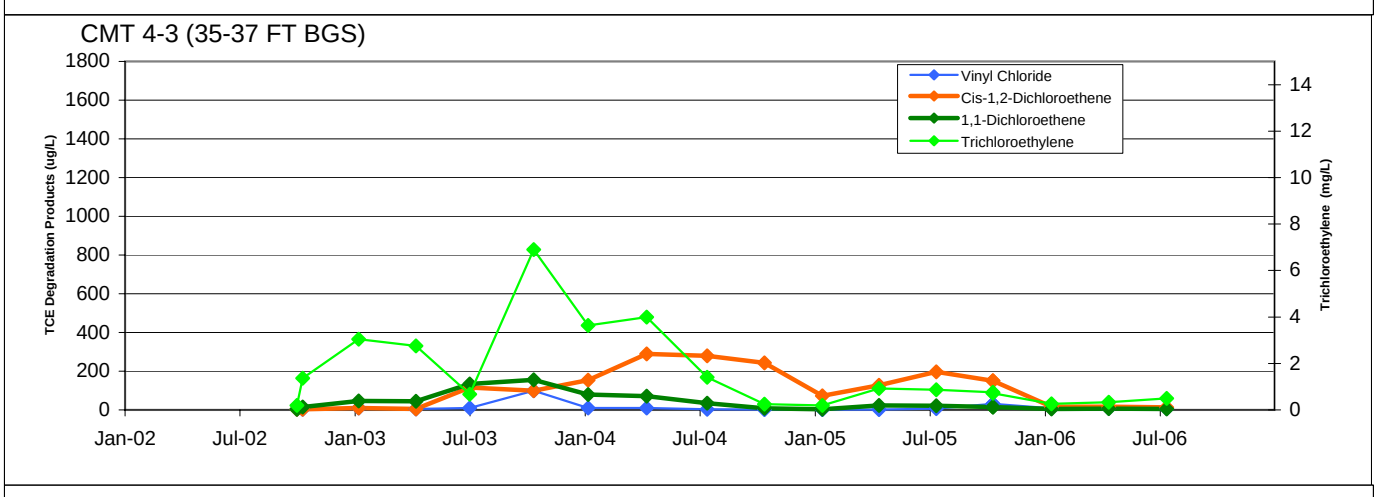


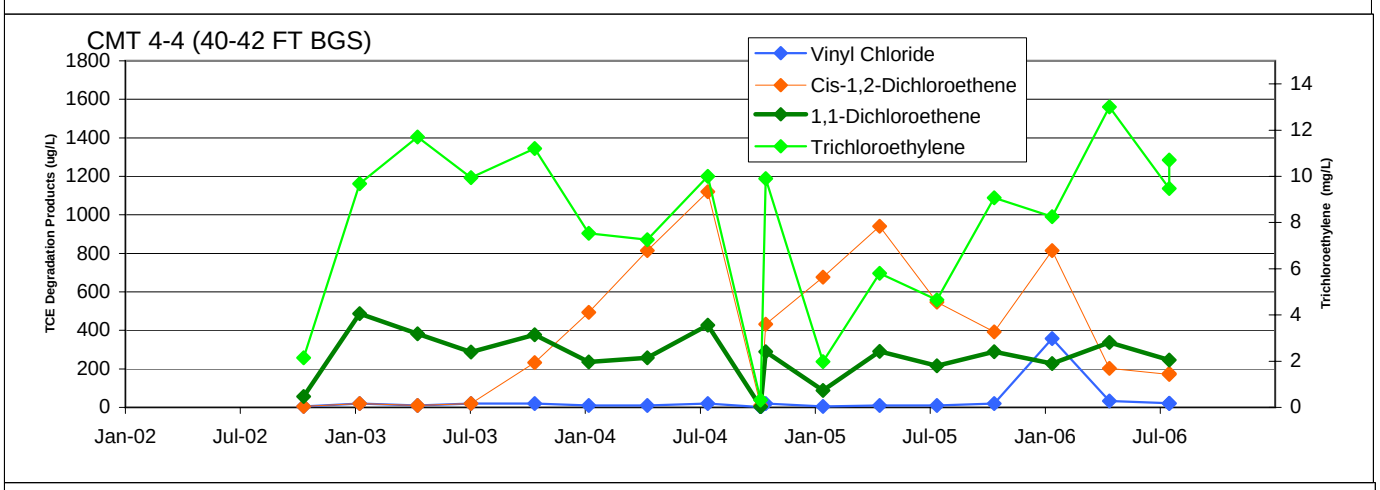
COLISEUM BOULEVARD PLUME
CMT 2 CONSTITUENT