APPENDIX G

Statistical Analysis and Time-Series Plots for Select Analytes in Select Wells

APPENDIX G.1

Statistical Analysis
(Raw Data on CD)

G.1 Statistical Analyses Methods and Outputs

Statistical procedures were used to evaluate groundwater and surface water quality and to evaluate trends over time. The statistical analyses performed on the water quality data includes: Goodness-of-fit, Dixon's Outlier, Thiel-Sen's Slope Estimator Plots, Mann-Kendall Tests, Kurskal-Wallis and Seasonal Kendall.

MW-20 is evaluated as an upgradient, background monitoring well. MW-2, MW-21, MW-33, MW-35, SW-W1 and SW-W2 are considered downgradient monitoring wells. For the statistical analysis, all were analyzed in an intrawell comparison for trend analysis.

Statistical analyses of the water quality data were performed using the software program ProUCL version 5.1.002 (EPA, 2013) and WQStat Plus™ v.9.0.34 (Sanitas Technologies, 2010). Normality testing and Dixon's Outlier, Thiel-Sen's Slope Estimator, and Mann-Kendall tests were performed in ProUCL. Seasonality testing using Kruskal-Wallis and Seasonal Kendall were performed in WQStat Plus™. The following is a general description of each test that was performed.

G.1A Goodness-of-Fit

The data were evaluated for goodness-of-fit using Q-Q plots for normal, lognormal and gamma distribution. Non-detects were not included in this evaluation. The resulting Q-Q plots, including goodness-of-fit test statistics are included in this appendix. The majority of the datasets are both normally and log-normally distributed. Nonparametric methods were used to perform the statistical analyses.

G.1B Dixon's Outlier

Dixon's Outlier test was used to determine if there were any results that were potentially statistically distinct from the population represented by the remainder of the dataset. Each combination of analyte and well was evaluated for outliers. Two statistically significant outliers were identified in the dataset.

G.1C Thiel-Sen's Slope Estimator Plots and Mann-Kendall Tests

Sen's Slope Estimator computes a linear trend, if present, by calculating the median slope between all the pairwise combinations of results. The slope is evaluated to determine if the trend of a particular water quality constituent concentration is increasing, decreasing, or zero (no change) over time. This method of estimating the slope is not greatly affected by gross data errors or outliers and can be computed when data is missing. The Mann-Kendall Test is an additional test used to determine whether or not a trend is statistically significant (at a specific confidence level—herein, that confidence level is 95 percent, as stated on the ProUCL data sheets).

The Thiel-Sen's Slope and Mann-Kendall test results are summarized in Table 6.8a of the main text.

If similar trends and slopes are observed in both the upgradient and the downgradient wells, then the observed trends are likely a result of general climatic or environmental conditions. However, if contrasting trends or statistically significantly different slopes are observed between the upgradient

and downgradient wells, then the observed trends may indicate groundwater quality impacts from the landfill.

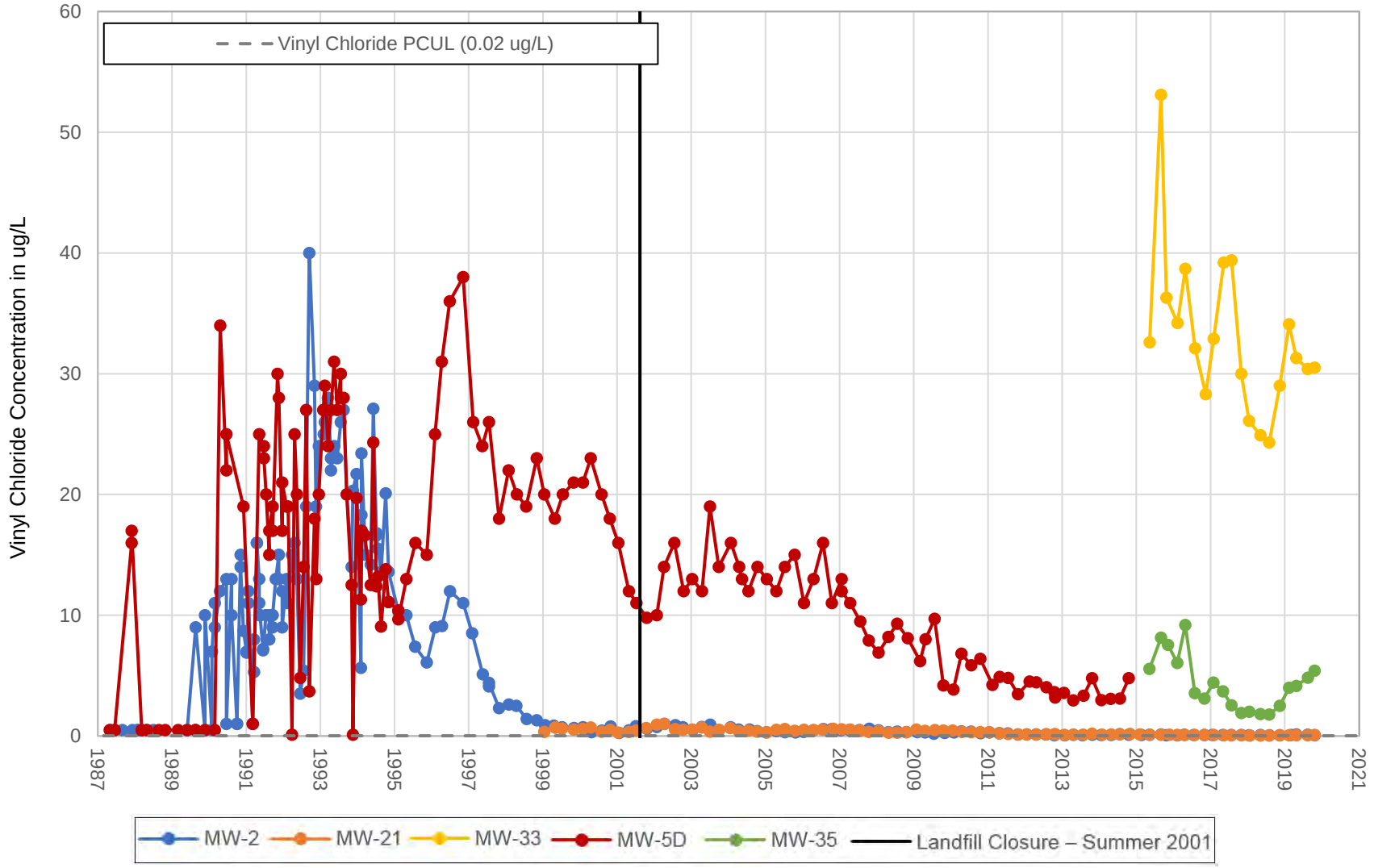
G.1D Seasonality Tests (Kruskal-Wallis and Seasonal Kendall)

