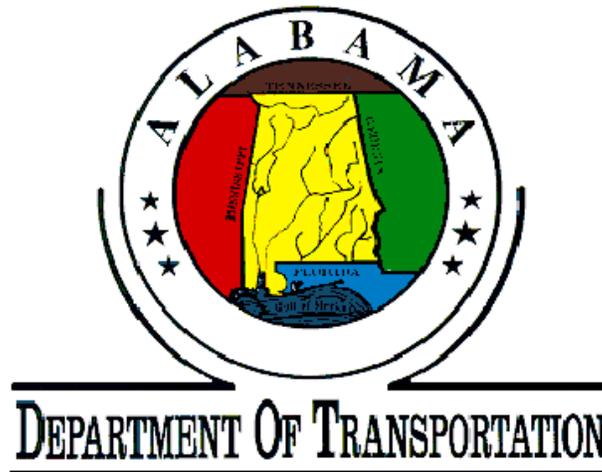


ANALYSIS OF TCE TRENDS OVER TIME THROUGH JANUARY 2005

COLISEUM BOULEVARD PLUME INVESTIGATION



May 6, 2005

**Submitted to:
The Alabama Department of Environmental Management
Montgomery, Alabama**

**ALABAMA DEPARTMENT OF TRANSPORTATION
COLISEUM BOULEVARD PLUME
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THROUGH JANUARY 2005**

BACKGROUND

Groundwater samples have been routinely collected from monitoring wells and Continuous Multichannel Tubing (CMT) wells located in the Coliseum Boulevard Plume (CBP) area over a period of three years, from 2001 through 2004. For most wells the sampling frequency is quarterly, providing as many as 12 discrete sets of samples from individual wells over this period. Both the number of samples and the three years that have elapsed since routine monitoring was initiated are adequate to evaluate changes in trichloroethylene (TCE) concentrations over time. The objectives of this trend evaluation are to identify wells where the TCE concentrations in the groundwater samples have significantly changed over time and to the extent possible identify a probable cause and to evaluate the spatial distribution of the wells where these significant trends have been observed. Analysis of these trends may provide additional insight on the movement and behavior of TCE in the groundwater.

A number of factors can be responsible for changes in TCE concentrations over time, including:

- Advective transport
- Seasonal and annual variation in recharge
- Land use changes
- Hydraulic controls
- Degradation/transformation
- Well construction

Advective transport is the horizontal and vertical movement of a contaminant with groundwater flow and it is conventionally considered a primary reason for changes in contaminant concentration over time. Related to advective transport is seasonal and annual variation in recharge. Groundwater recharge varies over the course of a year as seasonal precipitation patterns change, with longer duration lower intensity precipitation events in the winter and shorter duration higher intensity storms in the summer. The winter type storm pattern is more conducive to providing recharge to the groundwater. Interception and evapotranspiration by vegetation is also at a minimum during the winter, increasing the potential for rainfall to recharge the groundwater. Seasonal variations are typically cyclic. Longer term weather patterns also influence groundwater recharge. For instance, routine monitoring was initiated near the end of a prolonged drought while the past two years have been generally wetter than normal.

The effect of seasonal/annual variations in recharge on contaminant trends is most pronounced in areas where there is a large variation in land cover, as is found in portions of the CBP site. Groundwater recharge is most likely to occur in flat open areas (such as the open fields adjacent to the west Kilby Ditch east of Coliseum Boulevard). Related to land use changes, hydraulic controls include withdrawals of groundwater (e.g.; dewatering for sand and gravel mining) and surface water features (e.g.; both open and lined ditches and ponds).

Degradation and/or transformation of TCE in the groundwater along with advective transport are the two mechanisms most commonly attributed to observed changes in contaminant concentrations over time. There is little evidence that the rate of TCE degradation in the CBP area is sufficient to result in significant decreases in TCE concentrations over a 3-year period.

Well construction can, over the short term, affect TCE concentrations over time – as observed in the CMT wells. Drilling fluid is commonly introduced during construction of wells, and is removed during well development and well purging. In some instances, such as with the CMT wells, removal of all drilling fluid is difficult. As a consequence, the initial samples collected from the wells contain some drilling fluids, effectively diluting the groundwater concentrations. This effect is best observed in the TCE trends over time for the CMT-1 samples. The initial samples collected from the CMT wells were disregarded in the trend analysis to avoid biasing trend analysis.

GEOLOGY AND HYDROGEOLOGY OF THE COLISEUM BOULEVARD PLUME AREA

The following description of the geology and hydrogeology for the CBP area is summarized from past reports. A more detailed description is presented in the *Site Characterization and Technology Screening Report, Probehole 12 Area, Coliseum Boulevard Plume Site*, dated June 2003.

The CBP area is on 20 to 45 feet of terrace and alluvial deposits of the Alabama River and Catoma Creek. The majority of the CBP area is capped by a 2-to 20-foot-thick sandy clay. Beneath the clay is 1 to 10 feet of fine to coarse grained sand that is underlain by a 5 to 20 foot thick layer of sand and gravel. The gravel deposits are well-rounded, quartz, and pebble to cobble sized. These gravels (typically containing 10 percent to 50 percent gravel, by weight) are embedded in a fine-to coarse-grained sand matrix. Gravels of the terrace and alluvial deposits have been the target of gravel-mining operations in areas southwest, northwest and northeast of the CBP area.

The alluvial and terrace deposits are underlain by 30 to 60 feet of the Eutaw Formation, which is comprised of fine to coarse grained glauconitic sands with interbedded clay. The glauconitic sands may be the contact between the terrace deposits and the lower Eutaw Formation. This contact may not be distinct because the Eutaw Formation could have been reworked by alluvial processes. The shallow-zone and deep-zone monitoring wells and CMT wells that have been constructed during investigations of the CBP area have been completed within the alluvial and low-terrace deposits and/or underlying Eutaw Formation.

Beneath the glauconitic sand is a clay that has been referred to in investigations of the CBP area as “the first distinct clay beneath the water table”. The first distinct clay separates the “shallow zone” (saturated zone above the first distinct clay) and the “deep zone” (saturated zone immediately beneath the first distinct clay). The first distinct clay ranges from about 40 to 60 feet BLS, is generally 1 to 3 feet thick, brownish-yellow and light gray in color, and slightly sandy. Most of the probeholes and boreholes for shallow-zone monitoring wells were terminated at this clay. The depths to groundwater over the CBP area range from about 10 to about 40 BLS.

The sediments overlying the first distinct clay beneath the water table have been divided into five general hydrostratigraphic units. From the land surface to the first distinct clay, these hydrostratigraphic units are:

- Layer 1 – Surficial Sandy Clay
- Layer 2 – Fine- to Coarse-Grained Sand
- Layer 3 – Fine to Very Coarse Sand with Fine to Coarse Gravel
- Layer 4 – Fine- to Medium-Grained Glauconitic Sand
- Layer 5 – Medium- to Coarse-Grained Glauconitic Sand

The uppermost unit, Layer 1, is the surficial sandy clay and is unsaturated throughout most of the CBP area. Underlying the surficial sandy clay is the fine to coarse grained sand, designated hydrostratigraphic Layer 2, and like Layer 1 is unsaturated or partially unsaturated throughout most of the CBP area. Layer 3, the sand and gravel unit, is the first hydrostratigraphic unit that is partially to fully saturated throughout the majority of the CBP area. Underlying the sand and gravel unit (hydrostratigraphic Layer 3) is a relatively thick glauconitic sand unit that comprises the majority of the saturated thickness of the shallow saturated zone. The basal part of this unit is typically medium- to coarse-grained glauconitic sand (Layer 5) that fines upward to a fine to medium grained glauconitic sand (Layer 4).

Groundwater flow in the CBP area is largely controlled by topography, surface-water features, and groundwater withdrawals. The CBP area is within a peninsula shaped meander of the Alabama River that slopes toward the Alabama River to the west, Three Mile Branch to the east, and Galbraith Mill Creek to the north. In addition to these major surface-water features, there are numerous ditches and ponds within the CBP area. The most notable of these features are the Kilby Ditch network and the Montgomery Zoo ponds.

The Kilby Ditch drains a significant portion of the stormwater in the CBP area. Perennial flow does not occur in the Kilby Ditch until it reaches Coliseum Boulevard. Prior to establishment of the Montgomery Zoo in its current location, the Zoo ponds were originally borrow pits for sand and gravel. These ponds now serve as an alternating groundwater “source and sink” because surface water flows from the pond to the shallow saturated zone during and after significant precipitation events and groundwater flows into the pond in the intervening periods. Overall, ponds are predominately a groundwater sink.

In addition to flow toward the adjacent rivers, creeks, ditches, and ponds, there are a series of active borrow pits southwest of the CBP area that are withdrawing significant quantities of groundwater as part of their routine dewatering operations.

TREND EVALUATION METHODOLOGY

Locations of all wells used in the trend evaluation are presented on Figure 1a and Figure 1b. Trends were only evaluated for wells where measured TCE concentrations were above detection limit for a sufficient number of sampling events to develop valid time-trend relationships. TCE concentrations in the shallower wells tend to be lower than TCE concentrations in the deeper wells, and as a consequence there are fewer shallow wells with TCE concentrations above detectable levels. Approximately 40 percent of the wells

evaluated for trends over time are screened near the top of the water table aquifer and approximately 60 percent are screened in the lower portions of the water table aquifer. The highest TCE concentrations are typically in the fine grained glauconitic sands (Layer 4) that underlie the sand and gravel unit (Layer 3). The general downward hydraulic gradient in most areas of the CBP site is at least partially responsible for the vertical distribution of TCE. The only portions of the CBP site where the vertical gradient is not downward is in the vicinity of groundwater discharge areas such as portions of the Kilby Ditch and the “low lying area” to the northeast.

The methods used to evaluate TCE trends at different monitoring wells were time series plots and Shewhart-Cumulative Sum (CUSUM) statistical analysis. While the time series plots only provide for a qualitative assessment of trends over time the Shewhart-CUSUM statistics are quantitative metrics of trend and are thus useful in establishing significance of the trends.

Time Series Plots: TCE concentration data for all available sampling dates were plotted for individual wells with more than 4-sets of discrete samples with TCE concentrations above detectable levels. The time series plots for these individual wells are provided in Appendix A. Visual inspection of these time series plots allowed for evaluation of general trends of the TCE concentrations at different sampling well locations.

Shewhart-CUSUM Statistical Analysis: Intrawell statistical methods such as the Shewhart-CUSUM statistics rely on comparing recent monitoring results to a baseline. For the purpose of the trend analysis, baseline was assumed to be the first year of sampling for the well (the first four events). These first four events provided the initial levels by which all subsequent analytical result were compared. Shewhart-CUSUM method normalizes the baseline data such that the results are not biased by the absolute concentration level, rather the relative change from baseline.

Two sets of values are provided by this method. The Shewhart statistic represents the “current” trend relative to baseline while the CUSUM statistic represents the overall trend relative to baseline (the CUSUM statistic retains a “memory” of previous values). For instance, TCE trends at monitoring well MW-208 (Figure 2) have historically been flat to slightly decreasing, with a resulting CUSUM statistic that is slightly negative (indicating a decreasing, albeit not statistically significant trend). The most recent sample collected from the well in January 2005 is higher than any previous sample from that well. The Shewhart statistic, which represents only the most recent sample relative to “background” levels indicates a statistically significant increase in TCE concentrations (10.5). As a consequence, it is important to evaluate the short term trend relative to background represented by the Shewhart statistic as well as the long term trend represented by the CUSUM statistic.

Intrawell Time Series Plots MW-208

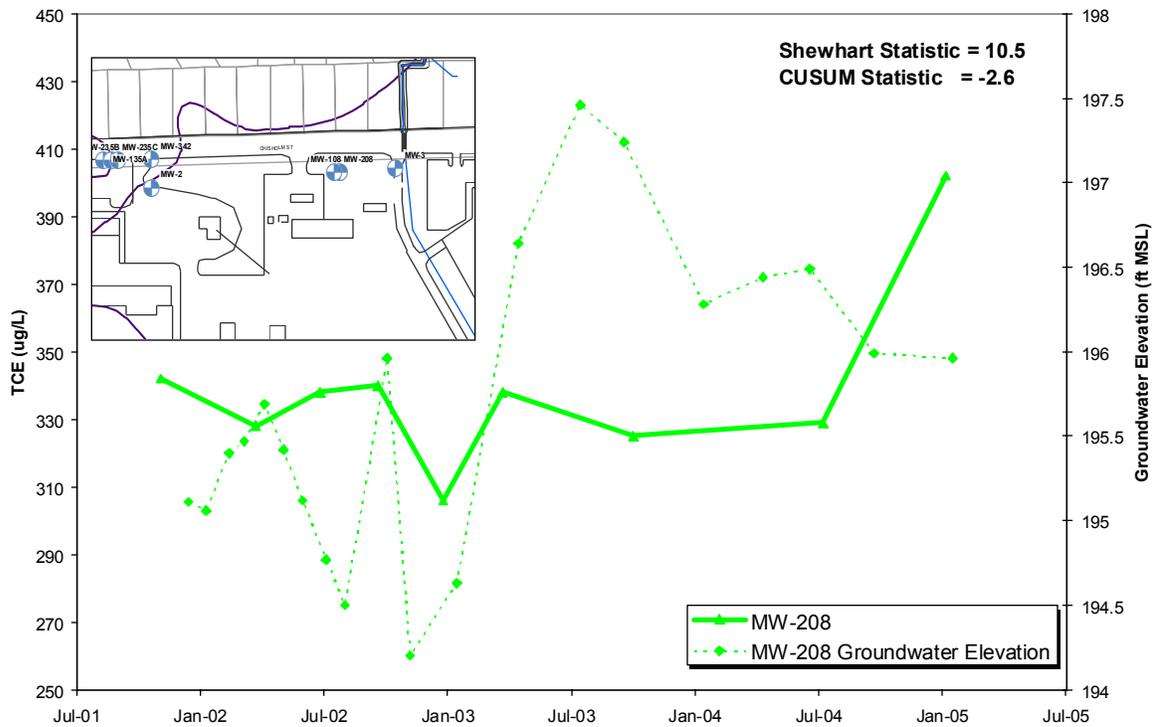


Figure 2 - Comparison of Shewhart and CUSUM Statistics

The Shewhart-CUSUM statistics works under the assumption that data analyzed are independently and normally distributed with a fixed mean, μ , and constant variance, σ^2 . It was assumed that these assumptions were valid for the TCE concentration data collected at each well. Using at least four of the initial concentrations measured at each well, mean (μ) and standard deviation (σ) of the measured concentrations were evaluated. The Shewhart statistic was then determined by calculating the standardized means at the most recent sampling events for each well using the mean (μ) and standard deviation (σ) calculated from the initial measured concentrations at the specific wells. The Shewhart statistics allowed comparison of the most recent TCE concentrations to the concentrations first measured for that well. In determining the CUSUM statistic, the Shewhart value evaluated at a specific sampling period was subtracted by a chosen reference parameter value, k , and the resulting value summed with that of the previous sampling period. The CUSUM statistic provides information about long term concentration trends at sampling locations. Because it is a summed statistic, the CUSUM value collects information about prior sampling periods, and thus the CUSUM value evaluated at the end of all the sampling periods can be used to detect the over all concentration trend at the sampling location. A more detailed discussion of the Shewhart-CUSUM procedure is presented in *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (EPA/530-SW-89-026).

The Shewhart and CUSUM values for the most recent samples were used to evaluate spatial distribution of the trends over time. Distribution of the Shewhart statistic for each well is presented on Figure 3a and distribution of the CUSUM statistic for each well is presented on Figure 3b. The actual values for the Shewhart statistics and CUSUM statistics are provided on Table 3 and 4, respectively.

RESULTS

Both trend analysis methods (the qualitative visual inspection of time series plots and quantitative Shewhart-CUSUM analysis) led to similar conclusions:

- Shallow wells were more likely to exhibit long term decreasing trends over time. At several locations where the decreasing trend is observed the trend at times correlates with localized increases in recharge from precipitation.
- Deeper wells were more likely to exhibit either no significant trend or an increasing trend over time. Where the increasing trend is observed, it appears to be due to lateral advective transport.
- The wells with significant increasing trends are along the dominant northeast-southwest orientation of the plume.
- The wells with significant decreasing trends are commonly in areas adjacent to open fields or drainage ditches.
- For wells immediately downgradient of areas with higher TCE concentrations, the TCE trends over time most often directly correlate with groundwater level trends over time.

Overall, TCE concentrations in samples collected from a majority of the monitoring wells exhibited either no significant trend or a significant decreasing trend over time. Less than 15 percent of the monitoring wells (12 percent for short term Shewhart trends and 10 percent for long term CUSUM trends) had significant increasing trends (Table 1). For the longer term trends, as represented by the CUSUM statistic, TCE in samples from a majority of the wells (65 percent) have been significantly decreasing in concentration. In contrast, TCE in a majority of the recent samples, as represented by the Shewhart statistic, were not significantly different from the initial (background) TCE concentrations, where 73 percent of the wells exhibited no significant trend. This shift from TCE in a majority of the wells significantly decreasing in concentration to no significant trend is a result of a recent increase in TCE concentrations, as illustrated in Figure 4 where the downward trend in the MW-135A through MW-235C well cluster has been reversed over the past year.

**TABLE 1
DISTRIBUTION OF TIME TRENDS BETWEEN
SHALLOW AND DEEP MONITORING WELLS**

Well Screen Interval	Shewhart Statistic				CUSUM Statistic			
	Increase	No Trend	Decrease	Total	Increase	No Trend	Decrease	Total
Shallow	3%	86%	11%	100%	3%	13%	84%	100%
Deep	19%	64%	17%	100%	17%	34%	49%	100%
All Wells	12%	73%	15%	100%	10%	24%	65%	100%

Note: Percentages were calculated for wells falling within a time trend direction. For example, for the Shewhart test, 3 percent of all shallow wells had a statistically significant increasing trend.

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

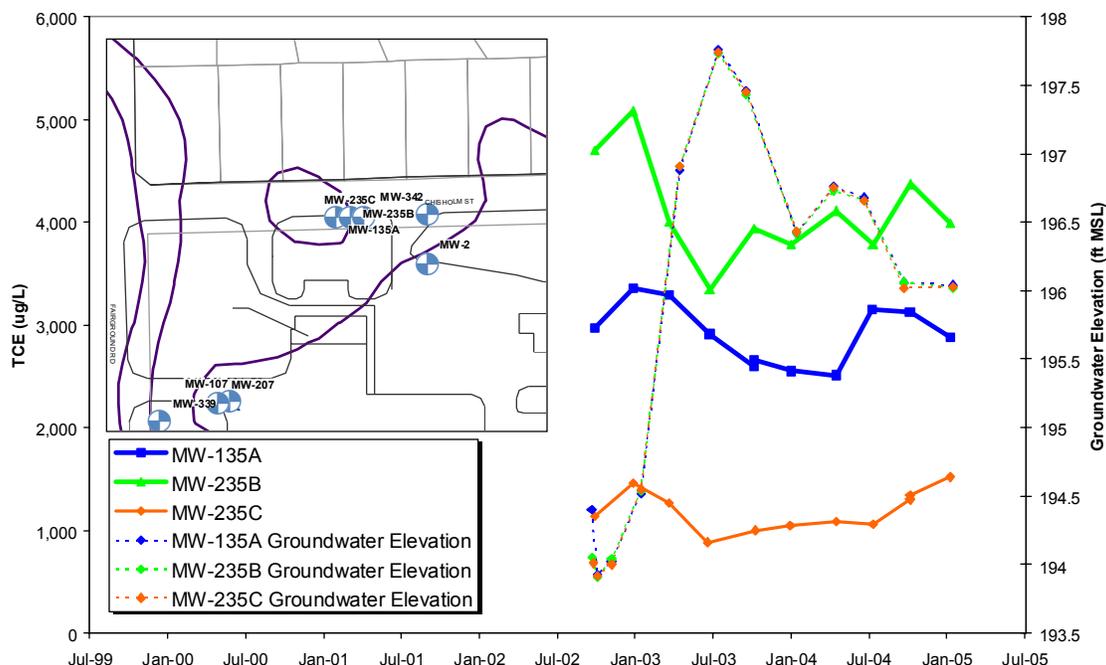


Figure 5: Trends in TCE concentration and groundwater level at wells MW-135A (shallow) through MW-235C (deep)

Over 85 percent of the significantly increasing trends for TCE were for deep wells, both short term and long term (Table 2). Significant decreasing trends were more evenly divided, with a slight majority of the recent decreasing trends associated with deep wells (59 percent) and a majority of significant long term decreasing trends associated with shallow wells (63 percent). The shift from the long term trend where a majority of the shallow wells exhibited significant decreasing trends to the short term trend where more deep wells exhibited a significant decrease in TCE concentrations is related to a proportionally greater increase in recent TCE concentrations in the shallow wells.

**TABLE 2
DEEP AND SHALLOW MONITORING WELL DISTRIBUTION
BY TIME TREND DIRECTION**

Well Screen Interval	Shewhart Statistic			CUSUM Statistic		
	Increase	No Trend	Decrease	Increase	No Trend	Decrease
Shallow	13%	57%	41%	13%	28%	63%
Deep	87%	43%	59%	87%	72%	37%
Total	100%	100%	100%	100%	100%	100%

Notes: Indicated trend direction “increase” and “decrease” are statistically significant trends. Percentages are calculated within each trend direction. For example, for the Shewhart test, 9 percent of all wells with significantly increasing trends are shallow wells and 91 percent of all wells with significantly increasing trends are deep wells.

Increasing TCE Trends

Wells with statistically significant increasing trends generally fall along the northeast-southwest trending axis that represents the dominant direction of advective flow within the CBP site (Figure 5). These wells are all down gradient of areas with higher TCE

concentrations and with only one exception (MW-131) are screened at a deeper interval, generally below the sand and gravel layer. The dominant mechanism influencing the significant increasing trends observed in these wells is horizontal advective transport. Figure 6 illustrates the increasing trend at well cluster MW-131 and MW-231, wells located within the 1 mg/L TCE isopleth and immediately downgradient of the 5 mg/L TCE isopleth.

