CHAPTER 10
WATER QUALITY IMPACTS ON RELIABILITY

10.1 OVERVIEW

Planning efforts of IEUA and the Chino Basin Watermaster emphasize the importance of water quality. The region enjoys generally good water quality, but isolated areas of poor quality require that certain water sources be blended, or be treated to meet drinking water standards.

The percentage of urban water use by source within the IEUA service area during 2010 is shown in Table 10-1. About 28 percent of the urban water use in 2010 was MWD water, while 38 percent of the urban water use was from Chino Basin (including desalter water). IEUA distributes MWD water to the Cucamonga Valley Water District (CVWD) and the Water Facilities Authority (WFA) in our service area. The WFA serves five retail water agencies: the Cities of Chino, Chino Hills, Ontario, Upland and the Monte Vista Water District (MVWD). In 2010, about 70,000 acre-feet of Chino Basin groundwater was used for urban water supply, while an estimated additional 21,000 acre-feet of groundwater was used for agricultural irrigation. In order to reduce reliance on imported MWD water, significant increases in the use of ground, recycled and desalter water will be needed. The expansion of use of local supplies is expected to have a positive effect on water quality and an increased focus on water quality monitoring of local supplies. Water quality of existing and future water supply sources is discussed below.

Table 10-1
Current Percentage of Urban Water Supplies within the IEUA Service Area

Water Source	Percent
Chino Basin Groundwater	31
Imported MWD water	23
Other basin groundwater	19
Surface Water	12
Recycled Water	8
Desalter Water	7

By year 2035, approximately half (45%) of the urban water supply is projected to be from Chino Basin groundwater wells. Thus, the discussion of water quality impacts on reliability presented in this chapter focuses primarily on water quality in the Chino Basin, although the water quality issues of the other water sources is also evaluated for impacts to reliability.

10.2 WATER QUALITY OF LOCAL SUPPLIES

Local water supplies include surface water from nearby mountain streams, recycled water from IEUA treatment plants, recovered groundwater from the Chino Basin Desalters, and groundwater extracted from the Chino Basin and other groundwater basins in the area.

Surface Water

Surface water from local sources that originate in the San Antonio Canyon, Cucamonga Canyon, Day Creek, Deer Creek, Lytle Creek and several other smaller surface streams is generally of high quality, as these creeks are fed by snowmelt and other precipitation in the San Gabriel Mountains. Nevertheless, surface water sources are treated prior to introduction to the potable water supply in order to insure bacteriological quality and compliance with state and federal drinking water quality standards.

Recycled Water

Recycled water holds the greatest potential as a new source of supply in the Chino Basin and in the southern California region as a whole; it also requires the highest level of treatment to meet Title 22[1] water recycling requirements. By the year 2035, direct recycled water use is projected at 40,000 AFY and another 21,000 AFY of recycled water will be used for groundwater replenishment.

All of IEUA water recycling treatment plants produce recycled water suitable for full body contact recreation and generally meet the more stringent aquatic habitat criteria. Due to salinity management (brine line) and the exclusive use of the SWP supply for imported water, TDS concentrations in recycled water remain relatively low for recycled water (typically 500 mg/l). Since recycled water is regulated and monitored carefully, water quality is expected to remain high.

Treated Groundwater

Treated groundwater from the Chino Desalters 1 and 2 is very high quality as a result of treatment by reverse osmosis (RO), ion exchange (IX) and air stripping. Raw groundwater from the Chino Basin is treated by the desalters, as it has high TDS and nitrates. TDS and nitrates are removed by the RO process and nitrate is removed by the IX process. Some of the groundwater wells for Desalter 1 have been impacted by a VOC plume located near the Chino Airport. In the future, other identified plumes (CIM plume and an Ontario Airport Plume) could impact desalter wells. VOCs are removed by an air stripping facility at Desalter 1. Areas within the Chino Basin with water quality concerns are discussed in Section 10.3.

Other Groundwater Basins

Limited information is available on water quality from the groundwater basins surrounding Chino Basin. Most of the surrounding groundwater basins have elevated concentrations of nitrate. Use of these local groundwater supplies by retail water agencies for potable water supply suggests that there are no significant water quality issues, or issues are solved by blending or well head treatment.

Imported Water

MWD supplies about half the water used in southern California. Its two main sources of water are: 1) water from northern California as part of the State Water Project (SWP) delivered via the California Aqueduct, and 2) water from the Colorado River via the Colorado River Aqueduct (CRA). The total dissolved solids in Colorado River water average about 650 mg/l during normal

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[1] The State Department of Health Services requirements as specified in Title 17 and Title 22 of the California Health

water years. Water supplies from the SWP have significantly lower TDS levels than the Colorado River, averaging 320 mg/l during the past 20 years. IEUA only imports MWD water from the SWP in order to meet TDS objectives in Chino Basin. Other major water quality concerns include the following:

- Perchlorate in Colorado River and local groundwater supplies
- Disinfection by-products
- MTBE in groundwater and local surface reservoirs
- NDMA in groundwater and treated surface waters
- Hexavalent chromium in groundwater
- Radon and gross alpha

10.3 CHINO BASIN GROUNDWATER QUALITY[2]

Background
Chino Basin groundwater is not only a critical resource to overlying water producers; it is a critical resource to the entire Santa Ana Watershed. From a regulatory perspective, the use of Chino Basin groundwater to serve potable demands is limited by drinking water standards, groundwater basin water quality objectives, and Santa Ana River water quality objectives. In August 1999, Phase 1 of the OBMP established that groundwater monitoring must be conducted in order to obtain current water quality and water level data in Chino Basin (WEI, 1999). These data are necessary for defining and evaluating specific strategies and locations for the mitigation of nitrate, TDS, and other Constituents of Potential Concern (COPCs); new recharge sites; and pumping patterns that result from the implementation of the OBMP.

In the past, various entities have collected groundwater quality data. Municipal and agricultural water supply entities have collected groundwater quality data to comply with the Department of Health Services' requirements in the California Code of Regulations, Title 22, or for programs that range from irregular study-oriented measurements to long-term periodic measurements. Groundwater quality observations have been made by the DWR, by participants in the 1969 Judgment on the Santa Ana River (Orange County Water District vs. City of Chino et al.), by dischargers under orders from the RWQCB, and by the County of San Bernardino. The DWR and the San Bernardino County Flood Control District were very active in collecting groundwater quality data in the Chino Basin prior to the adjudication of the Chino Basin. After the Judgment was entered in 1978, monitoring south of State Route 60 stopped almost completely with the exception of that conducted by the Cities of Chino, Chino Hills, and Norco; the Jurupa

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[2] Chino Basin Optimum Basin Management Program, State of the Basin Report – 2004, July 2005

Community Services District (JCSD); and the Santa Ana River Water Company. Most of the pre-1978 measurements were digitized by the DWR. In 1986, the MWDSC conducted the first comprehensive survey of groundwater quality, covering all constituents regulated under Title 22.

Watermaster initiated a regular monitoring program for Chino Basin in 1989. Groundwater quality data has been obtained periodically since 1990.

Water Quality Monitoring Programs

Watermaster began conducting a more robust monitoring program as part of the initial OBMP implementation. Watermaster's program relies on municipal producers, government agencies, and private consultants to supply their groundwater quality data on a cooperative basis. Watermaster supplements these data with data obtained through its own sampling and analysis program of private wells in the area generally south of State Route 60. Water quality data are also obtained from special studies and monitoring programs that take place under the orders of the RWQCB, the California Department of Toxic Substances Control (DTSC), and others. Watermaster has combined previously digitized groundwater quality data from all known sources into a comprehensive database.

Water Quality Monitoring Programs for Wells Owned by Municipal Water Suppliers

Water quality samples are collected from Appropriative Pool wells and some overlying Non-Agricultural Pool wells as part of formalized monitoring programs. Constituents include (i) those regulated for drinking water purposes in the California Code of Regulations, Title 22; (ii) those regulated in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan); or (iii) those that are of special interest to the pumper.

Water Quality Monitoring Programs for Private Water Supply Wells

Historically, private wells were sampled less methodically and less frequently than wells owned by members of the Appropriative Pool. As a result, there is little historical (pre-1999) groundwater quality information for most of the 600 private wells in the southern part of the Chino Basin. As mentioned above, the MWDSC conducted an assessment of water quality and water levels in the private wells south of State Route 60 in 1986. This assessment was a component of the Chino Basin groundwater storage program Environmental Impact Report (MWDSC et al., 1988). Nevertheless, the historical quality of groundwater produced at the majority of the wells in the southern Chino Basin is unknown.

In 1999, the Comprehensive Monitoring Program initiated the systematic sampling of private wells south of State Route 60 in the Chino Basin. Over a three-year period, Watermaster sampled all available wells at least twice to develop a robust baseline data set. This program has since been reduced to approximately 110 private key wells, and about half of these wells are sampled every other year. Groundwater quality samples are analyzed for general minerals, physical properties, and for regional COPCs (e.g. perchlorate, and volatile organic chemicals

[VOCs] in the vicinity of known VOC plumes). This key well monitoring program provides a good representation of the areal groundwater quality in this portion of the basin.

Water Quality Monitoring Programs Conducted Pursuant to Regulatory Orders

Groundwater monitoring is conducted by private and public entities as part of regulatory orders and voluntary cleanups. These programs consist of networks of monitoring wells designed specifically to delineate and characterize the extent of the responsible party's contamination. These monitoring programs may include monthly, quarterly, and/or annual sampling frequencies. The following is a summary of all the regulatory and voluntary contamination monitoring in Chino Basin:

- **Plume:** Alumax Aluminum Recycling Facility
  Constituent of Concern: TDS, sulfate, nitrate, chloride
  Order: RWQCB Cleanup and Abatement Order 99-38

- **Plume:** Chino Airport
  Constituent of Concern: VOCs
  Order: RWQCB Cleanup and Abatement Order 90-134

- **Plume:** California Institute for Men
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring

- **Plume:** Crown Coach International Facility
  Constituent of Concern: VOCs and Solvents
  Order: Voluntary Cleanup Monitoring

- **Plume:** General Electric Flatiron Facility
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring

- **Plume:** General Electric Test Cell Facility
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring

- **Plume:** Kaiser Steel Fontana Site
  Constituent of Concern: TDS/total organic carbon (TOC)
  Order: See discussion in Section 4.36.7.

- **Plume:** Milliken Sanitary Landfill
  Constituent of Concern: VOCs

Order: RWQCB Order No. 81-003

- **Plume:** Upland Sanitary Landfill
  Constituent of Concern: VOCs
  Order RWQCB Order No 98-99-07

- **Plume:** Ontario International Airport (VOC Plume – South of Ontario Airport)
  Constituent of Concern: VOC
  Order: This plume is currently being voluntarily investigated by a group of potentially responsible parties.

- **Plume:** Stringfellow National Priorities List (NPL) Site
  Constituent of Concern: VOCs, perchlorate, N-nitrosodimethylamine (NDMA), heavy metals
  Order: The Stringfellow Site is the subject of US Environmental Protection Agency (EPA) Records of Decision (RODs): EPA/ROD/R09-84/007, EPA/ROD/R09-83/005, EPA/ROD/R09-87/016, and EPA/ROD/R09-90/048.

Other Water Quality Monitoring Programs
In a letter dated July 13, 2000, the RWQCB expressed their concern to the IEUA that the historical recharge of recycled water at IEUA Regional Plant No. 3 (RP3) may have caused groundwater contamination at down-gradient wells. Other sources of groundwater contamination in the area include the Kaiser Steel Mill, Alumax, other industries, and historical agricultural activities, including citrus groves and hog feed lots. Several municipal wells have been shut down in MZ3 due to perchlorate and nitrate in groundwater. MZ3 includes areas that underlie all or part of the Fontana Water Company, the Marygold Mutual Water Company, the CVWD, and the City of Ontario. MZ3 groundwater is tributary to wells owned by the JCSD.

To characterize groundwater levels and quality in MZ3, Watermaster and the IEUA performed an investigation. The objectives of this investigation were to develop a groundwater sampling program, install two sentry wells at the distal end of the Kaiser plume, and perform further characterization of groundwater quality. Sampling was conducted at twenty-two selected key wells from late 2005 to 2007. Where possible, four quarterly samples and one annual sample were collected. In 2007, two triple-nested wells (MZ3-1 and MZ3-2) were installed down gradient of the Kaiser plume. These wells were sampled quarterly for one year. The sampling results provided data to further characterize the water quality patterns for contaminants of concern in the study area, including TDS, nitrate, sulfate, chloride, and perchlorate. And, the results from well MZ3-1/3 redefined the extent of the Kaiser plume.

Information Management
As with groundwater level and production data, Watermaster manages groundwater quality data in order to perform the requisite scientific and engineering analyses required to ensure that the goals of the OBMP are being met. Watermaster's relational database contains well

location, construction, lithology, specific capacity, groundwater level, and water quality data. Historical water quality data for the period prior to the mid-1980s were obtained from the DWR and supplemented with data from producers in the Appropriative and Overlying Non-Agricultural Pools and others. For the period from the mid-1980s forward, Watermaster has QA/QC'd and uploaded water quality data from its own sampling programs, the State of California Department of Public Health (CDPH, formerly the Department of Health Services) database, and other cooperating parties to its relational database. Occasionally, problems have been found with CDPH data, usually occurring in the form of incorrect constituent identification. In 2003, Watermaster launched the Chino Basin Relational Database effort to collect water quality data directly from each member agency and thereby circumvent past data problems. Cooperating parties provide all data (including geologic, geophysical, water levels, water quality, production, and recharge) to Watermaster on a routine basis. These data are delivered in electronic format directly from the laboratory or from the cooperating party.

Table 10-2
Summary of Water Quality Data for Groundwater from Chino Basin June 2003 through June 2008

Analyte Group/Constituents	Wells with Exceedances
Inorganic Constituents	
Nitrate	395
Total dissolved solids	221
Perchlorate	188
Iron	185
Sulfate	41
Aluminum	153
Chromium	30
Chloride	25
Managanese	58
Arsenic	24
Vanadium	25
General Physical	
Odor	21
Color	28
pH	14
Specific Conductance	121
Turbidity	78
Chlorinated VOCs	
1,1-Dichloroethane	11
1,1-Dichloroathane	31
1,2,3-Trichloropropane	23
1,2-Dichlorethane	17
cis-1,2-Dichloroethene	10
Tetrachloroethene (PCE)	37
Trichloroethene (TCE)	115
cis-1,2-dichloroethene	10

Source: Adapted from Chino Basin Watermaster, Optimum Basin

Groundwater Quality in Chino Basin

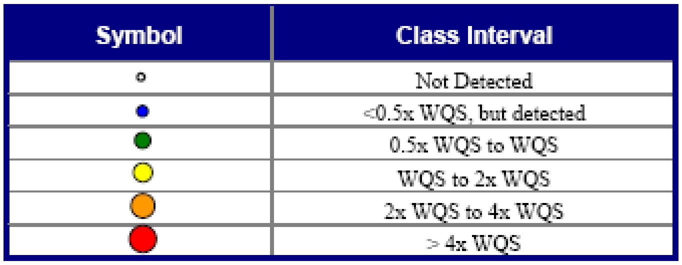
Figure 10-1 shows all wells with groundwater quality monitoring results for the 5-year period of July 2003 to June 2008.

Inorganic and organic constituents detected in groundwater samples from wells in the Chino Basin through June 2008 were analyzed synoptically. This analysis included all available data from production and monitoring wells. Hence, the data do not represent a programmatic investigation of potential sources nor do they represent a randomized study that was designed to ascertain the water quality status of the Chino Basin. These data do, however, represent the most comprehensive information available to date.

Monitoring wells targeted at potential sources tend to have greater concentrations than municipal or agricultural production wells. Wells with constituent concentrations greater than one-half of the MCL represent areas that warrant concern and inclusion in a long-term monitoring program. In addition, groundwater in the vicinity of wells with samples greater than the MCL may be impaired from a beneficial use standpoint.

Numerous water quality standards have been put in place by federal and state agencies. Primary MCLs are enforceable criteria that are set due to health effects. Secondary standards are related to the aesthetic qualities of the water, such as taste and odor. For some chemicals, there are “Notification Level” criteria that are set by the CDPH. When notification levels are exceeded, the CDPH recommends that the utility inform its customers and consumers about the presence of the contaminant and any health concerns associated with exposure. The level at which the CDPH recommends the drinking water system remove the affected drinking water source from service is the “Response Level.” These levels range from 10 to 100 times the notification level, depending on the chemical. Table 10-2 summarizes the constituents that exceeded at least one water quality criteria in more than 10 wells within the Chino Basin for the period of July 2003 through June 2008.

For all figures at the end of this section that depict water quality distributions in the Chino Basin, the following convention is typically followed in setting class intervals in the legend (where WQS is the applicable water quality standard [see table below]). Variations of this convention may be employed to highlight certain aspects of the data.



Symbol	Class Interval
○	Not Detected
🔵	<0.5x WQS, but detected
🟢	0.5x WQS to WQS
🟡	WQS to 2x WQS
🟠	2x WQS to 4x WQS
🔴	> 4x WQS

Total Dissolved Solids

In Title 22, TDS is regulated as a secondary contaminant. The California secondary drinking water MCL for TDS is 500 mg/L. Figure 10-2 shows the distribution of the maximum TDS concentrations in Chino Basin from July 2003 through June 2008. During this period, maximum TDS concentrations ranged from 48 mg/L to 4,790 mg/L with average and median concentrations of approximately 550 mg/L and 380 mg/L, respectively. The highest concentrations are located south of State Route 60 where the impacts from agriculture are greatest, which is consistent with the data reported in the 2006 State of the Basin Report.

The impacts of agriculture on TDS in groundwater are primarily caused by dairy waste disposal, consumptive use, and fertilizer use on crops. As irrigation efficiency increases, the impact of consumptive use on TDS in groundwater also increases. For example, if source water has a TDS concentration of 250 mg/L and the irrigation efficiency is about fifty percent (flood irrigation), the resulting TDS concentration in returns to groundwater would be 500 mg/L, which is exclusive of the mineral increments from fertilizer. If irrigation efficiency is increased to seventy-five percent, the resulting TDS concentration in the returns to groundwater would be 1,000 mg/L, which is also exclusive of the mineral increments from fertilizer. For modern irrigated agriculture, the TDS impacts of consumptive use are more significant than mineral increments from fertilizers.

Wells with low TDS concentrations in close proximity to wells with higher TDS concentrations suggests a vertical stratification of water quality. However, there is a paucity of information concerning well construction/perforation intervals; Thus, the vertical differences in water quality are currently unverifiable.

Nitrate-Nitrogen

In Title 22, the primary MCL for nitrate as nitrogen (NO3-N) in drinking water is 10 mg/L. By convention, all nitrate values are expressed in this report as NO3-N. Figure 10-3 displays the distribution of maximum NO3-N concentrations in the Chino Basin from July 2003 through June 2008.

Areas with significant irrigated land use or dairy waste disposal histories overlie groundwater with elevated nitrate concentrations. The primary areas of nitrate degradation were formerly or are currently overlain by:

- Citrus (the northern parts of the Chino-North MZ)
- Dairy and irrigated agriculture (the southern parts of the Chino-North MZ, the Chino-South MZ, the Chino-East MZ, and the Prado Basin MZ [PBMZ])

Nitrate concentrations in groundwater have increased slightly or remained relatively constant in the northern parts of the Chino-North MZ from 1960 to present. These areas were formerly occupied by citrus groves and vineyards. The nitrate concentrations underlying these areas rarely exceed 10 mg/L (as nitrogen). Over the same period, nitrate concentrations increased significantly in the southern parts of the Chino-North MZ, the Chino-South MZ, the Chino-East MZ, and the PBMZ. In these areas, land use was progressively converted from irrigated/non-irrigated agricultural land to dairies, and nitrate concentrations typically exceed the 10 mg/L MCL and frequently exceed 40 mg/L.

Other Constituents of Potential Concern

This section discusses the constituents with water quality standards that were exceeded in ten or more wells in Chino Basin with the exception of nitrate and TDS. The details of these exceedances are displayed graphically in Figures 10-4 through 10-17.

A query was developed to analyze water quality data in the Chino Basin from July 2003 through June 2008 that is in exceedance of any water quality standard. The results of this query are provided in a summary table in Appendix C, including:

- Chemical Constituents (listed alphabetically)
- Reporting Units
- Water Quality Standards (detailed explanations are provided in the table's footnote):
  - EPA Primary MCL
  - EPA Secondary MCL
  - California Primary MCL
  - California Secondary MCL
  - California Notification Level
- Minimum – the minimum concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Lower or First Quartile – the first value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.
- Median or Second Quartile – the second value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.
- Upper or Third Quartile – the third value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.
- Maximum – the maximum concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Average – the average concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Number of Samples – the total number of samples for the given constituent for the given time period.
- Number of Wells Sampled – the number of wells sampled in the given time period, not the number of samples collected.

- Number of Wells with Detects – the number of wells in the period wherein the constituent was detected at any concentration.
- Number of Wells with Exceedances – the number of wells in the given time period with any value that exceeded any of the five water quality standards.

VOCs

The following seven VOCs were detected at or above their MCL in more than 10 wells in the Chino Basin:

- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- 1,2,3-trichloropropane (1,2,3-TCP)
- 1,2-dichloroethane (1,2-DCA)
- *cis*-1,2-dichloroethene (cis-1,2-DCE)
- tetrachloroethene (PCE)
- trichloroethene (TCE)

Trichloroethene and Tetrachloroethene

Trichloroethene (TCE) and tetrachloroethene (PCE) were/are widely used industrial solvents. Both PCE and TCE are used as metal degreasers in the automotive and other metal working industries. PCE is commonly used in the dry-cleaning industry. TCE was commonly used as a food extractant. The areal distributions of TCE and PCE are shown in Figures 10-4 and 10-5, respectively. In general, PCE is below the detection limit for wells in the Chino Basin. Wells with detectable levels tend to occur in clusters, such as those around the Milliken Landfill, south and west of the Ontario Airport, and along the margins of the Chino Hills. The spatial distribution of TCE resembles that of PCE. TCE was not detectable in most of the wells in the basin, and similar clusters of wells occur around the Milliken Landfill, south and west of Ontario International Airport (OIA), south of Chino Airport, and in the Stringfellow plume.