Seasonality Tests were used to assess the potential impact of seasonality on groundwater quality, starting with the previously identified trends in groundwater quality. If results were substantially seasonal, it may indicate a need to adjust for seasonality broadly on all statistics. The results of Seasonality testing are summarized on Table 6.8b, and showed that only a small subset had statistically significant seasonality. Due to the limited impact of seasonality, it was determined that broader testing was unwarranted.

Seasonality Testing using the Kruskal-Wallis Test was performed for all well and analyte pairs that had statistically significant increasing slope values. Each pair was tested, and if found to be statistically significant, was further tested with a Seasonal Kendall to determine if the deseasonalized results still indicated a statistically significant trend. Seasonality testing was based on 2 seasonal periods with starting dates of April 1st and October 1st based on review of the data in Fig 3-12.

APPENDIX G.2

Time-Series Plots



Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.1
Time-Series Plots of Vinyl Chloride

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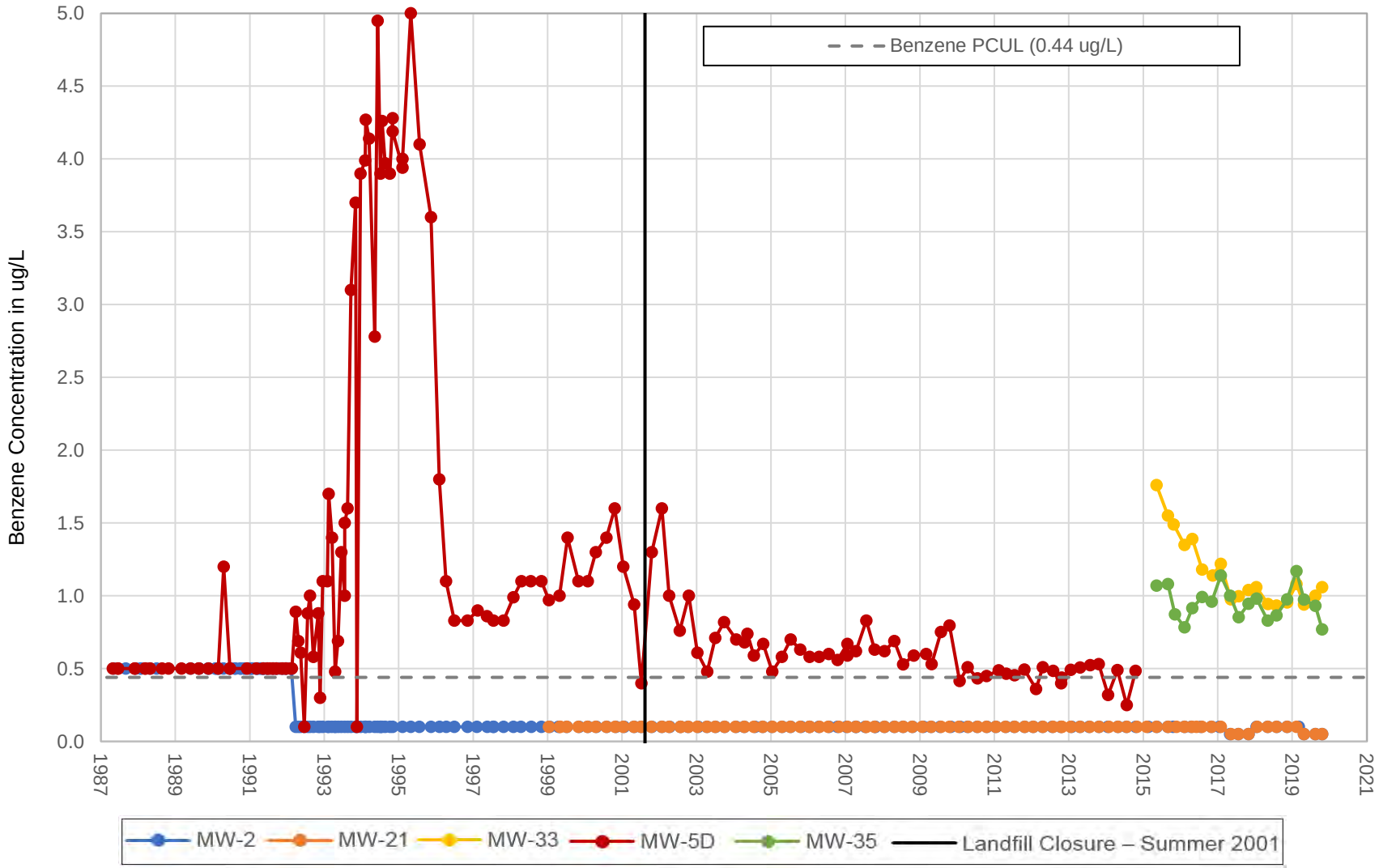