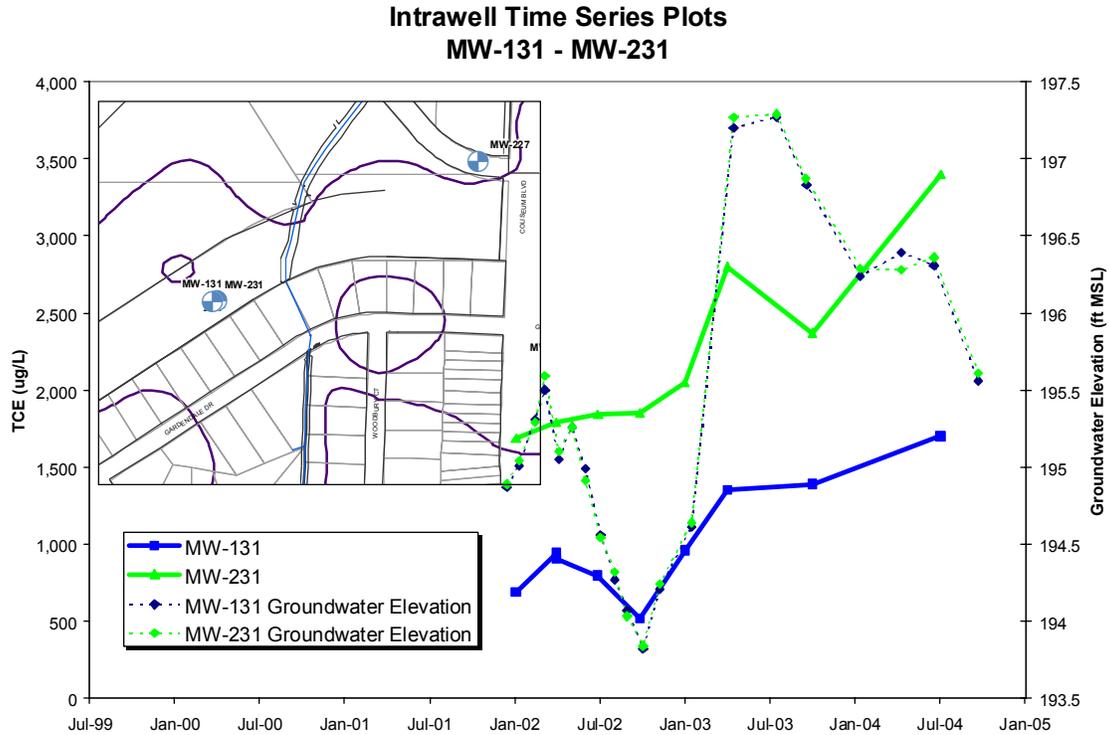


Figure 6: Trends in TCE concentration and groundwater level at wells MW-131 (shallow) and MW-231 (deep)

Decreasing TCE Trends

The majority of wells with statistically significant decreasing trends are located in or immediately adjacent to open field areas (Figure 7). The only exceptions are CMT-4, MW-106, and MW-237B. The CMT-4 wells (CMT 4-4 and CMT 4-7) and MW-106 are on the upgradient side of the PH-12 area, and as a consequence a general decrease in TCE concentrations is expected due to advective flow away from these wells.

MW-237B is immediately downgradient of the PH-12 area and a decrease in TCE concentrations generally would not be expected. MW-237B is one of a three well cluster, with MW-137A screened near the top of the fine grained glauconitic sand (Layer 4), MW-237B screened near the base of Layer 4, and MW-237C screened in the coarser grained glauconitic sand found at the base of the aquifer (Layer 5). TCE concentrations in MW-237C have increase significantly over the past year even though TCE in MW-237B has continued to decline (Figure 8). There is only about a 2-foot vertical separation between the bottom of the 4.5-foot screen interval for MW-237B and the top of the 4.5-foot screen interval for MW-237C, with no restrictive unit separating the two layers. The decreasing TCE trend in MW-237B inversely correlates with the response to groundwater elevations. The highest TCE concentrations measured in the well was at the end of the drought in 2002, dropping sharply as the groundwater level rose over 4 feet in response to heavy precipitation in 2003. Water levels over the past year (2004) have gradually

declined, with a corresponding decrease in the rate (slope) of the TCE decline in well MW-237B. If the observed TCE trend in this well is in response to precipitation/change in groundwater elevation, and a continued decrease in slope followed by an increase in TCE concentration is expected if the current precipitation patterns are maintained.

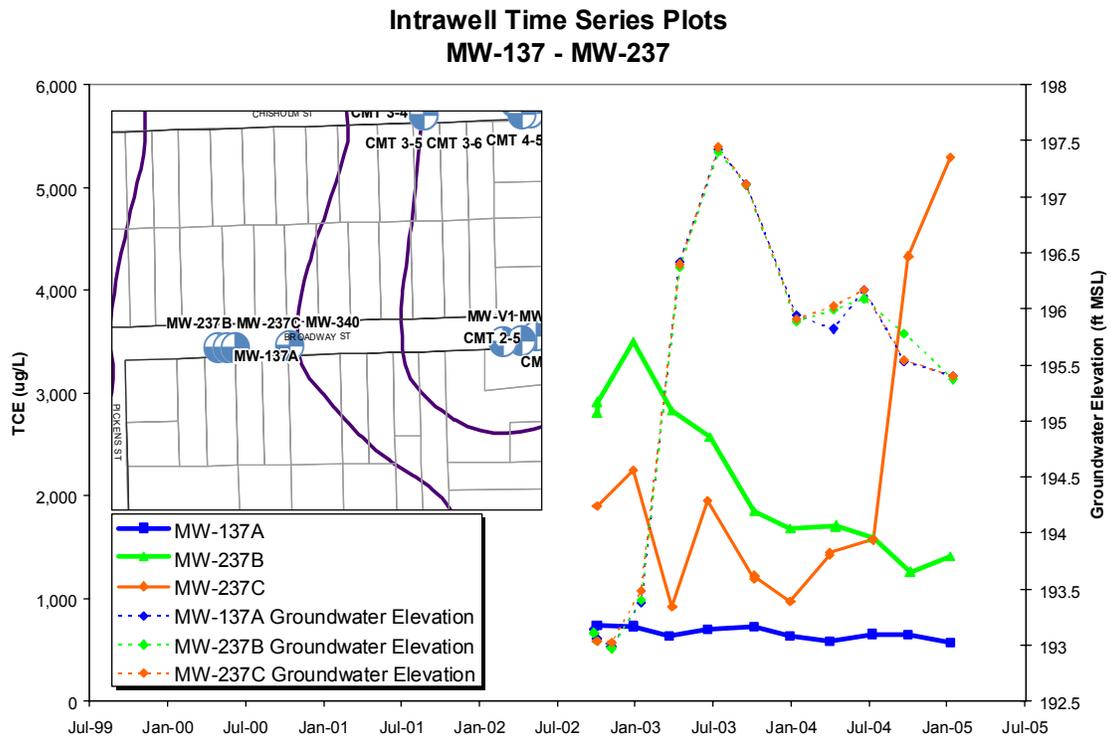


Figure 8 - Trends in TCE concentration and groundwater level at wells MW-137A (shallow) through MW-237C (deep)

The inverse relationship between change in groundwater elevation (in response to precipitation) and TCE concentrations observed in MW-237B is more evident in some of the shallow wells. This inverse trend is in response to increased recharge in open areas following the extended drought that ended in 2001/2002. Groundwater levels increased markedly in early 2003 in response to increased precipitation. TCE concentrations began to decrease in several shallow wells at approximately the same time (e.g., MW-106; Figure 9a and MW-111; Figure 9b).

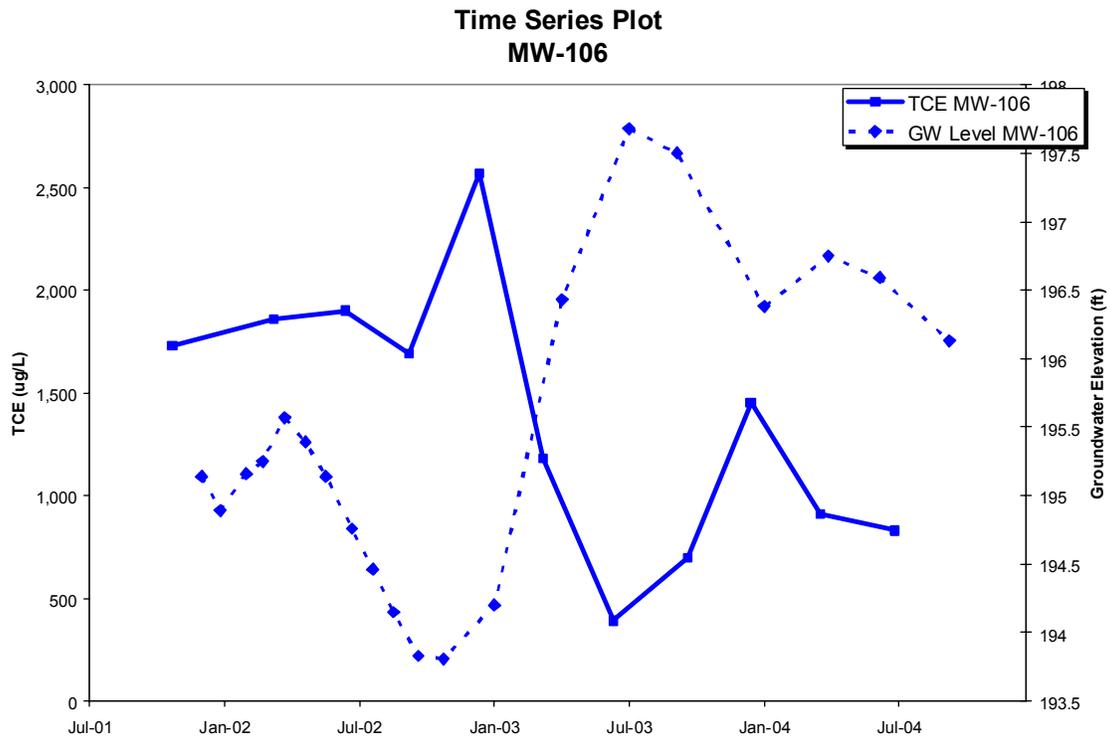


Figure 9a: Trends in TCE concentration and groundwater level at well MW-106

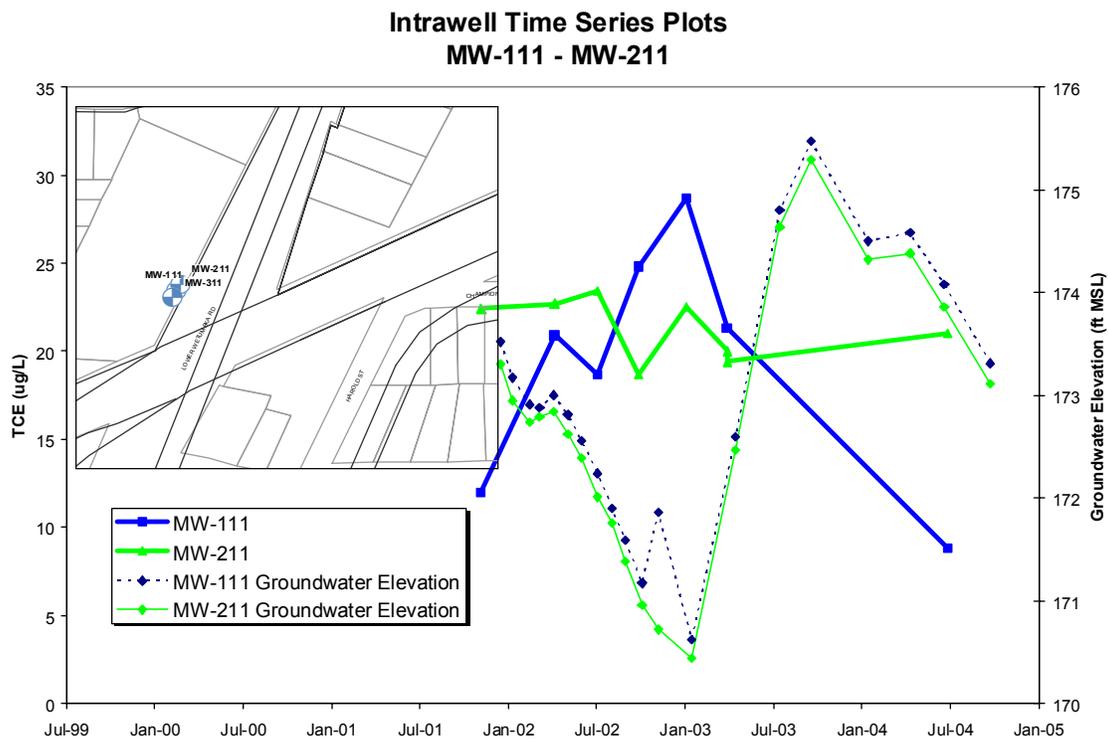


Figure 9b: Trends in TCE concentration and groundwater level at well MW-111 and MW-211

Deeper wells were less susceptible to recharge-related decrease of TCE concentration, and in any event would be expected to experience a delay in any such dilution effects. Some deep wells also showed evidence of recharge-induced dilution. For example MW-203 was experiencing an increase in TCE concentration until the end of the 2001/2002

drought (Figure 10). This well is located toward the northeast portion of the site, where the water table aquifer is relatively thin. The screen interval for MW-203 is relatively shallow for a “deep” well, from 29 feet to 33 feet below ground surface. This well is also located at the edge of a large open field and as a consequence, the TCE trends in this deep well may more closely mimic the general trends for many of the shallow wells that are next to open areas.

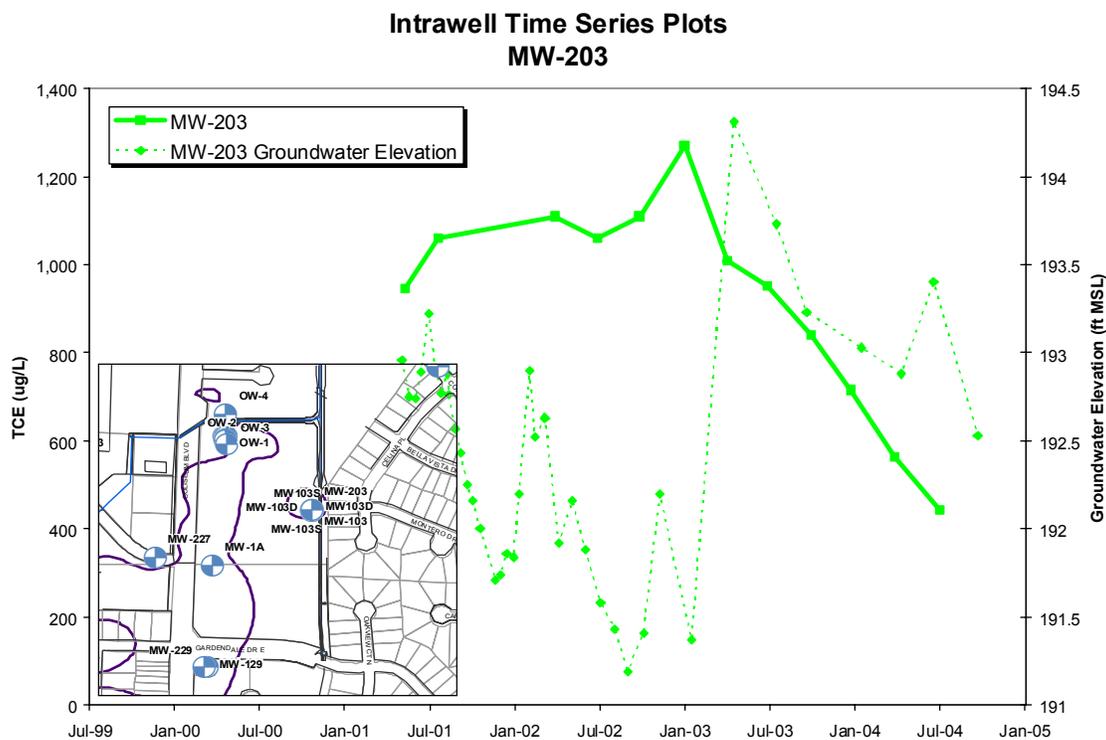


Figure 10: Trends in TCE concentration and groundwater level at well MW-203 (deep)

As with all generalizations, there are specific exceptions. For instance, TCE concentrations increased significantly over time in samples collected from MW-131 and decreased significantly over time in samples collected from MW-233. In both of these instances, probable causes can be identified. MW-131 is within the 1 mg/L isopleth, downgradient of an area where TCE concentrations exceed 5 mg/L. Advective transport of TCE is a likely cause of this trend, as supported by an even more significant increasing TCE trend in the lower clustered well (MW-231). Maps of the groundwater elevation (Figures 1a and 1b) demonstrate that the expected groundwater flow direction would be from the region where TCE concentrations exceed 5 mg/L towards MW-131 and MW-231.

This analysis of TCE trends over time provides a baseline of observations. The trends should be re-evaluated on a periodic basis (no less than annual) to identify deviations from past trends and to provide a better understanding of the factors influencing TCE trends. To date, the observed trends are consistent with the known TCE distribution and the dominant transport mechanisms responsible for movement of TCE in the groundwater.

**TABLE 3
SUMMARY OF SHEWHART TREND ANALYSIS METRICS**

Significant Increase		No Statistically Significant Trend				Significant Decrease	
Well	Shewhart	Well	Shewhart	Well	Shewhart	Well	Shewhart
MW-229	32.0	CMT 2-7	4.2	CMT 2-2	-0.1	MW-226	-4.8
MW-231	20.1	CMT 3-7	2.1	MW-136A	-0.1	MW-237B	-4.9
MW-217	13.1	CMT 3-5	1.8	MW-238B	-0.1	MW-116	-4.9
MW-208	10.5	MW-235C	1.4	MW-230	-0.2	MW-224	-5.6
MW-223	9.7	CMT 2-5	1.4	MW-207	-0.3	MW-2A	-5.8
MW-232	9.4	MW-236B	1.1	MW-235B	-0.4	MW-233	-6.2
MW-131	6.5	MW-3A	0.8	MW-211	-0.4	MW-213	-7.6
MW-237C	6.1	MW-225	0.8	MW-210	-0.5	MW-106	-7.6
MW-216	4.6	CMT 3-6	0.7	CMT 2-1	-0.7	MW-203	-8.4
		CMT 2-6	0.7	CMT 1-2	-0.8	CMT 4-4	-8.9
		MW-234	0.6	MW-125	-0.8	CMT 4-7	-11.3
		CMT 1-7	0.3	MW-215	-1.0		
		MW-228	0.2	CMT 3-4	-1.1		
		MW-236C	0.1	CMT 4-2	-1.1		
				MW-135A	-1.1		
				CMT 4-6	-1.2		
				CMT 4-3	-1.2		
				MW-117	-1.3		
				MW-101	-1.3		
				MW-138A	-1.3		
				MW-105	-1.4		
				CMT 1-1	-1.5		
				MW-107	-1.6		
				CMT 4-5	-1.7		
				MW-124	-1.7		
				CMT 3-3	-1.8		
				MW-134	-1.9		
				MW-111	-1.9		
				CMT 1-6	-1.9		
				CMT 1-3	-1.9		
				MW-128	-2.2		
				MW-129	-2.2		
				CMT 2-3	-2.4		
				CMT 2-4	-2.4		
				MW-238C	-2.5		
				MW-108	-2.5		
				MW-5A	-2.8		
				MW-1A	-2.9		
				MW-137A	-2.9		
				MW-201	-3.3		
				MW-130	-3.6		
				MW-133	-3.7		
				MW-227	-3.8		
				CMT 1-5	-4.2		

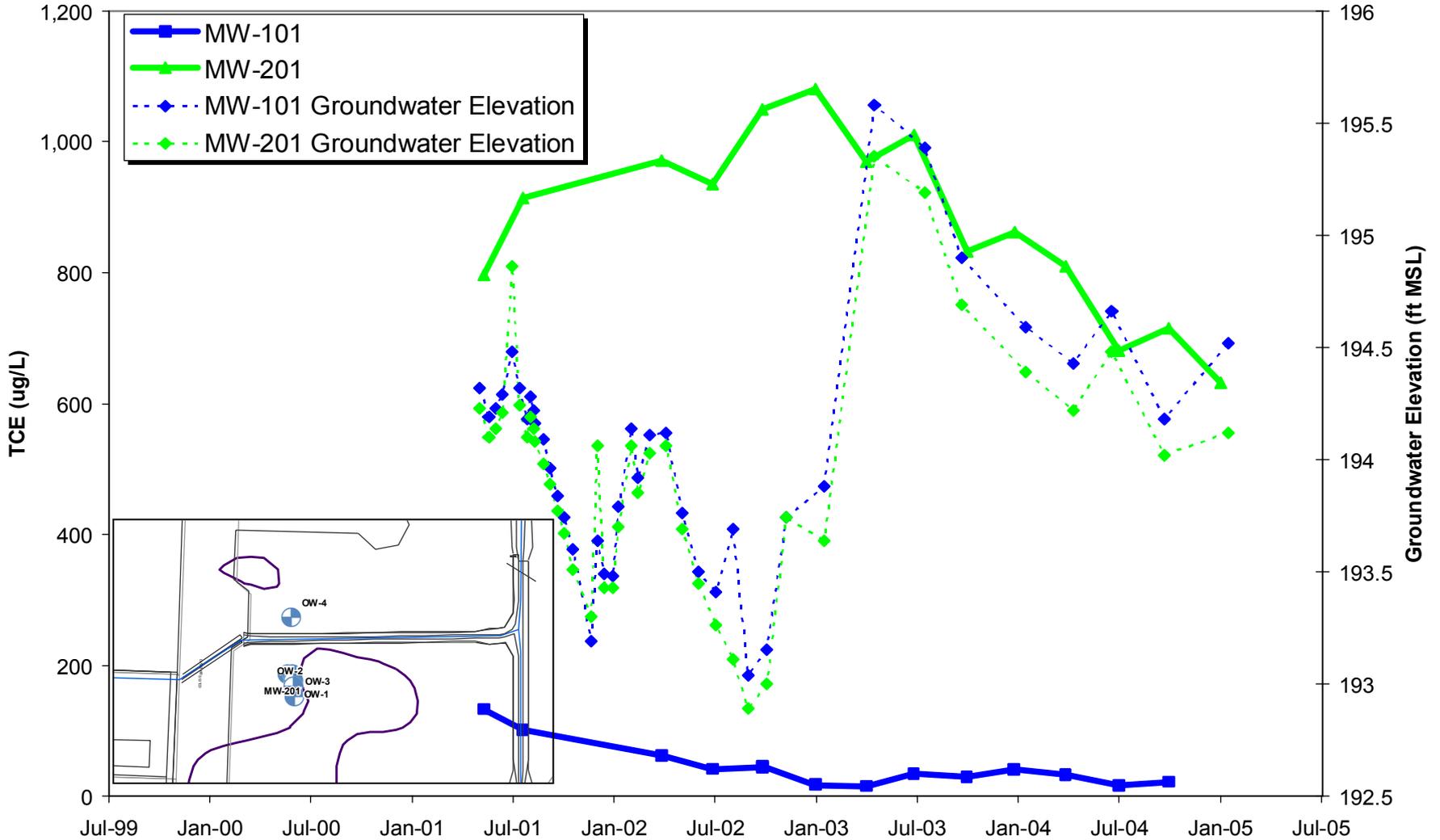
**TABLE 4
SUMMARY OF CUSUM TREND ANALYSIS METRICS**

