San Jacinto Salt Offset and Dairy Impacts Report

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Final

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Introduction

Provisions included in the National Pollutant Discharge Elimination System (NPDES) permit and Waste Discharge Requirements (WDRs) for Dairies and Related Facilities in the Santa Ana Region (Order R8-2013-0001) require that, "Within 18 months of adoption of this Order, the Dischargers in the San Jacinto area shall collect and submit to the Regional Board all groundwater monitoring data from wells within the Concentrated Animal Feeding Operations (CAFO) facilities and wells that are located within a five mile radius of the CAFO facilities to confirm that the CAFO discharges have not impacted the quality of groundwaters in the area." All dairies in the San Jacinto River basin are members of the Western Riverside County Agriculture Coalition (WRCAC), which will coordinate dairy activities to comply with the permit requirements.

An analysis was completed to fulfill the permit requirement and establish the degree to which elevated total dissolved solids (TDS) and nitrate concentrations detected in groundwater could be caused by dairy operation activities in the San Jacinto area. Extensive groundwater data are available from Eastern Municipal Water District (EMWD), including groundwater monitoring analytical data, groundwater levels, and well construction data for numerous wells throughout the San Jacinto area from as early as 1984 to the present. Additional groundwater data were received from Elsinore Valley Municipal Water District (EVMWD) for a single dairy located within their district. Available monitoring data were used to identify wells that are, to the extent possible, representative of groundwater conditions not influenced by dairy activities and wells that are representative of groundwater quality at the dairies. A mapping exercise was completed by Tetra Tech to establish the direction of groundwater flow and assess whether dairies overall have impacted regional groundwater TDS and nitrate levels (see Appendix A). In addition, a more focused, dairy-level statistical analysis was conducted to identify whether individual dairies have impacted local groundwater TDS and nitrate concentrations. The dairy-level analysis evaluated whether or not there have been significant changes in the groundwater TDS and nitrate levels in wells that could be attributable to dairies over the period of time covered by the available data. To the extent possible, the analysis also identified other potential influences on groundwater quality including non-dairy agricultural operations, irrigated land, backyard livestock areas, horse facilities, manure compost areas, poultry facilities, and septic system use. Recent groundwater TDS and nitrate concentrations were compared to long-term average groundwater quality identified for the periods 1954 to 1973, 1978 to 1997, and 1990 to 2009 in the San Jacinto area as presented in the *TIN/TDS Study - Phase 2A of the Santa Ana Watershed* (WEI 2000) and *Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1990 to 2009* (WEI 2011) (Wildermuth reports). Table 1 lists the historical averages and water quality objectives (WQOs) for each applicable management zone. WQOs are established in the Santa Ana Regional Water Quality Control Board (RWQCB) Region 8 Basin Plan, and represent, "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area". The groundwater WQOs for each management zone were established based on ambient water quality determinations from the "historical" period (1954-1973) (WEI 2011) and represent the desirable levels of nitrate and TDS with which the historical and current averages are compared throughout this report.

Table 1. Historical Averages and Water Quality Objectives

Groundwater Management Zone	Nitrate Average Concentration (mg/L)			TDS Average Concentration (mg/L)			Water Quality Objective		Dairies within Management Zone (start date)
	1954-1973	1978-1997	1990-2009*	1954-1973	1978-1997	1990-2009*	Nitrate	TDS	
Lakeview/Hemet North	1.8	2.7	2.6	519	830	890	1.8	520	• Boersma (Feb 1988) • Gerbin Hettinga Expressway (Dec 1982) • Dick Van Dam (May 1980) • Albert Goyenetche #2 (Old Ferriera Dairy) (Aug 1978) • Hettinga (May 1976) • Hollandia (Nov 1978) • John Bootsma (Feb 1981) • John & Margie Oostdam (Nov 1988) • Offinga (Oct 1977) • Oostdam (Oct 1979) • Pastime Lakes John Bidart (May 1980) • Marvo Holsteins #2 (Apr 1976) • Goyenetche Dairy #2 (Old Cawston Dairy) (Oct 1971) • Cottonwood (Apr 1981) • Bootsma-Silva Farms/Ramona Dairy #2 (Old Vermeer Dairy) (May 1973)
San Jacinto Lower Pressure	1.0	1.9	1.1	520	730	800	1.0	520	• Van Ryn (1980/1981) • Jim Bootsma Jr. (May 1985) • Marvo Holsteins (Apr 1987)
Menifee	2.8	5.4	4.4	1,021	3,360	2,050	2.8	1,020	• Abacherli (Apr 1980) • Boere (1978) • E.L. Farms (Feb 1988)
San Jacinto Upper Pressure	1.4	1.9	1.5	321	370	350	1.4	320	• Arie & Josh de Jong (Nov 1987) • CBJ (1950's) • Ed Vander Woude (Oct 1971) • John Oostdam (Jun 1990) • R&J Haringa (May 1983) • Scott Brothers (Jun 1978) • John & Margie Oostdam Heifer Ranch (Aug 2012)
Elsinore	1.0	2.6	2.2	476	480	470	1.0	480	• Herman De Jong (Oct 1971)

* As this report was being finalized, Wildermuth published the *Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012* (WEI 2014). The ambient concentrations reported for nitrate and TDS for the period 1993 to 2012 were comparable to the ambient concentrations for the period 1990 to 2009. TDS concentrations varied by 30 mg/L or less and nitrate concentrations varied by 0.5 mg/L or less between the two periods for the five applicable management zones..

The following sections describe the methods used to assess whether dairy operations in the San Jacinto basin have impacted nitrate and TDS concentrations in groundwater.

1.0 Methodology

1.1 Regional Mapping Evaluation

Depth to groundwater and groundwater quality data were used to generate time-series maps that display regional nitrate and TDS[1] plumes. Land use data were also mapped to support general observations about potential sources of nitrate and TDS in groundwater. The monitoring wells used for the mapping study include both observation wells and agricultural production wells; sampling of the wells does not occur on a regular schedule.

Mapping reflects annual average constituent concentrations for each well for each year included in the evaluation to normalize seasonal variability in the data. Although the entire data set included well observations dating to the mid-1980s, the mapping evaluation excludes the earlier years because data were not available for most of the wells. Groundwater elevations and well information including screened intervals were used to determine groundwater flow based on data dating to 1995.

The maps and a technical memo providing additional detail on the evaluation are provided in Appendix A. The evaluation resulted in the following general observations:

- TDS migration pathways appear to be different from nitrate and the two constituents might arise from different sources.
- TDS concentrations appear to be transient and could not be definitively associated with dairies, irrigated agriculture, or other potential agricultural sources.
- Areas with domestic livestock and equestrian activity appear to be most closely associated with nitrate concentrations.
- The association of septic systems with the nitrate plume indicates a possible relationship.
- In general, nitrate plumes mapped in the San Jacinto basin cannot be definitely correlated to dairy farming activity, but rather could be the result of other activity.
- A small sub-basin in the western portion of the study area (Lakeview Groundwater Management Zone in the vicinity of Albert Goyenetche Dairy #2, John Oostdam Dairy, and Offinga Dairy) may be influenced by dairy activity.

The remainder of this section details the data analysis conducted to identify potential groundwater impacts from individual dairies or groups of dairies and compares the results to the general observations from the mapping evaluation.

[1] Sulfate plumes were also mapped as another potential indicator of agricultural sources, especially irrigated agriculture. The technical memo in Appendix A discusses sulfate in conjunction with TDS and does not make any conclusions based solely on the sulfate mapping. Sulfate is not discussed further in this report as the permit requirements focus on nitrate and TDS.

1.2 Hydrogeology of the San Jacinto Basin

The San Jacinto Groundwater Basin underlying the study area is located in western Riverside County, which includes the San Jacinto, Perris, Moreno, and Menifee Valleys. The groundwater basin is composed of sediments that have eroded from the surrounding mountains and filled the valleys formed by erosion of the basement structures. The northwest-southeast oriented San Jacinto fault zone cuts through the eastern part of the basin and includes five distinct fault segments (San Jacinto, Claremont, Hot Springs, Park Hill, and Casa Loma). These active faults form barriers to groundwater movement. Thickness of the valley fill deposits is approximately 900 feet in the western and northern parts of the basin and may exceed 5,000 feet in the eastern part of the basin between the Casa Loma and Claremont faults. Most wells within the area west of the Casa Loma fault exist under water table conditions. Confined groundwater is found in the eastern part of the basin between the Casa Loma and Claremont fault due to the existence of finer grained layers within the stratigraphy (DWR 2006, WEI 2000).

Numerous hot springs occur along the base of the San Jacinto Mountains on the north side of the San Jacinto Upper Pressure management zone, and mineral-rich groundwater occurs naturally in areas downgradient of these hot springs. High mineral content as well as methane in the groundwater in some areas of the San Jacinto Lower Pressure management zone has resulted in groundwater quality unfit for human or livestock use. In addition, continued subsidence of Mystic Lake can lead to flooding of wells near the lake and in the adjacent wildlife area through unprotected well casings. Flooding might explain some of the variability in nitrate and TDS concentrations in those wells in the dataset used for this analysis (Scott 2014, personal communication).

Over the period of time studied since dairies began operating in the San Jacinto area, the direction of groundwater flow has changed due to numerous influences. DWR (2006) describes the groundwater level trends in the San Jacinto Groundwater Basin that have influenced the changes in direction of groundwater flow[2]:

> "Prior to the extraction of groundwater from the basin, groundwater flow was generally toward the course of the San Jacinto River and westward out of the basin. High extraction rates have produced groundwater depressions and locally reversed the historical flow pattern... During the 1970s through the 1990s, groundwater levels declined about 20 to 40 feet in the northern and southeastern parts of the basin [San Jacinto Upper Pressure and Lower Pressure management zones] and were relatively stable in the southern part of the basin [Hemet, Perris South and Menifee management zones]. During the 1970s through the 1980s, groundwater levels rose 80 to 200 feet in the western part of the basin [Lakeview, Perris North and Perris South management zones] because of infiltration from Lake Perris. During 2001 and 2002, groundwater levels generally rose in the central part of the basin [Hemet North, and portions of the

[2] The bracketed text in the quoted passage is not part of the original text but has been added to roughly correlate the areas described in the text with the groundwater management zones identified throughout the report.

> Lakeview and San Jacinto Upper Pressure management zones] and declined in the northeastern and southern parts of the basin [northeast portion San Jacinto Upper Pressure and southeast portion of San Jacinto Lower Pressure management zones]" (DWR 2006).

The primary sources for establishing recent and historical groundwater flow direction for these analyses are Figures 3-6 and 3-7 (Fall 1973 and Fall 1997 groundwater elevation contours, respectively) from the Wildermuth report (WEI 2000); Figure 9-6 (Spring 2012 Groundwater Elevation Contours) from the *Hemet/San Jacinto Groundwater Management Area Water Management Plan, 2012 Annual Report* (EMWD 2013) and the regional mapping evaluation (Appendix A).

Before pumping and artificial recharge began in this area, groundwater flow mimicked surface drainage patterns, flowing down from the surrounding mountains and following the flow of the San Jacinto River. Groundwater production and artificial recharge has significantly modified the groundwater flow systems within much of the region, in particular west of the Casa Loma Fault. For example, a groundwater sink has reversed the original westward flow of groundwater in the Hemet area. Westward flow of groundwater in the Lakeview area evident in 1973 groundwater contours has also reversed to its current eastward flow direction as a result of groundwater overdraft in the Lakeview area and artificial recharge and returns from agricultural use in the Perris area. Groundwater flow directions within the San Jacinto Upper and Lower Pressure zones have generally been stable over the study period. However, groundwater production has altered flow directions in small localized areas (WEI 2000).

Many of the dairies began operating starting in the 1970s, with the majority operating before 1985 (see Table 1), and in some cases significant changes in the groundwater flow direction have occurred during the period of record for this study. In particular, changes to the groundwater flow direction have occurred in areas surrounding six facilities located in the San Jacinto Upper Pressure management zone (R & J Haringa, John Oostdam, John & Margie Oostdam Heifer Ranch, Arie & Josh de Jong, CBJ, and Ed Vander Woude), and five facilities located east-northeast of Lakeview (Albert Goyenetche #2, John Bootsma, Offinga, Jim Bootsma Jr., and Marvo Holsteins) within the Lakeview and San Jacinto Lower Pressure management zones. Thechanges in groundwater flow direction during the time of the dairy operations and the time period covered by many of the groundwater samples makes it challenging to assess, with a high degree of certainty, the upgradient versus downgradient areas for these dairies. Variability in the historical groundwater flow direction is discussed in more detail in the analysis for each of the facilities.

1.3 Monitoring Well Selection

To the extent possible, monitoring wells were selected that best represent groundwater quality within the footprint of each dairy's production area ("facility wells"), as well as groundwater quality in areas that are upgradient and downgradient of each dairy. Privately owned wells that participate in the groundwater monitoring programs are protected from publication and are therefore referred to by well number only, which were assigned randomly.

To facilitate the selection of appropriate monitoring wells to use in the analysis, dairy locations and all available monitoring well locations were plotted in the Google Earth™ mapping service. Additional land use layers display dairy production areas (dairy intensive and non-intensive), irrigated land, backyard livestock areas, horse facilities, manure compost areas, poultry facilities, and septic system use in the study area. The land use layers are based on the geographical information systems (GIS) dataset created by Aerial Information Systems, Inc. (AIS). Under contract to WRCAC, AIS cataloged the agricultural land uses mapped in 2007 within the San Jacinto River watershed (AIS 2009). Groundwater flow direction was established primarily using the results of the groundwater flow mapping effort in the Wildermuth report and the *2012 Annual Report* (EMWD 2013), and supplemented by mapping static groundwater levels using data provided by EMWD. For most facilities, the groundwater flow direction has remained relatively stable during the period of the study. Selecting upgradient and downgradient well locations was straightforward. However, for some facilities the groundwater flow direction was variable over the study period and selecting upgradient and downgradient wells with a high degree of confidence was not possible. Variability in the historical groundwater flow patterns and the impact on well selection is discussed in the individual analysis sections for those facilities.

To assess the options for monitoring well selection, the locations of available facility, upgradient, and downgradient wells were reviewed. The review indicated that some dairies lack facility, upgradient, and/or downgradient monitoring wells. Of the dairies to be evaluated, five dairies have no available facility monitoring wells, seven have no available upgradient monitoring wells, and six have no available downgradient monitoring wells.

This pre-analysis review also revealed several groups of several adjacent dairies that must be analyzed as a group because the individual impact of a particular dairy cannot be determined by this screening analysis. Because close proximity to other dairies does not allow for establishing upgradient, downgradient, and in some cases even facility groundwater conditions for a specific dairy, the selected monitoring wells were used to represent upgradient, downgradient, and facility conditions for the entire group of dairies. The analysis of these groups of dairies combined all facility well data.

1.3.1 Facility Well Selection

To the extent possible, all available facility monitoring wells that are located within or immediately downgradient from the dairy production area were used to represent the groundwater quality at the dairy. When available, facility monitoring well data were compared to upgradient and downgradient well data. In some cases, no facility monitoring wells were present within the dairy production area. In those cases, the analysis compared upgradient well concentrations to downgradient well concentrations only. One of the dairies without facility wells also has no upgradient wells and historical averages from the Wildermuth report were used to represent pre-dairy conditions. It is important to note that in this case, confidence in conclusions might not be high and further investigation might be necessary.

1.3.2 Upgradient Well Selection

Based on the groundwater flow direction, wells were selected for each dairy that are located upgradient from the dairy production area and any land application fields associated with that dairy. To the extent possible, upgradient monitoring wells were selected that were not influenced by other dairy or non-dairy operations. All selected upgradient monitoring wells were located within 1.5 miles of the facility. The permit called for wells within a 5 mile radius of the facilities to be used in the study; however, a pre-analysis review of the distribution of available monitoring wells in the vicinity of each dairy revealed that selection of upgradient monitoring wells within a radius of 1.5 miles of each facility would result in the greatest number of monitoring wells while still being representative of upgradient conditions, and would most often result in a dataset that meets the data quality goal of having at least 10 samples and less than 20% non-detects; the minimum dataset necessary to complete a quantitative statistical analysis (see section 1.3). This approach was agreed upon in a phone conference with Santa Ana Regional Water Control Board (RWQCB) staff on January 13, 2014 (SARWQCB 2014) and documented in a memorandum submitted to the RWQCB on March 7, 2014 (Tetra Tech 2014).

In some cases (e.g., dairies located along the eastern flank of the Lakeview Mountains), there are dairies that have no upgradient or downgradient monitoring wells. In these cases the only wells available are located near the facility, but not in the direct groundwater flow path across the facility. Selecting these “crossgradient” monitoring wells allowed for establishing groundwater conditions in close proximity to the subject dairy but without the influence of other upgradient dairies. A review of the distribution of available monitoring wells in the vicinity of these dairies reveals that crossgradient monitoring well selection within a radius of 1.5 miles of each facility would result in the greatest number of monitoring wells while still being representative, and would most often result in a dataset that meets the goal of having at least 10 samples and less than 20% non-detects; the minimum necessary to complete quantitative statistical analysis. For these facilities, the analysis was limited to a comparison of the crossgradient well concentrations to the facility well concentrations only.

1.3.3 Downgradient Well Selection

Based on the groundwater flow direction, wells were selected that are located downgradient from the dairy production area and land application fields. To the extent possible, downgradient monitoring wells were selected that were not influenced by other dairy or non-dairy operations. Selected downgradient monitoring wells are located within 1.5 miles of the facility. As discussed above for upgradient well selection, a review of the distribution of available monitoring wells in the vicinity of each dairy revealed that downgradient monitoring well selection within a radius of 1.5 miles of each facility resulted in the greatest number of monitoring wells while still being representative of downgradient conditions, and will most often result in a dataset that meets the goal of having at least 10 samples and less than 20% non-detects; the minimum necessary to complete a quantitative statistical analysis.

1.4 Analytical Methods

For both individual dairies and groups of dairies evaluated together, information was tabulated for each well, including the perforated interval of the monitoring wells; sample dates; number of samples and number of non-detects; the mean, minimum, maximum, and standard deviation of TDS and nitrate concentrations in samples from each well; and a combined average concentration for all wells within each group of upgradient, downgradient, and facility wells.

Using combined data from wells representing upgradient, downgradient, and facility groundwater quality, boxplots (also termed "box and whisker" plots) were created using Minitab statistical software (Version 14). A boxplot is a graphic display of the median, 25th percentile, and 75th percentile values in a dataset (the box), the highest value within the upper limit and the lowest value within the lower limit (the whiskers), and any observations beyond the whiskers (outliers) as indicated in Figure 1.

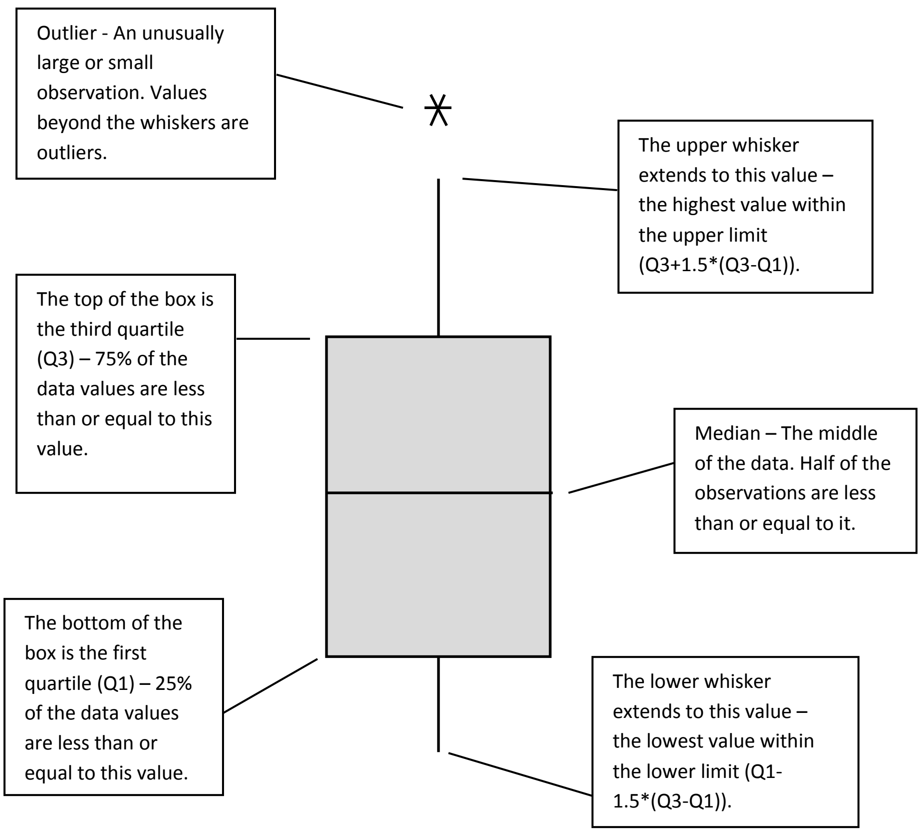


Figure 1. Example boxplot.

If possible, a quantitative statistical analysis of the groundwater quality data was performed to determine if the groundwater quality differed significantly between the groups (upgradient, facility, and downgradient wells). A Student's t-Test can be used to determine the probability that mean groundwater TDS or nitrate concentrations differ significantly between two groups of wells, e.g., upgradient vs. downgradient. Where data are available, one-way Analysis of Variance (ANOVA) can be used to test for significant differences among mean TDS or nitrate concentrations from more than two well groups, e.g. upgradient vs. facility vs. down gradient. Where significant differences among group means are indicated by ANOVA, one or more multiple range tests could be used to identify specifically which group means differ. Given the numerous sources of nutrients in groundwater (both dairy and non-dairy), significant differences in sample dates and number of samples, variation in screened intervals in the monitoring wells, and unknown groundwater sample depths, an alpha of 0.10 was used in the statistical analyses; thus, differences between well groups was reported with 90 percent confidence. Actual significance levels (*P* values) will be reported for all analyses.

1.5 Censored Data and Sampling Periods of Record

Approximately 15 percent of the available nitrate data were reported as non-detects, i.e., the true concentration in the sample was below the lower detection limit of the laboratory analysis. For these censored data, a value of one-half the detection limit was used for the calculation of mean and standard deviation, as well as in the creation of boxplots. Datasets with more than 20% non-detects were not used for quantitative statistical inference. In addition, data sets with fewer than 10 samples were not used for quantitative analysis.

In some cases the datasets used to assess the connection between dairy operations and groundwater quality have sample dates with little or no overlap between the upgradient, facility, and downgradient wells. Under such conditions, the lack of time alignment might add uncertainty to any conclusions because samples were collected under potentially different conditions and influences.

1.6 Uncertainties in Results

The following sections describe the dairy-level analyses and conclusions for each dairy or group of dairies. However, it should be noted that numerous uncertainties in the data and analyses reduce the level of confidence in conclusions of either no impact or significant impact. The conclusions section for each individual analysis identifies some of the general uncertainties included in the findings. A more detailed description of the uncertainties for the overall dairy-level analyses and for each individual analysis is included in Section 7.0, Conclusions and Recommendations.

2.0 Impacts Analysis – Lakeview/Hemet North Management Zone

2.1 Group of Dairies (John & Margie Oostdam, Hettinga, and Oostdam)

Three dairies identified as John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy[3] are located just south of the intersection of Ramona Expressway and Warren Road. Land identified as dairy intensive for these facilities is less than 700 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by Warren Road (see Figure 2). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine the impact of each individual dairy with any degree of confidence.

Based on groundwater mapping completed by Tetra Tech (see Appendix A) and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally from the south-southeast to the north-northwest, as identified by the generalized groundwater flow arrows in Figure 2. This group of dairies is located immediately north-northwest, and downgradient, of a series of buildings identified as poultry facilities with associated manure composting operations. Other potential impacts to

[3] Table 4 of the *Salt Offset Options for the San Jacinto River Basin Dairies* (WEI 2008), listed Hettinga Dairy in the San Jacinto Upper Pressure Management Zone.

groundwater quality in the vicinity include irrigated fields, septic systems, and an abandoned dairy. The group of dairies is bordered on the east and west by fault zones.

The analysis for this group of dairies includes 10 upgradient wells with a total of 67 nitrate and 69 TDS samples collected from 11/2/1984 to 9/26/2012, five facility wells with a total of 47 samples collected from 4/30/1996 to 3/6/2012, and three downgradient wells with a total of 26 samples collected from 10/5/2000 to 4/4/2012.

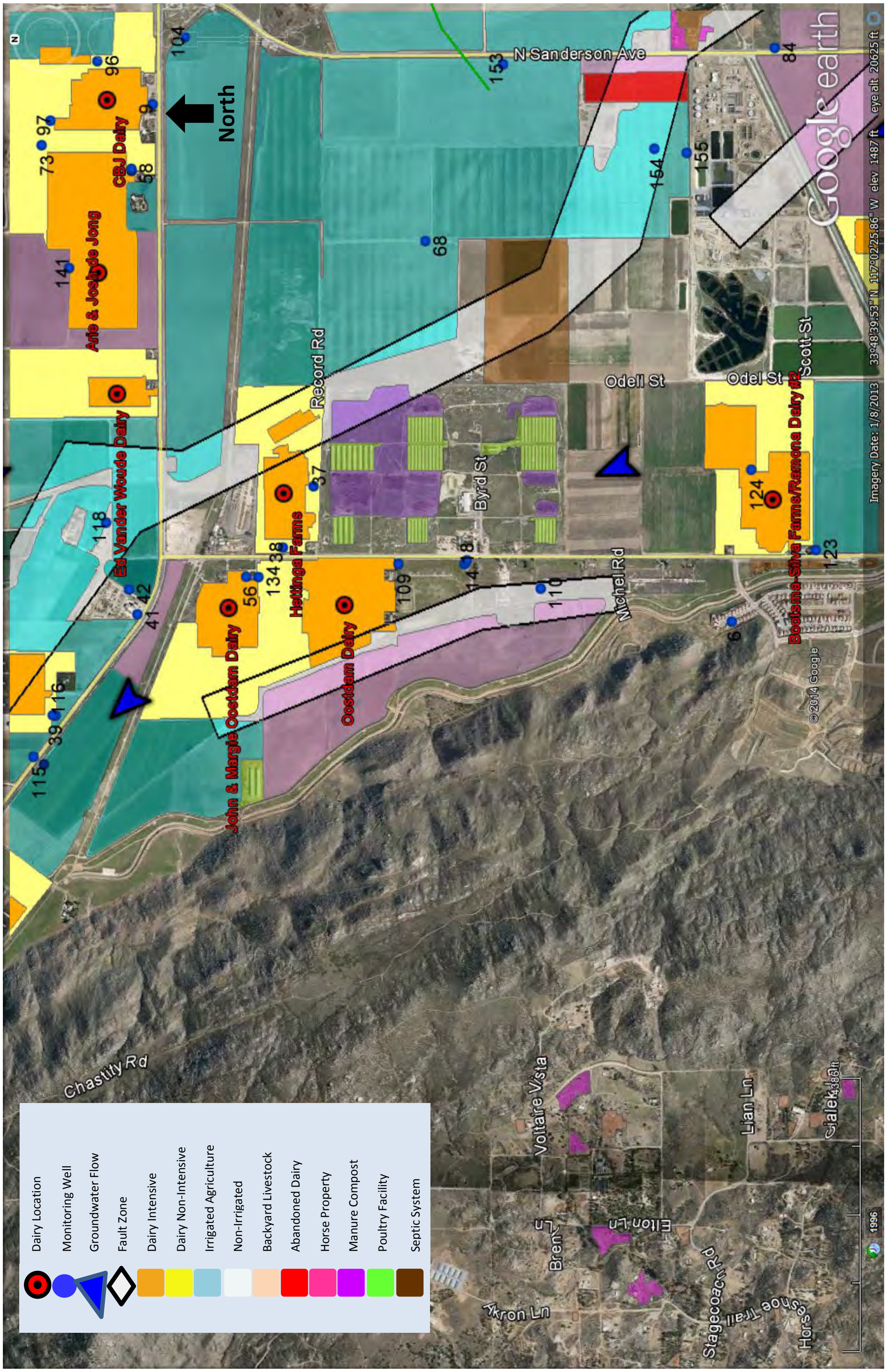


Figure 2. Location map of the vicinity of John & Margie Oostdam, Oostdam, and Hettinga Dairies

2.1.1 Summary Data

Tables 2 and 3 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 2. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairy Well Samples

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
6	-	9/3/08 - 3/6/12	4	0	0%	3.0	2.3	3.5	0.62
14	876 - 1332	11/2/84 - 8/20/12	17	0	0%	1.7	0.50	2.5	0.54
18	698 - 1078	7/25/95 - 8/20/12	17	1	6%	1.0	ND	2.0	0.49
110	-	3/3/94 - 9/26/95	2	0	0%	0.30	0.10	0.50	0.28
123	-	10/9/02 - 4/3/08	7	0	0%	5.0	1.7	6.8	2.2
124	1112 - 1302	9/23/04 - 12/16/05	2	0	0%	3.8	3.7	3.9	0.14
153	657 - 1094	6/21/96 - 10/10/02	5	3	60%	0.08	ND	0.10	0.027
154	1228 - 1438	3/27/95 - 7/15/04	4	3	75%	0.15	ND	0.40	0.17
155	-	5/24/00 - 4/1/02	3	2	67%	0.38	ND	1.0	0.53
68	648 - 1085	12/18/06 - 9/26/12	6	6	100%	0.04	ND	ND	0.013
Upgradient Group Summary			**67**	**15**	**22%**	**1.6**	**0.025**	**6.8**	**1.7**
Facility Group									
109	950 - 1154	4/30/96 - 12/16/06	5	0	0%	2.5	1.6	3.3	0.80
37	923 - 1198	6/19/02 - 3/6/12	13	0	0%	2.2	0.24	4.6	1.2
38	893 - 1213	6/19/02 - 3/6/12	12	0	0%	3.2	2.1	5.0	0.94
56	910 - 1270	6/19/02 - 3/6/12	8	0	0%	1.0	0.40	3.0	0.84
134	-----	10/9/02 - 8/26/10	9	0	0%	1.3	0.70	2.0	0.50
Facility Group Summary			**47**	**0**	**0%**	**2.1**	**0.24**	**5.0**	**1.2**
Downgradient Group									
41	643 - 1162	6/11/01 - 3/6/12	10	9	90%	0.09	ND	0.25	0.074
118	738 - 1058	10/5/00 - 2/21/06	4	4	100%	0.063	ND	ND	0.025
42	934 - 1154	6/22/01 - 4/4/12	12	12	100%	0.058	ND	ND	0.019
Downgradient Group Summary			**26**	**25**	**96%**	**0.071**	**ND**	**0.25**	**0.049**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 2 summary indicates that there does not appear to be an increase in nitrate concentrations downgradient from the facility and the average facility well concentration is approximately equal to or lower than the historical average nitrate concentrations for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.8 mg/L, 2.7 mg/L, and 2.6 mg/L, respectively (WEI 2000, 2011).

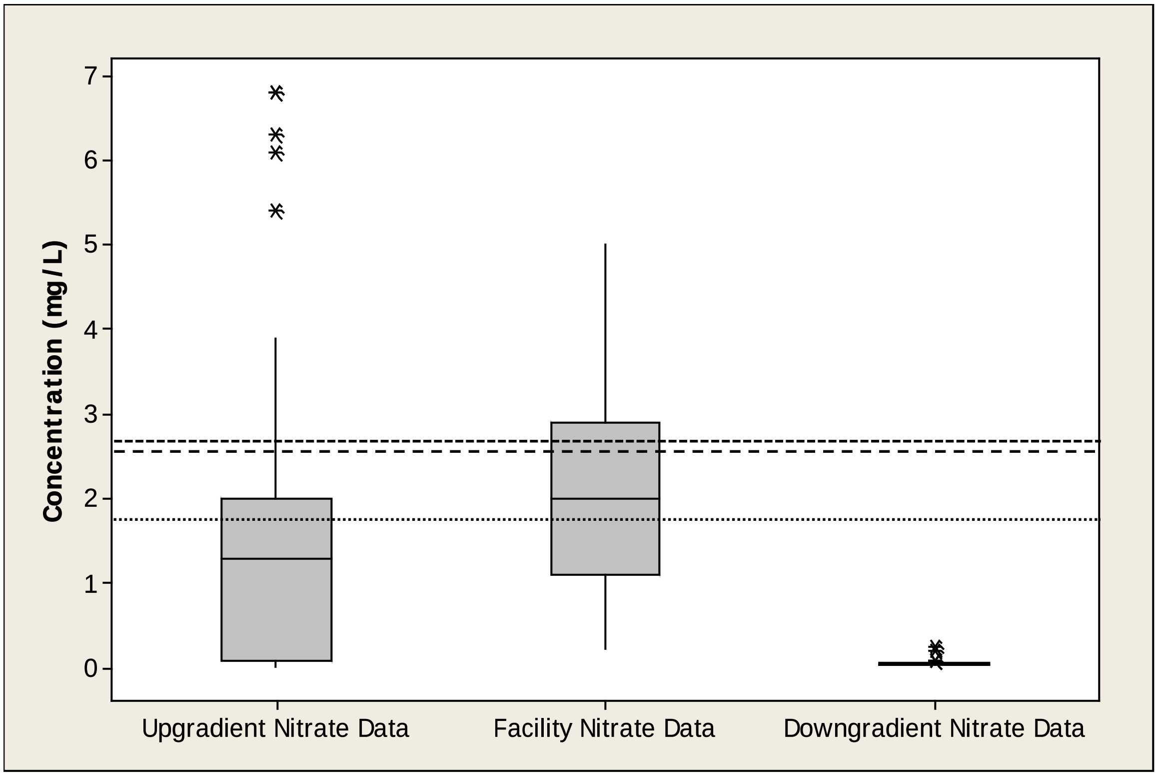
Table 3. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairy Well Samples

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
6	-	9/3/08 - 3/6/12	4	0	0%	645	570	690	54
14	876 - 1332	11/2/84 - 8/20/12	18	0	0%	551	400	987	211
18	698 - 1078	7/25/95 - 8/20/12	17	0	0%	973	830	1100	83
110	-	3/3/94 - 9/26/95	2	0	0%	504	372	635	186
123	-	10/9/02 - 4/3/08	7	0	0%	823	550	1010	181
124	1112 - 1302	9/23/04 - 12/16/05	2	0	0%	620	590	650	42
153	657 - 1094	6/21/96 - 10/10/02	5	0	0%	244	220	280	23
154	1228 - 1438	3/27/95 - 7/15/04	5	0	0%	396	270	480	83
155	-	5/24/00 - 4/1/02	3	0	0%	547	530	560	15
68	648 - 1085	12/18/06 - 9/26/12	6	0	0%	270	230	280	20
Upgradient Group Summary			**69**	**0**	**0%**	**630**	**220**	**1100**	**281**
Facility Group									
109	950 - 1154	4/30/96 - 12/16/06	5	0	0%	428	380	460	29
37	923 - 1198	6/19/02 - 3/6/12	13	0	0%	570	460	650	72
38	893 - 1213	6/19/02 - 3/6/12	12	0	0%	457	420	490	20
56	910 - 1270	6/19/02 - 3/6/12	8	0	0%	445	420	480	18
134	-----	10/9/02 - 8/26/10	9	0	0%	434	420	460	14
Facility Group Summary			**47**	**0**	**0%**	**479**	**380**	**650**	**70**
Downgradient Group									
41	643 - 1162	6/11/01 - 3/6/12	10	0	0%	416	380	480	31
118	738 - 1058	10/5/00 - 2/21/06	4	0	0%	373	350	400	21
42	934 - 1154	6/22/01 - 4/4/12	12	0	0%	557	530	580	15
Downgradient Group Summary			**26**	**0**	**0%**	**475**	**350**	**580**	**83**

The Table 3 summary suggests that the average TDS concentration in facility wells is lower than that in upgradient wells, and that there is a slight decrease in TDS concentrations downgradient from the facility. The facility well concentrations are lower than the average TDS concentrations for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 519 mg/L, 830 mg/L and 890 mg/L, respectively (WEI 2000, 2011).

2.1.2 Boxplots

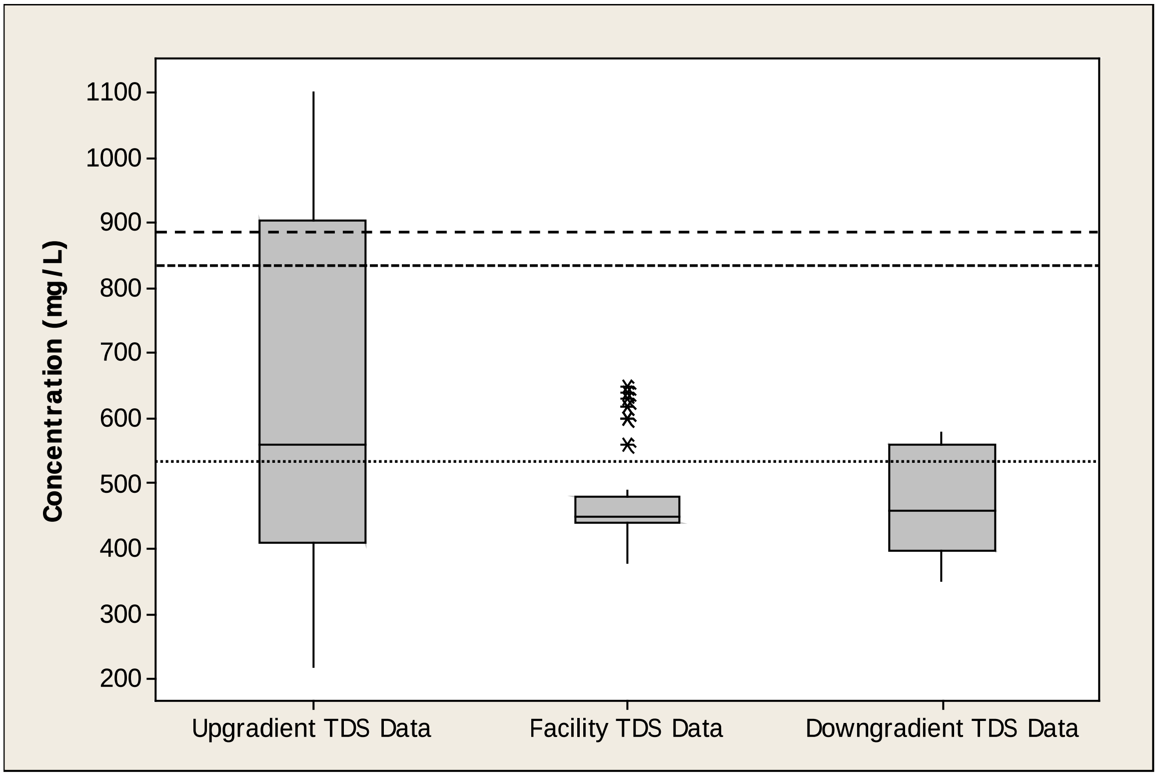
Boxplots using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality are shown in Figures 3 and 4 for nitrate and TDS concentrations, respectively.



Average nitrate concentration 1990 to 2009 of 2.6 mg/L (Lakeview/Hemet North management zone)
Average nitrate concentration 1978 to 1997 of 2.7 mg/L (Lakeview/Hemet North management zone)
Average nitrate concentration 1954 to 1973 of 1.8 mg/L (Lakeview/Hemet North management zone)

Figure 3. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairy Well Samples

The boxplots indicate that the distributions of nitrate concentrations in the facility wells have been somewhat higher than those measured in the upgradient wells and that the downgradient nitrate concentrations have been lower (in fact often less than the detection limit) than either upgradient or facility concentrations. In this case it could be inferred that although elevated nitrate levels in facility wells suggest the possibility of dairy influence on local groundwater quality, this influence does not extend to the downgradient groundwater.



Average TDS concentration 1990 to 2009 of 890 mg/L (Lakeview/Hemet North management zone)
Average TDS concentration 1978 to 1997 of 830 mg/L (Lakeview/Hemet North management zone)
Average TDS concentration 1954 to 1973 of 519 mg/L (Lakeview/Hemet North management zone)

Figure 4. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairy Well Samples

The boxplots shown in Figure 4 indicate that TDS concentrations in the facility wells have been lower and less variable than the upgradient wells and comparable to the downgradient well concentrations. However, the fact that the distribution of TDS concentrations for all three groups has occurred in the same overall range suggests that the dairy facilities have not contributed to increased groundwater TDS concentrations.

2.1.3 Quantitative Statistical Analysis

Because the nitrate datasets for upgradient and downgradient wells both contain greater than 20% non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and an ANOVA was used to test for significant differences among TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient). Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
630 a	479 b	475 b	10.05	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). ANOVA results indicate that a significant difference exists between the three well groups. In this case the facility and downgradient groundwater has significantly lower mean TDS concentrations compared to the upgradient, but facility and downgradient groundwater mean TDS levels do not differ.

2.1.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at John & Margie Oostdam, Oostdam, and Hettinga dairies have not increased nitrate or TDS concentrations in groundwater downgradient from the dairy operations. The following specific observations were made which support the conclusion:

- There is no increase in nitrate concentrations downgradient from the facility and the average facility well concentration is approximately equal to or lower than the historical averages for the Hemet North management zone.
- The boxplots of nitrate concentrations indicate downgradient well concentrations are lower than either upgradient or facility concentrations.
- The average TDS concentration in downgradient wells is lower than facility wells.
- TDS concentrations in facility wells are lower than the average historical TDS concentrations for the Lakeview/Hemet North management zone.
- The boxplot of TDS concentrations indicates no significant increase in downgradient wells compared to facility wells.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility and downgradient wells compared to upgradient wells.

However, the observation that nitrate concentrations in facility wells have tended to be higher than those in upgradient wells (Figure 3) suggest that continued monitoring and further investigation of facility influence on groundwater nitrate levels might be warranted in this case.

2.2 Group of Dairies (Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2)

Four dairies identified as Hollandia Dairy, Gerbin Hettinga Expressway Dairy, Boersma Dairy, and Marvo Holsteins Dairy #2 are located along Ramona Expressway, northwest of Warren Road and southeast of Pico Road. Areas identified as dairy intensive for these facilities is either directly adjacent or less than 900 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by Ramona Expressway (see Figure 5). These four dairies are analyzed as a group because the close proximity of the dairies does not make it feasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally from the southeast to northwest, as indicated by the generalized groundwater flow arrows in Figure 5. Monitoring wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located immediately north-northwest of, and downgradient from, the group of dairies identified in the previous section (John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy), so the upgradient groundwater quality is, in part, best represented by the monitoring wells from the upgradient facilities. Other potential impacts to groundwater quality in the vicinity include irrigated fields and a poultry facility. A fault zone is located northeast of Boersma Dairy and runs through the Hollandia, Gerbin Hettinga Expressway, and Marvo Holsteins #2 dairies.

The analysis for this group of dairies includes seven upgradient wells with a total of 68 samples collected from 10/5/2000 to 4/4/2012, nine facility wells with a total of 80 samples collected from 5/24/1996 to 10/3/2012, and five downgradient wells with a total of 28 samples collected from 3/16/1994 to 6/23/2008.

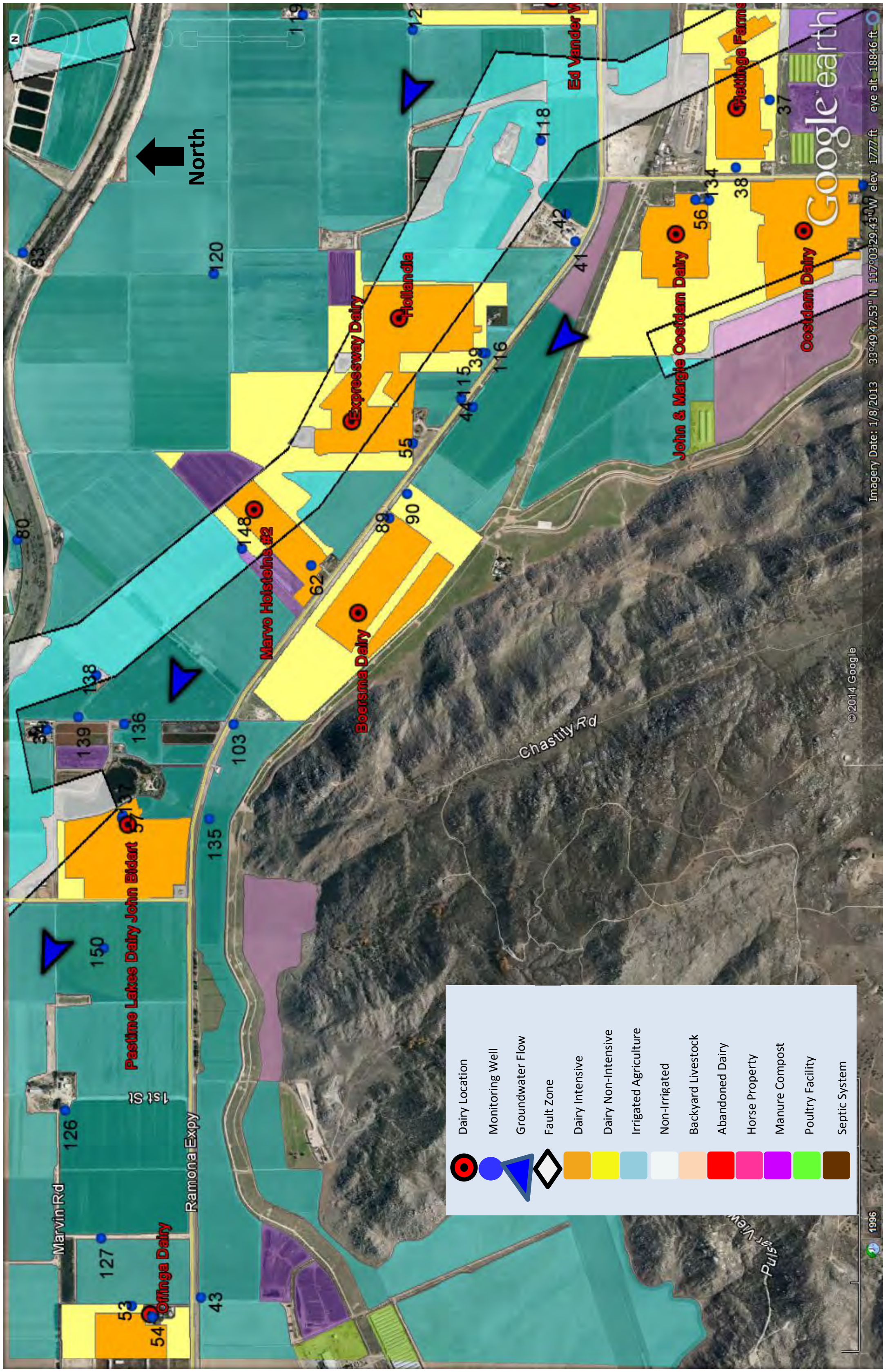


Figure 5. Location map of the vicinity of Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

2.2.1 Summary Data

Tables 4 and 5 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 4. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
37	923 - 1198	6/19/02 - 3/6/12	13	0	0%	2.2	0.24	4.6	1.2
38	893 - 1213	6/19/02 - 3/6/12	12	0	0%	3.2	2.1	5.0	0.94
41	643 - 1162	6/11/01 - 3/6/12	10	9	90%	0.09	0.05	0.25	0.074
118	738 - 1058	10/5/00 - 2/21/06	4	4	100%	0.063	0.05	0.10	0.025
42	934 - 1154	6/22/01 - 4/4/12	12	12	100%	0.058	0.05	0.10	0.019
56	910 - 1270	6/19/02 - 3/6/12	8	0	0%	1.0	0.40	3.0	0.84
134	-	10/9/02 - 8/26/10	9	0	0%	1.3	0.70	2.0	0.50
Upgradient Group Summary			**68**	**25**	**37%**	**1.3**	**0.050**	**5.0**	**1.4**
Facility Group									
89	-	6/18/02 - 3/29/10	10	0	0%	0.41	0.20	0.60	0.13
90	-	5/24/96 - 6/26/08	5	0	0%	0.94	0.10	1.8	0.80
115	-	6/24/02 - 6/25/08	7	0	0%	0.53	0.40	0.70	0.11
39	1011 - 1236	6/18/02 - 4/4/12	10	7	70%	0.16	0.05	0.80	0.23
116	-	6/23/08 - 3/31/09	2	1	50%	0.13	0.05	0.20	0.11
44	-	8/13/99 - 9/10/12	13	11	85%	0.08	0.05	0.28	0.06
55	-	6/7/02 - 10/3/12	11	0	0%	0.38	0.17	0.80	0.20
62	-	8/25/03 - 3/8/12	10	0	0%	1.6	0.30	2.1	0.49
148	-	10/5/00 - 3/20/09	12	10	83%	0.37	0.05	1.9	0.72
Facility Group Summary			**80**	**29**	**36%**	**0.50**	**0.05**	**2.1**	**0.61**
Downgradient Group									
103	899 - 1251	8/4/95 - 5/4/04	11	0	0%	1.2	0.60	1.7	0.32
135	-	3/16/1994	1	0	0%	0.68	0.68	0.68	-
136	-	5/10/04 - 4/7/08	3	0	0%	0.53	0.40	0.70	0.15
138	845 - 1245	9/12/00 - 6/25/03	5	5	100%	0.080	0.05	0.10	0.027
139	636 - 1244	6/30/00 - 6/23/08	8	6	75%	0.094	0.05	0.20	0.050
Downgradient Group Summary			**28**	**11**	**39%**	**0.59**	**0.05**	**1.70**	**0.55**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 4 summary indicates that there might be a slight increase in nitrate concentrations downgradient from the facilities; however, both facility and downgradient concentrations are lower than upgradient concentrations. The average facility well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.8 mg/L, 2.7 mg/L, and 2.6 mg/L, respectively (WEI 2000, 2011).

