C.2 UPPER CHINLE NON-MIXING ZONE TREND ANALYSIS

Sulfate concentration changes with time in water sampled from the Upper Chinle non-mixing zone wells are plotted on Figure C.2-1. Time trends are fairly flat except for the initial readings in well CW40. This change with time in sulfate concentration is due to the injection of fresh water into well CW13, and the decrease in sulfate concentration reflects the lower concentrations in the San Andres aquifer injection-water source. The data from well CW40 were not used in the background analysis because of the observed impacts of this injection. Upper Chinle well CW3 has been pumped continuously in 2002 and 2003, which has drawn some mixing zone water into the vicinity of the well. Sample data collected in 2002 and 2003 for well CW3 was therefore not used in the background concentration calculation.

Figure C.2-2 presents time plots of TDS concentrations for water sampled from Upper Chinle wells located in the non-mixing zone. The TDS concentrations in these wells have been fairly steady with time and vary over a fairly narrow band. TDS concentrations naturally increase in the Upper Chinle in the non-mixing zone east of the East Fault, and therefore a larger natural range of values would result from inclusion of data taken from these wells. However, these wells farther east of the East Fault were excluded from the background analysis for a variety of reasons.

Chloride concentrations in water from wells located in the non-mixing zone of the Upper Chinle aquifer are presented in Figure C.2-3. An overall steady decline in the chloride concentrations in well 931 water has been observed. This Upper Chinle well is located east of the East Fault in the area of transition from the high transmissivity zone near the fault to the much lower transmissivity zone farther away from the fault. Chloride concentrations in the Upper Chinle aquifer naturally increase as distance east of the East fault increases. These data indicate that the zone of naturally greater chloride concentrations east of the East Fault is gradually shifting even farther to the east. Concentrations at well 931 reflect this trend and are thought to be naturally occurring. Chloride concentrations in water collected from Upper Chinle well CW40 increased after

injection of San Andres aquifer water into well CW13 started in late 1996. The increase of concentrations in well CW40 water is attributable to the fresh-water injection into well CW13, and therefore data from this well were not used in the background water-quality statistical analysis. Figure C.2-4 presents time plots of uranium concentrations in the Upper Chinle wells in the non-mixing zone. The uranium data collected in 2002 and 2003 from well CW3 were not used in the background calculations because of the pumping impacts described earlier. One seemingly anomalous larger value of uranium concentration was observed in well 934, but it was not excluded from background analysis based on the statistical tests. Uranium concentrations in Upper Chinle well CW18 have gradually decreased since 1996, but this change is well within the natural range of variation.

Selenium concentrations in water from the Upper Chinle wells situated in the non-mixing zone are presented in Figure C.2-5. The selenium data acquired in 2002 and 2003 for well CW3 were not used in the background analysis. A significant decreasing trend was observed in monitoring well CW40. Like other constituents, this decrease in selenium concentration, beginning in 1997, reflects the migration of San Andres injection water into this area. Therefore, data from well CW40 were not used in the background calculations.

Time plots of molybdenum concentrations for the Upper Chinle wells in the non-mixing zone are presented in Figure C.2-6. All of the molybdenum concentrations are small except for one value from well 931 and one value from well 934. Statistical analysis does not indicate that these two data values were outliers and therefore were not removed.

Figure C.2-7 presents plots of nitrate concentration versus time for Upper Chinle wells in the non-mixing zone. This plot shows that low nitrate concentrations exist in the Upper Chinle wells in the non-mixing zone.