Significant Increase		No Statistically Significant Trend				Significant Decrease	
Well	CUSUM	Well	CUSUM	Well	CUSUM	Well	CUSUM
MW-231	64.9	CMT 3-7	3.8	CMT 3-6	-1.3	MW-125	-5.6
MW-229	60.2	MW-107	3.5	CMT 1-7	-1.5	MW-207	-5.7
MW-217	21.3	CMT 3-5	3.1	MW-225	-1.7	CMT 4-6	-6.2
MW-223	18.1	MW-128	2.6	MW-236B	-2.1	CMT 2-2	-6.5
MW-131	15.0	CMT 2-6	2.3	MW-208	-2.6	MW-136A	-6.6
MW-232	12.6	MW-237C	0.8	MW-111	-2.7	MW-105	-6.9
MW-216	9.4	MW-210	0.0	MW-215	-2.9	CMT 4-2	-7.0
CMT 2-5	5.0			MW-129	-3.2	MW-236C	-7.0
				CMT 2-7	-3.3	CMT 4-3	-7.8
				MW-228	-3.6	MW-1A	-7.9
				MW-234	-3.9	MW-235B	-8.2
				MW-211	-4.5	CMT 3-4	-8.3
						MW-124	-8.9
						CMT 3-3	-9.1
						MW-3A	-9.9
						CMT 1-2	-9.9
						MW-134	-9.9
						CMT 2-1	-11.5
						CMT 4-5	-12.0
						MW-227	-12.1
						MW-230	-12.8
						CMT 1-1	-13.0
						MW-116	-13.9
						MW-235C	-14.4
						CMT 1-6	-15.4
						MW-133	-15.5
						MW-135A	-15.6
						MW-2A	-16.6
						CMT 2-4	-16.7
						MW-137A	-16.8
						MW-117	-16.9
						MW-138A	-17.6
						MW-101	-17.7
						MW-201	-17.8
						MW-238B	-19.1
						MW-238C	-19.4
						CMT 1-3	-20.0
						MW-108	-20.2
						CMT 4-4	-22.0
						MW-226	-22.7
						MW-224	-25.2
						MW-5A	-25.5
						MW-233	-26.2
						CMT 1-5	-28.5
						MW-213	-31.1
						CMT 2-3	-33.1
						MW-237B	-36.2
						CMT 4-7	-40.1
						MW-130	-40.4
						MW-203	-40.5
						MW-106	-81.4