CONCENTRATION TIME SERIES PLOTS

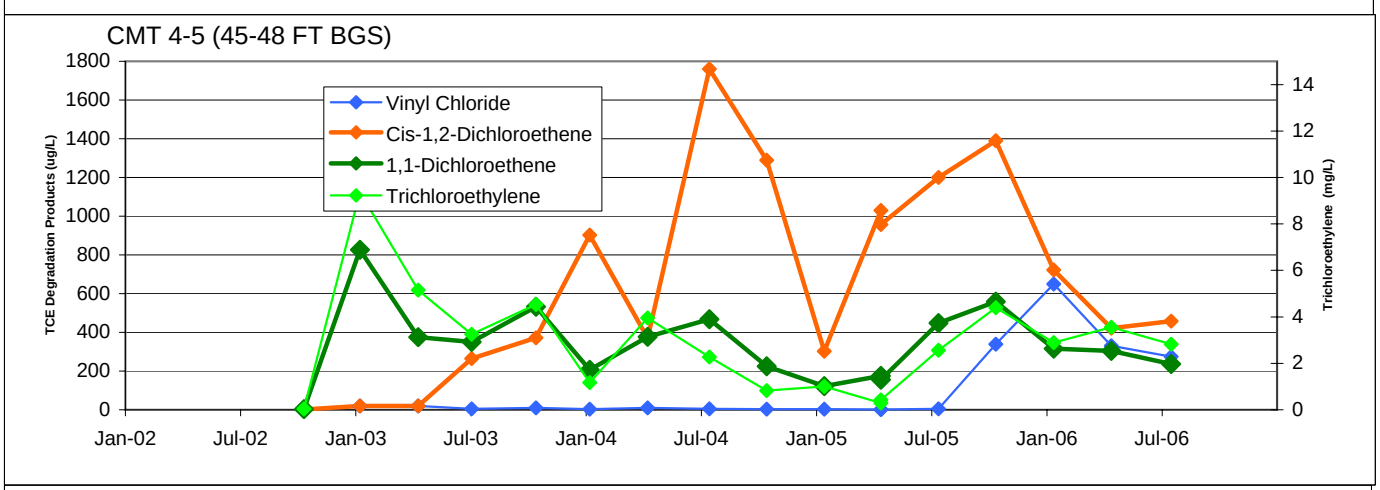


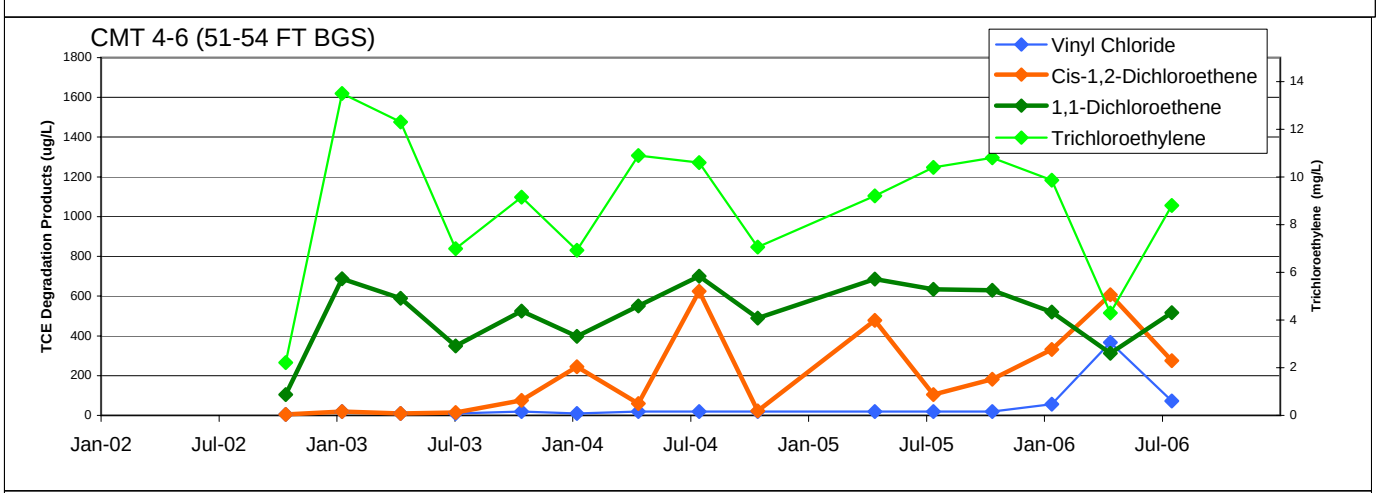
COLISEUM BOULEVARD PLUME