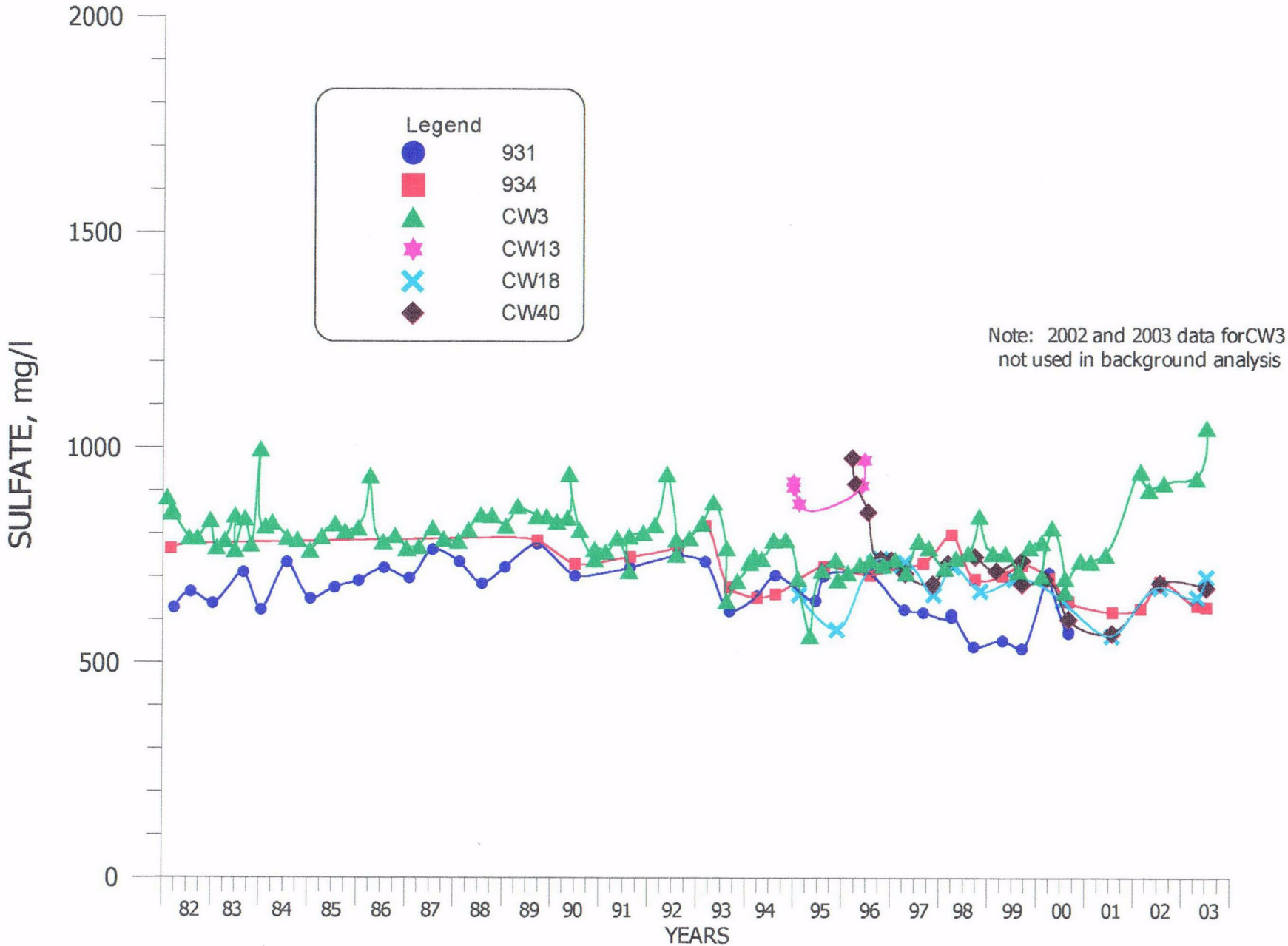

FIGURE C.2-1. SULFATE CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

C01

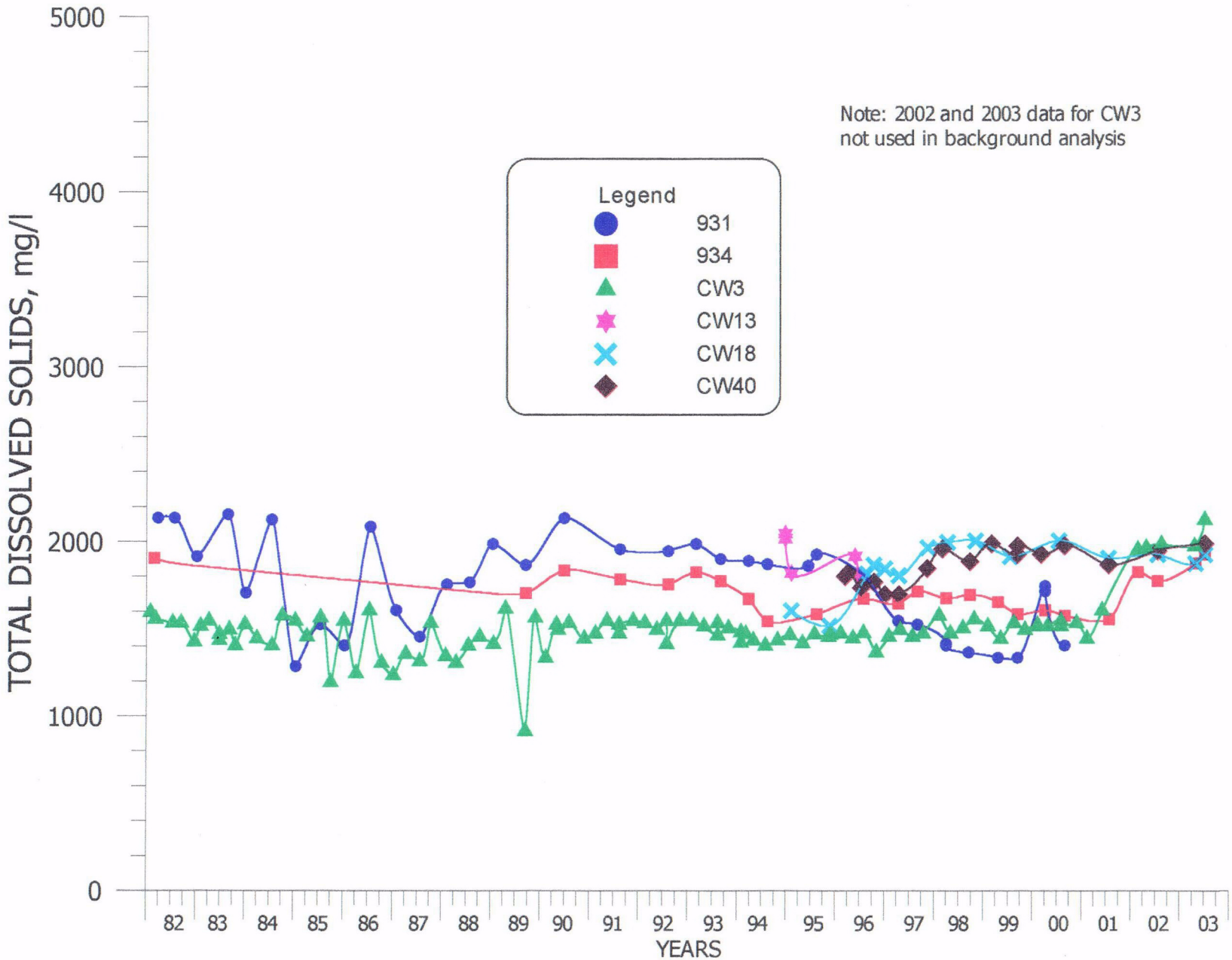

FIGURE C.2-2. TDS CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

C02

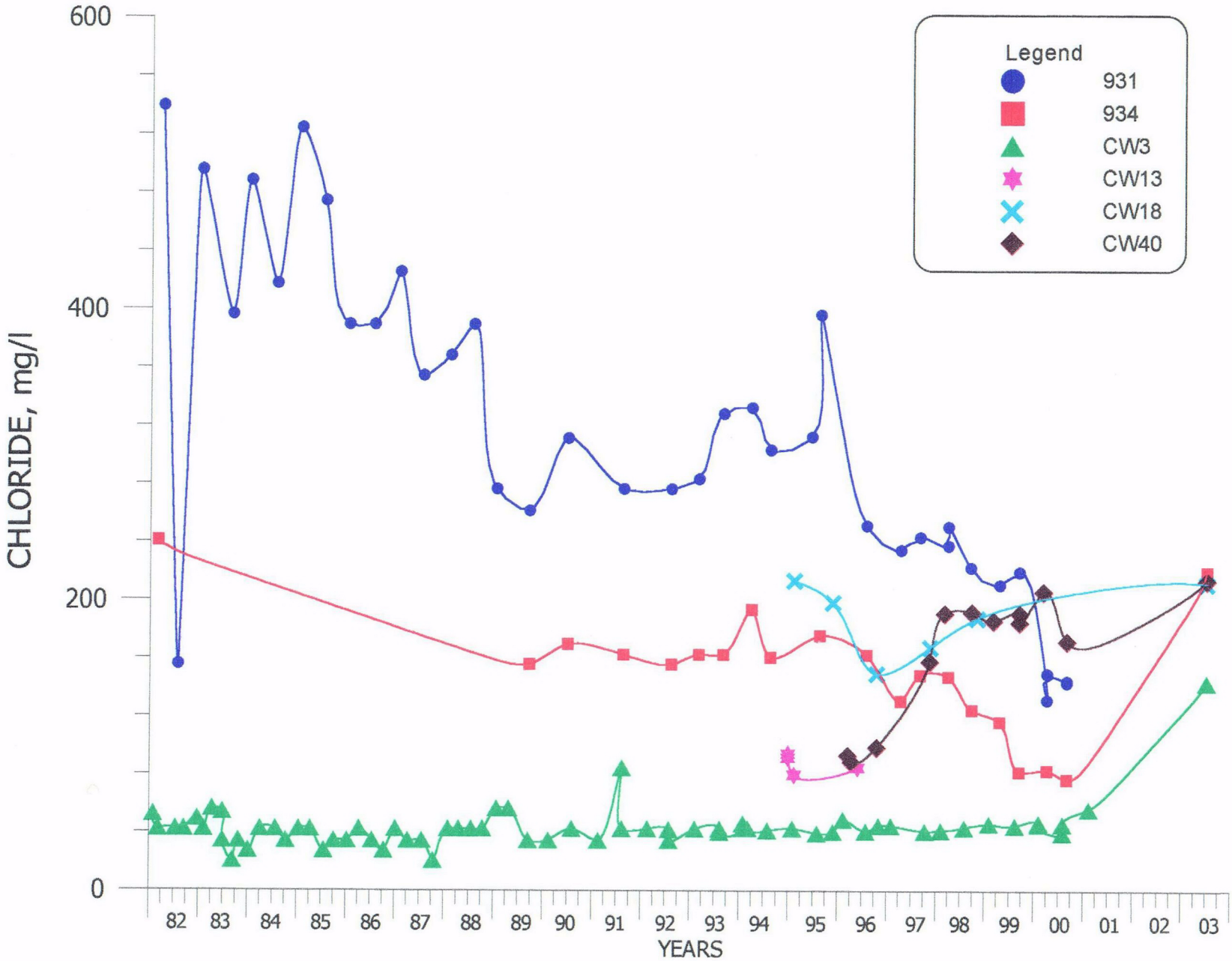

FIGURE C.2-3. CHLORIDE CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

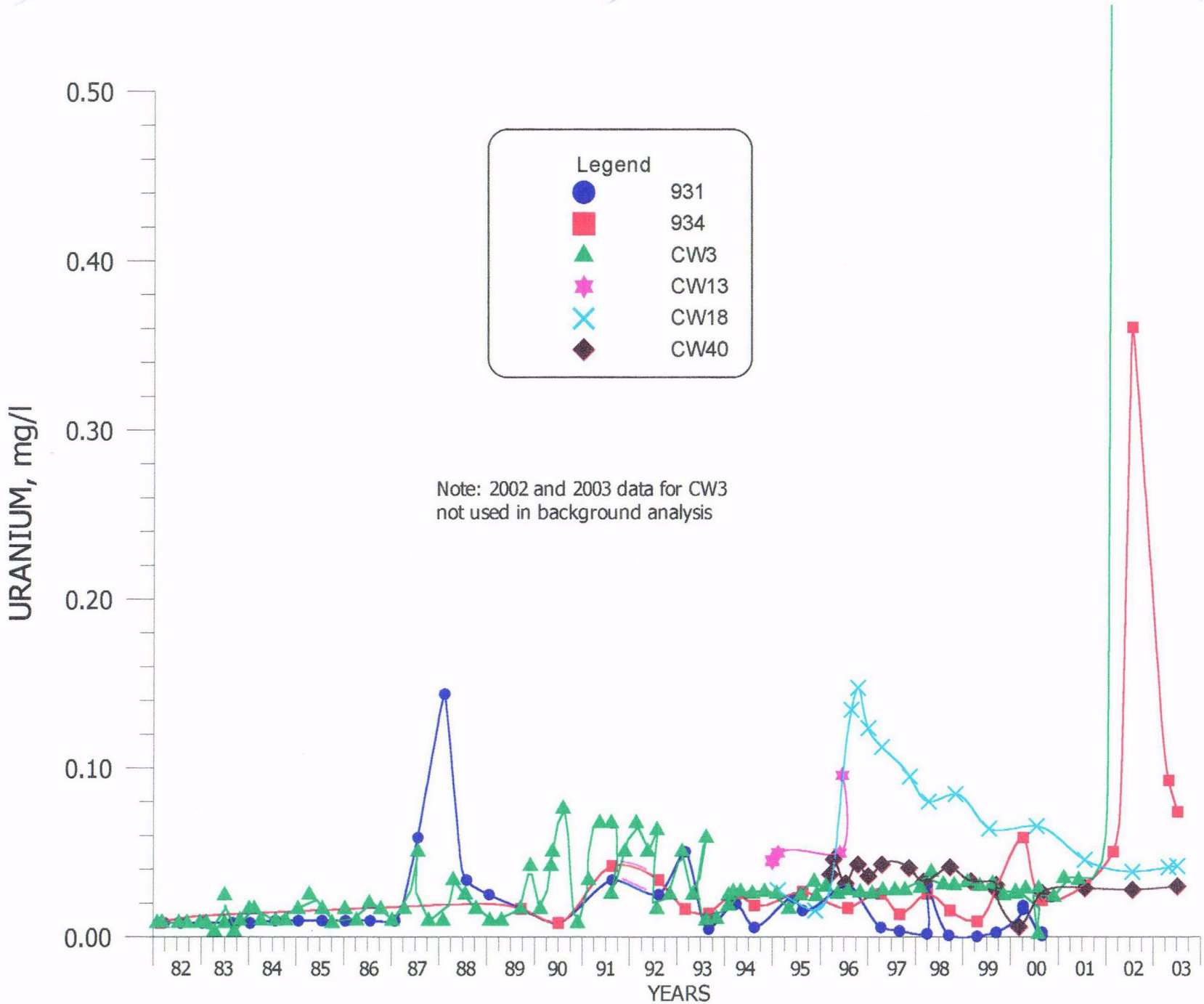

FIGURE C.2-4. URANIUM CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

C04

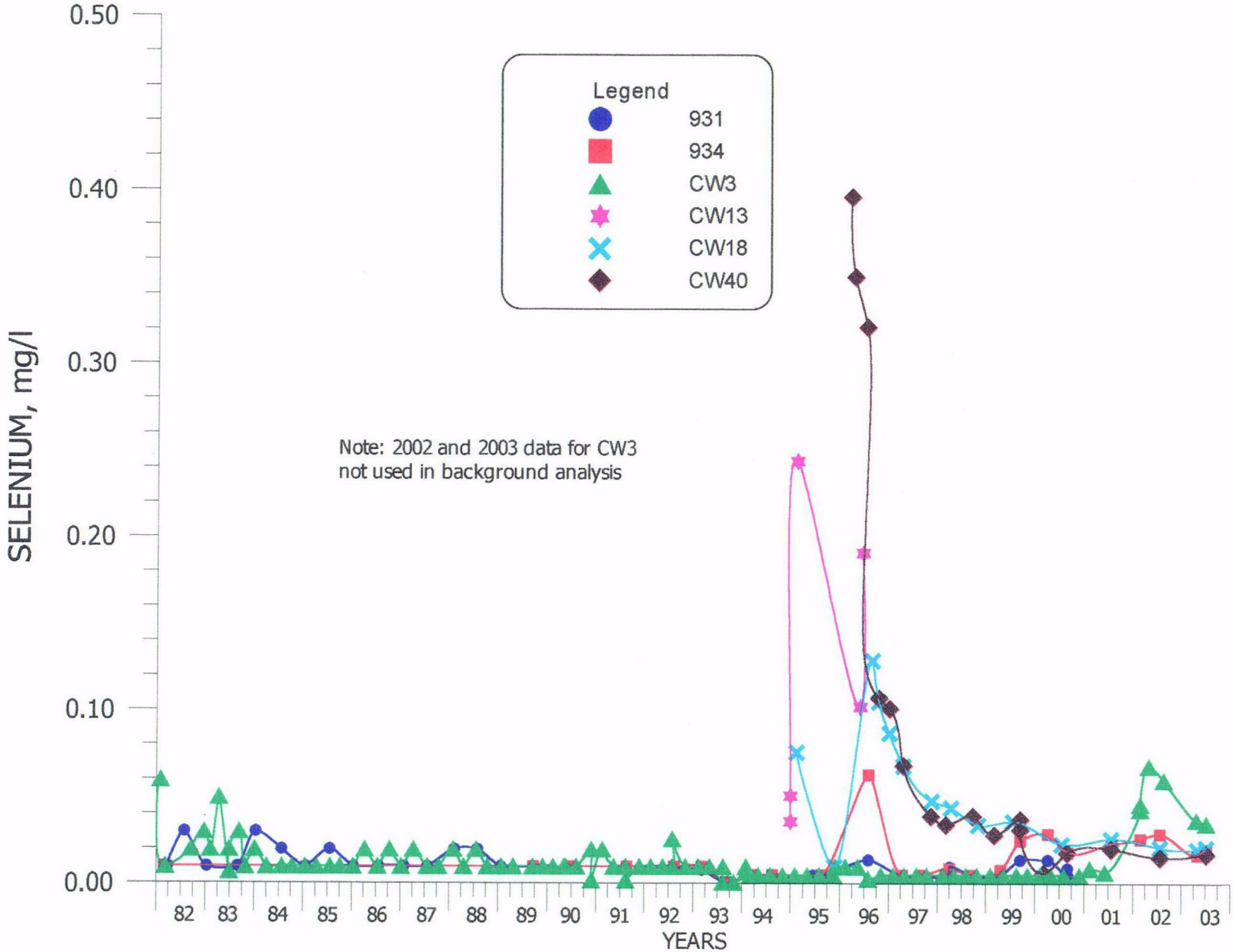

FIGURE C.2-5. SELENIUM CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

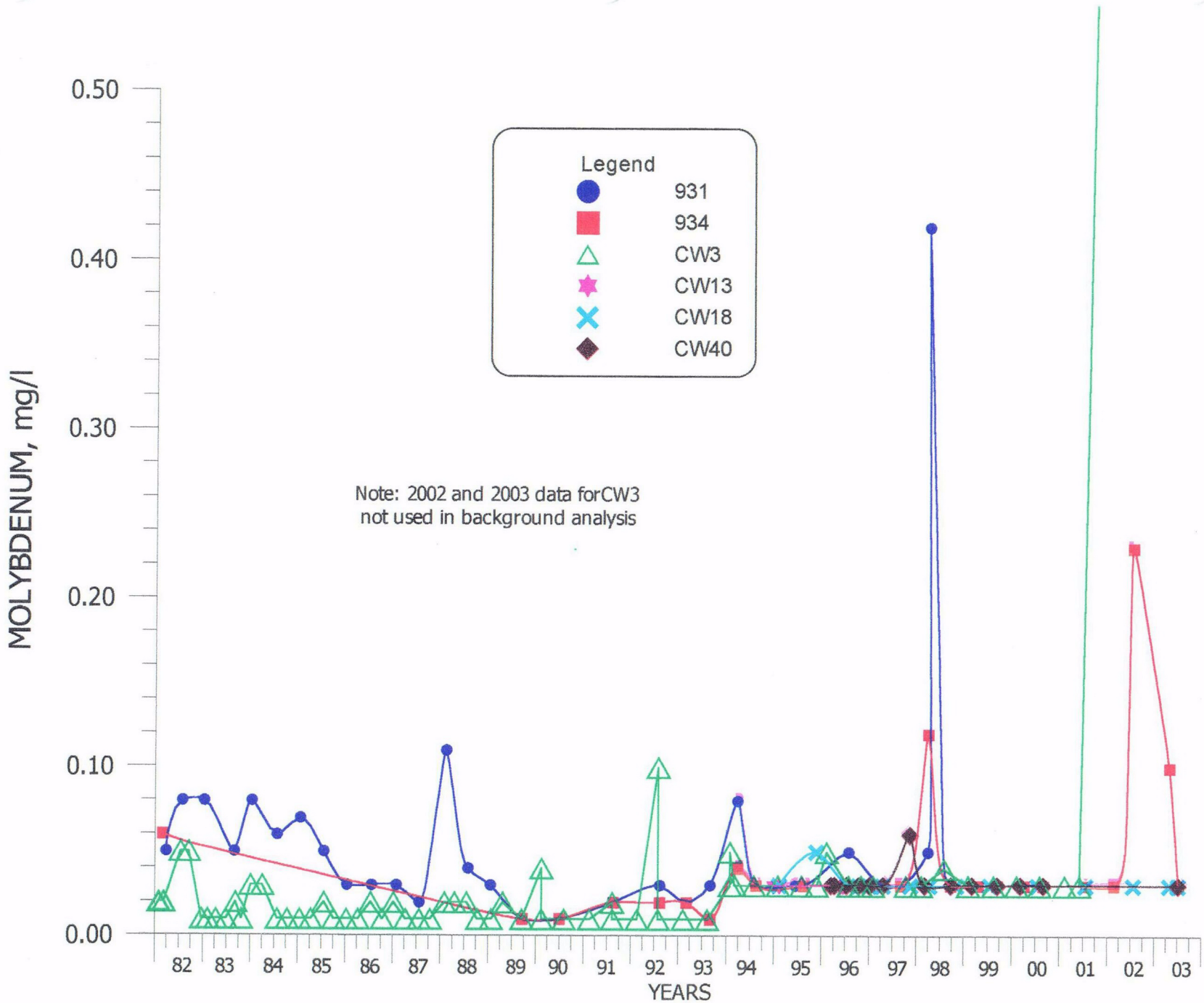

FIGURE C.2-6. MOLYBDENUM CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

COG

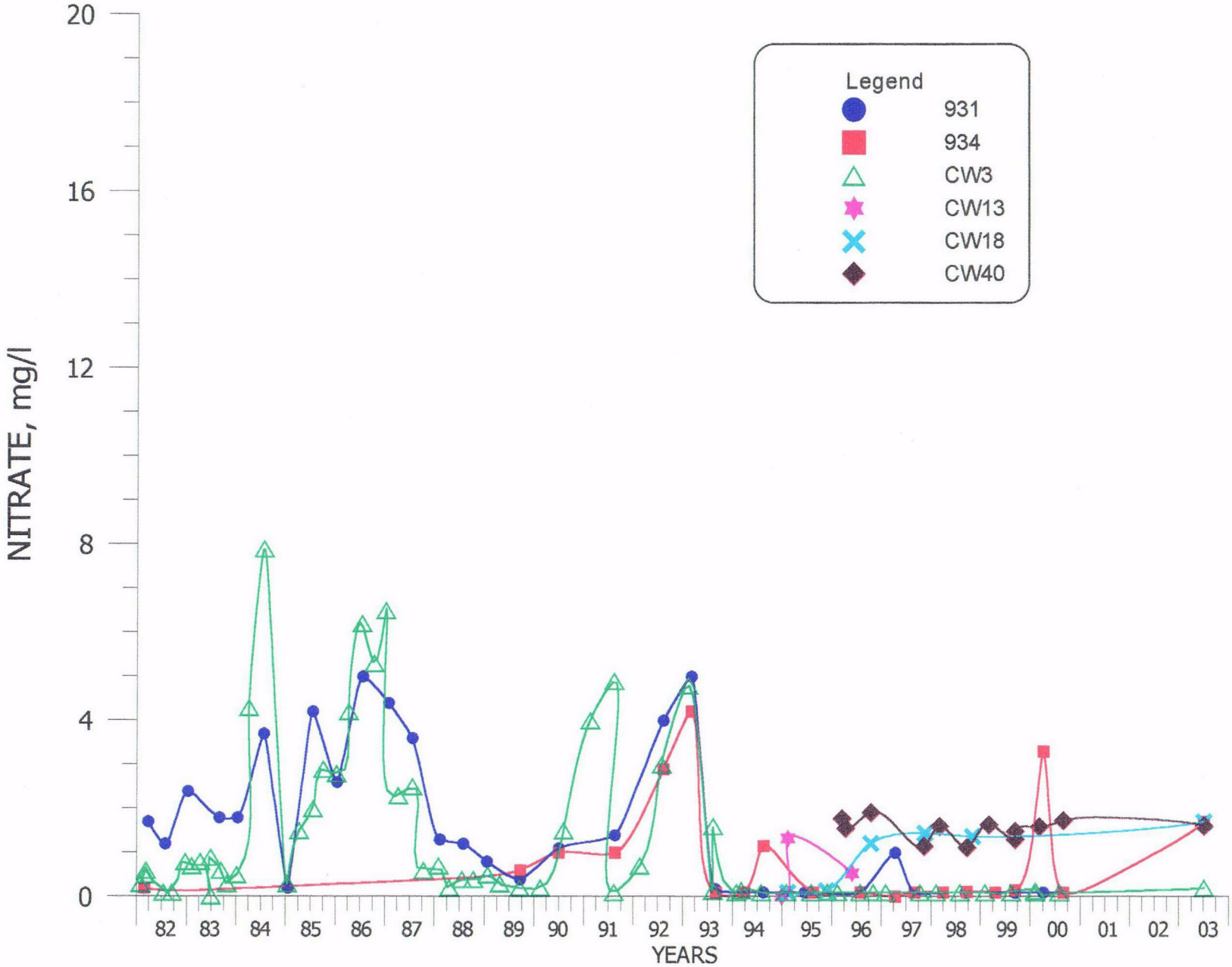

FIGURE C.2-7. NITRATE CONCENTRATIONS FOR UPPER CHINLE WELLS 931, 934, CW3, CW13, CW18 AND CW40 IN UPPER CHINLE NON-MIXING ZONE.

C07

C.3 MIDDLE CHINLE NON-MIXING ZONE TREND ANALYSIS

Examination of Figure C.3-1 reveals no significant time trends in sulfate concentrations for water collected from Middle Chinle non-mixing zone wells, with the exception of a small decrease in well CW1. This small change is thought to be of natural origin. The sulfate concentrations in Middle Chinle well CW2 have varied somewhat with time, but with no long-term consistent trend. No consistent trends have been observed in wells ACW, CW28 or WCW.

TDS concentrations in water in the Middle Chinle wells in the non-mixing zone are shown as time plots on Figure C.3-2. The changes in concentrations with time do not exhibit a consistent trend. A greater range of variation was observed in well ACW data, but the fluctuations are well within the expected range for the unimpacted portions of the Middle Chinle aquifer. Statistical evaluation identified two outliers which are noted on Figure C.3-2.

Chloride concentrations in the non-mixing zone in the Middle Chinle aquifer are presented in Figure C.3-3. A very gradual overall increase in chloride concentration was observed in Middle Chinle well WCW, but this small change in chloride concentration is well within the natural range of variation in the Middle Chinle aquifer. The statistical analysis identified outliers in the data sets of wells ACW and CW28.