Figure 10-19 shows the ratio of TCE, PCE, and their breakdown products in monitoring wells associated with the VOC plumes in the southern Chino Basin. The unique characteristics of these plumes can be seen by comparing TCE and PCE concentrations and dispersion. For example, the Milliken Landfill plume and the GE plumes near Ontario Airport have significant concentrations of both TCE and PCE while the Chino Airport and Stingfellow plumes have significant concentrations of TCE and only minor detections of PCE, and the OIA plume is characterized solely by TCE. These unique characteristics allow for differentiation between the plumes and determining the intermingling of plumes.

1,1-Dichloroethene, 1,2-Dichloroethane, and cis-1,2-Dichloroethene

1,1-Dichloroethene (1,1-DCE), 1,2-Dichloroethane (1,2-DCA), and cis-1,2-Dichloroethene (cis-1,2-DCE) are degradation by-products of PCE and TCE (Dragun, 1988) that are formed by reductive dehalogenation. The areal distributions of 1,1-DCE, 1,2-DCA, and cis-1,2-DCE are shown in Figures 10-6 through 10-8, respectively. 1,1-DCE, 1,2-DCA, and cis-1,2-DCE have not been detected in the majority of wells in the Chino Basin. 1,1-DCE is found near the Milliken Landfill, south and west of OIA, at the former Crown Coach Facility, and at the head of the Stringfellow plume. 1,2-DCA and cis-1,2-DCE are found in the same general locations.

1,1-Dichloroethane

1,1,-Dichloroethane (1,1-DCA) is a colorless oily liquid that is used as a solvent for plastics, as a degreaser, as a halon in fire extinguishers, and in the cementing of rubber, and is a degradation by-product of 1,1,1-TCA. Figure 10-9 shows the areal distribution of 1,1-DCA in the Chino Basin. Eleven wells were in exceedance of the primary CA MCL of 5 µg/L for 1,1-DCA for the period of July 2003 through June 2008. The majority of these wells are monitoring wells at the former Crown Coach Facility.

1,2,3-Trichloropropane

1,2,3-TCP is a colorless liquid that is used primarily as a chemical intermediate in the production of polysulfone liquid polymers and dichloropropene, and in the synthesis of hexafluoropropylene and as a cross linking agent in the synthesis of polysulfides. It has been used as a solvent, an extractive agent, a paint and varnish remover, and a cleaning and degreasing agent, and it has been formulated with dichloropropene in the manufacturing of soil fumigants, such as D-D.

The current California State Notification Level for 1,2,3-TCP is 0.005 µg/L. The adoption of the Unregulated Chemicals Monitoring Requirements regulations occurred before a method capable of achieving the required detection limit for reporting (DLR) was available. According to the CDPH, some utilities moved ahead with monitoring, and samples were analyzed using higher DLRs. Unfortunately, findings of non-detect with a DLR higher than 0.005 µg/L do not provide the CDPH with the information needed for setting a standard. New methodologies with a DLR of 0.005 µg/L have since been developed, and the CDPH has requested that any utility with 1,2,3-TCP findings of non-detect with reporting levels of 0.01 µg/L or higher do follow-up sampling using a DLR of 0.005 µg/L. Because 1,2,3-TCP may be a basin-wide water quality issue, private and public wells are continuing to be retested at the lower detection limit (0.005 µg/L).

Figure 10-10 shows the distribution of 1,2,3-TCP in Chino Basin, based on the data limitations discussed above. High 1,2,3-TCP values are associated with the Chino Airport Plume. Of particular note, there is a cluster of wells with 1,2,3-TCP concentrations greater than the Notification Level in the Jurupa region and a scattering of wells that exceed the Notification Level on the western margins of the basin. Watermaster will continue to monitor and investigate this constituent.

Iron, Arsenic, and Vanadium

Iron, arsenic, and vanadium concentrations depend on mineral solubility, ion exchange reactions, surface complexations, and soluble ligands. These speciation and mineralization reactions, in turn, depend on pH, oxidation-reduction potential, and temperature.

Iron

In general, iron is not detected across the Chino Basin, but there are some scattered detectable concentrations that are above regulatory limits. Iron concentrations are elevated in the vicinity of the Stringfellow Plume. Outside of the Stringfellow Plume, there were 85 wells with iron concentrations that exceed the MCL. Nevertheless, these exceedances may be an artifact of sampling methodology; relatively high concentrations of iron and trace metals are often the result of the dissolution of aluminosilicate particulate matter and colloids, which is caused by the acid preservative in unfiltered samples.

Arsenic

The US EPA implemented a new primary MCL for arsenic in 2006, decreasing the MCL from 50 µg/L to 10 µg/L. In November 2008, the Primary CA MCL was also changed from 50 µg/L to 10 µg/L. Figure 10-11 shows the distribution of arsenic in the Chino Basin. Eleven wells in the basin had arsenic concentrations that exceeded the MCL. Of these wells, three are associated with the Stringfellow Plume, and three are associated with Chino Airport Plume. Higher concentrations of arsenic are found in the Chino/Chino Hills area in the lower aquifer at depths greater than about 350 ft-bgs.

Vanadium

In the Chino Basin, vanadium has been detected above regulatory limits in some scattered wells. In groundwater, vanadium can result from mining and industrial activities or be of natural occurrence. While elemental vanadium does not occur in nature, vanadium compounds are found in fossil fuels and exist in over 60 different mineral ores. The primary industrial use of vanadium is in the steel industry where it is used to strengthen steel. Figure 10-12 shows the areal distribution of vanadium in the Chino Basin. The majority of the 25 wells in exceedance of the California Notification Level (0.05 mg/L) are associated with the Stringfellow Plume. Other exceedances are found near the Milliken Landfill, in deep wells in the Chino/Chino Hills area, and in one well near the Jurupa Mountains.

Perchlorate

Perchlorate has recently been detected in several wells in the Chino Basin (Figure 10-13), in other basins in California, and in other states in the west. The most probable reason why perchlorate was not detected in groundwater until recently is that analytical methodologies that could attain a low enough detection limit did not previously exist. Prior to 1996, the method detection limit for perchlorate was 400 µg/L. In March 1997, an ion chromatographic method was developed with a detection limit of 1 µg/L and a reporting limit of 4 µg/L.

As an environmental contaminant, perchlorate (ClO4-) originates from the solid salts of ammonium perchlorate (NH4ClO4), potassium perchlorate (KClO4), or sodium perchlorate (NaClO4). Perchlorate salts are quite soluble in water. The perchlorate anion (ClO4-) is exceedingly mobile in soil and groundwater environments. Because of its resistance to react with other available constituents, it can persist for many decades under typical groundwater and surface water conditions. Perchlorate is a kinetically stable ion, which means that reduction of the chlorine atom from a +7 oxidation state in perchlorate to a -1 oxidation state as a chloride ion requires activation energy or the presence of a catalyst to facilitate the reaction. Since perchlorate is chemically stable in the environment, natural chemical reduction is not expected to be significant.

Possible sources of perchlorate contamination are synthetic (ammonium perchlorate used in the manufacturing of solid propellant used for rockets, missiles, and fireworks) and natural (perchlorate derived from Chilean caliche that was used for fertilizer).

Fertilizers derived from Chilean caliche are currently used in small quantities on specialized crops, including tobacco, cotton, fruits, and vegetables (Renner, 1999). However, evidence suggests that usage may have been widespread for citrus crops in Southern California from the late 1800s through the 1930s.

The current CDPH Notification Level for perchlorate is 6 μg/L, which was established on March 11, 2004.

Perchlorate has been detected in 188 wells in the Chino Basin at levels greater than 6 μg/L. Perchlorate Notification Level exceedances occur in the following areas of the Chino Basin (Figure 10-13):

- 1,1-dichloroethane (1,1-DCA)
- Rialto-Colton Basin (There is a significant perchlorate plume in the Rialto-Colton Basin. The RWQCB is investigating the source of this plume, which appears to be near the Mid-Valley Sanitary Landfill. According to the RWQCB, several companies—including B.F. Goodrich, Kwikset Locks, American Promotional Events, and Denova Environmental—operated nearby and used or produced perchlorate. These companies were located on a 160-acre parcel at T1N R5W S21 SW1/4. Denova Environmental also operated on a 10-acre lot at T1N R5W S20 S1/2 (along the boundary between Sections 20 and 29). Perchlorate in the Fontana area of Chino Basin may be the result of (i) the Rialto-Colton perchlorate plume migrating across the Rialto-Colton fault, (ii) other point sources in Chino Basin, and/or (iii) the non-point application of Chilean nitrate fertilizer in citrus groves.)
- Downgradient of the Stringfellow Superfund Site (Concentrations have exceeded 600,000 μg/L at onsite observation wells. The plume has likely reached the Pedley Hills and may extend as far as Limonite Avenue.)
- City of Pomona well field (source[s] unknown)
- Wells in the City of Ontario water service area, south of OIA (source[s] unknown)
- Scattered wells in the Monte Vista water service area (source[s] unknown)
- Scattered wells in the City of Chino water service area (source[s] unknown)

A forensic isotope study was conducted to determine the source of perchlorate in Chino Basin groundwater. This forensic technique was developed using comprehensive stable isotope analyses (37Cl/35Cl and 18O/17O/16O) of perchlorate to determine the origin of the perchlorate (synthetic vs. naturally occurring). Stable isotope analyses of perchlorate from known man-made (e.g. samples derived from electrochemically synthesized ammonium- and potassium-perchlorate salts) and natural (e.g. samples from the nitrate salt deposits of the Atacama Desert in Chile) sources reveal systematic differences in isotopic characteristics that are related to the formation mechanisms (Bao & Gu, 2004; Böhlke et al., 2005; Sturchio et al., 2006). There is considerable anecdotal evidence that large quantities of Chilean nitrate fertilizer were imported into the Chino Basin in the early 1900s for the citrus industry, which covered the north, west and central portions of the basin.

The perchlorate isotope study consisted of 10 groundwater samples that were collected throughout the Chino Basin. The sampling points included private wells and municipal production wells. Samples were collected using a flow-through column with a highly perchlorate-selective anion-exchange resin. The exchange resin concentrates low levels of perchlorate in groundwater such that a sufficient amount can be acquired and for isotopic analysis. Results confirmed that most of the perchlorate in the west and central portions of the Chino Basin was derived from Chilean nitrate fertilizer. One sample collected south of the OIA is a potential mixture of natural and synthetic sources.

Total Chromium and Hexavalent Chromium

Figure 10-14 shows the areal distribution of total chromium in the Chino Basin. Thirty wells were found to be in exceedance of the CA MCL of 50 µg/L. The majority of these wells are associated with the Milliken Sanitary Landfill, the Stringfellow Plume, and the GE Test Cell Plume. The remaining wells include isolated wells near the Jurupa Mountains and in the southern Chino Basin and City of Pomona wells. Chromium in groundwater results from natural and anthropogenic sources.

Hexavalent chromium is currently regulated under the MCL for total chromium. In 1999, the CDPH identified that hexavalent chromium needed an individual MCL, and concerns over its carcinogenicity grew. Subsequently, the CDPH included it on the list of unregulated chemicals that require monitoring. California Health and Safety Codes (§116365.5 and §1163659a) compelled the adoption of a hexavalent chromium MCL by January 1, 2004, and required it to be close to the public health goals (PHG) established by the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA). At present, the PHG has not been established, and the CDPH cannot proceed with the MCL process. Figure 10-15 shows the areal distribution of hexavalent chromium in the Chino Basin. Only three wells in the Chino Basin were in exceedence of the CA MCL for total chromium. In the near future hexavalent chromium may become a more significant contaminant of concern in the Chino Basin when a lower MCL is determined by CDPH, and more wells are sampled for hexavalent chromium.

Chloride and Sulfate

Chloride and sulfate both exceeded secondary MCLs. As discussed previously, secondary MCLs apply to chemicals in drinking water that adversely affect its aesthetic qualities and are not based on the direct health effects associated with the chemical. Chloride and sulfate are major anions associated with TDS. All wells in the basin had detectable levels of sulfate (Figure 10-16), but most had concentrations that were less than 125 mg/L (one-half the water quality standard). A total of 41 wells had concentrations at or above the sulfate secondary MCL. In general, these wells are distributed in the southern portion of the basin, in the Stringfellow plume, and along the margins of the Chino Hills. All wells had detectable levels of chloride (Figure 10-17), but most had concentrations that were less 125 mg/L (one-half the MCL). The secondary MCL for chloride was exceeded in 25 wells; almost all of which are located in the southern portion of the basin.

Color, Odor, and Turbidity

In the last 5 years, color, odor, and turbidity have been detected above their secondary MCLs in more than 10 wells within the Chino Basin. These parameters are monitored purely for aesthetic reasons and should not substantially impair water quality in the Chino Basin.

Point Sources of Concern

The water quality discussion above described water quality conditions across the entire basin. The discussion below describes the water quality plumes associated with known point source discharges to groundwater. Figure 10-18 shows the locations of various point sources and associated areas of water quality degradation. Figure 10-19 shows the VOC plumes and features pie charts that display the relative percent of TCE, PCE, and other VOCs detected at groundwater wells within plume impacted areas. The pie charts demonstrate the chemical differentiation between the VOC plumes in the southern portion of Chino Basin.

Alumax Aluminum Recycling Facility

Between 1957 and 1982, an 18-acre aluminum recovery facility was operated in the City of Fontana. The byproducts of aluminum recycling are aluminum oxide wastes and brine water. During this 25-year period, solid wastes were stockpiled onsite. Process water containing sodium and potassium chloride salts was discharged onsite and allowed to percolate into native soil and groundwater. Discharge ceased in 1982, and the solid wastes were removed in 1992. Onsite groundwater monitoring was initiated in 1993 by then owner Alumax, Inc. The site was subsequently capped to prevent the future mobilization of salts offsite. Alcoa Davenport Works (Alcoa) purchased Alumax in 1998.

Currently, there are two onsite monitoring wells: MW-1 is located in the northeast corner of the property, and MW-2 is located in the southwest corner. These wells have steel casings and have experienced chloride corrosion and extensive accumulation of iron hydroxide scale. Rehabilitation efforts in 2001 failed to adequately clear the well screens. Both wells subsequently experienced partial casing constrictions or screen collapses. In 2007, it was discovered that over ten feet of iron oxide scale and sediment had accumulated in the bottom of MW-1. MW-2 was abandoned and replaced in 2008 as it could no longer be sampled.

Offsite monitoring began with the construction of four monitoring wells (AOS-1, AOS-2, AOS-3, and AOS-4) between 1999 and 2000. These wells are all located downgradient of the site and were constructed of PVC in an effort to avoid the scale and corrosion experienced at the onsite wells. In April 2008, the RWQCB stated that Alcoa would no longer be required to monitor offsite monitoring wells AOS-1, AOS-2, and AOS-3 unless elevated levels of salts were detected at upgradient well AOS-4 (RWQCB, 2008). Alcoa is currently evaluating the ownership transfer of wells AOS-1, AOS-2, and AOS-3 to Watermaster to allow for continued monitoring.

The plume emanating from the Alumax site is characterized by elevated concentrations of sulfate, nitrate, chloride, potassium, and sodium. Consequently, the TDS concentrations at the onsite wells are high, ranging from about 500 mg/L to over 2,000 mg/L. Offsite monitoring has yielded observed TDS concentrations that range from about 100 mg/L to 700 mg/L. Note that these TDS values are higher than those observed at up-gradient wells, which typically range from 200 to 300 mg/L.

Chino Airport

The Chino Airport is located approximately four miles east of the City of Chino and six miles south of the OIA and occupies about 895 acres. From the early 1940s until 1948, the airport was owned by the federal government and used for flight training and aircraft storage. The County of San Bernardino acquired the airport in 1948 and has operated and/or leased portions of the facility ever since. Since 1948, businesses and activities at the airport have included: the modification of military aircraft; crop-dusting; aircraft-engine repair; aircraft painting, stripping, and washing; dispensing of fire-retardant chemicals to fight forest fires; and general aircraft maintenance. The use of organic solvents for various manufacturing and industrial purposes has been widespread throughout the airport's history. From 1986 to 1988, a number of groundwater quality investigations were performed in the vicinity of the Chino Airport. Analytical results from groundwater sampling revealed the presence of VOCs above MCLs in six wells downgradient of the Chino Airport. The most common VOC detected above its MCL is TCE, as shown in Figure 10-19. TCE concentrations in the contaminated wells ranged from 6 to 75 µg/L.

In 1990, Cleanup and Abatement Order (CAO) No. 90-134 was issued to address groundwater contamination emanating from the Chino Airport. During 2003, five groundwater monitoring wells were installed onsite; and in 2005, an additional four groundwater monitoring wells were installed onsite for further characterization. During June and July of 2006, Watermaster conducted a focused sampling event of 25 wells within the vicinity of the Chino Airport plume. In 2007, the San Bernardino County Department of Airports began to focus their investigation on offsite characterization of the plume. In 2008, the RWQCB issued a CAO (No. R-8 2008-0064) to the San Bernardino County Department of Airports in order to define the lateral and vertical extent of the VOCs in groundwater and to prepare a remedial action plan. In late 2008, nine offsite monitoring wells were completed in three locations. Initial sampling of these wells was done in August 2009.

Figure 10-18 shows the approximate areal extent of TCE in groundwater at concentrations in exceedance of the MCL in the vicinity of the Chino Airport as of 2008. The plume is elongate in shape, up to 3,600 feet wide, and extends approximately 12,100 feet from the airport's northern boundary in a south to southwestern direction. From July 2003 to June 2008, the maximum TCE concentration detected at an individual well within the Chino Airport plume was 910 µg/L.

California Institute for Men

The California Institution for Men (CIM) is a state correctional facility located in the City of Chino and has been in existence since 1939. The property occupies approximately 1,500 acres, and is bounded by Eucalyptus Avenue to the north, Euclid Avenue to the east, Kimball Avenue to the south, and Central Avenue to the west. Site use includes agricultural operations, inmate housing, and correctional facilities. The Heman G. Stark Youth Correctional Facility occupies the eastern portion of the property (Geomatrix Consultants, 2005).

In 1990, PCE was detected at a concentration of 26 µg/L at CIM drinking water supply Well 1. Analytical results have indicated that the most common VOCs detected in groundwater underlying CIM are PCE and TCE. The maximum PCE concentration in groundwater detected at an individual monitoring well (MW-7) was 1990 µg/L, and the maximum TCE concentration in groundwater detected at an individual monitoring well (MW-6) was 160 µg/L (Geomatrix Consultants, 2007). Other detected VOCs include 1,2-DCE, bromodichloromethane, 1,1,1-TCA, carbon tetrachloride, chloroform, and toluene.

In 1992, construction began on a groundwater monitoring network of approximately 40 wells. These wells were sampled intermittently through 2007. An Interim Remedial Measure (IRM) was implemented to resume production at Well 1, treat extracted water to reduce VOC concentrations, and use that water as part of the CIM potable water distribution system. Since the implementation of the IRM, the concentrations of PCE and TCE in groundwater have decreased considerably. Of the 39 wells sampled in 2007, 6 wells in the shallow aquifer had PCE concentrations in exceedance of the MCL, and TCE was detected at one shallow monitoring well (Geomatrix Consultants, 2007). CIM submitted a Request for No Further Action (NFA) for groundwater PCE remediation to the RWQCB.

Figure 10-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding their MCLs as of 2008. The plume is up to 2,900 feet wide and extends about 5,800 feet from north to south. As Figure 10-19 illustrates, the CIM plume is primarily characterized by PCE. From July 2003 to June 2008, the maximum PCE and TCE concentrations in groundwater detected at an individual well within the CIM plume were 57 µg/L and 26 µg/L, respectively.

Crown Coach

The former Crown Coach site, located at 13799 Monte Vista Ave in the City of Chino, was used by the General Electric Corporation (GE) for the manufacturing and maintenance of semi-tractors and buses from the early 1970s onward. In 1987, it was discovered that twelve underground storage tanks were leaking lube oils, diesel, antifreeze, waste oil, and wastesolvents. All 12 tanks were removed by 1988, and the release of spent solvents in the underlying soil and groundwater was reported (Rosengarten Smith & Associates, 1992). Since 1988, sampling at 22 monitoring wells has determined the concentration and areal extent of the VOC plume. Contaminated soil and groundwater are contained onsite. The most common VOCs detected are TCE, PCE, and 1,1-DCE, as shown in Figure 10-19.

Concurrent with groundwater monitoring, a series of remediation activities have occurred on the property. Starting in June 1990, extracted groundwater was discharged to an onsite sewer connection, operating under an industrial wastewater discharge permit. A soil-vapor extraction system was brought onsite in 1992 to address vadose zone contamination. Starting in 2005, a Dual Phase Extraction Treatment System (DPETS) was used to remediate groundwater and soil. In May 2008, Duke Reality began redevelopment activities on the property. During construction, DPETS operations ceased, and Edible Oil Solution (EOS) was injected into ten monitoring and extraction wells as a remediation replacement.

Figure 10-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding their MCLs near the Crown Coach Facility as of 2008. The plume is approximately 500 feet in length and 250 feet wide. The last monitoring event in 2008 indicated that the lateral boundaries of the plume are decreasing, and PCE, TCE, and 1,1 DCE were not detected in deep aquifer wells (Rosengarten Smith & Associates, 2008). From July 2003 to June 2008, the maximum PCE and TCE concentrations detected at an individual well within the Crown Coach VOC plume were 182 µg/L and 125 µg/L, respectively.

In June 2009, GE submitted a report to the Regional Board evaluating the effectiveness of the EOS injections and the need for additional remedial measures. In this report GE concluded that the hydrogeologic conditions beneath the site are sufficient to protect the beneficial uses of groundwater in the regional aquifer and that no further monitoring and remediation activity is warranted at this site. A response from the Regional Board on this report is pending.