APPENDIX A

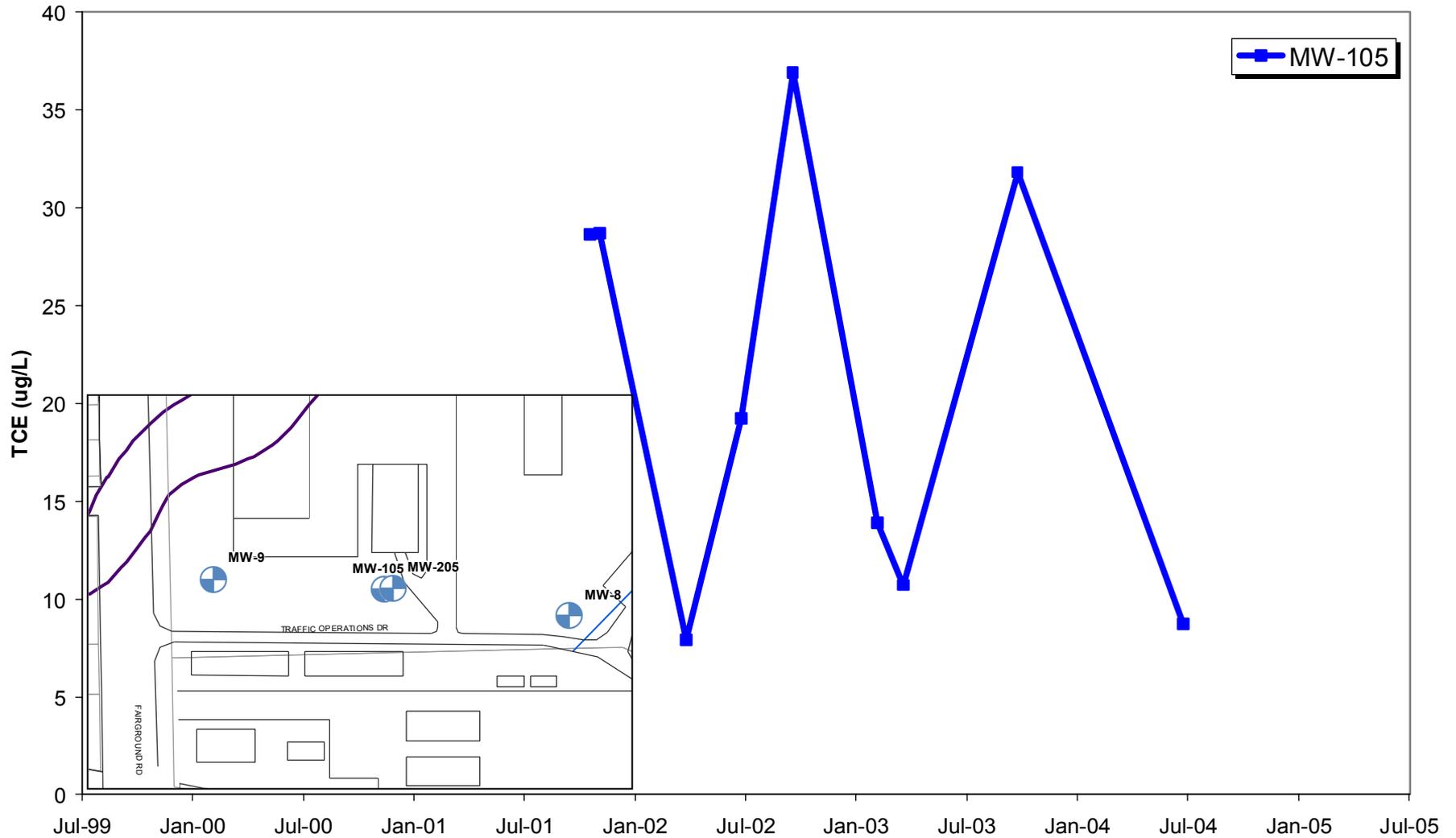
TIME TREND PLOTS FOR TCE CONCENTRATIONS

Intrawell Time Series Plots MW-101 - MW-201



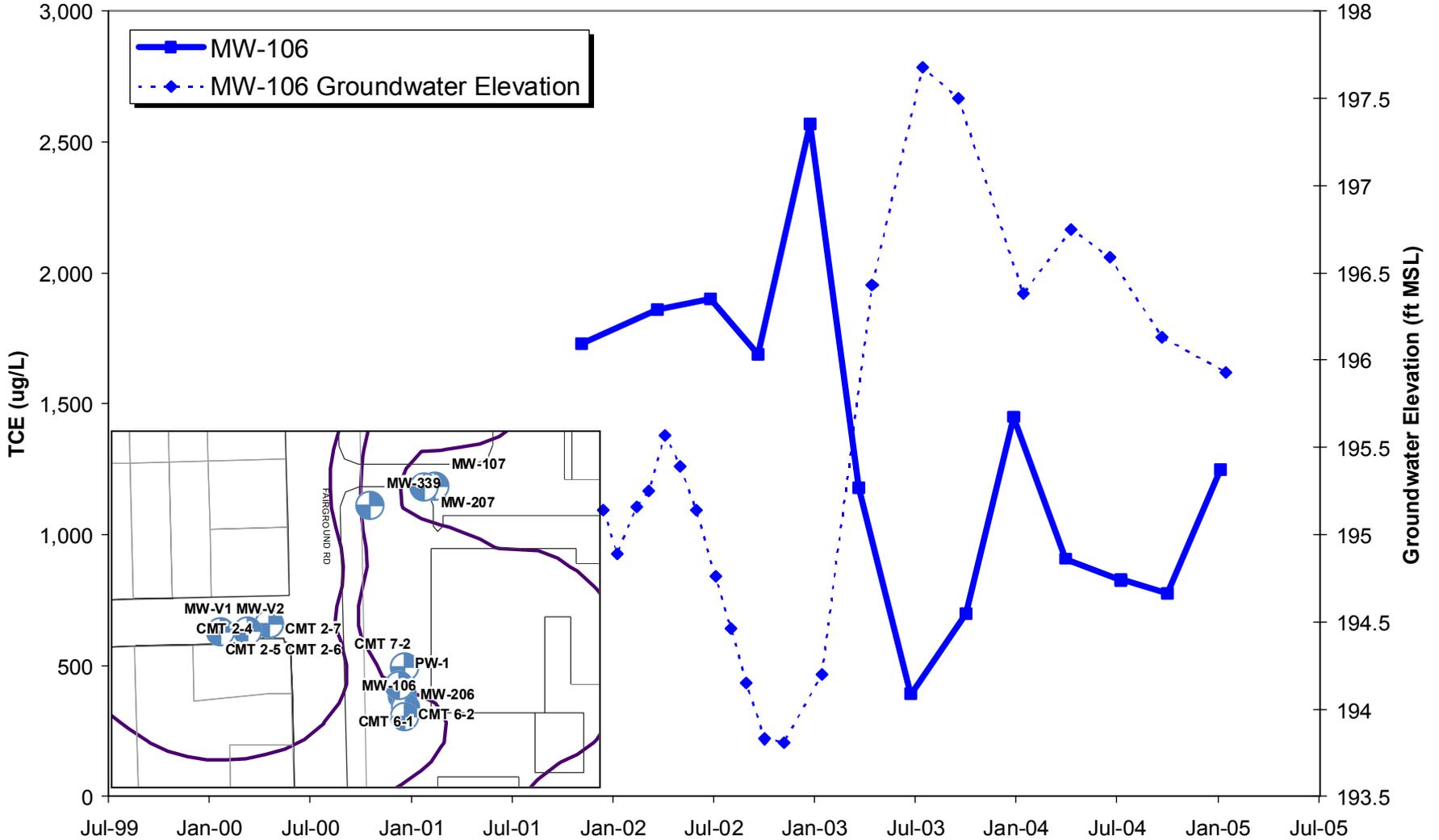
Intrawell Time Series Plots

MW-105



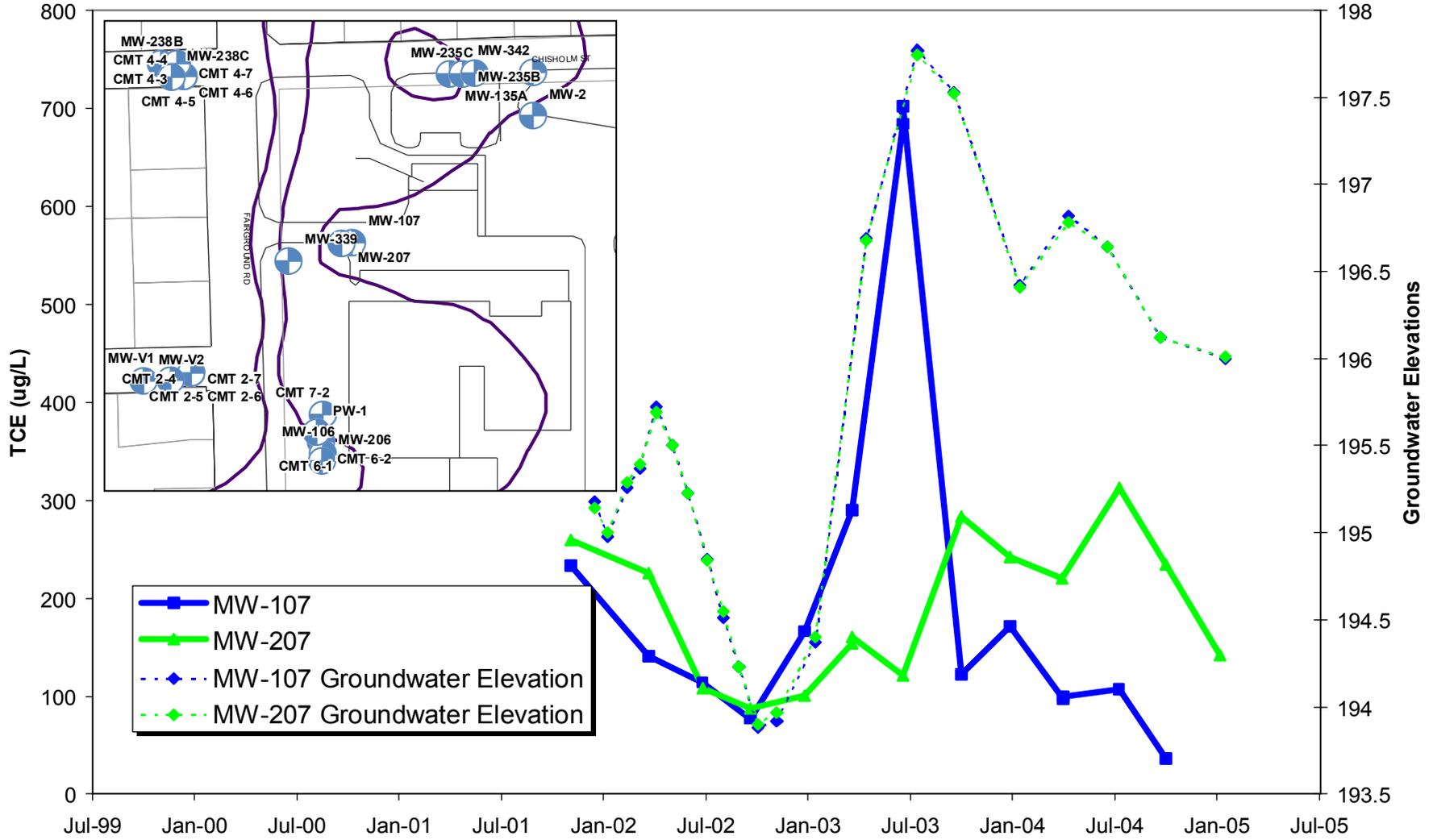
Intrawell Time Series Plots

MW-106



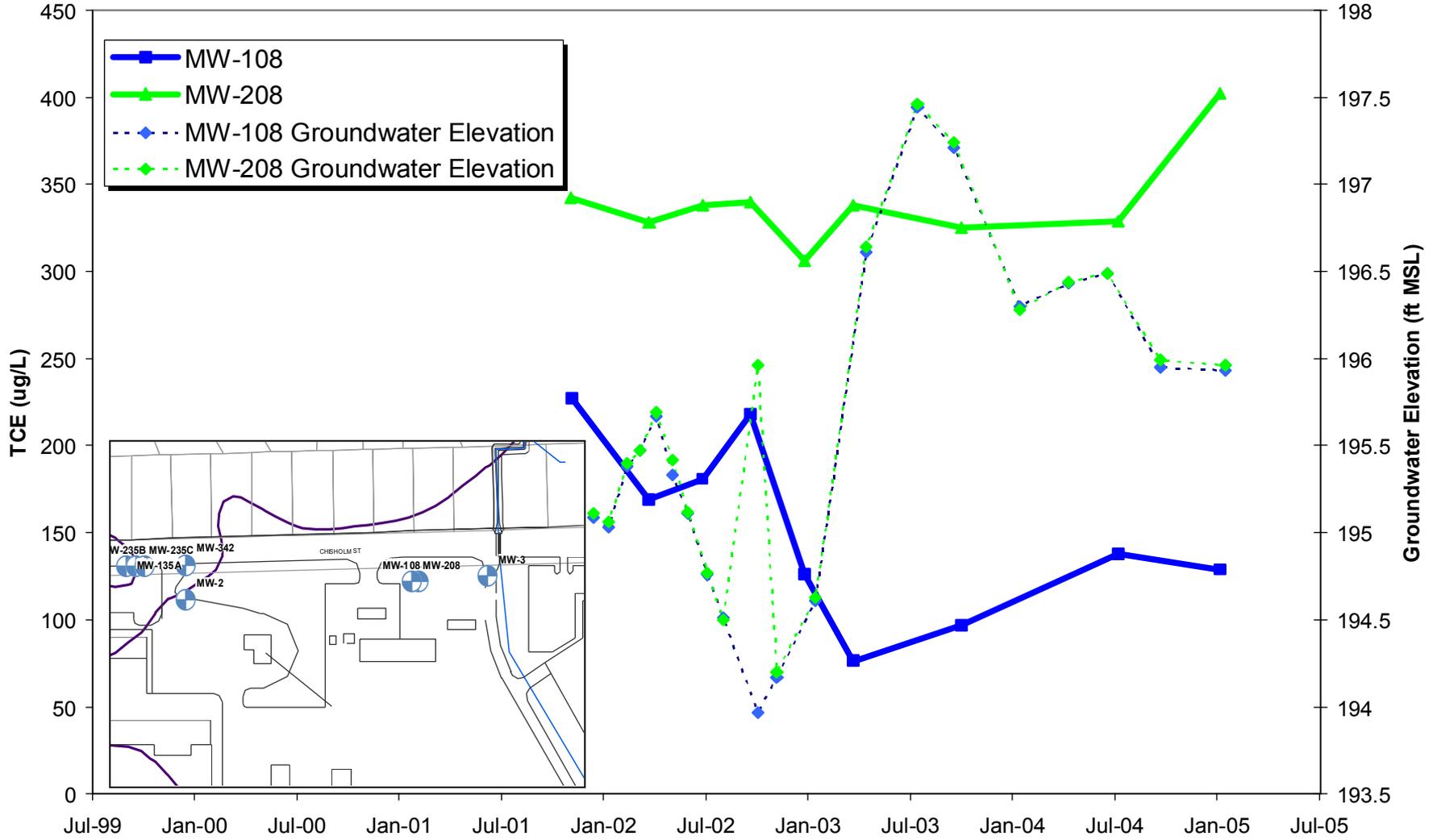
Intrawell Time Series Plots

MW-107 - MW-207



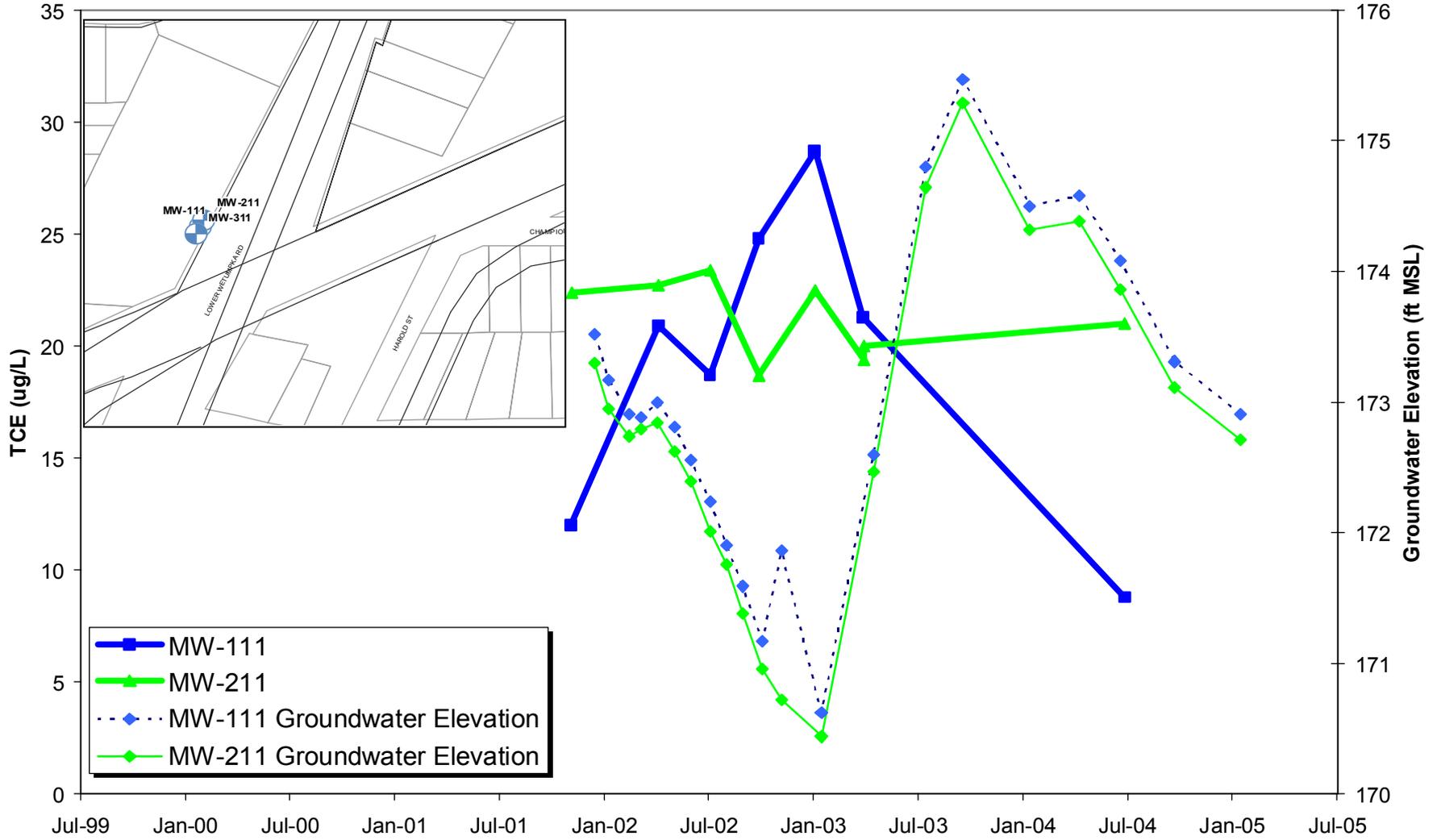
Intrawell Time Series Plots

MW-108 - MW-208



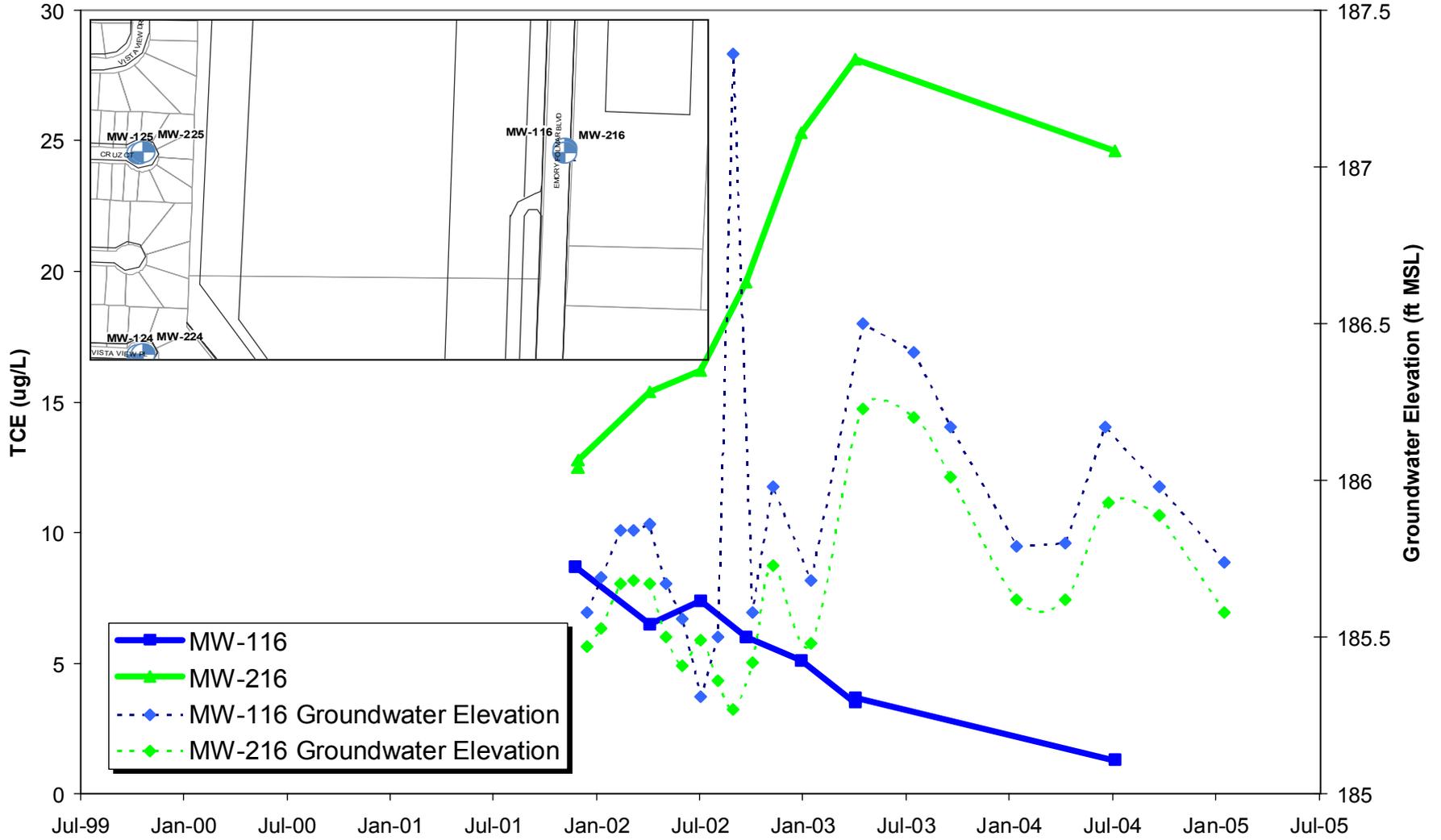
Intrawell Time Series Plots