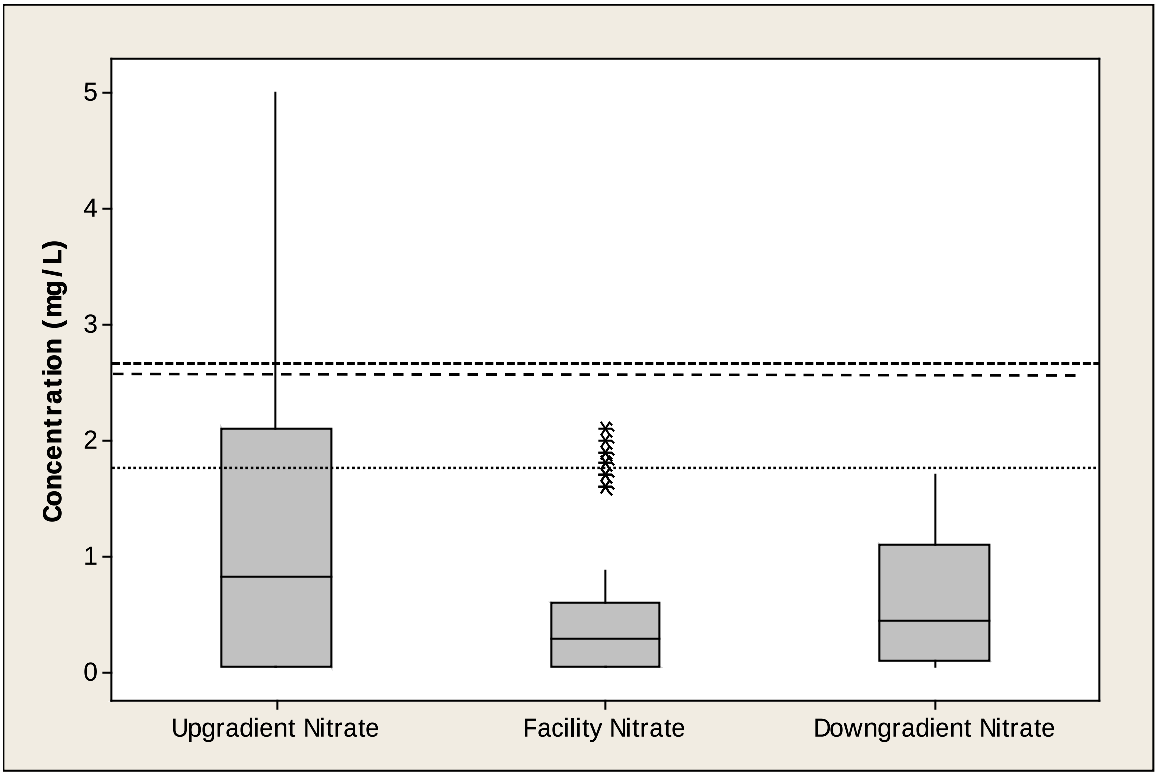
Table 5. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
37	923 - 1198	6/19/02 - 3/6/12	13	0	0%	570	460	650	72
38	893 - 1213	6/19/02 - 3/6/12	12	0	0%	457	420	490	20
41	643 - 1162	6/11/01 - 3/6/12	10	0	0%	416	380	480	31
118	738 - 1058	10/5/00 - 2/21/06	4	0	0%	373	350	400	21
42	934 - 1154	6/22/01 - 4/4/12	12	0	0%	557	530	580	15
56	910 - 1270	6/19/02 - 3/6/12	8	0	0%	445	420	480	18
134	-	10/9/02 - 8/26/10	9	0	0%	434	420	460	14
Upgradient Group Summary			**68**	**0**	**0%**	**481**	**350**	**650**	**75**
Facility Group									
89	-	6/18/02 - 3/29/10	10	0	0%	634	620	640	7.0
90	-	5/24/96 - 6/26/08	5	0	0%	598	590	600	4.5
115	-	6/24/02 - 6/25/08	7	0	0%	560	530	590	21
39	1011 - 1236	6/18/02 - 4/4/12	10	0	0%	505	440	560	43
116	-	6/23/08 - 3/31/09	2	0	0%	415	400	430	21
44	-	8/13/99 - 9/10/12	13	0	0%	494	450	540	29
55	-	6/7/02 - 10/3/12	11	0	0%	516	500	540	14
62	-	8/25/03 - 3/8/12	10	0	0%	598	360	690	88
148	-	10/5/00 - 3/20/09	12	0	0%	588	550	620	25
Facility Group Summary			**80**	**0**	**0%**	**553**	**360**	**690**	**66**
Downgradient Group									
103	899 - 1251	8/4/95 - 5/4/04	11	0	0%	565	490	620	37
135	-	3/16/1994	1	0	0%	530	530	530	-
136	-	5/10/04 - 4/7/08	3	0	0%	553	550	560	5.8
138	845 - 1245	9/12/00 - 6/25/03	5	0	0%	514	440	550	43
139	636 - 1244	6/30/00 - 6/23/08	8	0	0%	568	500	610	42
Downgradient Group Summary			**28**	**0**	**0%**	**554**	**440**	**620**	**41**

The Table 5 summary indicates that the average TDS concentration is greater in the facility wells compared to upgradient wells and there does not appear to be an increase in average TDS concentrations downgradient from the dairy facilities. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for the 1954 to 1973 period of 519 mg/L, but less than the 1978 to 1997 and 1990 to 2009 period of 830 mg/L and 890 mg/L, respectively (WEI 2000, 2011).

2.2.2 Boxplots

Boxplots were created using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality (Figures 6 and 7).



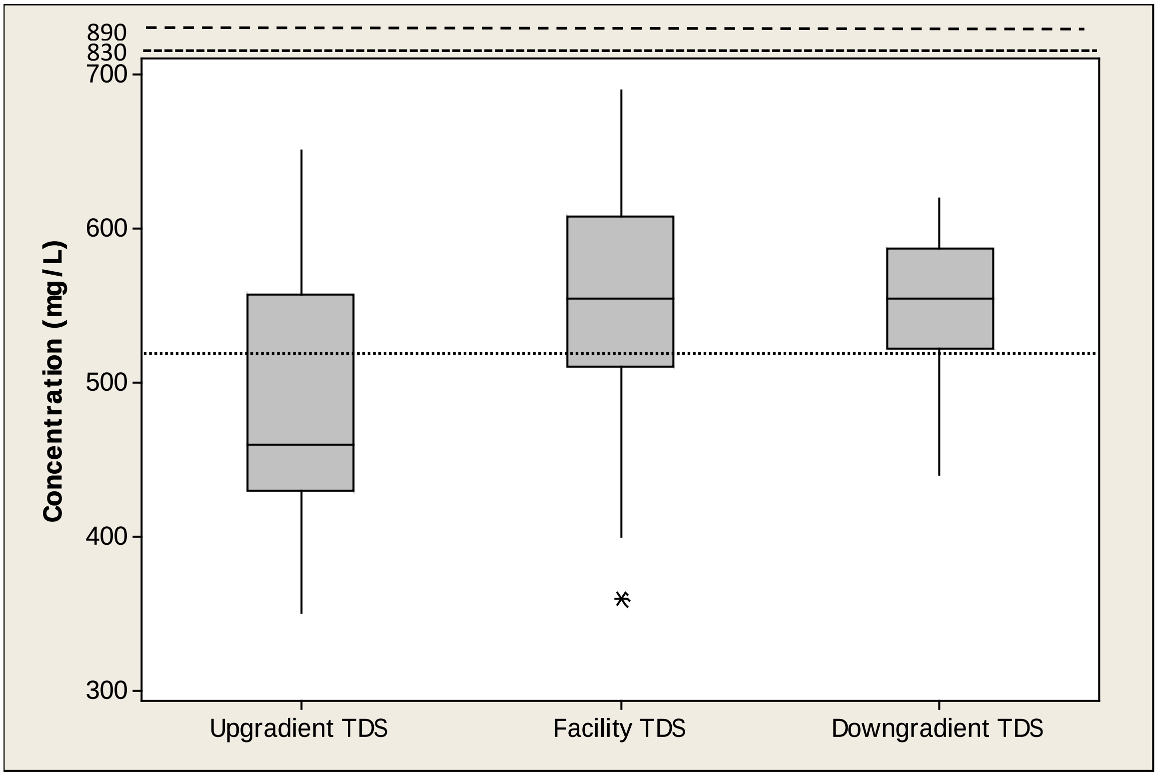
_ _ _ Average nitrate concentration 1990 to 2009 of 2.6 mg/L (Lakeview/Hemet North management zone)

----- Average nitrate concentration 1978 to 1997 of 2.7 mg/L (Lakeview/Hemet North management zone)

.... Average nitrate concentration 1954 to 1973 of 1.8 mg/L (Lakeview/Hemet North management zone)

Figure 6. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

The boxplots indicate that although the distribution of nitrate concentrations in the facility and downgradient well groups fall within the overall range of concentrations in the upgradient wells, nitrate levels in the facility wells tend to be lower than in the upgradient wells, and the downgradient well nitrate concentrations are slightly higher than the facility concentrations. Regardless of these slight apparent differences, the data do not seem to indicate a facility influence on downgradient nitrate levels.



_ _ _ Average TDS concentration 1990 to 2009 of 890 mg/L (Lakeview/Hemet North management zone)
----- Average TDS concentration 1978 to 1997 of 830 mg/L (Lakeview/Hemet North management zone)
.... Average TDS concentration 1954 to 1973 of 519 mg/L (Lakeview/Hemet North management zone)

Figure 7. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerbin Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tend to be higher than those recorded in the upgradient wells. This could suggest a facility influence on downgradient groundwater quality, though the average facility and downgradient concentrations are less than the 1978 to 1997 average of 830 mg/L and 1990 to 2009 average of 890 mg/L.

2.2.3 Quantitative Statistical Analysis

Because the nitrate datasets for all three well groups contain greater than 20% non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and an ANOVA was used to test for significant differences among mean TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient). Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
481 a	553 b	554 b	24.7	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results indicate that a significant difference exists among the three well groups. Mean TDS levels in both facility and downgradient groundwater have been significantly higher than that observed in upgradient wells.

2.2.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at Hollandia Dairy, Gerbin Hettinga Expressway Dairy, Boersma Dairy, and Marvo Holsteins Dairy #2 have not increased observed groundwater nitrate concentrations. The combined operations could be responsible for contributing to increased TDS concentrations in groundwater in the vicinity of the facilities and downgradient from the dairy operations. The following specific observations support these conclusions:

- There is a slight increase in nitrate concentrations downgradient from the facilities; however, average facility and downgradient well concentrations are lower than the upgradient concentrations.
- Average nitrate concentrations for all groups are lower than Lakeview/Hemet North management zone historical averages.
- The boxplot of nitrate concentrations indicates no significant increase in downgradient wells compared to facility wells.
- There are higher average TDS concentrations in facility and downgradient groundwater compared to upgradient.
- The average TDS concentration for facility and downgradient wells is less than the Lakeview/Hemet North management zone averages for 1978 to 1997 and 1990 to 2009.
- The boxplot of TDS concentrations shows an increase between upgradient and facility wells, but no increase between facility and downgradient wells.
- The statistical analysis of TDS concentrations indicates that facility and downgradient wells have significantly higher concentrations compared to upgradient wells.

Based on available information, it is not feasible to determine the source of elevated TDS concentrations or the individual contribution of each dairy in the potential impacts to downgradient groundwater quality. Numerous non-dairy sources of nitrate and TDS, variations in sample dates, unknown or dissimilar perforated intervals, the impact of fault zones, and the close proximity of individual wells make it infeasible to determine the direct TDS contribution for each dairy with a high degree of confidence. In this case, further study is needed to more accurately determine the individual impact of each dairy.

2.3 Group of Dairies (Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 (Old Vermeer Dairy))

Three dairies identified as Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 are located north of West 7th Street between Warren Road and North Sanderson Avenue. Land use areas identified as dairy intensive for Dick Van Dam Dairy and Cottonwood Dairy are less than 750 feet apart. The area identified as dairy intensive for Bootsma-Silva Farms/Ramona Dairy #2 is less than 3,000 feet north-northwest of Dick Van Dam Dairy and Cottonwood Dairy, and no non-facility monitoring wells exist between the three dairies (see Figure 8). These three dairies are analyzed as a group because the close proximity of the dairies and lack of non-facility monitoring wells makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally from the east-southeast to west-northwest, as indicated by the generalized groundwater flow arrows in Figure 8. Monitoring wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located south-southeast, and upgradient, from a group of dairies (John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy), so the downgradient groundwater quality is, in part, best represented by the monitoring wells located near the downgradient facilities. Other downgradient groundwater quality influences include poultry operations and manure compost. Upgradient influences include irrigated fields, septic systems and horse properties. Fault zones are located to the east and northwest of this group of dairies.

The analysis for this group of dairies includes six upgradient wells with a total of 14 samples collected from 7/11/1990 to 4/4/2012, five facility wells with a total of 25 samples collected from 10/9/2002 to 11/20/2012, and five downgradient wells with a total of 45 nitrate and 46 TDS samples collected from 11/2/1984 to 8/20/2012.

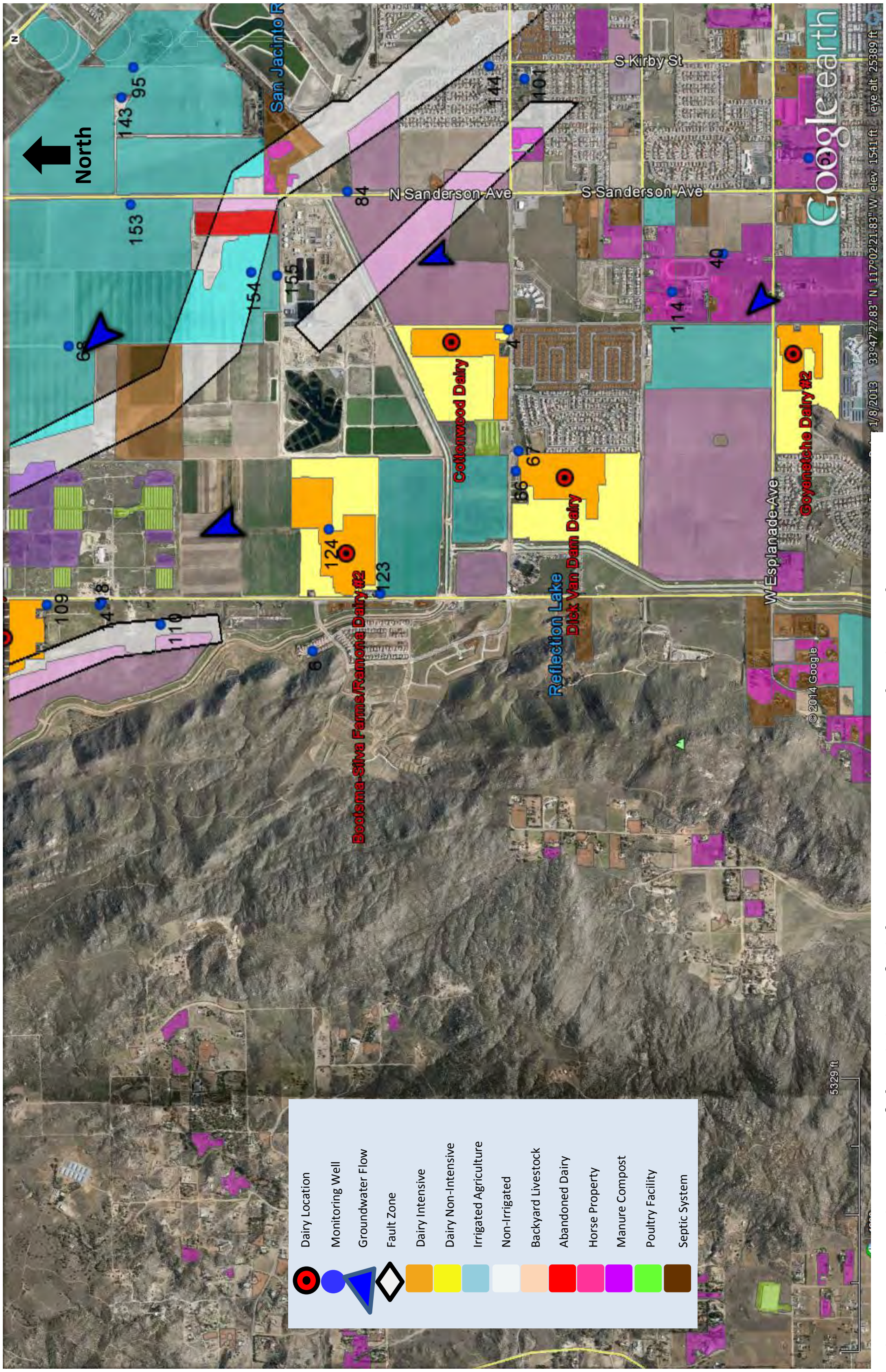


Figure 8. Location map of the vicinity of Dick Van Dam, Cottonwood Dairy and Bootsma-Silva Farms/Ramona Dairy #2

2.3.1 Summary Data

Tables 6 and 7 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 6. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
101	-	10/7/91	1	0	0%	2.9	2.9	2.9	-
114	-	4/24/09	1	0	0%	4.0	4.0	4.0	-
40	-	7/15/04 - 4/4/12	7	0	0%	2.3	2.0	2.8	0.28
144	-	7/25/00 - 9/23/03	3	1	33%	0.25	0.05	0.40	0.18
152	-	7/11/90	1	0	0%	2.3	2.3	2.3	-
156	-	4/15/91	1	0	0%	7.7	7.7	7.7	-
Upgradient Group Summary			**14**	**1**	**7%**	**2.4**	**0.05**	**7.7**	**1.9**
Facility Group									
4	1193 - 1303	5/4/04 - 3/6/12	7	0	0%	2.2	1.8	3.0	0.45
123	-	10/9/02 - 4/3/08	7	0	0%	5.0	1.7	6.8	2.2
124	1112 - 1302	9/23/04 - 12/16/05	2	0	0%	3.8	3.7	3.9	0.14
66	-	8/2/07 - 11/20/12	6	0	0%	9.1	2.8	14	4.9
67	-	8/2/07 - 3/6/12	3	0	0%	3.30	0.80	4.7	2.2
Facility Group Summary			**25**	**0**	**0%**	**4.9**	**0.80**	**14.0**	**3.7**
Downgradient Group									
6	-	9/3/08 - 3/6/12	4	0	0%	3.0	2.3	3.5	0.62
14	876 - 1332	11/2/84 - 8/20/12	17	0	0%	1.7	0.50	2.5	0.54
18	698 - 1078	7/25/95 - 8/20/12	17	1	6%	1.0	0.05	2.0	0.49
109	950 - 1154	4/30/96 - 12/16/06	5	0	0%	2.5	1.6	3.3	0.80
110	-	3/3/94 - 9/26/95	2	0	0%	0.30	0.10	0.50	0.28
Downgradient Group Summary			**45**	**1**	**2%**	**1.6**	**0.05**	**3.50**	**0.86**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 6 summary indicates that there is an increase in mean nitrate concentration in facility wells compared to upgradient wells and average facility well concentrations are higher than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.8 mg/L, 2.7 mg/L, and 2.6 mg/L, respectively (WEI 2000, 2011). However, there does not appear to be an increase in downgradient well concentrations and the average nitrate concentrations in downgradient wells are lower than historical averages for the Lakeview/Hemet North management zone.

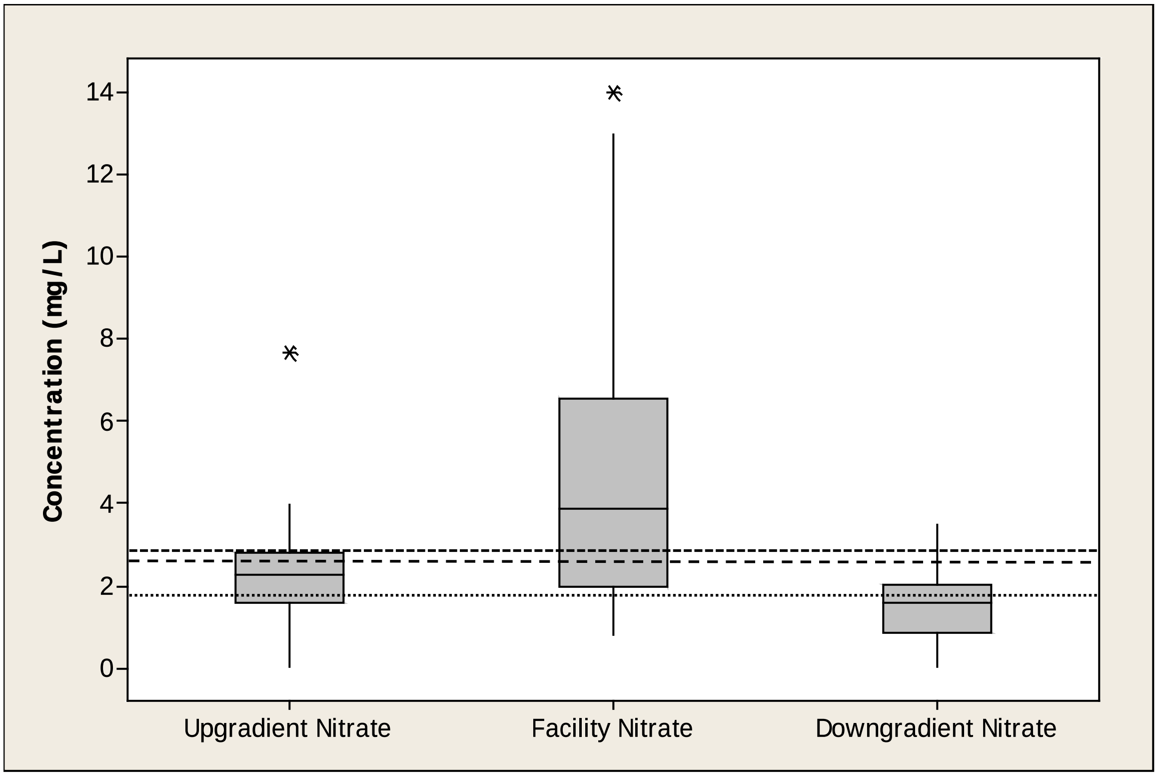
Table 7. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
101	-	10/7/91	1	0	0%	500	500	500	-
114	-	4/24/09	1	0	0%	590	590	590	-
40	-	7/15/04 - 4/4/12	7	0	0%	544	520	570	19
144	-	7/25/00 - 9/23/03	3	0	0%	430	420	450	17
152	-	7/11/90	1	0	0%	670	670	670	-
156	-	4/15/91	1	0	0%	940	940	940	-
Upgradient Group Summary			**14**	**0**	**0%**	**557**	**420**	**940**	**129**
Facility Group									
4	1193 - 1303	5/4/04 - 3/6/12	7	0	0%	499	480	540	23
123	-	10/9/02 - 4/3/08	7	0	0%	823	550	1010	181
124	1112 - 1302	9/23/04 - 12/16/05	2	0	0%	620	590	650	42
66	-	8/2/07 - 11/20/12	6	0	0%	847	570	1030	191
67	-	8/2/07 - 3/6/12	3	0	0%	730	610	810	106
Facility Group Summary			**25**	**0**	**0%**	**710**	**480**	**1030**	**198**
Downgradient Group									
6	-	9/3/08 - 3/6/12	4	0	0%	645	570	690	54
14	876 - 1332	11/2/84 - 8/20/12	18	0	0%	551	400	987	211
18	698 - 1078	7/25/95 - 8/20/12	17	0	0%	973	830	1100	83
109	950 - 1154	4/30/96 - 12/16/06	5	0	0%	428	380	460	29
110	-	3/3/94 - 9/26/95	2	0	0%	504	372	635	186
Downgradient Group Summary			**46**	**0**	**0%**	**700**	**372**	**1100**	**260**

The Table 7 summary indicates that the average TDS concentration is greater in the facility and downgradient wells compared to upgradient wells. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for the 1954 to 1973 period of 519 mg/L, but less than the 1978 to 1997 and 1990 to 2009 periods of 830 mg/L and 890 mg/L, respectively.

2.3.2 Boxplots

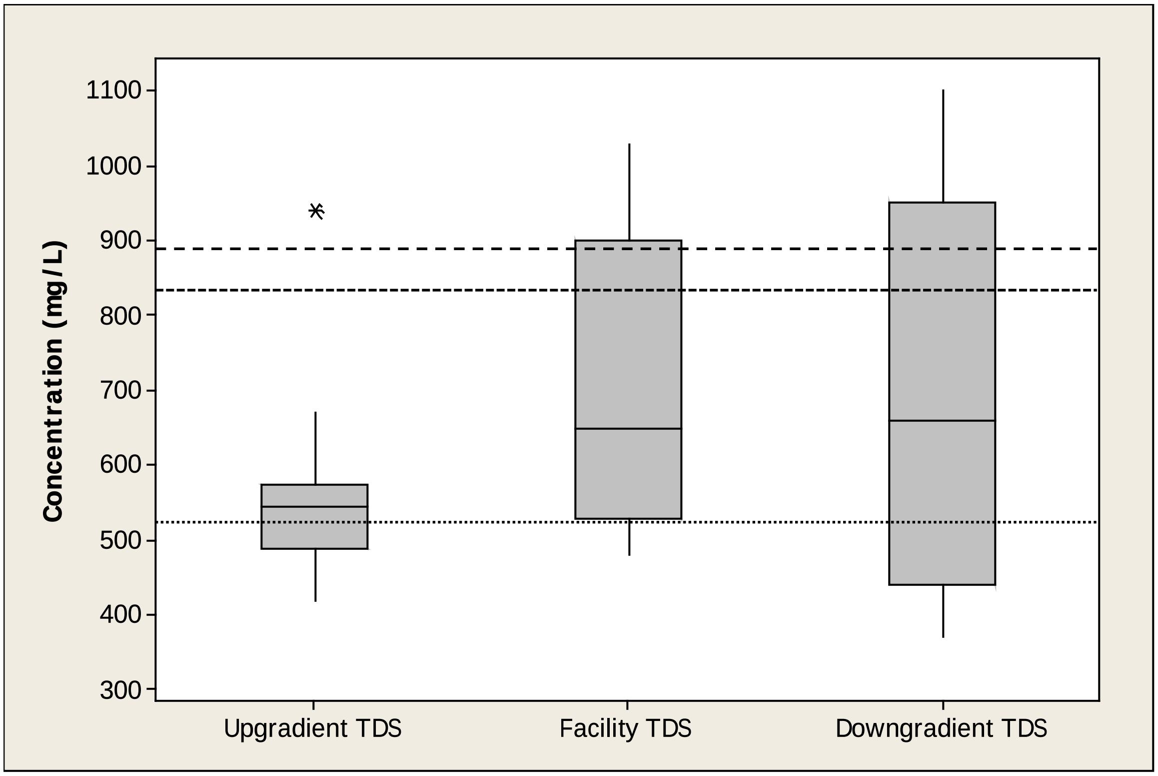
Boxplots were created using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality (Figures 9 and 10).



Average nitrate concentration 1990 to 2009 of 2.6 mg/L (Lakeview/Hemet North management zone)
Average nitrate concentration 1978 to 1997 of 2.7 mg/L (Lakeview/Hemet North management zone)
Average nitrate concentration 1954 to 1973 of 1.8 mg/L (Lakeview/Hemet North management zone)

Figure 9. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

The boxplots indicate that although the distribution of nitrate concentrations in the facility wells is higher than upgradient wells, nitrate levels are lower in the downgradient wells. In this case it could be inferred that although elevated nitrate levels in facility wells suggest the possibility of dairy influence on local groundwater quality, this influence does not extend to the downgradient groundwater. Average facility well nitrate concentrations are higher and average downgradient nitrate concentrations are lower than historic averages for the Lakeview/Hemet North management zone.



_ _ _ Average TDS concentration 1990 to 2009 of 890 mg/L (Lakeview/Hemet North management zone)
----- Average TDS concentration 1978 to 1997 of 830 mg/L (Lakeview/Hemet North management zone)
·········· Average TDS concentration 1954 to 1973 of 519 mg/L (Lakeview/Hemet North management zone)

Figure 10. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tends to be higher than those recorded in the upgradient wells, and average facility and downgradient concentrations are greater than the historic averages for the Lakeview/Hemet North management zone for the period 1954 to 1973, but less than the averages for the periods 1978 to 1997 and 1990 to 2009.

2.3.3 Quantitative Statistical Analysis

ANOVA was used to test for significant differences among mean nitrate and TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient). Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

	Mean Nitrate (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
2.4 a	4.9 b	1.6 a	17.8	<0.001

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
557 a	710 b	700 b	2.5	0.091

In each of the tables above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results indicate that a significant difference exists among the three well groups. Mean nitrate levels in facility groundwater have been significantly higher than those observed in either upgradient or downgradient wells. Mean TDS concentrations in facility and downgradient wells are significantly higher than that observed in upgradient groundwater.

2.3.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 have elevated nitrate concentrations in facility groundwater, but no increases in downgradient nitrate concentrations are apparent. The combined operations could be responsible for increased TDS concentrations in groundwater in the vicinity of the facilities and downgradient from the dairy operations. The following specific observations support these conclusions:

- Average nitrate concentrations in facility wells are higher than upgradient wells and the average facility well concentrations are higher than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots indicate the distribution of nitrate concentrations in the facility wells are higher than upgradient wells, but nitrate levels are lower in the downgradient wells.
- The statistical analysis for nitrate found that facility groundwater has significantly higher nitrate concentrations compared to the upgradient groundwater.
- The average TDS concentration is greater in the facility and downgradient wells compared to upgradient wells. The average facility and downgradient well concentrations are greater than averages for the period of 1954 to 1973 period of 519 mg/L, but less than the 1978 to 1997 and 1990 to 2009 periods of 830 mg/L and 890 mg/L.
- The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tend to be higher than those recorded in the upgradient wells.
- The statistical analysis of TDS concentrations indicates that facility and downgradient wells have significantly higher concentrations compared to upgradient wells.

Based on available information, it is not feasible to determine the source of elevated TDS concentrations or the individual contribution of each dairy for the potential impacts to downgradient groundwater quality. Numerous non-dairy sources of nitrate and TDS including upgradient irrigated fields, septic systems and horse properties; downgradient poultry operations and manure compost; variations in sample dates, unknown or non-similar perforated intervals in the monitoring wells, the impact of fault zones, and the close proximity of individual wells make it infeasible to determine the impact of the group of dairies with a high degree of confidence. In this case, further study is needed to more accurately determine the impact of the group of dairies and the individual impact of each dairy including additional groundwater monitoring.

2.4 Goyenetche Dairy #2 (Old Cawston Dairy)

Goyenetche Dairy #2 is located southwest of the intersection of West Esplanade Avenue and Cawston Avenue, and just north of Tahquitz High School. The area identified as dairy-intensive at Goyenetche Dairy #2 is located approximately 0.7 miles southeast of Dick Van Dam Dairy (see Figure 11). The monitoring well dataset did not include any facility wells or any wells within 1.5 miles upgradient of the facility. The nearest downgradient monitoring wells are located approximately 1 mile to the north-northwest and are located within the dairy-intensive areas of Dick Van Dam Dairy and Cottonwood Dairy. The nearest monitoring well of any kind is located approximately 0.35 miles northeast and is not located along the assumed groundwater flow path. Potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields, septic systems and horse properties. Northwest-southeast oriented fault zones are located to the east and northeast of this dairy.

The lack of available information of this dairy makes it infeasible to determine the potential impact on groundwater quality and further study is needed, including collecting upgradient, downgradient and facility groundwater samples.

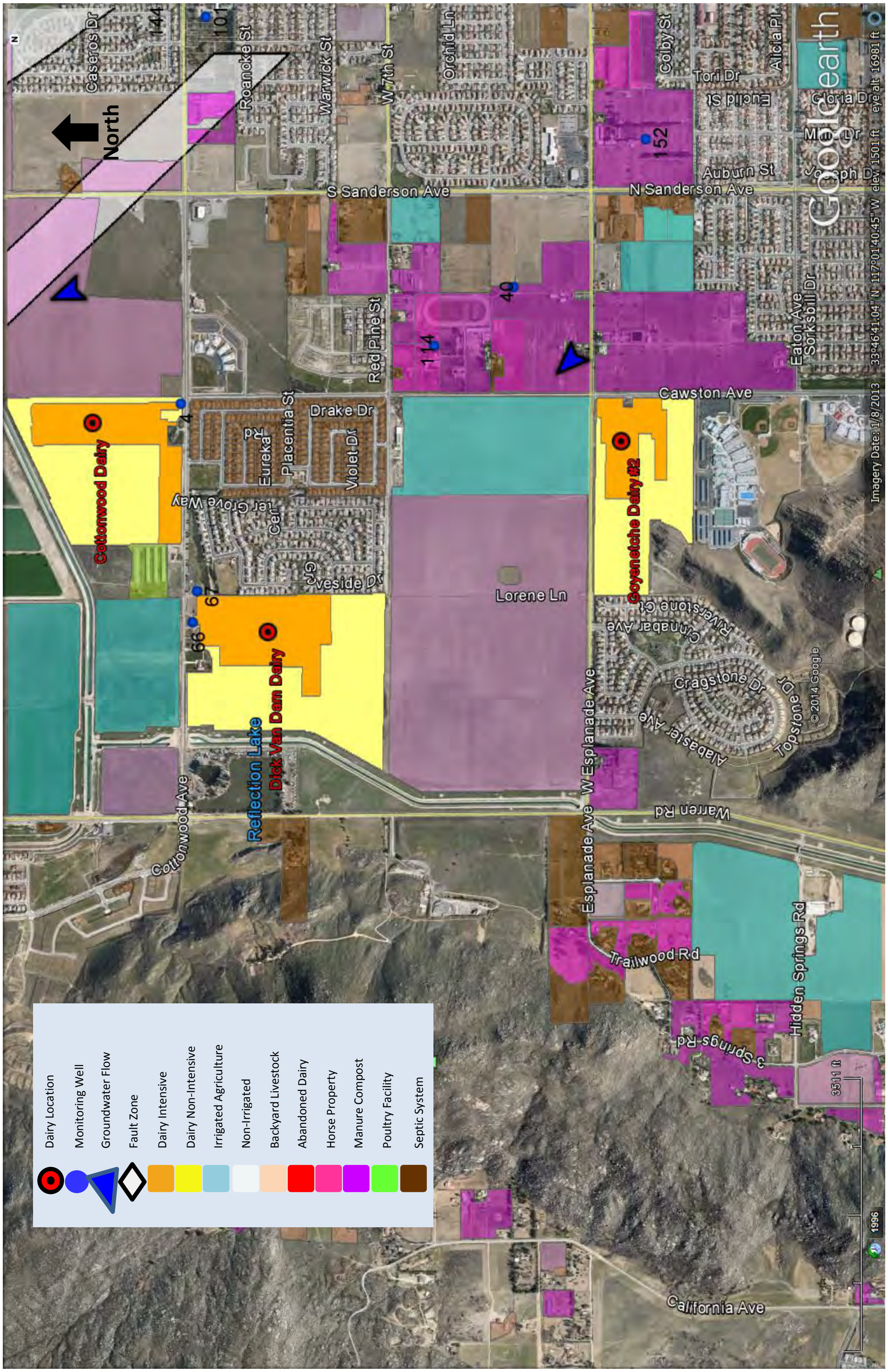


Figure 11. Location map of the vicinity of Goyenetche Dairy #2

2.5 Group of Dairies (Albert Goyenetche Dairy #2 (Old Ferriera Dairy), John Bootsma Dairy, and Offinga Dairy)

Three dairies identified as Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy are located north of Ramona Expressway between First and Sixth Street. Land identified as dairy intensive for these facilities is either adjacent or less than less than 150 feet apart, and all dairy non-intensive land for each dairy is side-by-side (see Figure 12). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies has been variable. Groundwater contours published in the Wildermuth report (Figure 3-7, Fall 1997 Water Level Elevation Contours) indicate a groundwater low in this area, with groundwater flow from the south, southwest, and northwest all converging into a groundwater low. The mapping completed by Tetra Tech indicates a similar groundwater elevation low in the vicinity of the dairies from 1995 to 2005 (see Appendix A). From 2010 to 2012, the contours indicate a less pronounced groundwater low, though this might be to some degree a reflection of the contour interval only. The EMWD report (see Figure 9-6) includes just a small portion of the area in question in their mapping. A southeast-northwest oriented fault zone is located northeast of the dairies and appears to form a barrier to groundwater flow. The groundwater flow arrows shown on Figure 12 are based on the available information, including average 2012 groundwater elevations from the database.

Monitoring wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located downgradient of a residential area utilizing septic systems, poultry operations, irrigated fields, horse properties.

The analysis for this group of dairies includes eight upgradient wells with a total of 104 nitrate and 102 TDS samples collected from 3/9/1984 to 3/22/2012, three facility wells with a total of 31 nitrate samples and 52 TDS samples collected from 4/23/1996 to 11/26/2012, and two downgradient wells with a total of 20 samples collected from 4/25/1994 to 1/20/2011.

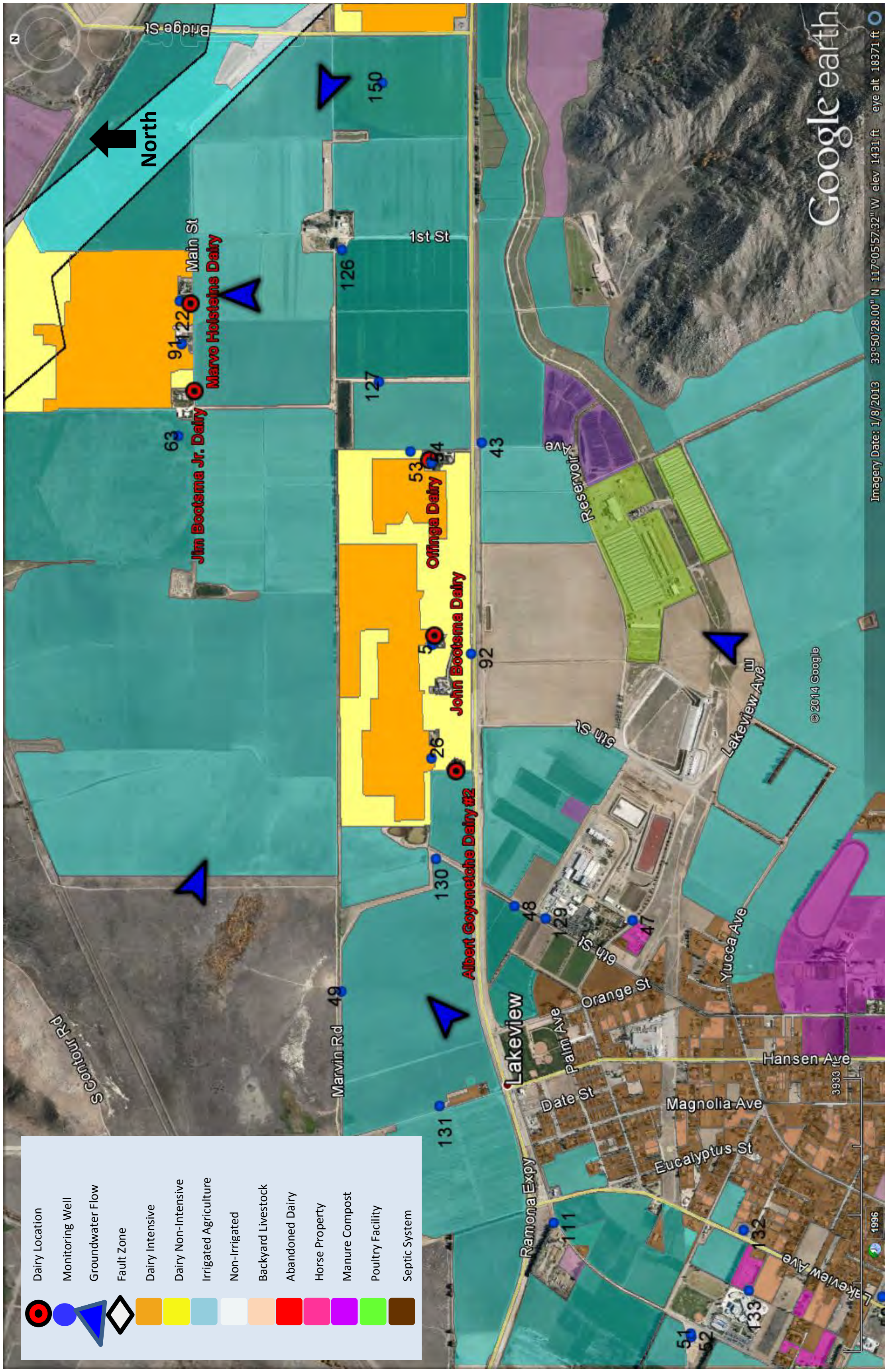


Figure 12. Location map of the vicinity of Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

2.5.1 Summary Data

Tables 8 and 9 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the combined data for each group of wells (upgradient, downgradient, and facility).

Table 8. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
111	854 - 1189	6/5/87 - 7/17/00	9	0	0%	0.36	0.11	1.0	0.33
47	-	7/2/87 - 3/22/12	15	0	0%	17	0.90	22	5.0
48	966 - 1276	7/6/93 - 3/12/12	13	0	0%	4.5	0.70	6.5	1.5
129	971 - 1281	7/6/93 - 5/6/08	6	0	0%	6.3	3.5	7.9	1.7
130	735 - 1042	7/6/93 - 2/9/06	12	0	0%	1.3	0.86	1.9	0.27
131	-	4/19/96 - 6/3/04	7	5	71%	0.09	0.05	0.10	0.02
132	953 - 1367	3/9/84 - 6/29/10	24	0	0%	12.2	7.0	18	4.0
133	658 - 1338	3/28/86 - 6/6/07	18	0	0%	6.5	1.8	9.7	2.5
Upgradient Group Summary			**104**	**5**	**5%**	**7.5**	**0.05**	**22**	**6.4**
Facility Group									
5	1273 - 1573	6/24/02 - 11/26/12	10	1	10%	0.91	0.05	1.5	0.48
92	-	6/6/02 - 5/25/06	5	0	0%	1.6	0.60	4.3	1.5
26	-	4/23/96 - 3/12/12	16	1	6%	2.4	0.05	4.0	1.4
Facility Group Summary			**31**	**2**	**6%**	**1.8**	**0.05**	**4.3**	**1.4**
Downgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	12	75%	0.08	0.05	0.20	0.04
127	963 - 1323	4/25/94 - 7/25/06	4	2	50%	0.06	0.05	0.10	0.03
Downgradient Group Summary			**20**	**14**	**70%**	**0.07**	**0.05**	**0.20**	**0.04**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 8 summary indicates that there is a decrease in average nitrate concentrations in facility wells compared to upgradient wells and that average downgradient well concentrations are lower than either upgradient or facility wells. Average upgradient nitrate concentrations are higher than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.8 mg/L, 2.7 mg/L, and 2.6 mg/L, respectively (WEI 2000, 2011). There does not appear to be an increase in facility and downgradient well concentrations and the average nitrate concentrations in facility wells are equal to historical averages for the management zone for the 1954 to 1973, and lower than historical averages for the Lakeview/Hemet North management zone, for the 1978 to 1997 and 1990 to 2009 periods.