General Electric Flatiron Facility

The General Electric Flatiron Facility (Flatiron Facility) occupied the site at 234 East Main Street, Ontario, California from the early 1900s to 1982. Its operations primarily consisted of manufacturing clothes irons. Currently, the site is occupied by an industrial park. The RWQCB issued an investigative order to GE in 1987 after an inactive well in the City of Ontario was found to contain TCE and chromium above drinking water standards. Analytical results from groundwater sampling have indicated that VOCs and total chromium are the major groundwater contaminants. The most common VOC detected at levels significantly above its MCL is TCE, as shown in Figure 10-19. TCE has reached a measured maximum concentration of

5,620 µg/L. Other VOCs—including PCE, toluene, and total xylenes—are periodically detected but commonly below their MCLs (Geomatrix Consultants, 1997).

The facility's eighteen monitoring wells are part of a quarterly monitoring program that began in 1991. Remediation activities began in 1995 with RWQCB Waster Discharge Requirement Order No. 95-62 for the pump and treat of groundwater at two extraction wells, EW-01 and EW-02. The operation of the extraction wells and remediation system is also referred to as the Final Remediation Measures (FRM). Groundwater from EW-01 is treated for VOCs, and groundwater from EW-02 is treated for VOCs and chromium. The two sources of treated water join, are pipelined to the West Cucamonga Channel and ultimately to the Ely Basins, where it percolates into the Chino Basin Aquifer. In late 2009 or early 2010, an injection well and pipeline will be completed, and treated groundwater will be injected into the Chino Basin. In addition to the remediation measures discussed above, a Soil Vapor Extraction (SVE) system has been in operation since 2003 to remove VOCs from impacted soil.

Figure 10-18 shows the approximate areal extent of TCE in groundwater at concentrations exceeding the MCL as of 2008. The plume is up to 3,400 feet wide and extends about 9,000 feet south-southwest (hydraulically downgradient) from the southern border of the site. From July 2003 to June 2008, the maximum TCE concentration detected at an individual well within the Flatiron Facility plume was 5,620 µg/L, and the maximum total chromium concentration detected at an individual well was 485 µg/L.

General Electric Test Cell Facility

The GE Engine Maintenance Center Test Cell Facility (Test Cell Facility) is located at 1923 East Avion, Ontario, California. From 1956 to present, primary operations at the Test Cell Facility have included the testing and maintenance of commercial and military aircraft engines. Historically, hazardous waste was disposed of in dry wells. In 1987, results of a preliminary investigation indicated the presence of VOCs in soils near the dry wells. In 1991, a soil and groundwater investigation and subsequent quarterly groundwater quality monitoring showed the presence of VOCs in the soil and groundwater beneath the Test Cell Facility and that the VOCs had migrated offsite (Dames & Moore, 1996). Subsequent investigations indicated that the most common and abundant VOC detected in groundwater beneath the site was TCE. The historical maximum TCE concentration measured at an onsite monitoring well (directly beneath the Test Cell Facility) was 1,240 µg/L. The historical maximum TCE concentration measured at an offsite monitoring well (downgradient) was 190 µg/L (BDM International, 1997). Other detected VOCs include PCE, cis-1,2-DCE, 1,2-dicholoropropane, 1,1-DCE, 1,1-DCA, and chloroform, among others.

A Consent Order between General Electric and CDPH was signed September 28, 1988 for groundwater and soil remediation (Docket No. 88/89-009CO). The groundwater investigation and cleanup is under the oversight of the RWQCB. Vapor extraction treatment system operations began in 1996 (Docket No. HAS 97/98-014). Quarterly monitoring and operations status reports have been submitted to the DTSC and the RWQCB since remediation commenced. Recently a study was conducted to evaluate the effectiveness of the soil remediation program. The results of this study were submitted to the DTSC in October 2008 (Geosyntec Consultants, 2008). In some regions of the facility, shallow soils have reached acceptable closure levels; however, remediation activities will continue until sufficient data can be evaluated.

Figure 10-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding federal MCLs as of 2008. The plume is elongate in shape, up to 2,400 feet wide, and extends approximately 10,300 feet from the Test Cell Facility in a southwesterly direction. As Figure 10-19 illustrates, the GE Test Cell Facility plume is characterized primarily by TCE, PCE, cis-1,2-DCE, and 1,1-DCE. From July 2003 to June 2008, the maximum TCE and PCE concentrations in groundwater detected at an individual well within the Test Cell Facility plume were 900 µg/L and 16 µg/L, respectively.

Kaiser Steel Fontana Steel Site

Between 1943 and 1983, the Kaiser Steel Corporation (Kaiser) operated an integrated steel manufacturing facility in Fontana. During the first 30 years of operations (1945-1974), a portion of the Kaiser brine wastewater was discharged to surface impoundments and allowed to percolate into the soil. In the early 1970s, the surface impoundments were lined to eliminate percolation to groundwater (Wildermuth, 1991). In July of 1983, Kaiser initiated a groundwater investigation that revealed the presence of a plume of degraded groundwater beneath the facility. In August 1987, the RWQCB issued CAO Number 87-121, requiring additional groundwater investigations and remediation activities. The results of those investigations showed that the major constituents of release to groundwater were inorganic dissolved solids and low molecular weight organic compounds. The wells sampled during the groundwater investigations had TDS concentrations ranging from 500 to 1,200 mg/L and TOC concentrations ranging from 1 to 70 mg/L. By November 1991, the plume had migrated almost entirely off the Kaiser site.

In 1993, Kaiser and the RWQCB entered into a settlement agreement; Kaiser was required to mitigate any adverse impacts caused by its plume at existing and otherwise useable municipal wells. Pursuant to the settlement, the RWQCB rescinded its earlier order 91-40, and Kaiser was granted capacity in the Chino II Desalter to intercept and remediate the Kaiser plume within the Chino Basin. In an effort to further characterize the plume, during 2005, a network of 22 public and private supply wells were selected for quarterly groundwater sampling for one year and annual sampling thereafter. In addition, two triple nested monitoring wells, MZ3-1 and MZ3-2, were installed between the distal edge of the plume and municipal supply wells in 2007. Well MZ3-1/3 was found to have elevated concentrations of TDS, sulfate, and TOC. Based on this finding, the Kaiser plume was extended to include this well.

Figure 10-18 shows the approximate areal extent of the TDS/TOC groundwater plume as of 2008. Based on a limited number of wells, including Kaiser monitoring wells MP-2 and KOSF, City of Ontario Wells 27 and 30, and monitoring wells MZ3-1 and MZ3-2, the plume is up to 7,000 feet wide and extends about 18,500 feet from the northeast to the southwest.

Milliken Sanitary Landfill

The Milliken Sanitary Landfill (MSL) is an inactive Class III Municipal Solid Waste Management Unit, located near the intersections of Milliken Avenue and Mission Boulevard in the City of Ontario. This facility is owned by the County of San Bernardino and managed by the County's Waste System Division. The facility operated from 1958 to 1999. Groundwater monitoring at the MSL began in 1987 with five monitoring wells as part of a Solid Waste Assessment Test (SWAT) investigation (IT, 1989). The results of this investigation indicated that the MSL had released organic and inorganic compounds to underlying groundwater. Based on this finding, the MSL conducted an Evaluation Monitoring Program (EMP) investigation. At the completion of the EMP, a total of 29 monitoring wells were drilled to evaluate the nature and extent of the groundwater impacts identified in the vicinity of the MSL (GeoLogic Associates, 1998). Analytical results have indicated that VOCsare the major constituents of release. The most commonly detected VOCs are TCE, PCE, and dichlorodifluoromethane. Other VOCs that have been detected above MCLs include vinyl chloride, benzene, 1,1-dichloroethane, and 1,2-dichloropropane. Historically, the maximum total VOC concentration in an individual monitoring well was 159.6 µg/L (GeoLogic Associates, 1998).

Figure 10-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding MCLs as of 2008. The plume is up to 1,800 feet wide and extends about 2,100 feet south of the MSL's southern border. As Figure 10-19 illustrates, the MSL plume is characterized by a mixture of PCE, TCE, and their degradation products. From July 2003 to June 2008, the maximum TCE and PCE concentrations detected at an individual well within the MSL plume were 12 µg/L and 8.4 µg/L, respectively.

Municipal Wastewater Disposal Ponds

Historically, treated municipal wastewater was disposed of in ponds located near the current IEUA Regional Plant 1 (RP1), located in south Ontario, and the former Regional Plant 3 (RP3) disposal ponds, located in south Fontana. The ponds located just east of RP1, commonly referred to as the Cucamonga ponds, were used to dispose of untreated effluent collected by the Cucamonga County Water District (now the CVWD) and the IEUA. The RP3 disposal ponds are located on the southwest corner of Beech and Jurupa Avenues in the City of Fontana. The discharge of treated wastewater to the Cucamonga ponds and the RP3 ponds ceased between the early 1970s and the mid-1980s. The contaminant plumes emanating from these ponds have never been characterized.

Upland Sanitary Landfill

The Upland Sanitary Landfill (USL) is located on the site of a former gravel quarry at the southeastern corner of 15th Street and Campus Avenue in the City of Upland. The facility operated from 1950 to 1979 as an unlined Class II and Class III municipal solid waste disposal site. In 1982, the entire USL disposal site was covered with a 10-inch thick, low permeability layer of sandy silt (GeoLogic Associates, 1997). Groundwater monitoring began at the USL in 1988, and there are now three onsite monitoring wells: an upgradient well, a cross-gradient well, and a downgradient well (City of Upland, 1998). Monitoring results indicate that the USL has released organic and inorganic compounds to underlying groundwater (GeoLogic Associates, 1997). Groundwater samples from the downgradient monitoring well consistently contain higher concentrations of organic and inorganic compounds than samples from the upgradient and cross-gradient wells. Historical groundwater samples have indicated that VOCs are the major constituents of release, and all three monitoring wells have shown detectable levels of VOCs. The most common VOCs detected above MCLs are dichlorodifluoromethane, PCE, TCE, and vinyl chloride. Other VOCs that have been periodically detected above MCLs include methylene chloride, cis-1,2-DCE, 1,1-DCA, and benzene. For the 1990 to 1995 period, the average total VOC concentration at the downgradient monitoring well was 125 µg/L (GeoLogic Associates, 1997). And, for the July 2003 to June 2008 period, the maximum TCE and PCE concentrations detected at USL monitoring wells were 0.6 µg/L and 3.5 µg/L, respectively.

Figure 10-18 shows the approximate areal extent of VOCs at concentrations exceeding MCLs as of 2008. Please note that this plume is only defined by three onsite monitoring wells. The extent of the plume may be greater than currently depicted in Figure 10-18.

VOC Plume – South of the OIA

A VOC plume, containing TCE, exists south of the OIA. This plume extends approximately from State Route 60 on the north and Haven Avenue on the east to Cloverdale Road on the south and South Grove Avenue on the west. It is up to 11,300 feet wide and 20,500 feet long. By the late 1980s, the RWQCB determined TCE was present in numerous private wells in the area south of the OIA, and identified past activities at the airport as a likely source of TCE (RWQCB, 2005b). By 2005, TCE in exceedance of the CA MCL (5µg/L) was detected in 92 of the 167 private wells in the area. In July 2005, Draft CAOs were issued by the RWQCB to six parties identified as former TCE dischargers on the OIA property: Aerojet, the Boeing Company (Boeing), the Department of Defense, the Lockheed Martin Corporation (Lockheed), and the Northrop Grumman Corporation (Northrop). On a voluntary basis, Lockheed, GE, Boeing, and Aerojet are funding current investigative work on the extent and source of the TCE plume. Three triple nested monitoring wells were constructed in 2008 between the OIA and the VOC plume. A fourth well will be completed in 2009.

Final CAOs will likely be issued in the future. Watermaster has been working closely with the RWQCB and the identified parties, providing any available information to assist in the investigation. Remediation of the plume will likely be achieved using the CDA's Chino Basin Desalter I facilities. Watermaster is currently seeking a settlement with the companies to recover treatment costs associated with the VOC plume.

Figure 10-18 shows the approximate areal extent of the plume as of 2008. As Figure 10-19 illustrates, the OIA plume is characterized solely by TCE. During the July 2003 to June 2008 period, the maximum TCE concentration detected at an individual well within this plume was 38 µg/L.

Stringfellow NPL Site

One facility in the Chino Basin, the Stringfellow site, is on the current NPL of Superfund Sites. This site is located in Pyrite Canyon north of Highway 60 near the community of Glen Avon in Riverside County (see Figure 10-18). From 1956 until 1972, this 17-acre site was operated as a hazardous waste disposal facility. More than 34-million gallons of industrial waste—primarily from metal finishing, electroplating, and pesticide production—were deposited at the site (US EPA, 2001). A groundwater plume of site-related contaminants exists underneath portions of the Glen Avon area. Groundwater at the site contains various VOCs, perchlorate, NDMA, and trace metals, such as cadmium, nickel, chromium, and manganese. In the original disposal area, soil is contaminated with pesticides, polychlorinated biphenyls (PCBs), sulfates, perchlorate, and trace metals. The original disposal area is covered by a clay cap, fenced, and guarded by security services. Contamination at the Stringfellow site has been addressed by cleanup remedies described in four EPA RODs. Since 1986, cleanup actions have focused on controlling the source of contamination, installing an onsite pretreatment plant, the cleanup of the lower part of Pyrite Canyon, and the cleanup of the community groundwater area below Highway 60. In 1996, the DTSC assumed responsibility for the maintenance of the Stringfellow Superfund Site through a Cooperative Agreement with the USEPA. In December 2007, the DTSC submitted the Draft Final Supplemental Feasibility Study (SFS), which identified and evaluated the final remedial alternatives for cleanup. The 2007 Draft SFS is a revised version of an earlier 2000 draft; reconsideration was required after perchlorate and other new contaminates were discovered in 2001. Once finalized, the SFS will be used by the US EPA to select a final remedial strategy and prepare a draft ROD. The draft ROD is anticipated in December 2009.

Figure 10-18 shows the approximate areal extent of the Stringfellow VOC plume as of 2008. The VOC plume is elongate in shape, up to 1,500 feet wide, and extends approximately 14,500 feet from the original disposal area in a southwesterly direction. The most common VOC detected at levels above the MCL is TCE. There are approximately 70 extraction wells throughout the length of the plume, which have been effective in stopping plume migration and removing TCE contamination. South of Highway 60, there are only a few isolated areas where TCE exceeds 5 µg/L (DTSC, 2008). During the 2003 to 2008 period, the maximum TCE concentration detected in the Stringfellow plume was 170 µg/L.

High levels of perchlorate associated with the Stringfellow site were detected in community groundwater south of Highway 60 in 2001. Residents connected to the JCSD water service were provided bottled water, and the DTSC contracted to install water mains and hook ups at each residence. Concurrent with the SFS, the DTSC is conducting a Remedial Investigation and Feasibility Study of remedial alternatives for perchlorate in the downgradient community area. As with TCE, the operation of the groundwater treatment system has resulted in a reduction of perchlorate. Since the discovery in 2001, perchlorate concentrations have been reduced by 30% to 50% throughout the monitored area (DTSC, 2008). Figure 10-18 shows the approximate areal extent of perchlorate concentrations exceeding the Notification Level (6 µg/L) as of 2008. The perchlorate plume is elongated in shape, up to 2,000 feet wide, and extends approximately

25,000 feet to the southwest from the original disposal area. During the 2003 to 2008 period, the maximum perchlorate concentration detected in the Stringfellow plume was 870 µg/L.

Water Quality by Management Zone

Figure 10-20 shows the locations of wells with groundwater quality time histories discussed herein and the five Chino Basin management zone boundaries. Wells were selected based on length of record, completeness of record, quality of data, and geographical distribution. Wells are identified by their local name (usually owner abbreviation and well number) or their X Reference ID (X Ref ID) if privately owned. The HCMP wells were selected because they are sampled at multiple depths and have a consistent water quality record for the past four years. Figures 10-21 through 10-28 are TDS and NO3-N time histories for the wells shown in Figure 10-20 from 1970 to 2008. These time histories illustrate water quality variation and trends within each management zone and the current state of water quality compared to historical trends.

Management Zone 1

MZ1 is an elongate region in the westernmost part of the Chino Basin. Figures 10-21 and 10-22 show TDS and NO3-N time histories for three wells representative of the northern portion of MZ1 (City of Upland well 8 [Upland 08], Monte Vista Water District well 5 [MVWD 05], and City of Upland well 20 [Upland 20]), two wells representative of the central region (City of Chino 5 [Chino 05] and City of Pomona well 23 [Pomona 23]), and two wells representative of the southern portion (Chino Institution for Men well 13 [CIM 13] and HCMP 3). In the northern portion of MZ1, NO3-N and TDS values have remained steady or decreased slightly over the time period depicted. Upland 08 exhibits NO3-N concentrations above the MCL (10 mg/L); however, slightly towards the west, near the Upland, Montclair, and College Heights Recharge Basins, NO3-N values drop below the MCL, as demonstrated by MVWD 05. TDS levels also decrease near the recharge basins. In the central region of MZ1, TDS and NO3-N concentrations have increased slightly over the last 30 years, but they are still below the MCLs. In the southern portion, NO3-N and TDS concentrations have increased significantly since 1990 and are above the MCLs, which is the trend seen in the majority of wells south of Highway 60. Quarterly sampling at HCMP 3 shows that TDS and NO3-N concentrations have remained stable over the past four years. HCMP 3 also shows the variation of water quality from the shallow to deeper aquifers. Overall, NO3-N and TDS concentrations in MZ1 escalate from north to south but have not increased over the last five years.

Management Zone 2

MZ2 is an elongate region in the center part of the Chino Basin. Figures 10-23 and 10-24 show TDS and NO3-N time histories for two wells representative of the northern portion of MZ2 (CVWD Well 5 [CVWD 05] and City of Ontario well 24 [ONT 24]), one well representative of the central region (City of Ontario well 17 [ONT 17]), and three wells representative of the southern portion (X Ref 29, HCMP 1, and X Ref 5333). Similar to MZ1, NO3-N and TDS values increase from north to south. Over the time period depicted, NO3-N and TDS concentrations have remained stable in the northern portion of MZ2, increased slightly in the central region, and increased considerably in the southern portion. At X Ref 5333 and HCMP 1, in the southern portion of MZ2, TDS concentrations are currently greater than twice the MCL (500 mg/L), and NO3-N concentrations are twice the MCL (10mg/L) or greater. In addition, HCMP 1 exemplifies the variation of high TDS and NO3-N levels in the shallow aquifer and low levels in the deeper aquifer. Overall, NO3-N and TDS concentrations have not increased over the last five years with the exception well X Ref 5333.

Management Zone 3

MZ3 is an elongate region that borders the majority of the Chino Basin's eastern boundary. Figures 10-25 and 10-26 show TDS and NO3-N time histories for one well representative of the northern portion (City of Fontana 37A [F37A]), one well representative of the central region (City of Ontario well 31 [ONT 31]), and two wells representative of the southern portion (Jurupa Community Service District well 16 [JCSD 16], and X Ref 5736). Similar to MZ1 andMZ2, NO3-N and TDS values increase from north to south. In the northern and central areas of MZ3, TDS values have slightly increased since 1980 but still remain below the MCL (500 mg/L). Over the time period depicted, NO3-N concentrations increase in all regions of MZ3. Well F37A, in the northern region, exhibits NO3-N concentrations slightly above the MCL (10 mg/L). In the southern portion of MZ3, current TDS and NO3-N concentrations are near double the MCLs. At JCSD 16, NO3-N and TDS concentrations have increased significantly since 1990. In general, NO3-N and TDS concentrations have not increased over the last five years.

Management Zone 4

MZ4 – also known as Chino-East – is a wedge shaped region, bounded by the Jurupa Hills to the northeast, the Pedley Hills to the southeast, Management Zone 5 to the south, and Management Zone 3 to the west. Figures 10-27 and 10-28 show TDS and NO3-N time-histories for one well representative of the western region (HCMP-9), one well representative of the northern region (Jurupa Community Service District Well 24 [JCSD 24]), and one well representative of the eastern region (CDPH Stringfellow monitoring well [CTP-TW1]). In the western portion of MZ4, at HCMP-9, TDS and NO3-N concentrations are above the MCLs in the shallow aquifer but quite low in the deeper aquifer. The TDS and NO3 concentrations at JCSD 24 are slightly lower than those in the western portion, but they are slightly below or equal to the MCLs. In the eastern portion, at CTP-TW1, TDS and NO3-N concentrations are significantly above the MCLs. High TDS and NO3-N concentrations in the eastern portion of MZ4 are predominantly associated with the Stringfellow plume. Pre-1990 water quality data was not available for wells in this region. Since 1990, MZ4 TDS and NO3-N levels have remained relatively stable and decreased slightly over the last few years.

Management Zone 5

MZ5 – also known as Chino-South – is a small region towards the southeastern boundary of the Chino Basin. It is bordered by MZ4 to the north and MZ3 to the east. Figures 10-27 and 10-28 show TDS and NO3-N time histories for three wells representative of the northern portion of MZ5 (San Ana River Water Company Well 1A [SARWC 01A], JCSD 01, and HCMP-8). None of the wells in the southern region of MZ5 have sampling records that are complete enough to be considered representative. At JCSD 01 and SARWC 01A, TDS concentrations have historically been above the MCL (500 mg/L) and began to notably increase in 1990. Starting in 1995, NO3-N concentrations at JCSD 01 and SARWC 01A began to increase slightly above the MCL. Water quality sampling at these two wells ceased around 2005; however, HCMP-8 shows that TDS and NO3-N concentrations have decreased significantly since then.

Current State of Groundwater Quality in Chino Basin

The groundwater quality in Chino Basin is generally very good with better groundwater quality found in the north where recharge occurs. In the southern portion of the basin, TDS and NO3-N concentrations increase. Between July 2003 and June 2008, 32 percent of the wells sampled south of Highway 60 had TDS concentrations below the secondary MCL, an improvement from the 20 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). In some places, wells with low TDS concentrations are proximate to wells with higher TDS concentrations, suggesting a vertical stratification of water quality. Between July 2003 and June 2008, about 69 percent of the wells sampled south of Highway 60 had NO3-N concentrations greater than the MCL, an improvement from the 80 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). However, please note that these statistical improvements may be an artifact of sampling occurrence and frequency.