MW-111 - MW-211



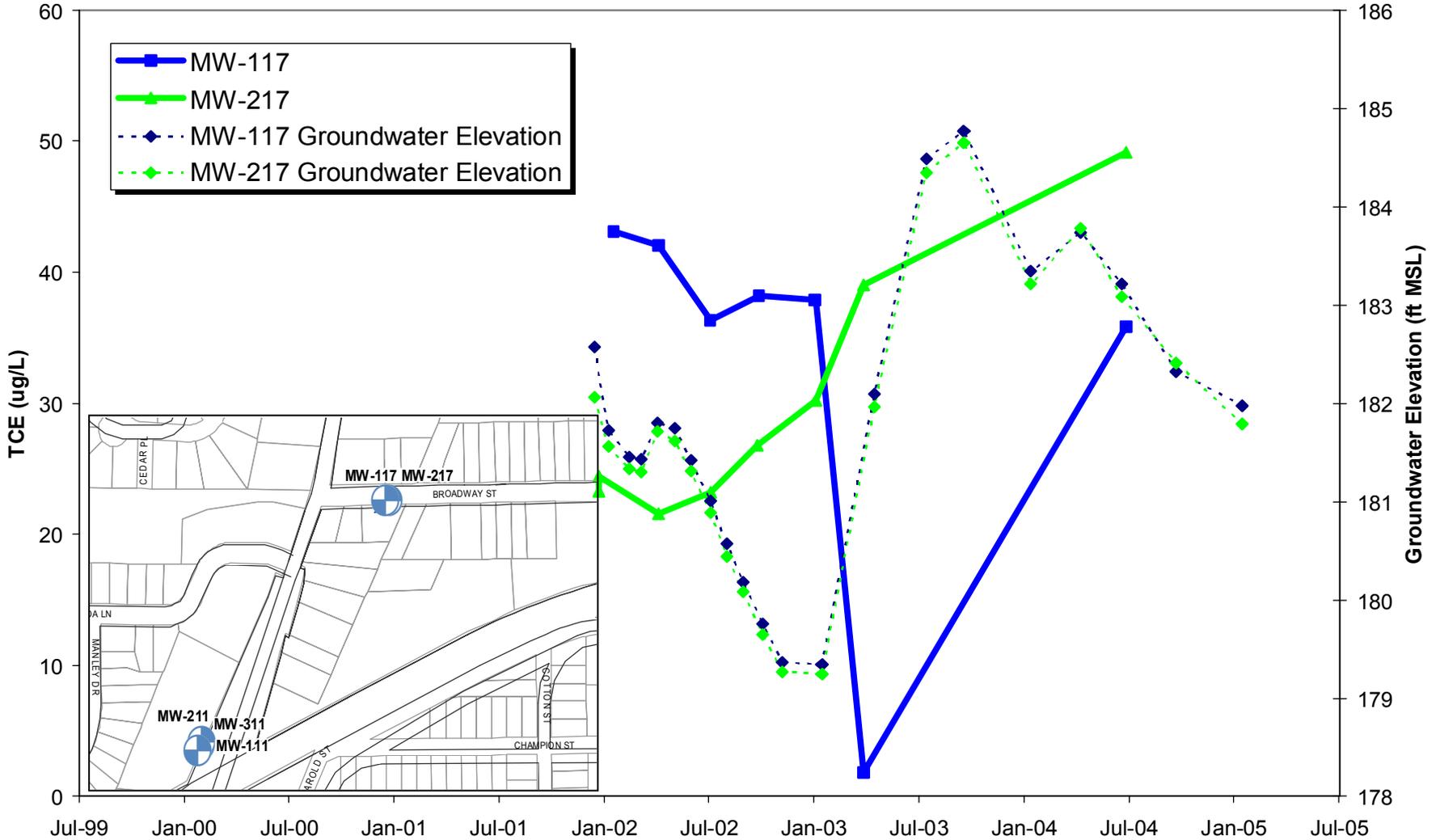
Intrawell Time Series Plots

MW-116 - MW-216

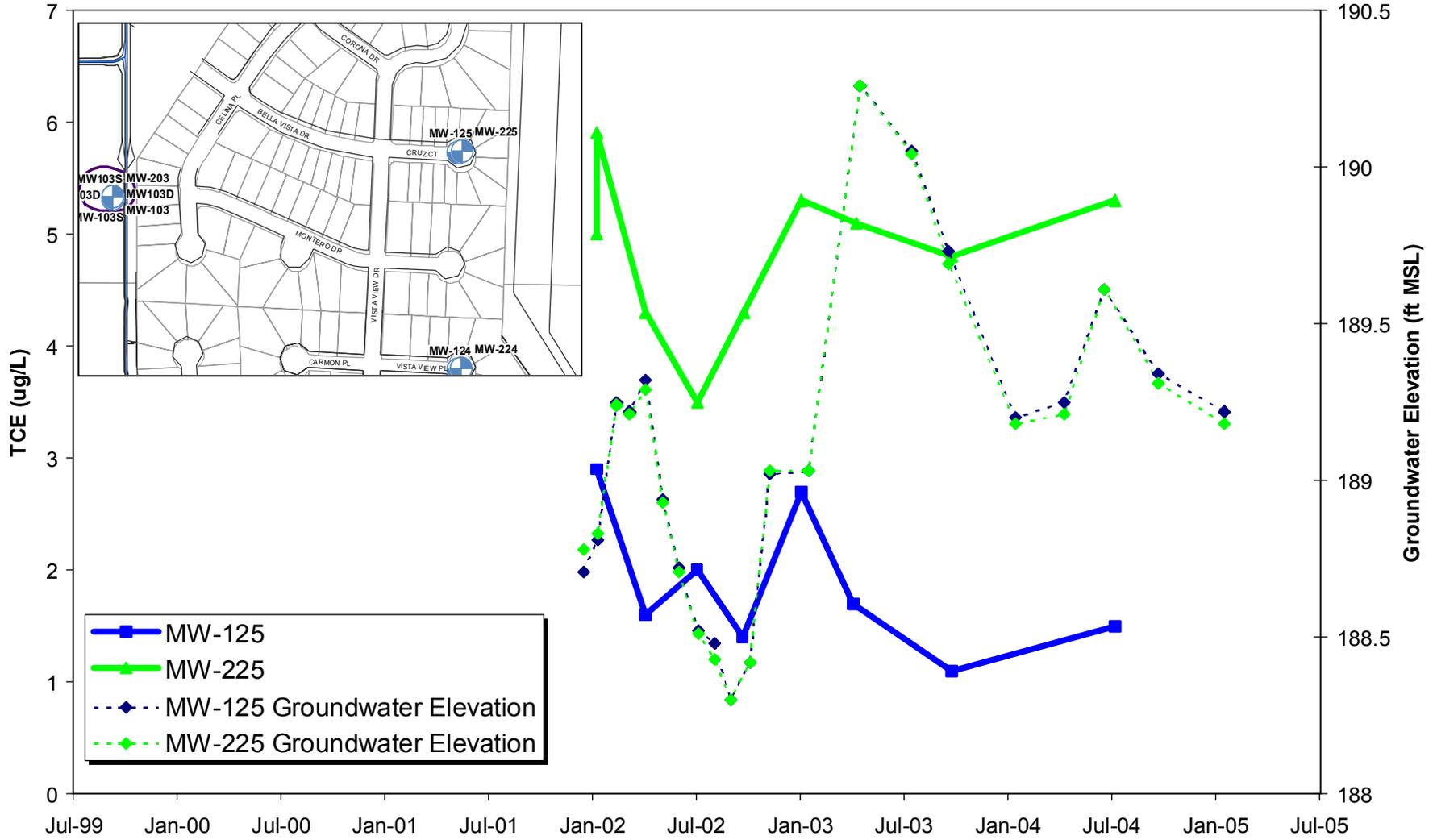


Intrawell Time Series Plots

MW-117 - MW-217

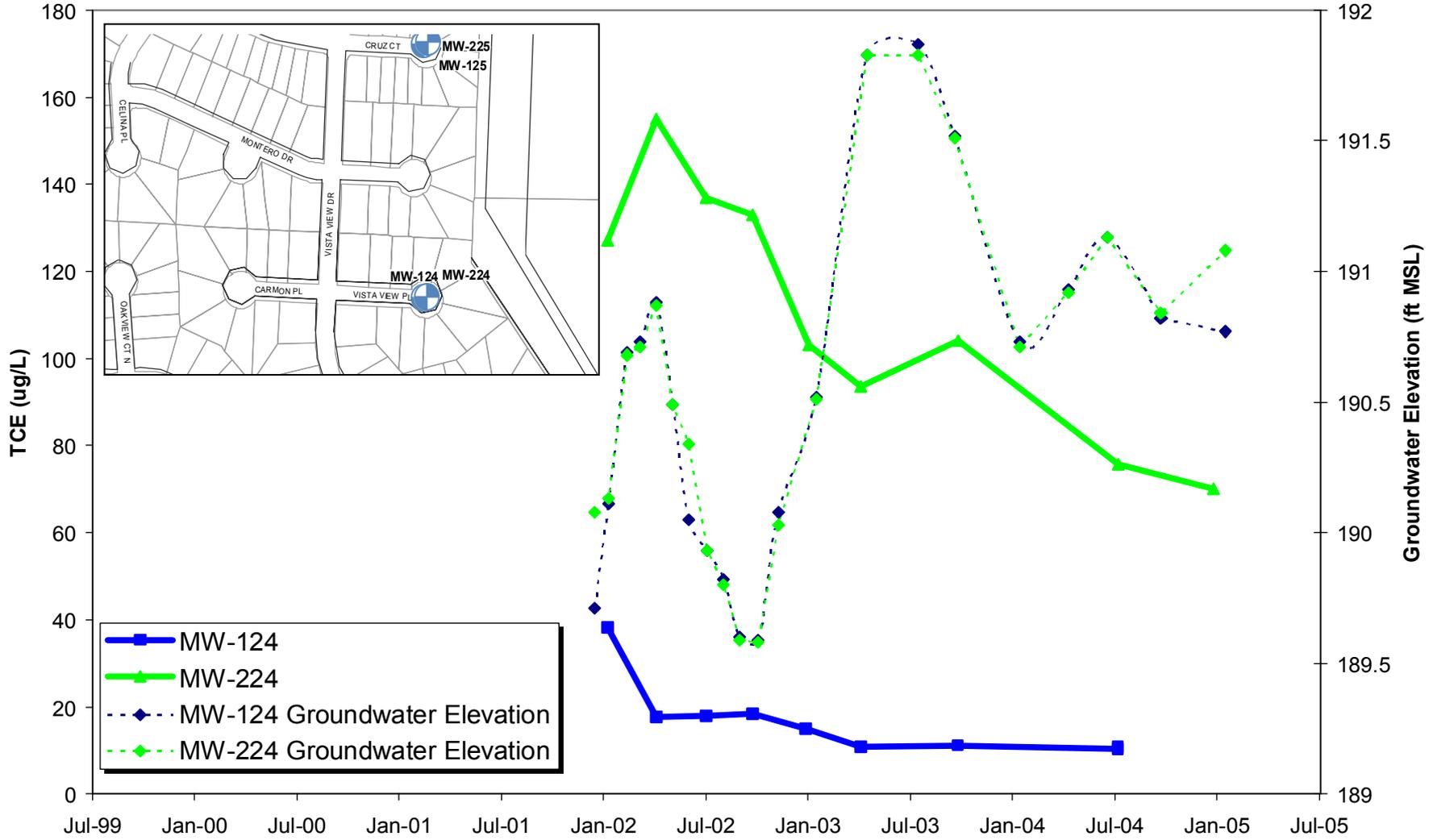


Intrawell Time Series Plots MW-125 - MW-225



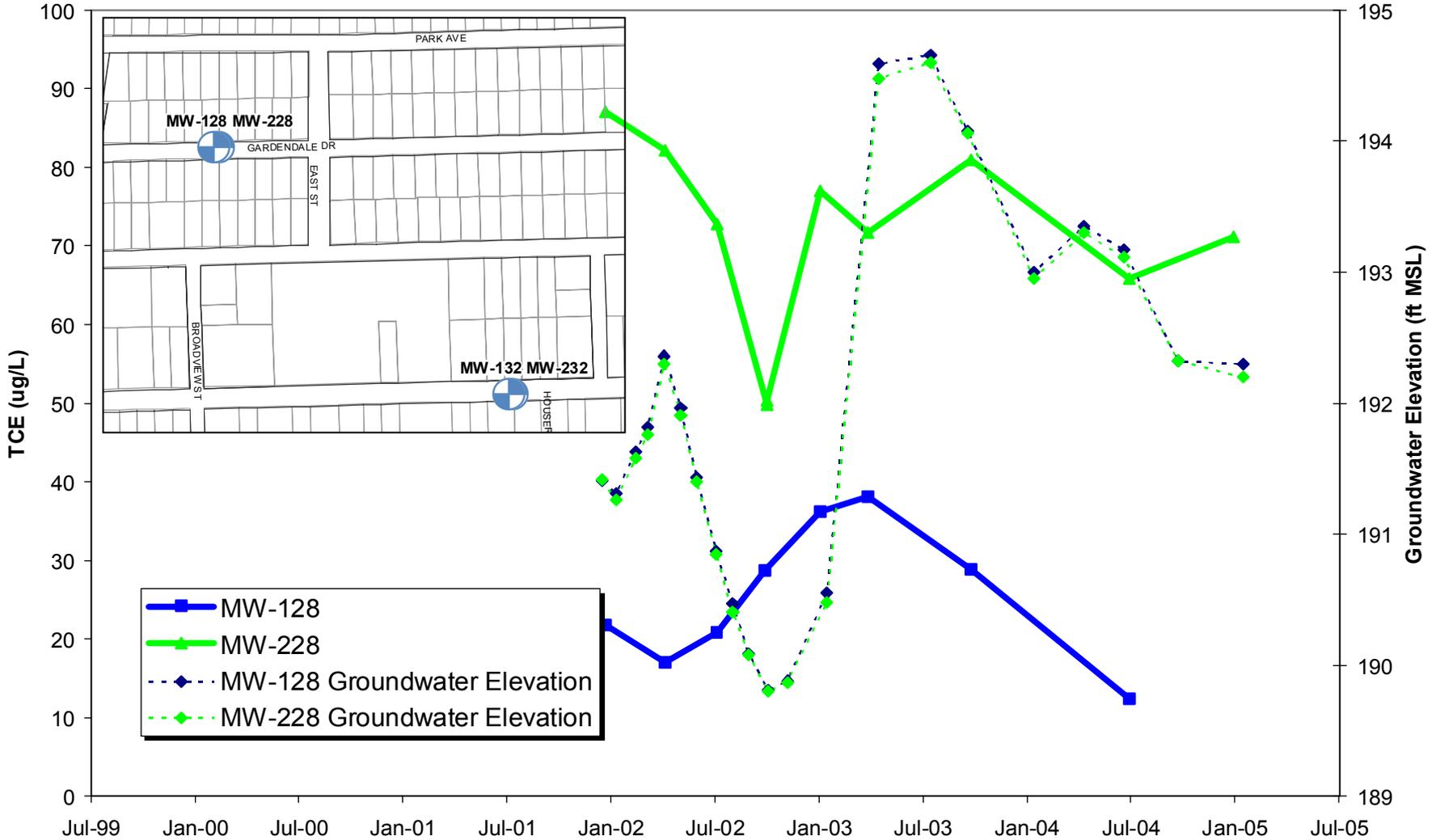
Intrawell Time Series Plots

MW-124 - MW-224



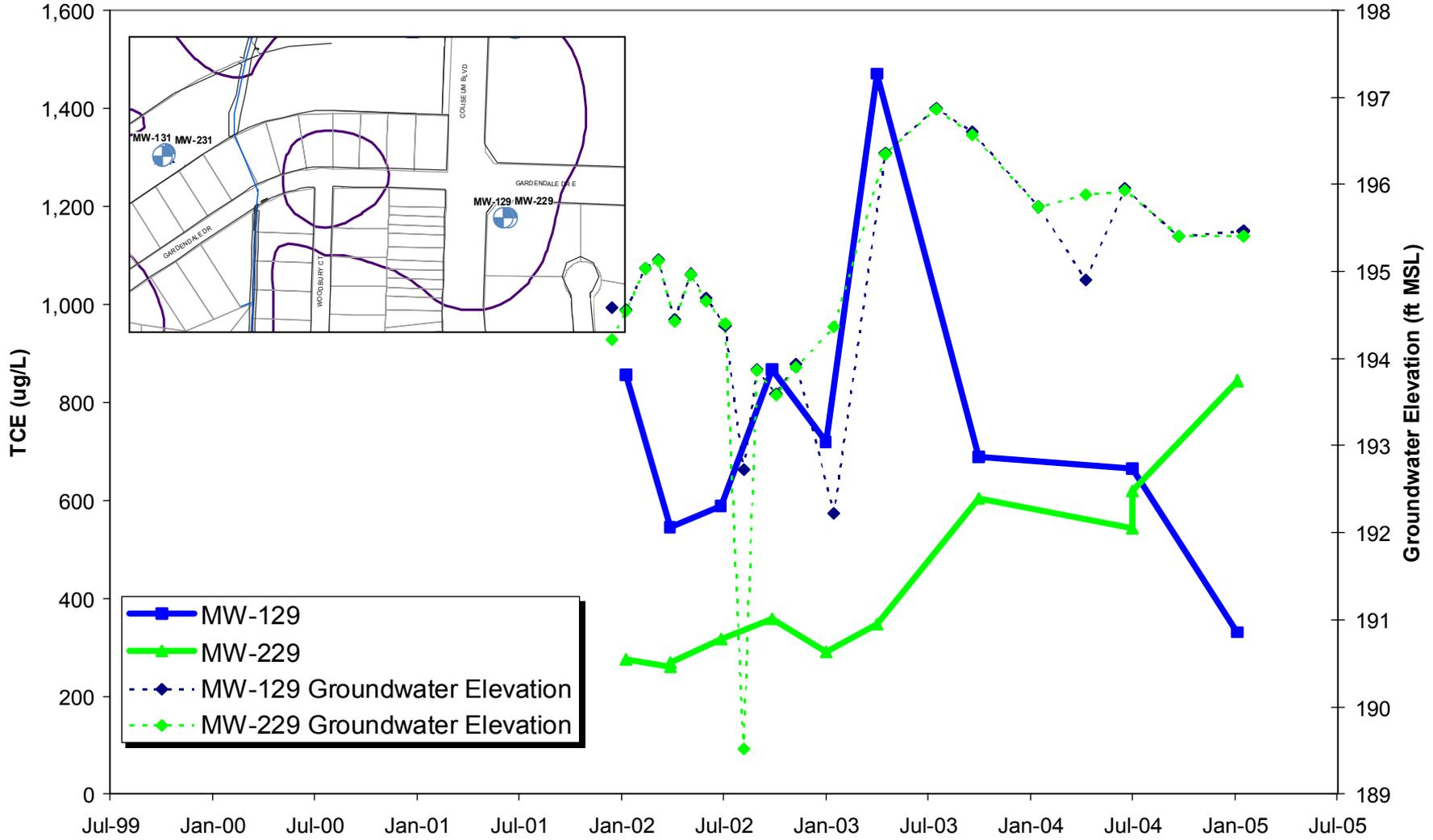
Intrawell Time Series Plots

MW-128 - MW-228

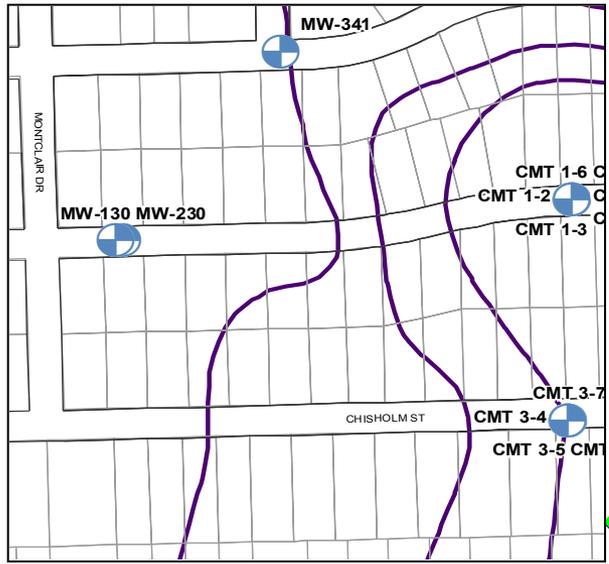
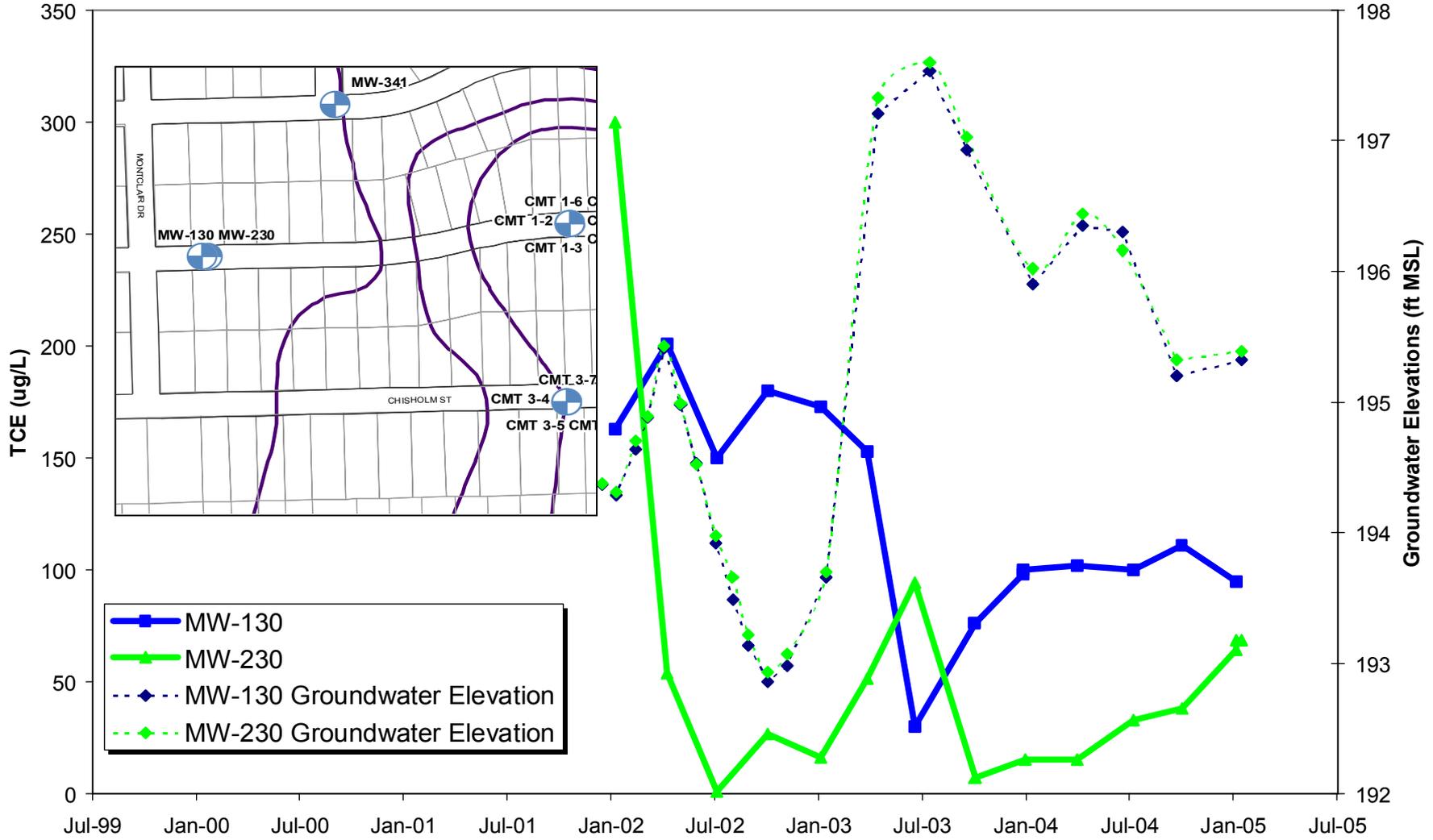