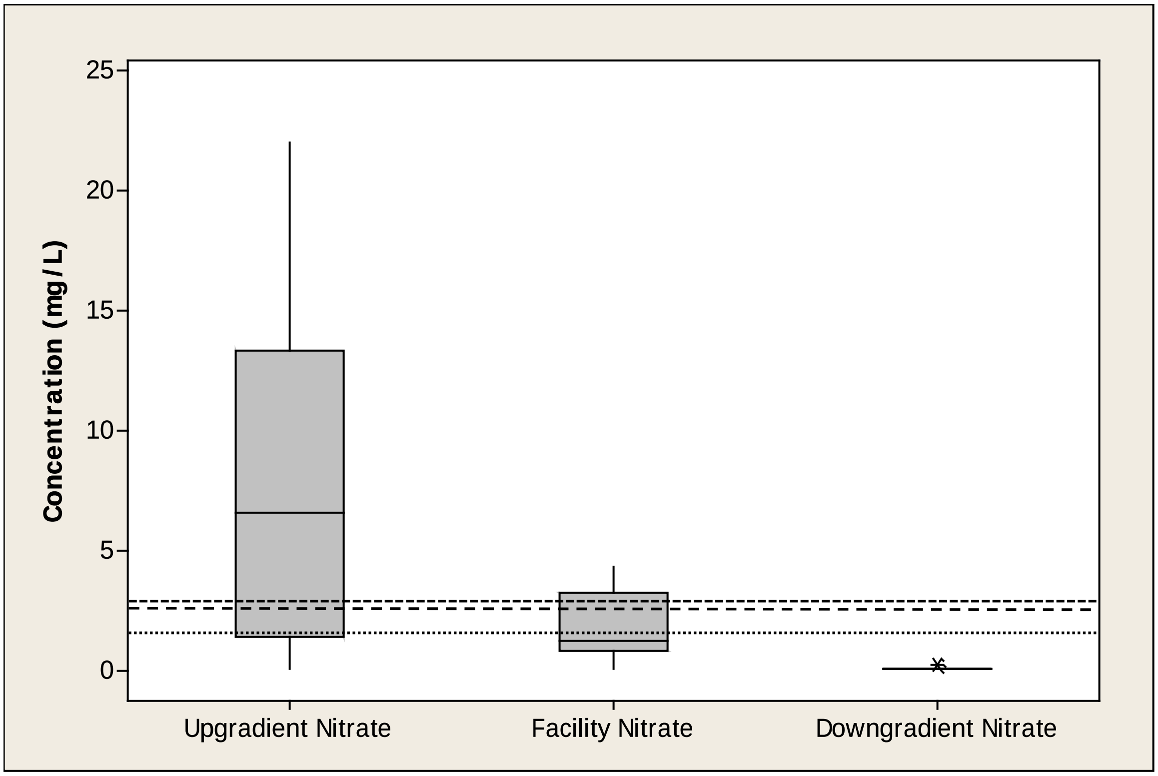
Table 9. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
111	854 - 1189	6/5/87 - 7/17/00	10	0	0%	806	610	975	114
47	-	7/2/87 - 3/22/12	14	0	0%	524	449	645	47
48	966 - 1276	7/6/93 - 3/12/12	15	0	0%	548	470	710	64
129	971 - 1281	7/6/93 - 5/6/08	6	0	0%	523	470	630	56
130	735 - 1042	7/6/93 - 2/9/06	12	0	0%	556	490	590	28
131	-	4/19/96 - 6/3/04	7	0	0%	751	500	890	130
132	953 - 1367	3/9/84 - 6/29/10	21	0	0%	762	335	2200	521
133	658 - 1338	3/28/86 - 6/6/07	17	0	0%	1114	490	3600	973
Upgradient Group Summary			**102**	**0**	**0%**	**722**	**335**	**3600**	**500**
Facility Group									
5	1273 - 1573	6/24/02 - 11/26/12	17	0	0%	475	440	510	18
92	-	6/6/02 - 5/25/06	5	0	0%	514	460	580	44
26	-	4/23/96 - 3/12/12	30	0	0%	537	460	640	32
Facility Group Summary			**52**	**0**	**0%**	**515**	**440**	**640**	**41**
Downgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	0	0%	574	520	610	21
127	963 - 1323	4/25/94 - 7/25/06	4	0	0%	568	530	640	52
Downgradient Group Summary			**20**	**0**	**0%**	**573**	**520**	**640**	**28**

The Table 9 summary indicates that average TDS concentration is greater in the upgradient compared to facility and downgradient wells. Average facility well concentrations are less than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 519 mg/L, 830 mg/L and 890 mg/L, respectively. The average downgradient TDS concentrations are greater than the 1954 to 1973 period averages, but lower than the 1978 to 1997 and 1990 to 2009 period averages.

2.5.2 Boxplots

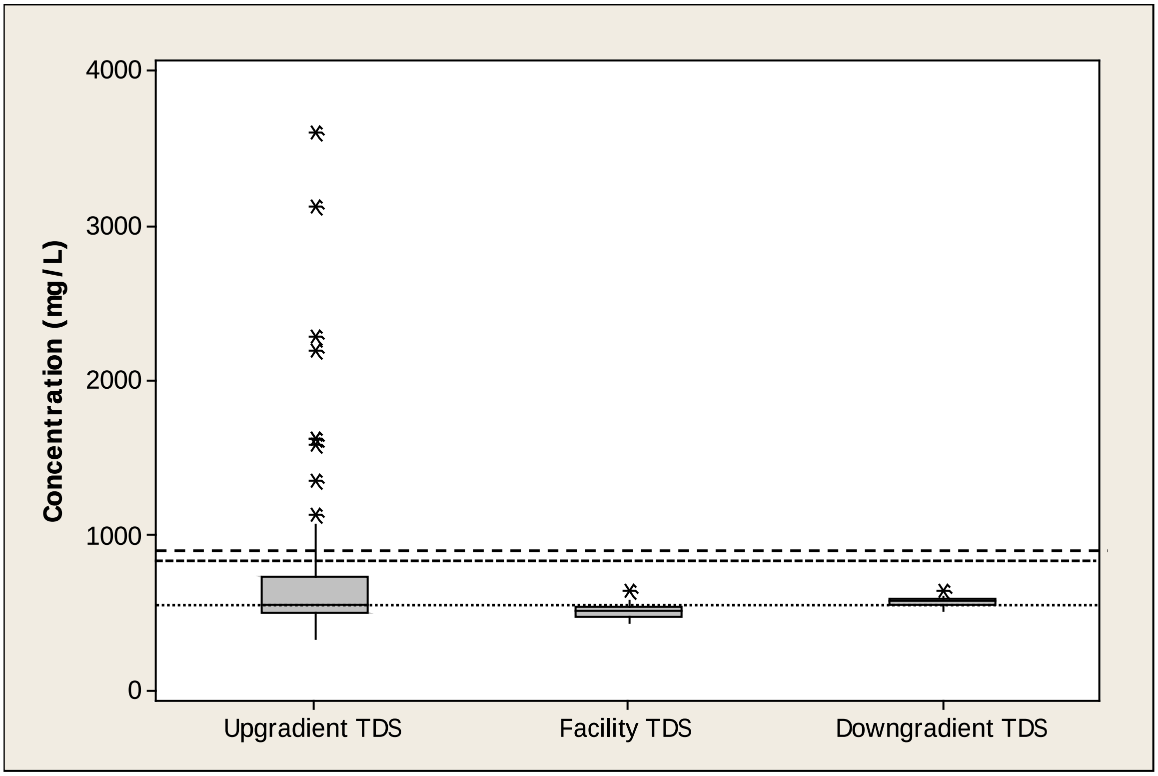
Boxplots were created using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality (Figures 13 and 14).



_ _ _ Average nitrate concentration 1990 to 2009 of 2.6 mg/L (Lakeview/Hemet North management zone)
----- Average nitrate concentration 1978 to 1997 of 2.7 mg/L (Lakeview/Hemet North management zone)
.... Average nitrate concentration 1954 to 1973 of 1.8 mg/L (Lakeview/Hemet North management zone)

Figure 13. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

The boxplots indicate that the distribution of nitrate concentrations in the facility wells is lower than upgradient wells, and downgradient well concentrations are nearly all at non-detected levels. Median facility and downgradient well nitrate concentrations are lower than the historic averages for the Lakeview/Hemet North management zone.



_ _ _ Average TDS concentration 1990 to 2009 of 890 mg/L (Lakeview/Hemet North management zone)
----- Average TDS concentration 1978 to 1997 of 830 mg/L (Lakeview/Hemet North management zone)
.... Average TDS concentration 1954 to 1973 of 519 mg/L (Lakeview/Hemet North management zone)

Figure 14. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tends to be lower than that recorded in the upgradient wells, and average facility and downgradient concentrations are approximately equal to the 1954 to 1973 historic averages and lower than the 1978 to 1997 and 1990 to 2009 historic averages for the Lakeview/Hemet North management zone.

2.5.3 Quantitative Statistical Analysis

Because the nitrate dataset for downgradient wells contains greater than 20% non-detects an ANOVA is not appropriate. However, upgradient and facility mean nitrate concentrations were compared with a t-Test at the 90% confidence interval with the results as follows:

Mean Nitrate (mg/L)			
Upgradient	Facility	t value	*P* value
7.52	1.78	4.95	< 0.001

The *P* value indicates that there is greater than 99 percent probability that the mean nitrate concentration in upgradient wells was significantly higher than the mean nitrate concentration in facility wells.

However, all of the TDS data represent detected concentrations, and ANOVA was used to test for significant differences among mean TDS concentrations from all three well groups. Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

Mean TDS (mg/L)				
Upgradient	Facility	Downgradient	F value	*P* value
720 a	515 b	573 ab	5.3	0.006

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results confirm that a significant difference exists among the three well groups. Mean TDS levels in facility groundwater have been significantly lower than that observed in upgradient groundwater; mean TDS levels in downgradient groundwater do not differ significantly from either facility or upgradient groundwater.

2.5.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy have not increased nitrate or TDS concentrations in facility groundwater or groundwater downgradient from the dairy operations. The regional mapping evaluation found evidence of a nitrate plume upgradient of the Albert Goyenetche Dairy #2 and John Bootsma Dairy wells; however, the focused evaluation completed here indicates that the dairies have not impacted nitrate in groundwater in the vicinity of the dairy. The following specific observations were made which support the conclusion:

- There is no increase in nitrate concentrations downgradient from the facility and the median facility well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots of nitrate concentrations indicate downgradient well concentrations are lower than either upgradient or facility concentrations.
- Average TDS concentrations in facility and downgradient wells is lower than upgradient wells.
- TDS concentrations in facility wells are generally equal to or lower than the average historical TDS concentrations for the Lakeview/Hemet North management zone.
- The boxplot of TDS concentrations indicates no significant increase in downgradient wells compared to facility wells.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility and downgradient wells compared to upgradient wells.
- The t-Test results indicate that facility well concentrations are significantly lower than upgradient well concentrations.

2.6 Pastime Lakes Dairy John Bidart

Pastime Lakes Dairy John Bidart is located northeast of the intersection of Ramona Expressway and Bridge Street. The area identified as dairy-intensive at Pastime Lakes Dairy John Bidart is located approximately 0.7 miles northeast of Marvo Holsteins Dairy #2 and Boersma Dairy, and 1.1 miles east of Offinga Dairy (see Figure 15).

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally from the southeast to northwest, as indicated by the generalized groundwater flow arrows in Figure 15. Monitoring wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located immediately northwest, and downgradient, from the group of dairies identified in a previous section (Hollandia Dairy, Boersma Dairy, and Marvo Holsteins #2 Dairy), so the upgradient groundwater quality is, in part, best represented by the monitoring wells from the upgradient facilities. Potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields, manure compost storage, and the dairy operations located to the southeast. A northwest-southeast oriented fault zone is located to the east and north of this dairy.

The analysis of this dairy includes five upgradient wells with a total of 48 samples collected from 8/4/1995 to 3/8/2012, four facility wells with a total of 16 samples collected from 3/16/1994 to 4/5/2012, and two downgradient wells with a total of 17 samples collected from 4/25/1994 to 1/20/2011.

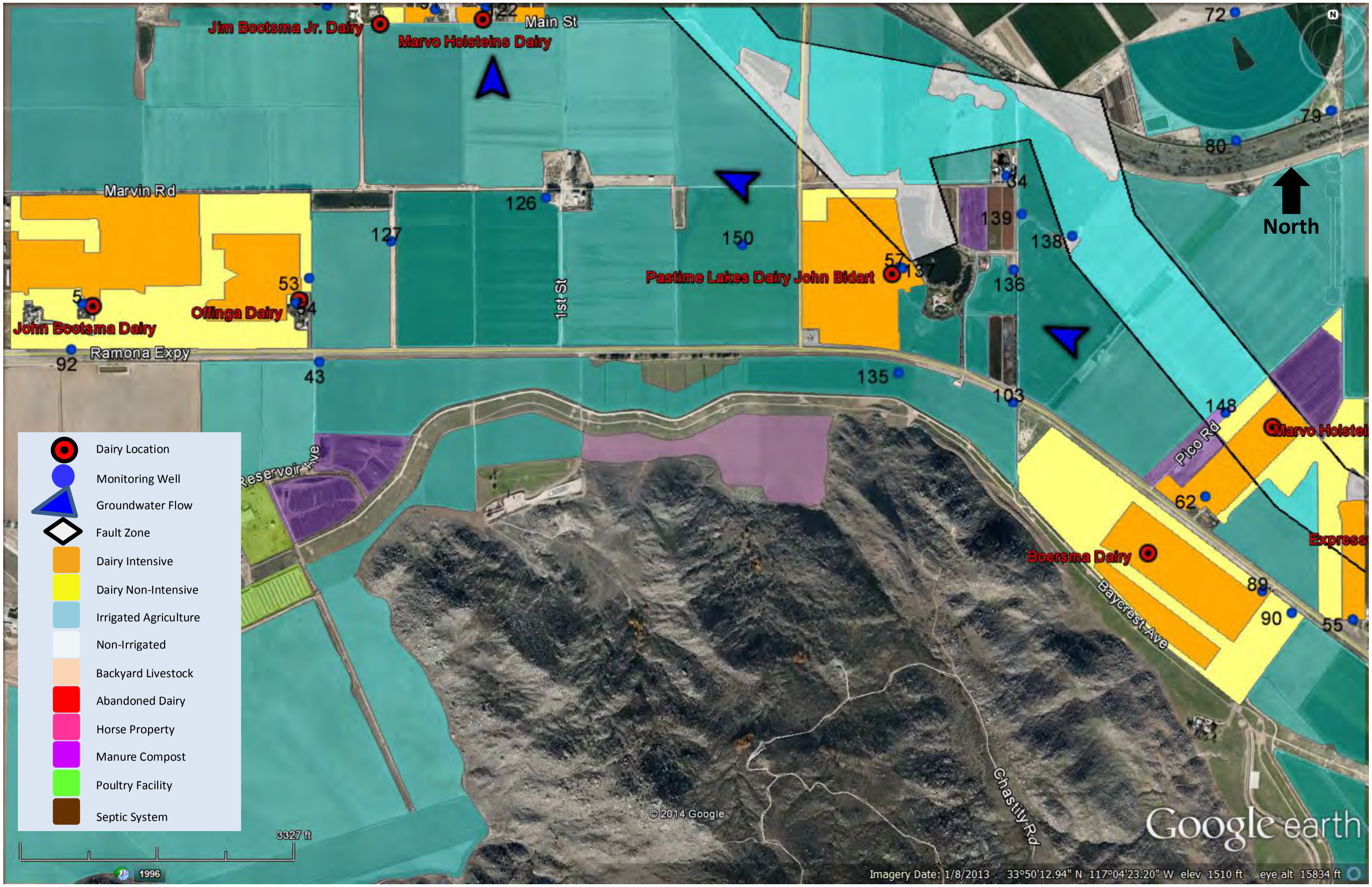


Figure 15. Location map of the vicinity of Pastime Lakes Dairy John Bidart

2.6.1 Summary Data

Tables 10 and 11 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 10. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Pastime Lakes Dairy John Bidart

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
89	-	6/18/02 - 3/29/10	10	0	0%	0.41	0.20	0.60	0.13
90	-	5/24/96 - 6/26/08	5	0	0%	0.94	0.10	1.80	0.80
103	899 - 1251	8/4/95 - 5/4/04	11	0	0%	1.18	0.60	1.70	0.32
62	-	8/25/03 - 3/8/12	10	0	0%	1.61	0.30	2.10	0.49
148	-	10/5/00 - 3/20/09	12	10	83%	0.37	0.05	1.90	0.72
Upgradient Group Summary			**48**	**10**	**21%**	**0.88**	**0.05**	**2.10**	**0.70**
Facility Group									
135	-	3/16/94	1	0	0%	0.68	0.68	0.68	-
136	-	5/10/04 - 4/7/08	3	0	0%	0.53	0.40	0.70	0.15
137	-	11/19/07 - 1/17/11	5	0	0%	0.61	0.20	1.00	0.35
57	-	6/19/02 - 4/5/12	7	0	0%	0.96	0.50	1.60	0.34
Facility Group Summary			**16**	**0**	**0%**	**0.75**	**0.20**	**1.60**	**0.34**
Downgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	12	75%	0.08	0.05	0.20	0.04
150	-	7/7/93	1	0	0%	0.70	0.70	0.70	-
Downgradient Group Summary			**17**	**12**	**71%**	**0.11**	**0.05**	**0.70**	**0.16**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 10 summary indicates that there is a decrease in average nitrate concentrations in facility wells compared to upgradient wells and average downgradient well concentrations are lower than either upgradient or facility wells. All nitrate concentrations are lower than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.8 mg/L, 2.7 mg/L and 2.6 mg/L, respectively (WEI 2000, 2011).

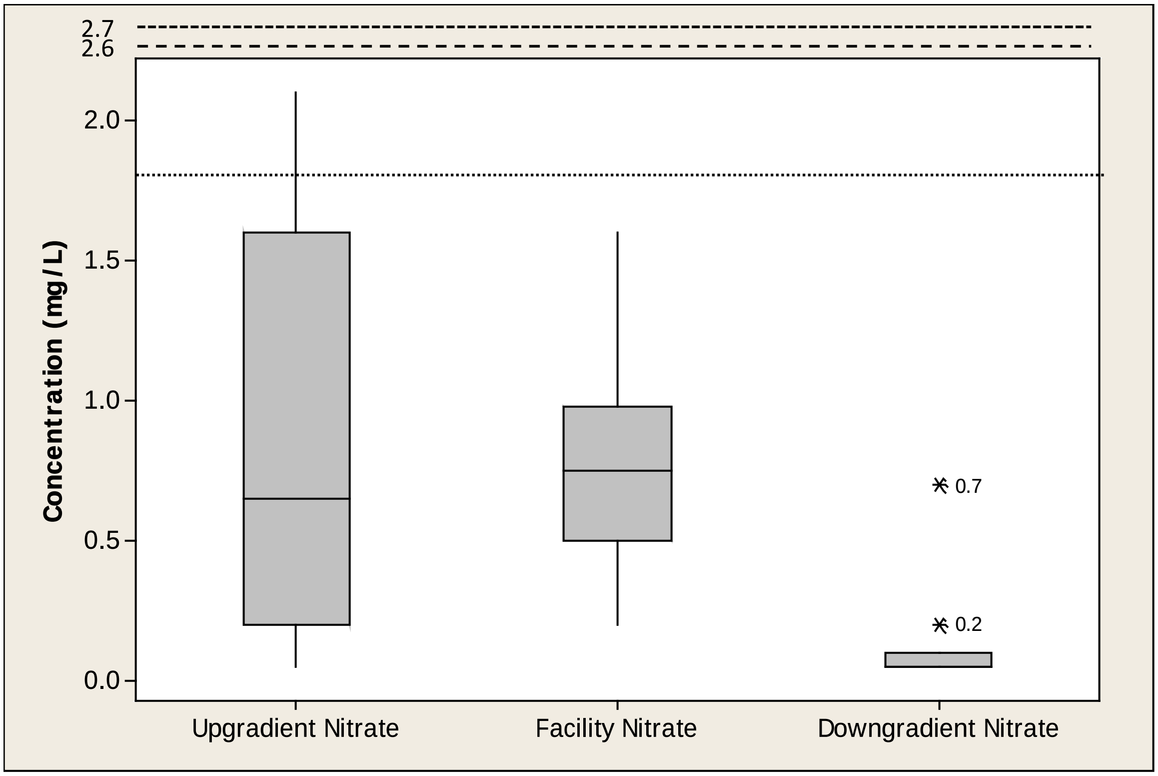
Table 11. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Pastime Lakes Dairy John Bidart

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
89	-	6/18/02 - 3/29/10	10	0	0%	634	620	640	7.0
90	-	5/24/96 - 6/26/08	5	0	0%	598	590	600	4.5
103	899 - 1251	8/4/95 - 5/4/04	11	0	0%	565	490	620	37
62	-	8/25/03 - 3/8/12	10	0	0%	598	360	690	88
148	-	10/5/00 - 3/20/09	12	0	0%	588	550	620	25
Upgradient Group Summary			**48**	**0**	**0%**	**595**	**360**	**690**	**50**
Facility Group									
135	-	3/16/94	1	0	0%	530	530	530	-
136	-	5/10/04 - 4/7/08	3	0	0%	553	550	560	5.8
137	-	11/19/07 - 1/17/11	5	0	0%	556	530	580	18
57	-	6/19/02 - 4/5/12	7	0	0%	524	480	570	29
Facility Group Summary			**16**	**0**	**0%**	**540**	**480**	**580**	**26**
Downgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	0	0%	574	520	610	21
150	-	7/7/93	1	0	0%	552	552	552	-
Downgradient Group Summary			**17**	**0**	**0%**	**573**	**520**	**610**	**21**

The Table 11 summary indicates that the average TDS concentration is greater in the upgradient compared to facility and downgradient wells. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973 of 519 mg/L, but less than the 1978 to 1997 and 1990 to 2009 averages of 830 mg/L and 890 mg/L, respectively.

2.6.2 Boxplots

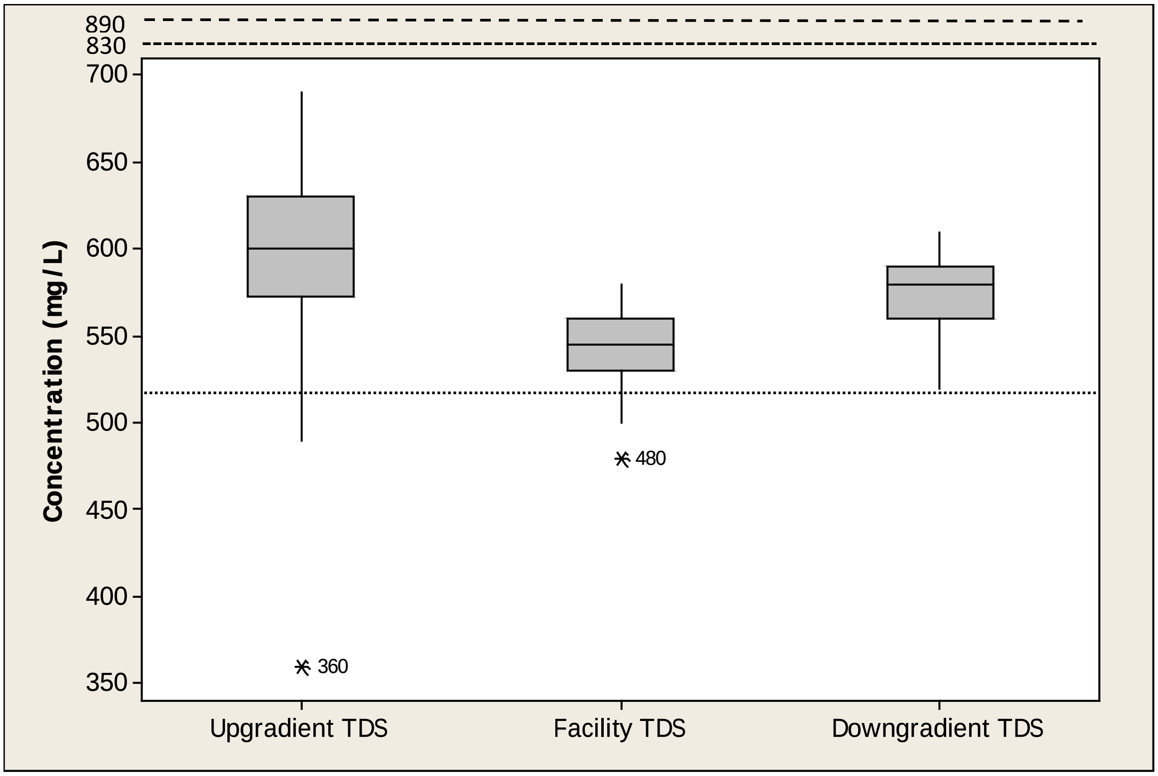
Boxplots were created using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality (Figures 16 and 17).



_ _ _ Average nitrate concentration 1990 to 2009 of 2.6 mg/L (Lakeview/Hemet North management zone)
\----- Average nitrate concentration 1978 to 1997 of 2.7 mg/L (Lakeview/Hemet North management zone)
·········· Average nitrate concentration 1954 to 1973 of 1.8 mg/L (Lakeview/Hemet North management zone)

Figure 16. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for Pastime Lakes Dairy John Bidart

The boxplots indicate that the median value for facility wells is greater than the upgradient median, though the distribution of nitrate concentrations in the facility wells less variable than upgradient wells. Downgradient well concentrations are nearly all at non-detected levels. In this case, it could be inferred that although slightly elevated nitrate levels in facility wells suggest the possibility of dairy influence on local groundwater quality, this influence does not appear to extend to the downgradient groundwater. Median values for upgradient, facility and downgradient well nitrate concentrations are lower than the historic averages for the Lakeview/Hemet North management zone.



_ _ _ Average TDS concentration 1990 to 2009 of 890 mg/L (Lakeview/Hemet North management zone)
----- Average TDS concentration 1978 to 1997 of 830 mg/L (Lakeview/Hemet North management zone)
.... Average TDS concentration 1954 to 1973 of 519 mg/L (Lakeview/Hemet North management zone)

Figure 17. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for Pastime Lakes Dairy John Bidart

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells are lower than upgradient wells. All three group median concentrations are greater than the 1954 to 1973 historic averages and lower than the 1978 to 1997 and 1990 to 2009 averages for the Lakeview/Hemet North management zone.

2.6.3 Quantitative Statistical Analysis

ANOVA was used to test for significant differences among TDS concentrations from all three well groups. Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

Mean TDS (mg/L)				
Upgradient	Facility	Downgradient	F value	*P* value
595 a	540 b	573 c	10.9	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results confirm that a significant difference exists among the three well groups. Mean TDS levels in facility and downgradient groundwater have been significantly lower than that observed in upgradient groundwater; mean TDS concentration in facility groundwater has been significantly lower than that observed in downgradient wells.

2.6.4 Conclusions

Based on the available monitoring well data, it appears that Pastime Lakes Dairy John Bidart has not increased nitrate or TDS concentrations in facility groundwater or groundwater downgradient from the dairy operations. The following specific observations were made which support the conclusion:

- There is no increase in nitrate concentrations downgradient from the facility and the median facility well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots of nitrate concentrations indicate downgradient well concentrations are lower than either upgradient or facility concentrations.
- Average TDS concentrations in facility and downgradient wells are lower than upgradient wells.
- Median TDS concentrations in facility wells are lower than the average historical TDS concentrations for the periods 1978 to 1997 and 1990 to 2009 for the Lakeview/Hemet North management zone.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility and downgradient wells compared to upgradient wells.

3.0 Impacts Analysis – San Jacinto Lower Pressure Management Zone

3.1 Van Ryn Dairy

Van Ryn Dairy is located south of Gilman Springs Road between Curtis Street and Central Avenue, east and north of Mystic Lake within the San Jacinto Lower Pressure management zone (see Figure 18). As of the date of the analysis the dairy is vacant.

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally from north-northeast to south-southwest, as indicated by the generalized groundwater flow arrows in Figure 18. Monitoring wells were selected from those available in the vicinity of the dairies that best represent facility and downgradient groundwater conditions. No upgradient wells are available in the vicinity of the dairy. Non-dairy impacts to groundwater quality in the vicinity include nutrient accumulation and other impacts related to Mystic Lake in the downgradient wells. A northwest-southeast oriented fault zone is located to the north of the dairy.

The analysis of this dairy includes one facility well with a total of two samples collected from 11/8/1993 to 3/3/1994 and two downgradient wells with a total of 11 samples collected from 5/31/1997 to 11/26/2012. There are no wells upgradient of the facility available.

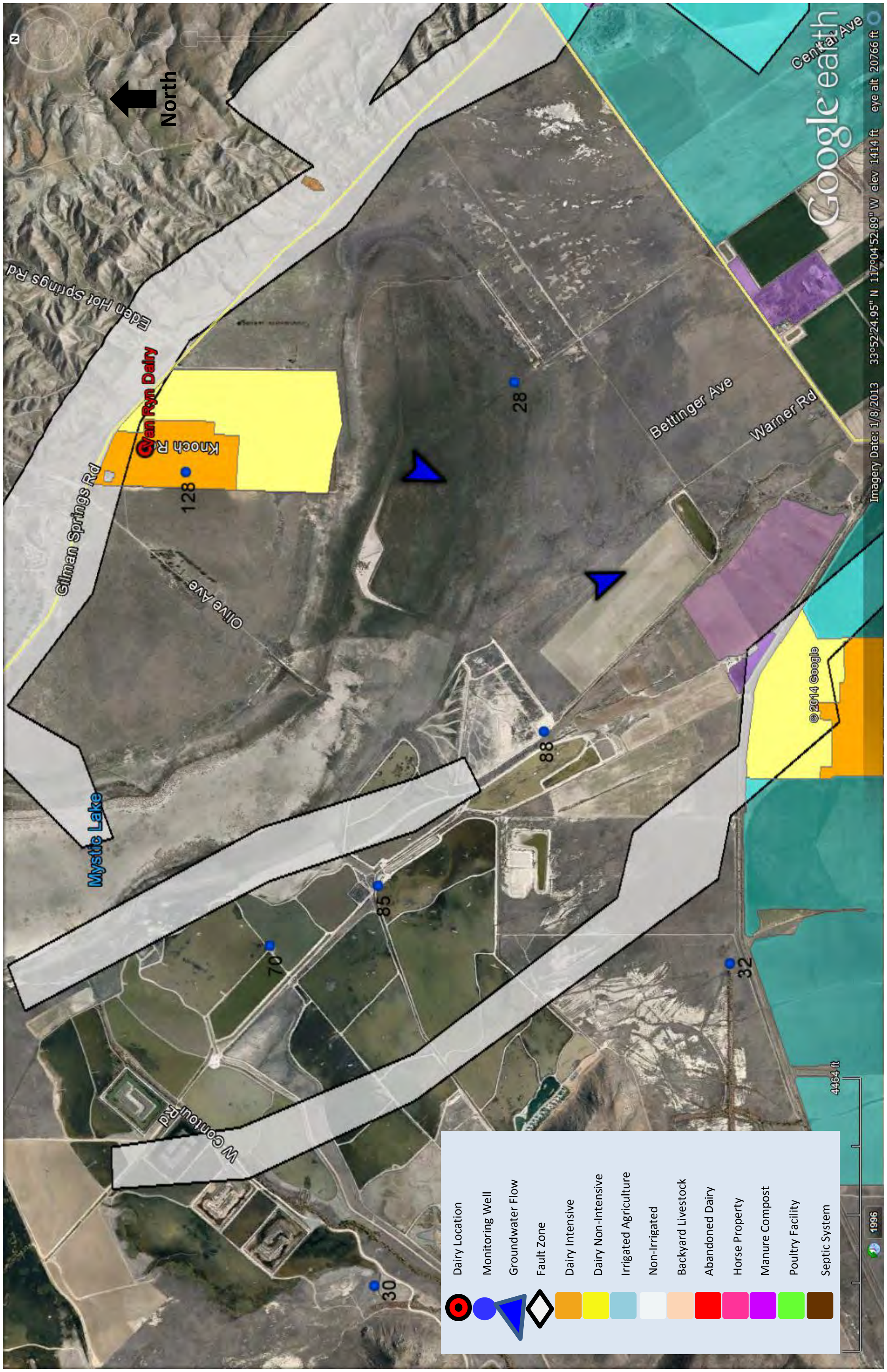


Figure 18. Location map of the vicinity of Van Ryn Dairy

3.1.1 Summary Data

Tables 12 and 13 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 12. Comparison of Facility and Downgradient Nitrate Concentrations for Van Ryn Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
None Available			-	-	-	-	-	-	-
Facility Group									
128	-	11/8/93 - 3/8/94	2	0	0%	0.31	0.11	0.50	0.27
Facility Group Summary			**2**	**0**	**0%**	**0.31**	**0.11**	**0.50**	**0.27**
Downgradient Group									
88	1023 - 1283	5/31/97 - 10/18/99	2	1	50%	0.08	0.05	0.10	0.04
28	702 - 1072	1/18/01 - 11/26/12	9	9	100%	0.06	0.05	0.10	0.02
Downgradient Group Summary			**11**	**10**	**91%**	**0.059**	**0.050**	**0.10**	**0.02**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 12 summary indicates that there is a decrease in average nitrate concentrations in downgradient wells compared to facility wells. Facility and downgradient nitrate concentrations are lower than the historical averages for the San Jacinto Lower Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.0 mg/L, 1.9 mg/L and 1.1 mg/L, respectively.

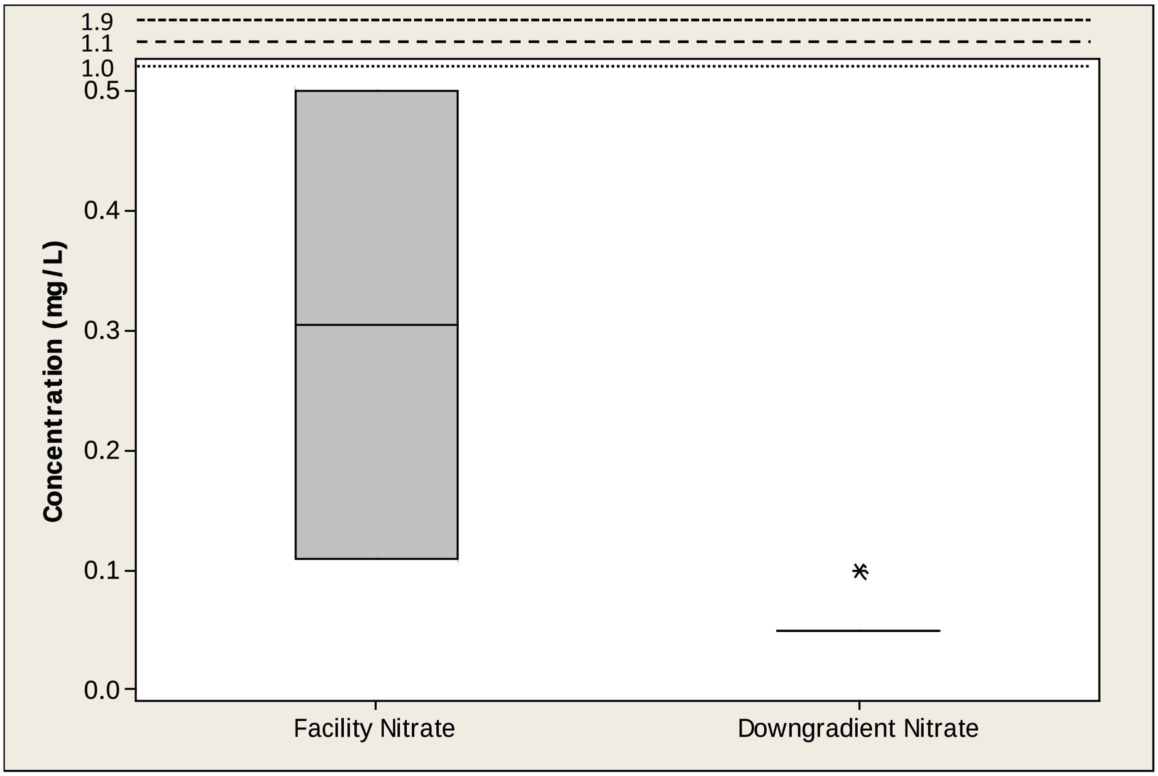
Table 13. Comparison of Facility and Downgradient TDS Concentrations for Van Ryn Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
None Available			-	-	-	-	-	-	-
Facility Group									
128	-	11/8/93 - 3/8/94	2	0	0%	1,278	1,200	1,355	110
Facility Group Summary			**2**	**0**	**0%**	**1,278**	**1,200**	**1,355**	**110**
Downgradient Group									
88	1023 - 1283	5/31/97 - 10/18/99	2	0	0%	693	675	710	25
28	702 - 1072	1/18/01 - 11/26/12	9	0	0%	426	360	520	50
Downgradient Group Summary			**11**	**0**	**0%**	**474**	**360**	**710**	**117**

The Table 13 summary indicates that the average TDS concentration is lower in the downgradient wells compared to the facility well. The average facility well concentrations are greater than the average TDS concentrations for the San Jacinto Lower Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 520 mg/L, 730 mg/L and 800 mg/L, respectively.

3.1.2 Boxplots

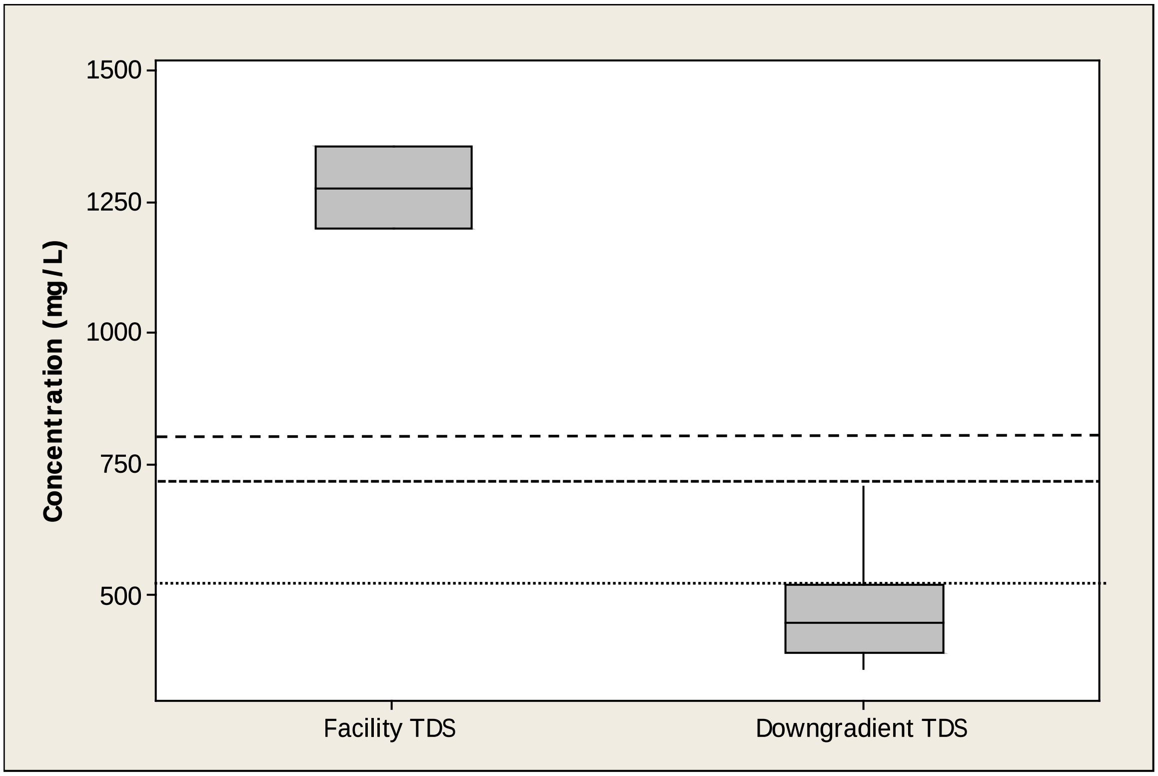
Boxplots were created using combined data from monitoring wells representing facility and downgradient groundwater quality (Figures 19 and 20).



Average nitrate concentration 1990 to 2009 of 1.1 mg/L (San Jacinto Lower Pressure management zone)
Average nitrate concentration 1978 to 1997 of 1.9 mg/L (San Jacinto Lower Pressure management zone)
Average nitrate concentration 1954 to 1973 of 1.0 mg/L (San Jacinto Lower Pressure management zone)

Figure 19. Boxplot of Facility and Downgradient TDS Concentrations for Van Ryn Dairy

The boxplots indicate that the median value for facility wells is greater than the downgradient wells, but both are less than historic averages for the San Jacinto Lower Pressure management zone.



_ _ _ Average TDS concentration 1990 to 2009 of 800 mg/L (San Jacinto Lower Pressure management zone)
----- Average TDS concentration 1978 to 1997 of 730 mg/L (San Jacinto Lower Pressure management zone)
.... Average TDS concentration 1954 to 1973 of 520 mg/L (San Jacinto Lower Pressure management zone)

Figure 20. Boxplot of Facility and Downgradient TDS Concentrations for Van Ryn Dairy

The boxplots indicate the distribution of TDS levels in facility wells are greater than the historic averages for the San Jacinto Lower Pressure management zone, but the downgradient groundwater does not appear to be impacted.

3.1.3 Quantitative Statistical Analysis

Mean TDS concentrations in facility and downgradient groundwater were compared using a t-Test:

Mean TDS (mg/L)			
Facility	Downgradient	t value	*P* value
1,278	474	8.98	0.067

The result of the t-Test indicates that mean TDS concentration was significantly higher in the facility wells than in the downgradient groundwater. However, these results are highly uncertain since the facility dataset includes only two samples.

3.1.4 Conclusions

It appears that based on samples collected in 1993 and 1994, Van Ryn Dairy has elevated TDS concentrations in facility groundwater; however, based on the available data downgradient groundwater has not been impacted. The following specific observations were made which support the conclusion:

- Average TDS concentrations are lower in downgradient wells compared to facility wells, and downgradient well concentrations are less than historical concentrations for the San Jacinto Lower Pressure management zone.
- TDS concentrations in facility wells are greater than the average historical TDS concentrations for the San Jacinto Lower Pressure management zone.
- The ANOVA results indicate that TDS concentrations are significantly higher in facility wells compared to downgradient wells.

It is strongly cautioned that inferences of differences between facility and downgradient groundwater quality in this case are highly uncertain because samples were collected for the two groups over two completely different time periods and the facility dataset includes only two samples. To determine the impact to groundwater with a higher degree of confidence more facility and downgradient groundwater samples are required to better analyze groundwater quality as it relates to this facility. Upgradient groundwater quality information is also needed.

3.2 Pair of Dairies (Jim Bootsma Jr. and Marvo Holsteins)

Two dairies identified as Jim Bootsma Jr. Dairy and Marvo Holsteins Dairy are located approximately 1 mile northwest of the intersection of Bridge Street and Main Street. Land identified as dairy intensive for the two facilities is located side-by-side (see Figure 21). The two dairies were analyzed together because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies has been variable. Groundwater contours published in the Wildermuth report (Figure 3-7, Fall 1997 Water Level Elevation Contours) indicate a groundwater low in this area, with groundwater flow from the south, southwest, and northwest all converging into a groundwater low. The mapping completed by Tetra Tech indicates a similar groundwater elevation low in the vicinity of the dairies from 1995 to 2005 (see Appendix A). From 2010 to 2012 the contours indicate a less pronounced groundwater low, though this might be to some degree a reflection of the contour interval only. The EMWD report (see Figure 9-6) includes just a small portion of the area in question in its mapping. A southeast-northwest oriented fault zone located northeast of the dairies forms a barrier to groundwater flow. The groundwater flow directions indicated by the arrows on Figure 21 are based on the available information, including average 2012 groundwater elevations.

Monitoring wells were selected from those available in the vicinity of the dairies that best represent upgradient and facility groundwater conditions. This group of dairies is located downgradient of a residential area utilizing septic systems and horse properties located southwest of the dairies, poultry operations located south-southwest of the dairies, and irrigated fields to the east, west, and south of the dairies.

The analysis for this group of dairies includes three upgradient wells with a total of 21 nitrate and TDS samples collected from 7/7/1993 to 1/20/2011, and three facility wells with a total of 29 nitrate and 38 TDS samples collected from 6/27/1996 to 12/11/2012. Because the southeast-northwest-oriented fault zone located northeast of the dairies forms a barrier to groundwater flow, no downgradient wells are available for these dairies. Groundwater on the north side of the fault appears to flow south-southeast (see Figure 21).

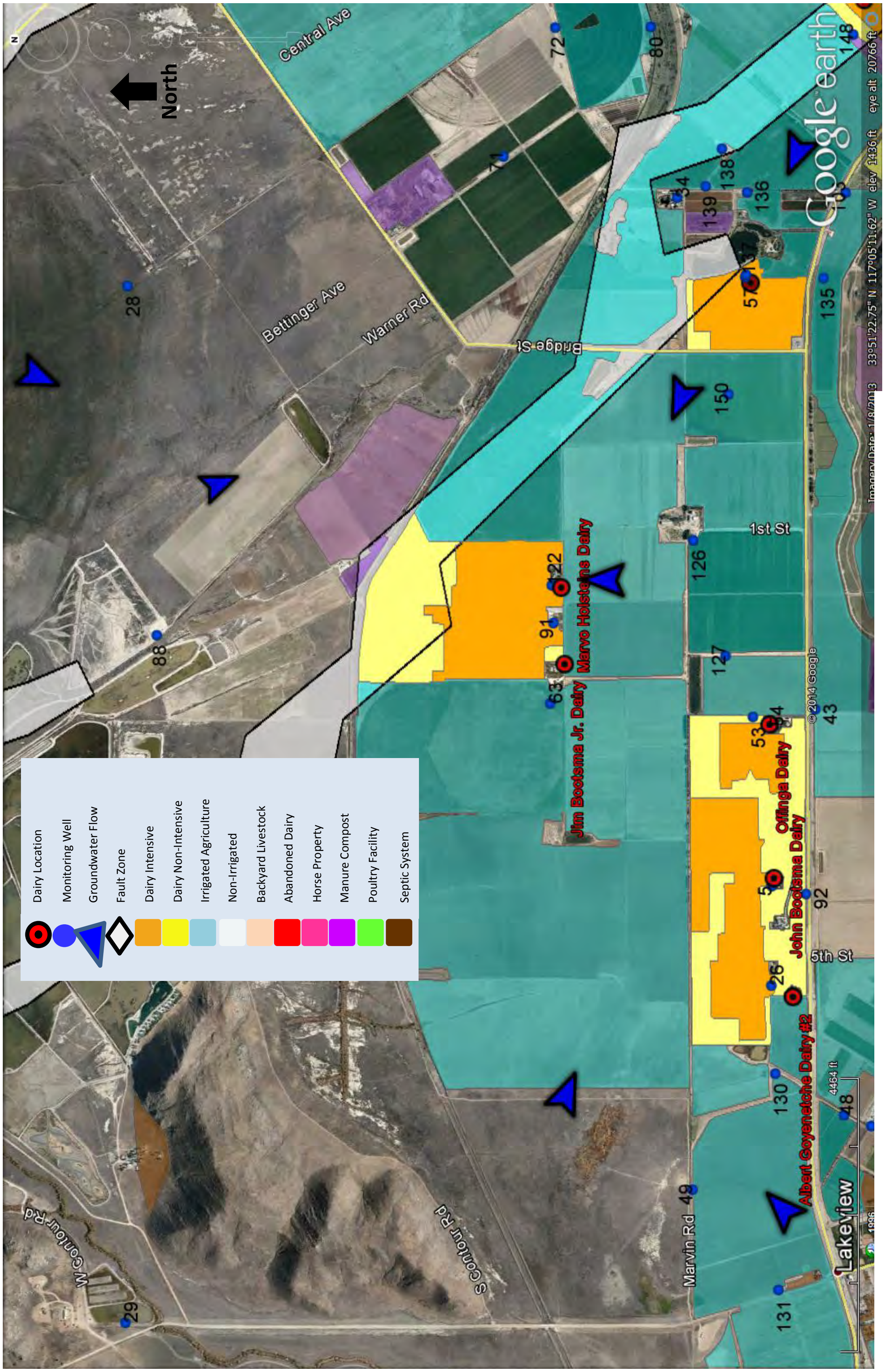


Figure 21. Location map of the vicinity of Jim Bootsma Jr. and Marvo Holsteins Dairies

3.2.1 Summary Data

Tables 14 and 15 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 14. Comparison of Upgradient and Facility Nitrate Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	12	75%	0.08	0.05	0.20	0.04
127	963 - 1323	4/25/94 - 7/25/06	4	2	50%	0.06	0.05	0.10	0.03
150	-	7/7/93	1	0	0%	0.70	0.70	0.70	-
Upgradient Group Summary			**21**	**14**	**67%**	**0.10**	**0.05**	**0.70**	**0.14**
Facility Group									
91	-	5/17/02 - 10/6/11	10	8	80%	0.10	0.05	0.30	0.08
122	-	6/5/02 - 1/12/10	10	9	90%	0.08	0.05	0.20	0.05
63	832 - 1062	6/27/96 - 12/11/12	9	7	78%	0.08	0.05	0.10	0.03
Facility Group Summary			**29**	**24**	**83%**	**0.09**	**0.05**	**0.30**	**0.06**
Downgradient Group									
None Available			-	-	-	-	-	-	-

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 14 summary indicates that there is a decrease in average nitrate concentrations in facility wells compared to upgradient wells. Average upgradient and facility nitrate concentrations are less than the historical averages for the San Jacinto Lower Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.0 mg/L, 1.9 mg/L and 1.1 mg/L, respectively (WEI 2000, 2011).