Figure C.3-4 presents the uranium concentration trend analysis for the Middle Chinle non-mixing zone wells. This plot shows some variation in uranium concentration with time. Uranium concentrations in wells CW1 and CW2, north of the Large Tailings pile, have varied up to roughly 0.1 mg/l of uranium. Similar uranium concentration variations have been observed east of the East Fault in Middle Chinle well CW28. These small concentrations in Middle Chinle well CW28 could possibly be a result of impact by the alluvial aquifer south of well CW28. However, uranium concentrations in well CW28 are within the natural range for the Middle Chinle aquifer and are therefore included in the background analysis.

Selenium concentrations in water collected from Middle Chinle wells in the non-mixing zone are presented in Figure C.3-5. Review of this figure shows that the majority of the Middle Chinle wells in the non-mixing zone contain water with very low selenium concentrations. Concentrations in water from Middle Chinle wells CW14 and CW28 are slightly higher but are well within the range of observed selenium concentrations in the unimpacted portions of the Chinle aquifers. Because these concentrations fall within the natural range, and because of the consistent level of other constituents in these wells, this data is judged to be useful in defining the natural background selenium concentrations in the non-mixing zone.

Figure C.3-6 presents plots of molybdenum concentrations in water from the Middle Chinle non-mixing zone wells. The majority of the measurements for the Middle Chinle wells are less than the laboratory detection limit. For these measurements, the absolute value of the detection limit is presented on Figure C.3-6. All of the molybdenum concentrations are thought to be naturally occurring.

Nitrate concentrations in water sampled from the Middle Chinle non-mixing zone wells are plotted versus time on Figure C.3-7. Some variation in nitrate concentrations in these wells has been observed with time, but no significant long-term trends have been identified. The observed range of nitrate concentrations is thought to be representative of the natural conditions in the Middle Chinle aquifer in the non-mixing zone. Statistical analysis indicated that ten nitrate values were outliers, and they were subsequently excluded from the background data set.