Intrawell Time Series Plots

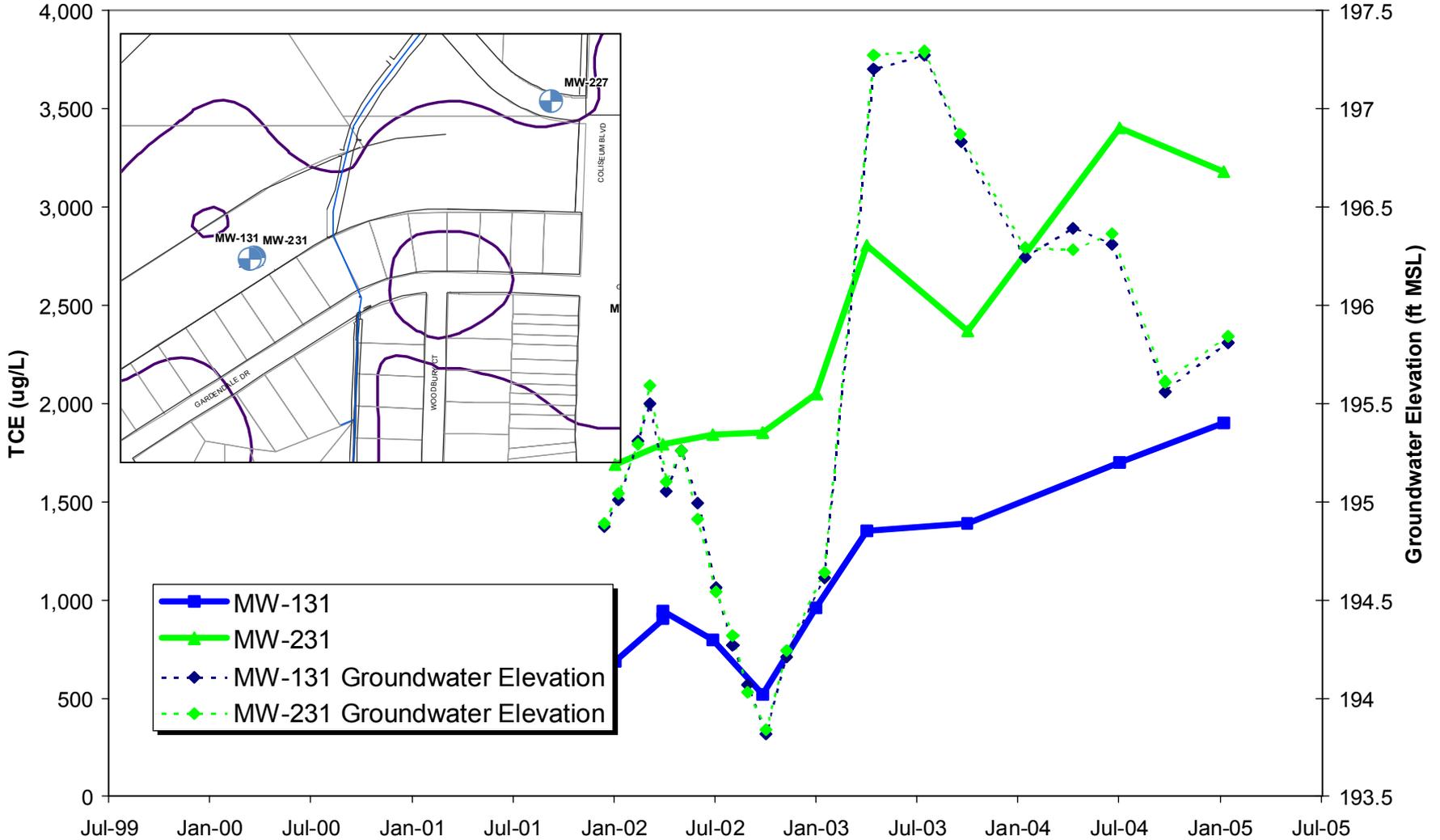
MW-129 - MW-229



Intrawell Time Series Plots MW-130 - MW-230

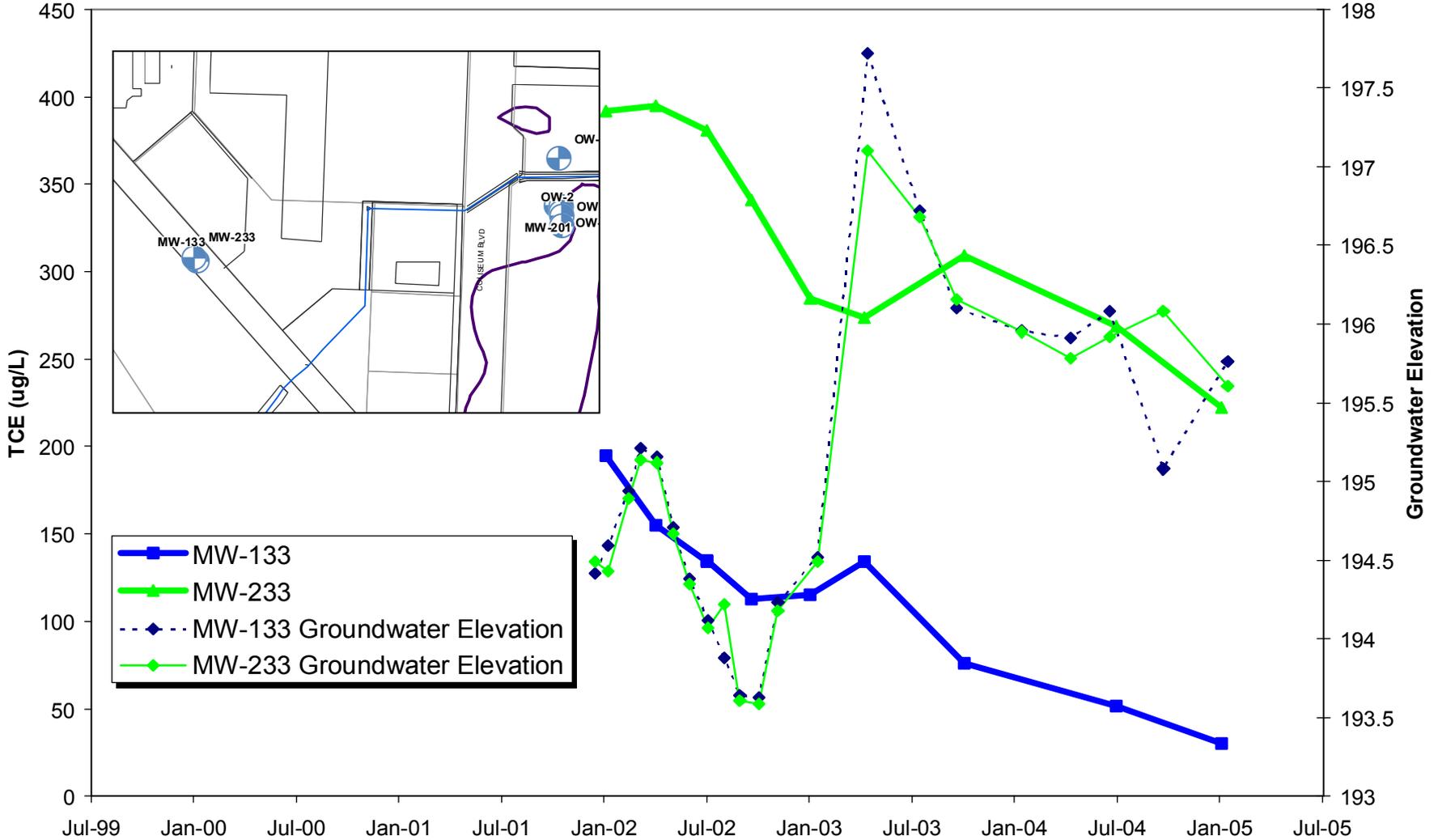


Intrawell Time Series Plots MW-131 - MW-231



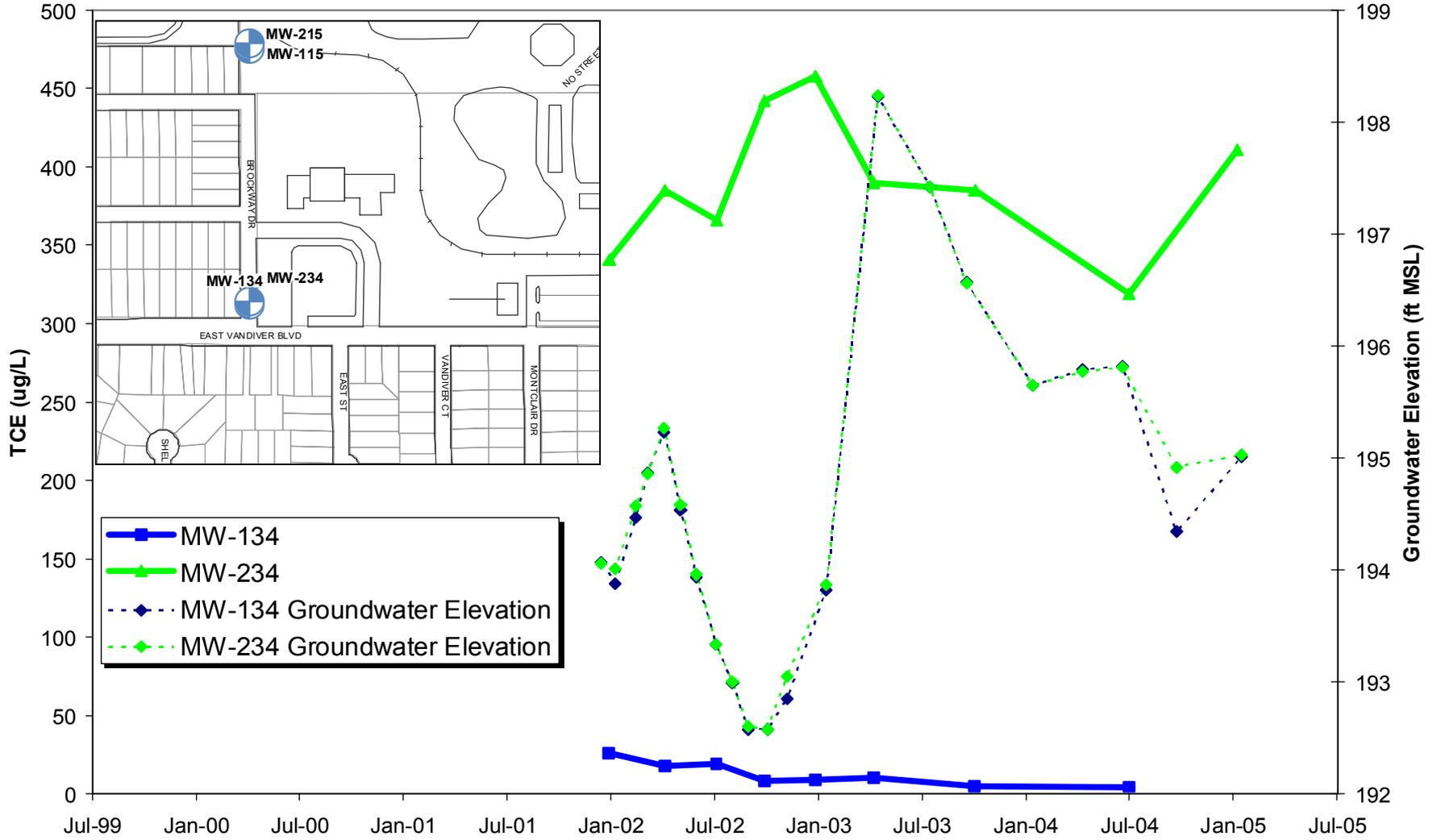
Intrawell Time Series Plots

MW-133 - MW-233



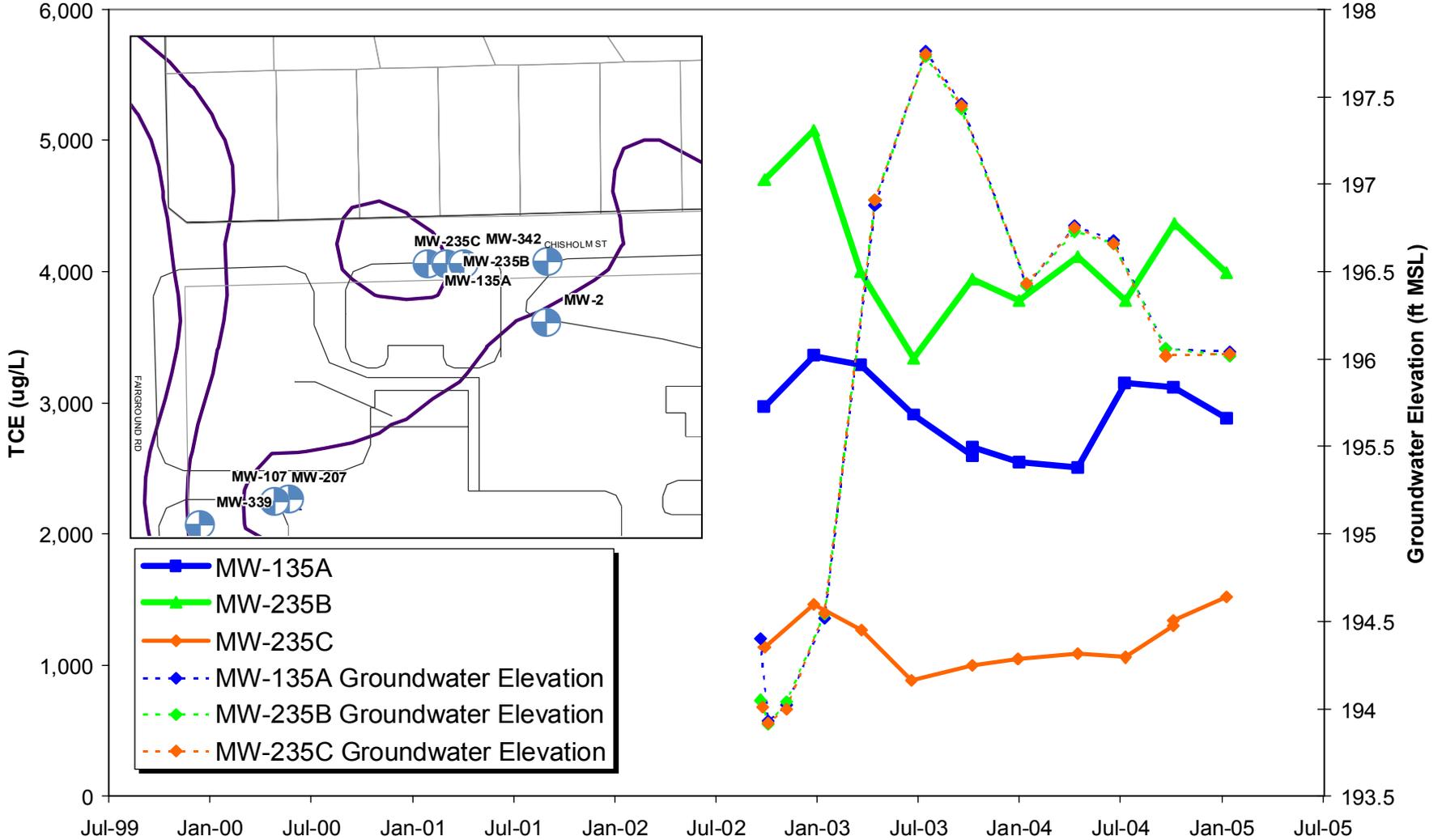
Intrawell Time Series Plots

MW-134 - MW-234



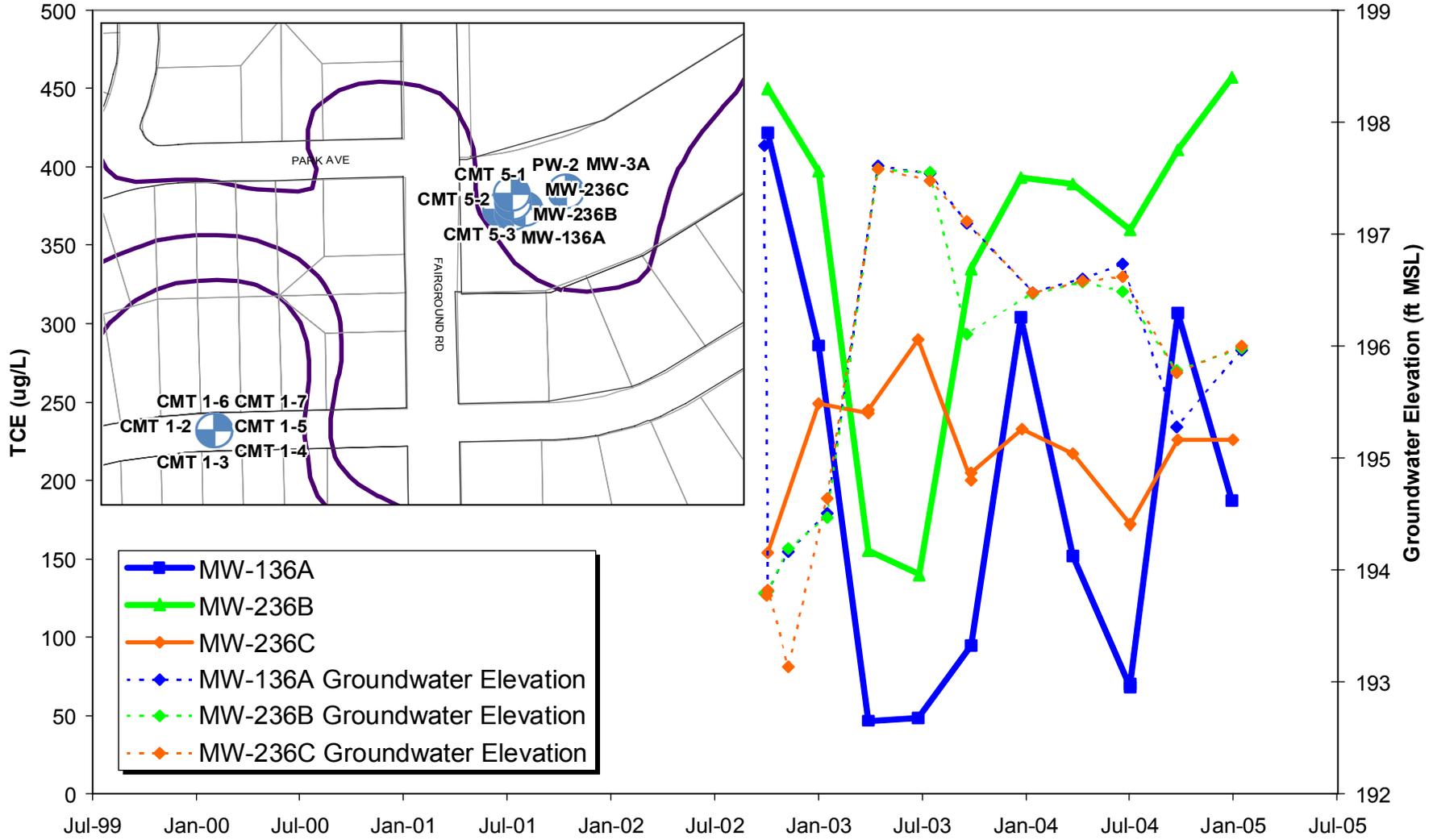
Intrawell Time Series Plots

MW-135A - MW-235C



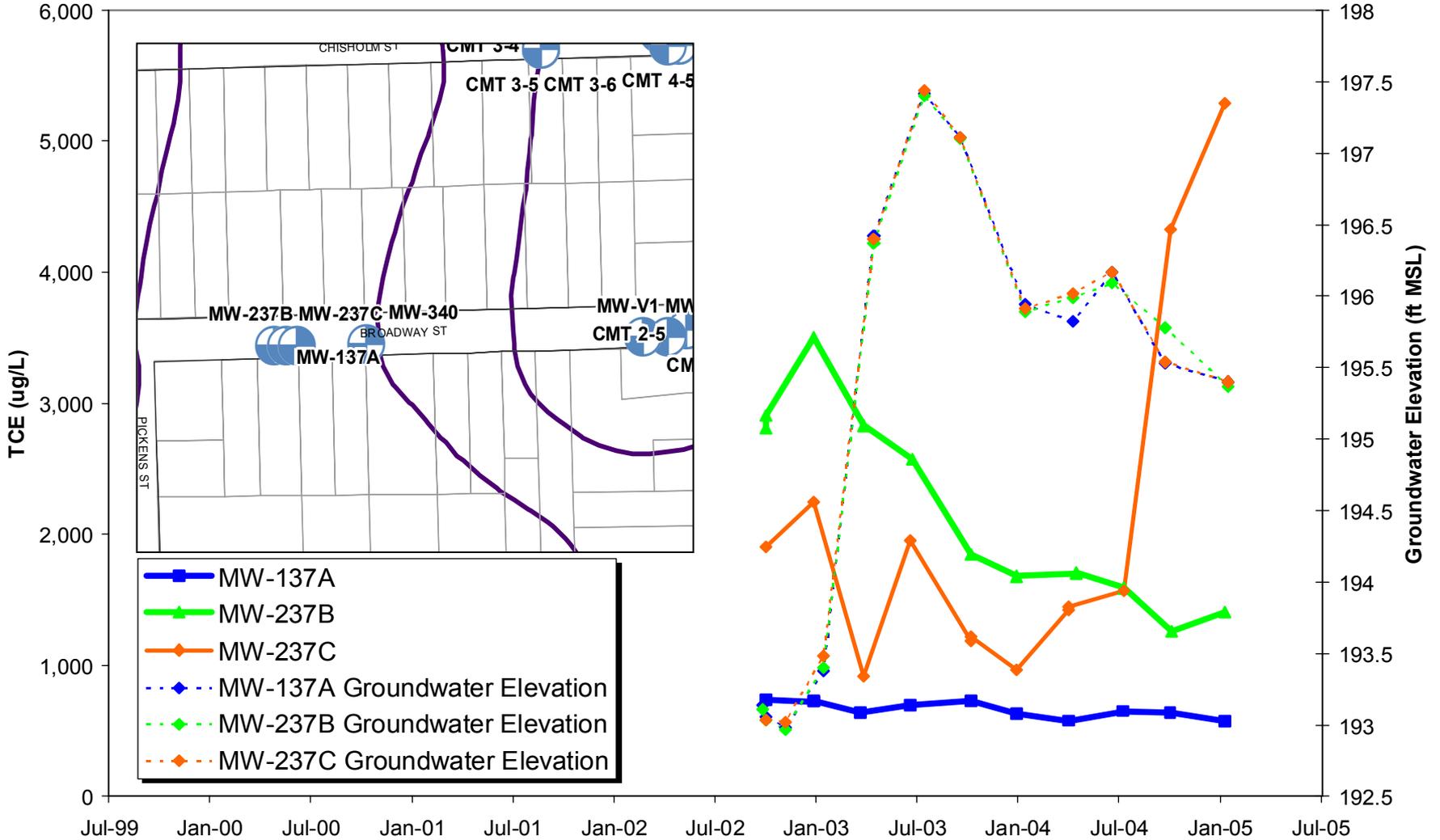
Intrawell Time Series Plots

MW-136A - MW-236C

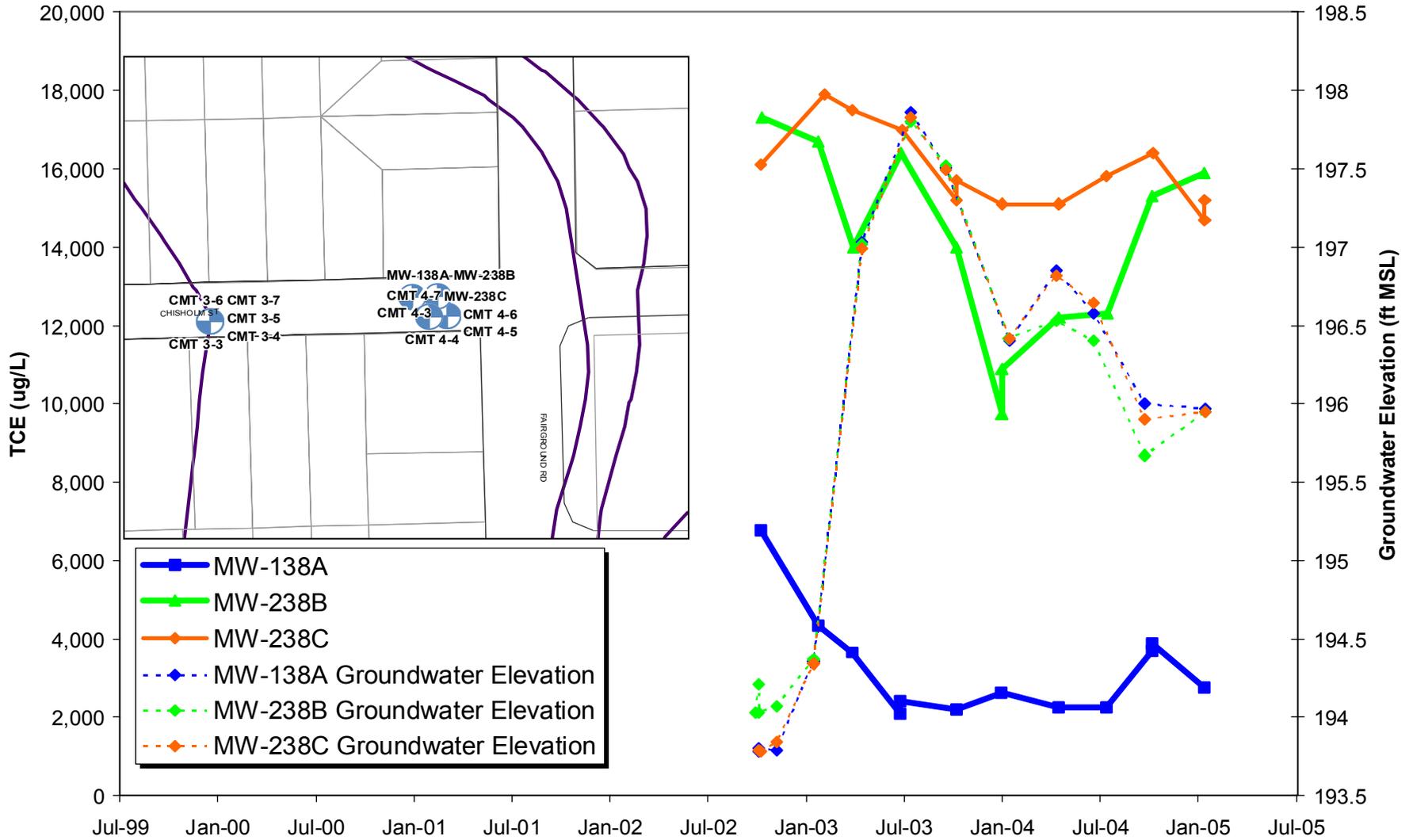


Intrawell Time Series Plots

MW-137 - MW-237

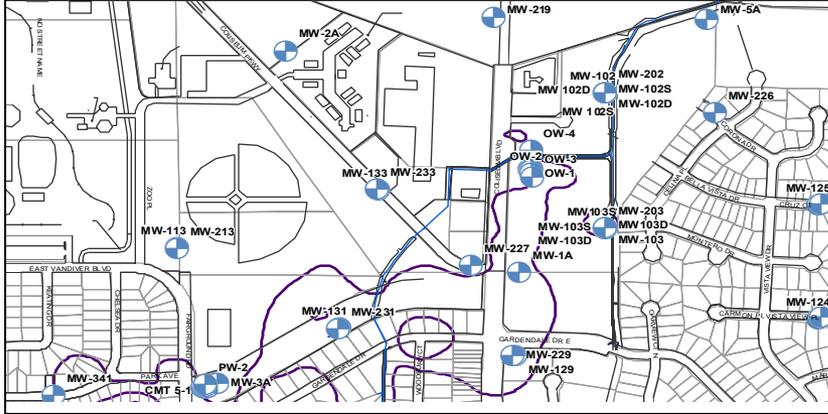
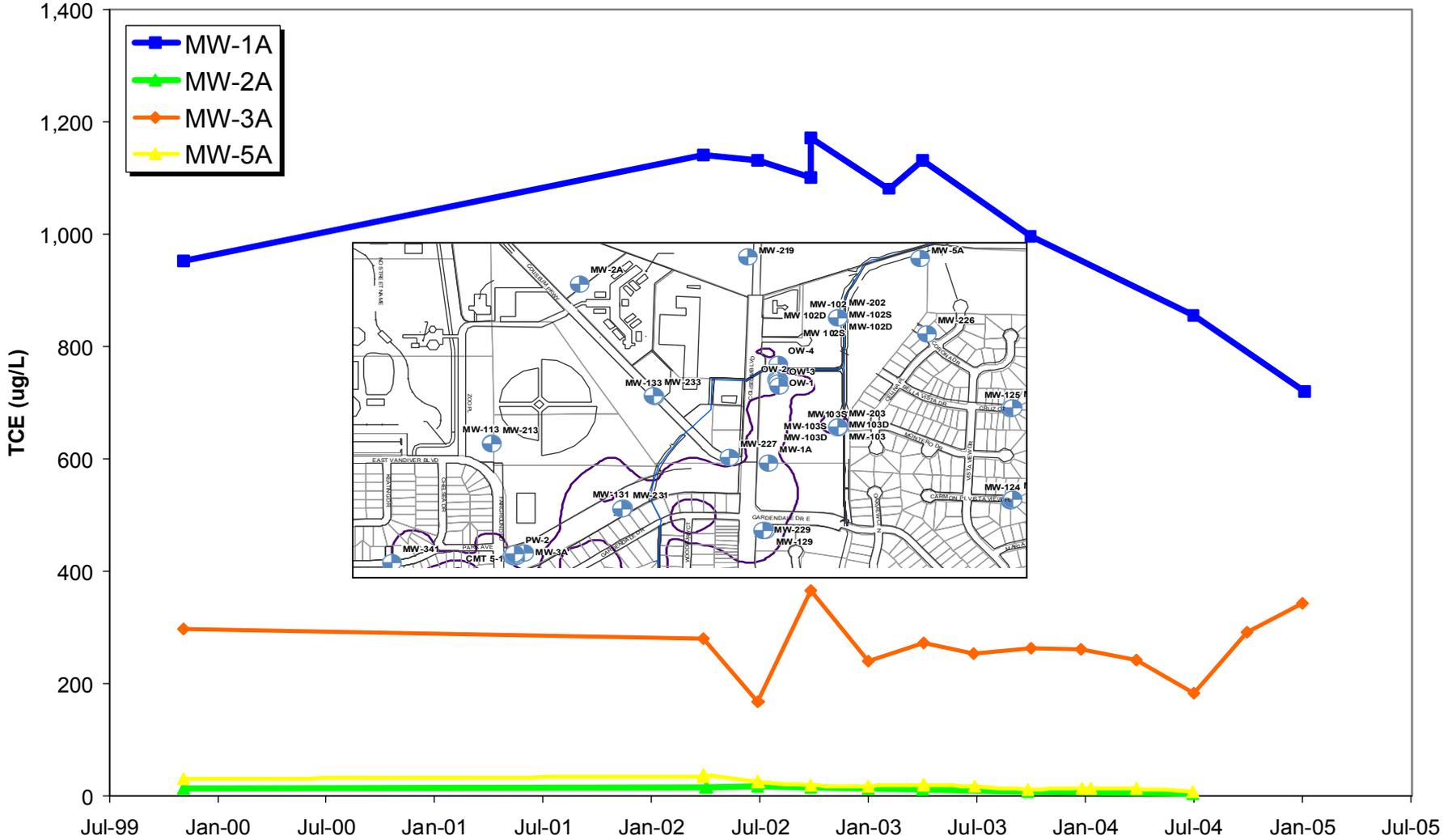