Notes:

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Figure G.2
Time-Series Plots of Benzene

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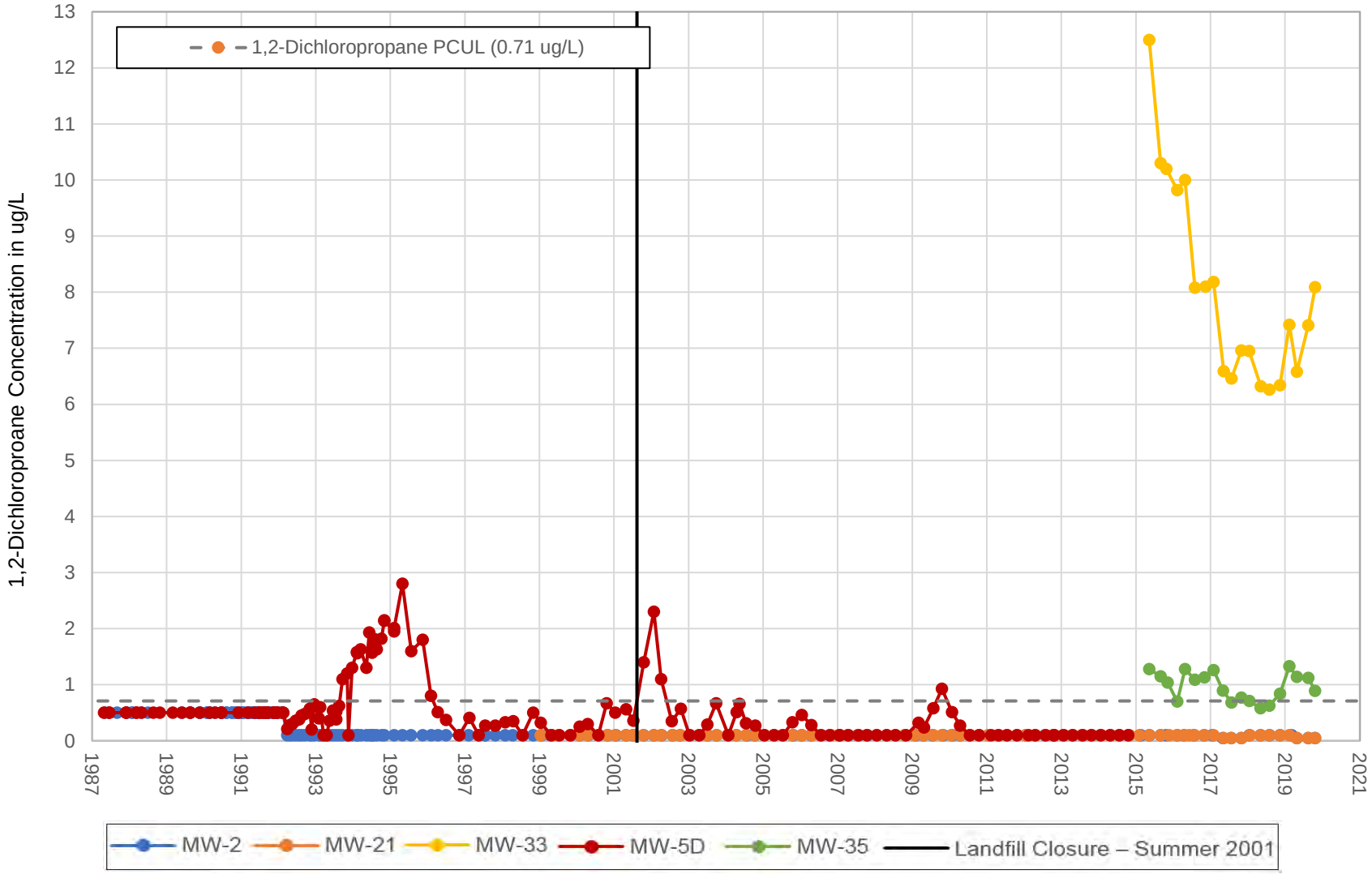