CMT 4 CONSTITUENT CONCENTRATION TIME SERIES PLOTS

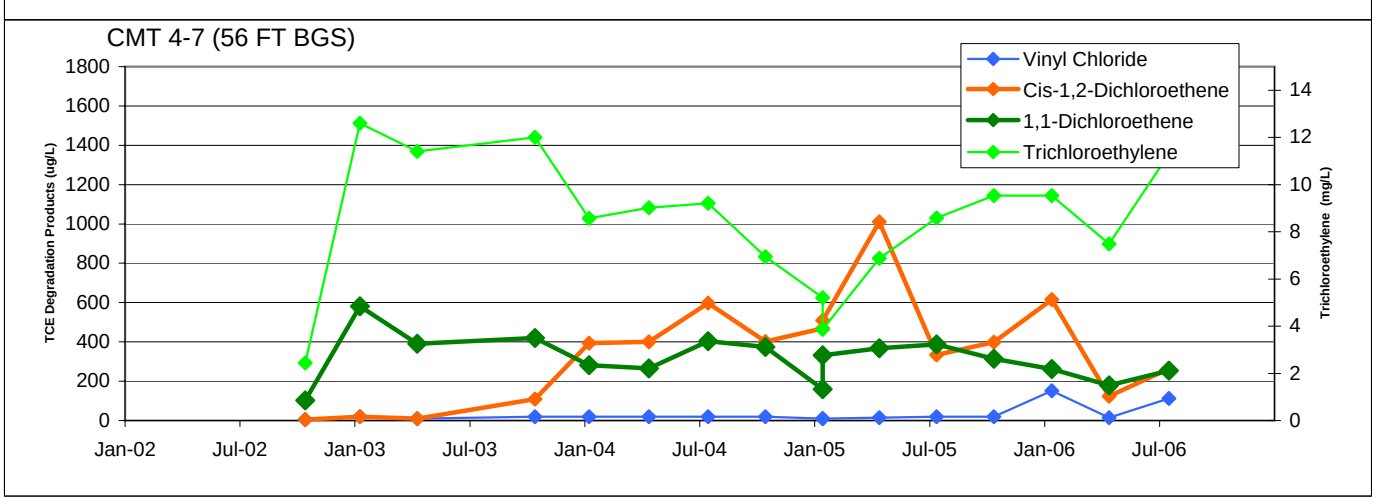




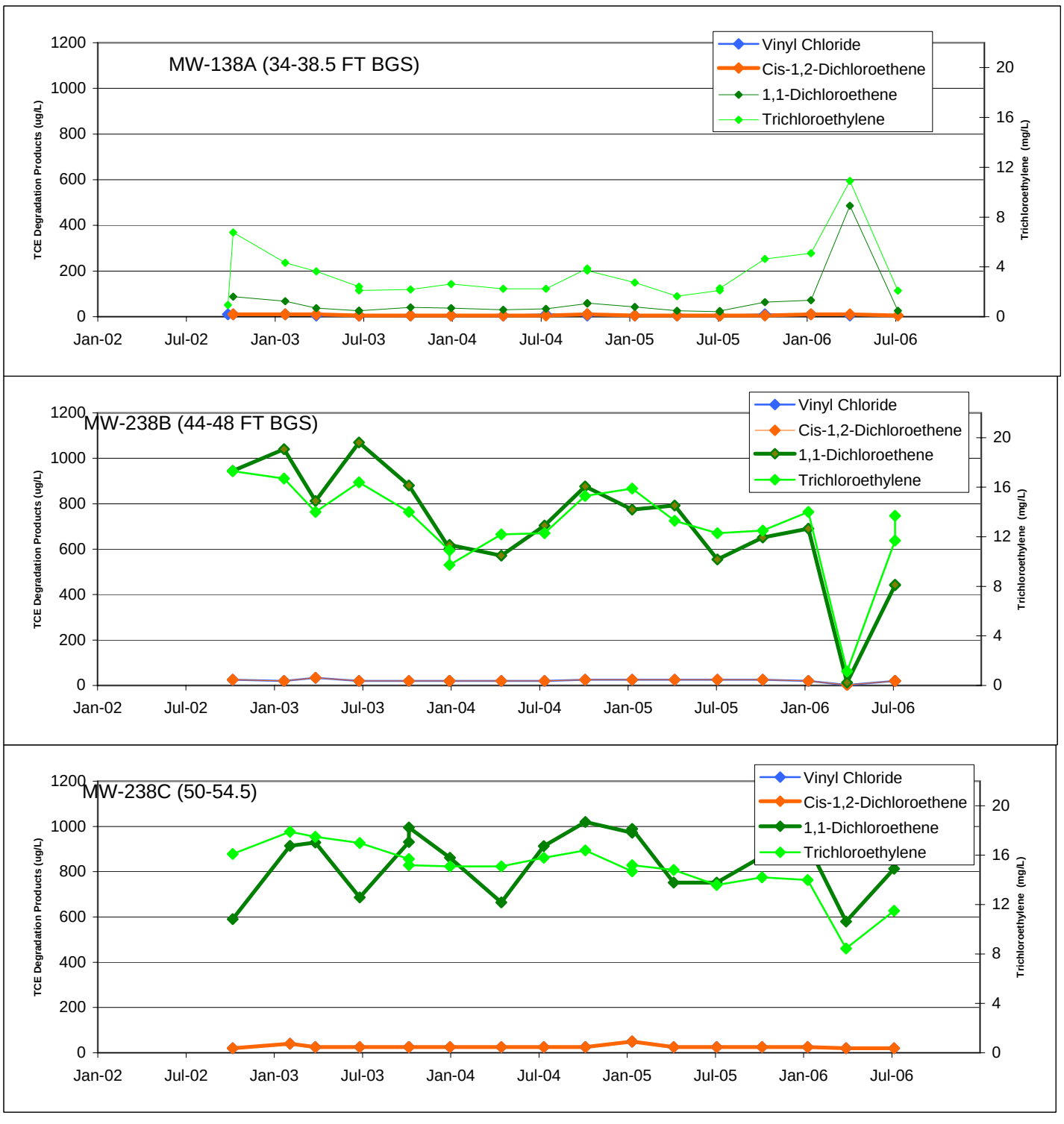