Intrawell Time Series Plots MW-138A - MW-238C



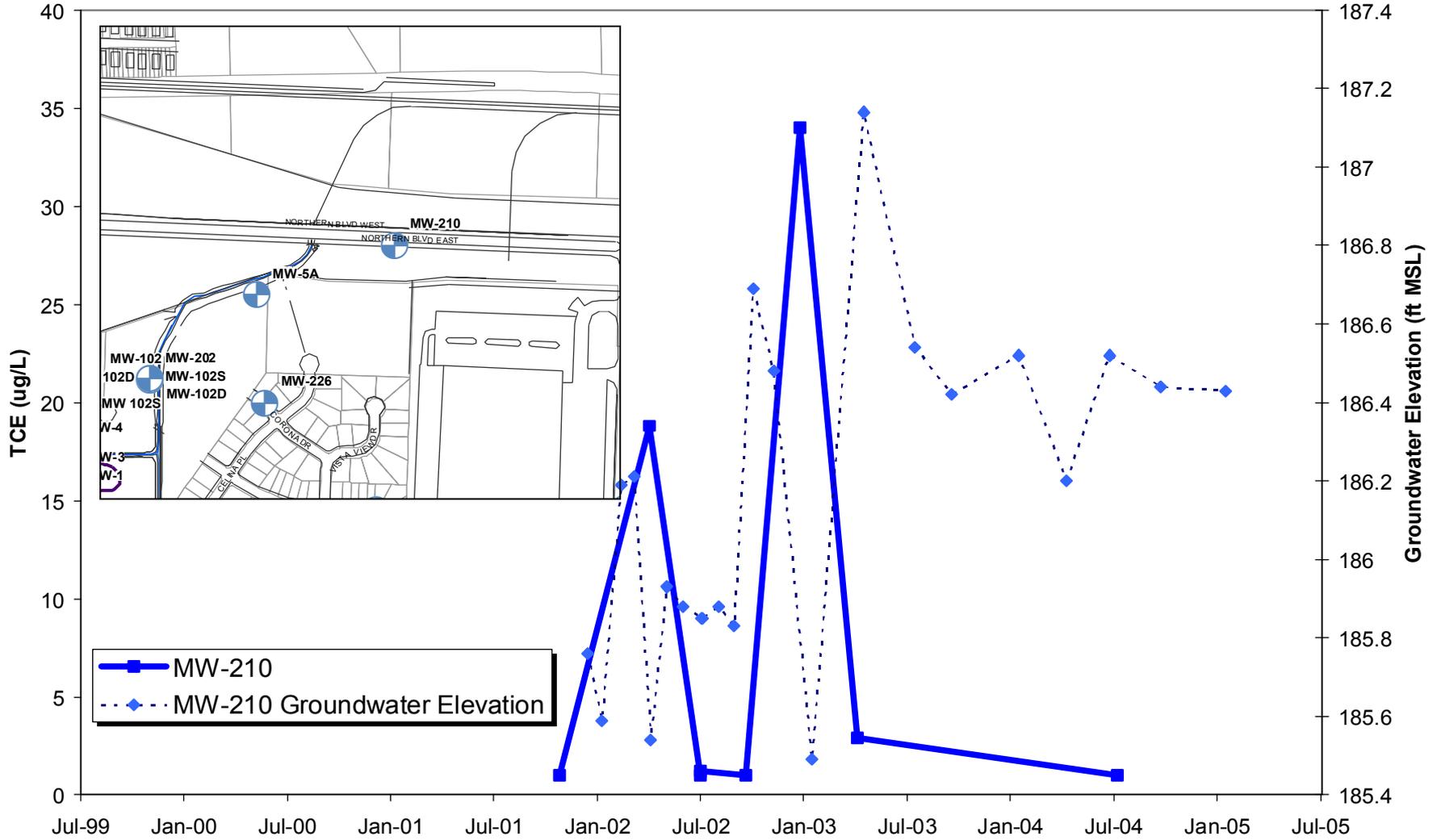
Intrawell Time Series Plots

MW-1A - MW-5A



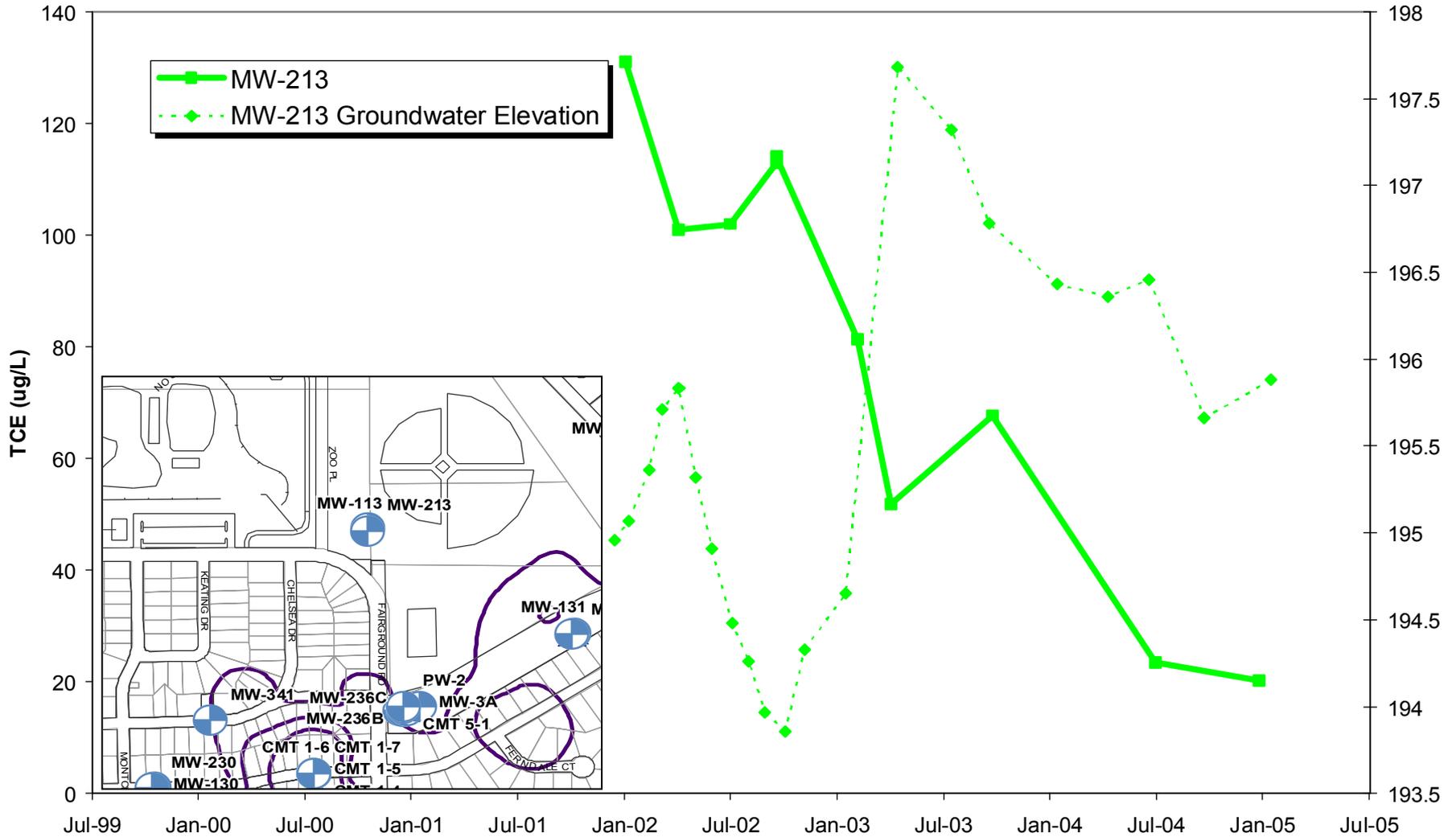
Intrawell Time Series Plots

MW-210

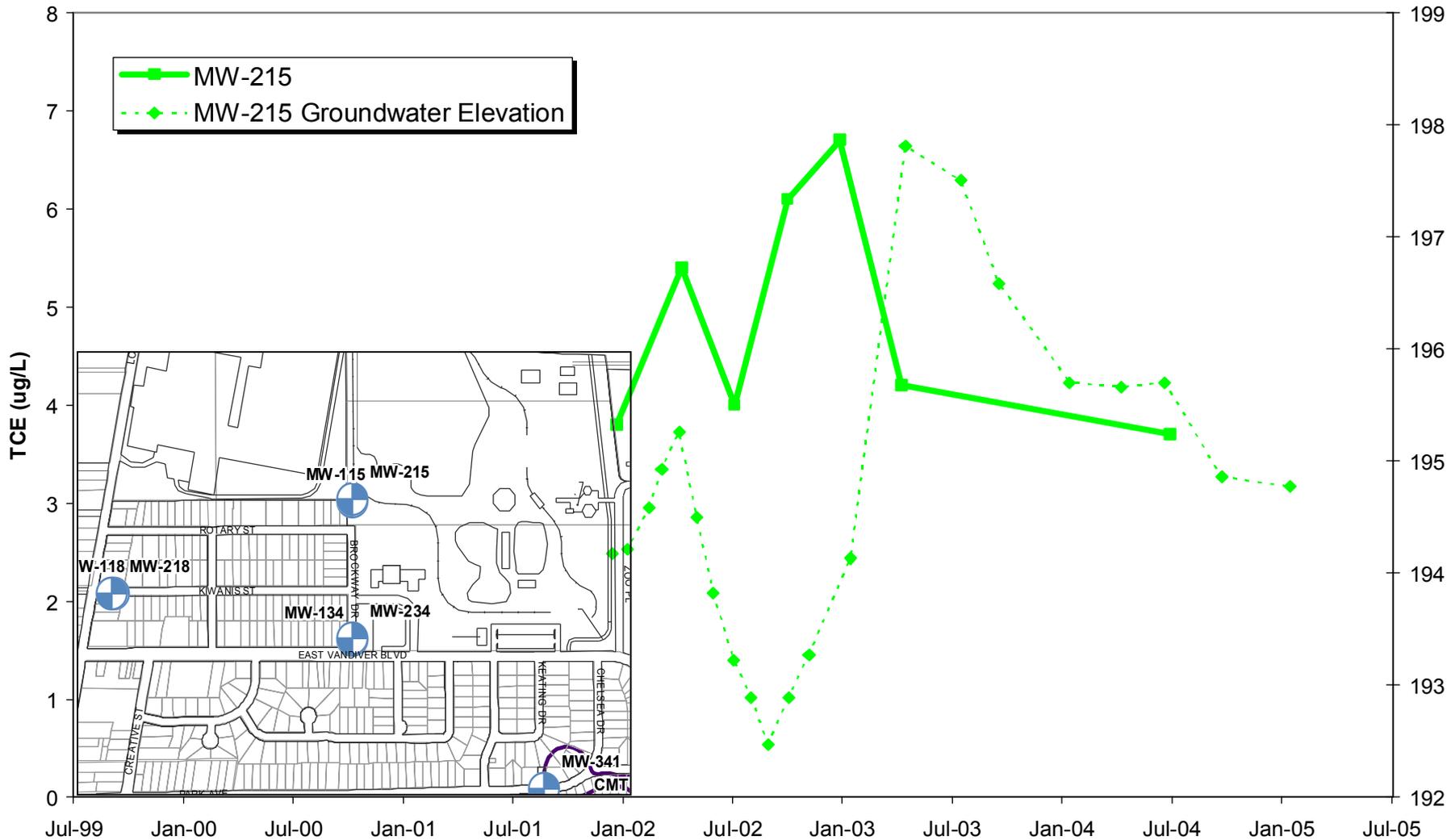


Intrawell Time Series Plots

MW-213

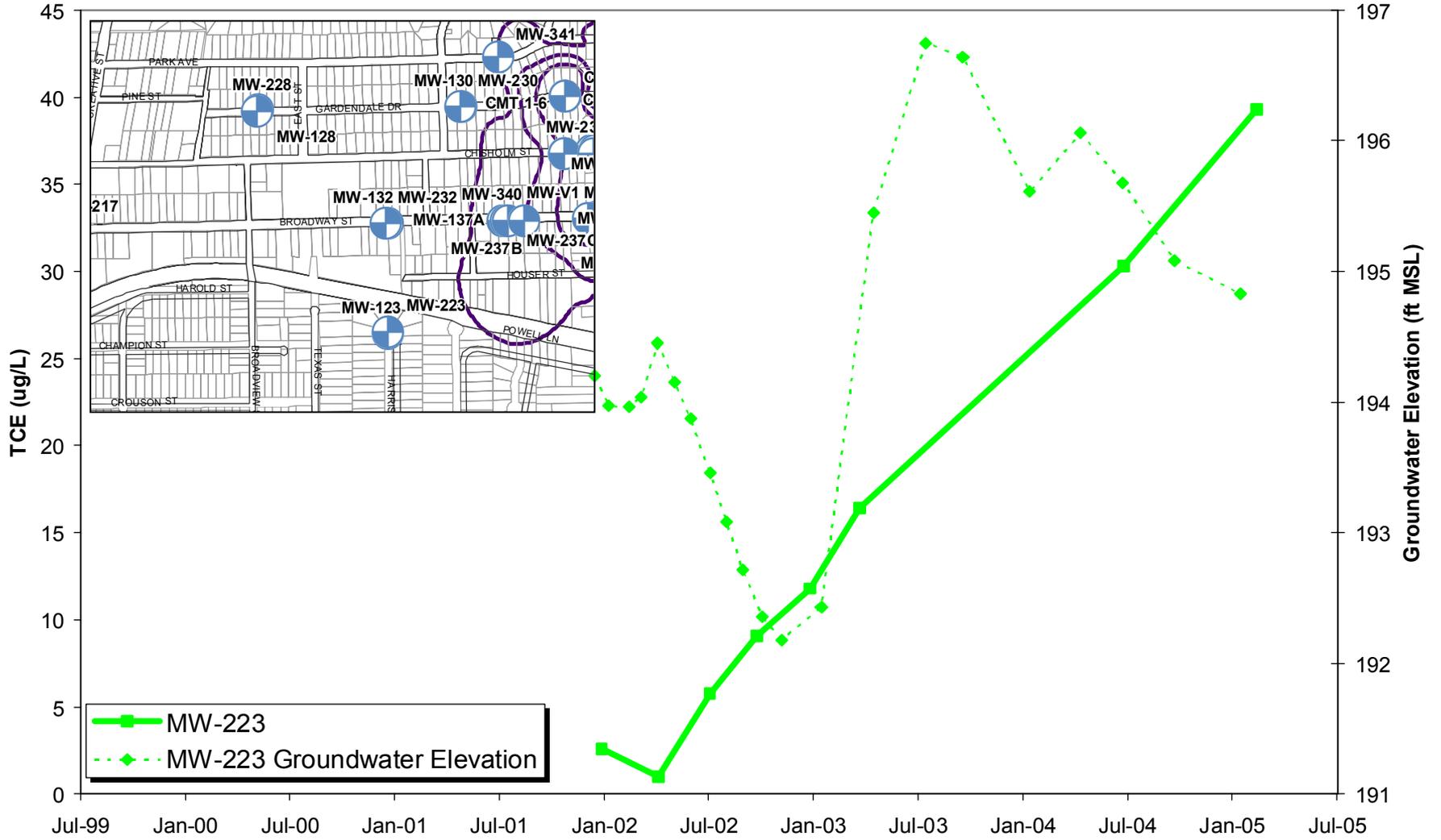


Intrawell Time Series Plots MW-215



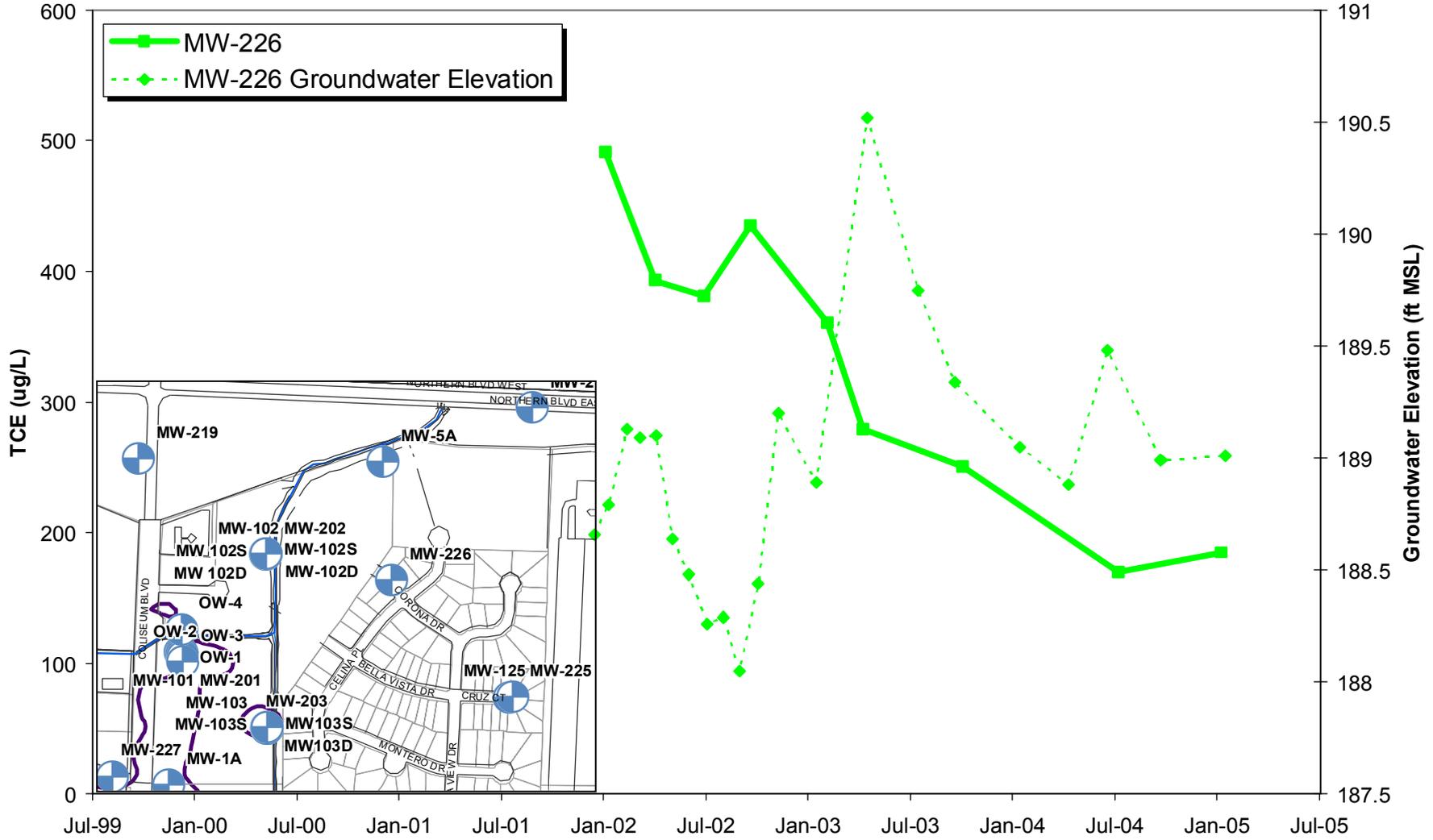
Intrawell Time Series Plots

MW-223



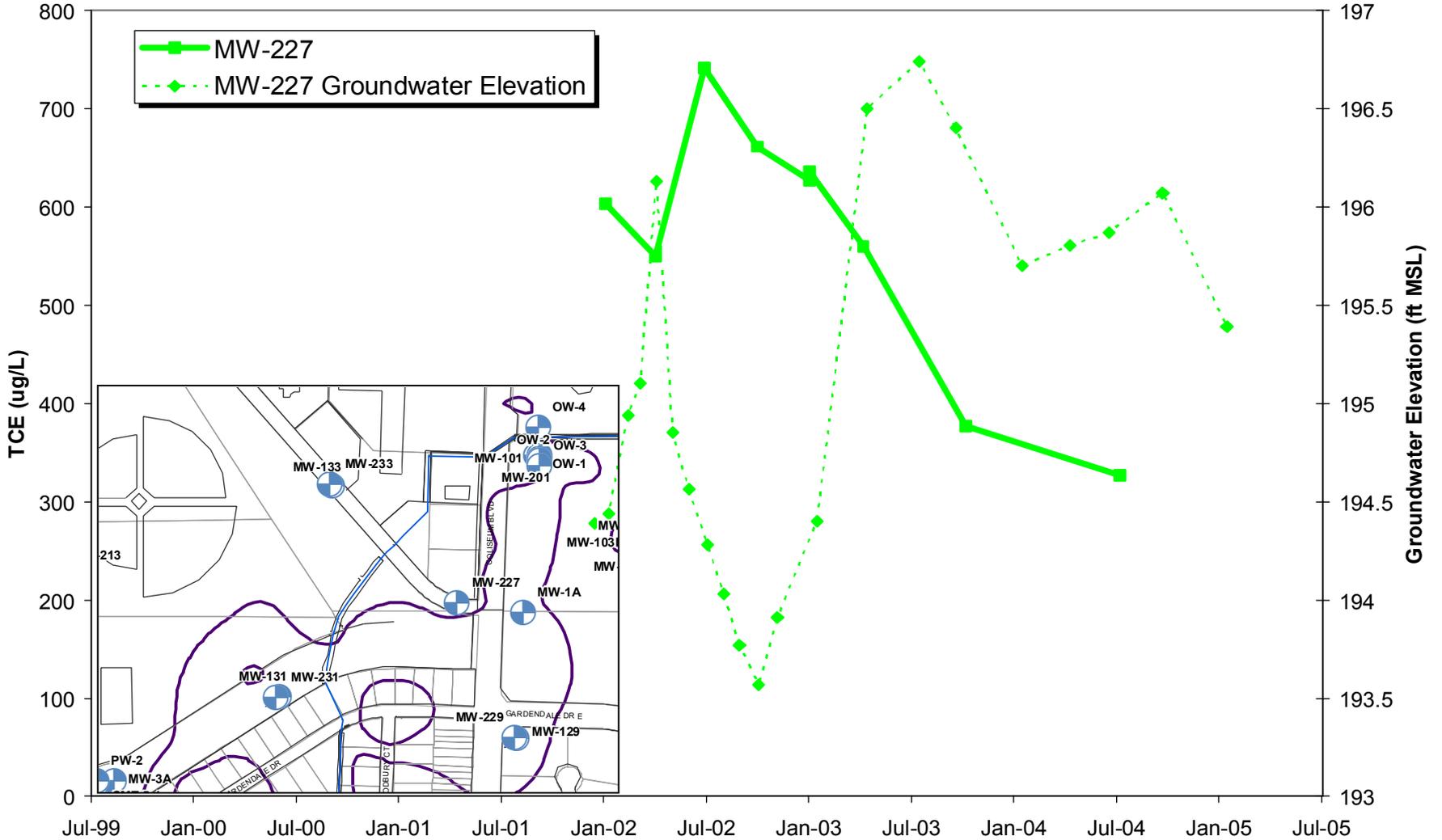
Intrawell Time Series Plots

MW-226



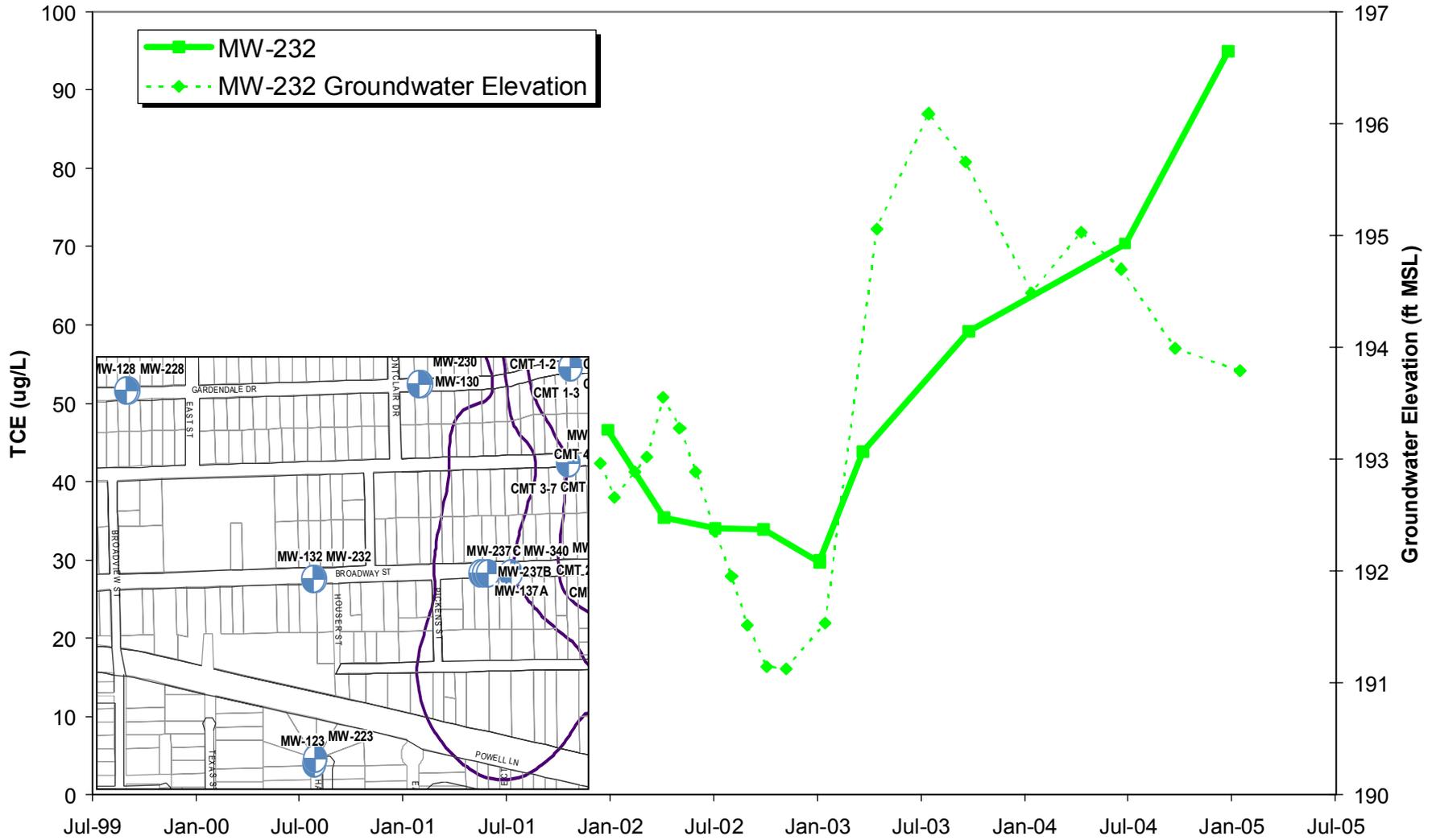
Intrawell Time Series Plots

MW-227

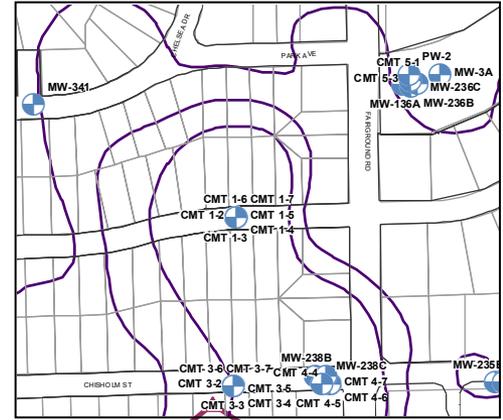
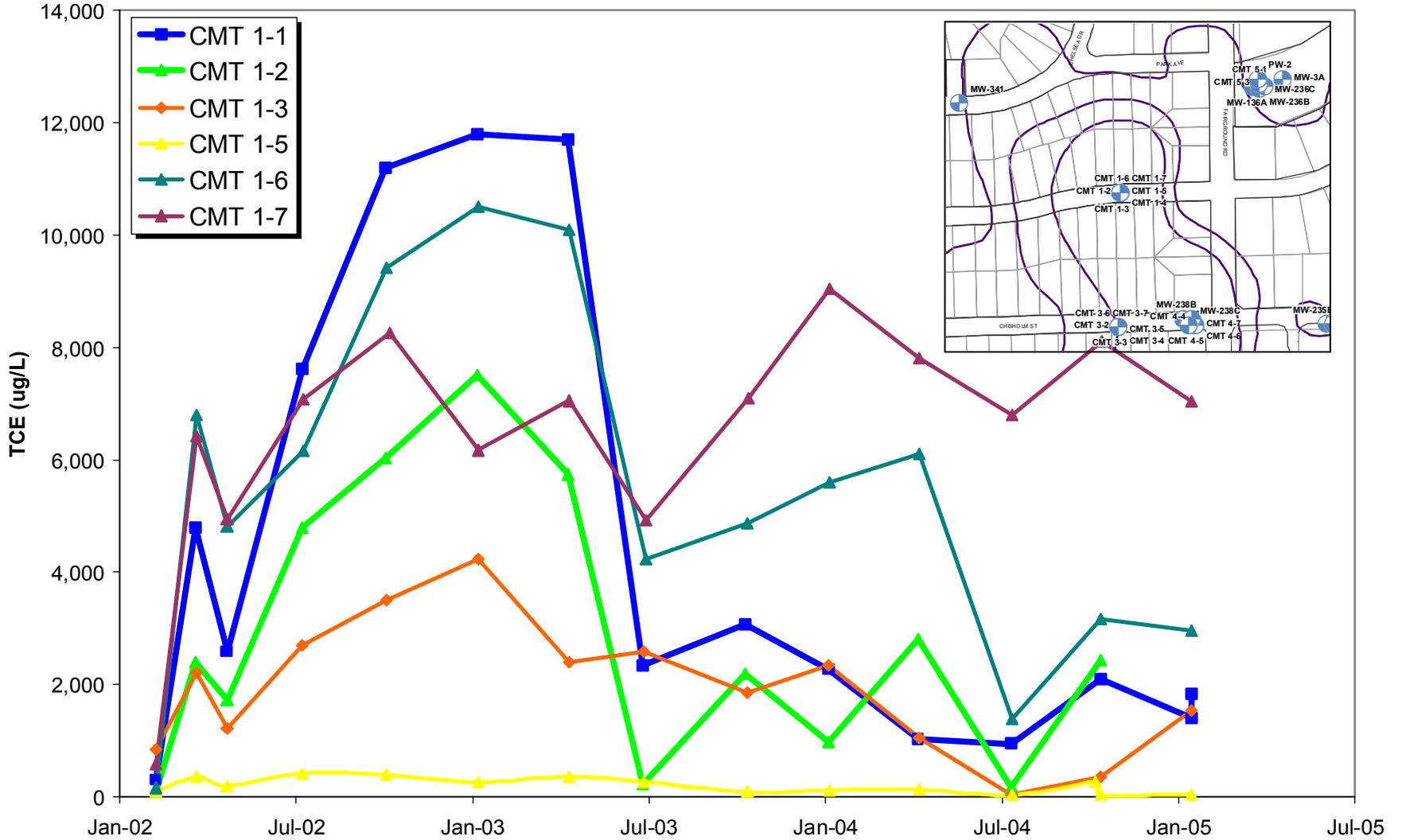


Intrawell Time Series Plots

MW-232

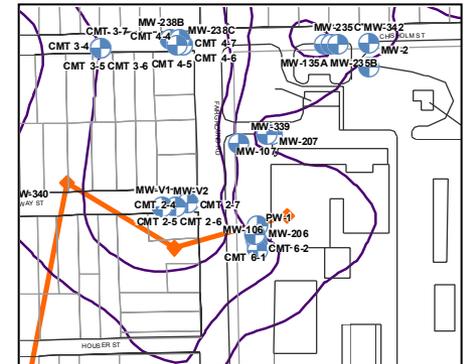
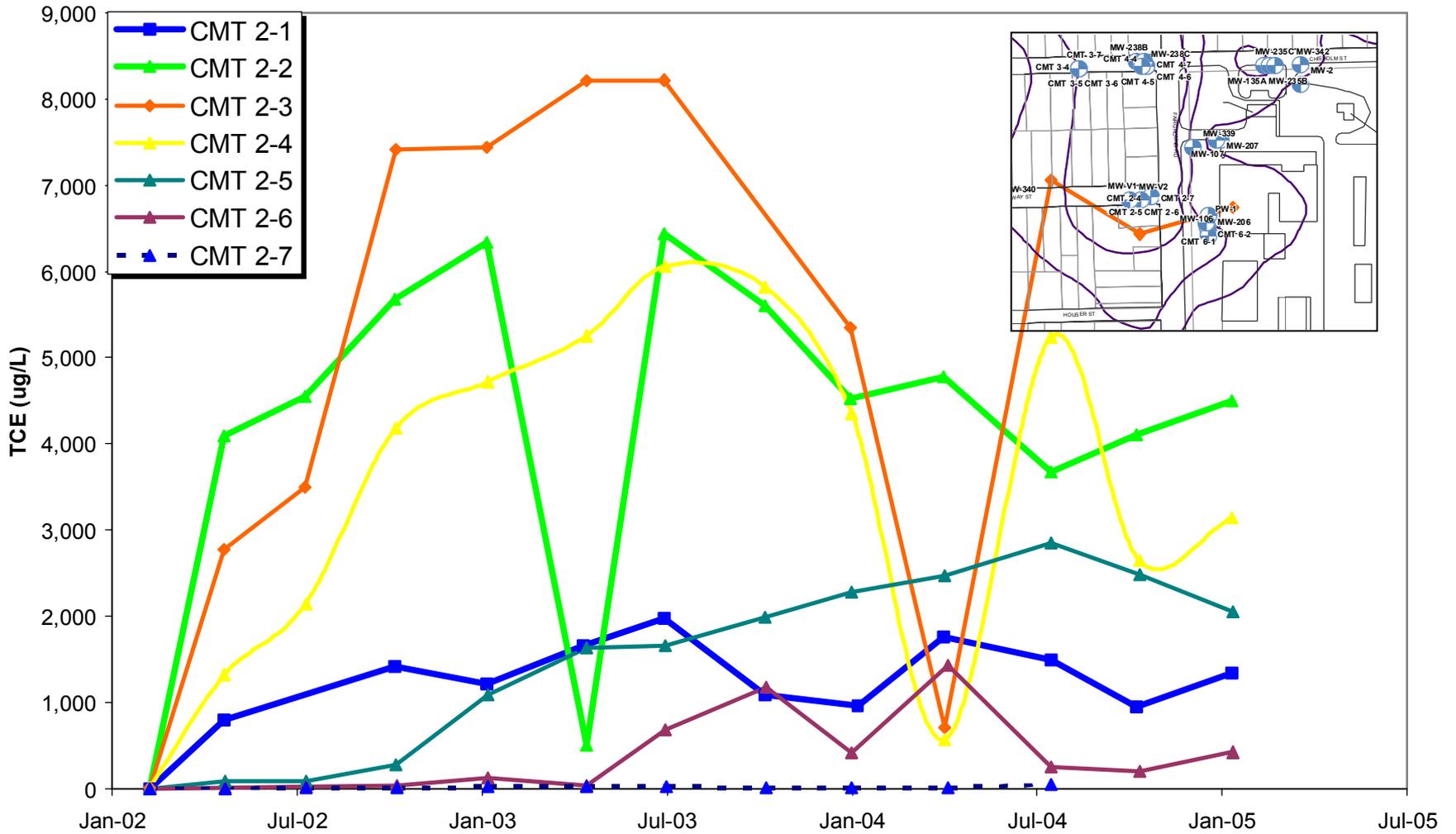