Notes:

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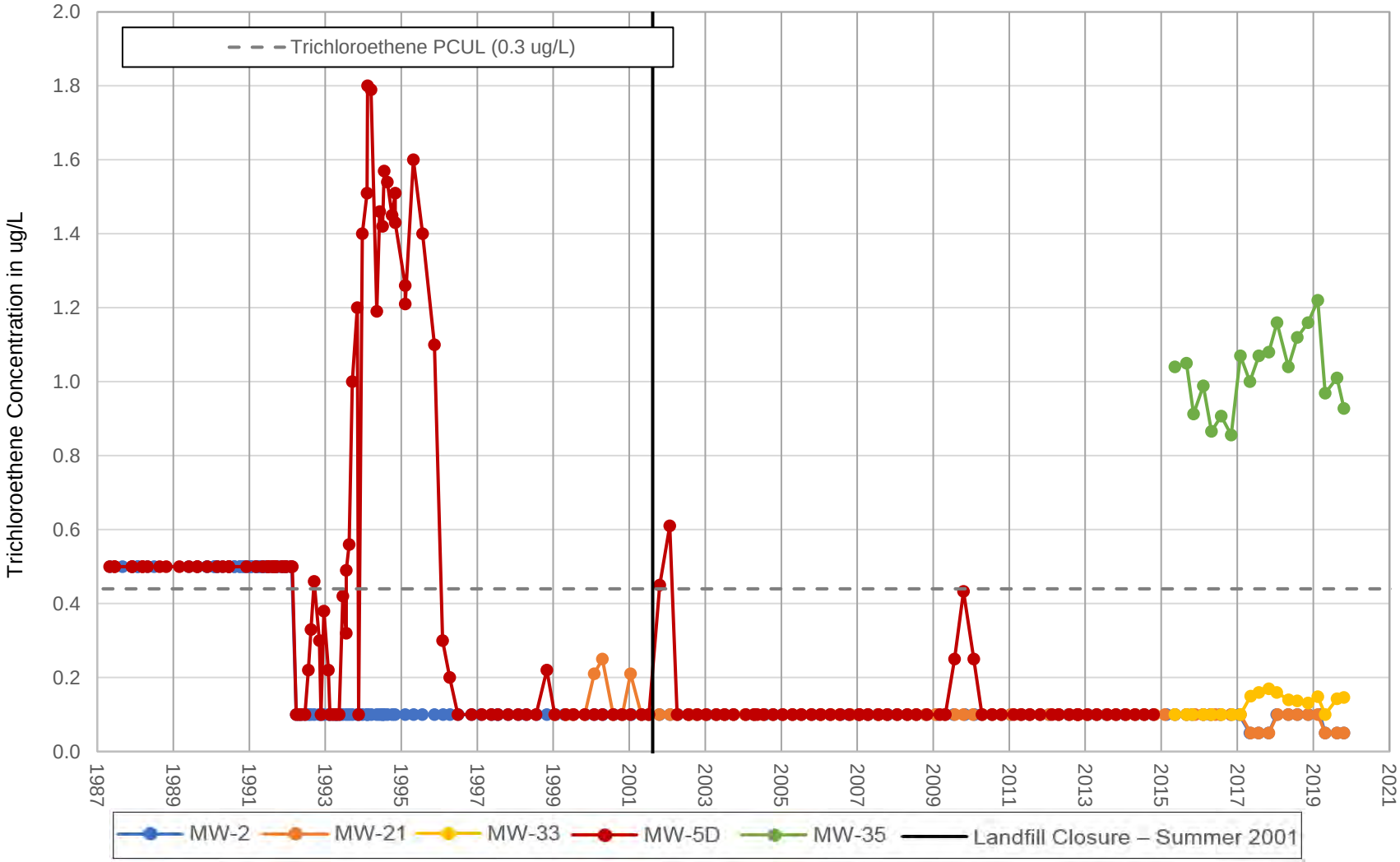
Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.3
Time-Series Plots of 1,2-Dichloroproane



Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.4
Time-Series Plots of Trichloroethene