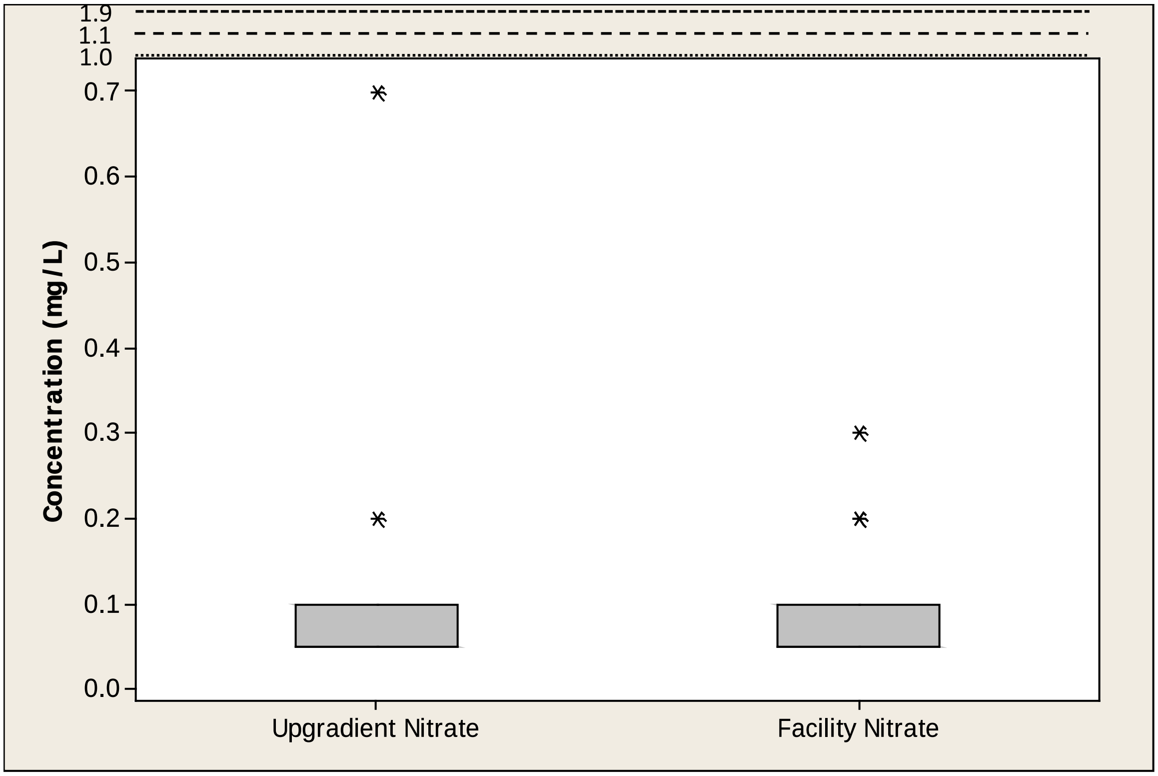
Table 15. Comparison of Upgradient and Facility TDS Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
126	796 - 1139	4/25/94 - 1/20/11	16	0	0%	574	520	610	21
127	963 - 1323	4/25/94 - 7/25/06	4	0	0%	568	530	640	52
150	-	7/7/93	1	0	0%	552	552	552	-
Upgradient Group Summary			**21**	**0**	**0%**	**572**	**520**	**640**	**27**
Facility Group									
91	-	5/17/02 - 10/6/11	19	0	0%	589	560	654	25
122	-	6/5/02 - 1/12/10	10	0	0%	617	550	680	36
63	832 - 1062	6/27/96 - 12/11/12	9	0	0%	620	590	660	24
Facility Group Summary			**38**	**0**	**0%**	**603**	**550**	**680**	**31**
Downgradient Group									
None Available			-	-	-	-	-	-	-

The Table 15 summary indicates that the average TDS concentration is greater in the facility wells compared to upgradient wells. The average upgradient and facility well concentrations are less than the average TDS concentrations for the San Jacinto Lower Pressure management zone for the periods 1978 to 1997 and 1990 to 2009 of 730 mg/L and 800 mg/L, respectively.

3.2.2 Boxplots

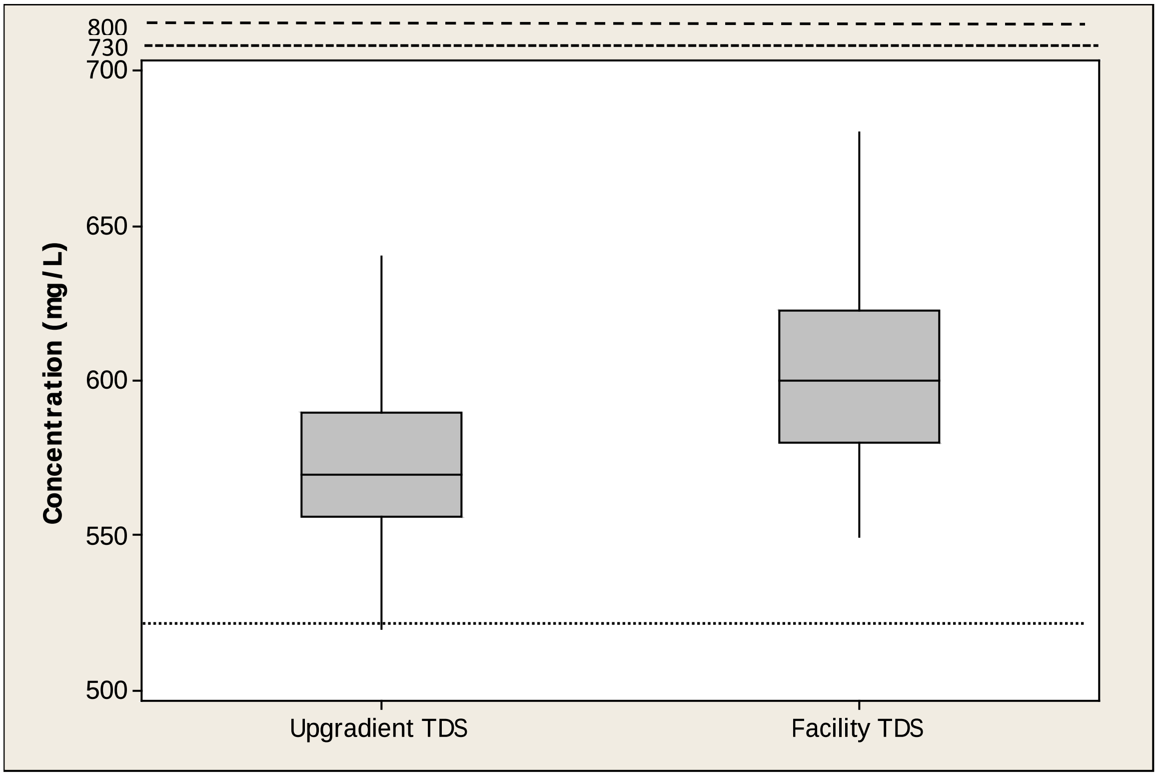
Boxplots were created using combined data from monitoring wells representing upgradient and facility groundwater quality (Figures 22 and 23).



Average nitrate concentration 1990 to 2009 of 1.1 mg/L (San Jacinto Lower Pressure management zone)
Average nitrate concentration 1978 to 1997 of 1.9 mg/L (San Jacinto Lower Pressure management zone)
Average nitrate concentration 1954 to 1973 of 1.0 mg/L (San Jacinto Lower Pressure management zone)

Figure 22. Boxplot of Upgradient and Facility Nitrate Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

The boxplots indicate that the distribution of nitrate concentrations in the facility wells is approximately the same as upgradient wells and that a high percentage of the observations are at non-detected levels. Median facility and downgradient well nitrate concentrations are lower than the historic averages for the Lakeview/Hemet North management zone.



Average TDS concentration 1990 to 2009 of 800 mg/L (San Jacinto Lower Pressure management zone)
Average TDS concentration 1978 to 1997 of 730 mg/L (San Jacinto Lower Pressure management zone)
Average TDS concentration 1954 to 1973 of 520 mg/L (San Jacinto Lower Pressure management zone)

Figure 23. Boxplot of Upgradient and Facility TDS Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

The boxplots indicate that the distribution of TDS levels in facility wells is greater than that in upgradient wells and the median concentrations are less than the 1978 to 1997 and 1990 to 2009 historic averages but greater than the 1954 to 1973 historic average for the San Jacinto Lower Pressure management zone.

3.2.3 Quantitative Statistical Analysis

The percentage of censored data was too high to support quantitative analysis for nitrate levels in groundwater. Mean TDS concentrations in upgradient and facility groundwater were compared using a t-Test. Minitab statistical software was used to run a t-Test comparing upgradient to facility TDS concentrations at the 90% confidence interval with the results as follows:

Mean TDS (mg/L)			
Upgradient	Facility	t value	*P* value
572	603	3.90	< 0.001

The *P* value indicates that there is greater than 99 percent probability that the mean TDS concentrations in upgradient wells are significantly lower than the mean TDS concentration in facility wells.

3.2.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at Jim Bootsma Jr. and Marvo Holsteins dairies have not increased observed groundwater nitrate concentrations. It appears that the operations have increased TDS concentrations in facility groundwater compared to available upgradient well concentrations. However, average TDS concentrations in facility wells are less than the historic average for the periods 1978 to 1997 and 1990 to 2009 and no downgradient well information is available to determine if the combined operations have impacted downgradient groundwater quality. The following observations support the conclusion:

- Average nitrate concentrations in facility wells are lower than upgradient wells.
- The boxplots for nitrate indicate that the distribution of nitrate concentrations in the facility wells is approximately the same as upgradient wells and that both groups include a high percentage of non-detects.
- The average TDS concentration is greater in the facility wells compared to upgradient wells.
- The average upgradient and facility well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973 of 520 mg/L, but less than the 1978 to 1997 and 1990 to 2009 averages of 730 mg/L and 800 mg/L, respectively.
- The t-Test results indicate that facility well TDS concentrations are significantly greater than upgradient well TDS concentrations.

Based on the available information, it is not feasible to determine if the combined dairy operations have impacted downgradient nitrate and TDS concentrations, because no groundwater wells are available. It is also not feasible to determine the individual contribution of each dairy in the potential impacts to groundwater quality because the dairies are adjacent. Numerous non-dairy sources of nitrate and TDS, variations in sample dates, unknown or dissimilar perforated intervals, the impact of fault zones, the absence of downgradient monitoring wells, and the close proximity of individual wells make it infeasible to determine the impact of the dairies with a high degree of confidence. In this case, further study is needed to more accurately determine the combined dairy operation impacts and the individual impact of each dairy.

4.0 Impacts Analysis – Menifee Management Zone

4.1 Abacherli Dairy and Boere Dairy

Abacherli Dairy and Boere Dairy are now closed but were previously located east of Menifee, California, southwest of the intersection of Briggs Road and Gold Crest Drive (see Figure 24). Dense residential developments with a golf course within Salt Creek surrounded the dairies on the north, west, and south sides. Other potential impacts to groundwater quality in the vicinity included irrigated fields, septic systems, and a poultry facility immediately adjacent to both dairies. Because the dairies are now closed no further analysis is necessary.

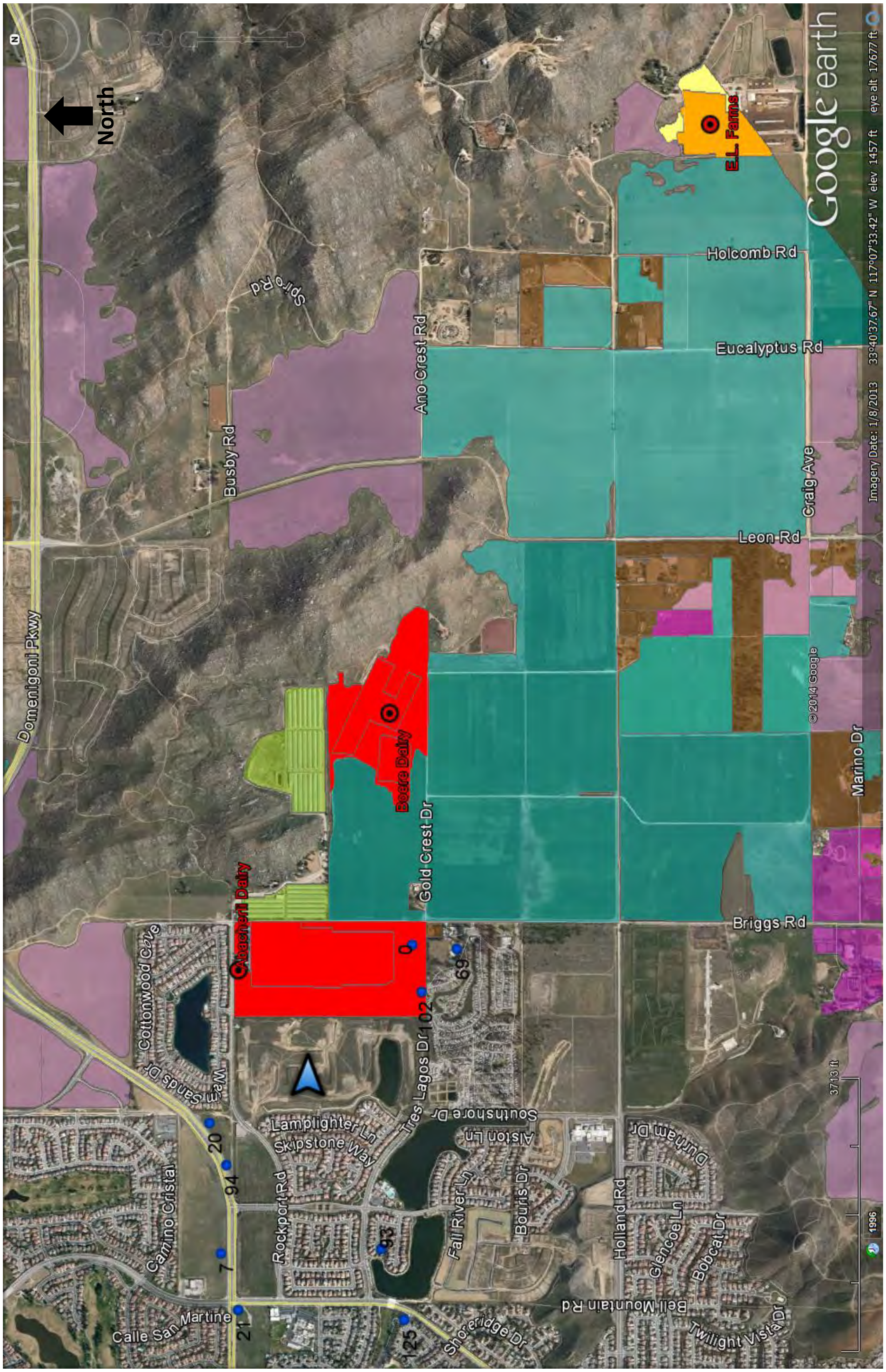


Figure 24. Location map of the vicinity of Abacherli, Boere and E.L. Farms Dairies

4.2 E.L. Farms

E.L. Farms is located approximately 1.8 miles east-southeast of the location of the former Boere Dairy, northeast of the intersection of Craig Avenue and Beeler Road (see Figure 24). The E.L. Farms property is located in both Region 8 (Santa Ana Region) and 9 (San Diego Region). The northwestern most corral area of E.L. Farms is the only portion in Region 8. The southeast corrals and all the wastewater ponds are in Region 9. The groundwater flow in the vicinity of the dairy is generally from west to east, though the groundwater flow in the immediate area of the dairy is not known. The monitoring well dataset includes three facility wells that are all located near the southwest corner facility within Region 9. The nearest upgradient monitoring well is located approximately 1.1 miles to the west in an area surrounded by irrigated fields. Potential non-dairy impacts to groundwater quality in the vicinity include residential development, the upgradient dairy operations at Abacherli and Boere Dairies, irrigated fields, septic systems and poultry operations.

The lack of available information (i.e., facility and downgradient wells) for this dairy makes it infeasible to determine the potential impact on groundwater quality. In this case, further study is needed to more accurately determine the dairy operation impacts, including facility and downgradient groundwater quality information.

5.0 Impacts Analysis – San Jacinto Upper Pressure Management Zone

5.1 Group of Dairies (Arie & Josh de Jong, CBJ, and Ed Vander Woude)

Three dairies identified as Arie & Josh de Jong, CBJ, and Ed Vander Woude are located northwest of the intersection of Ramona Expressway and North Sanderson Avenue. Land identified as dairy intensive for these facilities is less than 700 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by a narrow strip of irrigated field (see Figure 25). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping completed by Tetra Tech (see Appendix A) and published reports (WEI 2000, EMWD 2013) the groundwater flow direction in the vicinity of the dairies is variable. The Fall 1997 groundwater flow map in the Wildermuth report indicates that flow in the immediate vicinity of the dairies is from southeast to northwest, as identified by the generalized groundwater flow arrows in Figure 25. The Spring 2012 groundwater elevation contours from the EMWD report indicates that a groundwater divide is located somewhere between the intersection of Ramona Expressway and North Sanderson Avenue, and the vicinity of R&J Haringa and John Oostdam dairies, located to the east-southeast. The variability in groundwater flow direction, including possible areas of groundwater flow reversal during different periods of time, make it difficult to determine upgradient well locations. The upgradient wells selected represent the best available wells based on the Fall 1997 groundwater contours, but might simply represent wells outside of the dairy footprint. The potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields and septic systems. Fault zones are located west and east of the group of dairies.

The analysis for this group of dairies includes three upgradient wells with a total of 26 samples collected from 4/13/1995 to 6/29/2010, seven facility wells with a total of 42 samples collected from 4/16/2002 to 10/3/2012, and three downgradient wells with a total of 18 samples collected from 6/11/2001 to 7/9/2009.

Ed Vander Woude Dairy does not have any monitoring wells within or near the dairy intensive or non-intensive areas.

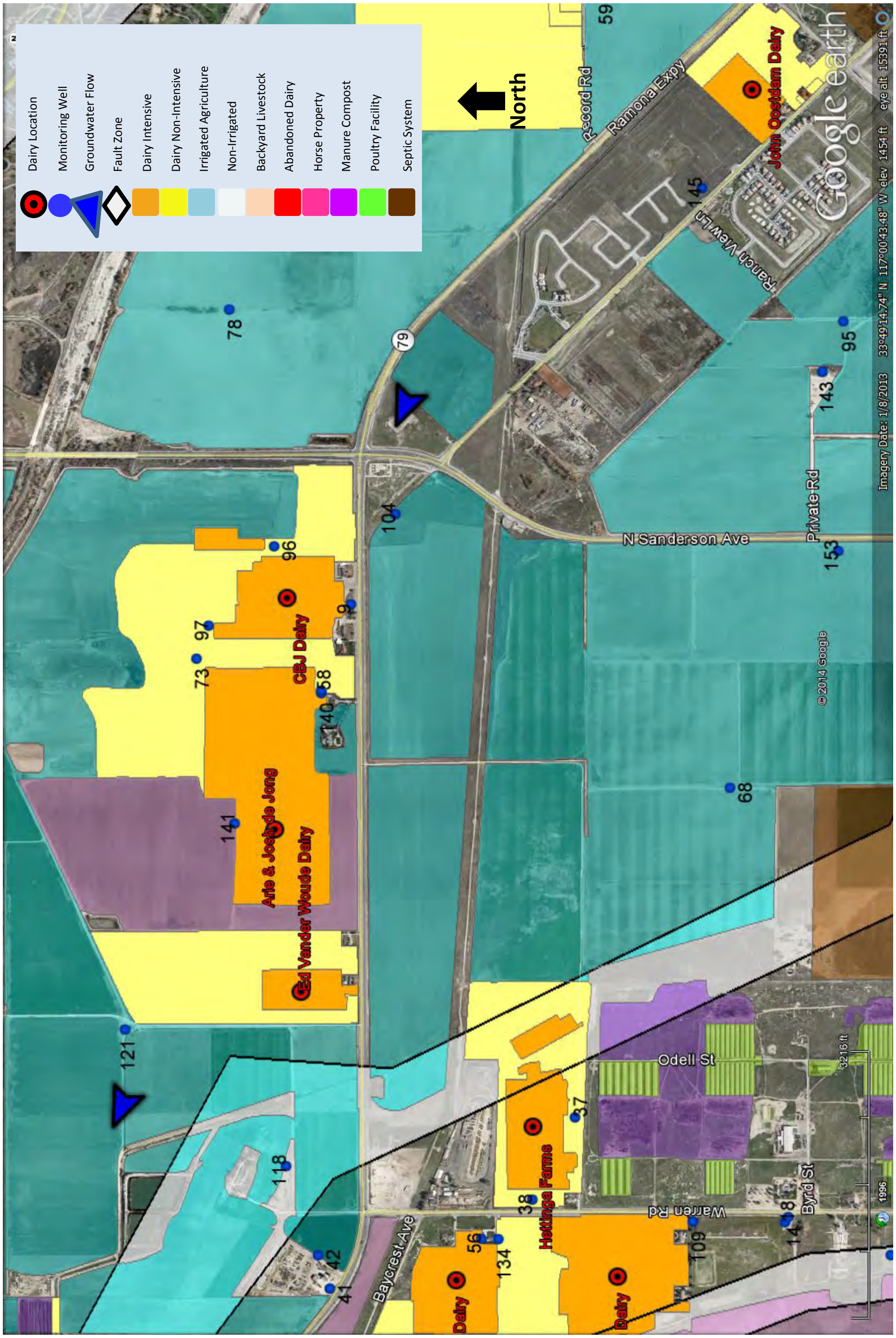


Figure 25. Location map of the vicinity of Arie & Josh de Jong, CBJ, and Ed Vander Woude Dairies

5.1.1 Summary Data

Tables 16 and 17 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 16. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Arie & Josh de Jong, CBJ, and Ed Vander Woude Well Samples

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
75	680 - 1270	4/13/95 - 6/29/10	11	8	73%	0.57	0.05	5.6	1.7
78	-	12/29/99 - 5/27/09	8	8	100%	0.06	0.05	0.10	0.02
104	813 - 1317	8/4/95 - 9/11/01	7	3	43%	0.21	0.05	0.90	0.31
Upgradient Group Summary			**26**	**19**	**73%**	**0.32**	**0.05**	**5.6**	**1.1**
Facility Group									
9	-	8/28/03 - 10/3/12	13	10	77%	0.08	0.05	0.20	0.06
96	928 - 1158	4/2/09	1	1	100%	0.05	0.05	0.05	-
97	853 - 1253	4/5/07	1	1	100%	0.05	0.05	0.05	-
73	853 - 1053	8/28/03 - 6/23/10	8	8	100%	0.06	0.05	0.10	0.02
140	-	4/16/02 - 9/5/08	5	5	100%	0.06	0.05	0.10	0.02
141	-	8/28/03 - 6/23/10	7	7	100%	0.06	0.05	0.10	0.02
58	-	11/19/07 - 10/3/12	7	7	100%	0.05	0.05	0.05	0.00
Facility Group Summary			**42**	**39**	**93%**	**0.064**	**0.05**	**0.20**	**0.04**
Downgradient Group									
119	647 - 1067	8/1/01	1	1	100%	0.05	0.05	0.05	-
120	-	6/11/01 - 6/17/09	9	9	100%	0.06	0.05	0.10	0.02
121	605 - 1025	6/11/01 - 7/9/09	8	8	100%	0.06	0.05	0.10	0.02
Downgradient Group Summary			**18**	**18**	**100%**	**0.061**	**0.05**	**0.10**	**0.02**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 16 summary indicates that there does not appear to be an increase in nitrate concentrations in facility or downgradient wells compared to upgradient wells. All group averages are lower than the average nitrate concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.4 mg/L, 1.9 mg/L and 1.5 mg/L, respectively.

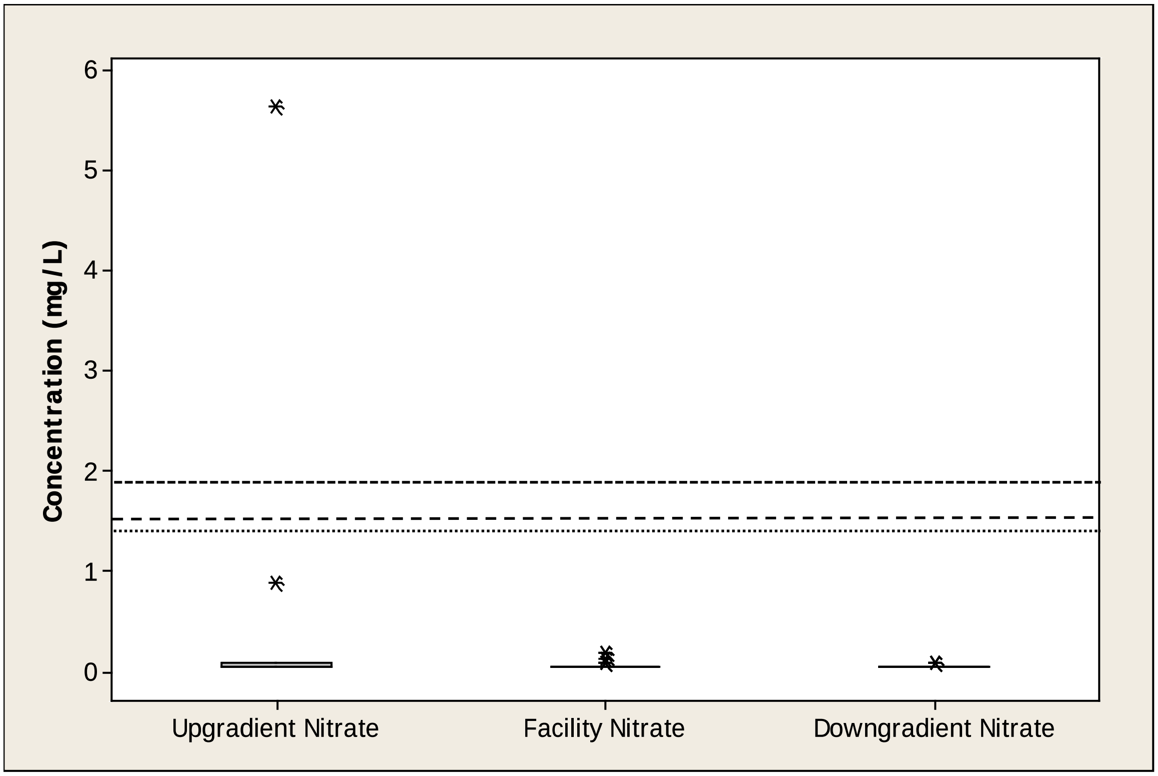
Table 17. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Arie & Josh de Jong, CBJ, and Ed Vander Woude Well Samples

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Upgradient Group									
75	680 - 1270	4/13/95 - 6/29/10	11	0	0%	211	170	260	24
78	-	12/29/99 - 5/27/09	8	0	0%	215	180	230	17
104	813 - 1317	8/4/95 - 9/11/01	7	0	0%	225	220	240	7.6
Upgradient Group Summary			**26**	**0**	**0%**	**216**	**170**	**260**	**19**
Facility Group									
9	-	8/28/03 - 10/3/12	13	0	0%	225	210	240	12
96	928 - 1158	4/2/09	1	0	0%	250	250	250	-
97	853 - 1253	4/5/07	1	0	0%	210	210	210	-
73	853 - 1053	8/28/03 - 6/23/10	8	0	0%	224	200	280	24
140	-	4/16/02 - 9/5/08	5	0	0%	234	210	290	34
141	-	8/28/03 - 6/23/10	7	0	0%	217	190	250	20
58	-	11/19/07 - 10/3/12	7	0	0%	224	200	240	16
Facility Group Summary			**42**	**0**	**0%**	**224**	**190**	**290**	**20**
Downgradient Group									
119	647 - 1067	8/1/01	1	0	0%	230	230	230	-
120	-	6/11/01 - 6/17/09	9	0	0%	253	230	270	12
121	605 - 1025	6/11/01 - 7/9/09	8	0	0%	236	220	250	9.0
Downgradient Group Summary			**18**	**0**	**0%**	**244**	**220**	**270**	**14**

The Table 17 summary suggests that the average TDS concentration in facility wells is slightly greater than in upgradient wells, and that there is a slight increase in TDS concentrations downgradient from the facility. The average concentrations for all three well groups are lower than the average TDS concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 321 mg/L, 370 mg/L and 350 mg/L, respectively. These average TDS concentrations are the lowest of all management zones included in this study.

5.1.2 Boxplots

Boxplots using combined data from monitoring wells representing upgradient, downgradient, and facility groundwater quality are shown in Figures 26 and 27 for nitrate and TDS concentrations, respectively.



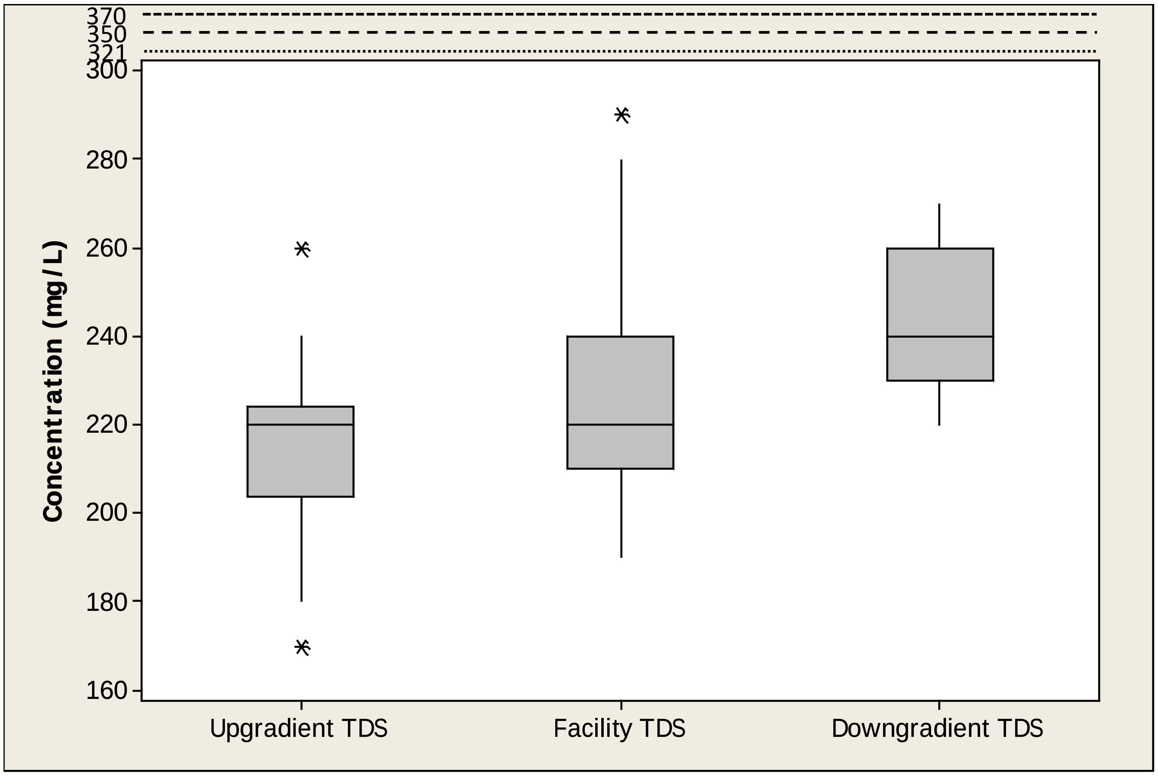
_ _ _ Average nitrate concentration 1990 to 2009 of 1.5 mg/L (San Jacinto Upper Pressure management zone)

----- Average nitrate concentration 1978 to 1997 of 1.9 mg/L (San Jacinto Upper Pressure management zone)

.... Average nitrate concentration 1954 to 1973 of 1.4 mg/L (San Jacinto Upper Pressure management zone)

Figure 26. Boxplot of Upgradient, Facility, and Downgradient Nitrate Concentrations for Arie & Josh de Jong, CBJ, and Ed Vander Woude Well Samples

The boxplots indicate that most nitrate results are at non-detected concentration, and other than an outlier in the upgradient well results, all distributions of nitrate concentrations are less than the historical averages for the San Jacinto Upper Pressure management zone.



– – – Average TDS concentration 1990 to 2009 of 350 mg/L (San Jacinto Upper Pressure management zone)
----- Average TDS concentration 1978 to 1997 of 370 mg/L (San Jacinto Upper Pressure management zone)
.... Average TDS concentration 1954 to 1973 of 321 mg/L (San Jacinto Upper Pressure management zone)

Figure 27. Boxplot of Upgradient, Facility, and Downgradient TDS Concentrations for Arie & Josh de Jong, CBJ, and Ed Vander Woude Well Samples

The boxplots indicate that the median TDS concentration in facility wells is similar to that from upgradient wells, but the interquartile range and maximum values in facility wells tend to be greater than in upgradient wells. TDS levels in downgradient wells tend to be greater than those in either facility or upgradient. However, all results for all three well groups are less than the average TDS concentrations for the San Jacinto Upper Pressure management zone.

5.1.3 Quantitative Statistical Analysis

Because the nitrate datasets for all well groups contain greater than 20% non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and ANOVA was used to test for significant differences among TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient). Minitab statistical software was used to run the ANOVA at the 90% confidence interval with the results as follows:

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
216 a	224 b	244 c	12.7	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results show that mean TDS concentrations in all three locations are significantly different from each other. Mean facility TDS level was significantly higher than mean upgradient TDS concentration, and mean TDS level downgradient significantly exceeded both facility or upgradient mean TDS concentrations.

5.1.4 Conclusions

Based on the available monitoring well data, it appears that the combined dairy operations at Arie & Josh de Jong and CBJ dairies have increased TDS concentrations in facility and downgradient groundwater. The extent to which Ed Vander Woude Dairy might have contributed to the increases cannot be determined based on available information. The following specific observations were made which support the conclusion:

- There does not appear to be an increase in nitrate concentrations in facility or downgradient wells compared to upgradient wells and all well concentrations are lower than the historical averages for the San Jacinto Upper Pressure management zone.
- The average TDS concentration in downgradient wells is higher than that in upgradient or facility wells.
- TDS concentrations in all well groups are lower than the average historical TDS concentrations for the San Jacinto Upper Pressure management zone.
- The boxplot of TDS concentrations indicates an increase in downgradient wells compared to facility wells.
- The ANOVA results indicate that TDS concentrations are significantly higher in facility and downgradient wells compared to upgradient wells.

Based on the available information, it is not feasible to determine the extent to which the Arie & Josh de Jong and CBJ dairy operations have impacted downgradient TDS concentrations. Numerous non-dairy sources of TDS, including irrigated fields and septic systems make it infeasible to determine the impact of the dairy operations alone. The variable groundwater flow direction reported in the referenced reports makes it difficult to identify upgradient wells with a high degree of confidence; therefore, the comparisons to upgradient groundwater quality are questionable.

In this case, further study is needed to more accurately determine the dairy operation impacts including additional groundwater samples collected over a similar time period, further analysis of groundwater flow directions; and an inventory of sources of TDS to groundwater, such as leaky storage ponds, irrigation of cropland, and disposal of dairy manure and wastewater to land.

5.2 R & J Haringa Dairy

R & J Haringa Dairy is located northeast of the intersection of Ramona Expressway and Record Road, and approximately 0.5 mile northeast of John Oostdam Dairy (see Figure 28).

Based on groundwater mapping completed by Tetra Tech (see Appendix A) and published reports (WEI 2000, EMWD 2013) the groundwater flow direction in the vicinity of R & J Haringa Dairy is variable. The Fall 1997 groundwater flow map in the Wildermuth report indicates that flow in the immediate vicinity of the dairy as east to west. The Spring 2012 groundwater elevation contours from the EMWD report shows a groundwater divide to the north of the dairy and groundwater flow in the vicinity of the dairy from northwest to southeast. The variability in groundwater flow direction, including possible areas of groundwater flow reversal during different periods of time, make it difficult to determine upgradient and downgradient well locations. Based on currently available information, selection of upgradient and downgradient wells with a high degree of confidence is not possible and the best analysis is a comparison of facility wells located within the footprint of the dairy intensive and non-intensive areas to wells outside of the dairy footprint. The selected outside of dairy footprint wells are located north, northwest, southwest and south of the dairy. Additionally, the facility well concentrations are compared to the historical averages. Potential non-dairy impacts to groundwater quality in the vicinity include a golf course, irrigated fields and septic systems. A fault zone is located to the northeast of the dairy.

The analysis for this dairy includes 12 wells located outside of the dairy area with a total of 92 nitrate and 97 TDS samples collected from 4/13/1995 to 12/18/2012 and six facility wells with a total of 33 samples collected from 3/29/1995 to 10/3/2012.

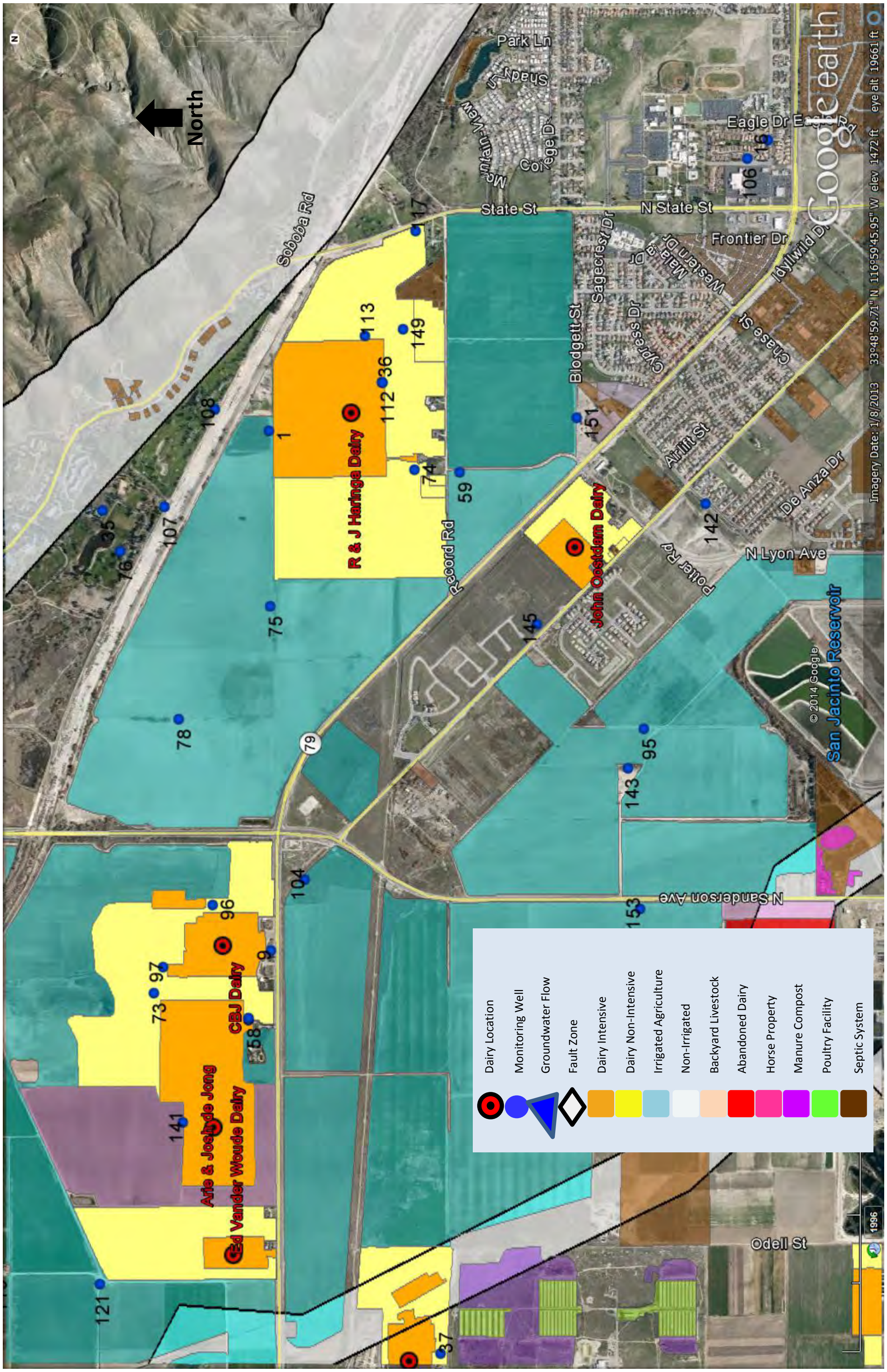


Figure 28. Location map of the vicinity of R & J Haringa Dairy and John Oostdam Dairy

5.2.1 Summary Data

Tables 18 and 19 summarize the available nitrate and TDS monitoring well data used in the analysis of this group of dairies for wells located within the dairy footprint (dairy intensive and non-intensive land use) and wells located outside the dairy footprint. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 18. Comparison of Nitrate Concentrations in Facility Wells vs. Wells located Outside the Facility for R & J Haringa Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Outside of Facility Footprint Group									
75	680 - 1270	4/13/95 - 6/29/10	11	8	73%	0.57	0.05	5.6	1.7
78	-	12/29/99 - 5/27/09	8	8	100%	0.06	0.05	0.1	0.0
16	-	5/2/95 - 8/7/12	20	13	65%	0.08	0.05	0.3	0.0
106	519 - 979	9/3/86 - 8/4/94	3	0	0%	0.18	0.11	0.2	0.1
76	695 - 1105	8/25/03 - 12/15/10	7	6	86%	0.06	0.05	0.1	0.0
35	-	12/2/05 - 12/18/12	8	8	100%	0.05	0.05	0.1	0.0
107	-	9/21/99 - 6/30/10	8	8	100%	0.06	0.05	0.1	0.0
108	-	9/6/00 - 6/30/10	6	4	67%	1.38	0.05	8.0	3.2
142	703 - 1231	5/9/96 - 9/23/03	7	5	71%	0.09	0.05	0.1	0.0
59	848 - 1388	7/26/95 - 9/26/12	11	5	45%	0.22	0.03	0.7	0.3
145	-	9/22/03 - 5/17/04	2	2	100%	0.08	0.05	0.10	0.04
151	-	8/4/87	1	0	0%	0.02	0.02	0.02	-
Outside of Facility Footprint Group Summary			**92**	**67**	**73%**	**0.23**	**0.02**	**8.0**	**1.0**
Facility Group									
112	-	3/1/99 - 6/2/06	8	8	100%	0.07	0.05	0.10	0.03
113	-	8/23/95 - 8/3/98	8	0	0%	0.13	0.05	0.40	0.11
74	985 - 1225	6/30/99 - 6/23/10	8	7	88%	0.06	0.05	0.10	0.02
36	-	8/1/07 - 10/3/12	7	6	86%	0.07	0.05	0.22	0.06
117	-	3/29/95	1	0	0%	0.10	0.10	0.10	-
149	-	3/29/95	1	0	0%	0.10	0.10	0.10	-
Facility Group Summary			**33**	**21**	**64%**	**0.086**	**0.05**	**0.40**	**0.07**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 18 summary indicates that when compared to facility wells there appears to be higher nitrate concentrations in the wells located outside of the dairy to the north, northwest, southwest and south. However, the highest concentrations in the outside well group are found in the Golden Era Golf Course well. Both group averages are considerably lower than the average nitrate concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.4 mg/L, 1.9 mg/L and 1.5 mg/L, respectively. Additionally, the facility and outside of facility footprint group averages are less than the WQO for the San Jacinto Upper Pressure management zone of 1.4 mg/L.