Time Series Plots CMT 1-1 - CMT 1-7



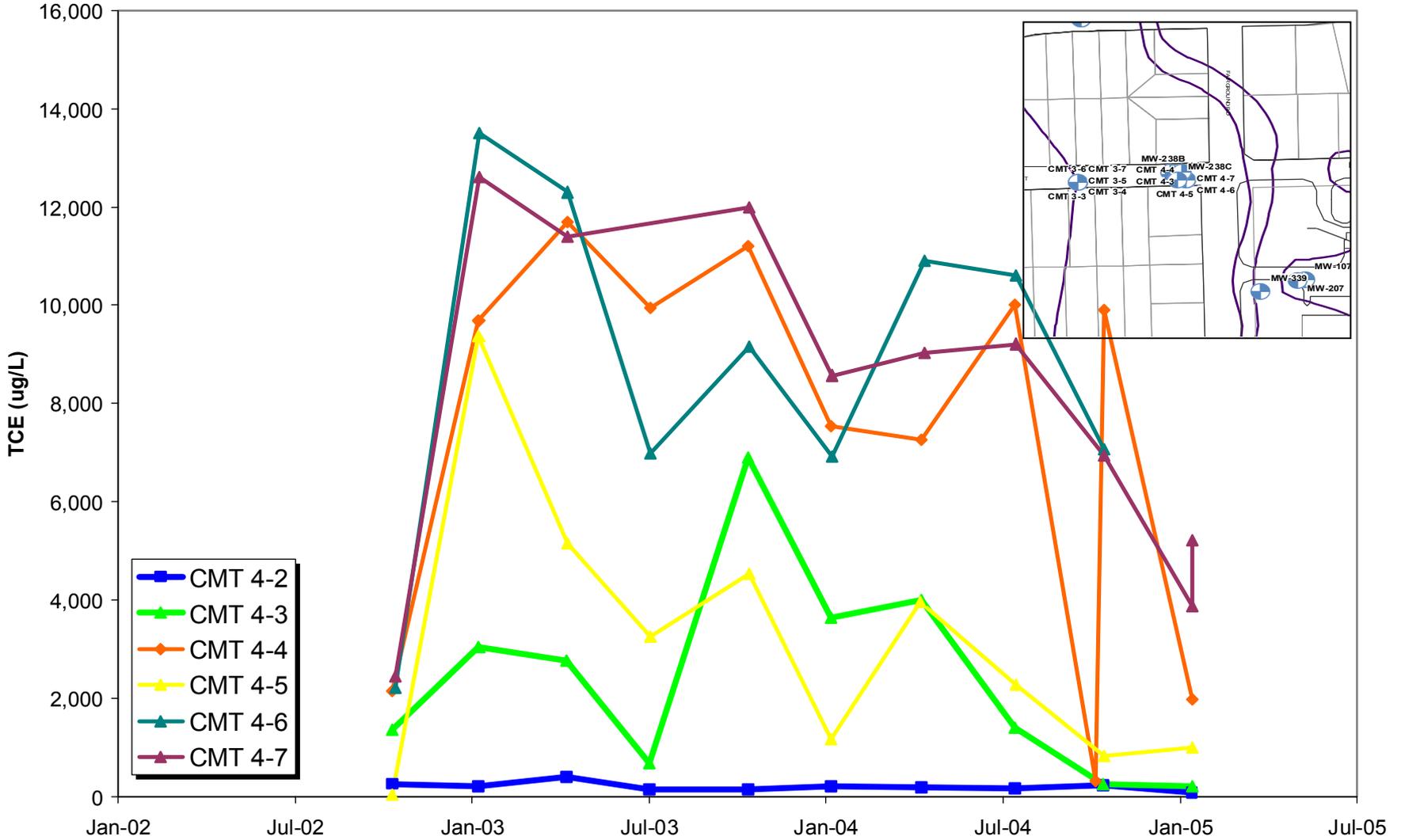
Intrawell Time Series Plots

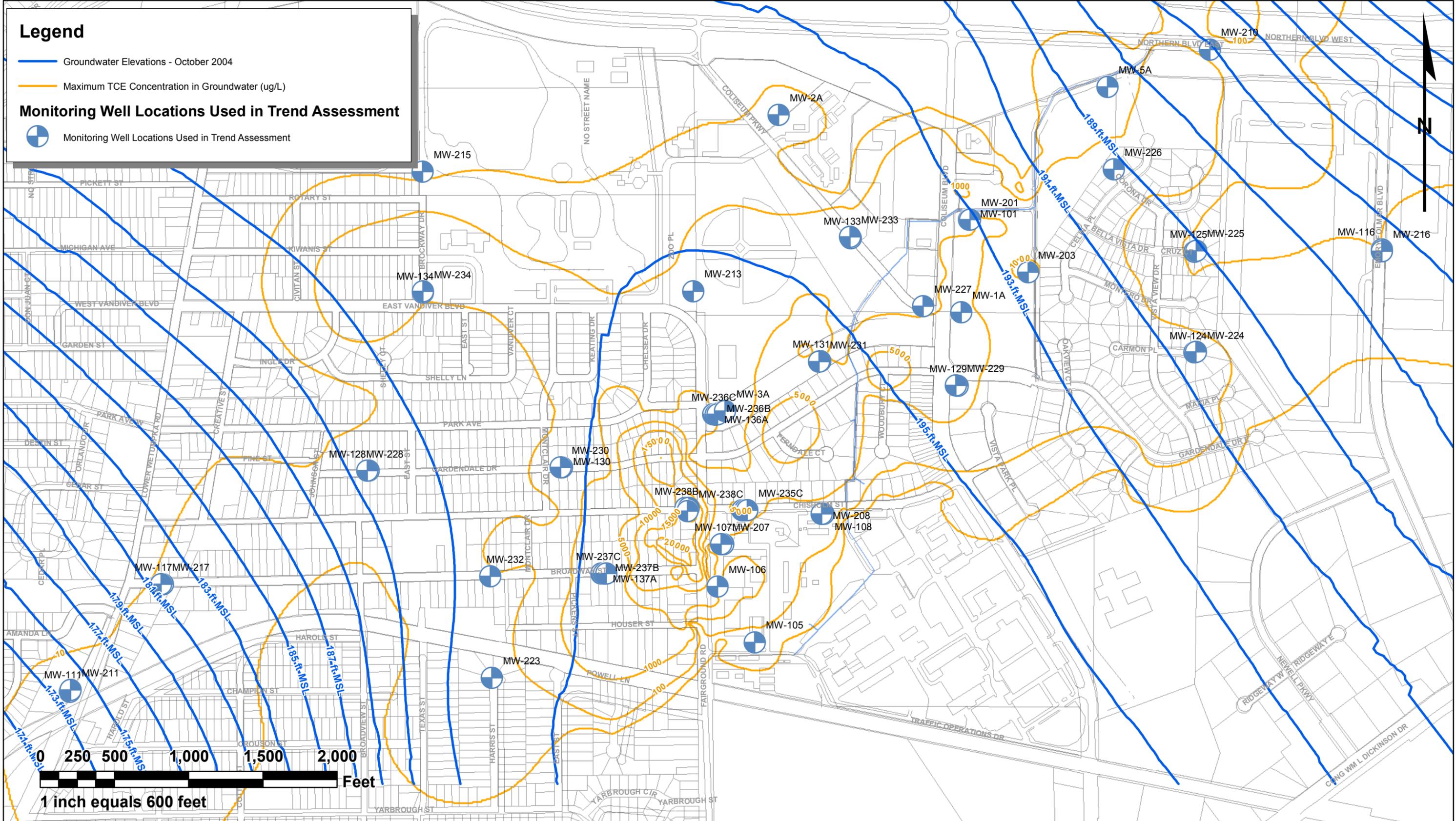
CMT 2-1 - CMT 2-7



Intrawell Time Series Plots

CMT 4-2 - CMT 4-7



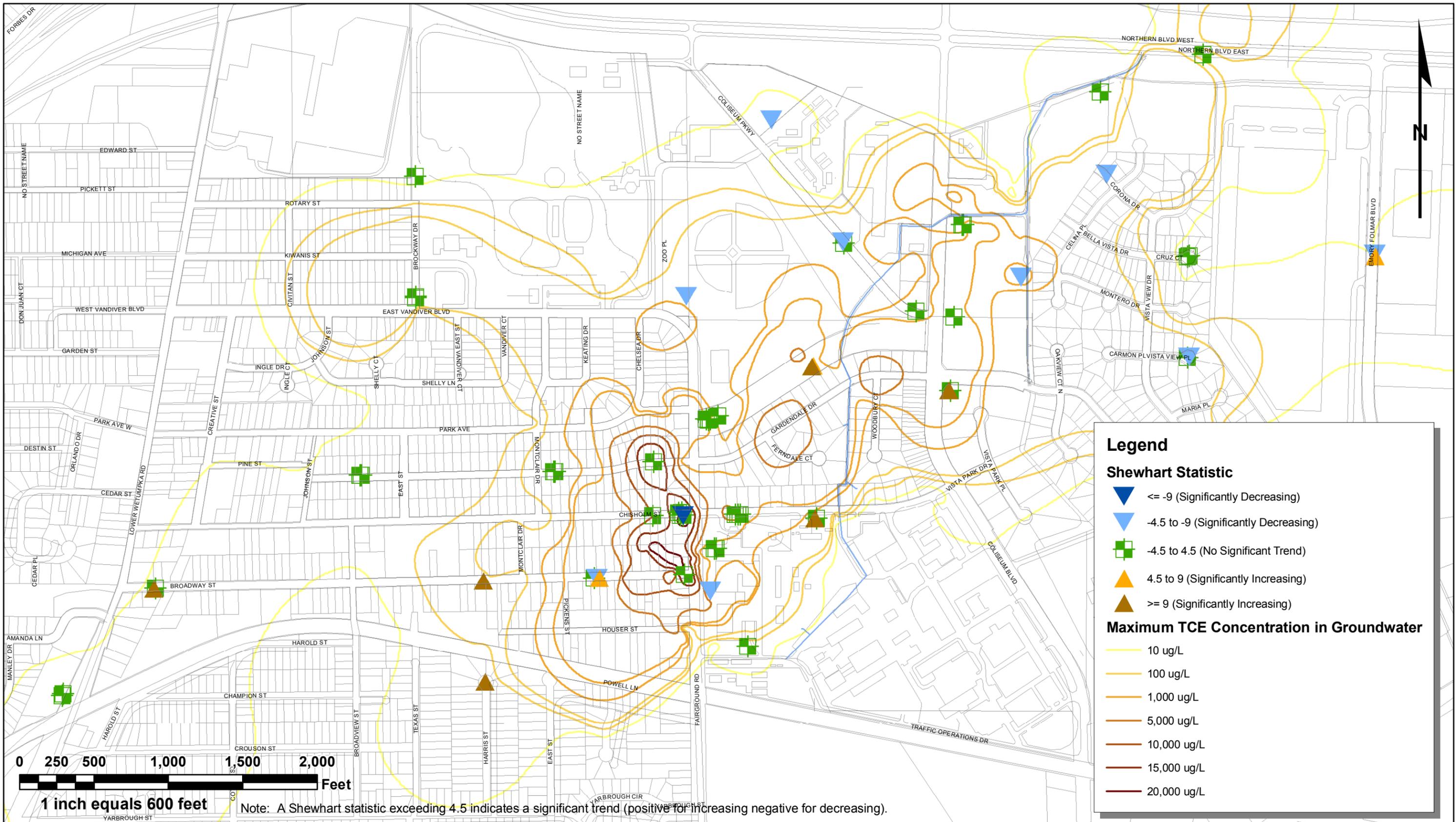


Alabama Department of Transportation
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Location of Monitoring Wells Used in TCE Trend Assessment

FIGURE 1a

April 2005

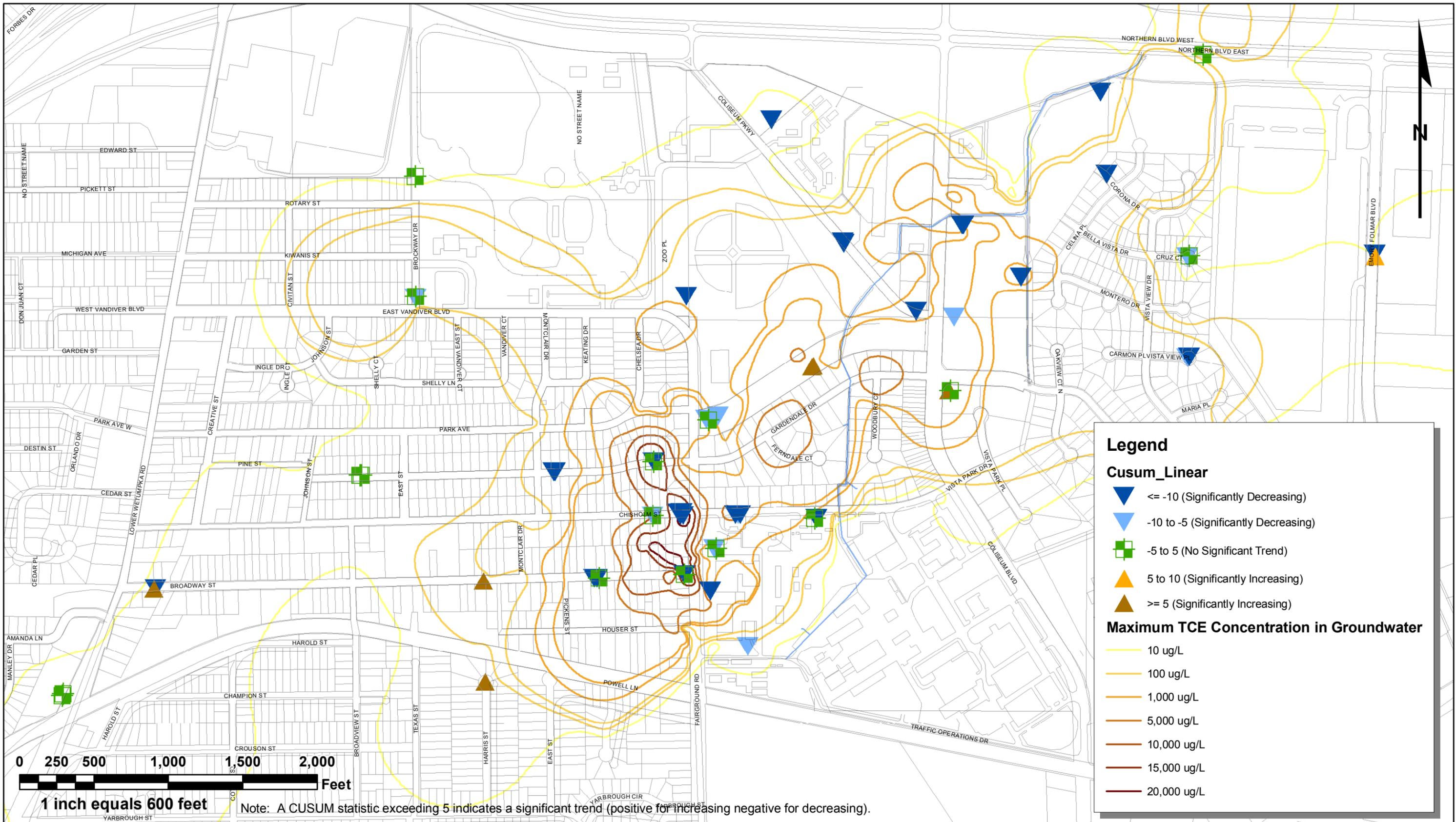


Alabama Department of Transportation
Coliseum Boulevard Project

Shewhart Trend Summary for TCE Concentrations in Groundwater

FIGURE 3a

April 2005



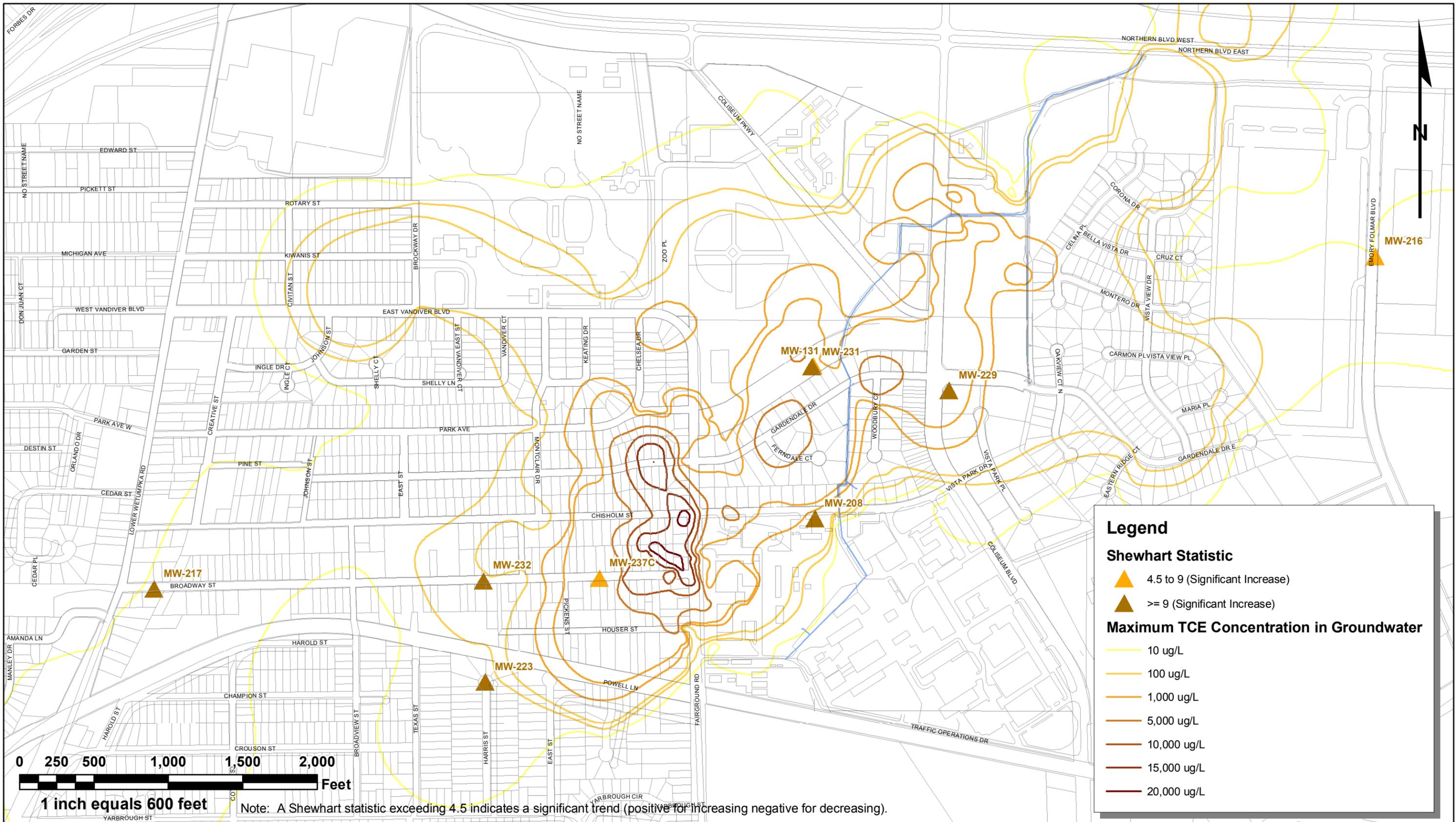
Alabama Department of Transportation
Coliseum Boulevard Project

CUSUM Trend Summary for TCE Concentrations in Groundwater

FIGURE 3b

April 2005



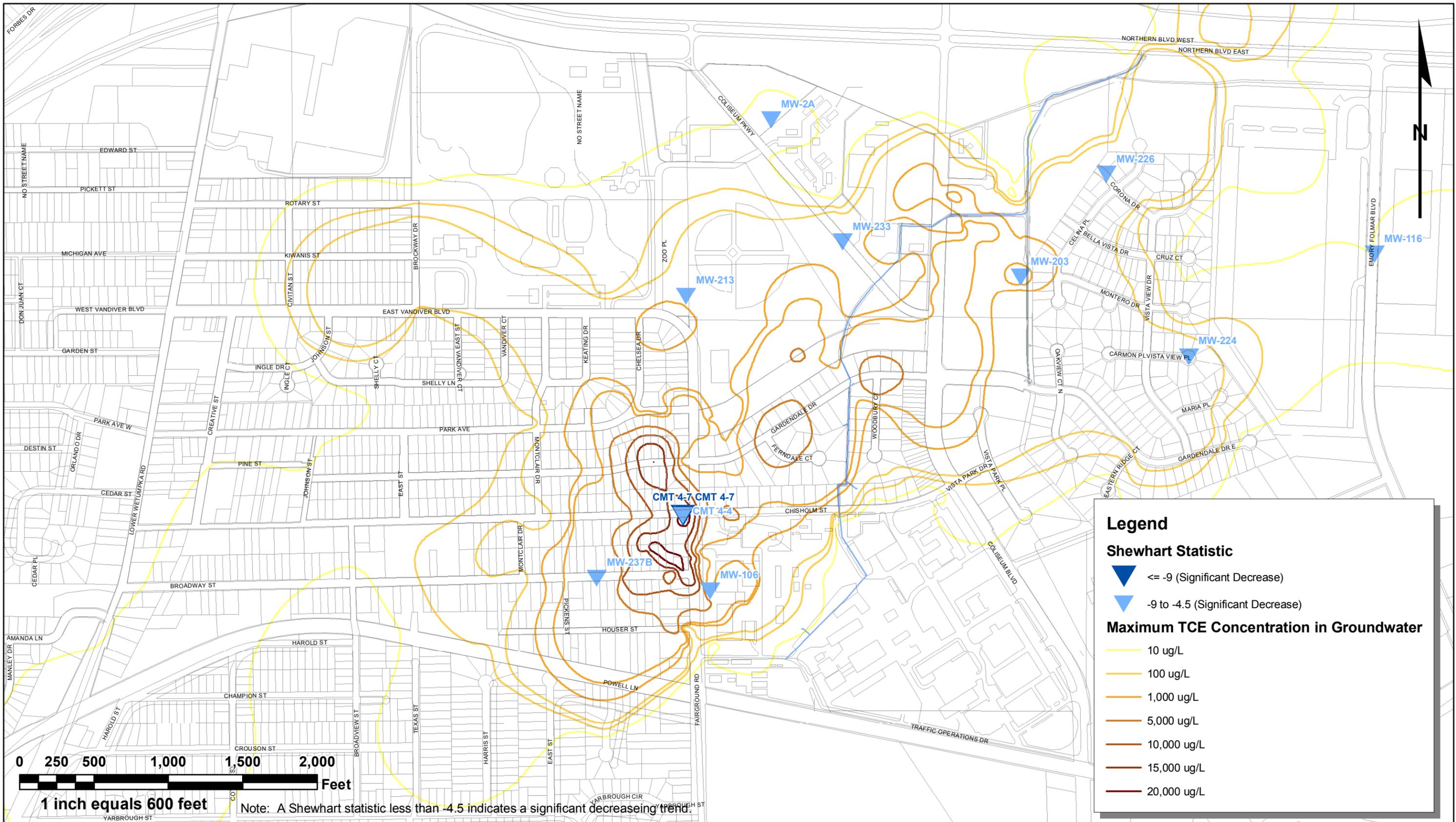


**Alabama Department of Transportation
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Shewhart Trend Summary - Significant TCE Increase in Groundwater

FIGURE 5

April 2005



Alabama Department of Transportation
Coliseum Boulevard Project

Shewhart Trend Summary - Significant TCE Decrease in Groundwater

FIGURE 7

April 2005



DEPARTMENT OF TRANSPORTATION