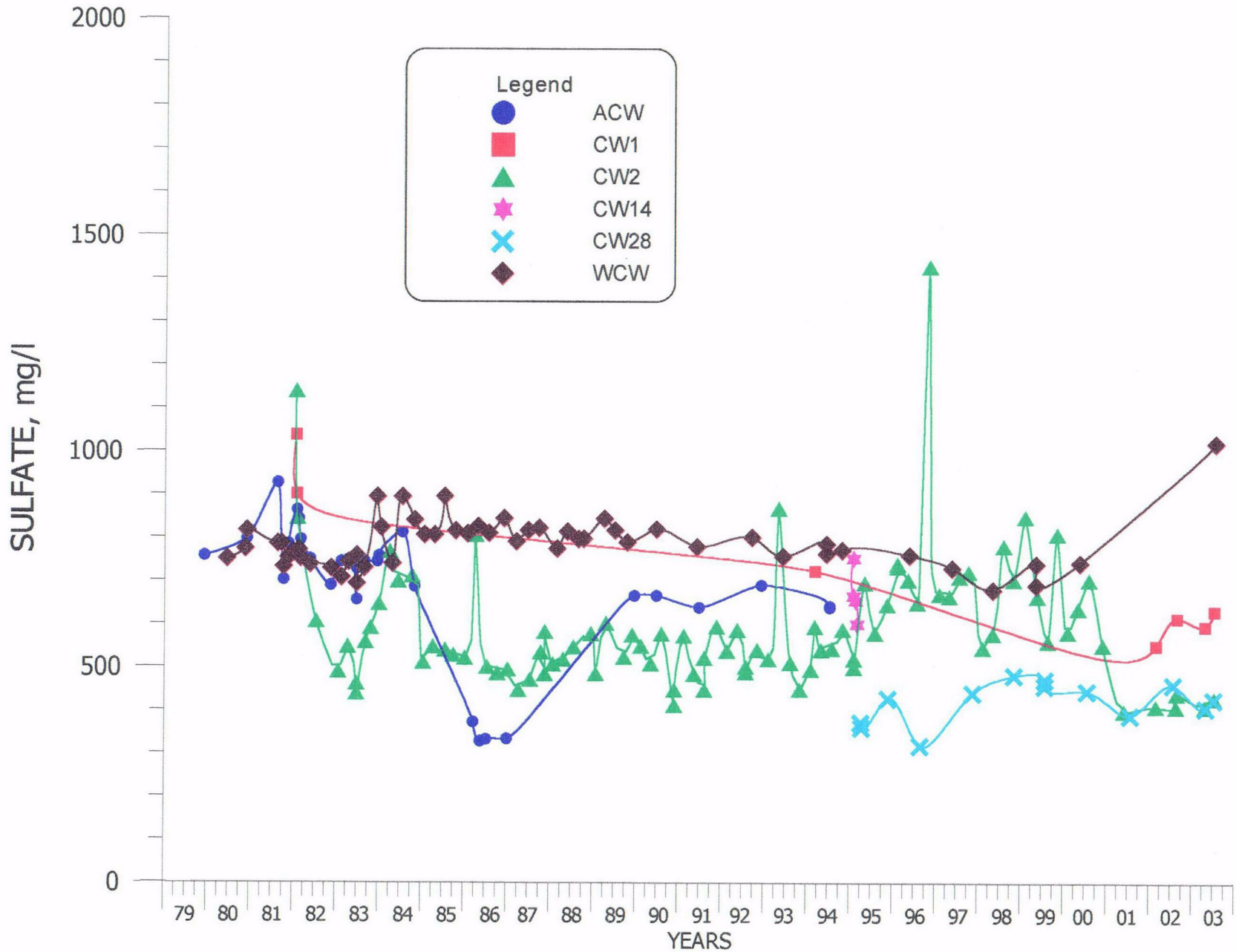

FIGURE C.3-1. SULFATE CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

C08

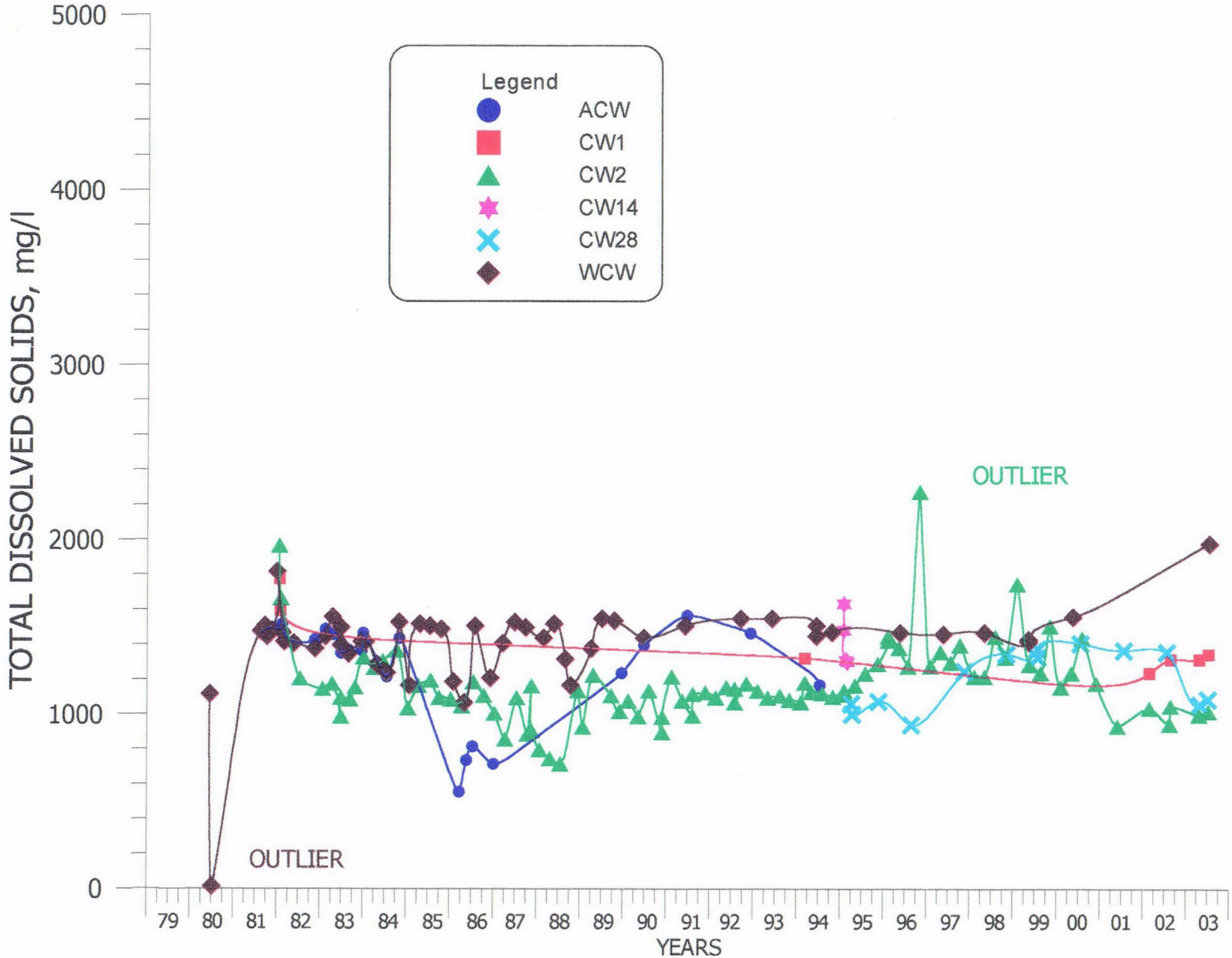

FIGURE C.3-2. TDS CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

C09

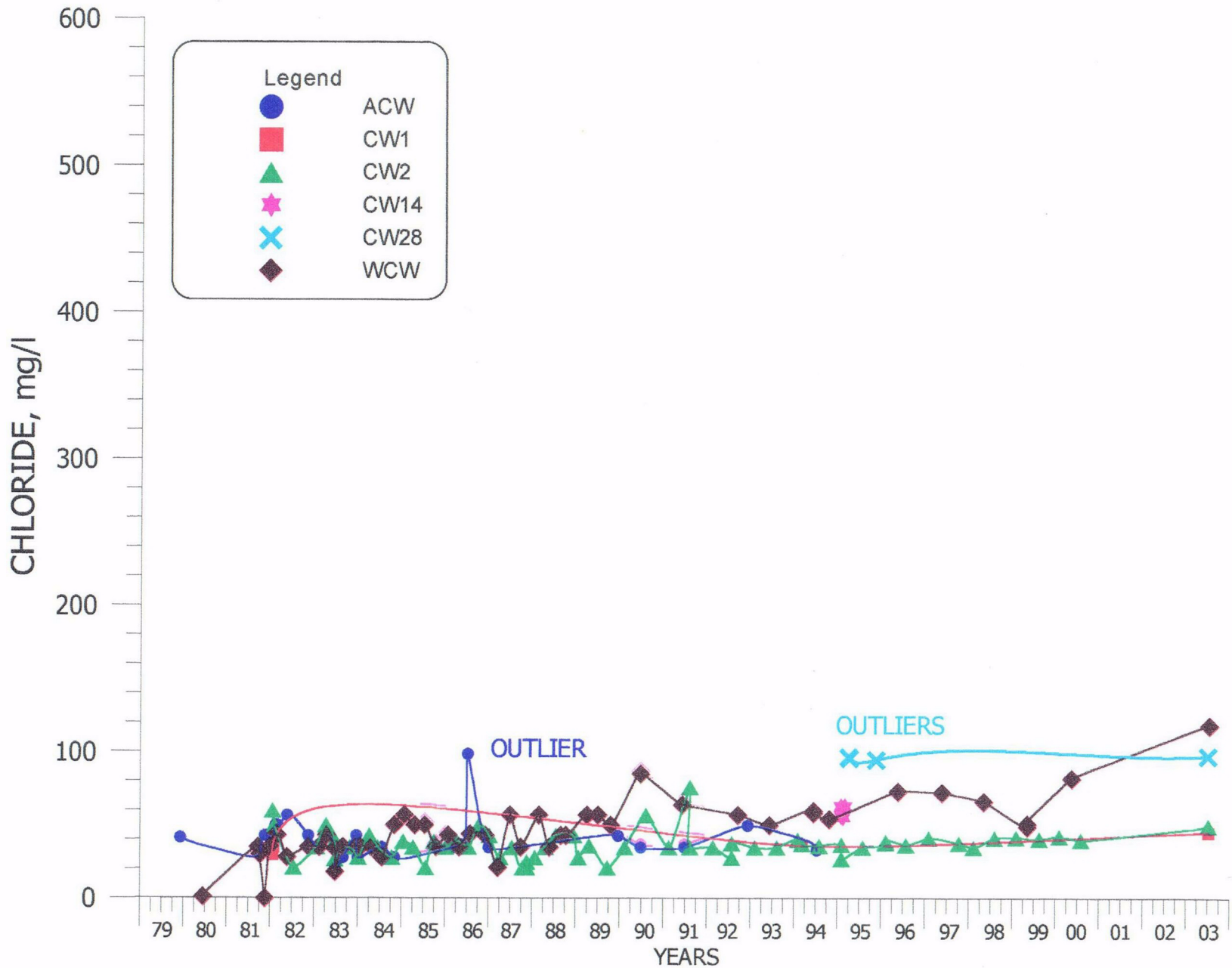

FIGURE C.3-3. CHLORIDE CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