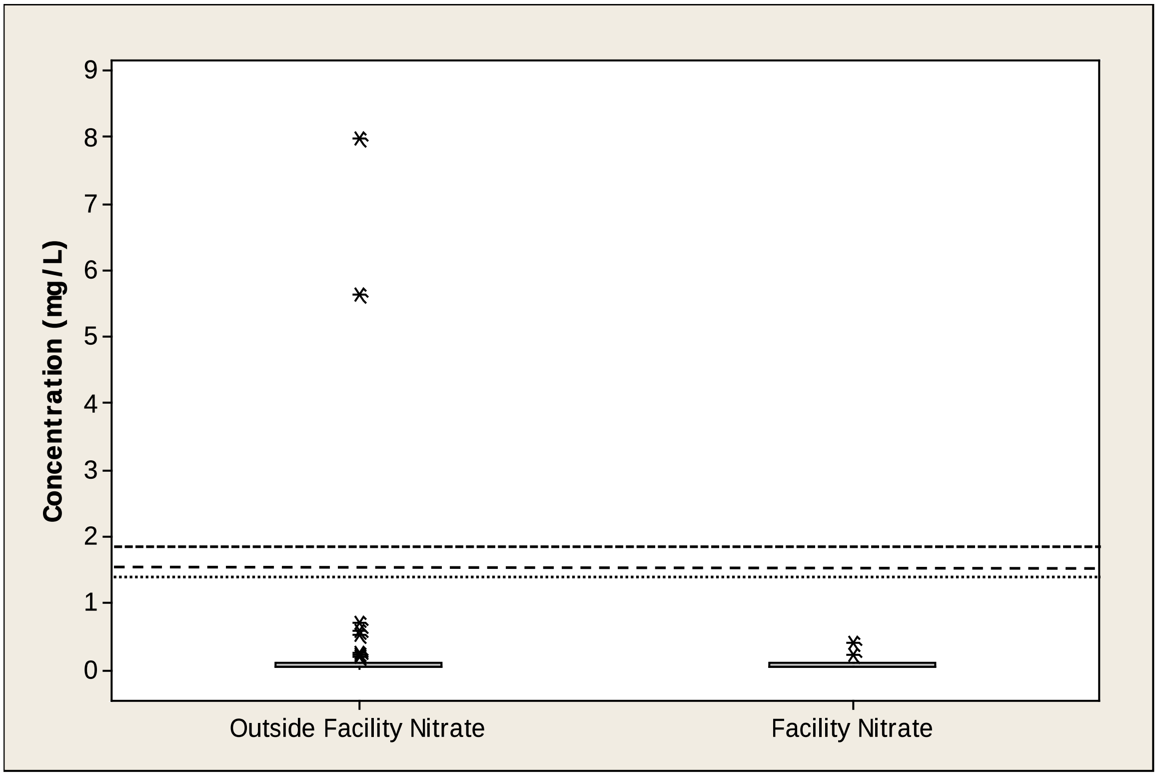
Table 19. Comparison of TDS Concentrations in Facility Wells vs. Wells located Outside the Facility for R & J Haringa Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Outside of Facility Footprint Group									
75	680 - 1270	4/13/95 - 6/29/10	11	0	0%	211	170	260	24
78	-	12/29/99 - 5/27/09	8	0	0%	215	180	230	17
16	-	5/2/95 - 8/7/12	20	0	0%	189	160	220	17
106	519 - 979	9/3/86 - 8/4/94	8	0	0%	187	164	210	16
76	695 - 1105	8/25/03 - 12/15/10	7	0	0%	249	200	330	41
35	-	12/2/05 - 12/18/12	8	0	0%	221	180	240	20
107	-	9/21/99 - 6/30/10	8	0	0%	209	120	240	39
108	-	9/6/00 - 6/30/10	6	0	0%	225	212	230	7.7
142	703 - 1231	5/9/96 - 9/23/03	7	0	0%	190	180	220	15
59	848 - 1388	7/26/95 - 9/26/12	11	0	0%	343	200	620	139
145	-	9/22/03 - 5/17/04	2	0	0%	210	210	210	0
151	-	8/4/87	1	0	0%	195	195	195	-
Outside of Facility Footprint Group Summary			**97**	**0**	**0%**	**222**	**120**	**620**	**68**
Facility Group									
112	-	3/1/99 - 6/2/06	8	0	0%	210	190	230	12
113	-	8/23/95 - 8/3/98	8	0	0%	219	200	240	13
74	985 - 1225	6/30/99 - 6/23/10	8	0	0%	256	210	280	24
36	-	8/1/07 - 10/3/12	7	0	0%	214	190	260	23
117	-	3/29/95	1	0	0%	440	440	440	-
149	-	3/29/95	1	0	0%	205	205	205	-
Facility Group Summary			**33**	**0**	**0%**	**231**	**190**	**440**	**45**

The Table 19 summary suggests that when compared to facility wells there appears to be lower average TDS concentration in wells located outside of the dairy to the north, northwest, southwest and south. The average concentrations for both well groups are lower than the average TDS concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 321 mg/L, 370 mg/L and 350 mg/L, respectively. Additionally, the facility and outside of facility footprint group averages are less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.2.2 Boxplots

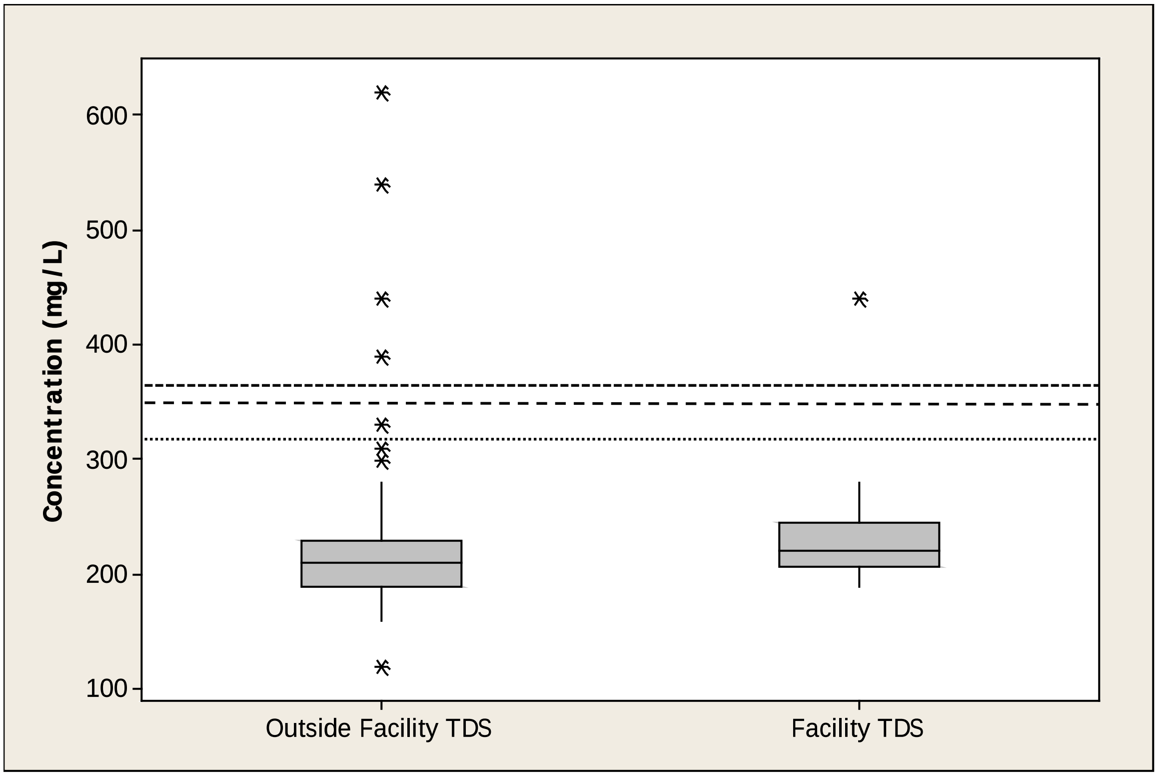
Boxplots using combined data from wells located within the dairy footprint (dairy intensive and non-intensive land use) and wells located outside the dairy footprint are shown in Figures 29 and 30 for nitrate and TDS concentrations, respectively.



Average nitrate concentration 1990 to 2009 of 1.5 mg/L (San Jacinto Upper Pressure management zone)
Average nitrate concentration 1978 to 1997 of 1.9 mg/L (San Jacinto Upper Pressure management zone)
Average nitrate concentration 1954 to 1973 of 1.4 mg/L (San Jacinto Upper Pressure management zone)

Figure 29. Boxplot of Nitrate Concentrations for Facility Wells vs. Wells located Outside the Facility for R & J Haringa Dairy Well Samples

The boxplots indicate that most nitrate results are at non-detected concentration, and other than a two outliers in the outside of facility well results, all distributions of nitrate concentrations are less than the historical averages for the San Jacinto Upper Pressure management zone.



Average TDS concentration 1990 to 2009 of 350 mg/L (San Jacinto Upper Pressure management zone)
Average TDS concentration 1978 to 1997 of 370 mg/L (San Jacinto Upper Pressure management zone)
Average TDS concentration 1954 to 1973 of 321 mg/L (San Jacinto Upper Pressure management zone)

Figure 30. Boxplot of TDS Concentrations for Facility Wells vs. Wells located Outside for R & J Haringa Dairy Well Samples

The boxplots indicate that although the median TDS concentration in facility wells exceeds that in wells outside the facility, some individual TDS observations from wells outside the facility have been considerably higher than TDS in facility groundwater. However, other than outliers, all results for both well groups are less than the average TDS concentrations for the San Jacinto Upper Pressure management zone.

5.2.3 Quantitative Statistical Analysis

Because the nitrate datasets for both well groups contain greater than 20% non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and a t-Test was used to test for significant differences in TDS concentrations between the two well groups. Minitab statistical software was used to run a t-Test comparing upgradient to facility nitrate and TDS concentrations at the 90% confidence interval with the results as follows:

Mean TDS (mg/L)			
Outside Facility	Facility	t value	*P* value
222	231	0.68	0.50

The *P* value indicates that the mean TDS concentrations in wells located outside the facility do not differ significantly from mean TDS concentrations in facility wells.

5.2.4 Conclusions

Based on the available monitoring well data, it appears that the dairy operations at R & J Haringa Dairy have not increased nitrate or TDS concentrations in groundwater outside of the facility boundaries. The following specific observations were made which support the conclusion:

- The nitrate concentrations in the wells located outside of the dairy appear to be higher than wells located within the facility boundaries. However, the highest concentrations in the outside well group are found in the Golden Era Golf Course well.
- Except for two outliers in the outside of facility well results, both distributions of nitrate concentrations are less than the historical averages and the WQO for the San Jacinto Upper Pressure management zone.
- The average TDS concentration in facility wells is not significantly greater than that in wells located outside the facility.
- The average TDS concentration both well groups are lower than the average historical TDS concentrations and the WQO for the San Jacinto Upper Pressure management zone.

5.3 John Oostdam Dairy

John Oostdam Dairy was located northwest of North Lyon Avenue between North Ramona Blvd and West Ramona Expressway, approximately 0.6 miles southwest of R & J Haringa Dairy, in the San Jacinto Lower Pressure management zone (see Figure 28). As of the date of this analysis the dairy was vacant.

Based on groundwater mapping completed by Tetra Tech (see Appendix A) and published reports (WEI 2000, EMWD 2013) the groundwater flow direction in the vicinity of John Oostdam Dairy is variable. The Fall 1997 groundwater flow map in the Wildermuth report indicates that flow in the immediate vicinity of the dairy as east to west. The Spring 2012 groundwater elevation contours from the EMWD report shows a groundwater divide to the north of the dairy and groundwater flow in the vicinity of the dairy from northwest to southeast. The variability in groundwater flow direction, including possible areas of groundwater flow reversal during different periods of time, make it difficult to determine upgradient and downgradient well locations. Additionally, John Oostdam Dairy has no facility monitoring wells. For this dairy, the analysis will consist of a comparison of the nitrate and TDS concentrations in surrounding wells to the average concentrations for the San Jacinto Upper Pressure management zone. Potential non-dairy impacts to groundwater quality in the vicinity include a golf course, irrigated fields and septic systems. A fault zone is located to the northeast of the dairy.

The analysis for this dairy includes six wells located outside of the dairy area with a total of 29 samples collected from 8/4/1987 to 9/26/2012.

5.3.1 Summary Data

Tables 20 and 21 summarize the available nitrate and TDS monitoring well data used in the analysis of this dairy for wells located outside of the dairy only. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for the group of wells located outside the footprint of the dairy.

Table 20. Nitrate Concentrations for John Oostdam Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Outside of Facility Footprint Group									
95	-	8/28/03 - 6/17/05	3	2	67%	0.12	0.05	0.2	0.1
142	703 - 1231	5/9/96 - 9/23/03	7	5	71%	0.09	0.05	0.1	0.0
143	1071 - 1317	7/18/00 - 5/20/04	5	5	100%	0.07	0.05	0.1	0.0
59	848 - 1388	7/26/95 - 9/26/12	11	5	45%	0.22	0.03	0.7	0.3
145	-	9/22/03 - 5/17/04	2	2	100%	0.08	0.05	0.10	0.04
151	-	8/4/87	1	0	0%	0.02	0.02	0.02	-
Outside of Facility Footprint Group Summary			**29**	**19**	**66%**	**0.13**	**0.02**	**0.7**	**0.2**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 20 summary indicates that the average nitrate concentrations in wells surrounding the facility are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.4 mg/L, 1.9 mg/L and 1.5 mg/L, respectively. Additionally, the outside of facility footprint group average is less than the WQO for the San Jacinto Upper Pressure management zone of 1.4 mg/L.

Table 21. TDS Concentrations for John Oostdam Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Outside of Facility Footprint Group									
95	-	8/28/03 - 6/17/05	3	0	0%	227	210	240	15
142	703 - 1231	5/9/96 - 9/23/03	7	0	0%	190	180	220	15
143	1071 - 1317	7/18/00 - 5/20/04	5	0	0%	250	230	280	20
59	848 - 1388	7/26/95 - 9/26/12	11	0	0%	343	200	620	139
145	-	9/22/03 - 5/17/04	2	0	0%	210	210	210	0
151	-	8/4/87	1	0	0%	195	195	195	-
Outside of Facility Footprint Group Summary			**29**	**0**	**0%**	**264**	**180**	**620**	**107**

The Table 21 summary indicates that the average TDS concentrations in wells surrounding the facility are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 321 mg/L, 370 mg/L and 350 mg/L, respectively. Additionally, the outside of facility footprint group averages are less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.3.2 Boxplots

Boxplots are not applicable for this analysis.

5.3.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

5.3.4 Conclusions

Based on groundwater monitoring samples collected in six wells located in the vicinity of John Oostdam Dairy, it does not appear that the dairy has impacted offsite groundwater quality in excess of average concentrations reported for the San Jacinto Upper Pressure management zone; however, the degree of confidence in this conclusion is low because it is based solely on wells located outside the dairy footprint. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.
- Average TDS concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary, including facility groundwater quality data and further study to determine groundwater flow direction in the vicinity of the dairy.

5.4 Scott Brothers Dairy

Scott Brothers Dairy is located southwest of Gilman Springs Road, approximately one mile northwest of the intersection of Gilman Springs Road and North Sanderson Avenue (see Figure 31).

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies is generally to the southwest, as indicated by the generalized groundwater flow arrow in Figure 31. Scott Brothers Dairy has no wells within the area identified as dairy intensive. It appears that the facility impoundments are located approximately 0.5 miles southwest of the cow pens, which were not identified as dairy intensive in the land use files. For this dairy, the analysis will consist of a comparison of the nitrate and TDS concentrations in downgradient wells to the average concentrations for the San Jacinto Upper Pressure management zone. Potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields. A southeast-northwest-oriented fault zone runs directly across the southern half of the cow confinement area and second fault zone is located under the easternmost impoundment.

The analysis for this dairy includes five wells located downgradient of the dairy with a total of 37 samples collected from 6/11/2001 to 5/10/2012.

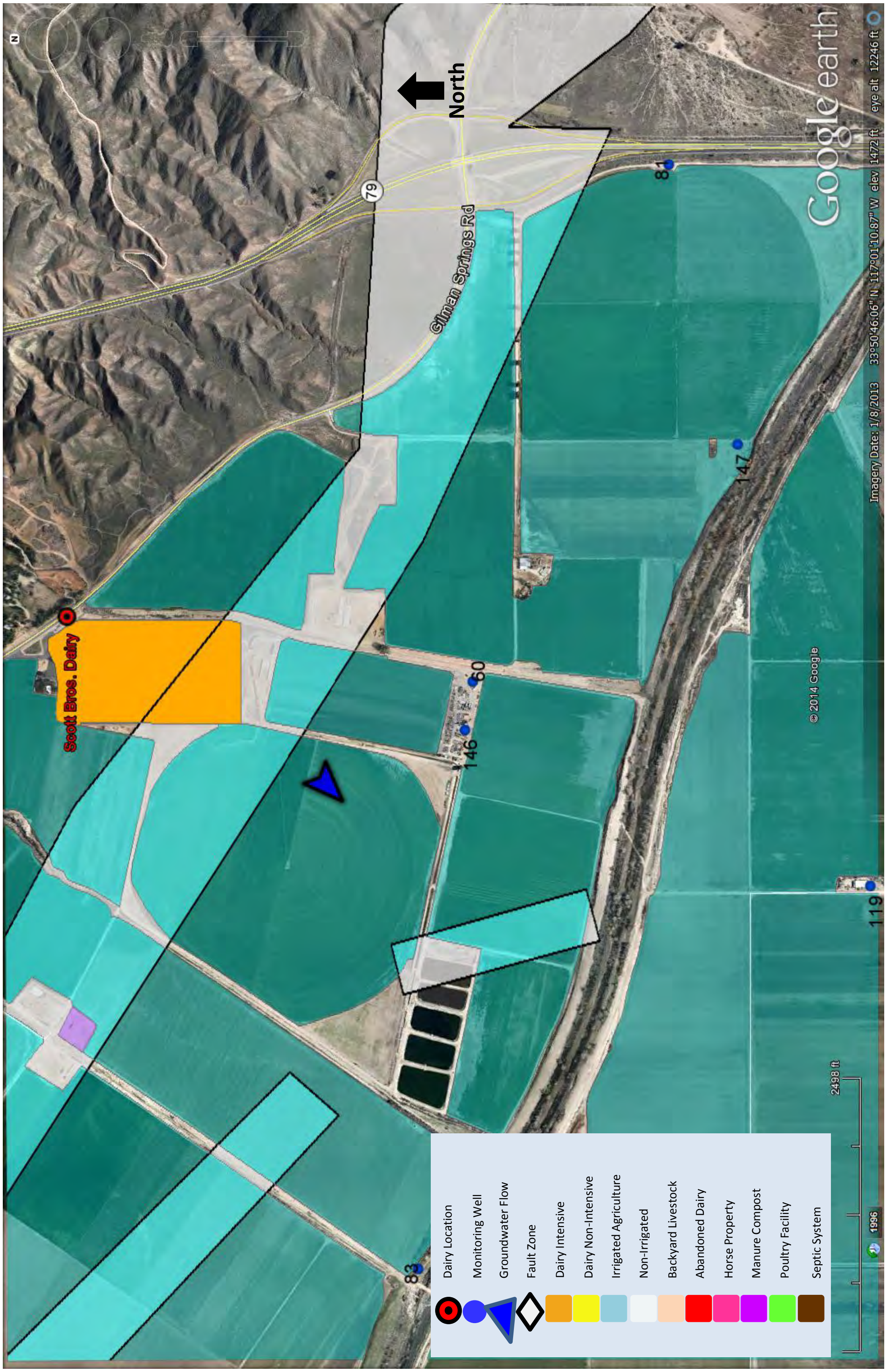


Figure 31. Location map of the vicinity of Scott Brothers Dairy

5.4.1 Summary Data

Tables 22 and 23 summarize the available nitrate and TDS monitoring well data used in the analysis of this dairy for wells located downgradient of the dairy only. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for the group of wells located downgradient of the dairy.

Table 22. Downgradient Nitrate Concentrations for Scott Brothers Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Downgradient Group									
83	704 - 1024	6/11/01 - 4/14/08	7	6	86%	0.17	0.05	0.80	0.28
146	440 - 1200	9/28/01 - 2/10/09	8	6	75%	0.23	0.05	0.70	0.29
147	-	7/31/02 - 6/7/07	6	5	83%	0.09	0.05	0.20	0.06
81	617 - 1057	9/28/01 - 4/14/08	9	9	100%	0.07	0.05	0.10	0.03
60	613 - 1033	7/3/03 - 5/10/12	7	5	71%	0.09	0.05	0.20	0.06
Downgradient Group Summary			**37**	**31**	**84%**	**0.13**	**0.05**	**0.80**	**0.19**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 22 summary indicates that the average nitrate concentrations in wells downgradient of the facility are considerably lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 1.4 mg/L, 1.9 mg/L and 1.5 mg/L, respectively. The outside of facility footprint group average is also less than the WQO for the San Jacinto Upper Pressure management zone of 1.4 mg/L.

Table 23. Downgradient TDS Concentrations for Scott Brothers Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Downgradient Group									
83	704 - 1024	6/11/01 - 4/14/08	7	0	0%	277	260	290	11
146	440 - 1200	9/28/01 - 2/10/09	8	0	0%	334	260	370	35
147	-	7/31/02 - 6/7/07	6	0	0%	288	260	350	36
81	617 - 1057	9/28/01 - 4/14/08	9	0	0%	319	300	350	19
60	613 - 1033	7/3/03 - 5/10/12	7	0	0%	280	260	300	17
Downgradient Group Summary			**37**	**0**	**0%**	**302**	**260**	**370**	**33**

The Table 23 summary indicates that the average TDS concentrations in wells downgradient of the facility are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 321 mg/L, 370 mg/L and 350 mg/L, respectively. The outside of facility footprint group average is also less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.4.2 Boxplots

Boxplots are not applicable for this analysis because there are no facility or upgradient wells.

5.4.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

5.4.4 Conclusions

Based on groundwater monitoring samples collected in five wells located downgradient of the Scott Brothers Dairy cow pens, it does not appear that the dairy has impacted offsite groundwater quality in excess of average concentrations reported for the San Jacinto Upper Pressure management zone; however, the degree of confidence in this conclusion is low because it is based on only a downgradient dataset. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.
- Average TDS concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary to accurately characterize the facility groundwater quality.

5.5 John & Margie Oostdam Heifer Ranch

John & Margie Oostdam Heifer Ranch is located west of Alessandro Avenue, approximately 0.25 miles south of the intersection of West Ramona Expressway and Alessandro Avenue (see Figure 32).

Based on groundwater mapping and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the heifer ranch is generally to the southwest, as indicated by the generalized groundwater flow arrow in Figure 32. John & Margie Oostdam Heifer Ranch has no wells within the area identified as dairy intensive, and the nearest downgradient wells are located at least 1.5 miles downgradient where significant residential development exists, including dense areas of septic use. Potential non-dairy impacts to groundwater quality in the vicinity of the dairy include a plant nursery, septic systems, and irrigated fields. A southeast-northwest-oriented fault zone is located along the base of the mountains approximately one mile to the northeast.

The lack of available information for this dairy (i.e., facility and downgradient wells) makes it infeasible to determine the potential impact on groundwater quality. In this case, further study is needed to more accurately determine the dairy operation impacts, including facility and downgradient groundwater quality information.

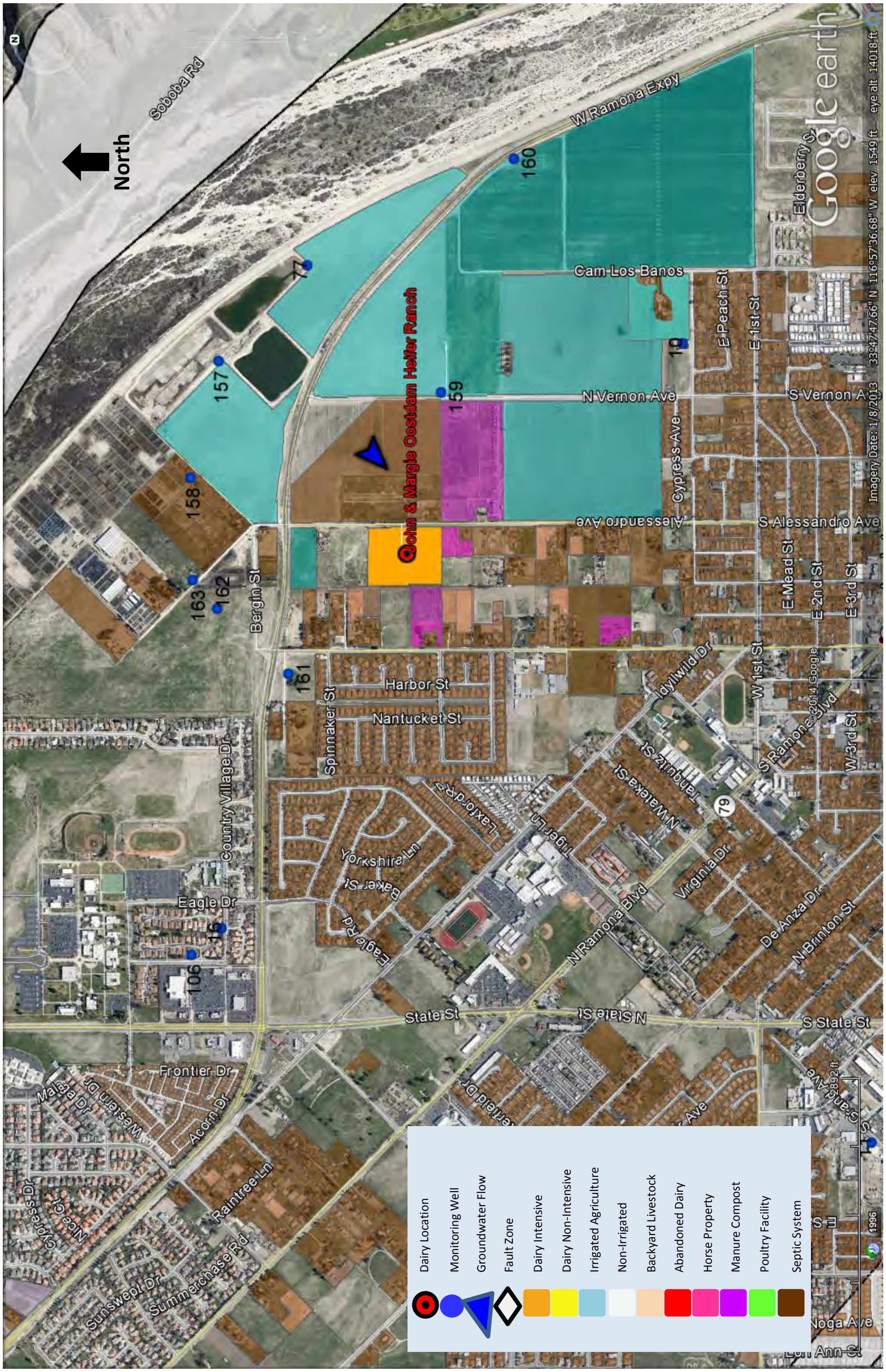


Figure 32. Location map of the vicinity of John & Margie Oostdam Heifer Ranch

6.0 Impacts Analysis – Elsinore Groundwater Management Zone

6.1 Herman De Jong Dairy

Herman De Jong Dairy is located south of the intersection of Corydon Road and Garden Street near Sedco Hills. The dairy is located in the Elsinore management zone in the Elsinore/Temescal Valley groundwater basin (see Figure 33).

No precise groundwater flow information was available for this facility, though groundwater flow would generally be expected to flow toward Lake Elsinore, located approximately 2 miles northeast of the facility. Herman De Jong has no facility monitoring wells. For this dairy, the analysis will consist of a comparison of the nitrate and TDS concentrations in surrounding wells to the average concentrations for the Elsinore management zone. Potential non-dairy impacts to groundwater quality in the vicinity include residential development, Lake Elsinore, an airport, and septic systems. A southeast-northwest trending fault zone is located to the southwest of the dairy.

The analysis for this dairy includes six wells located outside of the dairy area with a total of 29 samples collected from 8/4/1987 to 9/26/2012.

Figure 33. Location map of the vicinity of Herman De Jong Dairy

6.1.1 Summary Data

Tables 24 and 25 summarize the available nitrate and TDS monitoring well data used in the analysis of this dairy for wells located outside of the dairy only. The summarized data include the perforated interval of the monitoring well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, minimum, maximum, and standard deviation for each individual well, as well as the summary data for the group of wells located outside the footprint of the dairy.

Table 24. Nitrate Concentrations for Herman De Jong Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean Nitrate (mg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)	Standard Deviation (mg/L)
Outside of Facility Group									
98	-	1997 - 2008	12	4	33%	2.29	0.05	10	3.6
99	-	1997 - 2012	16	10	63%	0.34	0.05	1.4	0.50
100	-	1997 - 2008	12	1	8%	1.13	0.013	1.8	0.54
105	-	2008 - 2012	5	0	0%	1.04	0.80	1.2	0.17
Outside of Facility Group Summary			**45**	**15**	**33%**	**1.2**	**0.013**	**10.0**	**2.0**

Note: Mean and standard deviation are calculated using one-half the detection limit for all non-detects.

The Table 24 summary indicates that the average nitrate concentrations in wells surrounding the facility are greater than historical averages for the Elsinore management zone for the periods 1954 to 1973 of 1.0 mg/L, and less than the historical averages for the periods 1978 to 1997 and 1990 to 2009 of 2.6 mg/L and 2.2 mg/L, respectively.

Table 25. TDS Concentrations for Herman De Jong Dairy

Well	Perforated Interval (elev. feet)	Sample Date(s)	Number of Samples	Number of Non-Detects	Percent Non-Detects	Mean TDS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Standard Deviation (mg/L)
Outside of Facility Group									
98	-	1997 - 2008	10	0	0%	454	278	580	96
99	-	1997 - 2012	16	0	0%	371	260	514	77
100	-	1997 - 2008	12	0	0%	326	290	440	53
105	-	2008 - 2012	5	0	0%	506	458	558	36
Outside of Facility Group Summary			**43**	**0**	**0%**	**393**	**260**	**580**	**94**

The Table 25 summary indicates that the average TDS concentrations in wells surrounding the facility are lower than the historical averages for the Elsinore management zone for periods 1954 to 1973, 1978 to 1997 and 1990 to 2009 of 476 mg/L, 480 mg/L and 470 mg/L, respectively. The outside of facility group average is also less than the WQO for the Elsinore management zone of 480 mg/L.

6.1.2 Boxplots

Boxplots are not applicable for this analysis.

6.1.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

6.1.4 Conclusions

Based on groundwater monitoring samples collected in six wells located in the vicinity of Herman De Jong Dairy, it does not appear that the dairy has impacted offsite groundwater quality in excess of the most recent average concentrations reported for the Elsinore management zone. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in wells surrounding the dairy are slightly greater than the Elsinore management zone historical concentrations for 1954 to 1973 of 1.0 mg/L, and less than the historical averages for the periods 1978 to 1997 and 1990 to 2009 of 2.6 mg/L and 2.2 mg/L, respectively.
- Average TDS concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the Elsinore management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary to accurately characterize the facility groundwater quality.

7.0 Conclusions and Recommendations

The project was conducted to screen for potential impacts of dairies on groundwater quality in the San Jacinto and Lake Elsinore areas. An initial mapping exercise established the direction of groundwater flow and made a broad preliminary assessment of dairies' impacts on regional groundwater TDS and nitrate levels (see Appendix A). Subsequently, a more focused, dairy-level statistical analysis of available groundwater quality data was conducted to identify whether individual dairies or groups of dairies have affected local groundwater TDS and nitrate concentrations. Over the period of time covered by the available data, the dairy-level analysis compared nitrate and TDS concentrations in groundwater upgradient, under the dairy/dairies, and downgradient to evaluate whether there have been significant changes in the groundwater TDS and nitrate levels potentially attributable to dairies.

The regional mapping evaluation suggested that there is no obvious association between dairy locations and annual changes in groundwater nitrate and TDS concentrations, with the exception of a possible association between dairies and the nitrate plume in the western portion of the study area (Lakeview groundwater management zone). In addition, the mapping evaluation suggests a likely relationship between nitrate plumes and other activity, including backyard livestock, compost/manure piles, equestrian activity, other non-dairy livestock, and septic systems. Land use mapping indicates that the Lakeview groundwater management zone has the highest concentration of septic system use in the study area. In addition, long-term irrigated agriculture using recycled water in the Lakeview area could contribute to groundwater quality degradation, although the available data did not clearly show increases in groundwater constituents of concern coinciding with the use of recycled water (beginning circa late 1990s).

The dairy-level statistical analysis concluded that for most dairies or groups of dairies, there was no statistically significant elevation of groundwater nitrate or TDS concentrations in facility or downgradient wells. A significant impact was suggested for a few locations (see Table 26). However, it should be noted that numerous uncertainties in the data and analyses reduce the level of confidence in conclusions of either no impact or significant impact. These uncertainties include:

- Lack of systematic sampling of monitoring wells results in variable overlap in the time periods covered by samples from upgradient, facility, and downgradient wells;
- Unknown depths of groundwater sampled and large variations in the perforated intervals in the monitoring wells;
- Close proximity of some dairies;
- Lack of adequate data from upgradient or downgradient groundwater;
- High incidence of censored data for nitrate;
- Lack of site-specific knowledge of groundwater flow direction and velocity; and
- Incomplete information on dairy management and land use information to document the magnitude of nitrate and/or TDS generation.

The permit requires submittal within 18 months of adoption of the permit that the dischargers in the San Jacinto watershed shall collect and analyze groundwater monitoring data from wells within a 5 mile radius[4] of the CAFO facilities to confirm that the CAFO facilities have not impacted the quality of groundwaters in the area. This analysis meets this permit requirement.

The permit also states that 6 months after acceptance of the monitoring well data by the RWQCB, individual dairies with impacts will identify an action plan and submit for approval to the RWQCB, followed by implementation within 6 months of plan approval.

The summary table shows that 20 dairies have no impact for nitrates, 3 dairy facilities are closed and 6 dairies and one heifer ranch have data that is inconclusive for various reasons. TDS results indicate that 8 dairies have no impact, 3 dairy facilities are closed, 9 dairies have inconclusive data and 9 have potential impact although additional determinations are necessary due to commingling or proximity to other possible sources. There is no evidence that any of the dairies are directly responsible for impacting groundwater quality at this time. A smart regional plan of action for better determining individual dairy impacts is warranted.

[4] A pre-analysis review of the distribution of available monitoring wells in the vicinity of each dairy revealed that selection of upgradient monitoring wells within a radius of 1.5 miles of each facility would result in the greatest number of monitoring wells that are representative of upgradient and downgradient conditions while minimizing interference from other possible sources, and would most often result in a dataset that meets the data quality goal of having at least 10 samples and less than 20% non-detects; the minimum dataset necessary to complete a quantitative statistical analysis (see section 1.3). This approach was discussed and agreed upon in a conference call with the Santa Ana Regional Board on January 13, 2014 (SARWQCB 2014).

Table 26. Summary of Conclusions of Dairy Impacts on Groundwater Quality

Report Section	Dairy	Nitrate (source(s) of uncertainty) [a]	TDS (source(s) of uncertainty) [a]
2.1	Hettinga Dairy	No impact (1-4)	No impact (1-4)
2.1	John & Margie Oostdam Dairy	No impact (1-4)	No impact (1-4)
2.1	Oostdam Dairy	No impact (1-4)	No impact (1-4)
2.2	Boersma Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2	Gerbin Hettinga Expressway Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2	Hollandia Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2	Marvo Holsteins Dairy #2	No impact (1-4)	Potential impact (1-4,6)
2.3	Dick Van Dam Dairy	No impact (1-4)	Potential impact (1-4,6)
2.3	Cottonwood Dairy	No impact (1-4)	Potential impact (1-4,6)
2.3	Bootsma-Silva Farms/Ramona Dairy #2	No impact (1-4)	Potential impact (1-4,6)
2.4	Goyenetche Dairy #2	Inconclusive (1-4,7-9)	Inconclusive (1-4,7-9)
2.5	Albert Goyenetche Dairy #2	No impact (1-5)	No impact (1-5)
2.5	John Bootsma Dairy	No impact (1-5)	No impact (1-5)
2.5	Offinga Dairy	No impact (1-5)	No impact (1-5)
2.6	Pastime Lakes Dairy - John Bidart	No impact (1-4)	No impact (1-4)
3.1	Van Ryn Dairy [b]	Facility closed	Facility closed
3.2	Jim Bootsma Jr. Dairy	No impact (1-5)	Inconclusive (1-5,9)
3.2	Marvo Holsteins Dairy	No impact (1-5)	Inconclusive (1-5,9)
4.1	Abacherli Dairy [b]	Facility closed	Facility closed
4.1	Boere Dairy [b]	Facility closed	Facility closed
4.2	E.L. Farms	Inconclusive (1-4,7-9)	Inconclusive (1-5,7-9)
5.1	Arie & Josh de Jong Dairy	No impact (1-5)	Potential impact (1-6)
5.1	CBJ Dairy	No impact (1-5)	Potential impact (1-6)
5.1	Ed Vander Woude Dairy	Inconclusive (1-5,8)	Inconclusive (1-5,8)
5.2	R&J Haringa Dairy	Inconclusive 1-5,7-9)	Inconclusive (1-5,7-9)
5.3	John Oostdam Dairy	No impact (1-5)	No impact (1-5)
5.4	Scott Brothers Dairy	Inconclusive (1-4,7,8)	Inconclusive (1-4,7,8)
5.5	John & Margie Oostdam Heifer Ranch	Inconclusive (1-5,8,9)	Inconclusive (1-5,8,9)
6.1	Herman De Jong Dairy	Inconclusive (1-5,8)	Inconclusive (1-5,8)

a. Sources of uncertainty:
1) Unknown impact of non-dairy sources of nitrate and/or TDS.
2) Lack of groundwater samples collected over a similar time period.
3) Comparison of samples from wells with different perforated intervals.
4) Uncertainty of rate of groundwater movement.
5) Uncertainty in groundwater flow direction and/or impact of groundwater withdrawal on short-term flow patterns.
6) Close proximity of groups of dairies leads to uncertainty in impact of individual dairy.
7) No upgradient groundwater quality information.
8) No facility groundwater quality information.
9) No downgradient groundwater quality information.

b. Facility no longer exists and no further action is necessary.

The analyses conducted for this report were based on readily available data and were subject to the limitations noted above. As such, this should be considered a screening analysis for possible dairy impacts on groundwater quality in the San Jacinto area. These results should be confirmed before recommending any dairy-specific mitigation or remedial action. Verification of the screening-level findings could be conducted on a site-specific basis, but would be better and more efficiently implemented as part of a coordinated regional effort in cooperation with EMWD and the Hemet-San Jacinto Basin Watermaster.

The following future studies are suggested to refine and improve understanding of groundwater flow and quality in the entire San Jacinto area:

- Collect data on the direction and rate of groundwater movement to support an assessment of likely time frames in which to expect to see influences of dairies on groundwater quality (or the effects of remediation efforts). The data collection should be focused on areas that would support generalizations about the direction and rate of groundwater flow in the vicinity of the dairies.
- Develop an inventory of potential nitrate or TDS sources such as potentially leaky storage ponds, irrigation of cropland, and dairy wastewater disposal on pastures to provide data that will support development of improved basin-wide monitoring activities that will, in turn, support improved understanding of the sources and movement of nitrate and TDS across the basin.
- Work with EMWD to ensure continued sampling of existing wells occurs on a contemporary and concurrent schedule to support direct comparison of results, perhaps focusing on a limited number of wells if knowledge of the groundwater system can eliminate some wells as redundant.

In specific cases where the screening analysis has suggested a potential impact from a particular facility or group of facilities, further investigation should be conducted to gather site specific data and information to address the sources of uncertainty in the screening analysis. Such investigations could include:

- Site investigations to identify potential sources of elevated nitrate or TDS as well as other potential, non-dairy TDS and nitrate sources, as the basis of a more detailed analysis of site specific impacts. This should include expertise from EMWD to verify local groundwater flow direction. Investigations could be conducted as part of a basin-wide inventory of potential nitrate and TDS sources as described above. Investigations should be conducted for each facility for which the screening analysis suggests a potential impact on groundwater nitrate or TDS. Review of site investigation data might suggest additional shallow water table wells, either for broad characterization of the facility/group area or around a specific potential source (e.g., up and downgradient from a crop field being irrigated with dairy wastewater or a suspected leaky wastewater pond).
- A detailed geophysical investigation to document depth to groundwater table(s), permeability of the aquifer(s) and the overlying unsaturated zone, specific local groundwater flow patterns and velocities, and the influence of pumping wells on local groundwater. The investigations could

include additional observation wells (discussed below), soil borings, well pump tests, and other procedures to generate new data for the purposes of confirming or rejecting the screening-level conclusion. In high-priority cases, analysis for parameters of groundwater quality other than nitrate or TDS (e.g., isotopes, trace metals) that could be more sensitive tracers of dairy influence. Investigations could be conducted for each facility for which the screening analysis suggests a potential impact on groundwater nitrate or TDS but might be more feasible if conducted as part of a regional effort that targets specific areas of uncertainty.

- Additional investigations could include a targeted intensive groundwater sampling program to identify possible plumes of nitrate or TDS moving from specific sources, movement during wet vs. dry periods, annual rates of change in concentration, etc. Existing wells that were not included in the data provided by EMWD or identified as part of the current effort might be available for data collection to achieve the objectives below; those wells should be identified as part of the detailed site investigations recommended above.
- As additional observation wells are added on a regional basis, locations should be considered which would provide additional data for certain facilities found to have a potential impact, or where the screening analyses was inconclusive because of a lack of upgradient, downgradient, or facility observation wells, as summarized in Table 27.

Table 27. Recommended Locations for Additional Data Collection based on Screening Level Analysis.

Dairy	Screening Level Conclusion	Data Location Needs
Boersma	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
Gerbin Hettinga Expressway		Upgradient, downgradient and facility
Hollandia		Upgradient, downgradient and facility
Marvo Holsteins #2		Upgradient, downgradient and facility
Dick Van Dam	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
Cottonwood		Upgradient, downgradient and facility
Bootsma-Silva Farms/Ramona Dairy #2 (old Vermeer Dairy)		Upgradient, downgradient and facility
Arie & Josh de Jong	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
CBJ		Upgradient, downgradient and facility
Goyenetche Dairy #2 (old Cawston Dairy)	Inconclusive impact	Upgradient, downgradient and facility
Jim Bootsma Jr.		Downgradient
Marvo Holsteins		Downgradient
E.L. Farms		Upgradient, downgradient and facility
Ed Vander Woude		Facility
R & J Haringa		Upgradient, downgradient and facility
Scott Brothers		Upgradient and facility
John & Margie Oostdam Heifer Ranch		Downgradient and facility
Herman De Jong		Facility

7.1 Action Plan

This groundwater monitoring analysis, based on the available data, does not suggest widespread impacts on groundwater TDS or nitrates in the San Jacinto watershed caused by the dairy industry. The data also do not point to definitive impacts on groundwater TDS and nitrates from individual dairies in the basin. The dairy industry has therefore met the monitoring analysis requirement of the CAFO permit (Order R8-2013-0001). However, because gaps in the data exist, as summarized in Table 27, WRCAC suggests pursuing a regional approach to collection of additional data to verify the findings of this analysis and support a collaborative approach among dairies and between dairies and other potential sources to reducing groundwater TDS and nitrate. WRCAC believes that additional actions are warranted to refine the level of information available and to enhance future groundwater analysis efforts. The following action plan items should be completed.

ACTION ITEMS	COMPLETION DATE
1. Stakeholder outreach /copies of the final approved analysis	April 1, 2015
2. Site Assessment for Potential Impact locations	July 1, 2015
3. Regional GW coordination with EMWD & Watermaster	December 31, 2016

This may include collection of additional data, inventory lists, continued EMWD sampling coordination efforts, or regional approach for new GW wells

4. Site Assessment specific studies as needed	Ongoing

This may include items such as: geophysical investigations, future land use information and updates for potential sources, GW flow directions, participation in basin wide inventory activities or other activities to assist in EMWD in GW activities.

8.0 References

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Bruce Scott. 2014. Personal communication, October 21, 2014

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Appendix A

Regional Mapping Evaluation

TETRA TECH

TECHNICAL MEMORANDUM

To:	Jennifer Ferrando
From:	Dave Richers
Date:	January 30, 2014 (Revised November 11, 2014)
Cc:	Andrew Harley; File
Project No.:	114-910045X.20
Subject:	San Jacinto Dairies Salt Offset Study

1. INTRODUCTION

A review of existing data pertaining to groundwater quality and the potential source of groundwater impacts within the San Jacinto Valley of California was conducted. Data provided by the client for groundwater chemistry, water table elevations, and general land use were available over the study area. Elevation and groundwater chemistry data ranged between the years 1995 to 2012, although sampling events did vary between years and all locations are not represented in all years. The data set was used as received and not evaluated for its representitiveness or reliability.

Figure 1 shows the location of the wells utilized in this study, inferred groundwater flow based on static groundwater elevations, and major mapped geologic faults within the basin.

2. GROUNDWATER FLOW

Depth to water table information was utilized between the years 1995 through 2012. Data were imported into a POSTGRES database and queried to provide average depth to water table by well by year. These data were imported into the GRASS 6.1 GIS system and iso-contour elevation maps were generated using inverse distance weighing. The resulting grids were masked to show only the area of interest (AOI) and color contoured (Figures 2a through 2f). Based upon the relative static water table elevations, flow in the main basin is inwards towards the basin center with highest flow generally from the northwest.

3. GROUNDWATER CHEMISTRY

Figures 3a-3d present the relationship of nitrate within the basin for years 2005, 2010, 2011, and 2012. In that nitrates are often introduced into groundwater systems from agricultural and horticultural activities, it is essential that potential source points for this constituent be identified. All chemical data are based on average compositions measured in a well over the year sampled. Major faults within the basin trend northwest to southeast with the southwestern-most fault appearing to control the migration of nitrate present in the groundwater wells.

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Figures 4a-4d and 5a-5d show the distribution of total dissolved solids (TDS) and sulfate, respectively over time periods of 2005 to 2012 relative to fault locations. These constituents do not appear to be controlled by the basement faults. This would suggest that their migration pathways are different from nitrate and that they have a different source than nitrate. One suggestion is that they may be introduced and mobilized during irrigation practices and will be evaluated in Section 4.

4. POINT SOURCE EVALUATION

Comparison of the spatial distribution of various land use practices with mapped iso-concentration contours was conducted to evaluate relationships between a given land-use and constituent concentrations.

Figures 6a-6e show the distribution of nitrate over the time interval of 2000 to 2012 in the groundwater wells in relationship to dairy farm operations. In general, the nitrate plume is most evident in the southwestern portion of the main basin and is upgradient of the dairy operations in the vicinity of wells 5 and 26. The plume does appear to be migrating towards the north-northeast over time; however it would be difficult to define its source as the dairies as there does not appear to be any direct correlation.

An evaluation of other land use operations with respect to nitrate was undertaken including backyard livestock, equestrian activity, other livestock, poultry operations, and manure/compost storage. Figures 7a-7e show the distribution of nitrate over time relative to these non-dairy land uses. Overall, areas with domestic livestock and equestrian activity were most closely associated with nitrate concentrations.

As indicated, backyard livestock, poultry operations, and other potential nitrate generating activity exists in the area of the nitrate plume. This suggests that the presence of elevated nitrate in groundwater may in-part be due to these non-dairy activities. Further as indicated in Figure 8a-8d, over the time span of 2005 to 2012, the association of septic systems with the nitrate plume indicates a possible relationship. While not all areas serviced by septic systems show high levels of nitrate, most areas with reported high nitrate levels are proximal to septic system coverage.

Concentrations of sulfate (Figures 9a-9d) and TDS (Figures 10a-10d) in groundwater was compared to areas of agricultural irrigation as a possible source. Although several areas of high constituent concentrations can be identified, these were not consistent from year to year and appear to be transient. The area of high concentrations shown in 2010 are in the general vicinity of wildlife/wetlands areas in the western-most portion of the main basin associated with reservoirs or lakes which may provide a contribution.

5. CONCLUSION

Comparison of groundwater constituents with land use categories such as dairy, equestrian, irrigated agricultural land, backyard livestock, poultry, and other non-dairy horticulture suggests that nitrate plumes mapped in the San Jacinto Valley cannot be definitely correlated to dairy farming activity, but rather may be the result of other activity. Spatial distribution of backyard livestock, compost/manure piles, equestrian activity, and other non-dairy livestock suggests a likely relationship between nitrate plumes and such land use. Further, septic system influence, particularly in the southwestern portion of the main basin may be a contributing factor. The small sub-basin in the extreme southwestern portion of the study area may be influenced by dairy activity, although more data and monitoring may be required to determine this definitively.