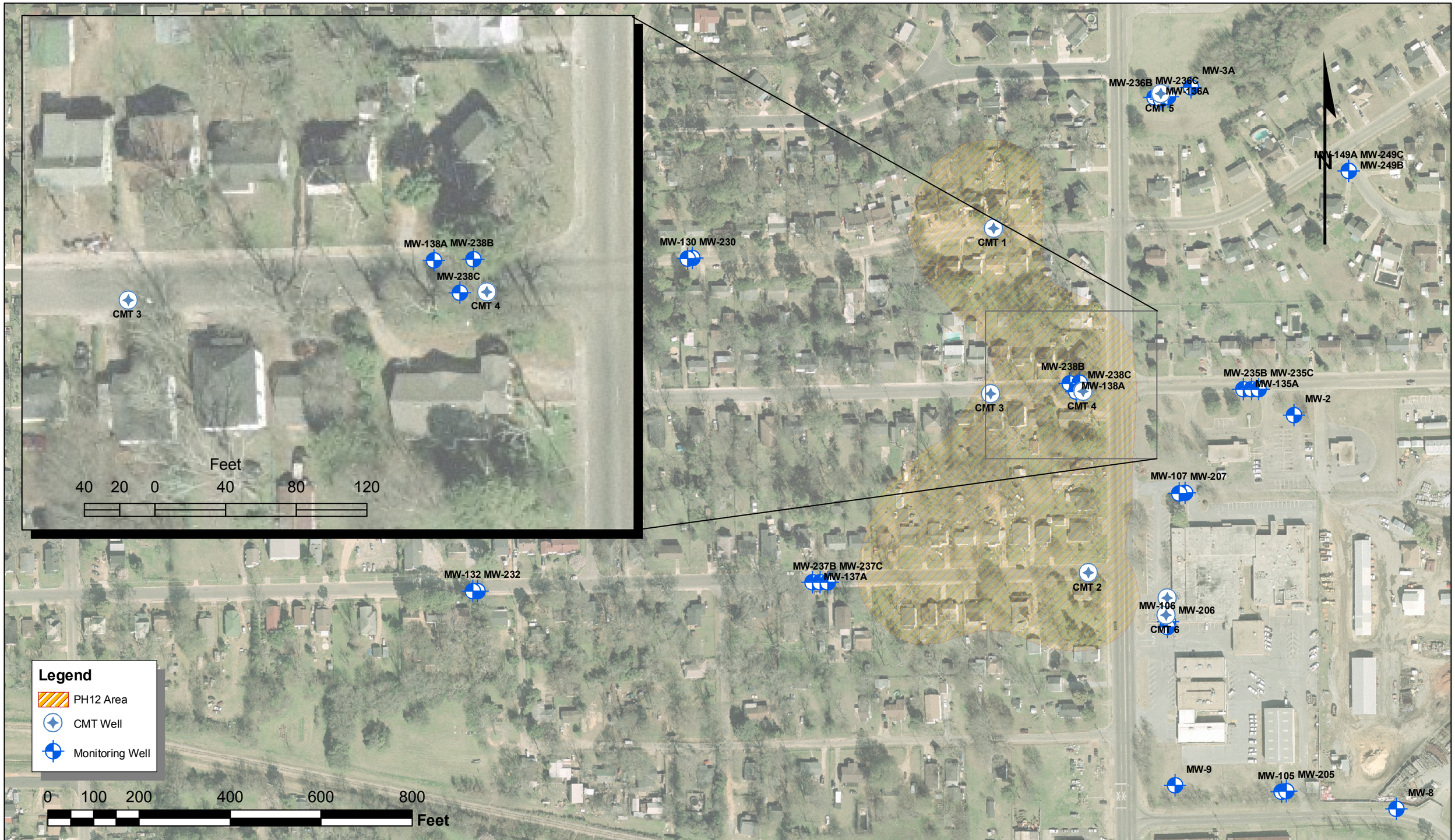




COLISEUM BOULEVARD PLUME
MW-138A/238B/238C CONSTITUENT CONCENTRATION TIME SERIES PLOTS



Note: Vinyl Chloride and Cis-1,2 Dichloroethene were not present above detectable levels in any of the samples