Other constituents that impact groundwater quality from a regulatory or Basin Plan standpoint include certain VOCs, arsenic, and perchlorate. As discussed in the State of the Basin Report (2008), there are a number of point source releases of VOCs in the Chino Basin that are in various stages of investigation or cleanup. There are also known point source releases of perchlorate (MVSL area, Stringfellow, etc.), and non-point source related perchlorate contamination appears to have resulted from natural and anthropogenic sources. Arsenic at levels above the WQS appears to be limited to the deeper aquifer zone near the City of Chino Hills. Hexavalent chromium, while not currently a groundwater quality issue in the Chino Basin, may become so, depending on the promulgation of future standards.

10.4 IMPORTED WATER QUALITY

MWD's planning efforts have recognized the importance of the quality of its water supplies. To the extent possible, MWD responds to water quality concerns by concentrating on protecting the quality of the source wate rand developing water management programs that maintain and enhance water quality. Contaminants that cannot be sufficiently controlled through protection of source waters must be handled through changed water treatment protocols or blending. These practices can increase costs and/or reduce operating flexibility and safety margins. In addition, MWD has developed enhanced security practices and policies in response to national security concerns.

Implementing the major components of Metropolitan's planning efforts – groundwater storage, recycled water, and minimized impacts on the Delta – requires meeting specific water quality targets for imported water. Metropolitan has two major sources of water: the Colorado River and the State Water Project (SWP). Groundwater inflows are also received into the SWP through groundwater banking programs in the Central Valley. Each source has specific quality issues, which are summarized below. To date, Metropolitan has not identified any water quality risks that cannot be mitigated. As described below, the only potential effect of water quality on the level of water supplies based on current knowledge could result from increases in the salinity of water resources. If diminished water quality caused a need for membrane treatment, Metropolitan could experience losses of up to 15 percent of the water processed. However, Metropolitan would only process a small proportion of the affected water and would reduce total salinity by blending the processed water with the remaining unprocessed water. Thus, Metropolitan anticipates no significant reductions in water supply availability from these sources due to water quality concerns over the study period.

Colorado River

High salinity levels represent a significant issue associated with Colorado River supplies. In addition, Metropolitan has been engaged in efforts to protect its Colorado River supplies from threats of uranium, perchlorate and Chromium VI, which are discussed later in this chapter.

Metropolitan has also been active in efforts to protect these supplies from potential increases in nutrient loading due to urbanization, as well as investigating the sources and occurrence of constituents of emerging concern, such as N-nitrosodimethylamine (NDMA) and pharmaceuticals and personal care products (PPCPs). Metropolitan fully expects its source water protection efforts to be successful, so the only foreseeable water quality constraint to the use of Colorado River water will be the need to blend (mix) it with SWP supplies to meet the adopted salinity standards.

State Water Project

The key water quality issues on the SWP are disinfection byproduct precursors, in particular, total organic carbon and bromide. Metropolitan is working to protect the water quality of this source, but it has needed to upgrade its water treatment plants to deal adequately with disinfection byproducts. Disinfection byproducts result from total organic carbon and bromide in the source water reacting with disinfectants at the water treatment plant, and they may place some near term restrictions on Metropolitan's ability to use SWP water. Metropolitan expects these treatment restrictions to be overcome through the addition of ozone disinfection at its treatment plants. Arsenic is also of concern in some groundwater storage programs.

Groundwater inflows into the California Aqueduct are managed to comply with regulations and protect downstream water quality while meeting supply targets. Additionally, nutrient levels are significantly higher in the SWP system than within the Colorado River, leading to the potential for algal related concerns that can affect water management strategies. Metropolitan is engaged in efforts to protect the quality of SWP water from potential increases in nutrient loading from wastewater treatment plants. Also, as in the Colorado River watershed, Metropolitan is active in studies on the occurrence, sources, and fate and transport of constituents of emerging concern, such as NDMA and PPCPs.

Local Agency Supplies and Groundwater Storage

New standards for contaminants, such as arsenic, and other emerging standards may add costs to the use of groundwater storage and may affect the availability of local agency groundwater sources. These contaminants are not expected to affect the availability of Metropolitan supplies, but they may affect the availability of local agency supplies, which could in turn affect the level of demands on Metropolitan supplies if local agencies abandon supplies in lieu of treatment options. Metropolitan has not analyzed the effect that many of these water quality issues could have on local agency supply availability. There have, however, been some investigations into the supply impacts of perchlorate groundwater contamination as indicated later in this section.

In summary, the major regional concerns include the following:

- Salinity
- Perchlorate
- Total organic carbon and bromide (disinfection byproduct precursors)
- Nutrients (as it relates to algal productivity)
- Arsenic
- Uranium
- Chromium VI
- N-nitrosodimethylamine (NDMA)
- Pharmaceuticals and personal care products (PPCPs)

Metropolitan has taken several actions and adopted programs to address these contaminants and ensure a safe and reliable water supply. These actions, organized by contaminant, are discussed below. Another constituent previously identified in the 2005 RUWMP as a regional concern, methyl tertiary-butyl ether (MTBE), is now a decreasing concern due to the elimination of this chemical as a gasoline additive in California. This is also further discussed below, along with other water quality programs that Metropolitan has been engaged in to protect its water supplies (MWD’s 2010 RUWMP).

10.5 SUMMARY OF WATER QUALITY IMPACTS

The groundwater quality in Chino Basin is generally good, with better groundwater quality found in the northern portion of Chino Basin where recharge occurs. Salinity (TDS) and nitrate concentrations increase in the southern portion of Chino Basin. About 83 percent of the private wells south of the 60 Freeway had nitrate concentrations greater than the MCL.

The other constituents that have the potential to impact groundwater quality from a regulatory or Basin Plan standpoint are certain VOCs, arsenic, and perchlorate. As discussed in Section 9.12, there are a number of point source releases of VOCs in Chino Basin. These are in various stages of investigation or cleanup. Likewise, there are known point source releases of perchlorate (Mid-Valley Sanitary Land Fill area, Stringfellow, et cetera) as well as what appears to be non-point source related perchlorate contamination from currently undetermined-sources. Arsenic at levels above its water quality standard appears to be limited to the deeper aquifer zone near the City of Chino Hills.

The Chino Basin Watermaster is coordinating it efforts to address water quality issues in the basin with the Santa Ana Regional Water Quality Control Board to ensure proactive efforts protect the basin quality.