TETRA TECH

FIGURES

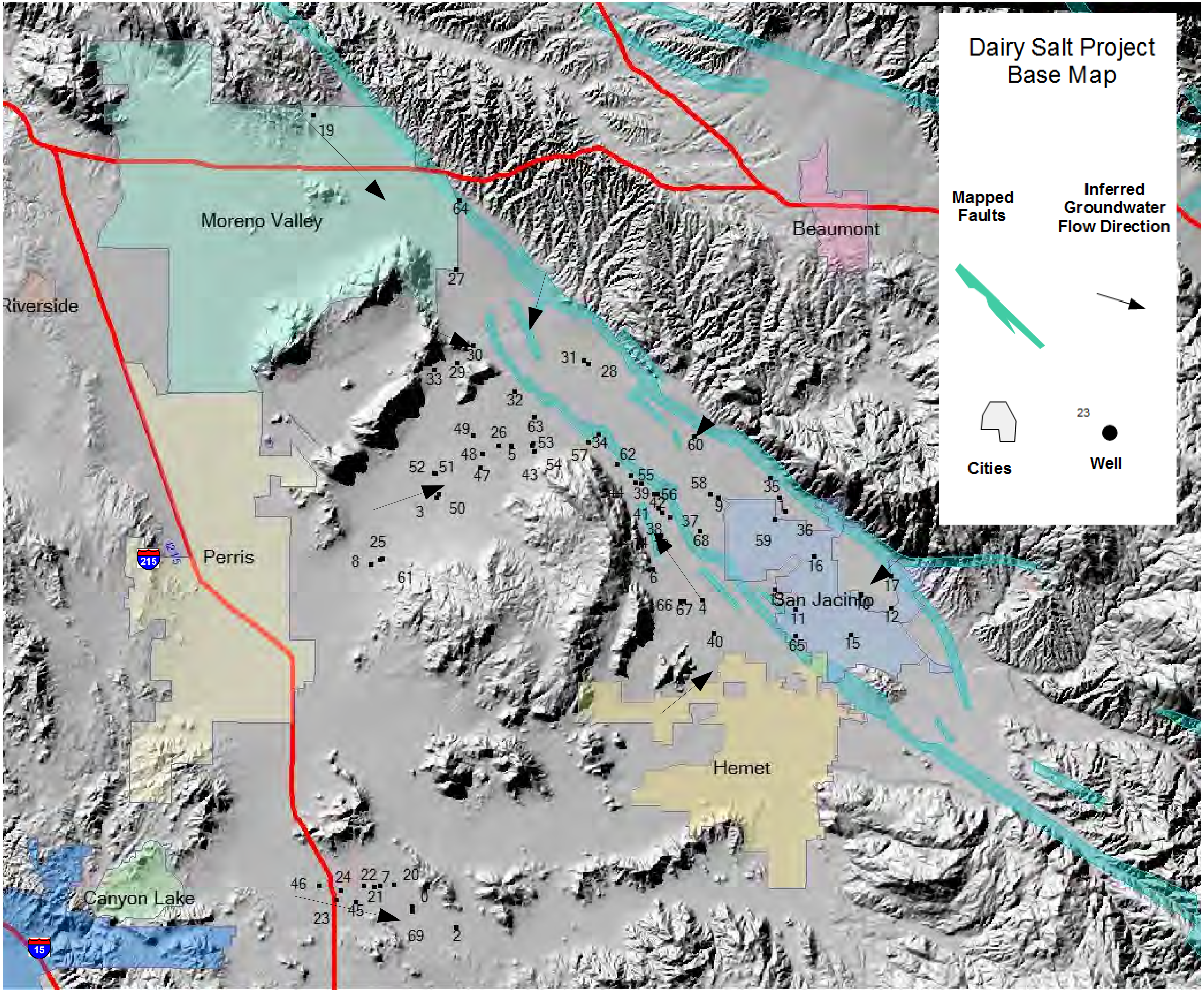


Figure 1. Map of Study Area

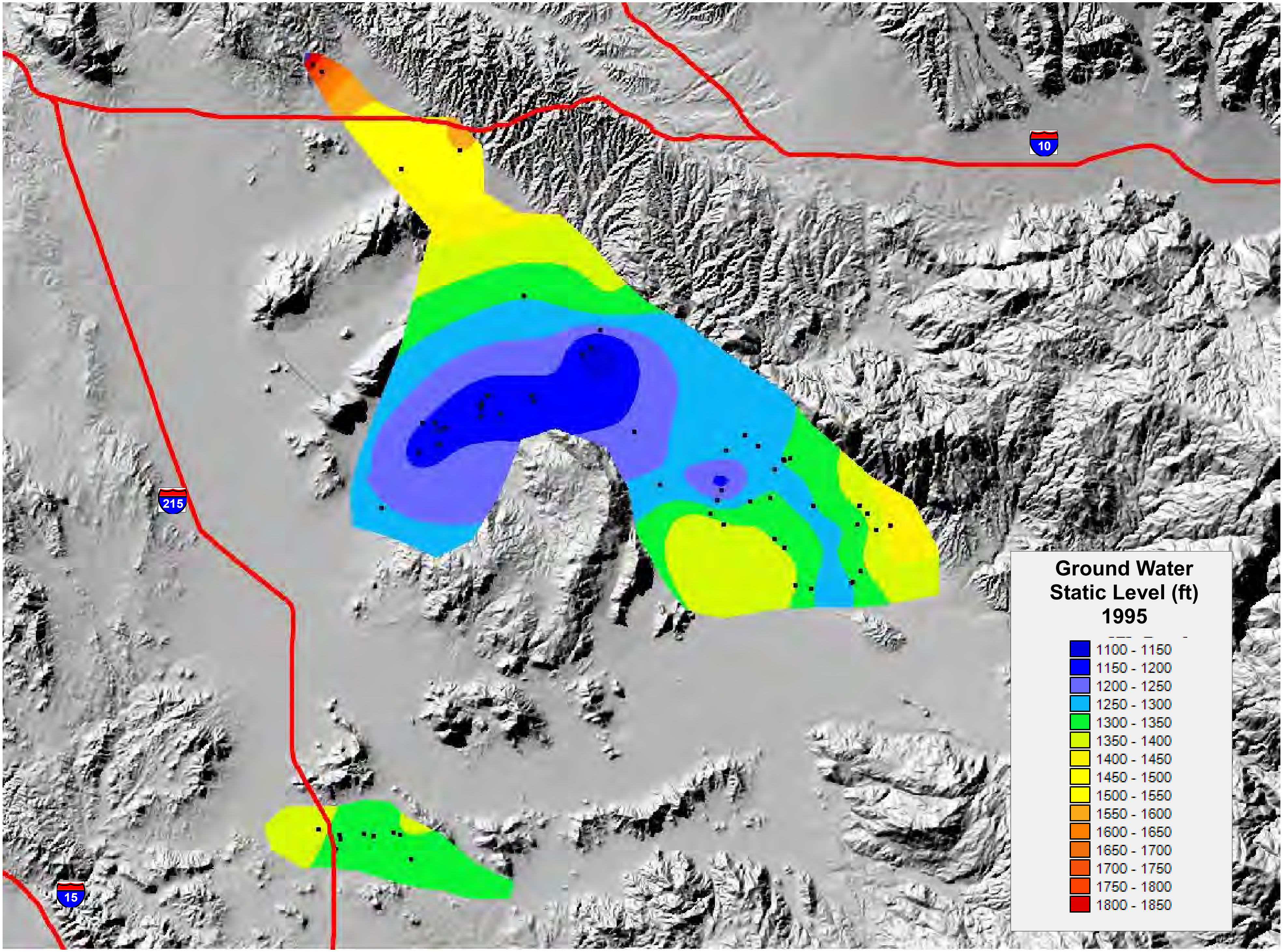


Figure 2a. Average Static Groundwater Level - 1995

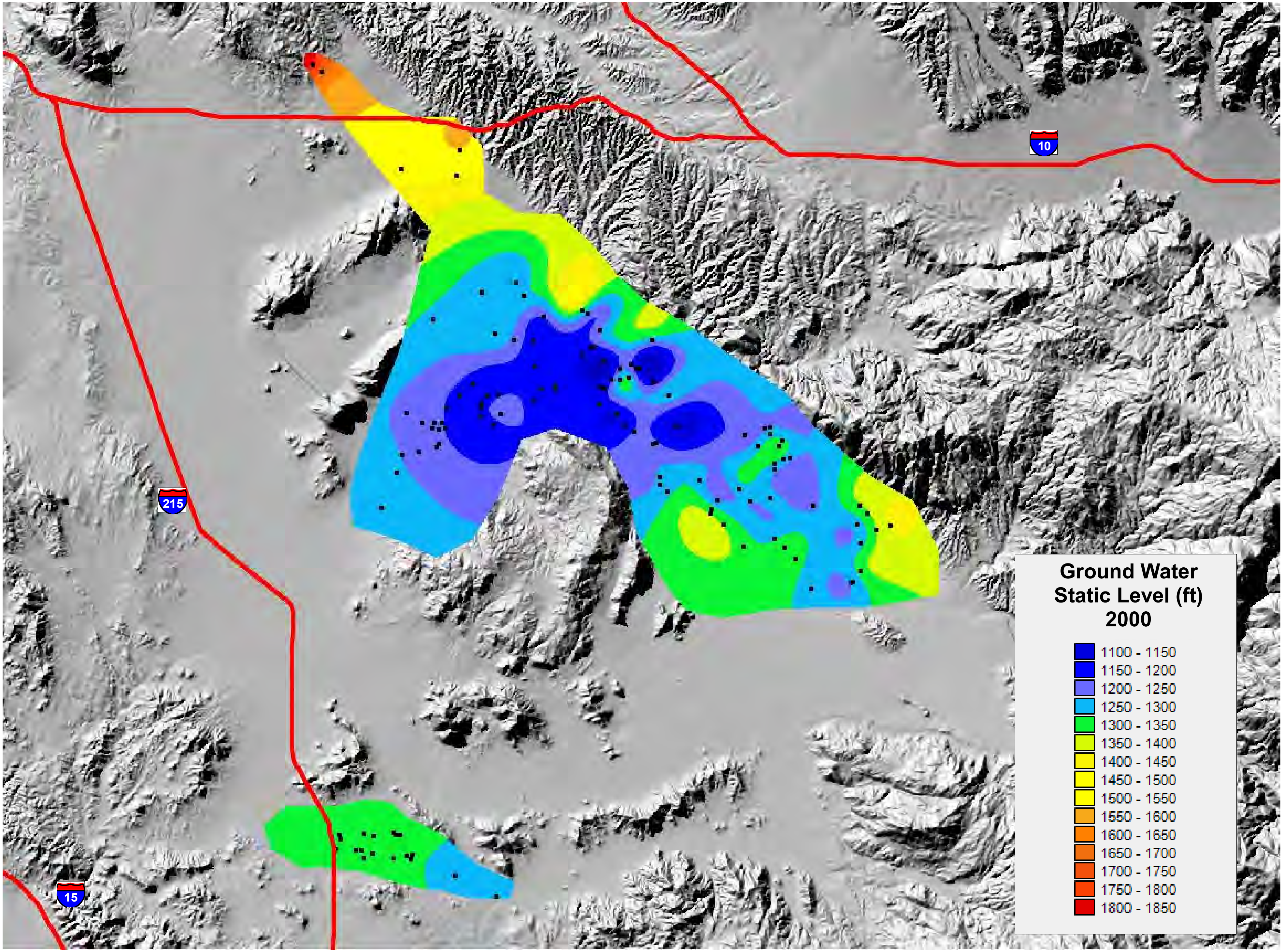


Figure 2b. Average Static Groundwater Level - 2000

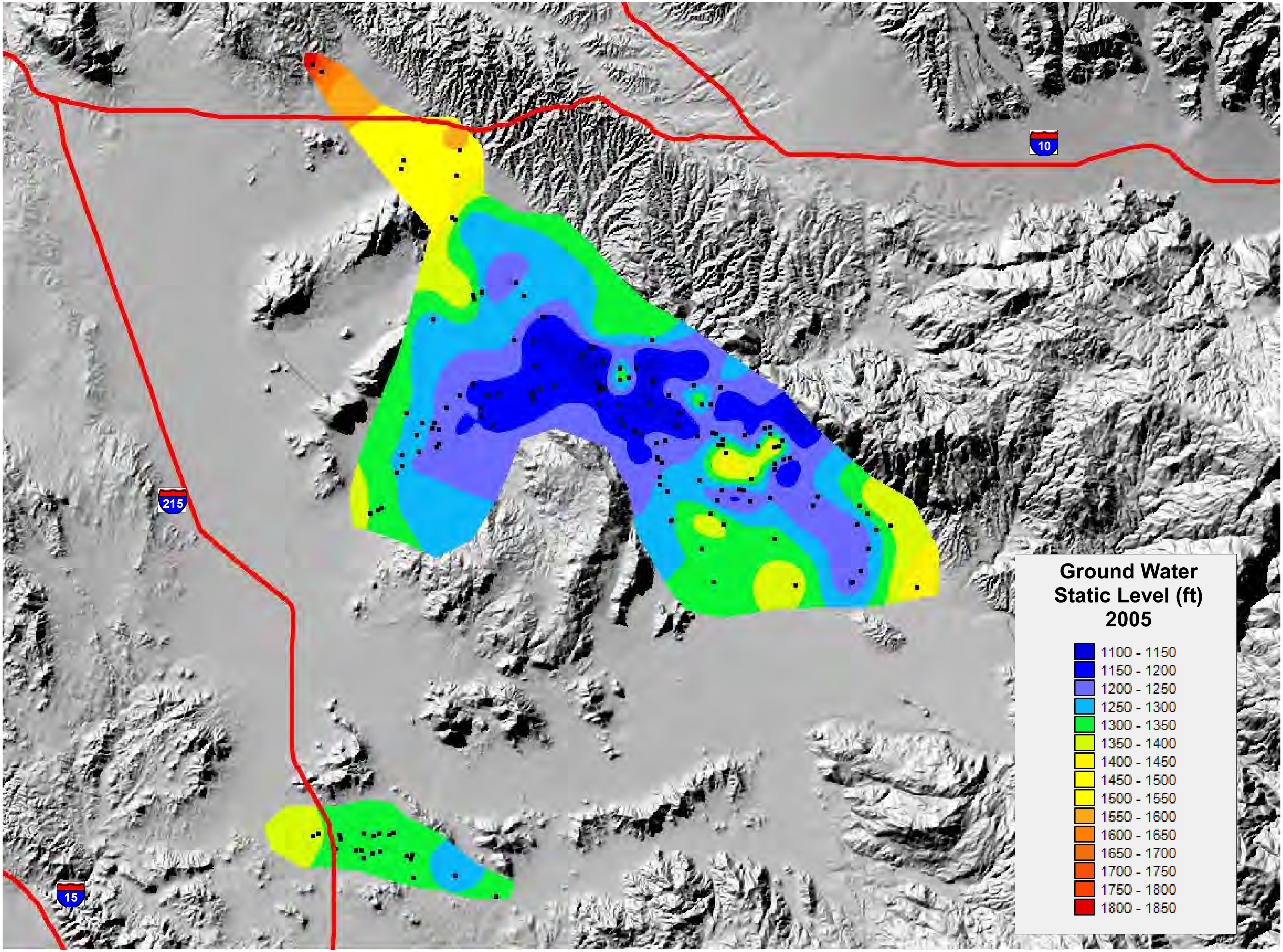


Figure 2c. Average Static Groundwater Level - 2005

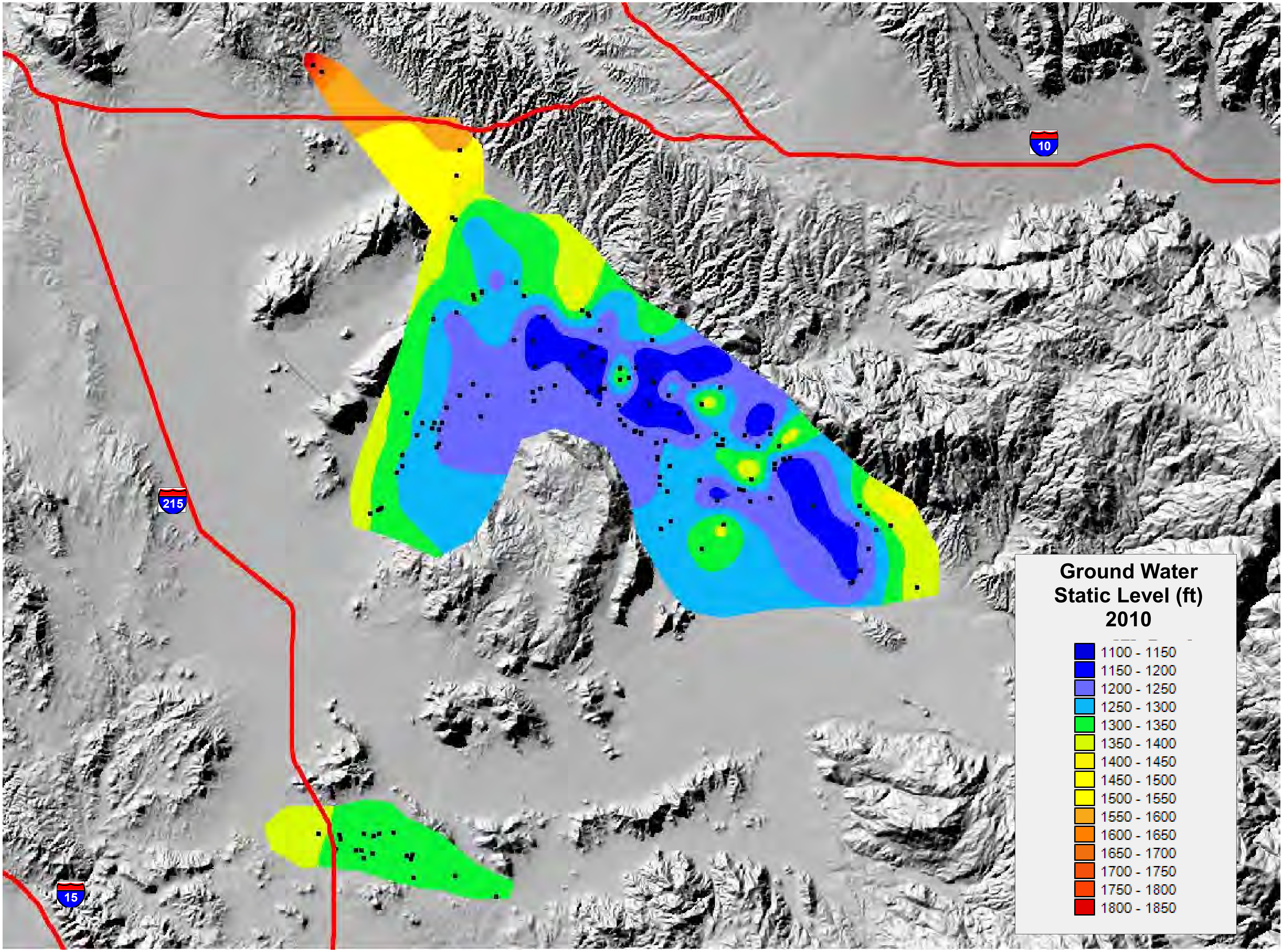


Figure 2d. Average Static Groundwater Level - 2010

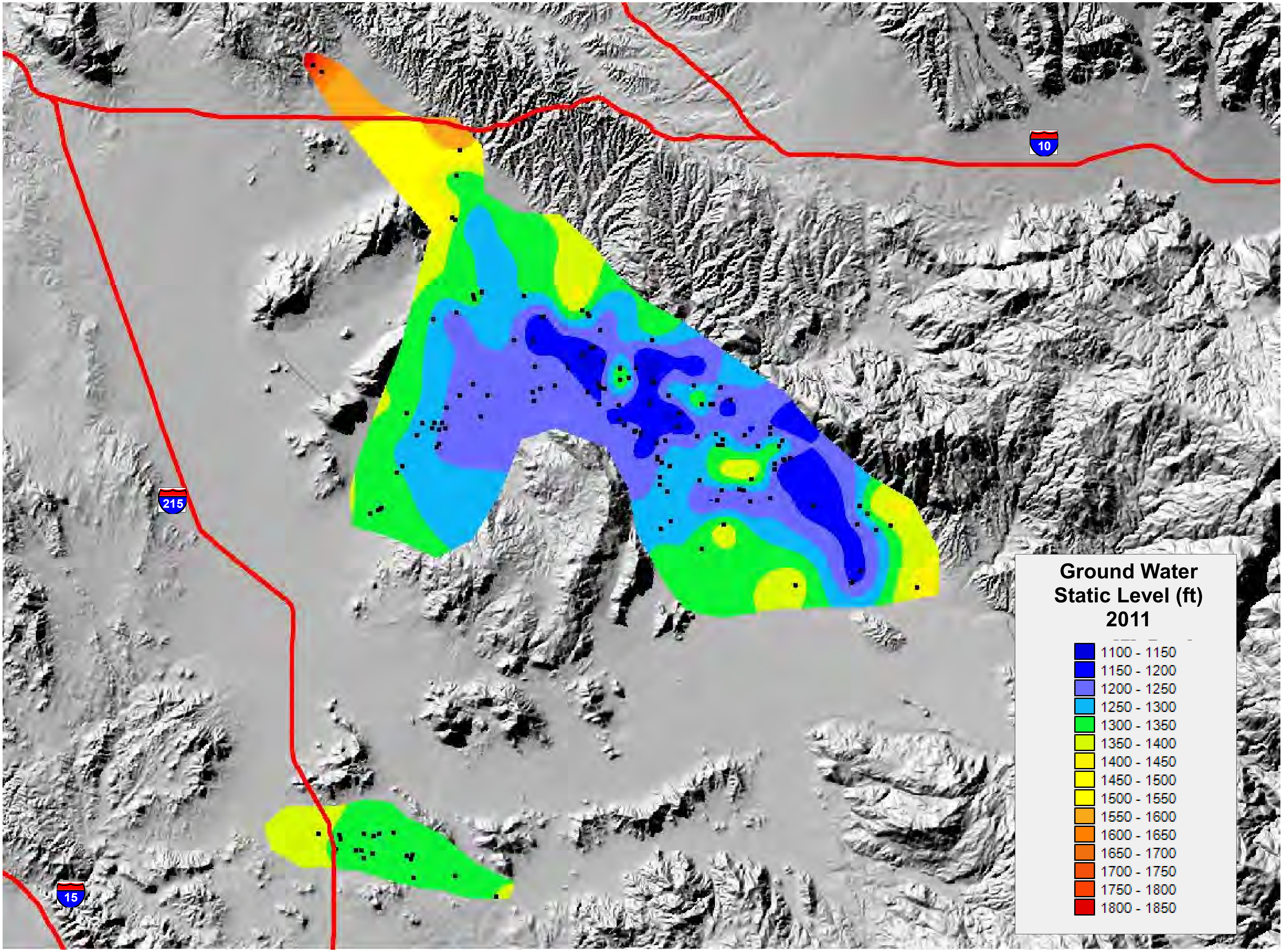


Figure 2e. Average Static Groundwater Level - 2011

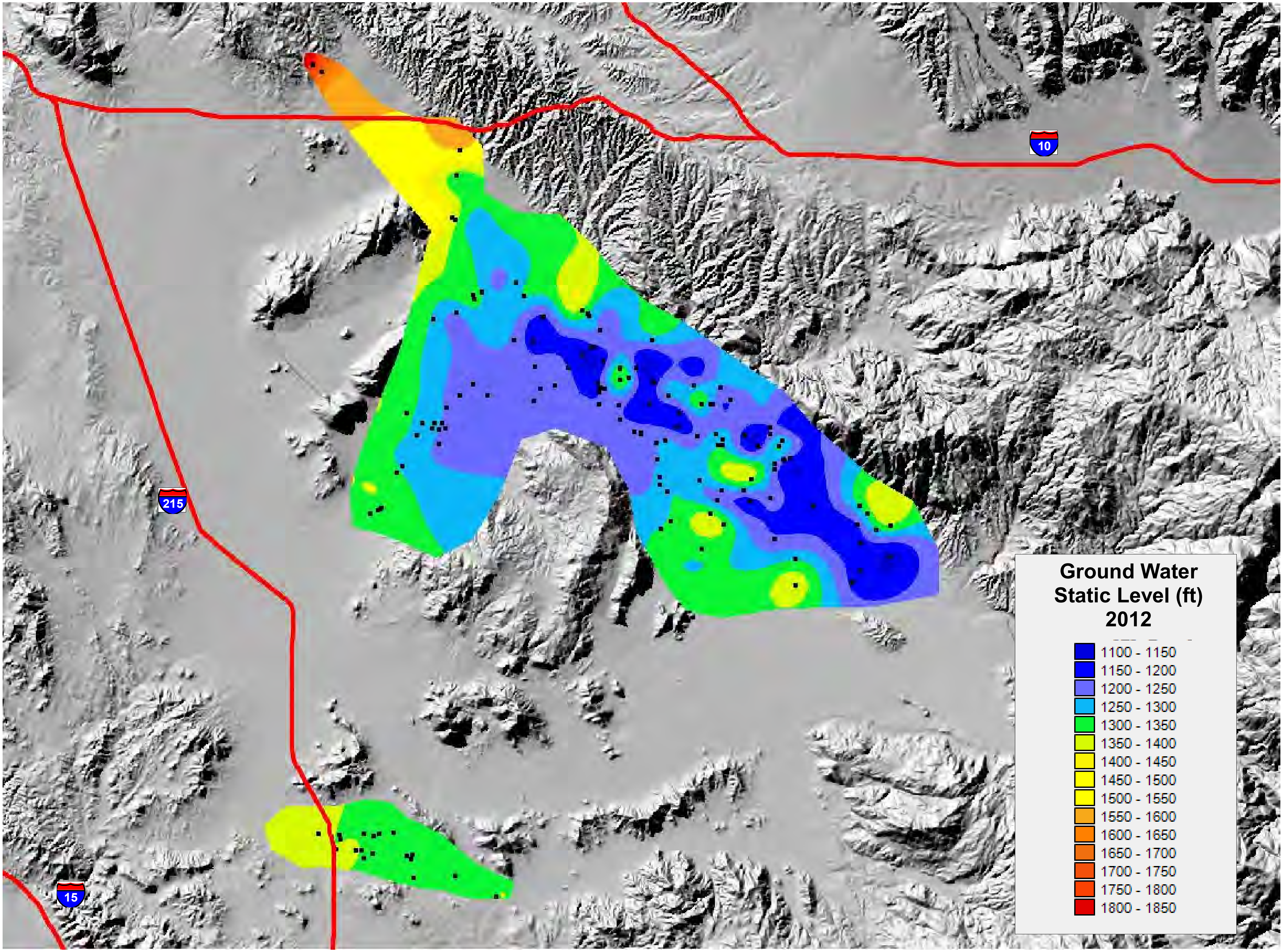


Figure 2f. Average Static Groundwater Level - 2012

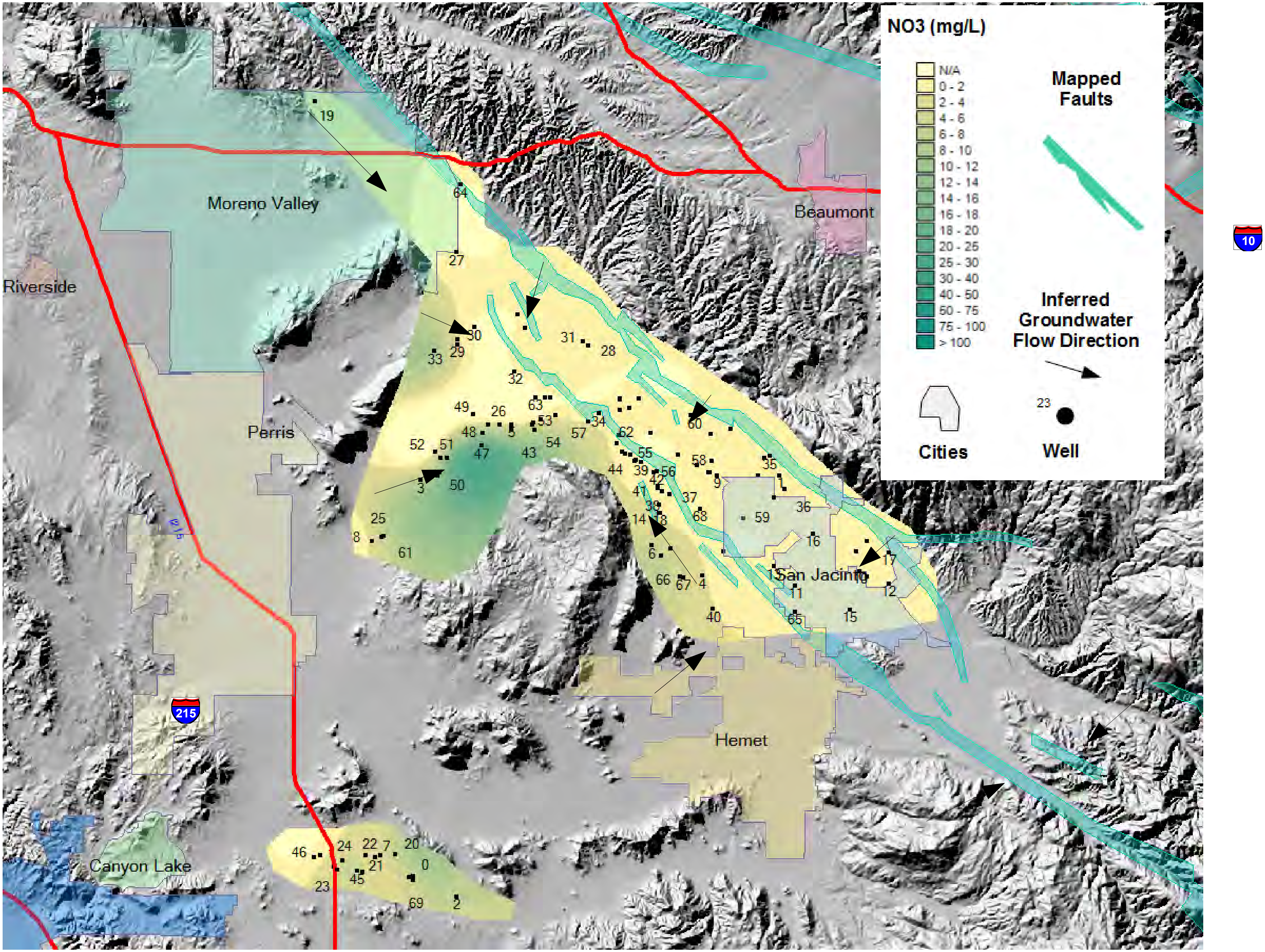


Figure 3a. Average Groundwater Nitrate Concentrations - 2005

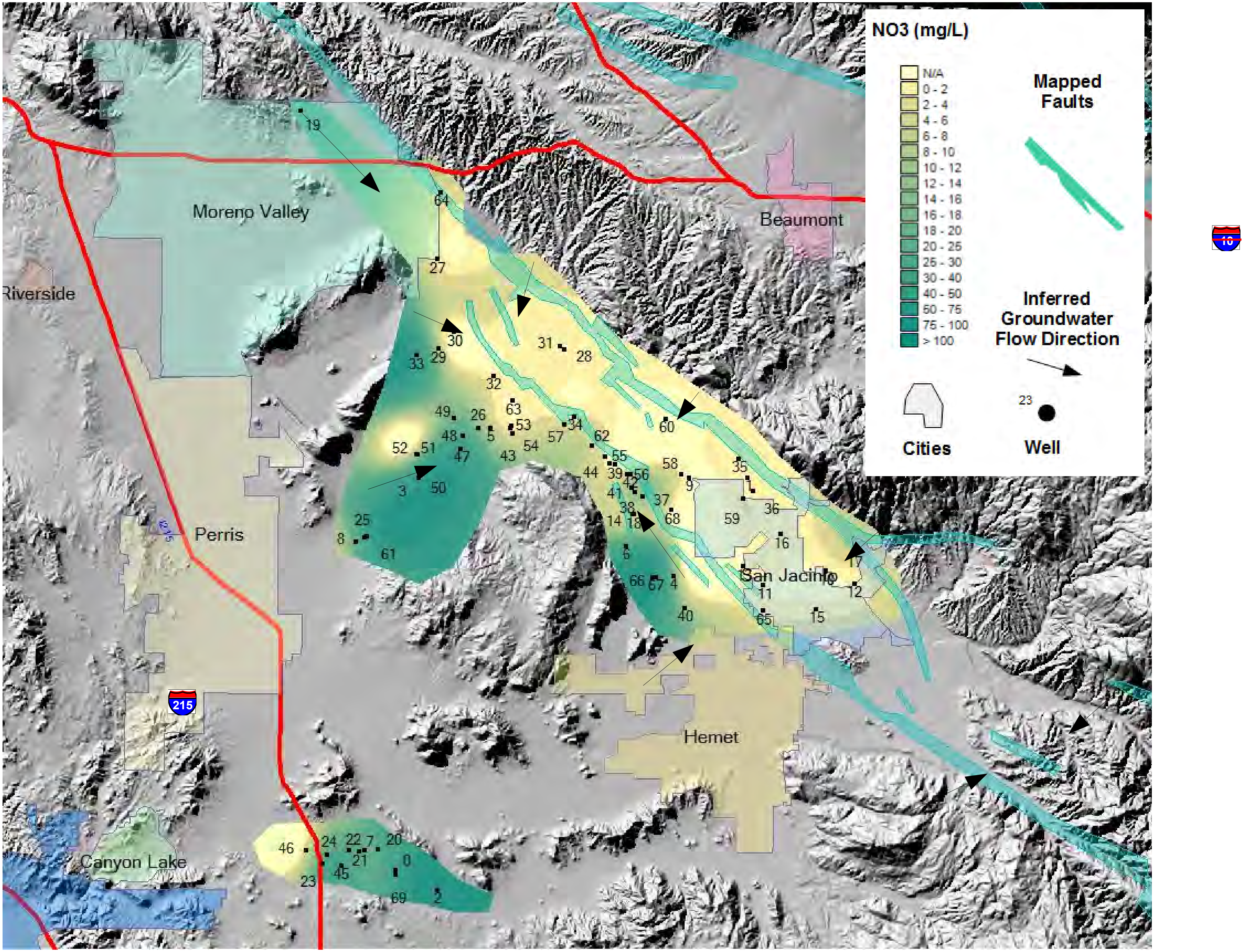


Figure 3b. Average Groundwater Nitrate Concentrations - 2010

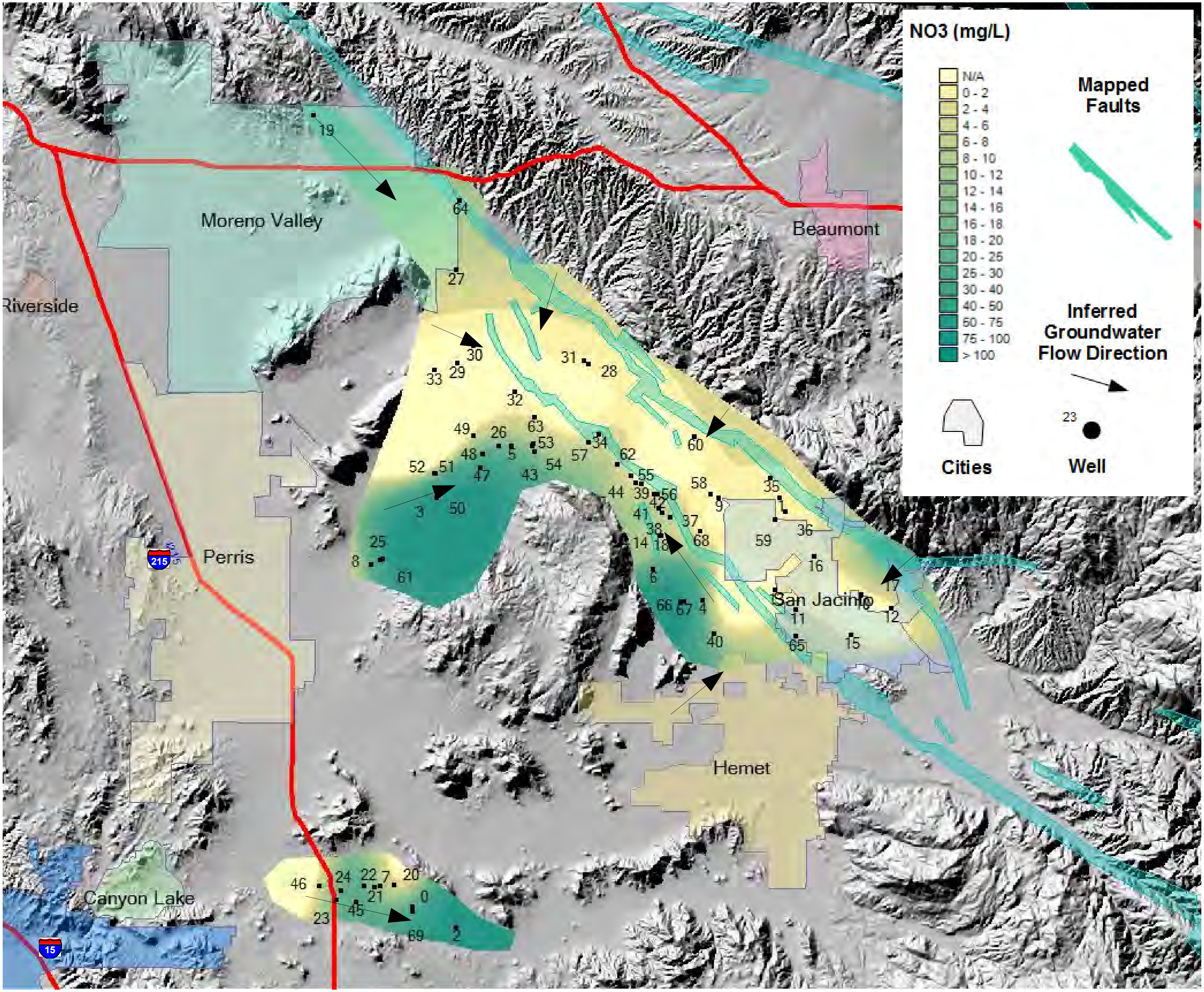
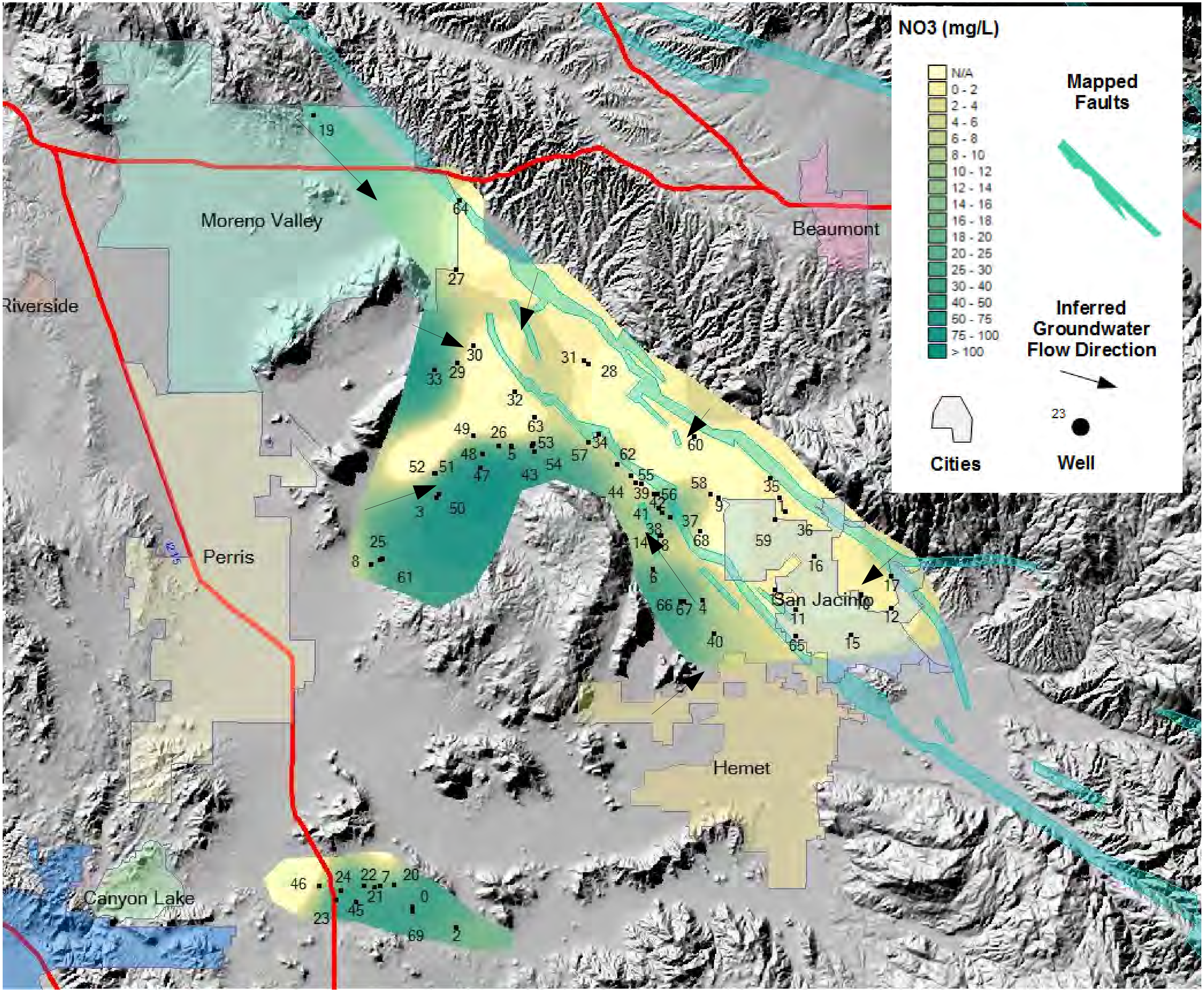


Figure 3c. Average Groundwater Nitrate Concentrations - 2011



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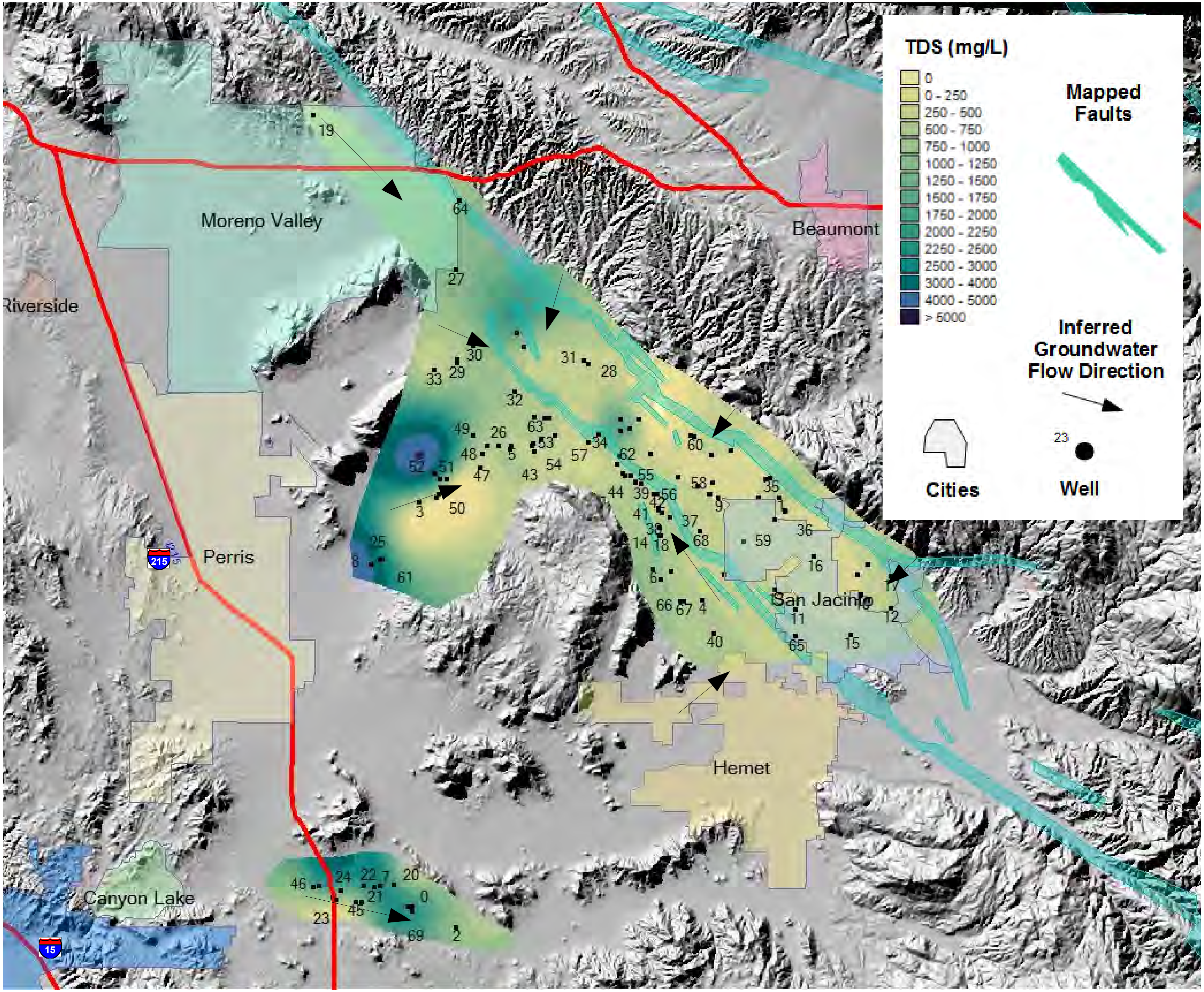