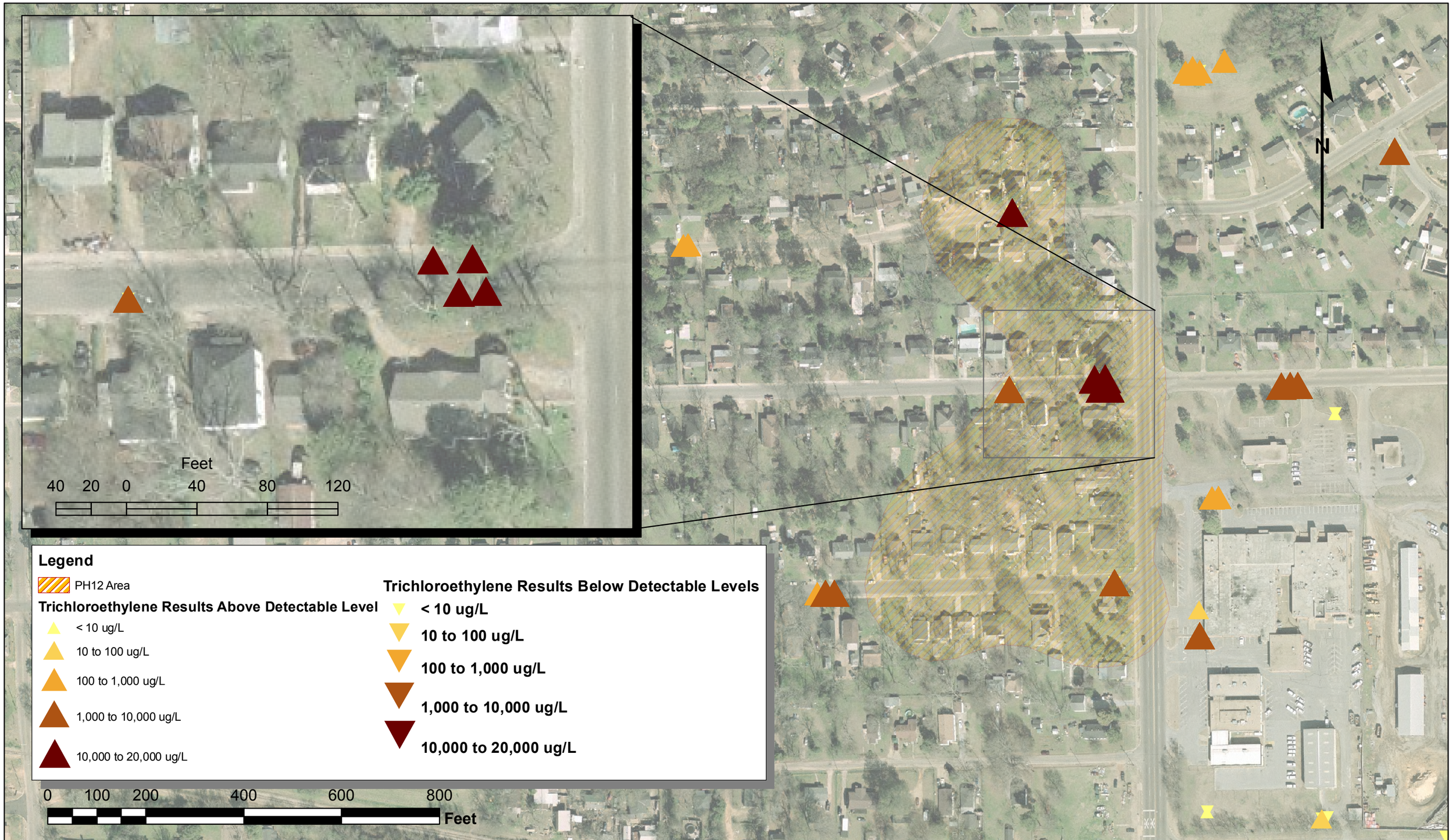


Alabama Department of Transportation
Coliseum Boulevard Project

ROUTINE WATER TABLE AQUIFER MONITORING LOCATIONS IN PH12 AREA

FIGURE B-1

March 2007



Alabama Department of Transportation
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MAXIMUM TRICHLOROETHYLENE CONCENTRATION IN GROUNDWATER FOR A PERIOD OF RECORD RANGING FROM MAY 2001 - OCTOBER 2006

FIGURE B-2

March 2007

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MAXIMUM VINYL CHLORIDE CONCENTRATION IN GROUNDWATER FOR A PERIOD OF RECORD RANGING FROM MAY 2001 - OCTOBER 2006