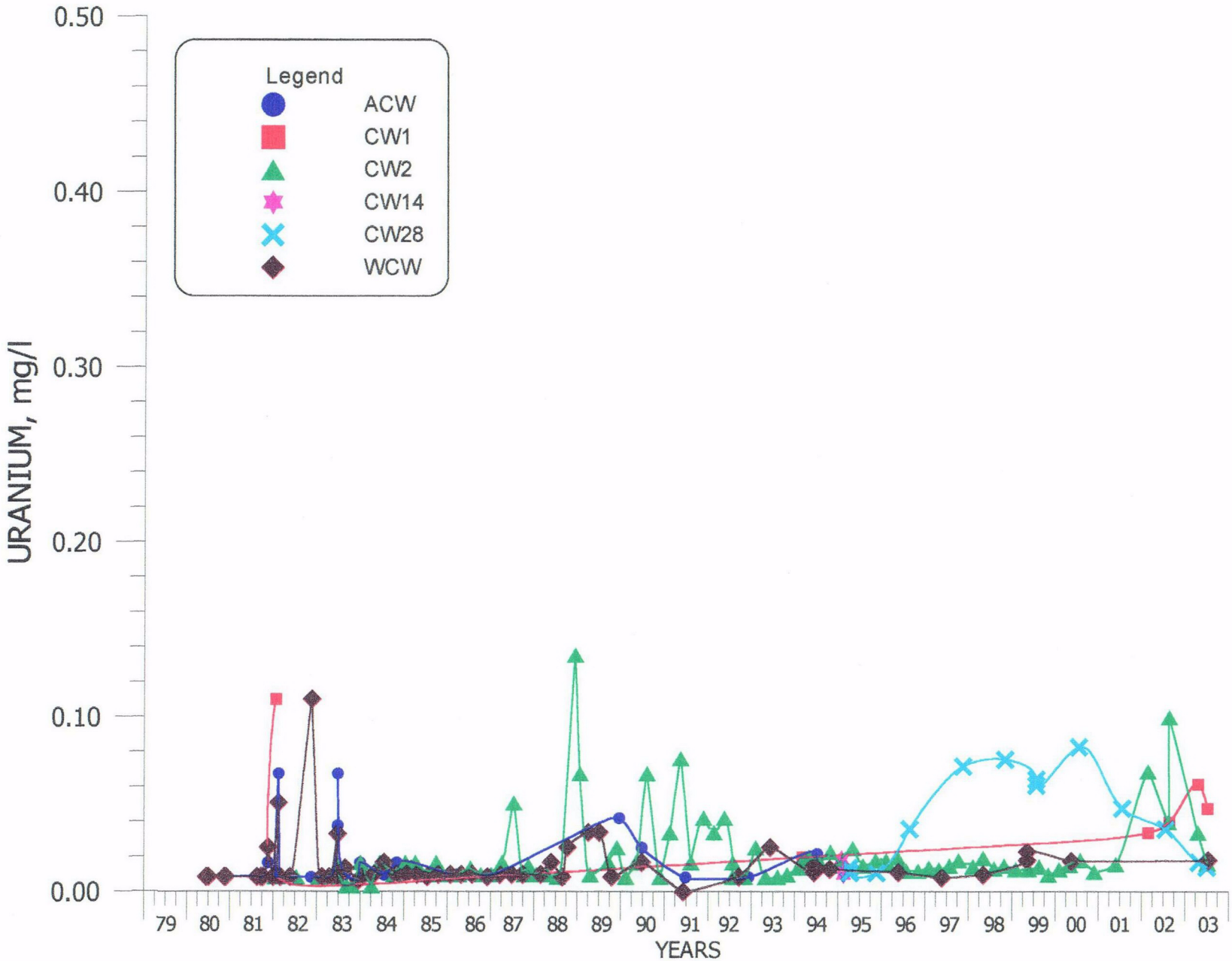

FIGURE C.3-4. URANIUM CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

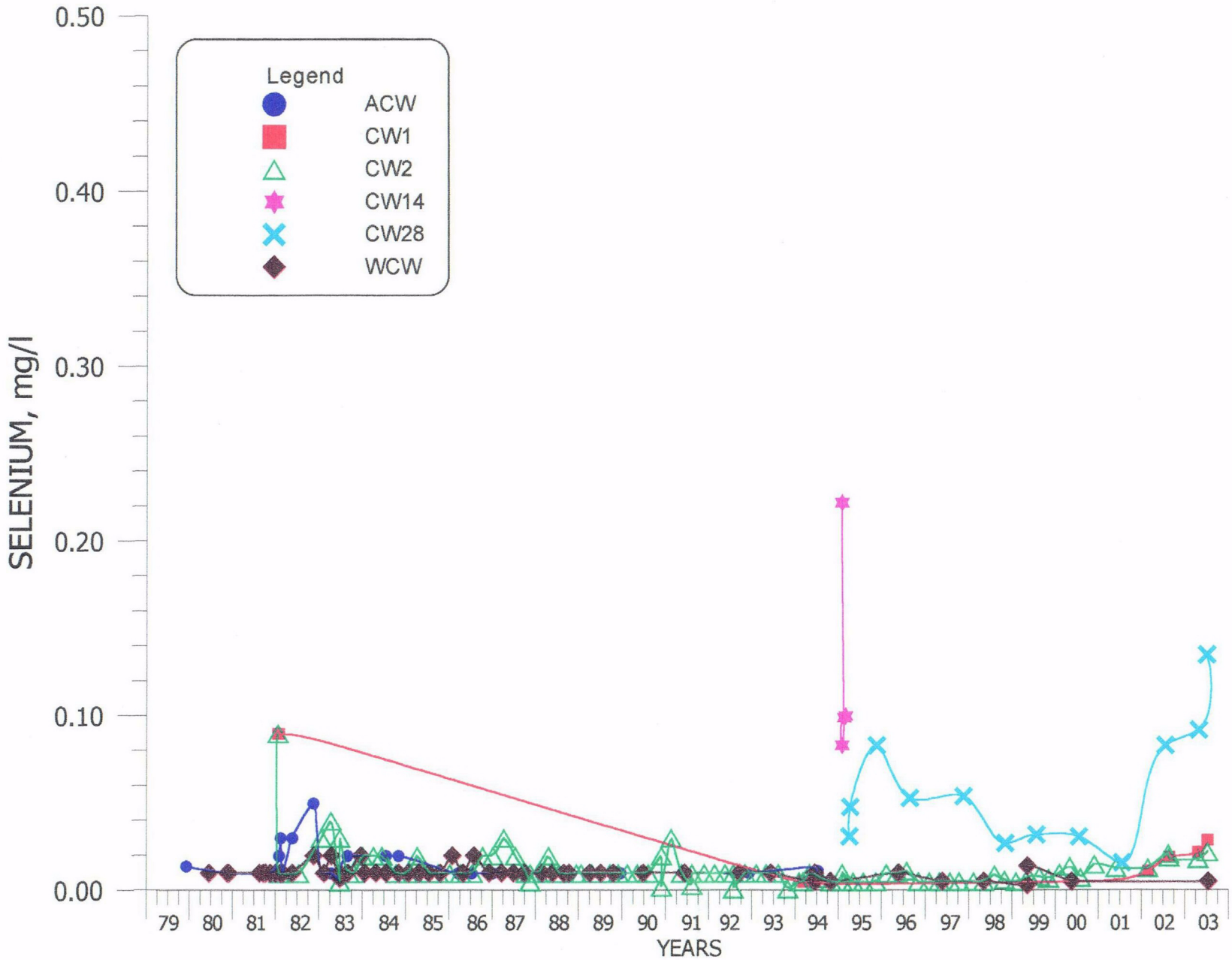

FIGURE C.3-5. SELENIUM CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

C12

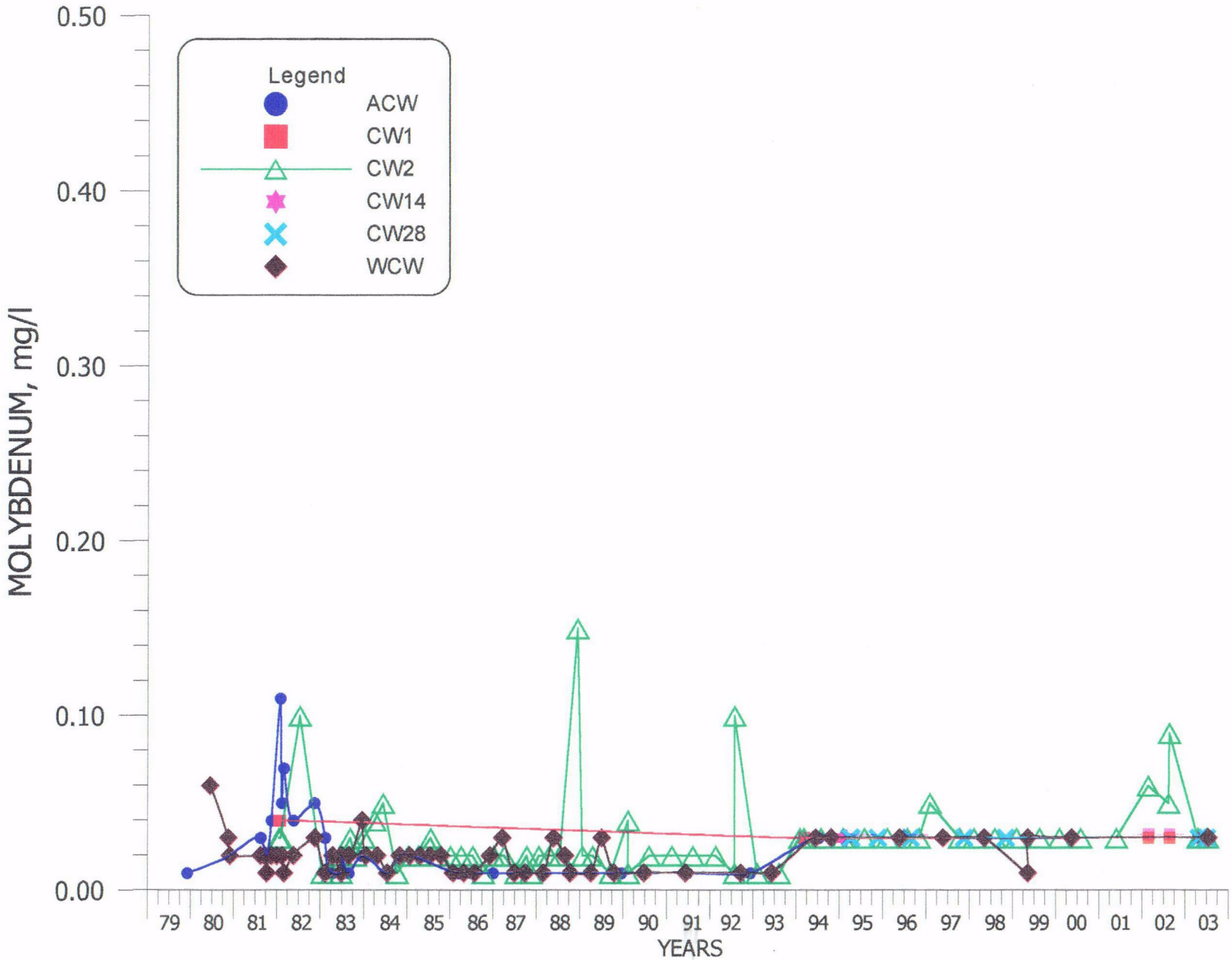

FIGURE C.3-6. MOLYBDENUM CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE.