Figure 10-1
Location of Groundwater Wells in Chino Basin

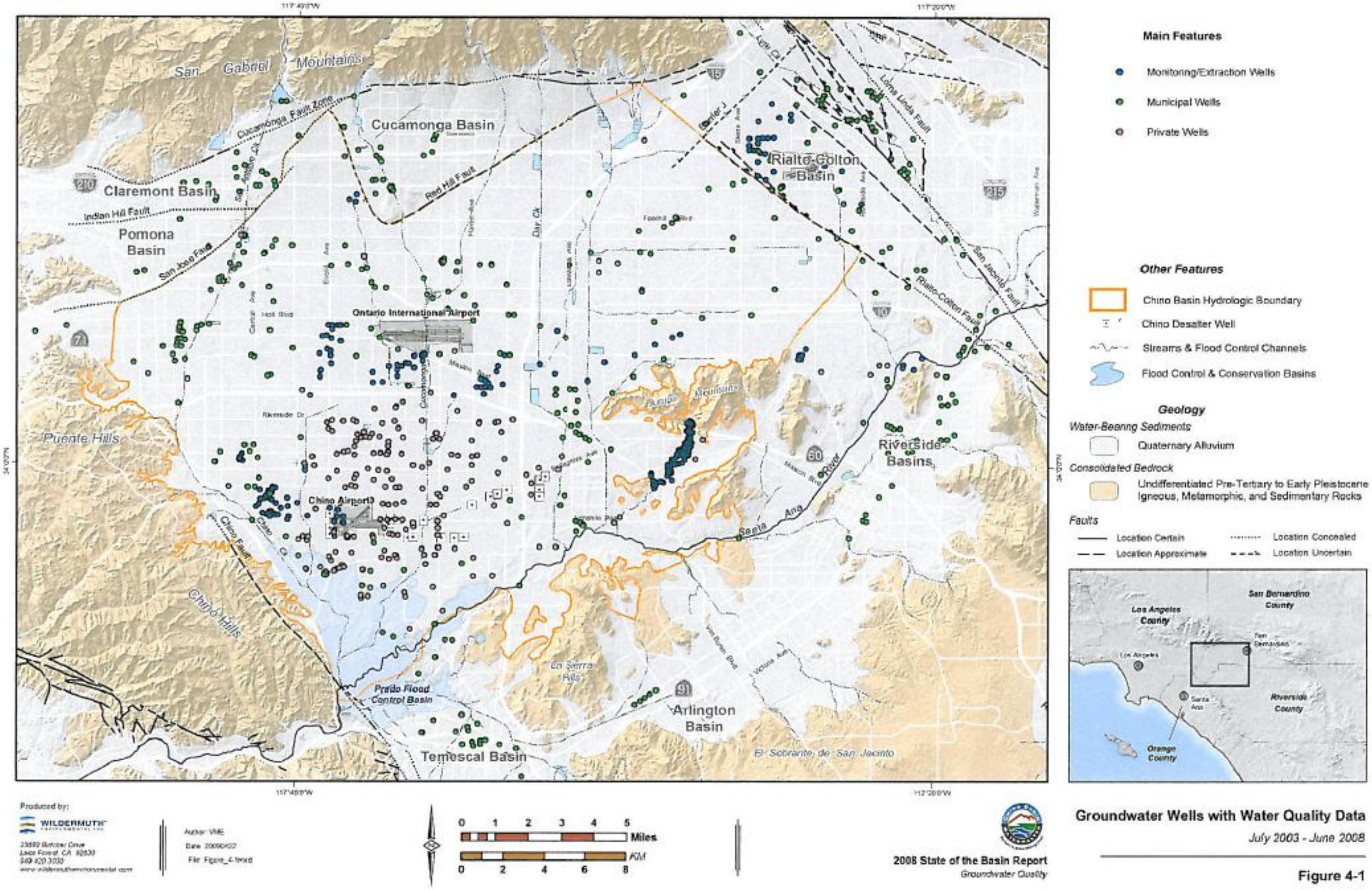


Figure 10-2
Total Dissolved Solids in Groundwater in the Chino Basin

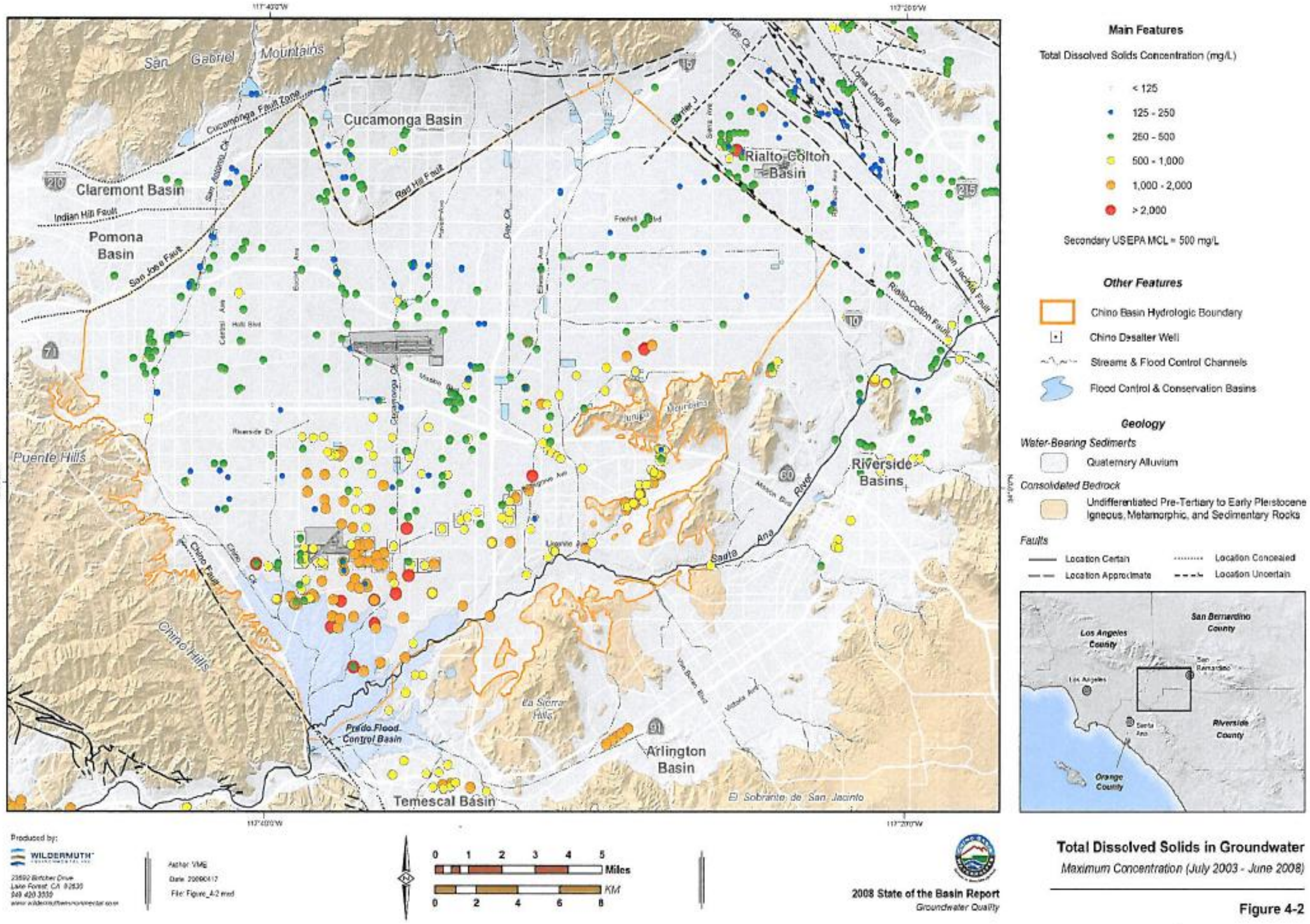


Figure 10-3
Nitrate-Nitrogen in Groundwater

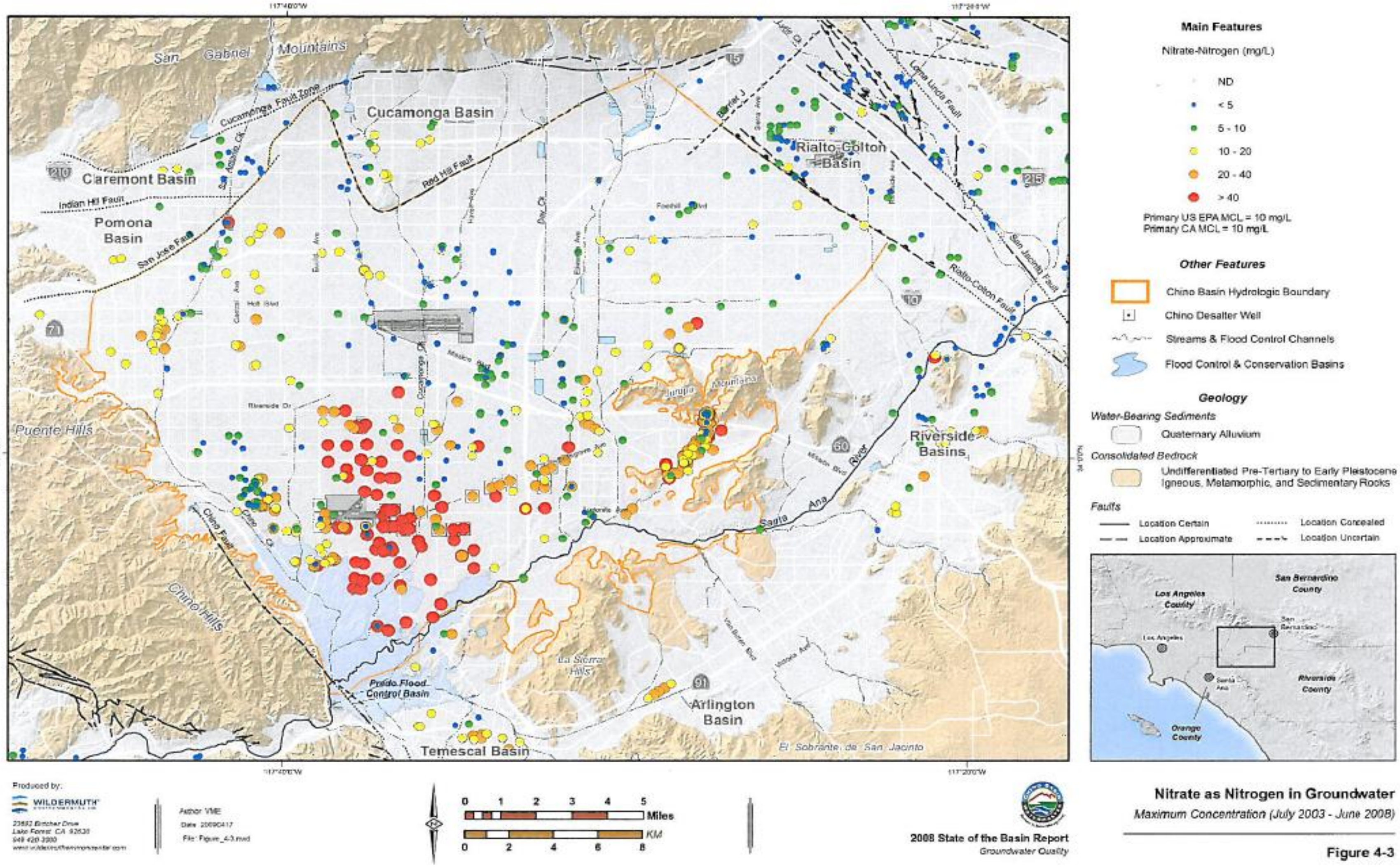


Figure 10-4
Trichloroethene in Groundwater

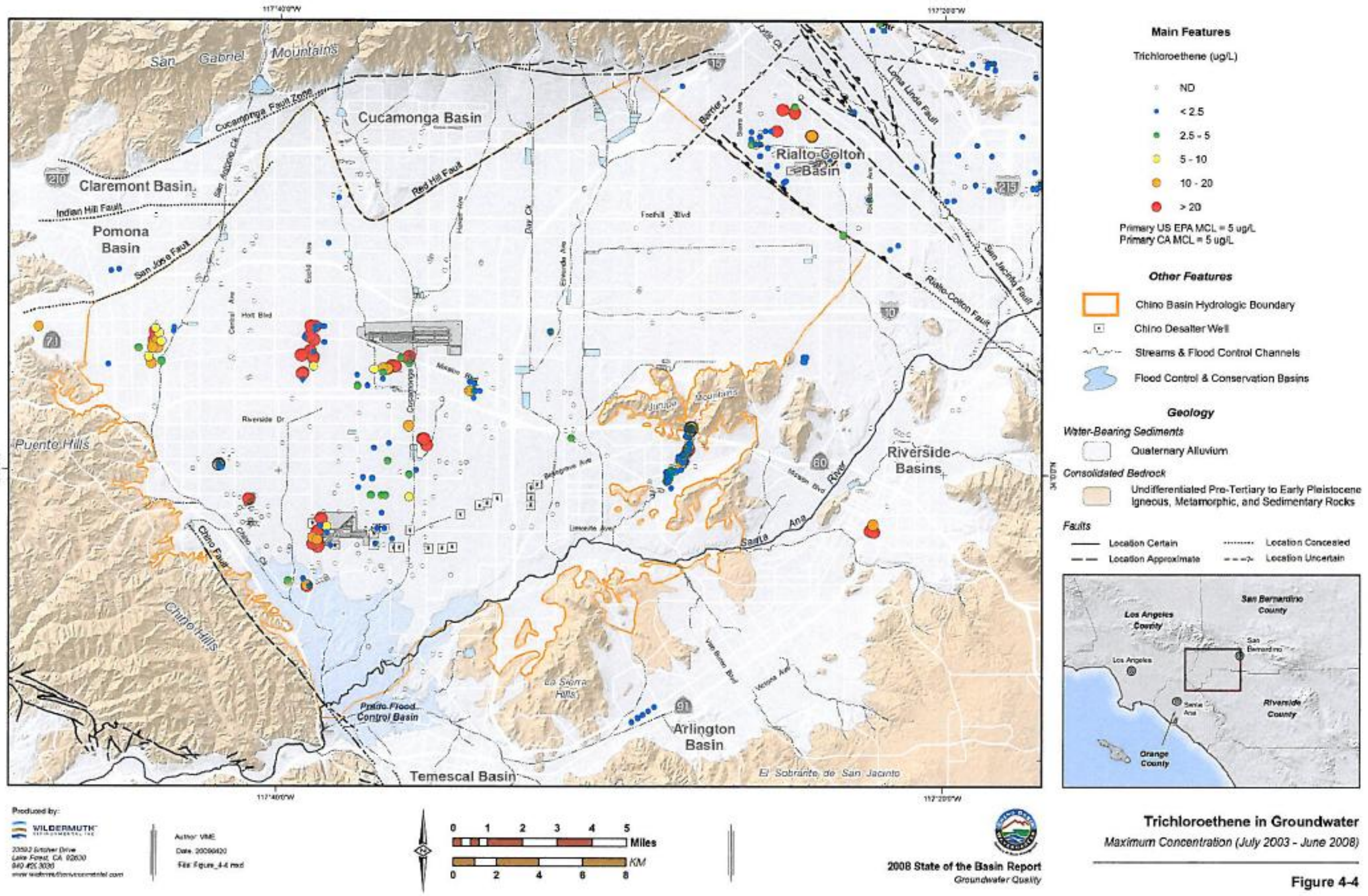


Figure 10-5
Tetrachloroethene in Groundwater

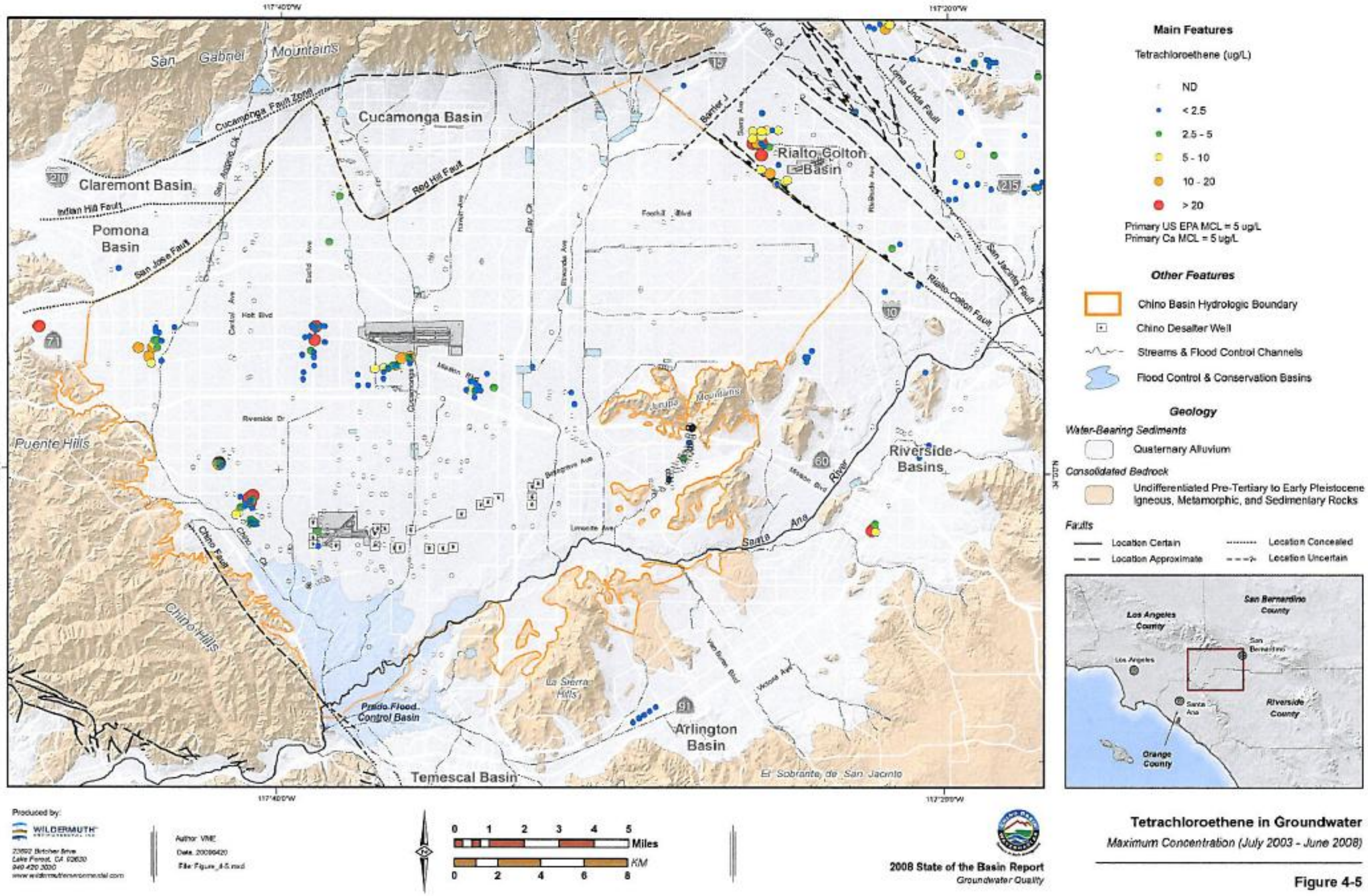


Figure 10-6
1,1-Dichlorethene in Groundwater

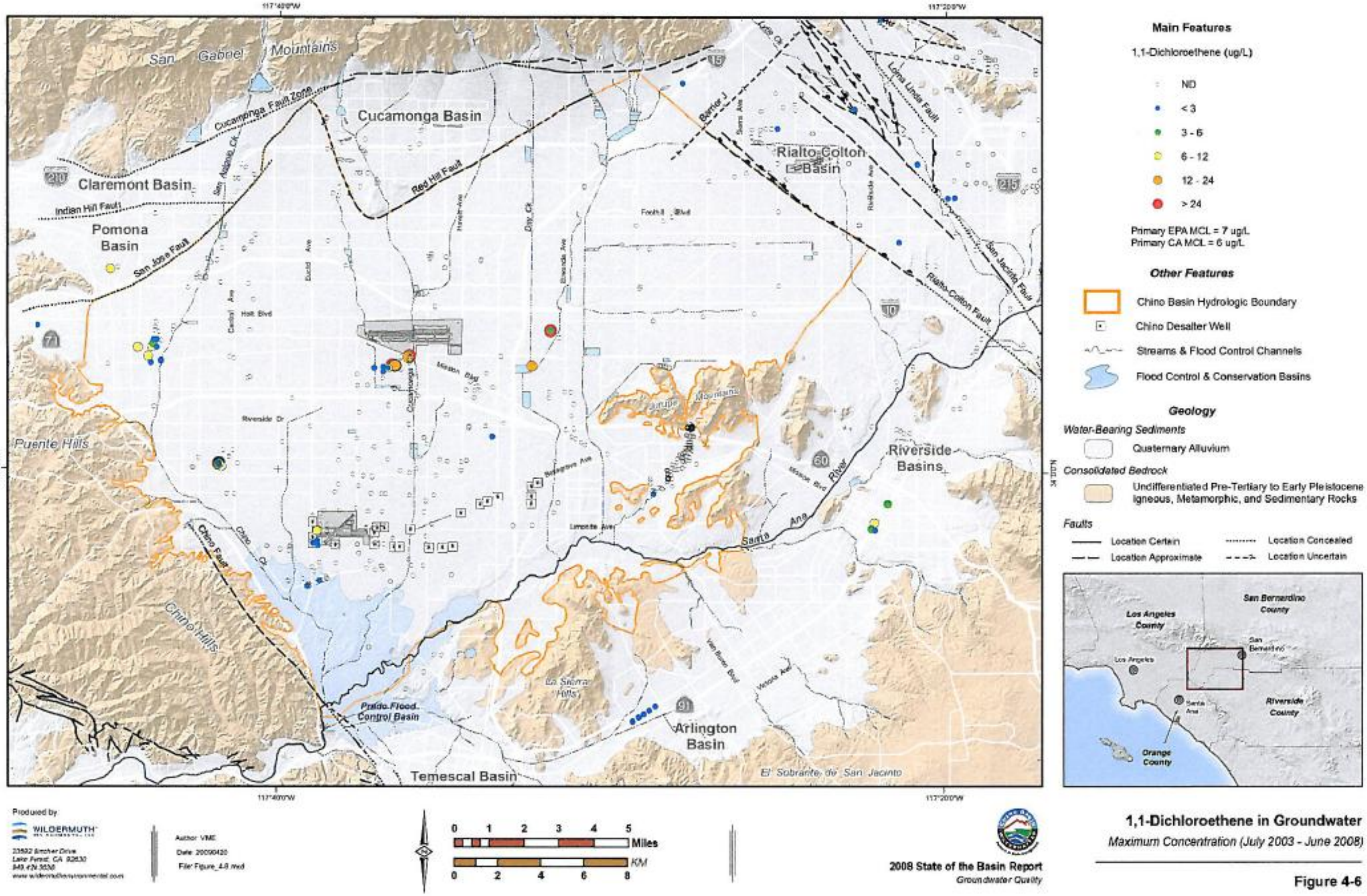


Figure 10-7
1,2-Dichloroethane in Groundwater

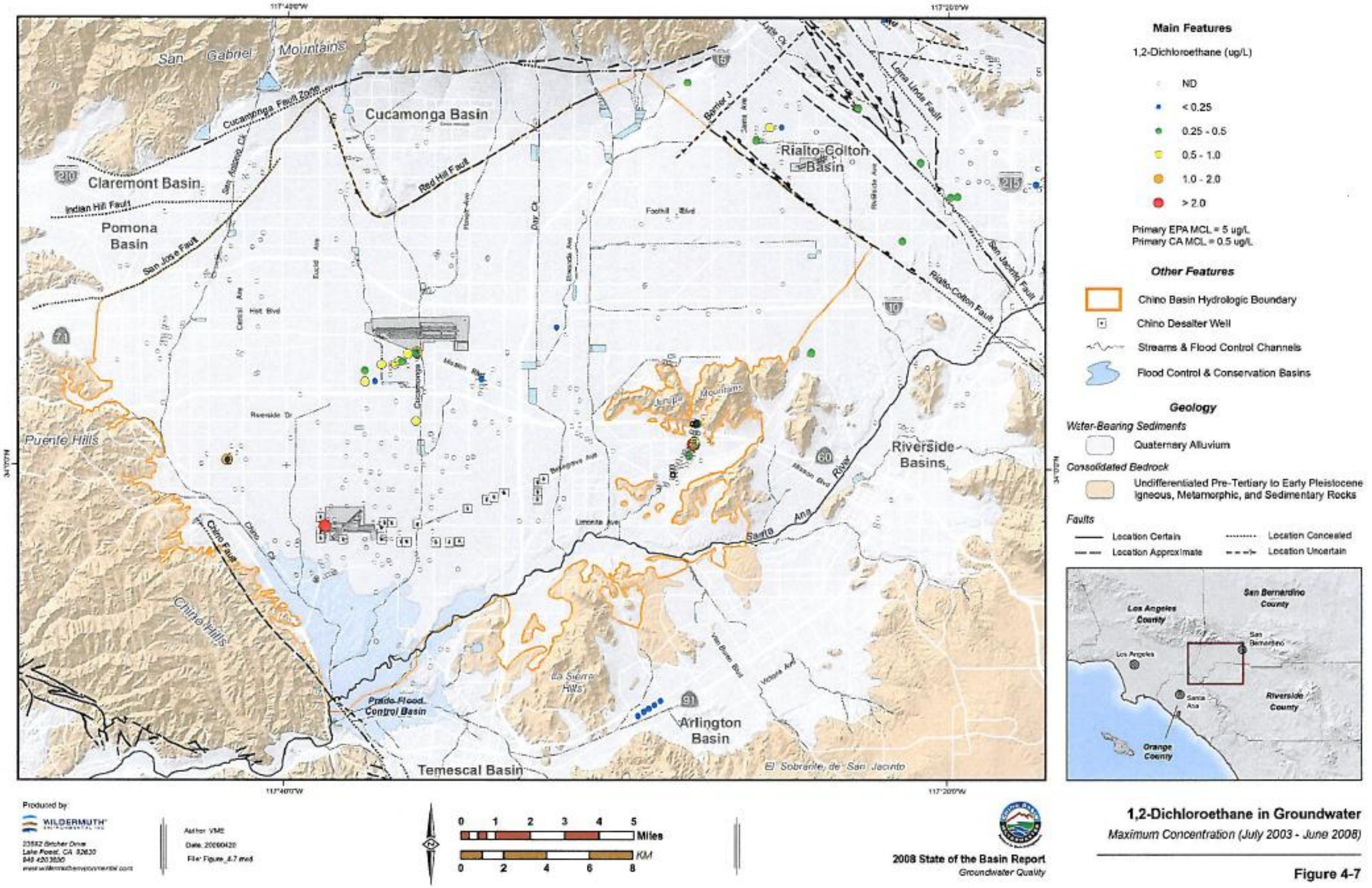


Figure 10-8
Cis-1,2-Dichloroethene in Groundwater