FIGURE B-3

March 2007

Alabama Department of Transportation
Coliseum Boulevard Project

MAXIMUM METHANE CONCENTRATION IN GROUNDWATER FOR A PERIOD OF RECORD RANGING FROM MAY 2001 - OCTOBER 2006

FIGURE B-4

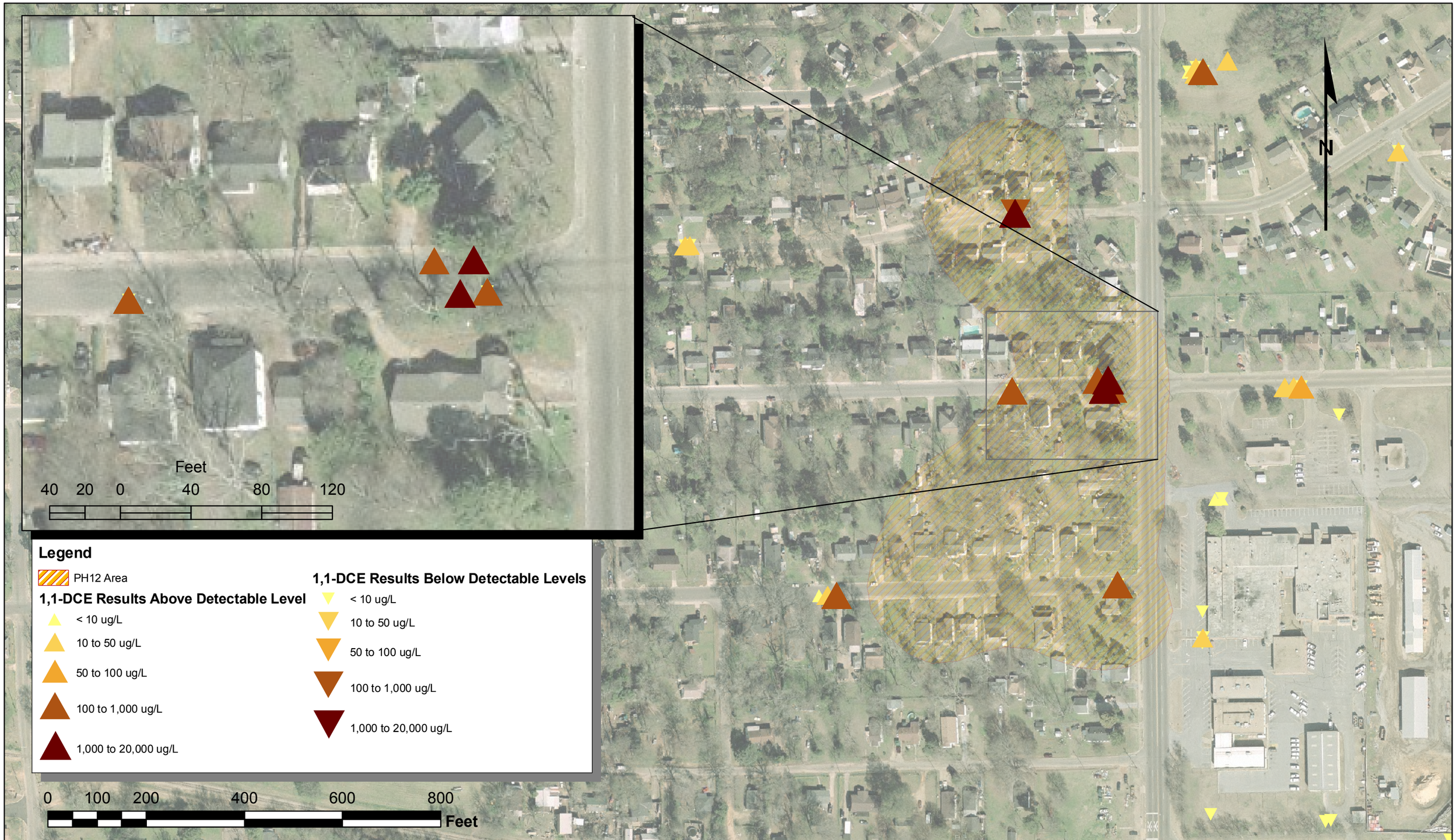
March 2007

Alabama Department of Transportation
Coliseum Boulevard Project

MAXIMUM CIS 1,2-DICHLOROETHENE CONCENTRATION IN GROUNDWATER FOR A PERIOD OF RECORD RANGNG FROM MAY 2001 - OCTOBER 2006

FIGURE B-5

March 2007



Alabama Department of Transportation
Coliseum Boulevard Project

MAXIMUM 1,1-DICHLOROETHENE CONCENTRATION IN GROUNDWATER FOR A PERIOD OF RECORD RANGING FROM MAY 2001 - OCTOBER 2006

FIGURE B-6

March 2007