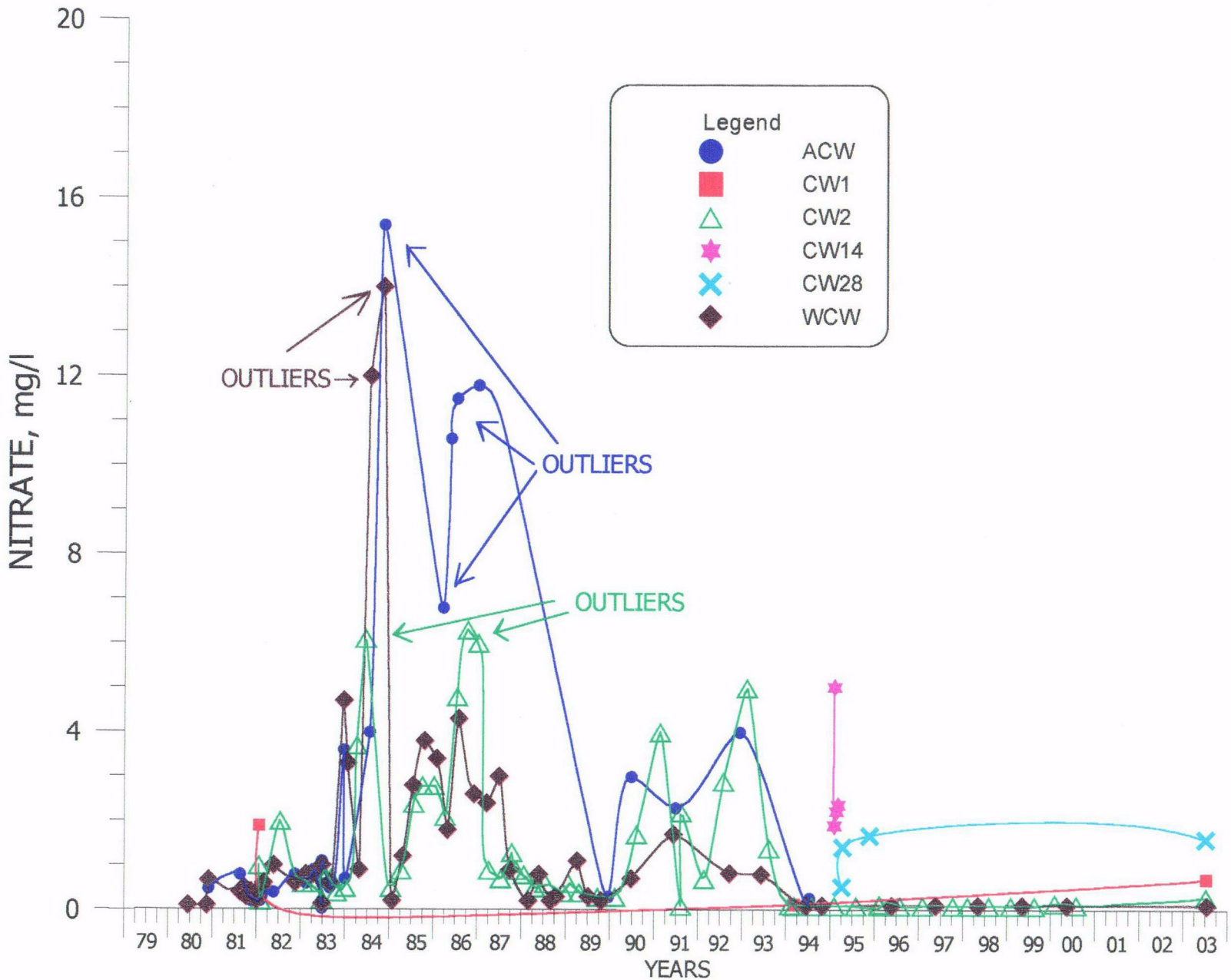

FIGURE C.3-7. NITRATE CONCENTRATIONS FOR MIDDLE CHINLE WELLS ACW, CW1, CW2, CW14, CW28 AND WCW IN MIDDLE CHINLE NON-MIXING ZONE. C14

C.4 LOWER CHINLE NON-MIXING ZONE TREND ANALYSIS

Sulfate concentrations in water collected from Lower Chinle wells in the non-mixing zone are presented in Figure C.4-1. The first few data points for wells CW31 and CW32 show a significant change with time. This early data may have been influenced by the well-completion process in low permeability material, but the concentrations are within the natural observed range for the Lower Chinle aquifer in this area.

TDS data for the Lower Chinle wells in the non-mixing zone are plotted on Figure C.4-2. Review of this figure indicates that there is some variation with time of TDS concentrations in water from these Lower Chinle wells. Two outliers were removed from the background data set for TDS. Chloride concentrations for the Lower Chinle wells in the non-mixing zone are presented on Figure C.4-3. The range of chloride concentrations in the non-mixing zone of the Lower Chinle is slightly larger than the range for sulfate or TDS concentrations.

Measured uranium concentrations in the Lower Chinle non-mixing zone wells are presented in Figure C.4-4. All of these observed uranium concentrations are small with no significant trend.

Selenium concentrations in water from the Lower Chinle non-mixing zone wells are plotted versus time on Figure C.4-5. Except for the concentrations in samples from well CW26, selenium concentrations are small in the Lower Chinle wells. Selenium concentrations in well CW26 do not show a consistent trend with time but are significantly greater than concentrations in the remainder of the Lower Chinle wells in the non-mixing zone. However, observed selenium concentrations in well CW26 fall within the range of observed natural selenium concentrations in other areas of the Grants Project ground-water system. Other constituents from well CW26 do not indicate contamination from tailings seepage, and therefore the selenium data from well CW26 is judged to be appropriate to use in the background water-quality analysis for

the Lower Chinle aquifer's non-mixing zone. Based on statistical testing, one outlier was removed from the Lower Chinle selenium data set.

Figure C.4-6 presents the limited molybdenum data taken from analyses of water in the Lower Chinle non-mixing zone wells. All molybdenum concentration data is at the detection level except for one outlier value from well CW26.

Nitrate concentrations in water collected from Lower Chinle non-mixing zone wells are presented as time plots on Figure C.4-7. All of these nitrate concentrations are low, and no significant long-term trend in nitrate concentration is discernible. The presence of multiple detection level concentrations during the same sampling cycle has resulted in the overlay of multiple graph symbols at one location on Figure C.4-7. This may obscure data points for some wells, but there are samples for each well listed in the legend.