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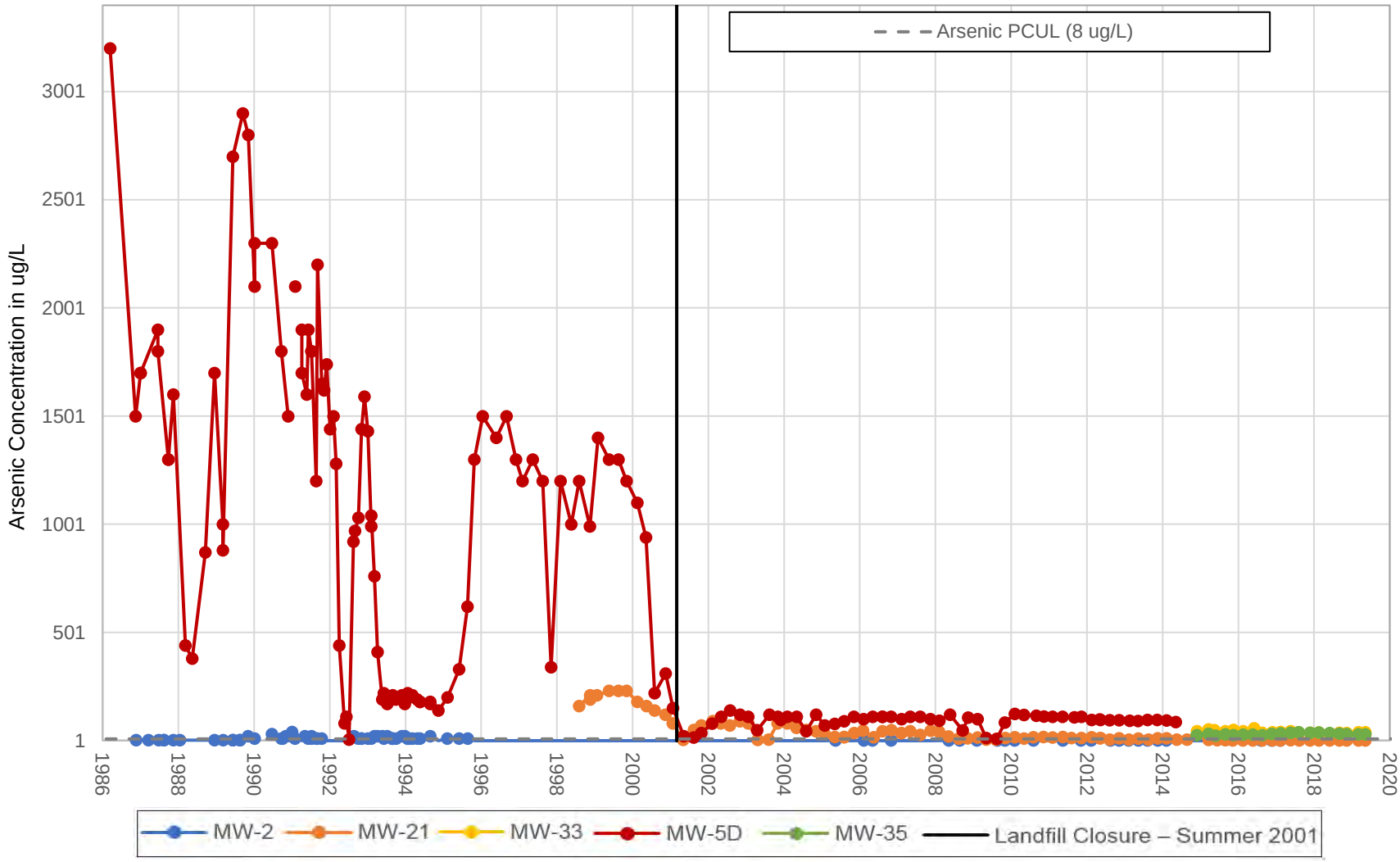

Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.5
Time-Series Plots of Dissolved Arsenic