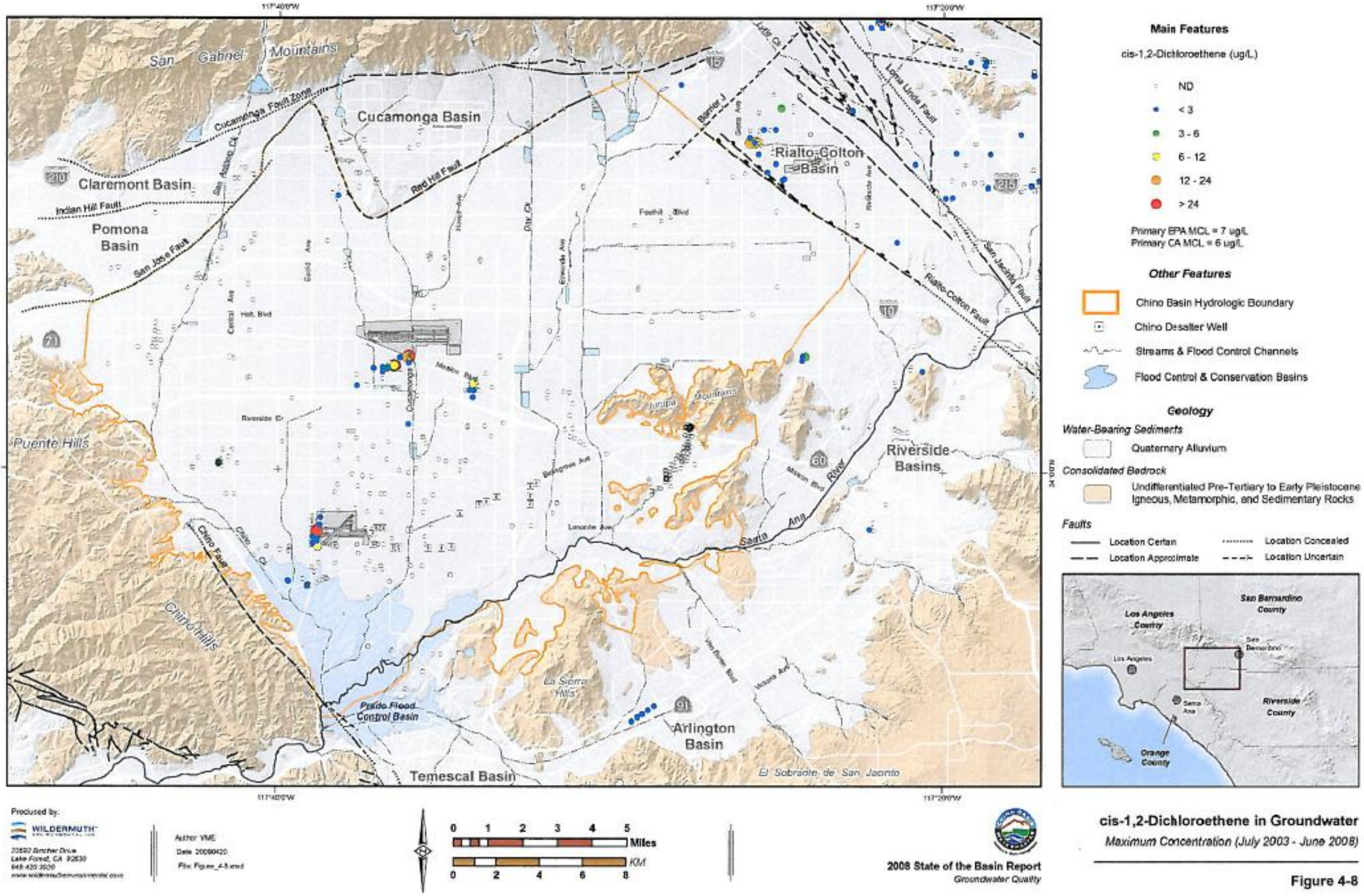


Figure 10-9
1,1-Dichloroethane in Groundwater

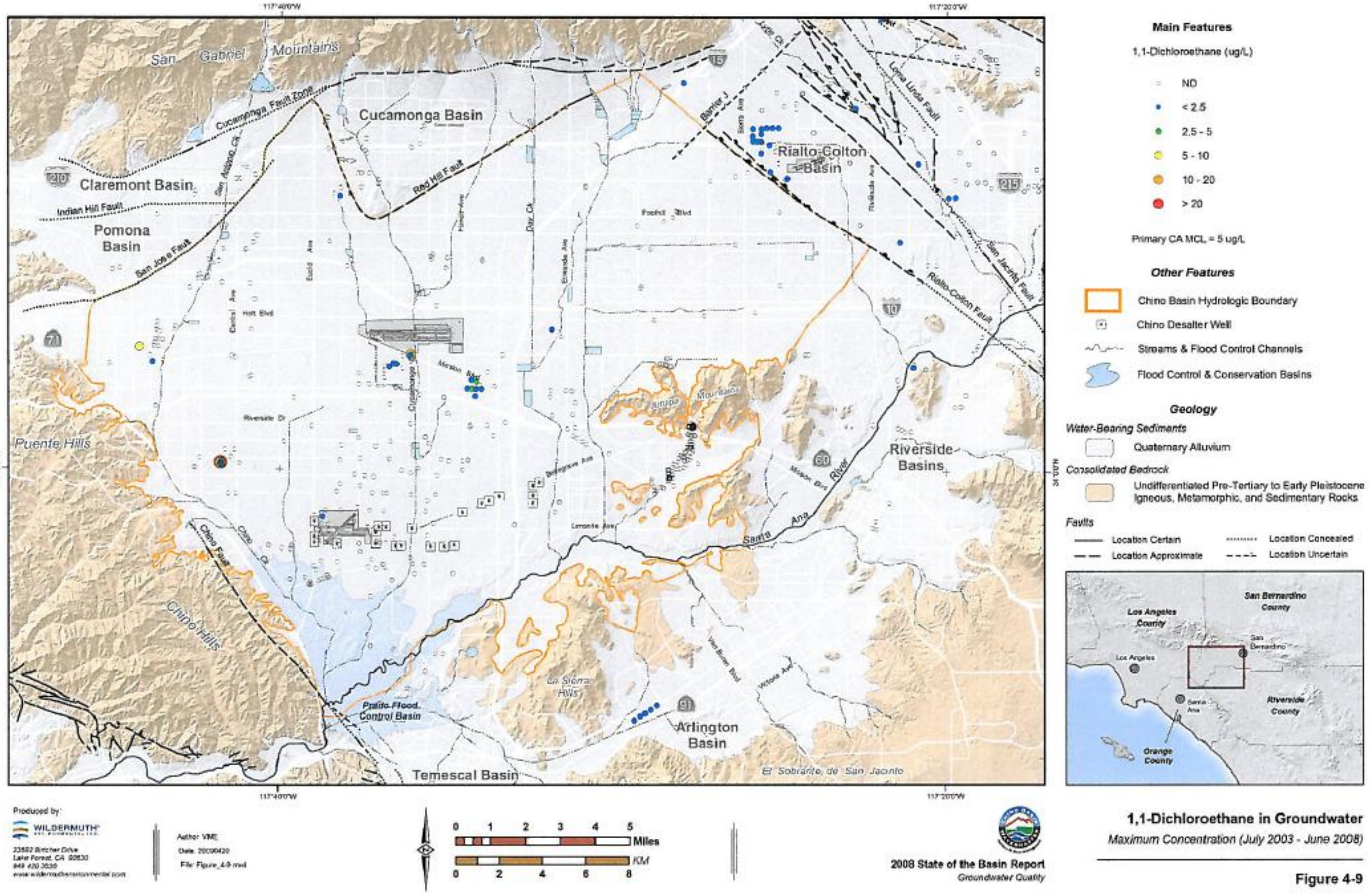


Figure 10-10
1,2,3-Trichloropropane in Groundwater

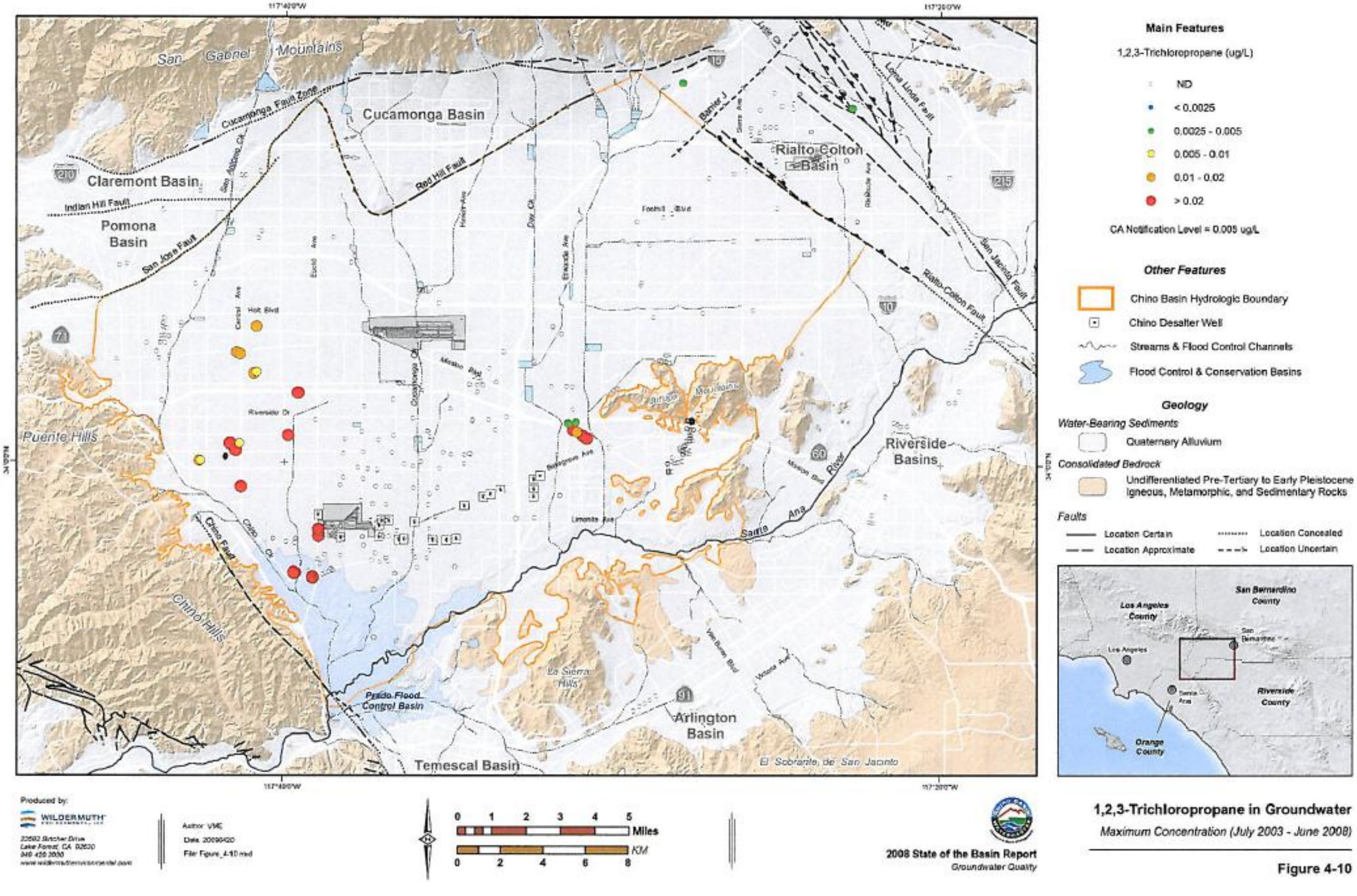


Figure 10-11
Arsenic in Groundwater

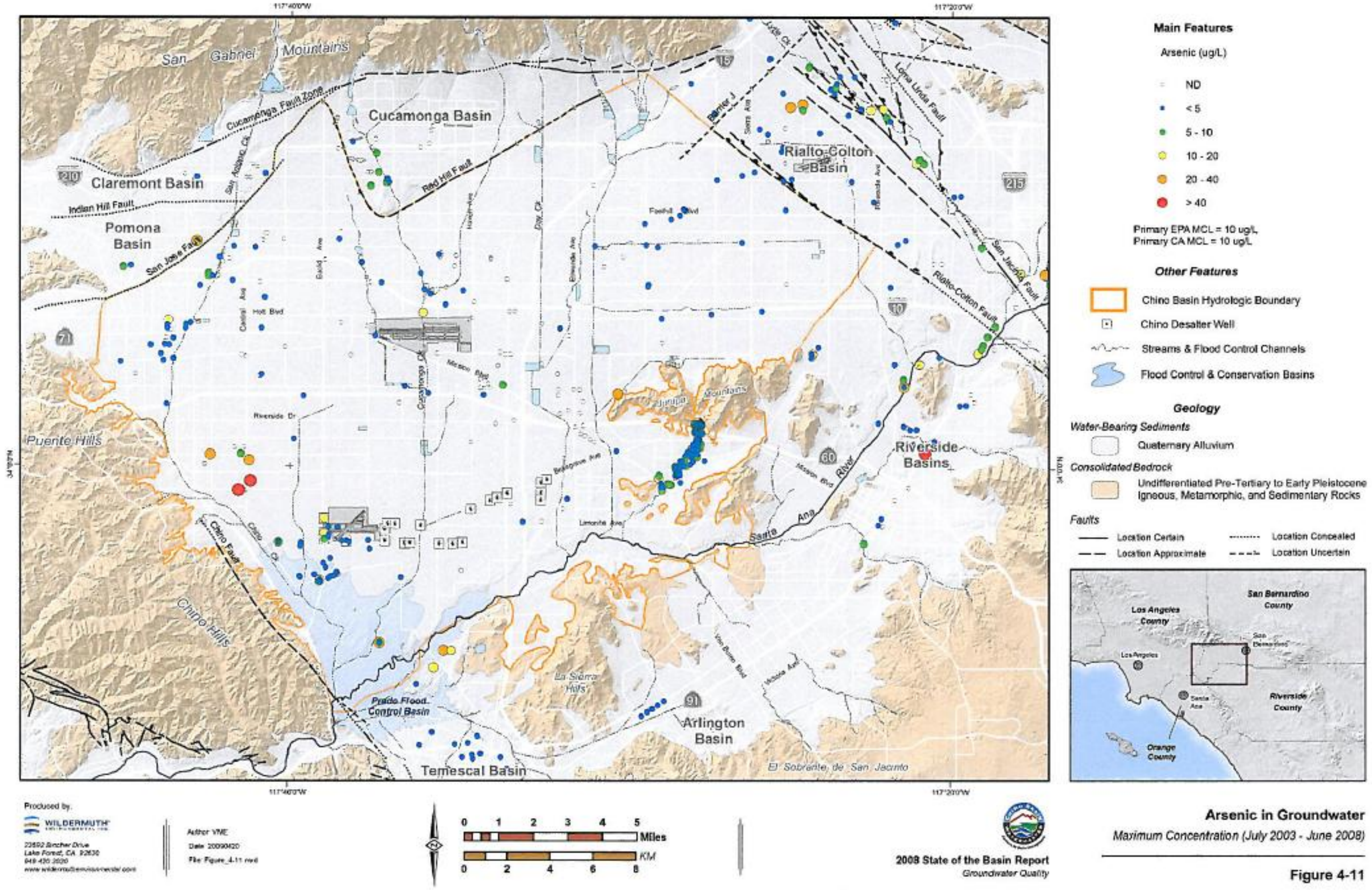


Figure 10-12
Vanadium in Groundwater

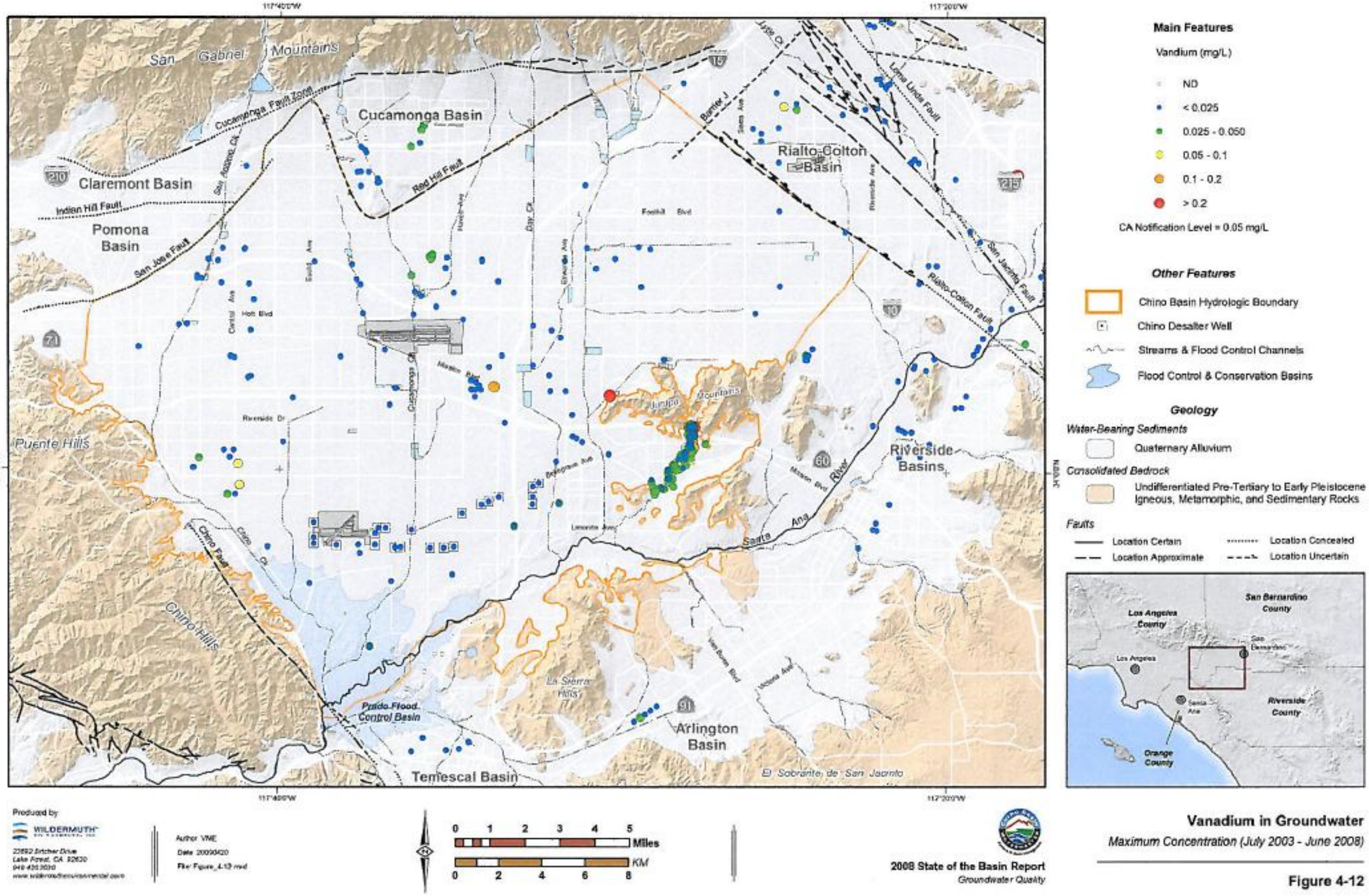


Figure 10-13
Perchlorate in Groundwater

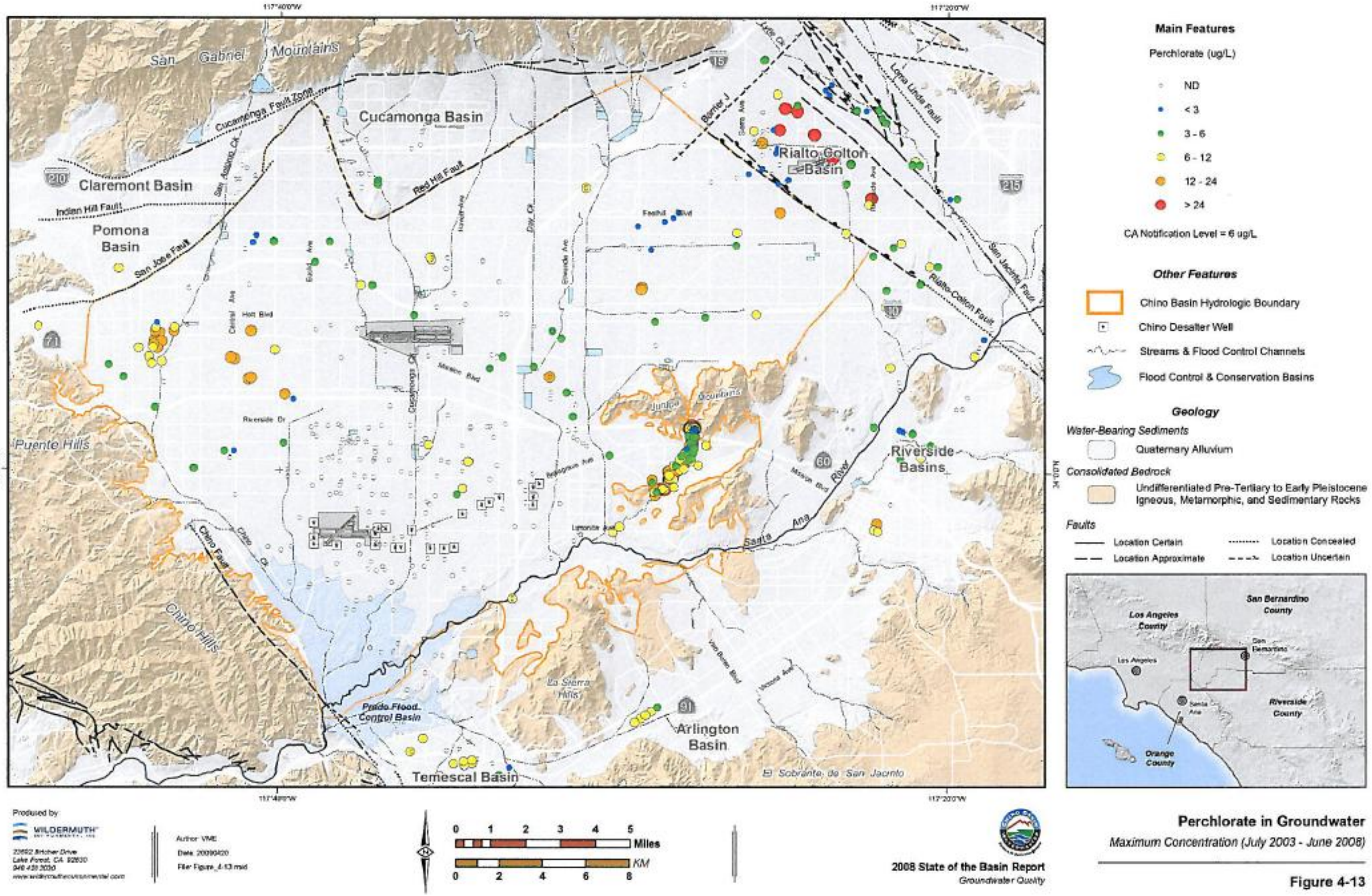


Figure 10-14
Total Chromium in Groundwater

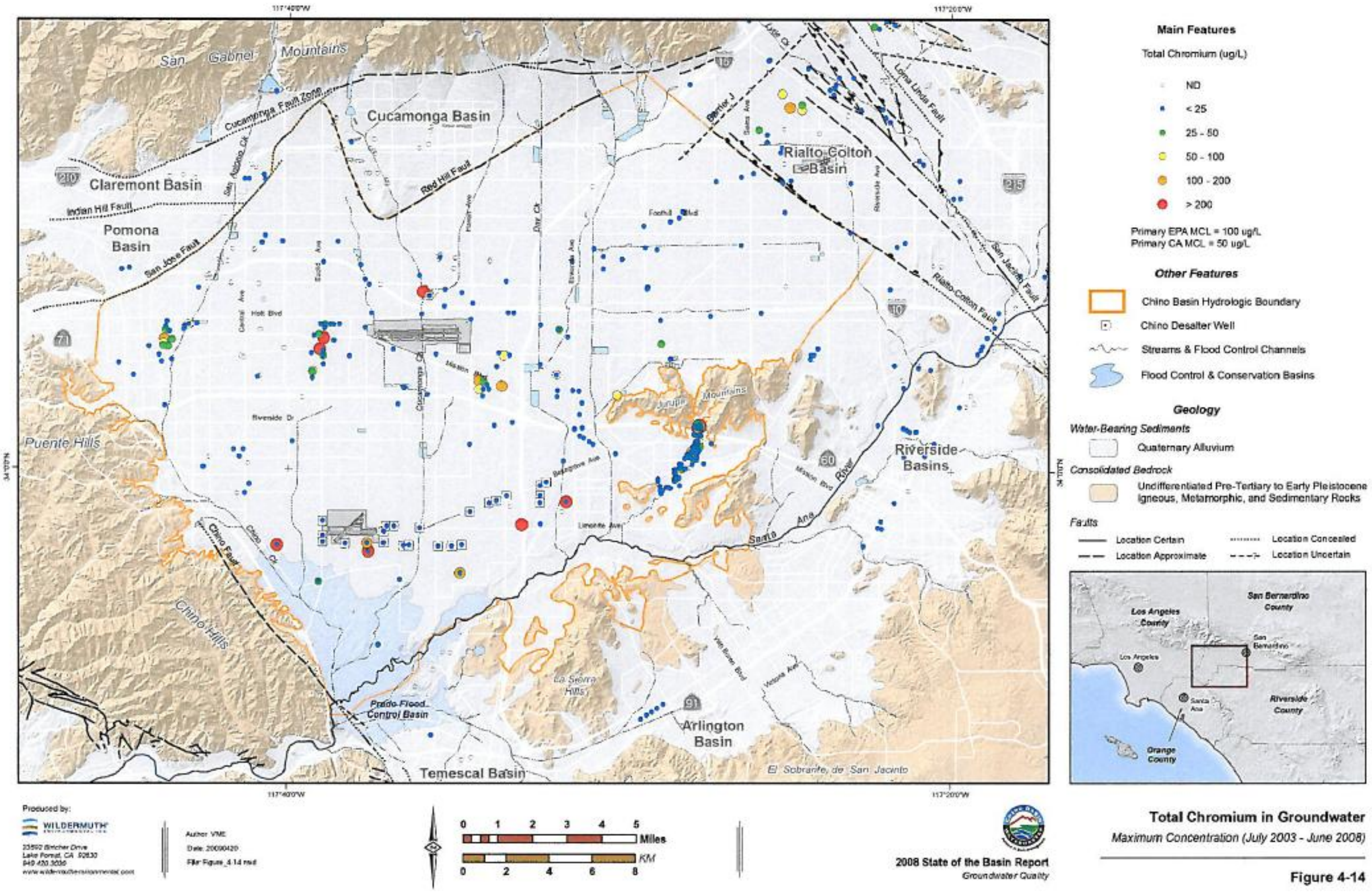


Figure 10-15
Hexavalent Chromium in Groundwater

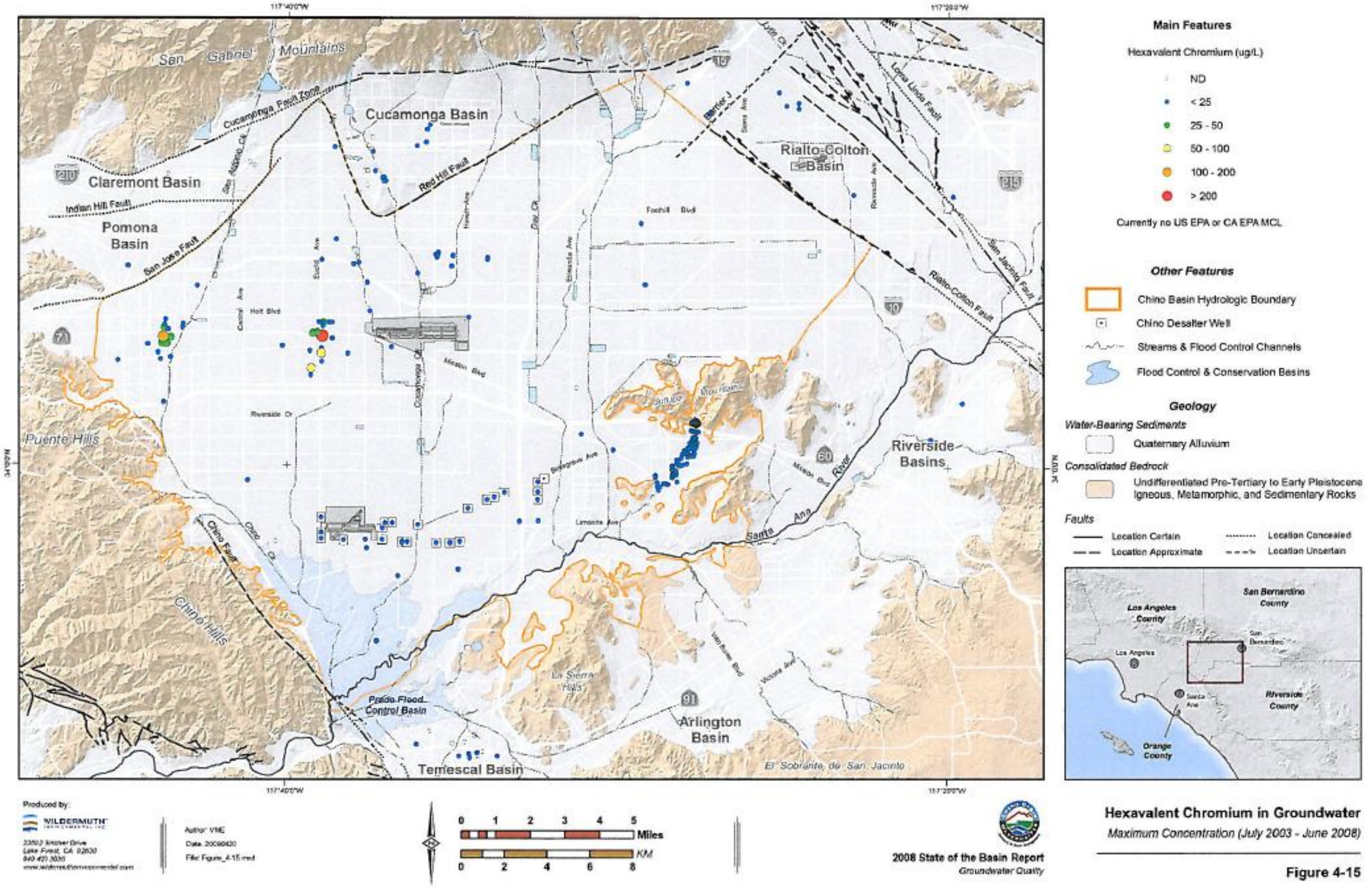


Figure 10-16
Sulfate in Groundwater