Figure 4a. Average Groundwater TDS Concentrations - 2005

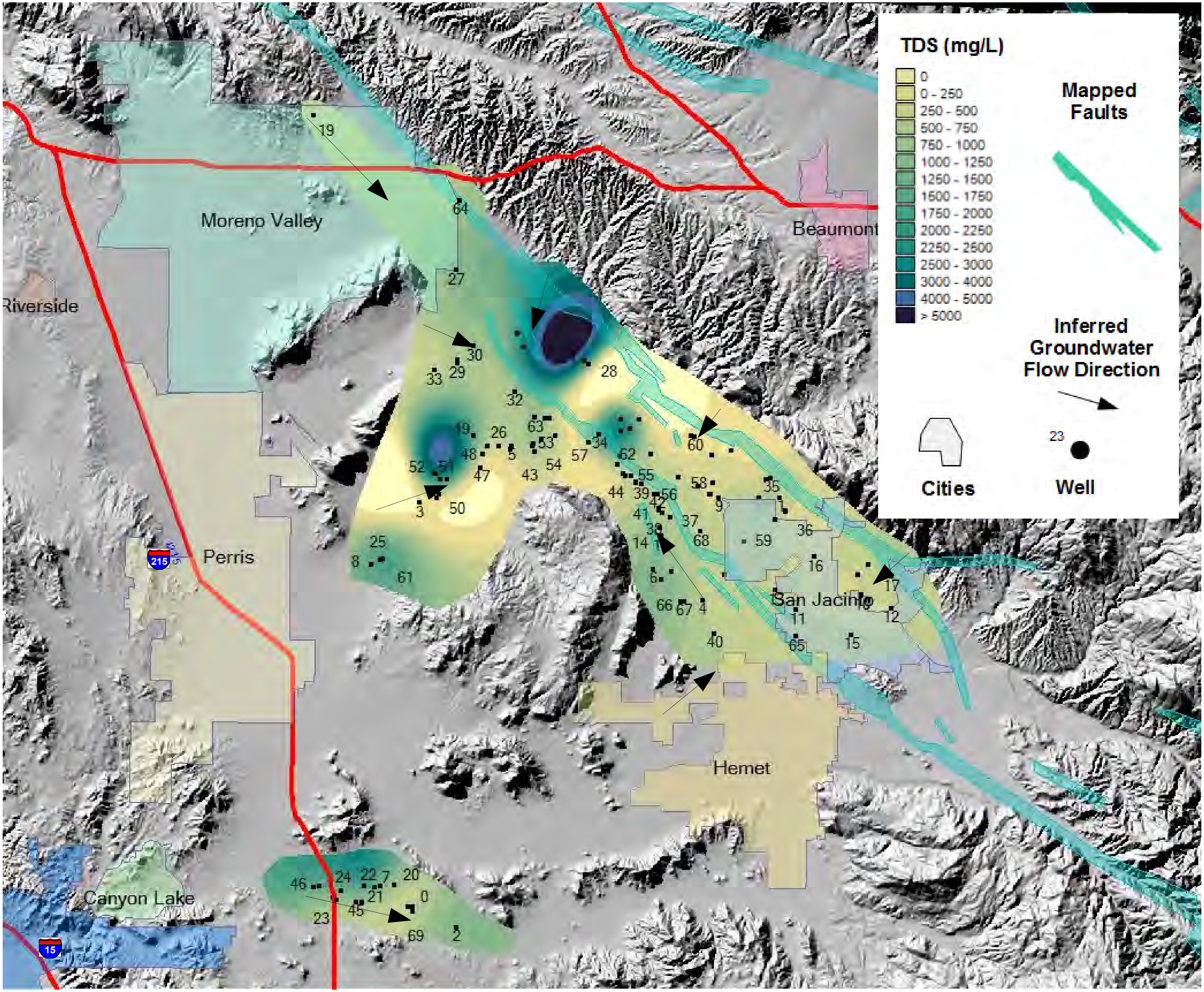


Figure 4b. Average Groundwater TDS Concentrations - 2010

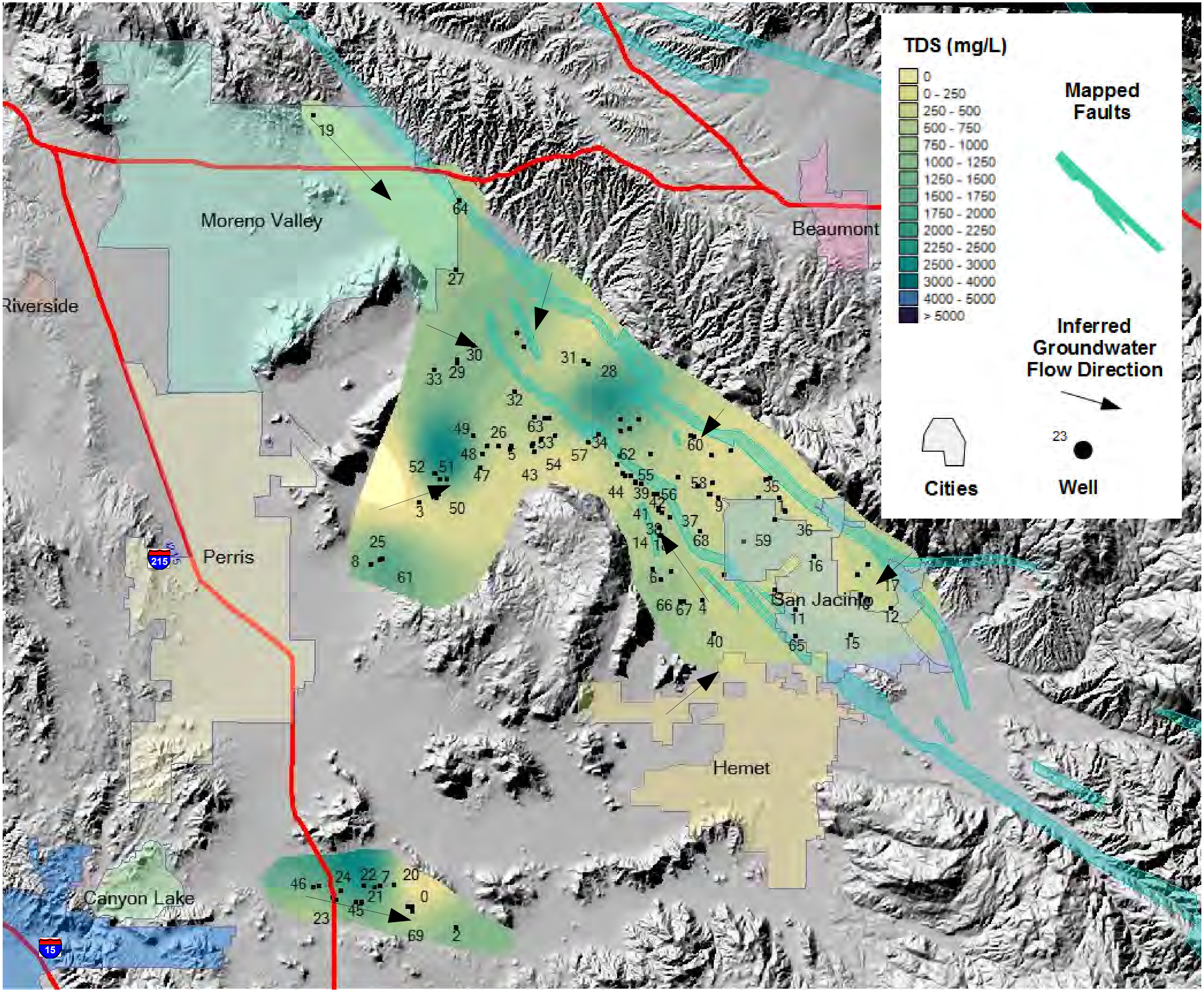
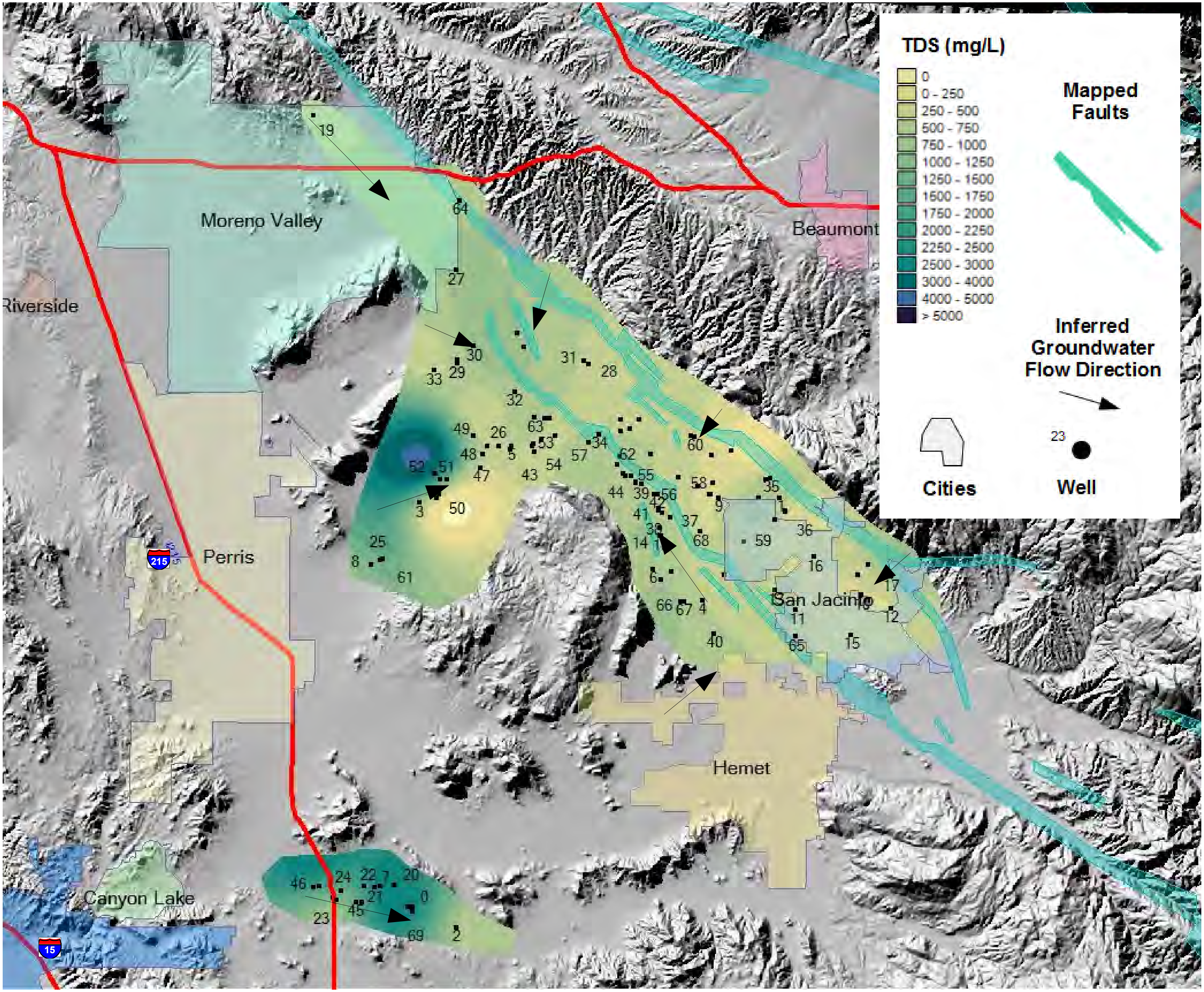


Figure 4c. Average Groundwater TDS Concentrations - 2011



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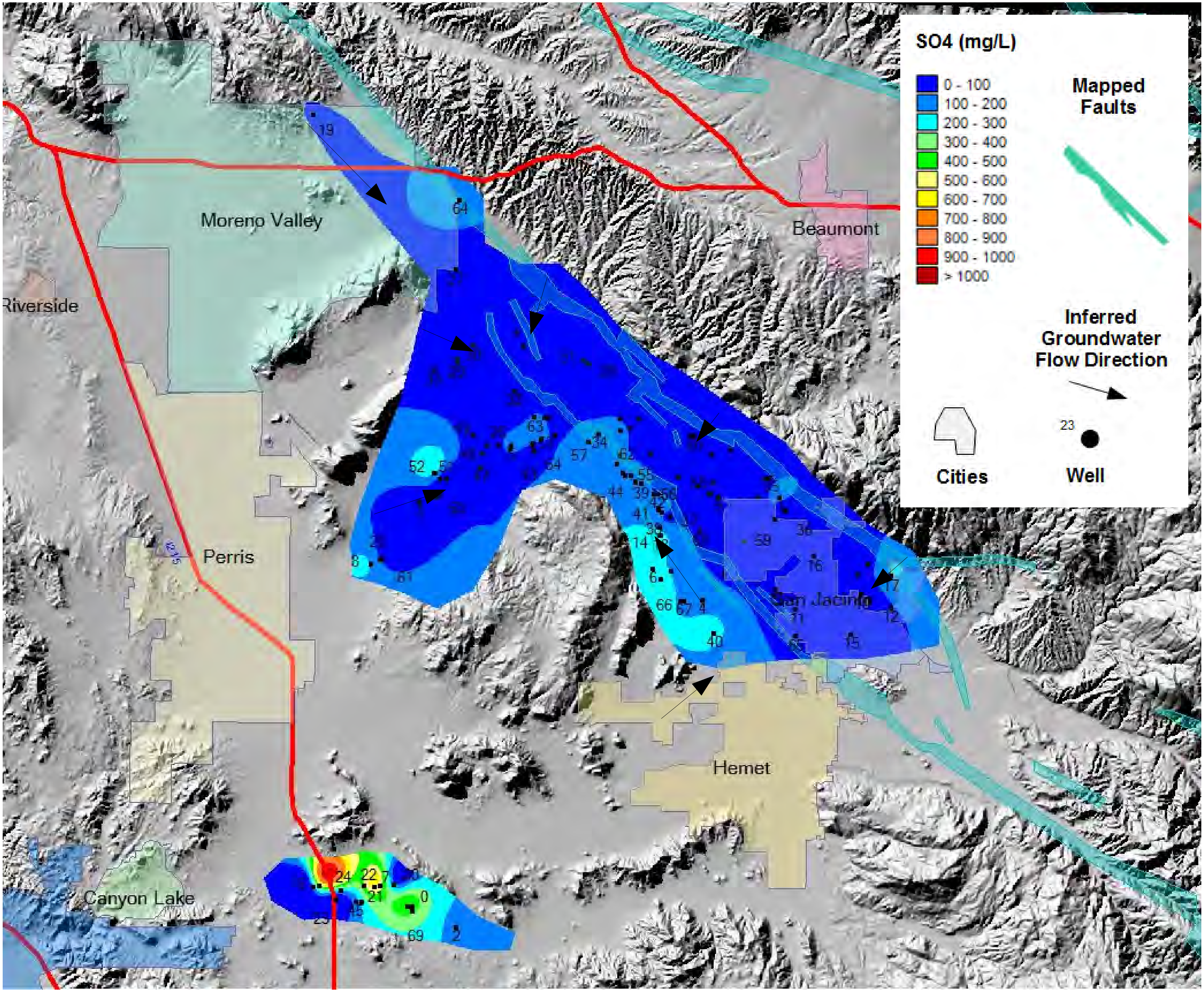


Figure 5a. Average Groundwater Sulfate Concentrations - 2005

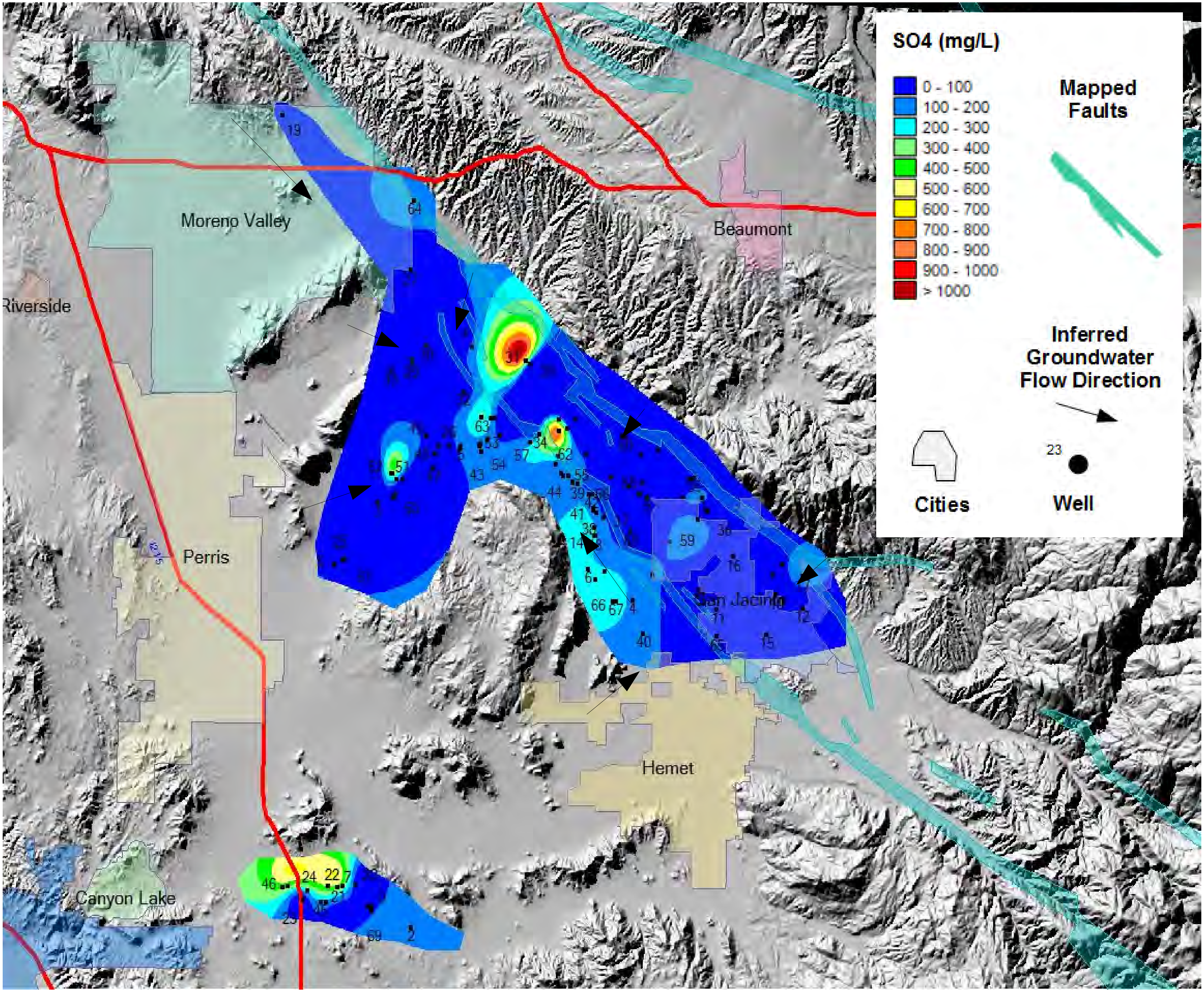
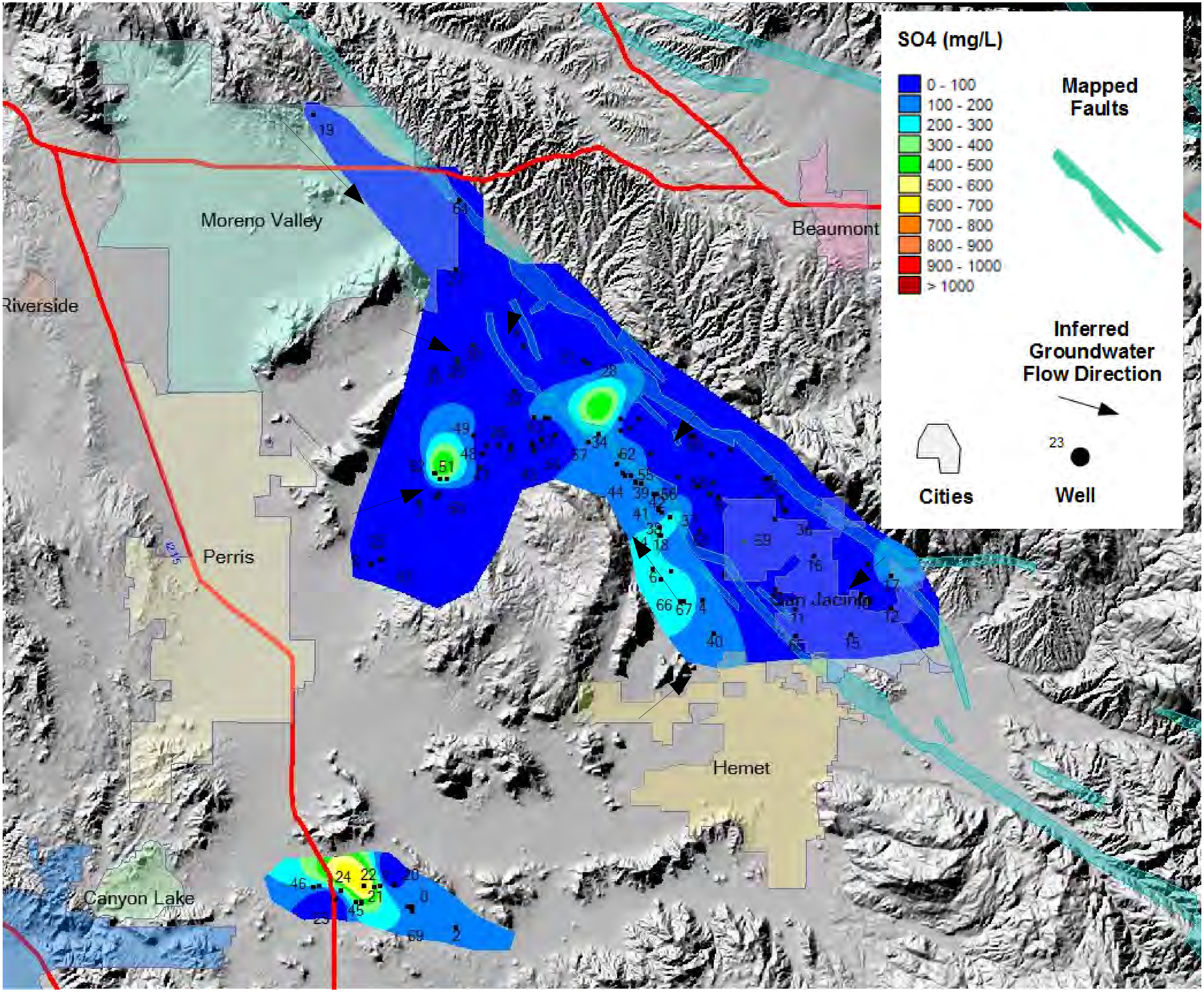


Figure 5b. Average Groundwater Sulfate Concentrations - 2010



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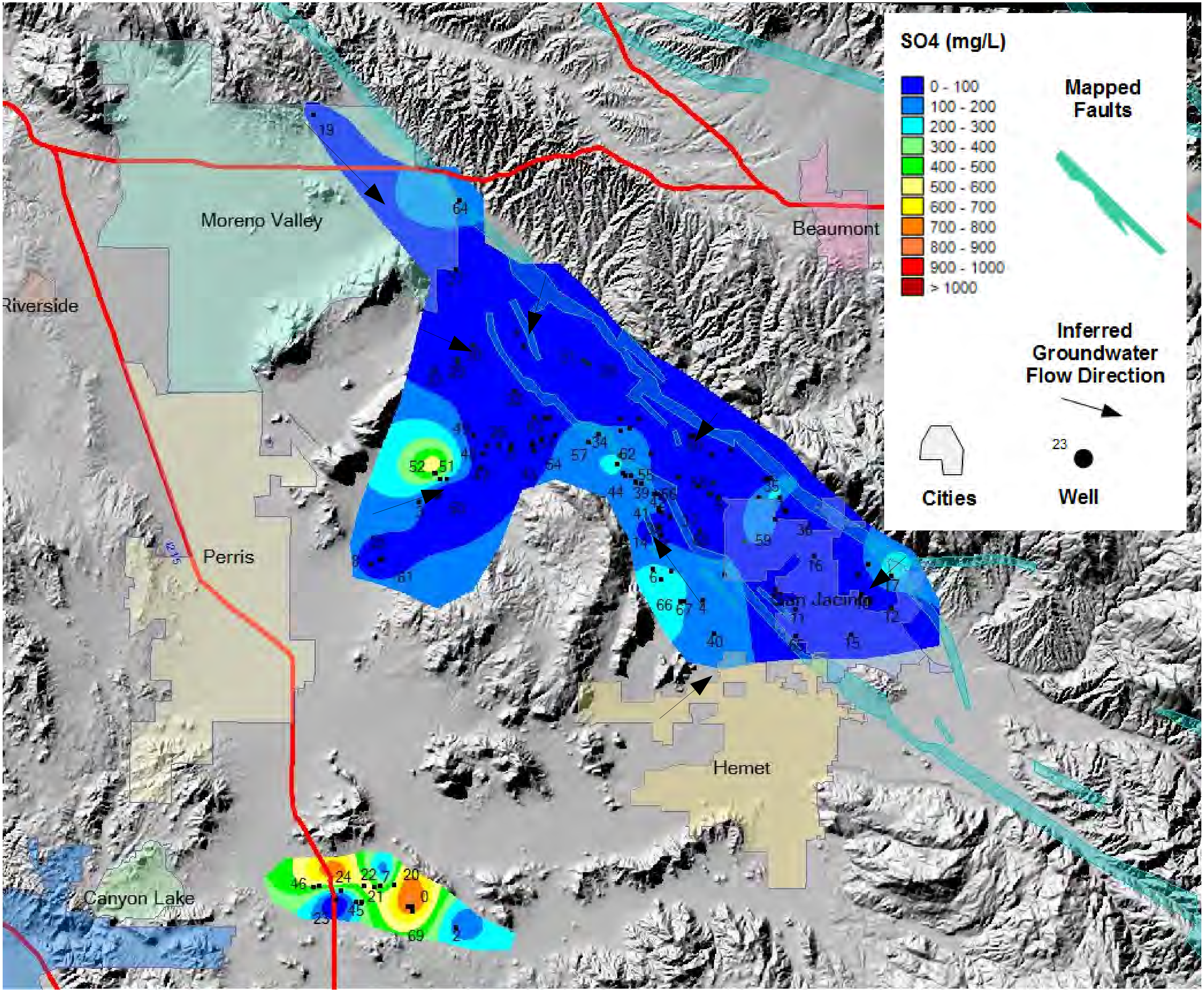


Figure 5d. Average Groundwater Sulfate Concentrations - 2012

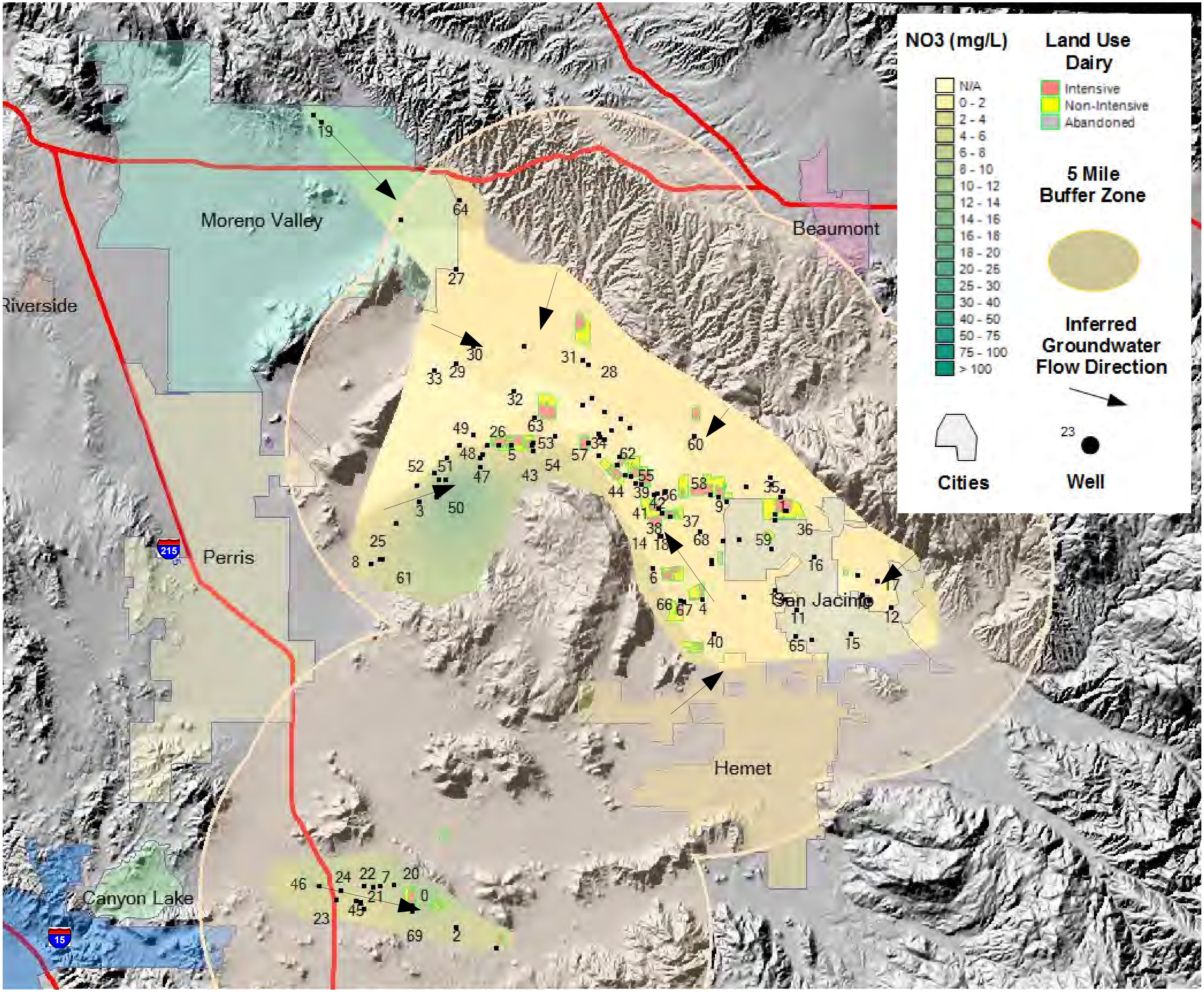
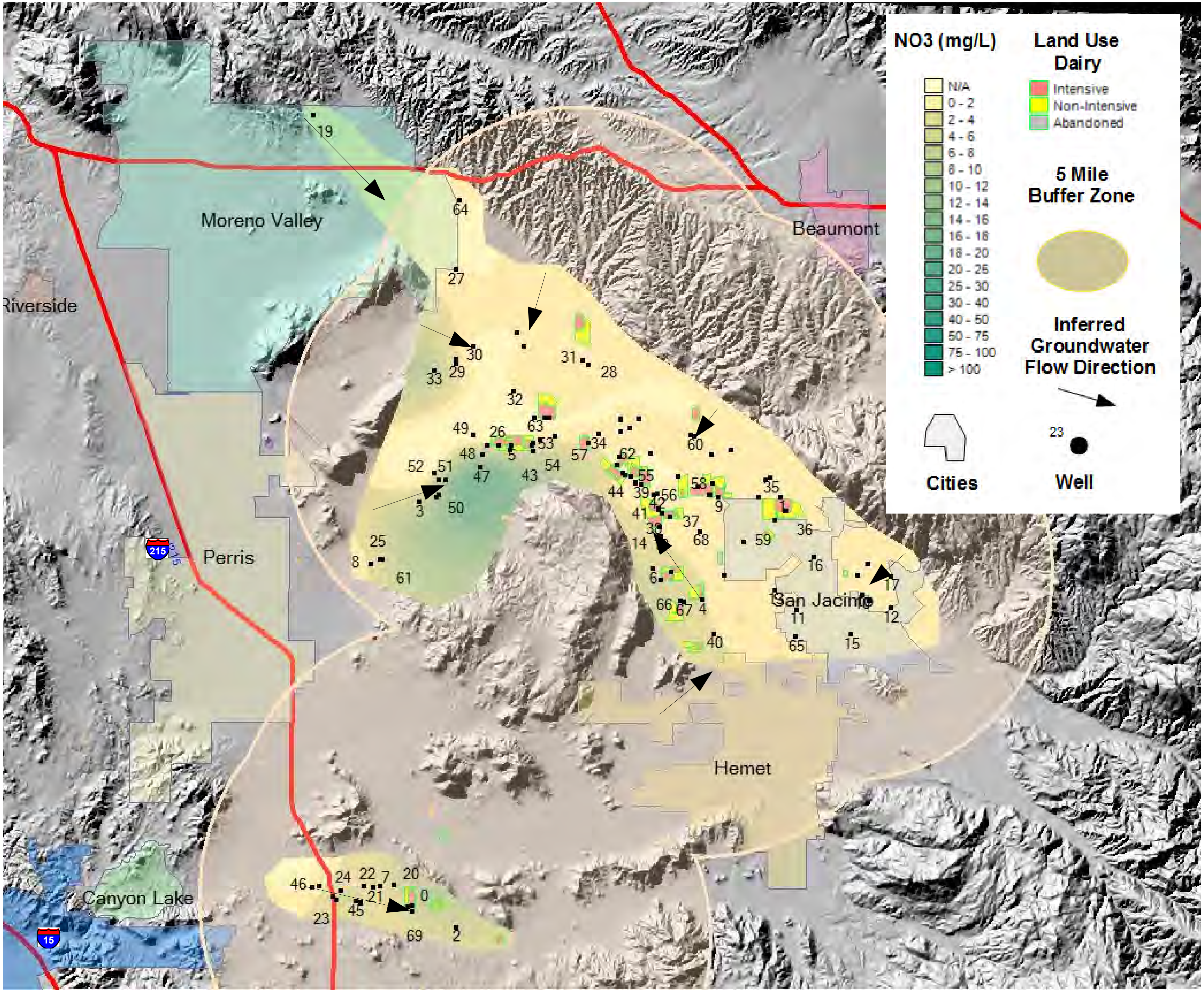


Figure 6a. Average Groundwater Nitrate Concentrations relative to Dairy Land Use - 2000



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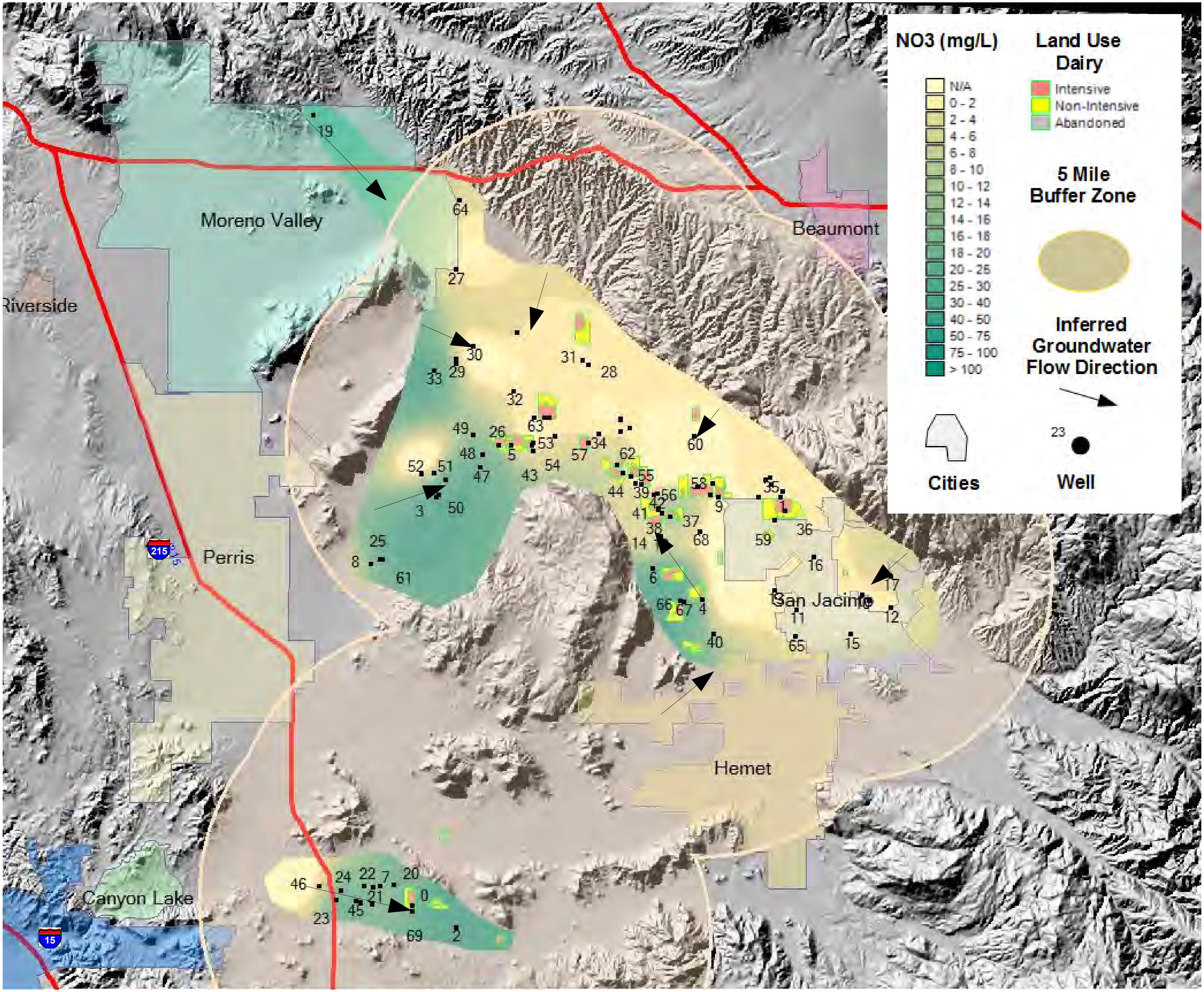

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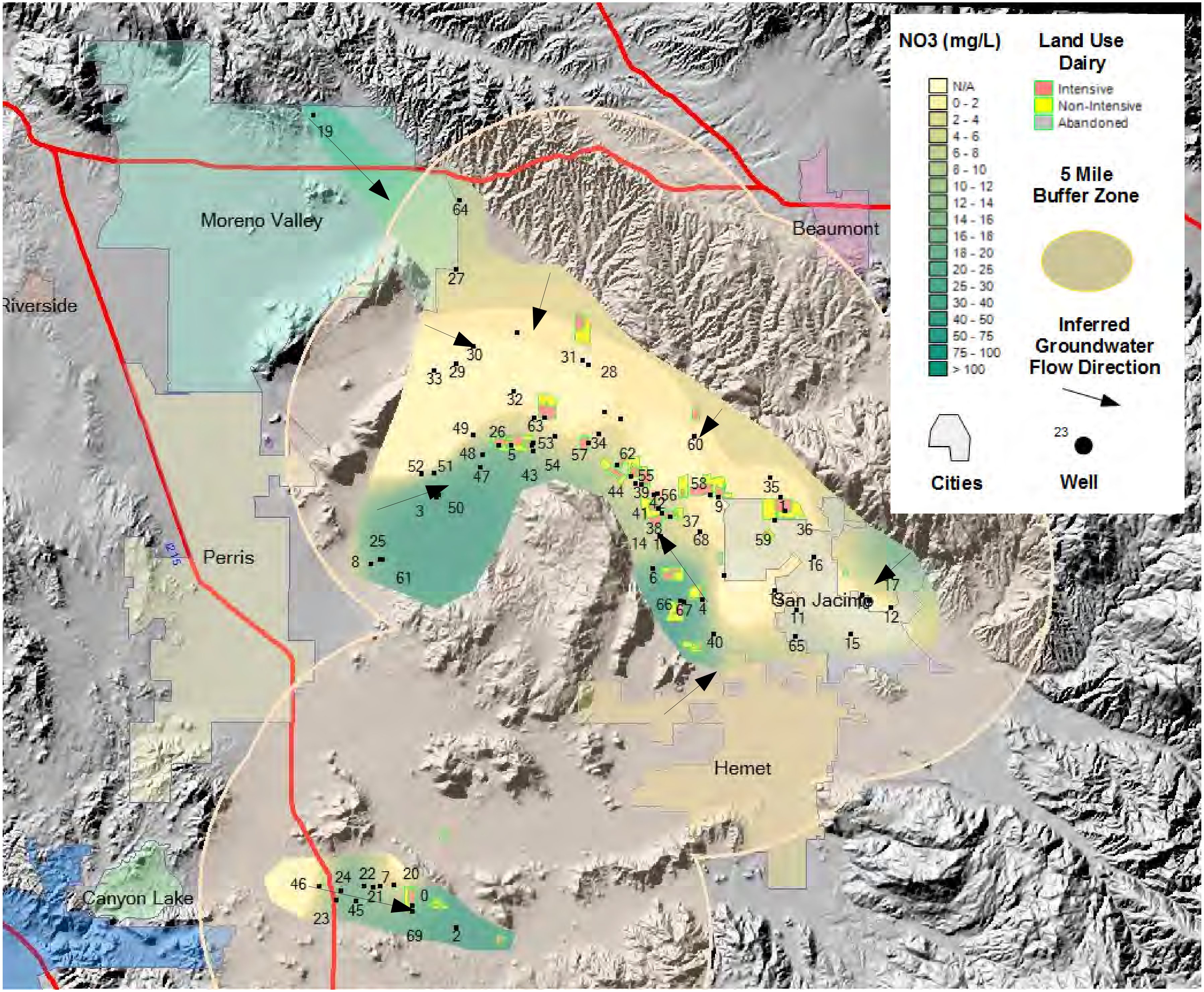

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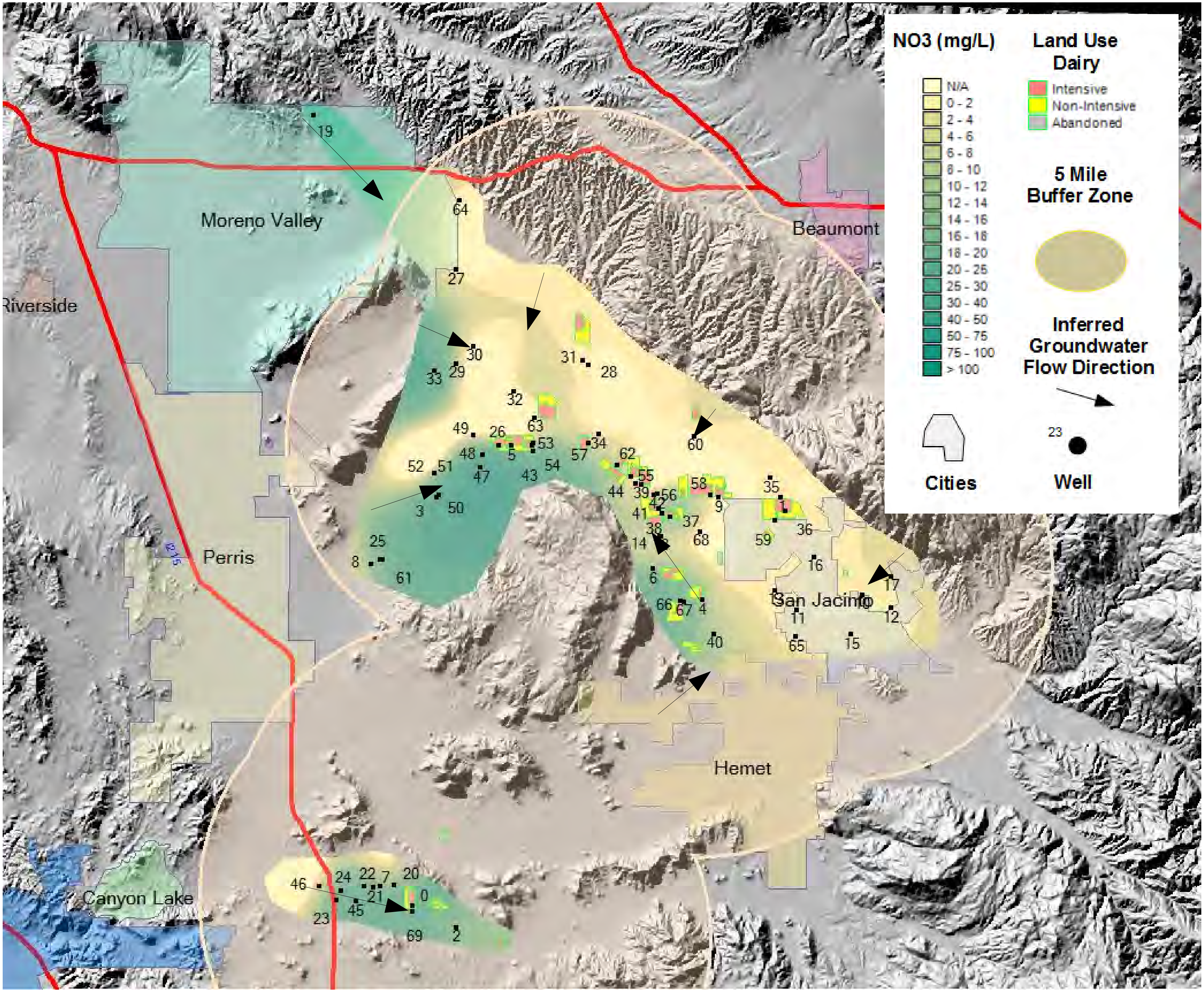


Figure 6e. Average Groundwater Nitrate Concentrations relative to Dairy Land Use - 2012

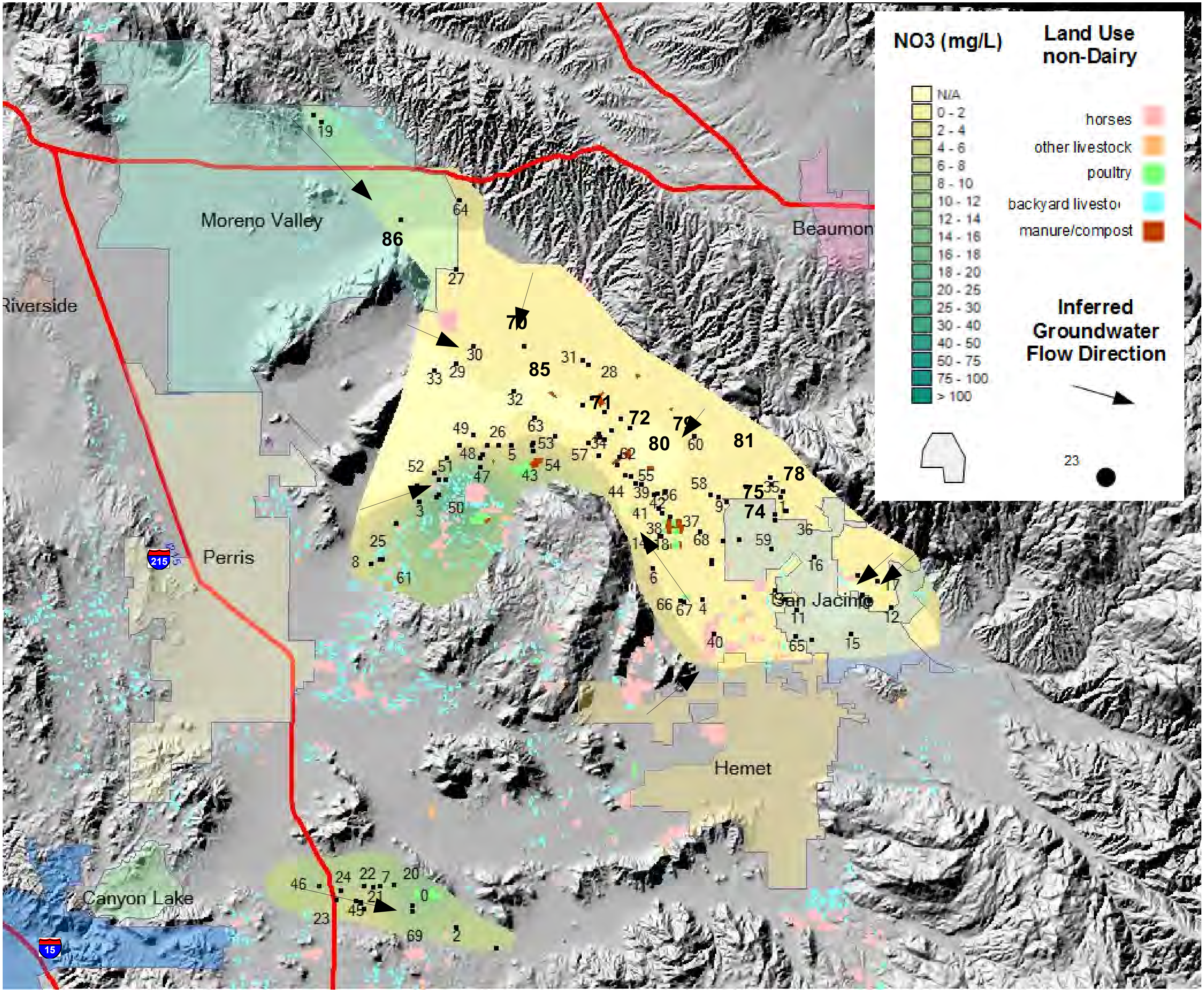
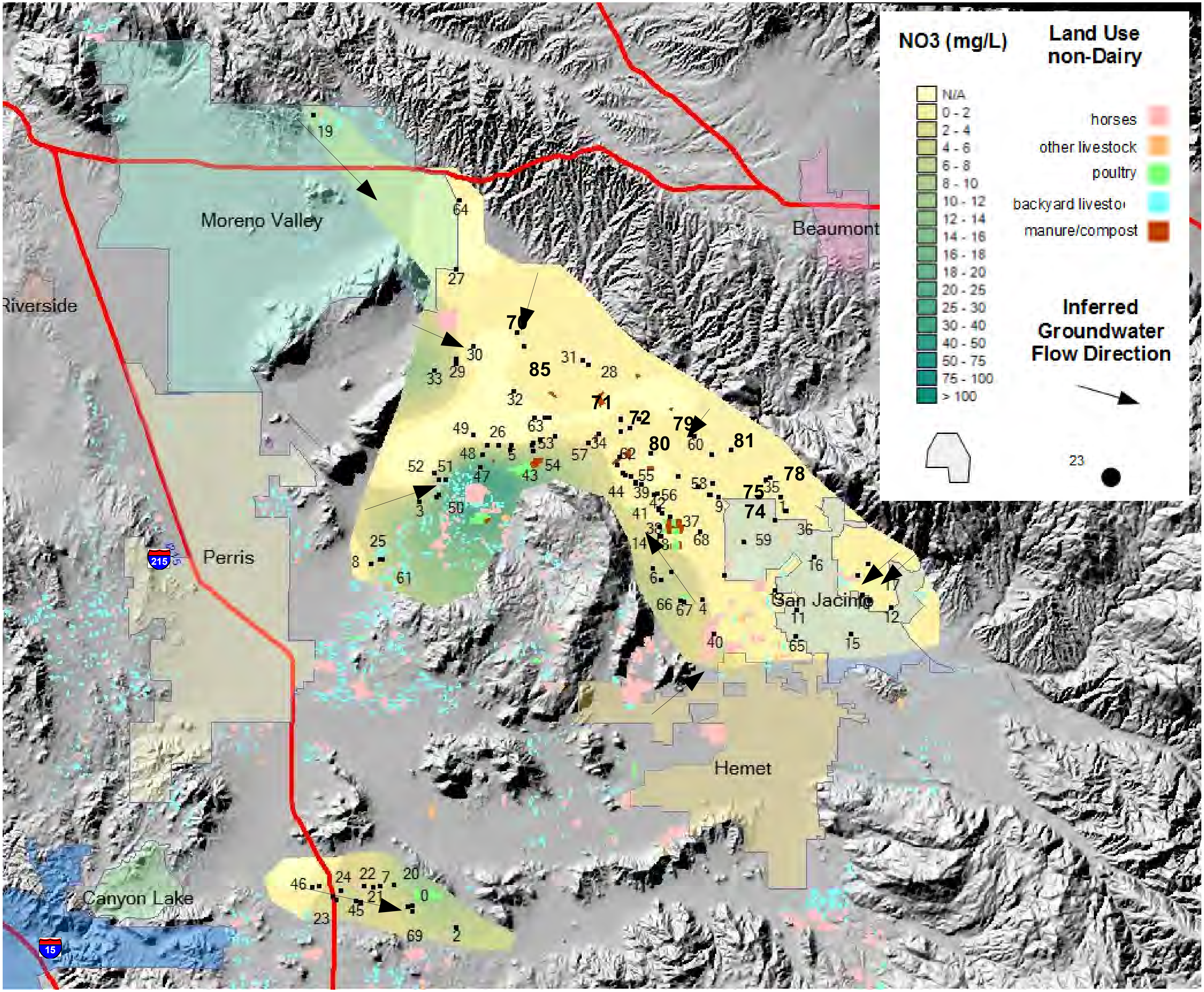