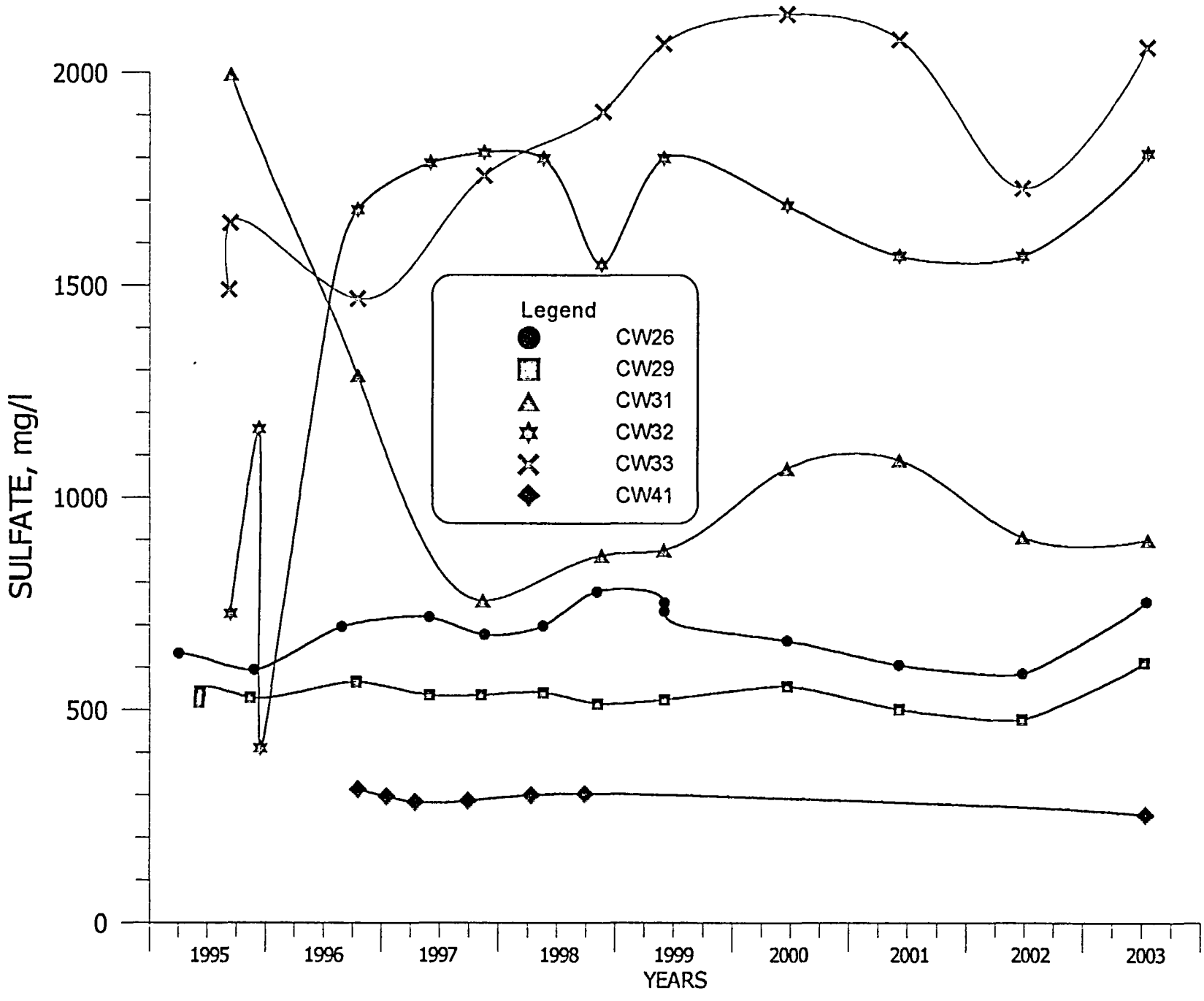

FIGURE C.4-1. SULFATE CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

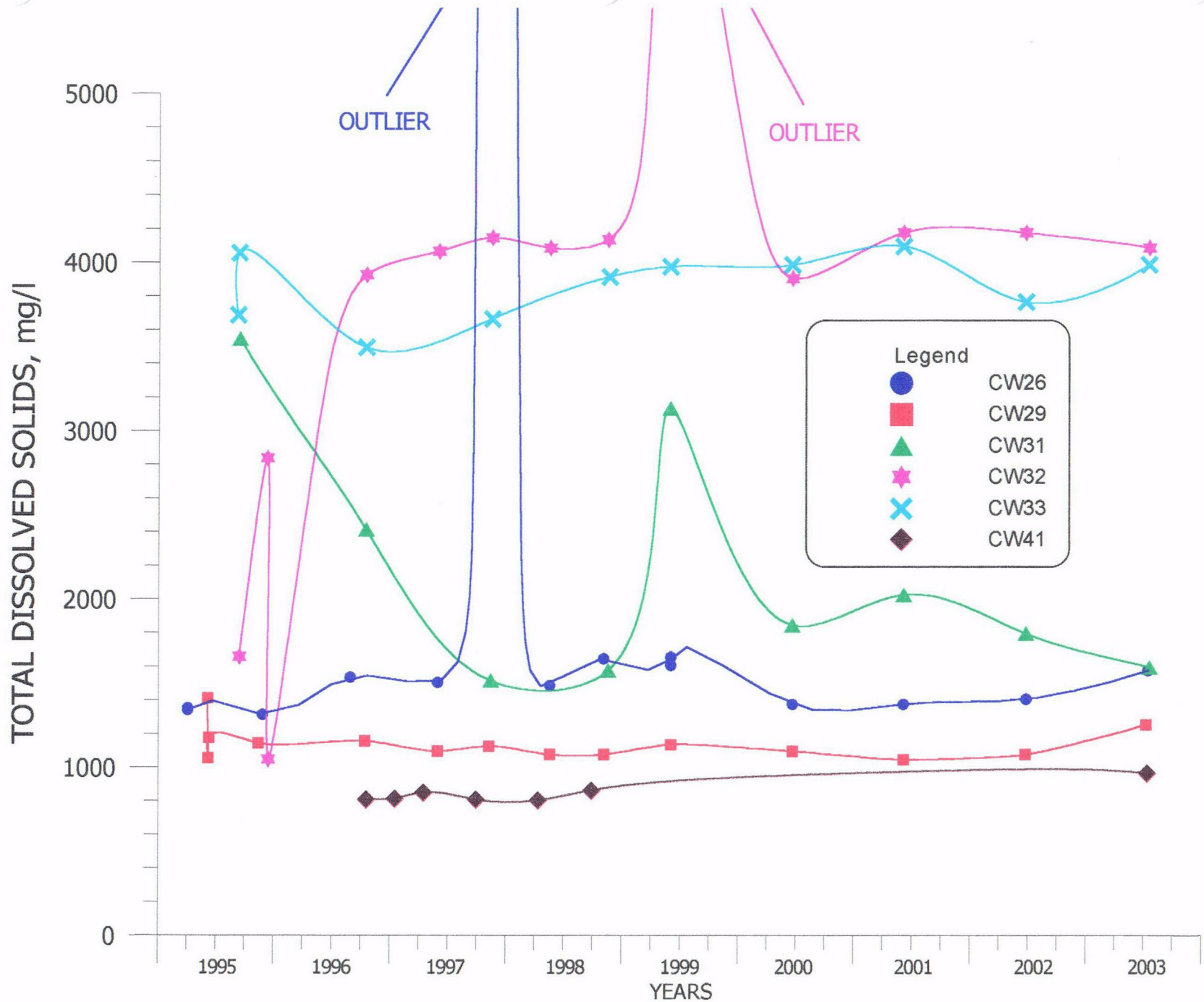

FIGURE C.4-2. TDS CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

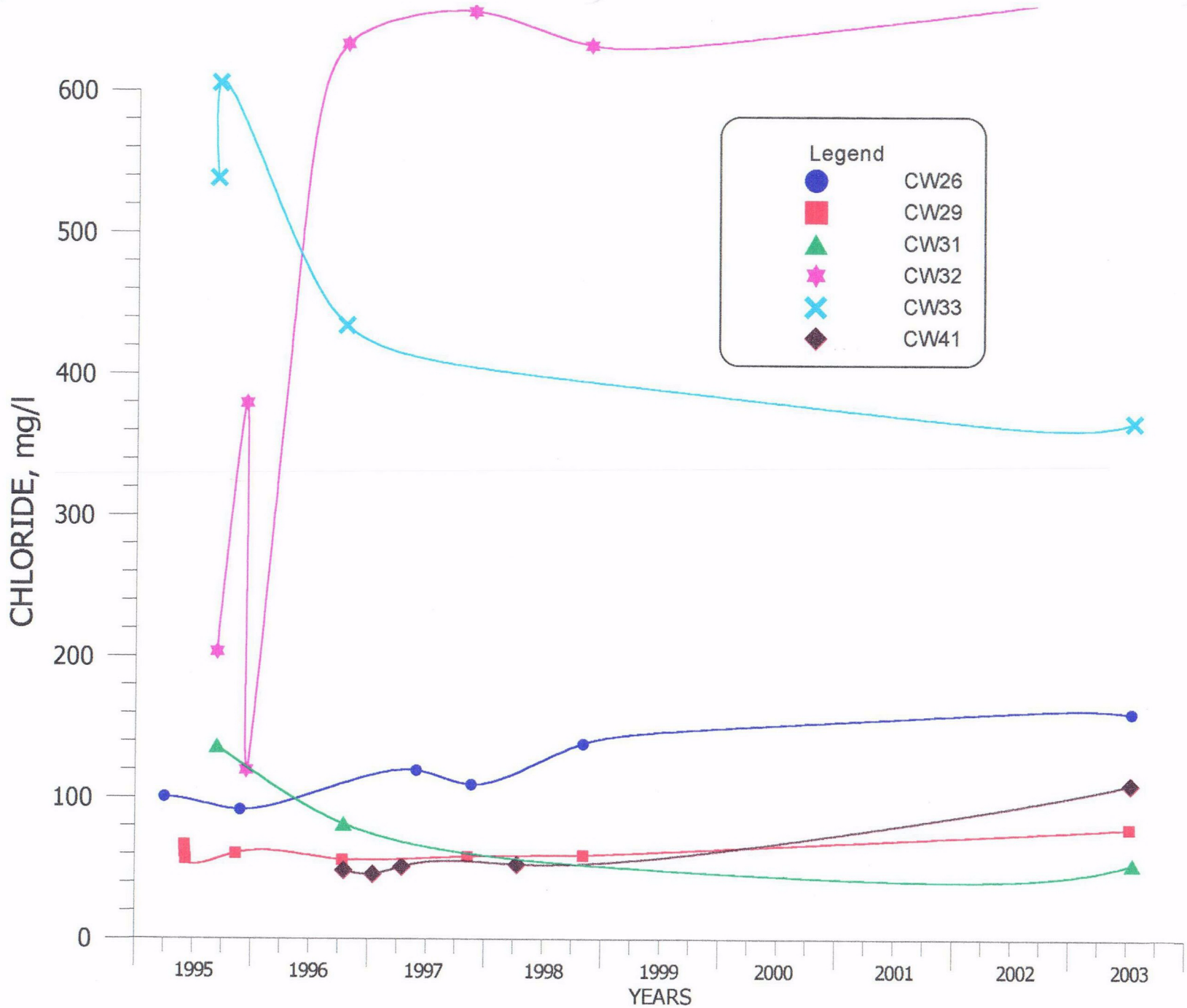

FIGURE C.4-3. CHLORIDE CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

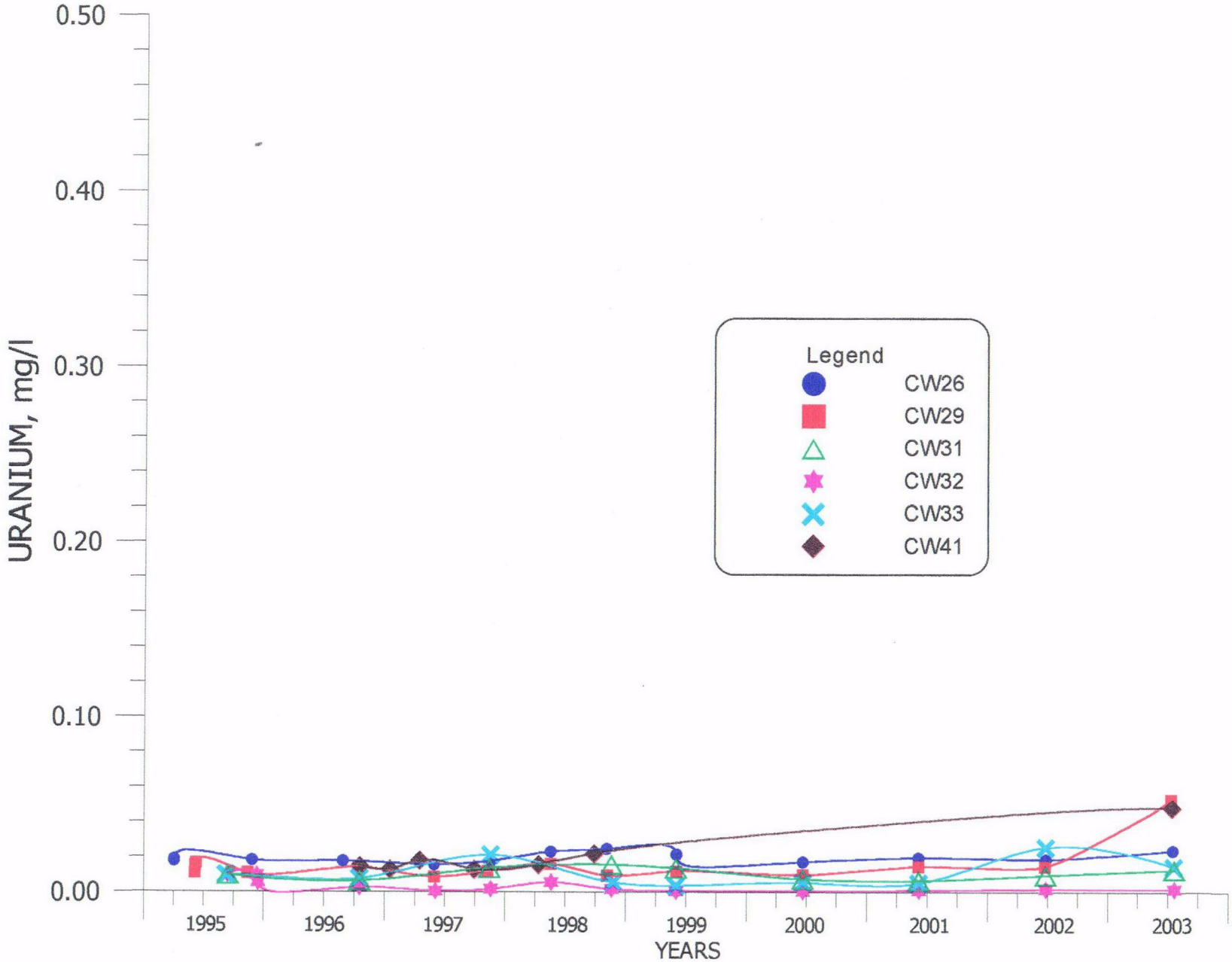

FIGURE C.4-4. URANIUM CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