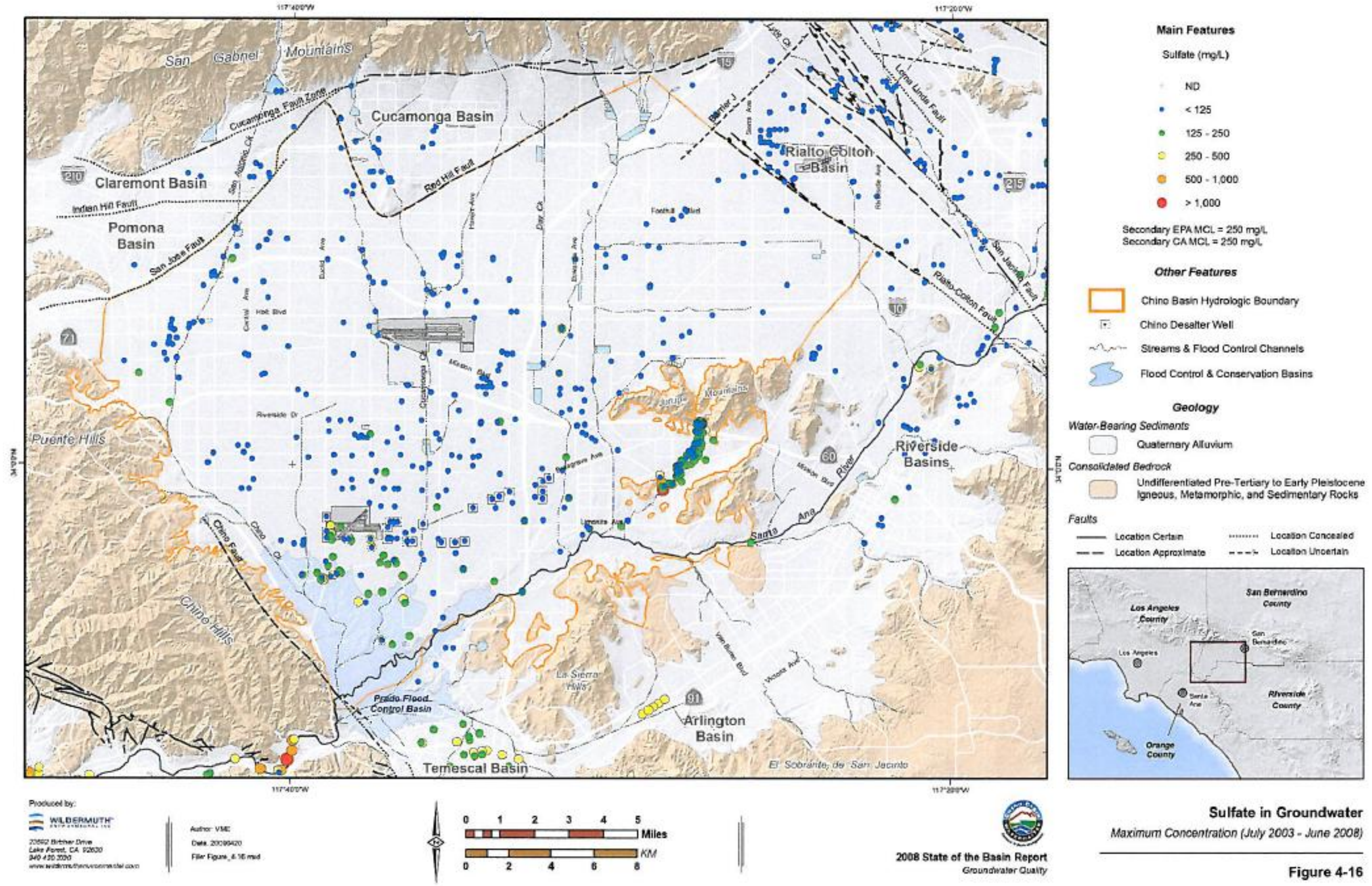


Figure 10-17
Chloride in Groundwater

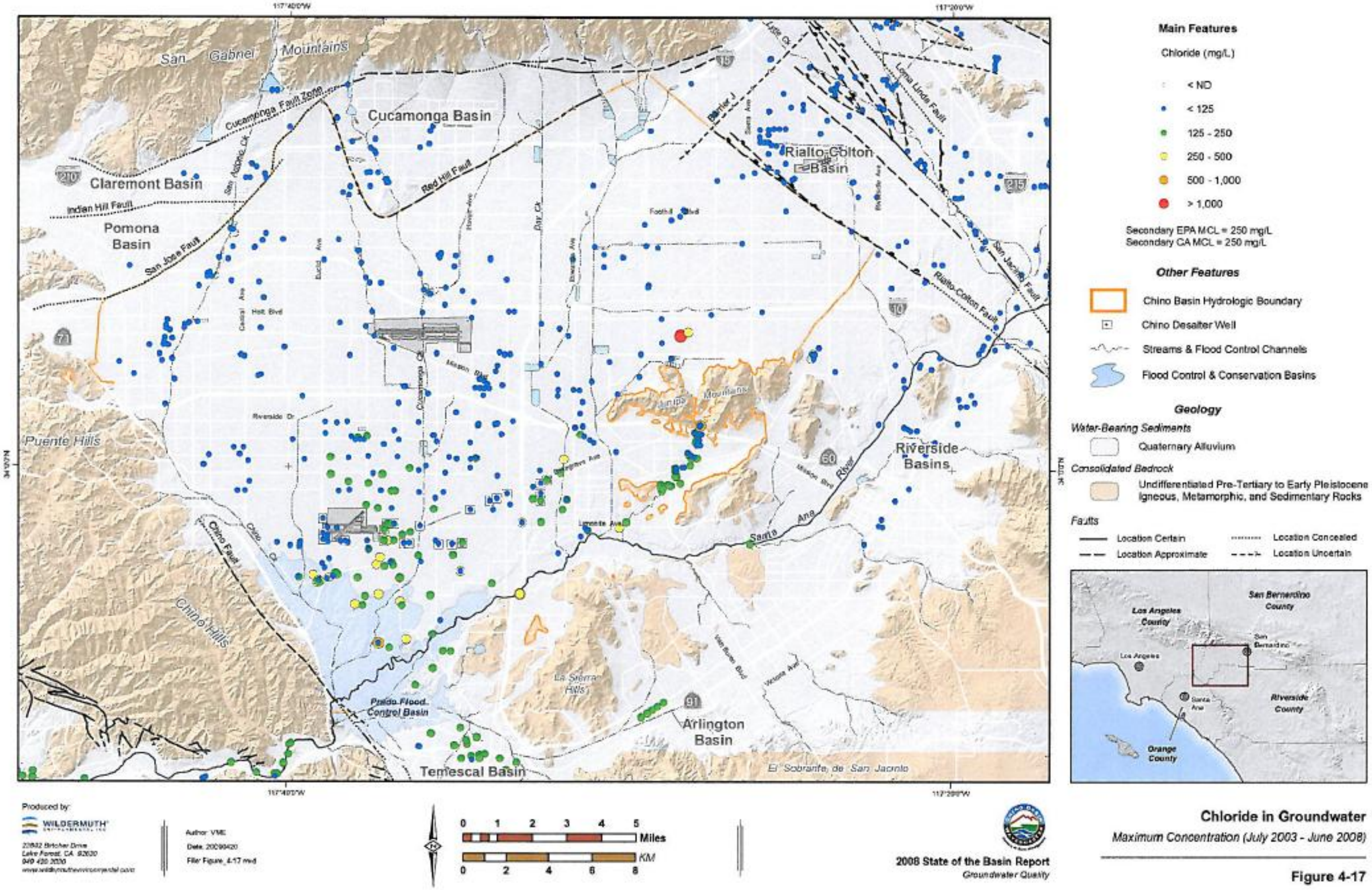


Figure 10-18
Groundwater Contamination in Groundwater

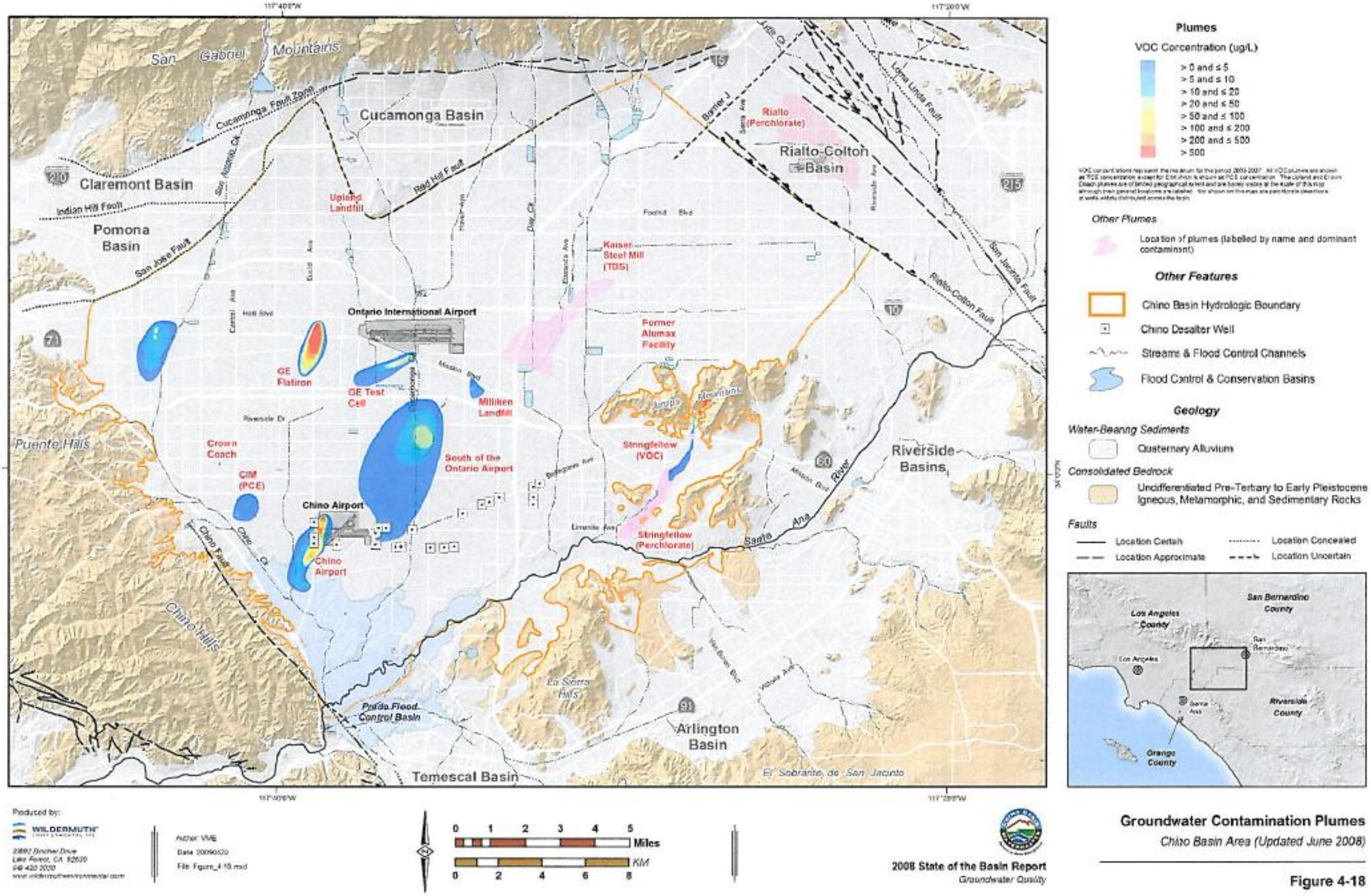


Figure 10-19
Chino Basin Management Zone 1

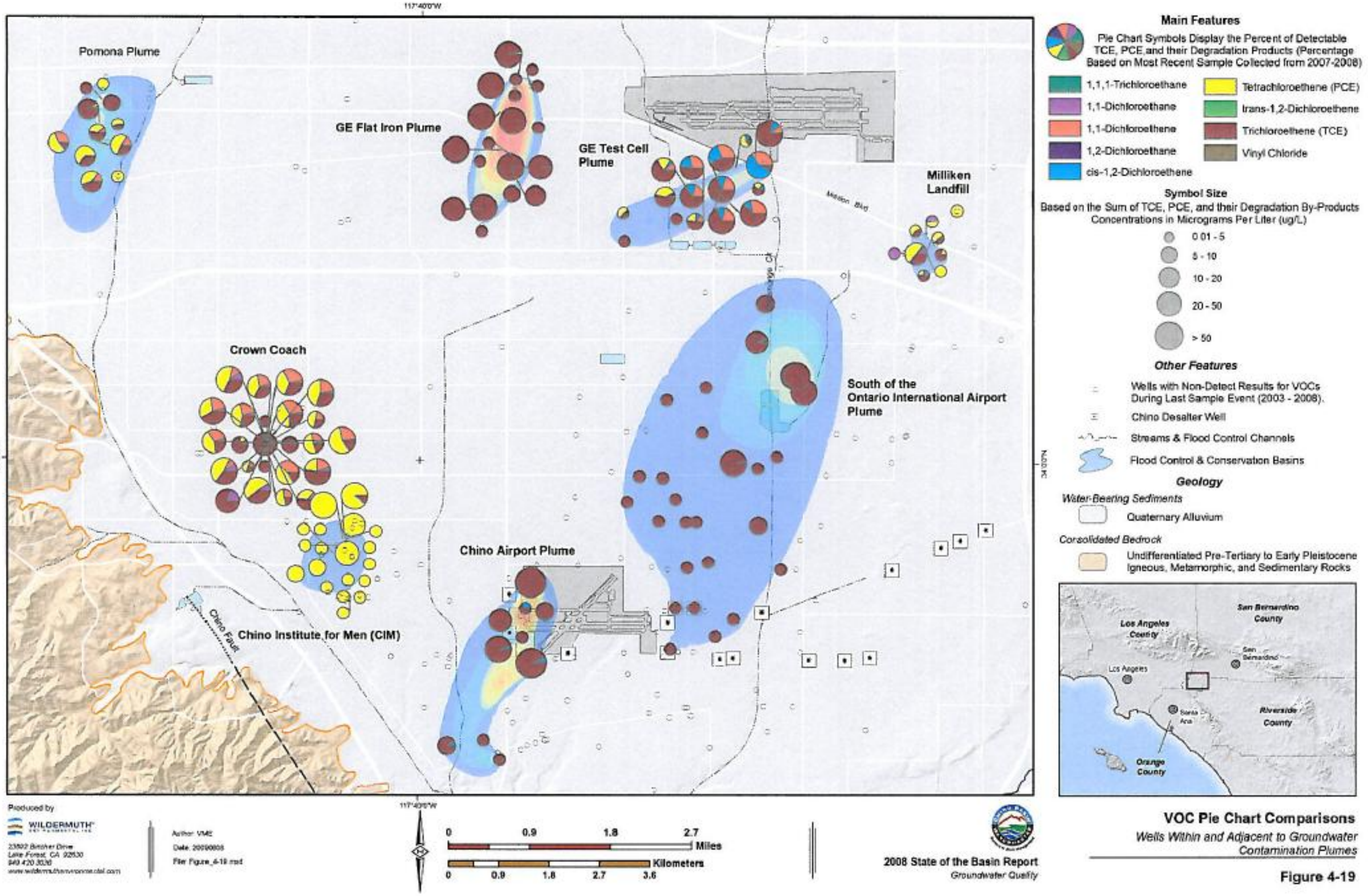


Figure 10-20
Well Locations

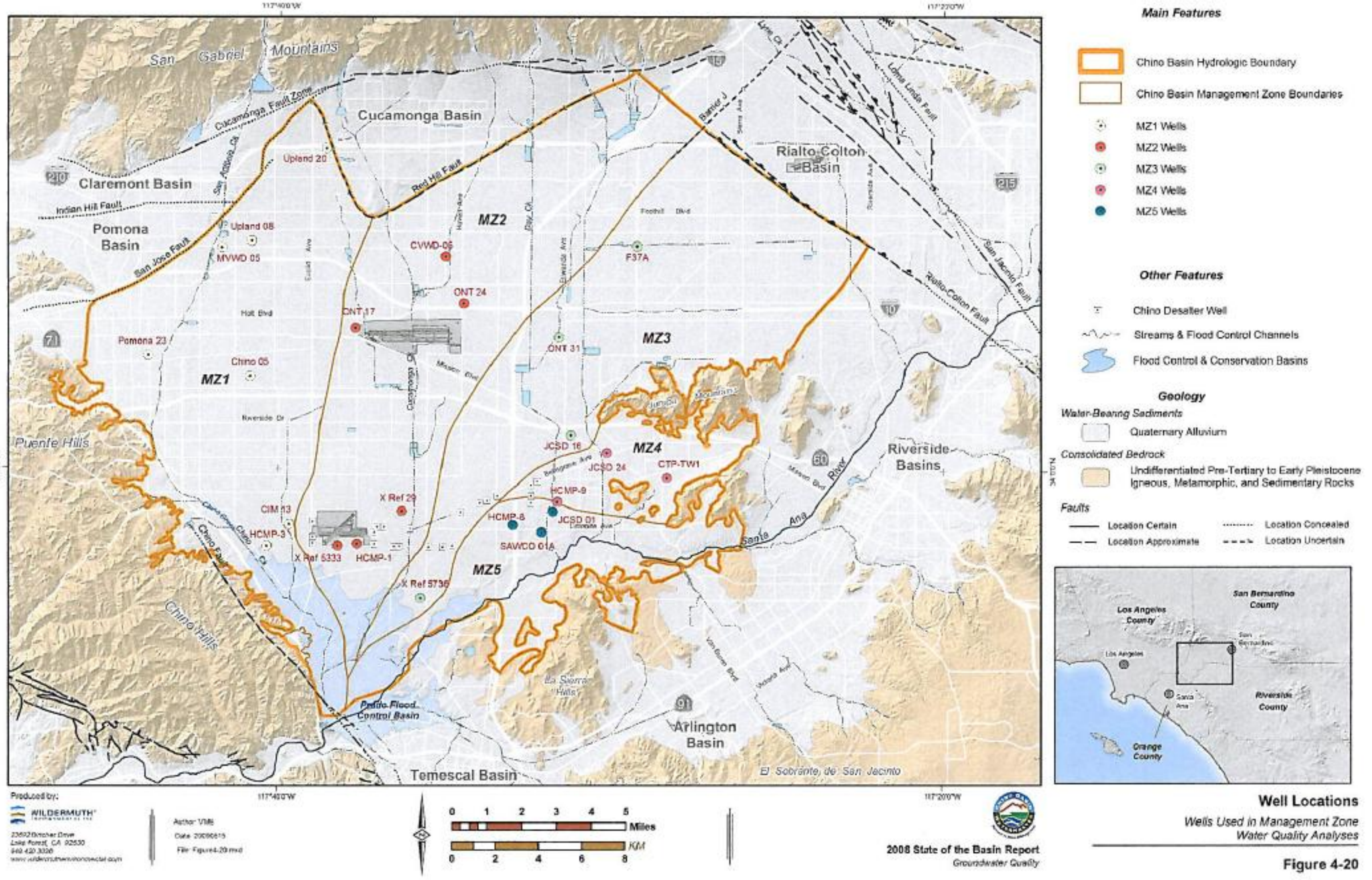


Figure 10-21
Chino Basin Management Zone 1 – Total Dissolved Solids Concentrations

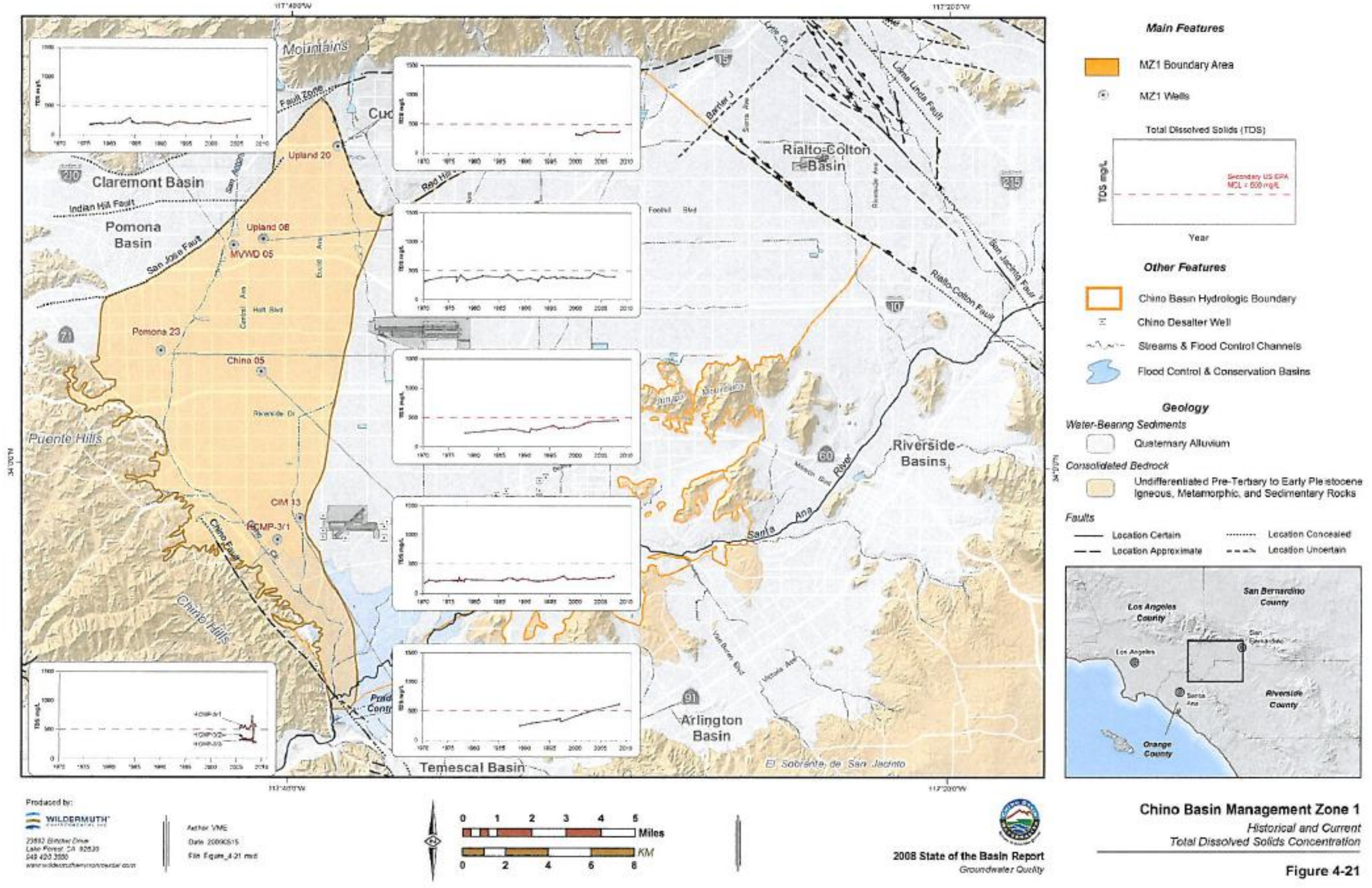


Figure 10-22
Chino Basin Management Zone 1 – Nitrogen Concentrations

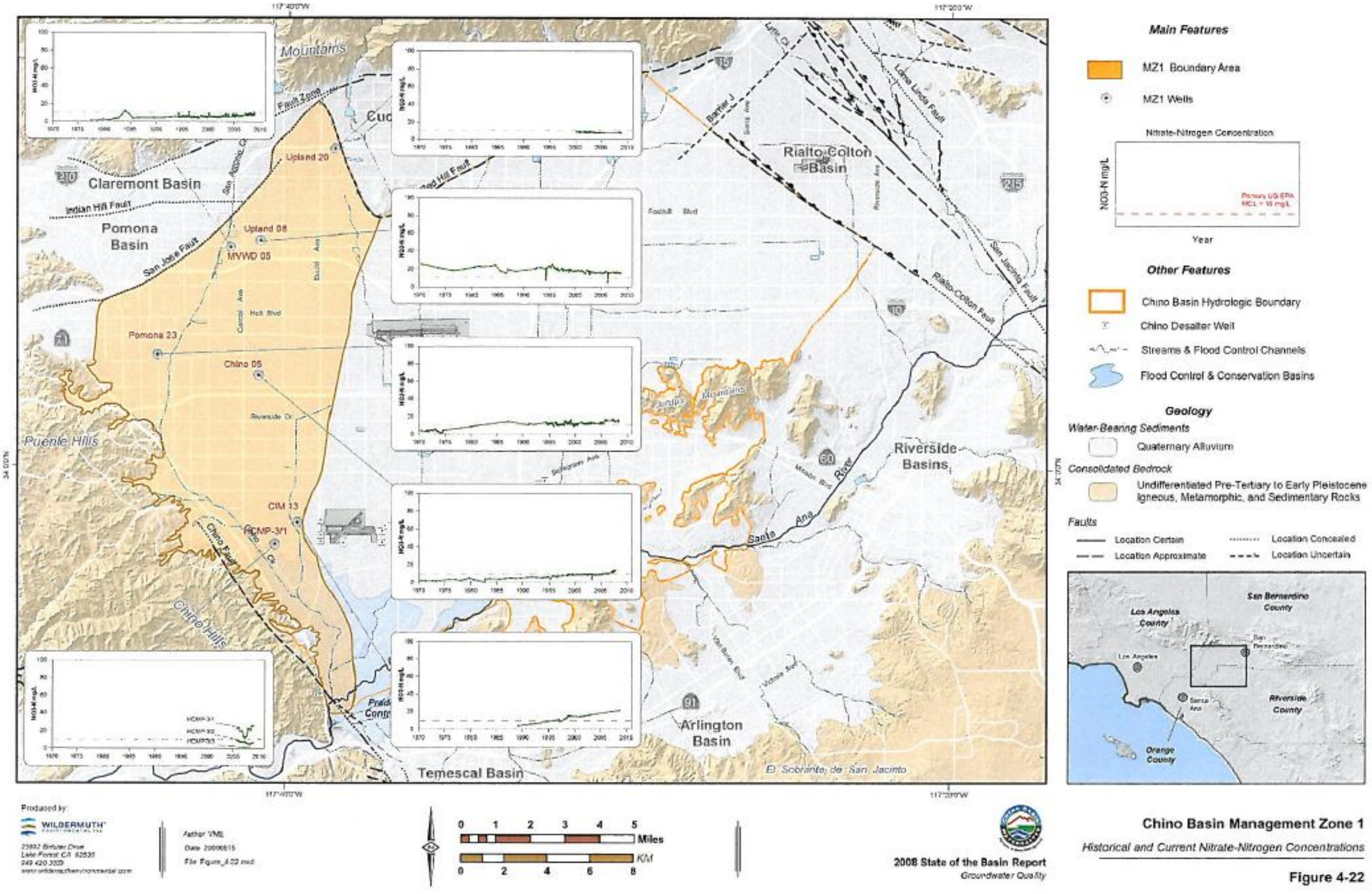


Figure 10-23
Chino Basin Management Zone 2 – Total Dissolved Solids Concentrations