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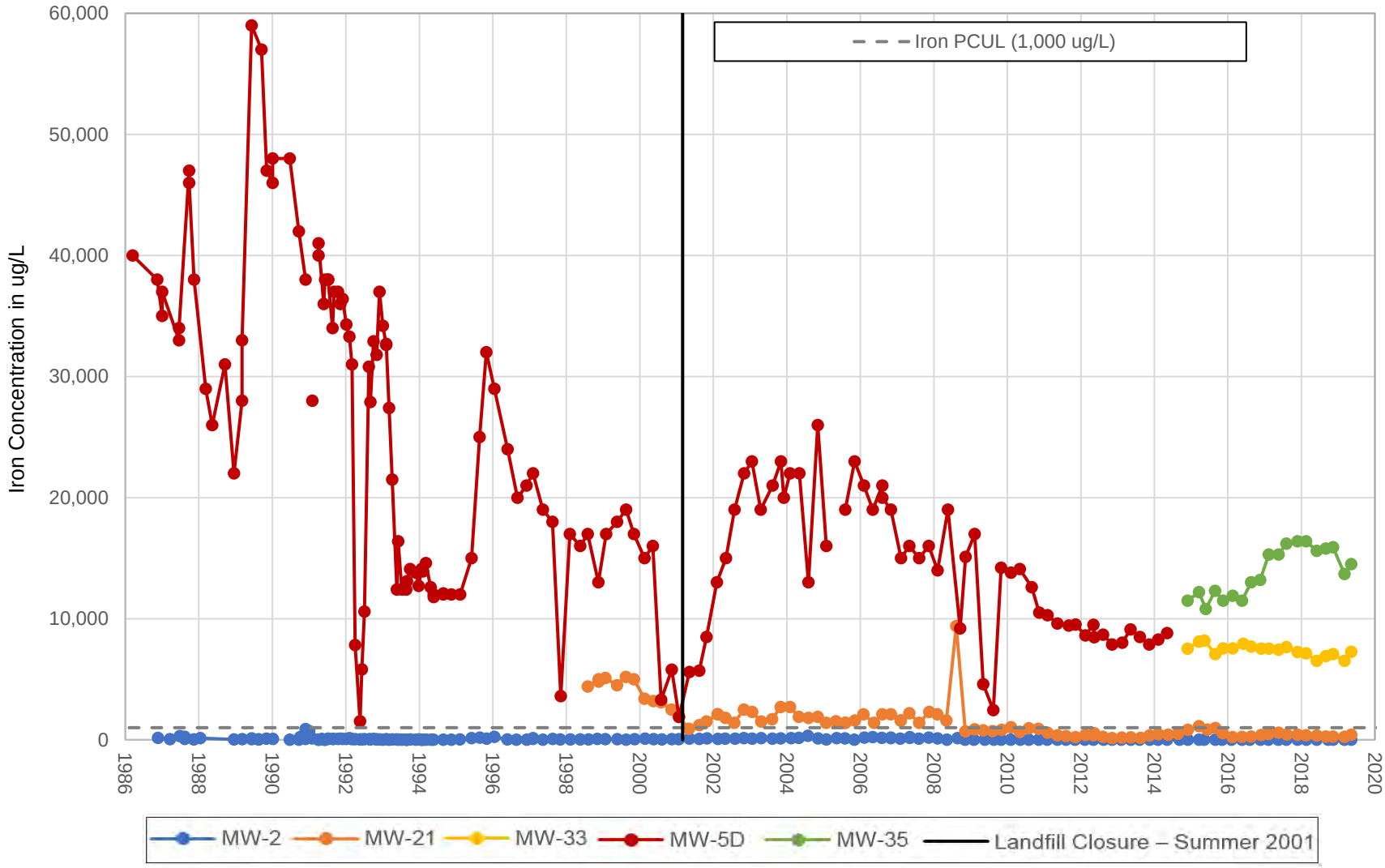

Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.6
Time-Series Plots of Dissolved Iron

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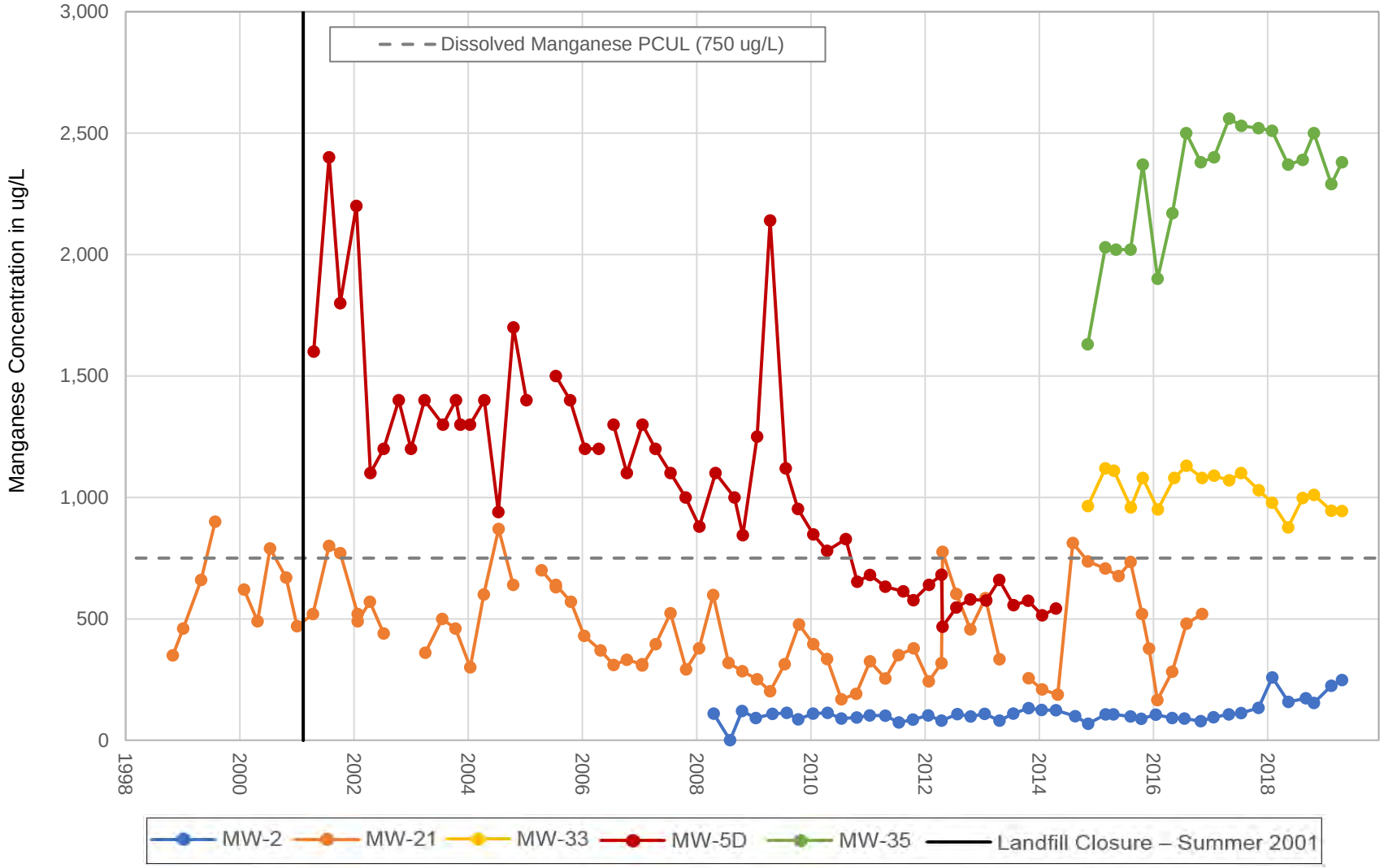

Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.7

Time-Series Plots of Dissolved Manganese

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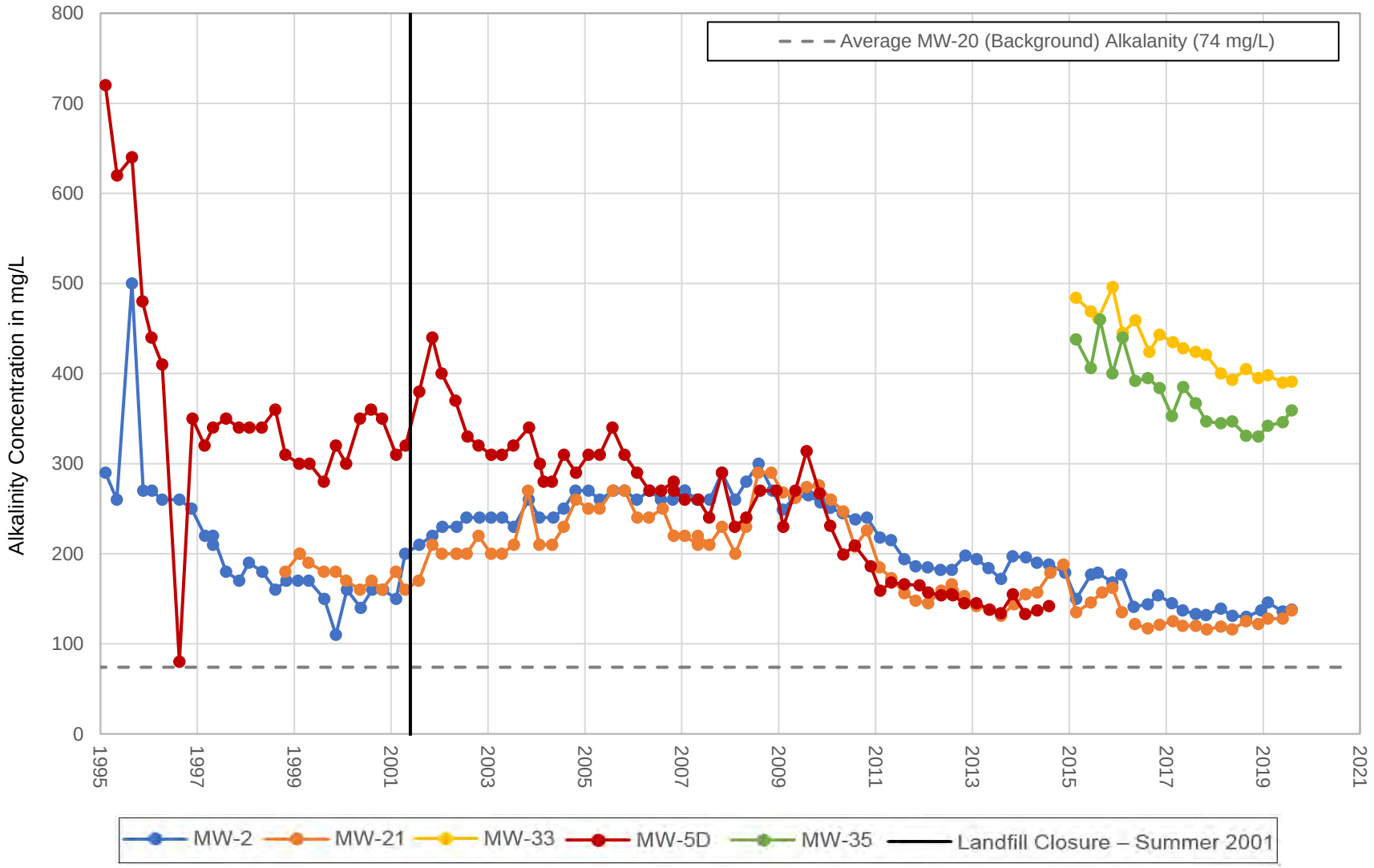

Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.8
Time-Series Plots of Alkalinity

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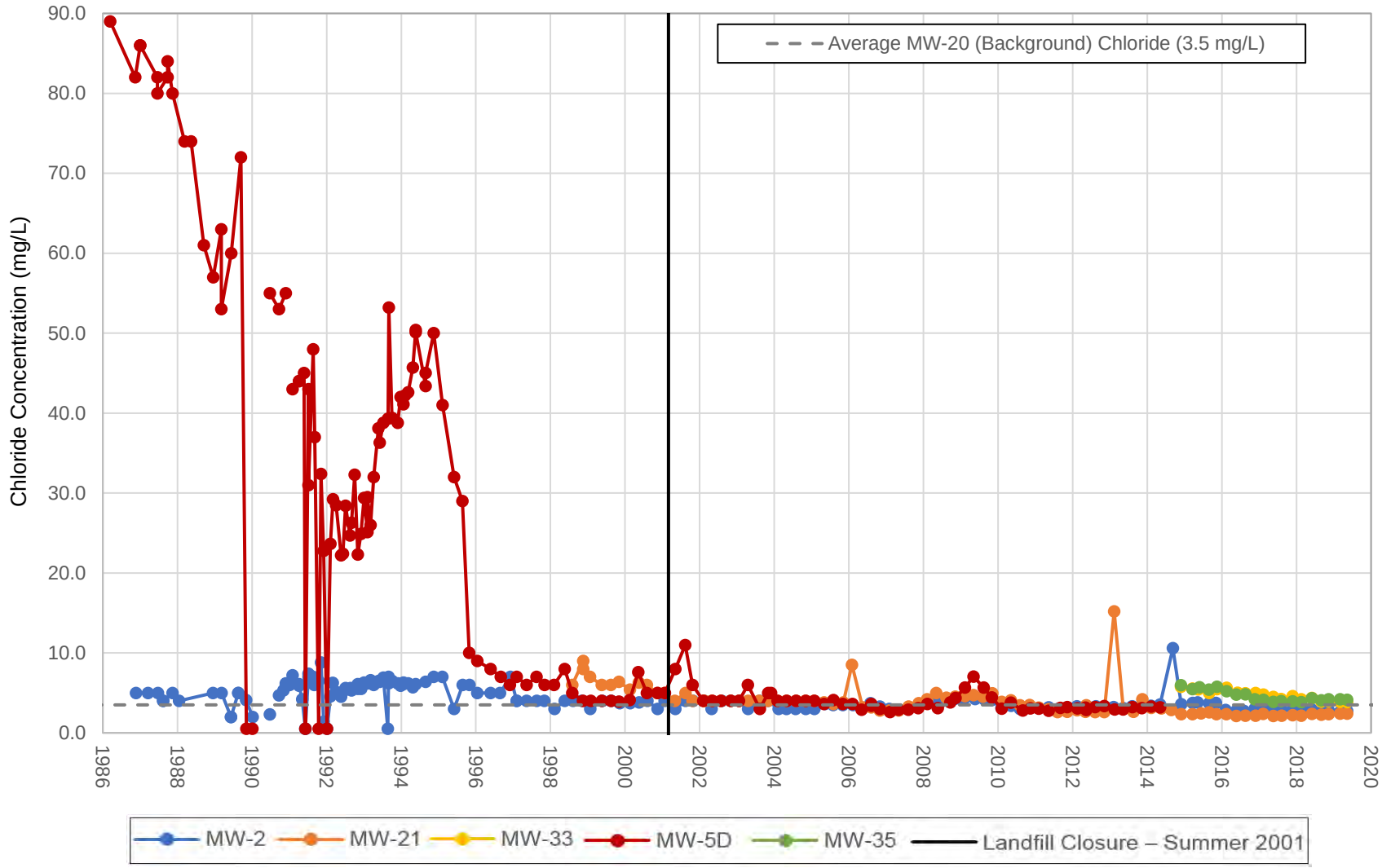

Notes:

PCUL = Preliminary Cleanup Levels

Only Unit C wells with COC concentrations exceeding screening levels in past 10 years are illustrated.

Non-detect data are shown as one half the detection limit.

Figure G.9
Time-Series Plots of Chloride

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