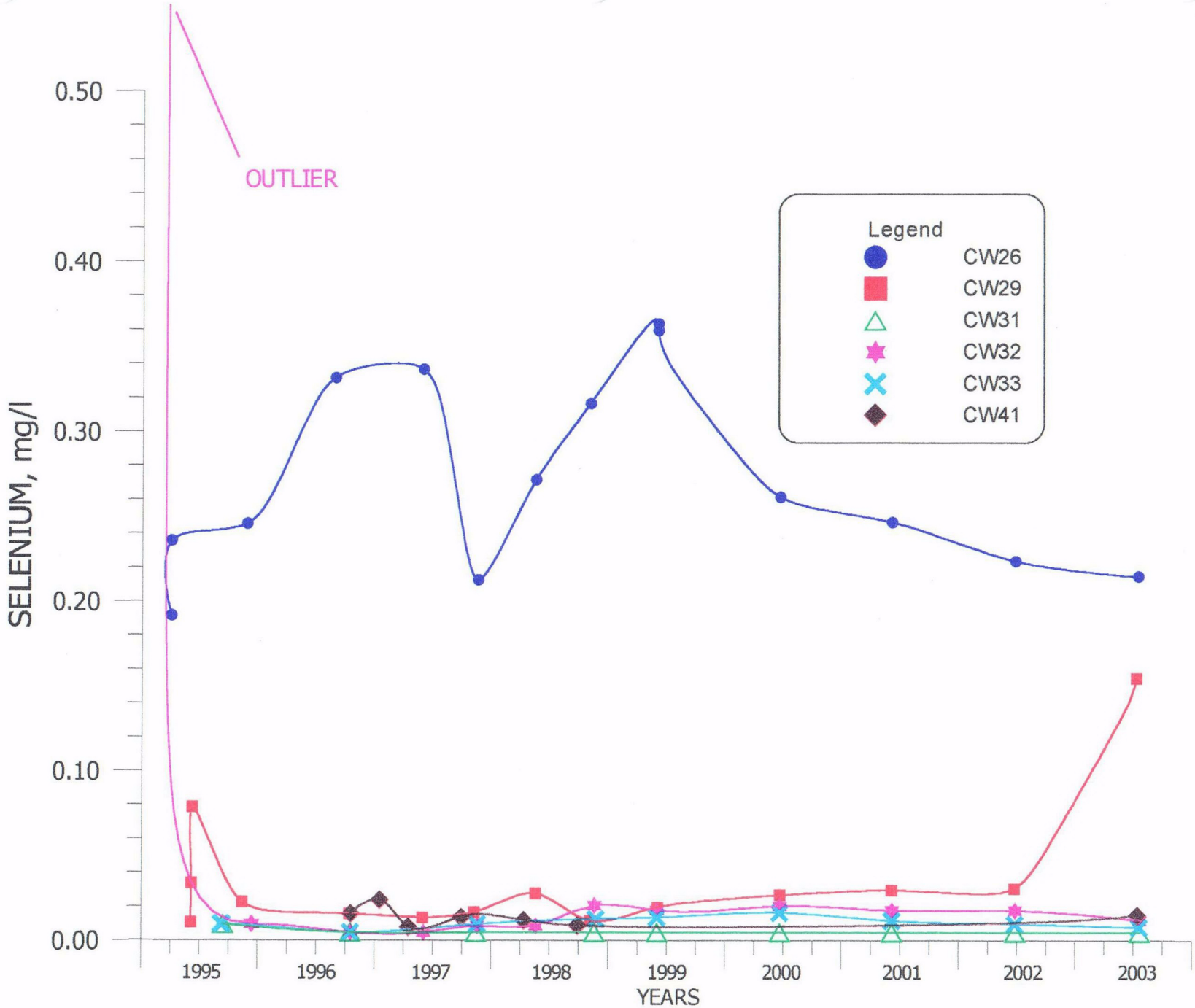

FIGURE C.4-5. SELENIUM CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

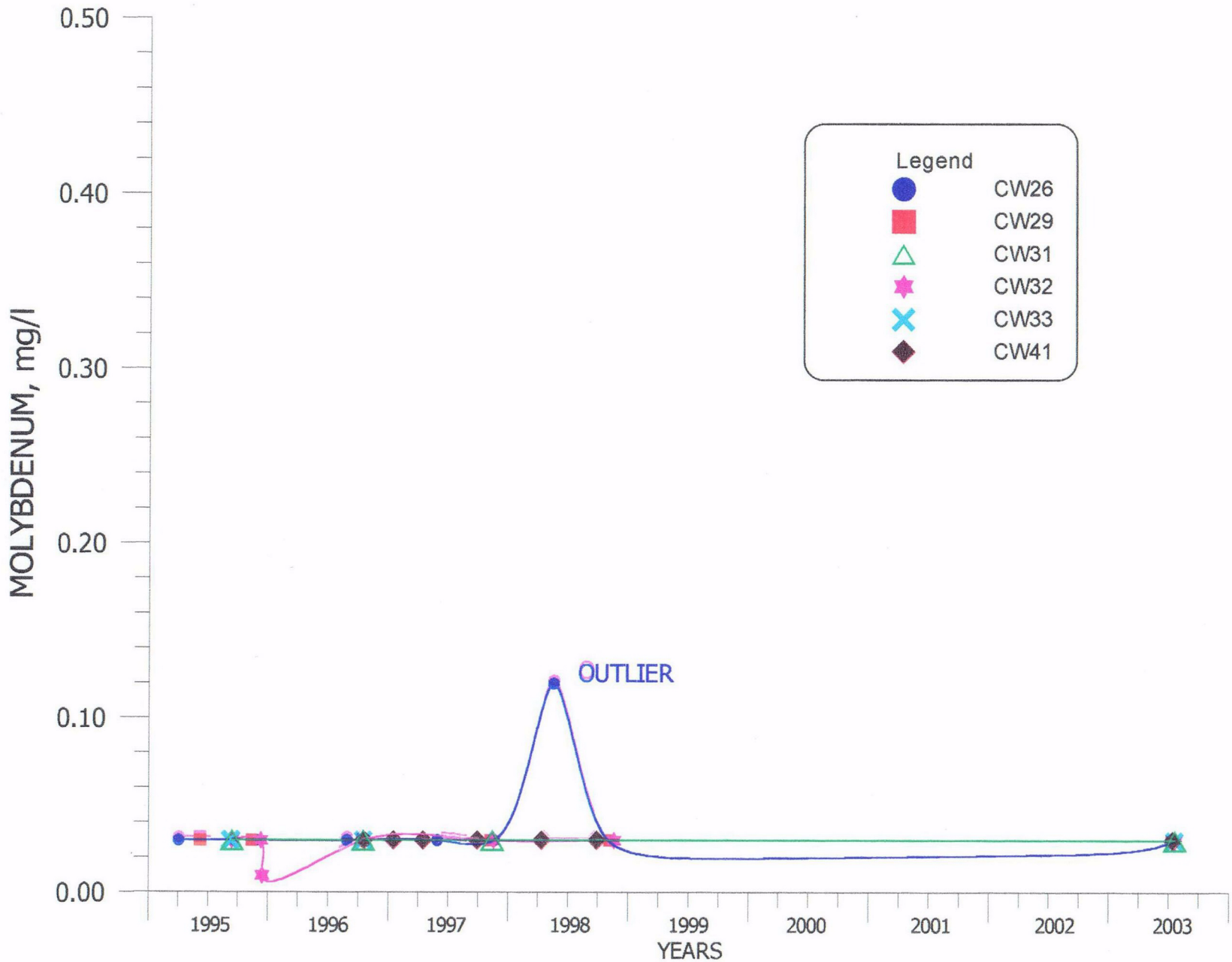

FIGURE C.4-6. MOLYBDENUM CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE.

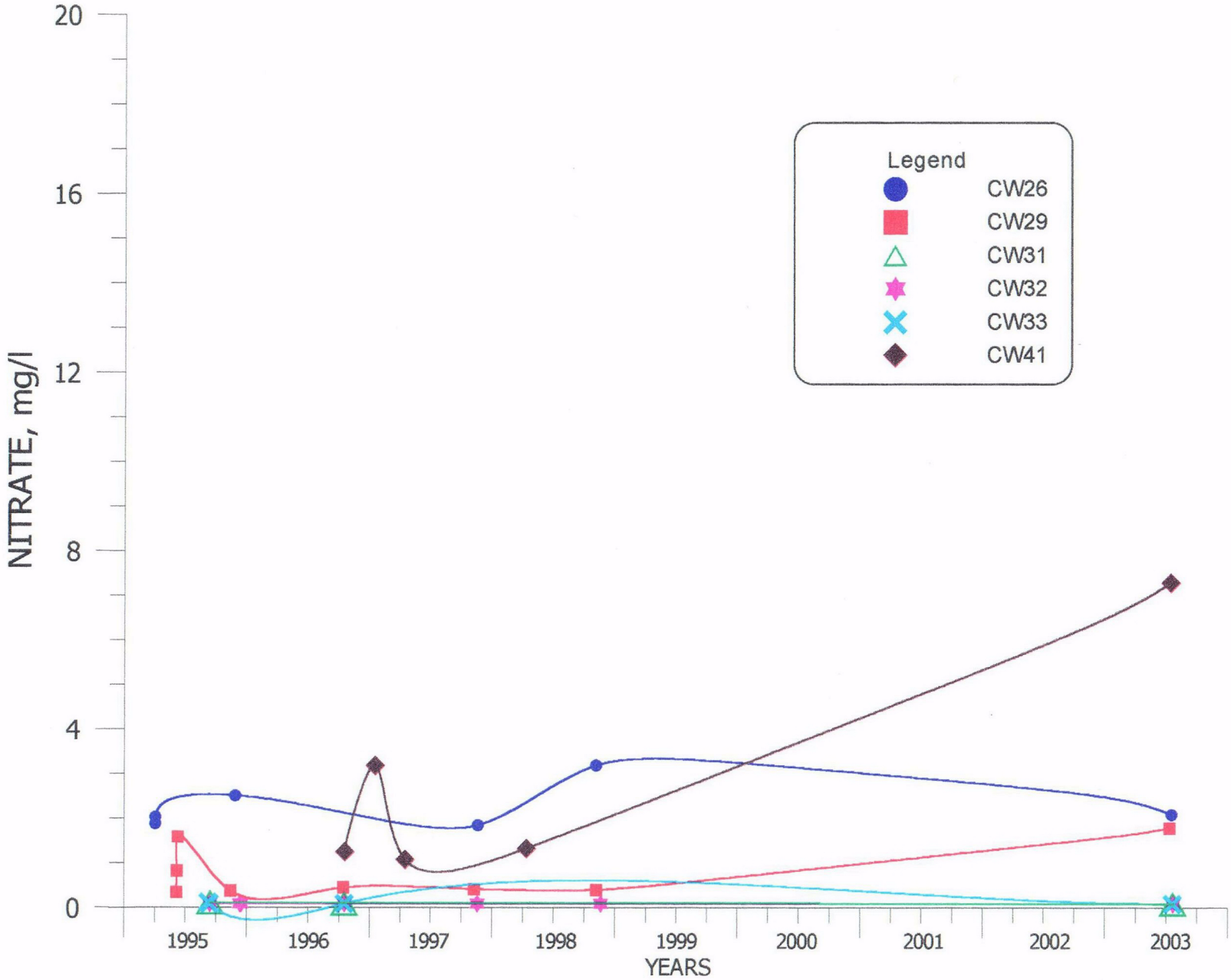

FIGURE C.4-7. NITRATE CONCENTRATIONS FOR LOWER CHINLE WELLS CW26, CW29, CW31, CW32, CW33 AND CW41 IN LOWER CHINLE NON-MIXING ZONE. CZO