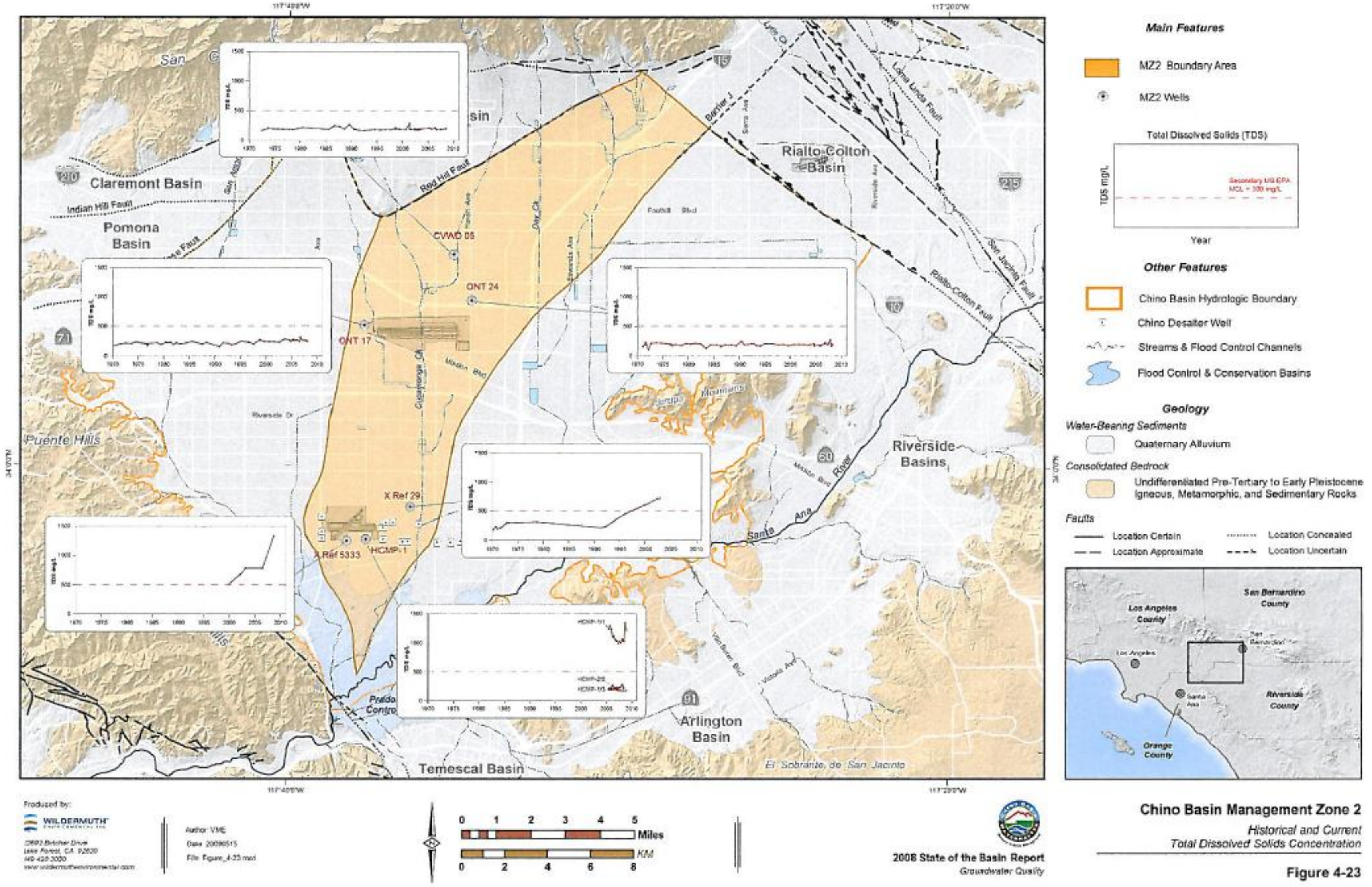


Figure 10-24
Chino Basin Management Zone 2 – Nitrogen Concentrations

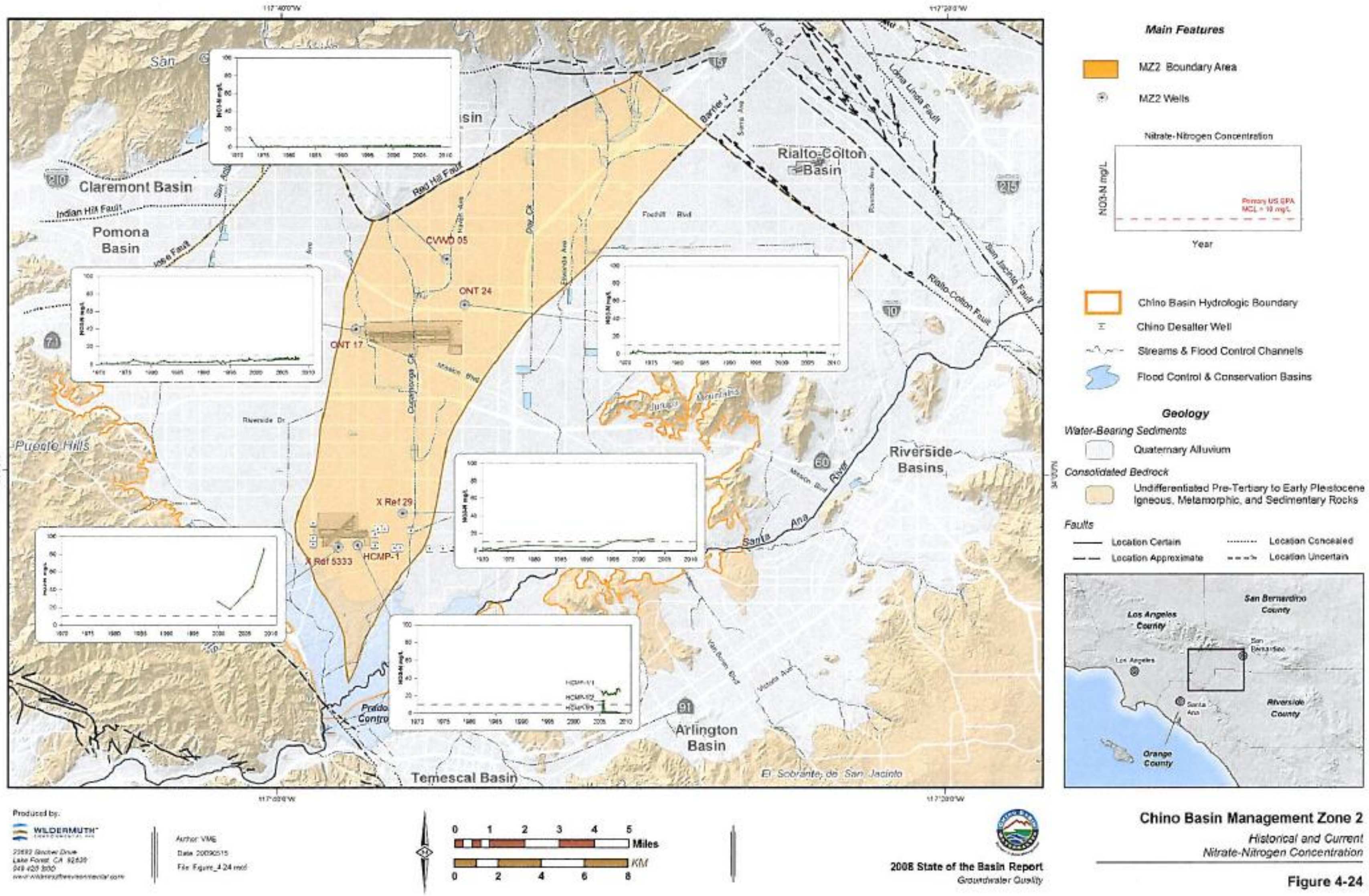


Figure 10-25
Chino Basin Management Zone 3 – Total Dissolved Solids Concentrations

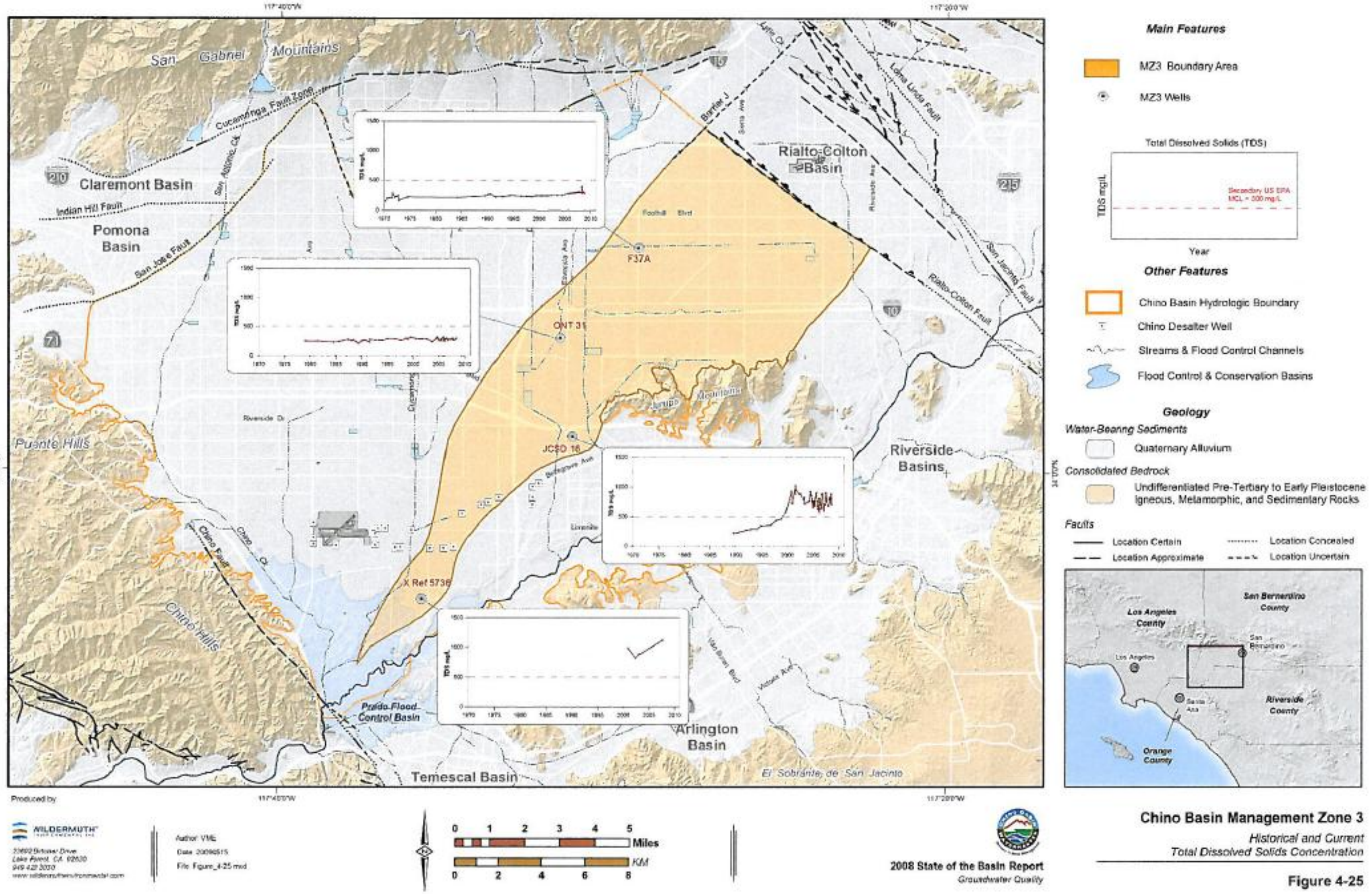


Figure 10-26
Chino Basin Management Zone 3 – Nitrogen Concentrations

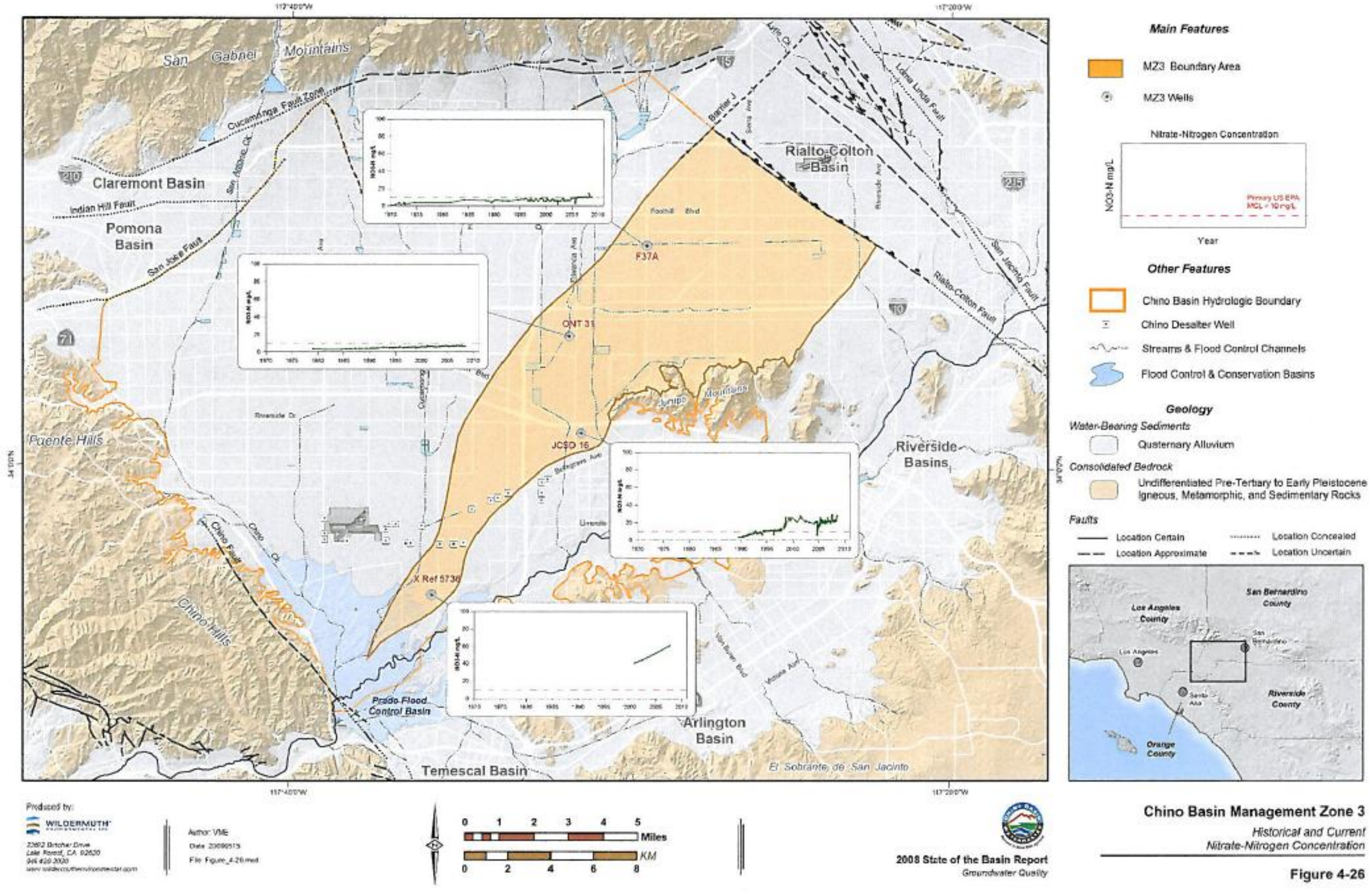


Figure 10-27
Chino Basin Management Zones 4 & 5 – Total Dissolved Solids Concentrations

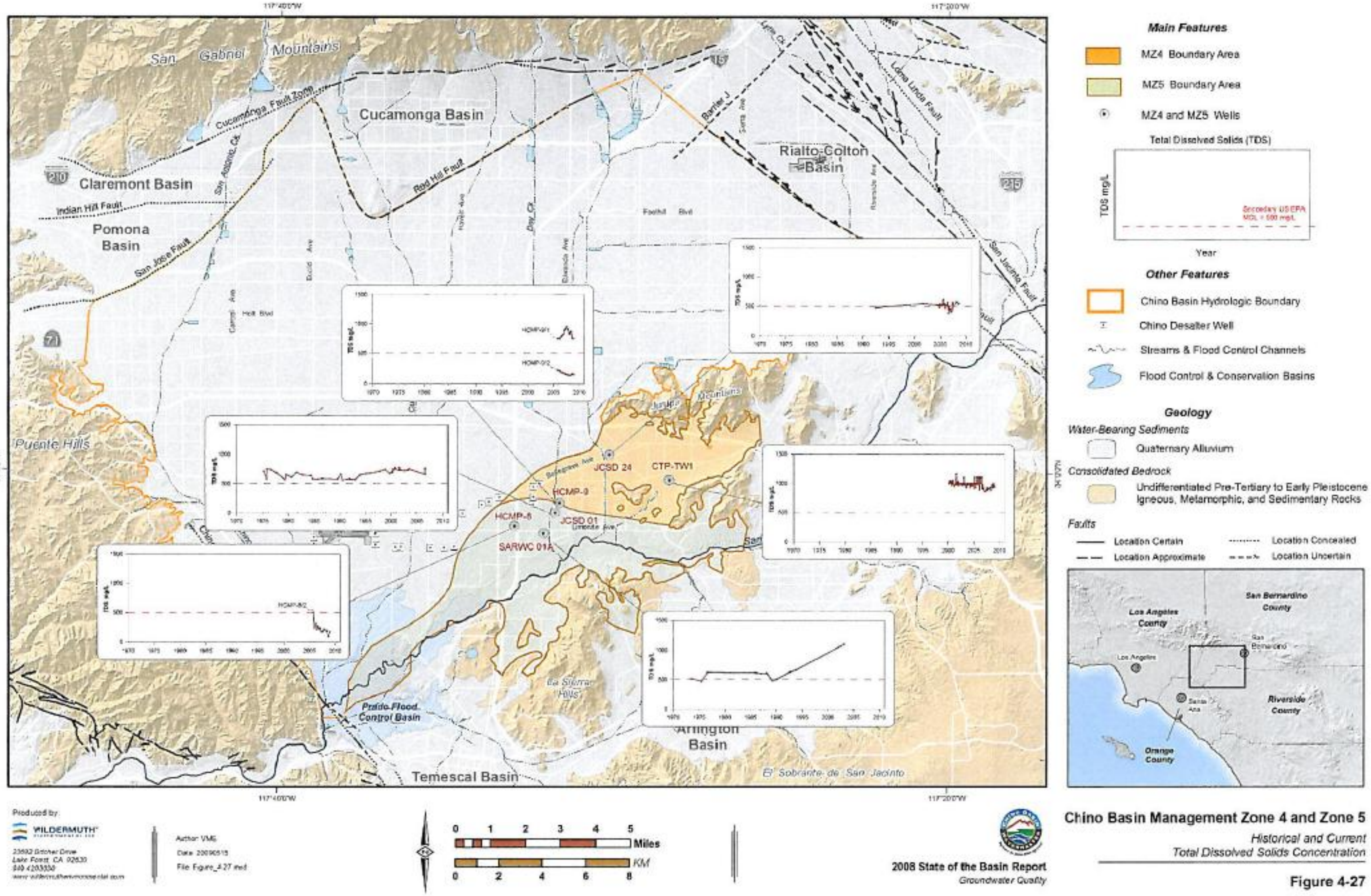


Figure 10-28
Chino Basin Management Zones 4 & 5 – Nitrogen Concentrations