Figure 7a. Average Groundwater Nitrate Concentrations relative to non-Dairy Land Use - 2000



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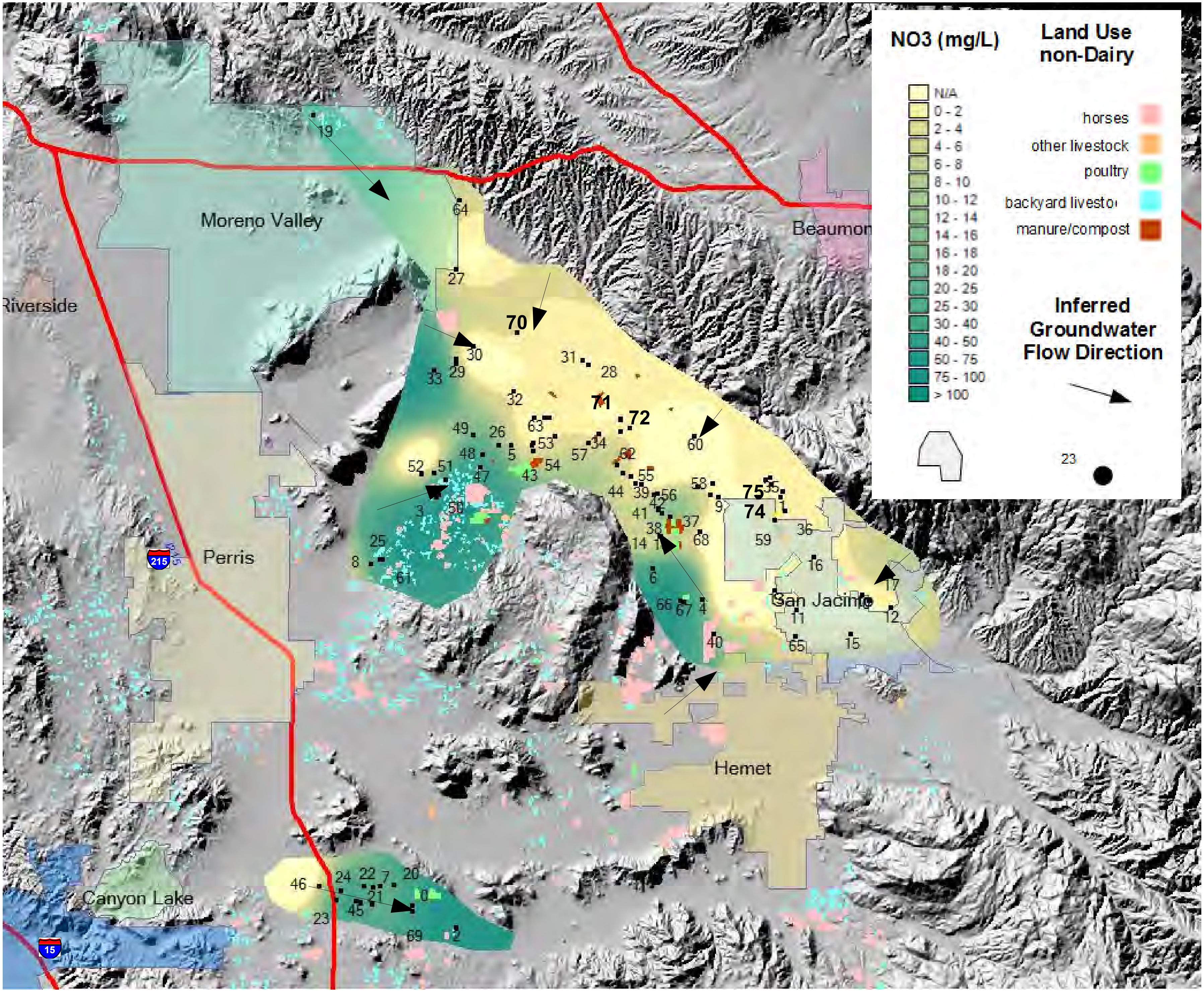

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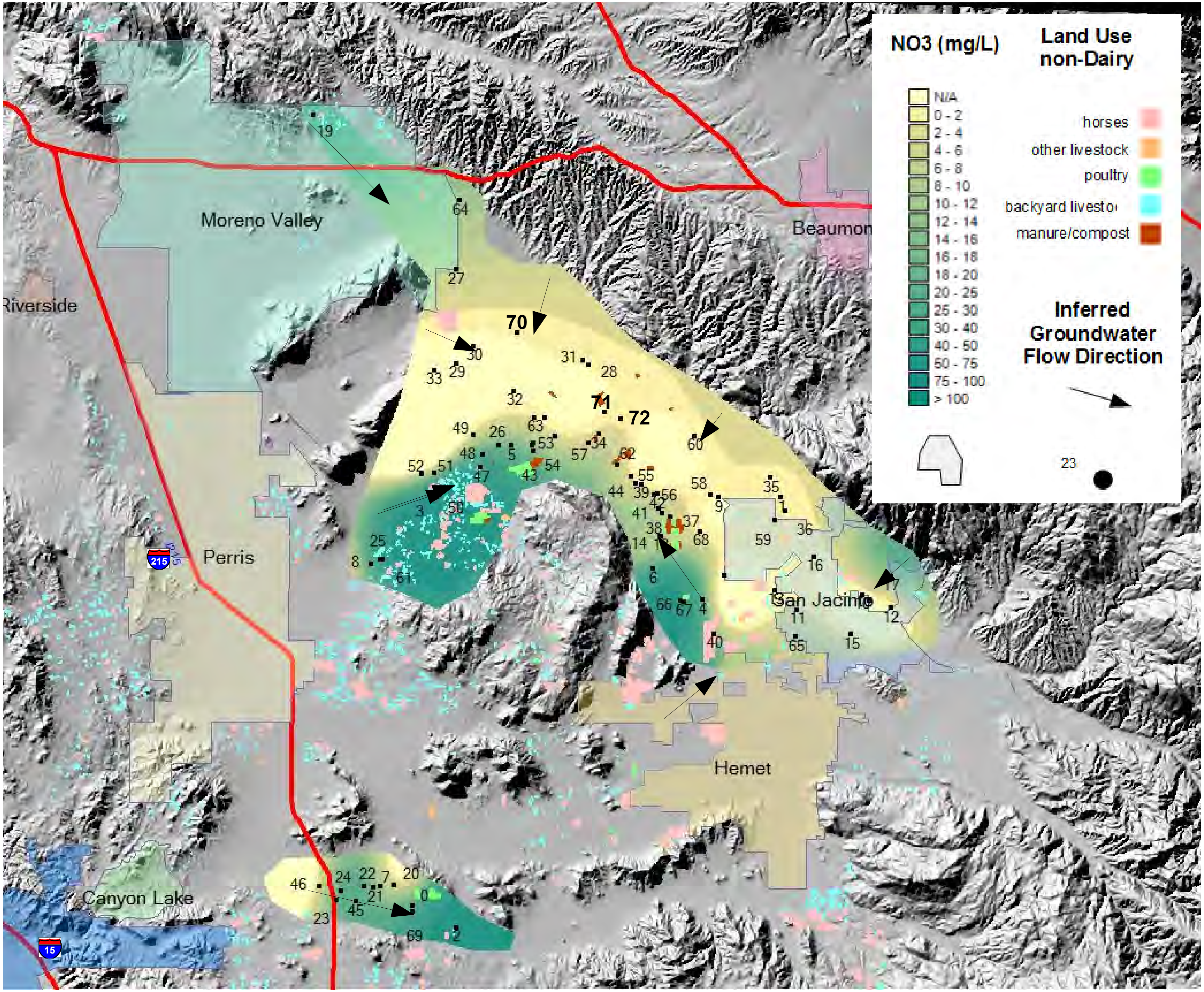

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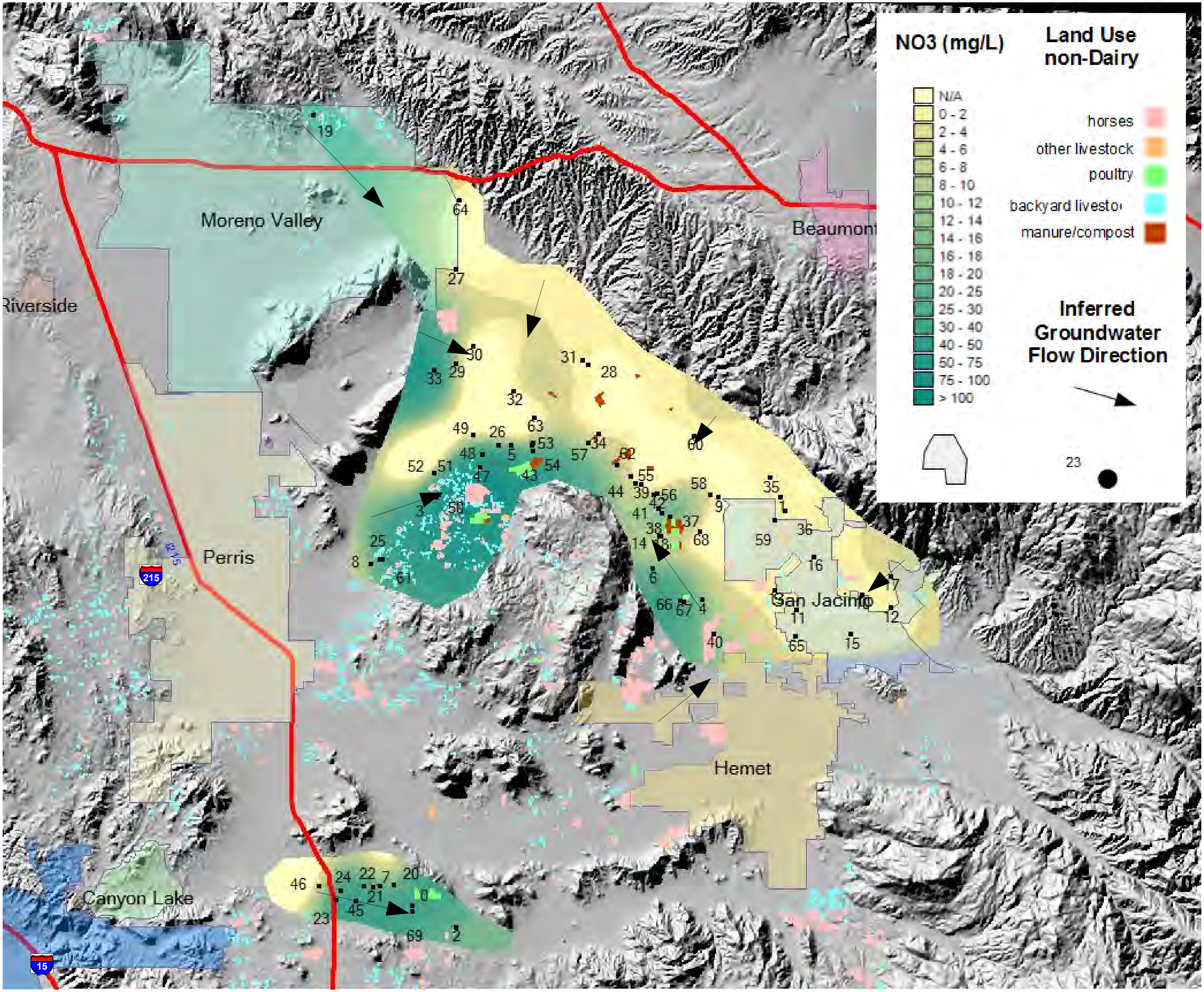


Figure 7e. Average Groundwater Nitrate Concentrations Relative to Non-Dairy Land Use - 2012

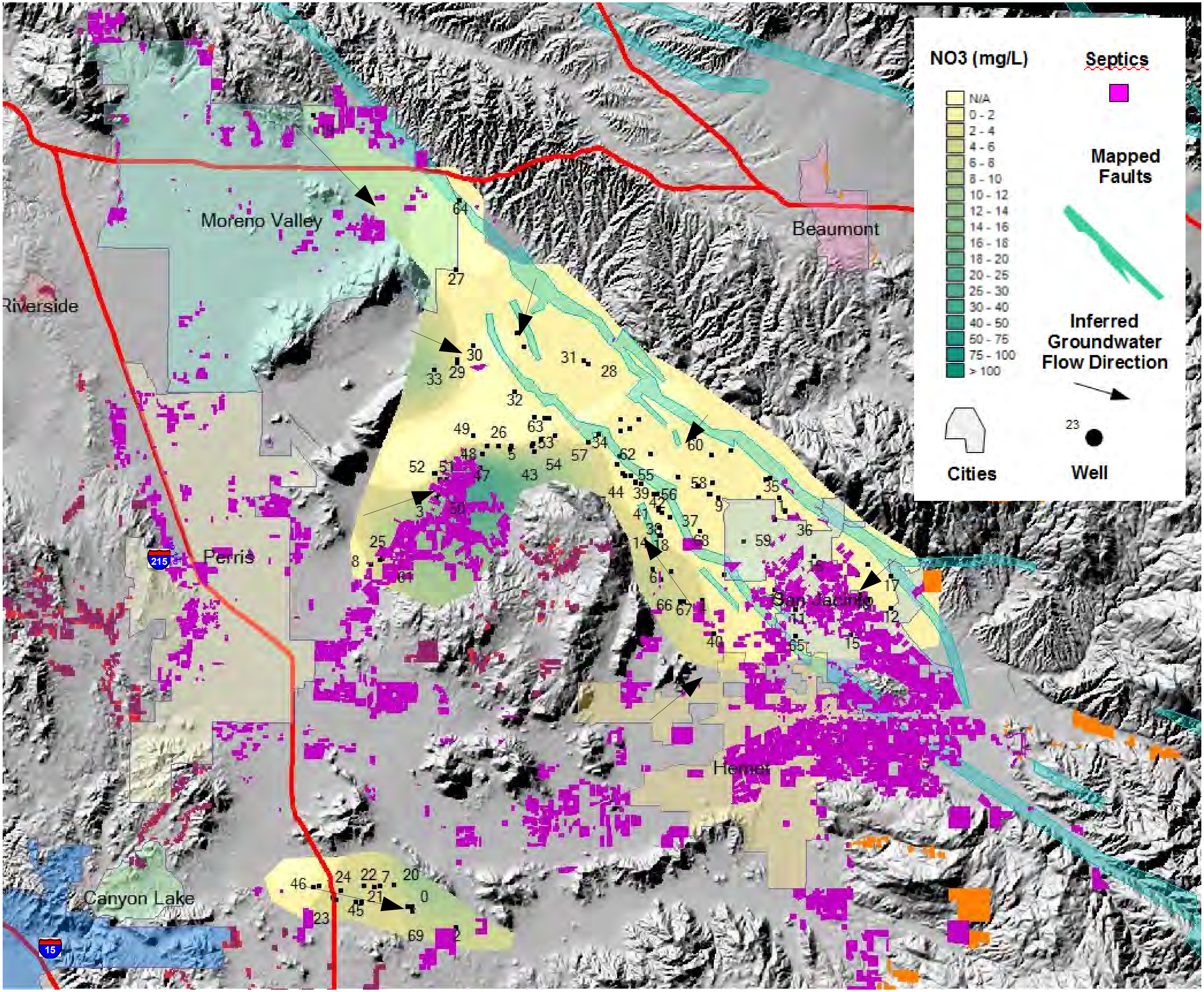
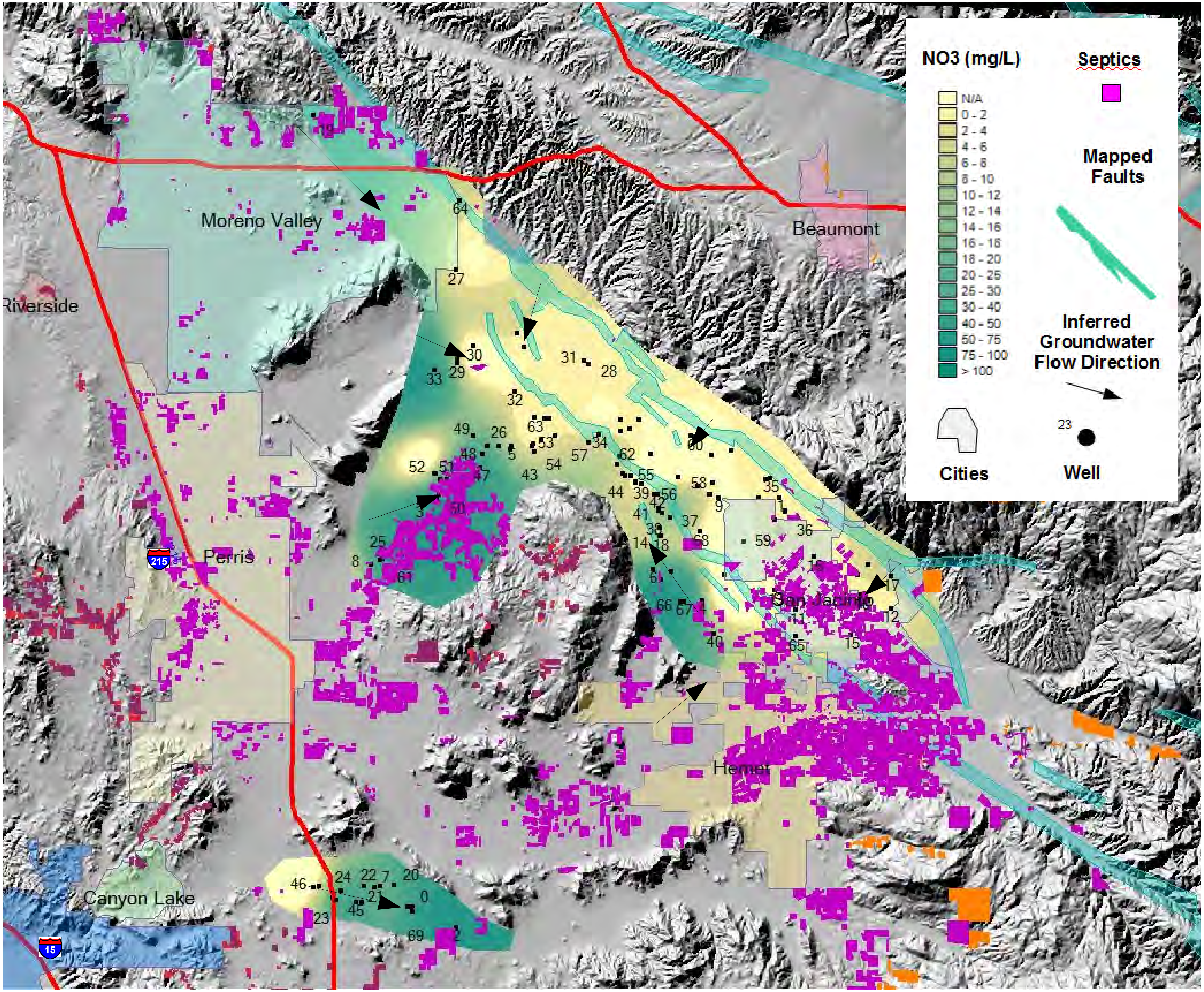


Figure 8a. Average Groundwater Nitrate Concentrations Relative to Septic Location - 2005



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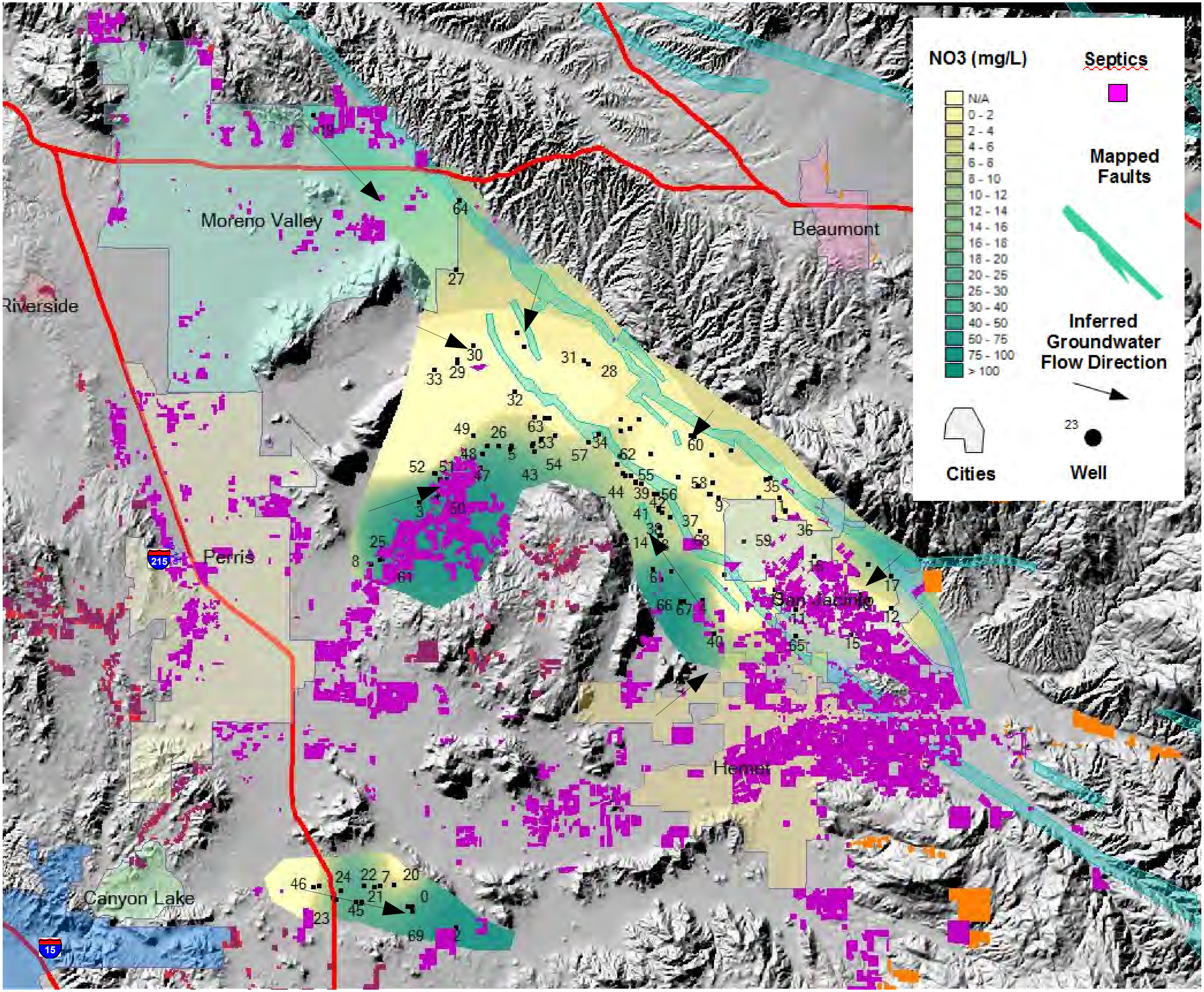

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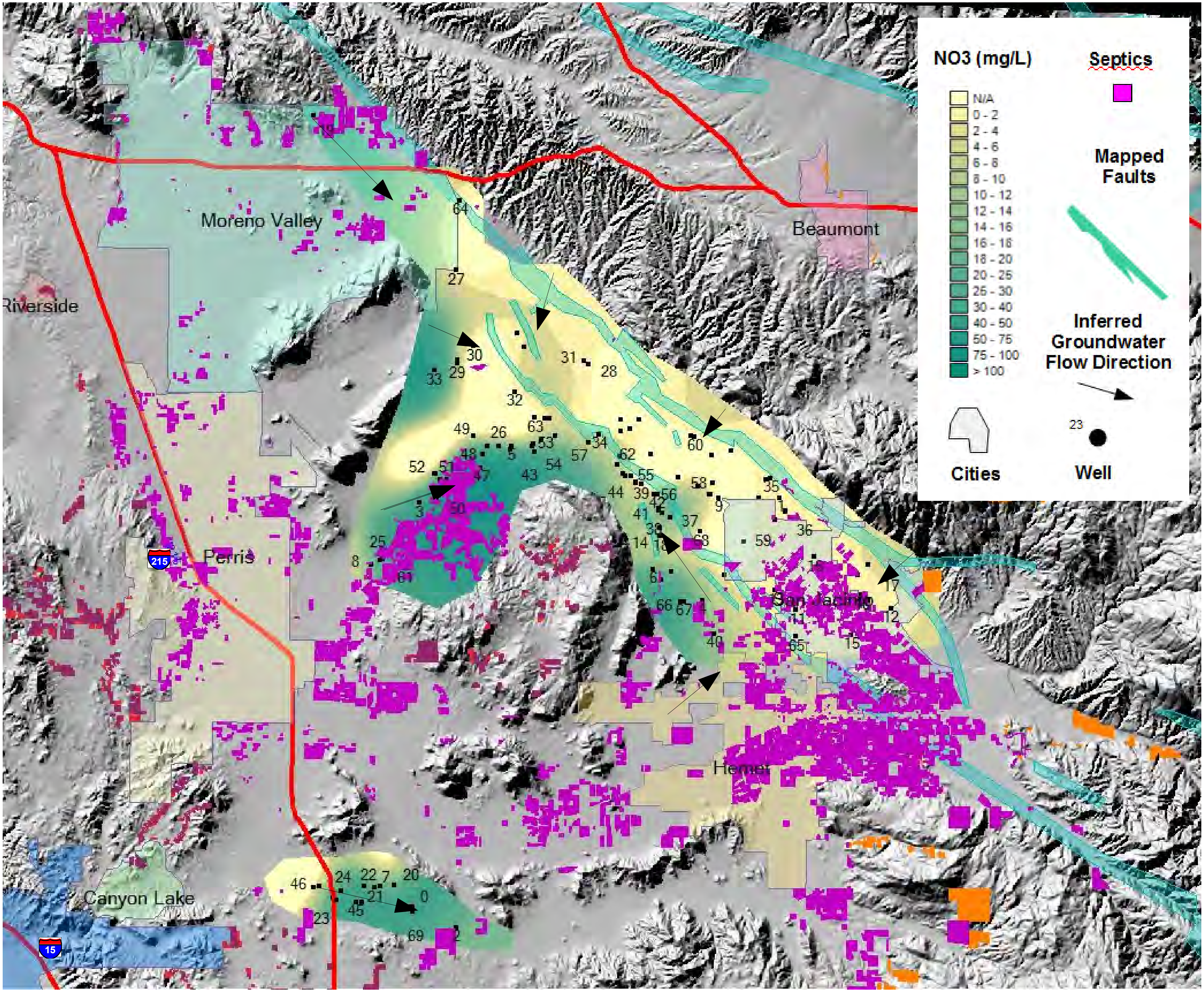

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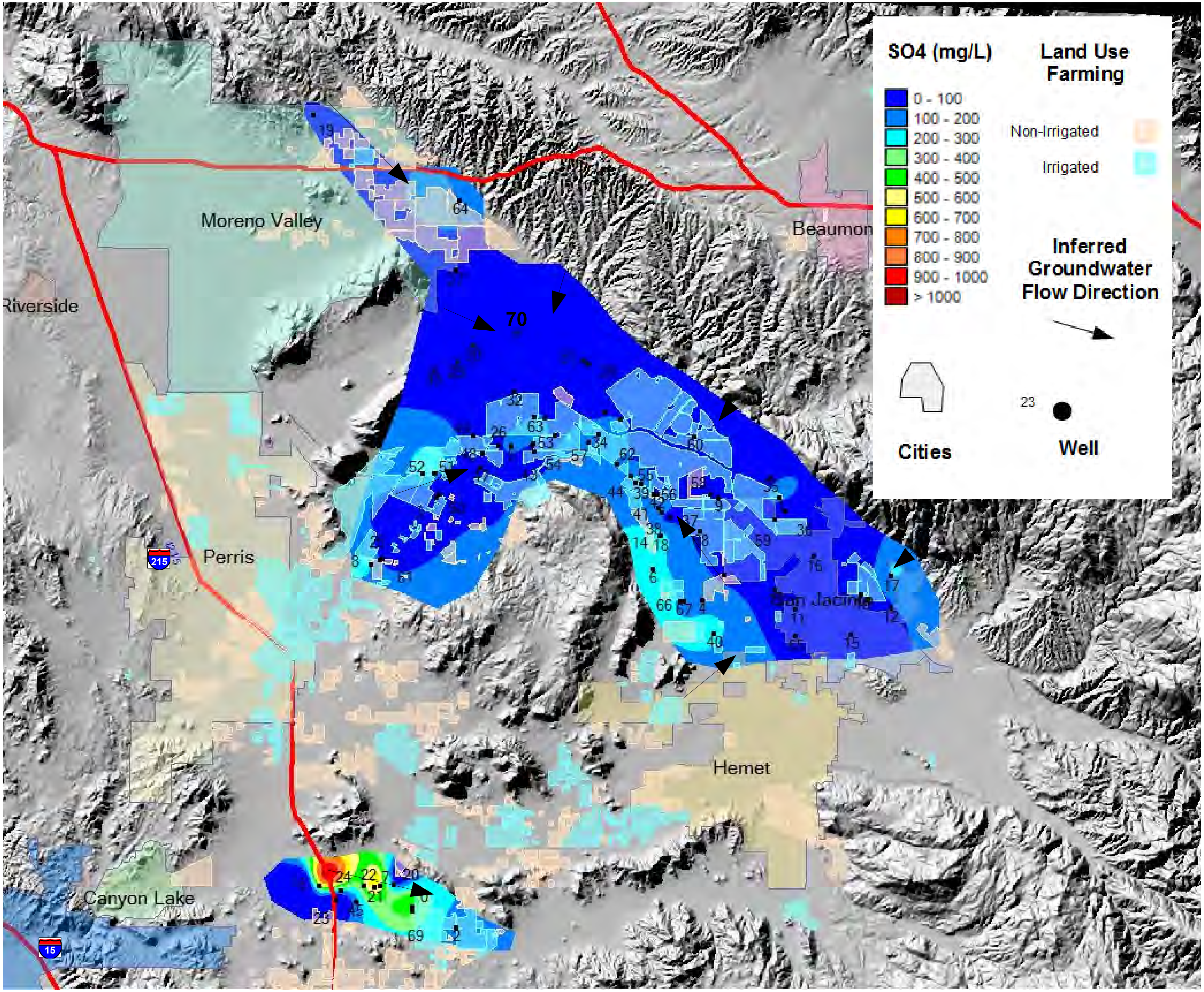
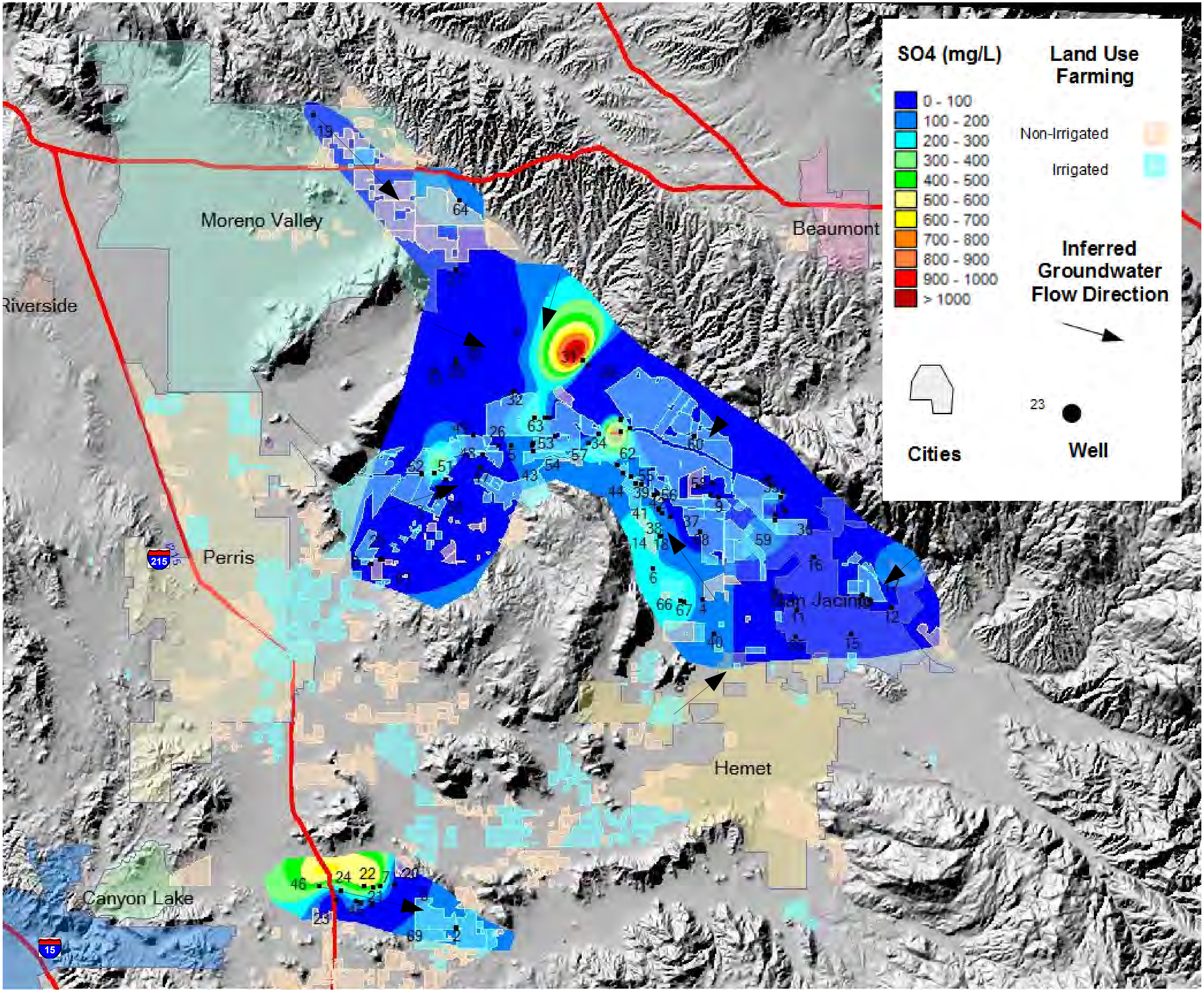


Figure 9a. Average Groundwater Sulfate Concentrations relative to Irrigation - 2005



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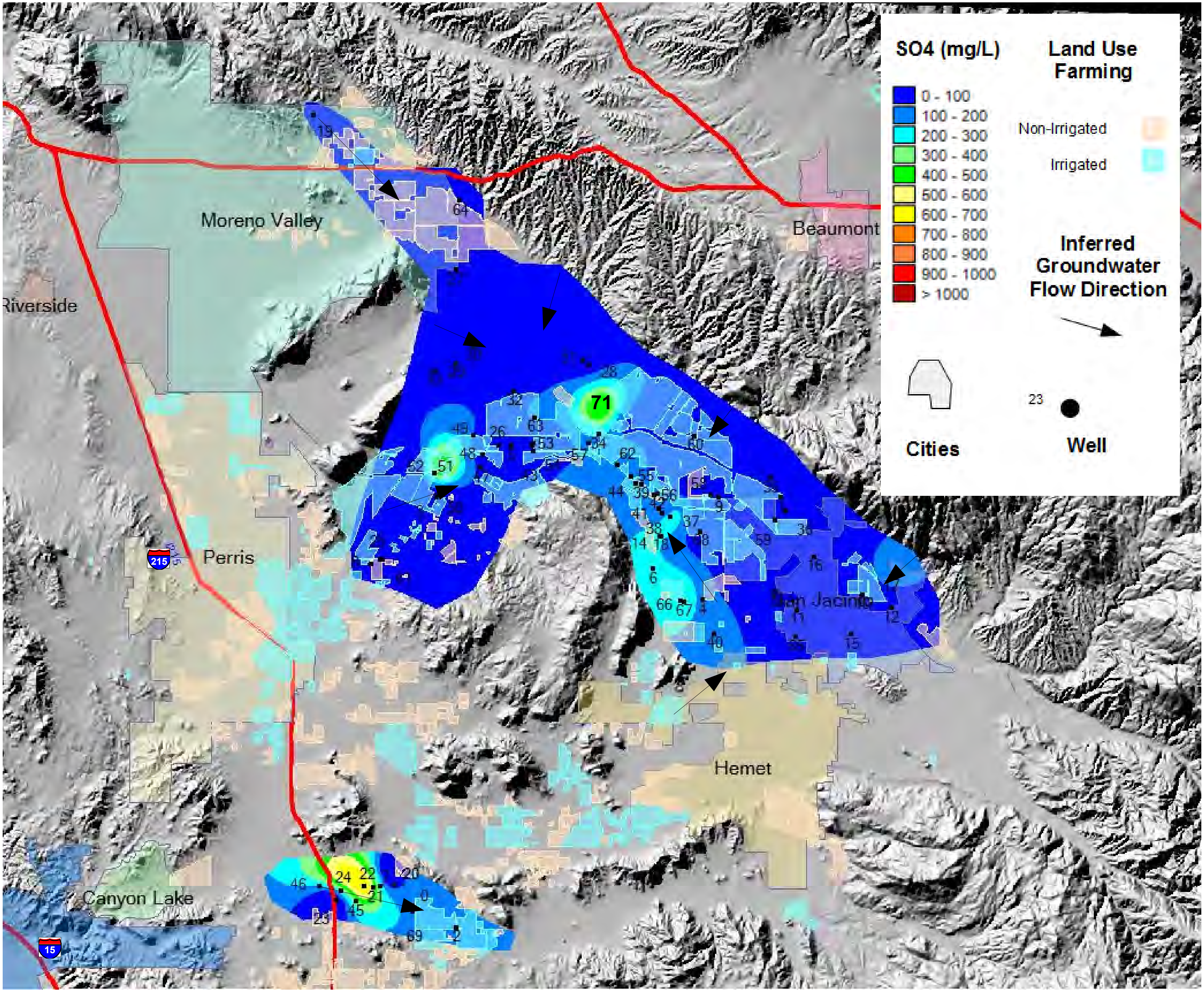

Figure 9c. Average Groundwater Sulfate Concentrations relative to Irrigation - 2011

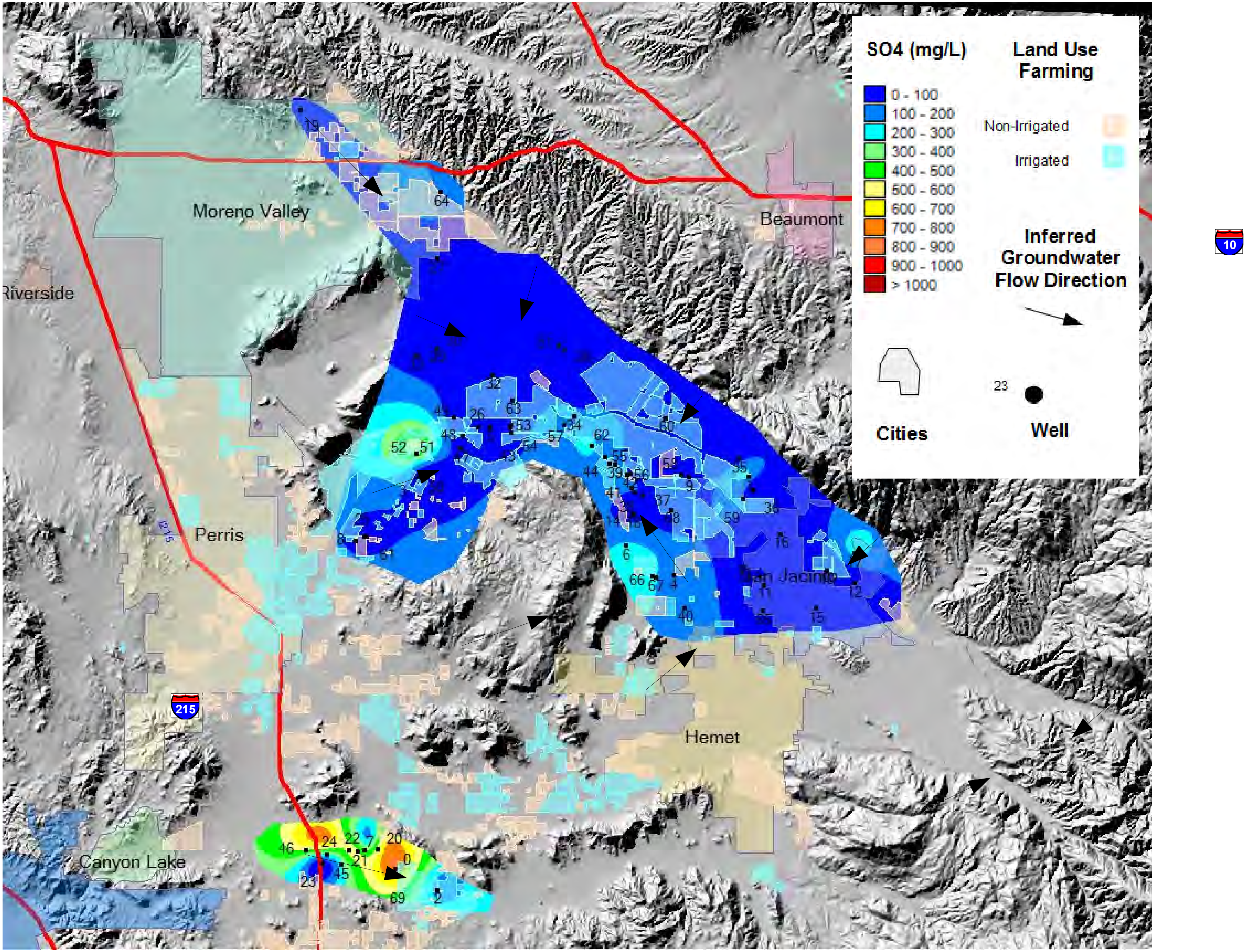

Figure 9d. Average Groundwater Sulfate Concentrations relative to Irrigation - 2012

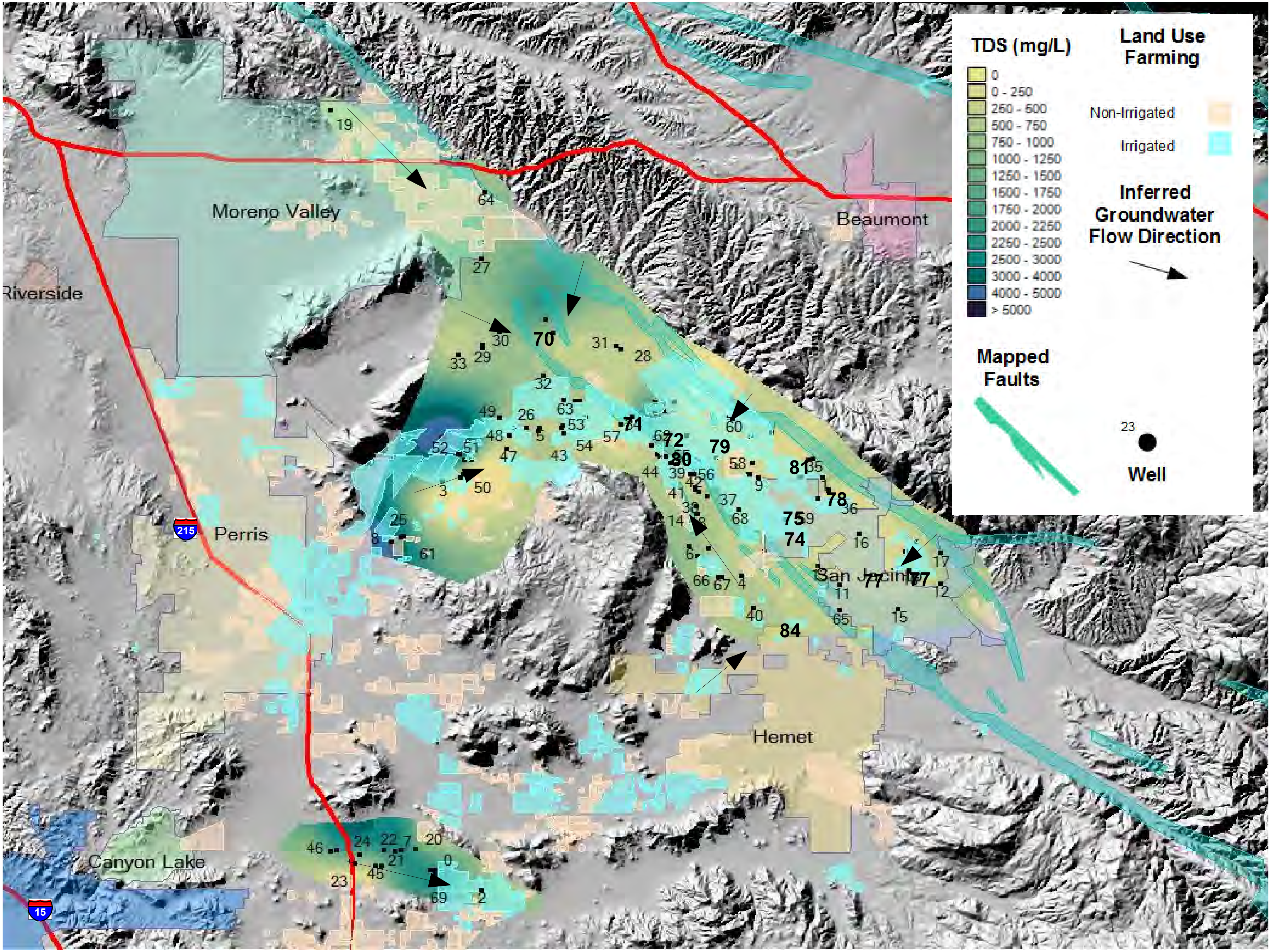

Figure 10a. Average Groundwater TDS Concentrations relative to Irrigation - 2005

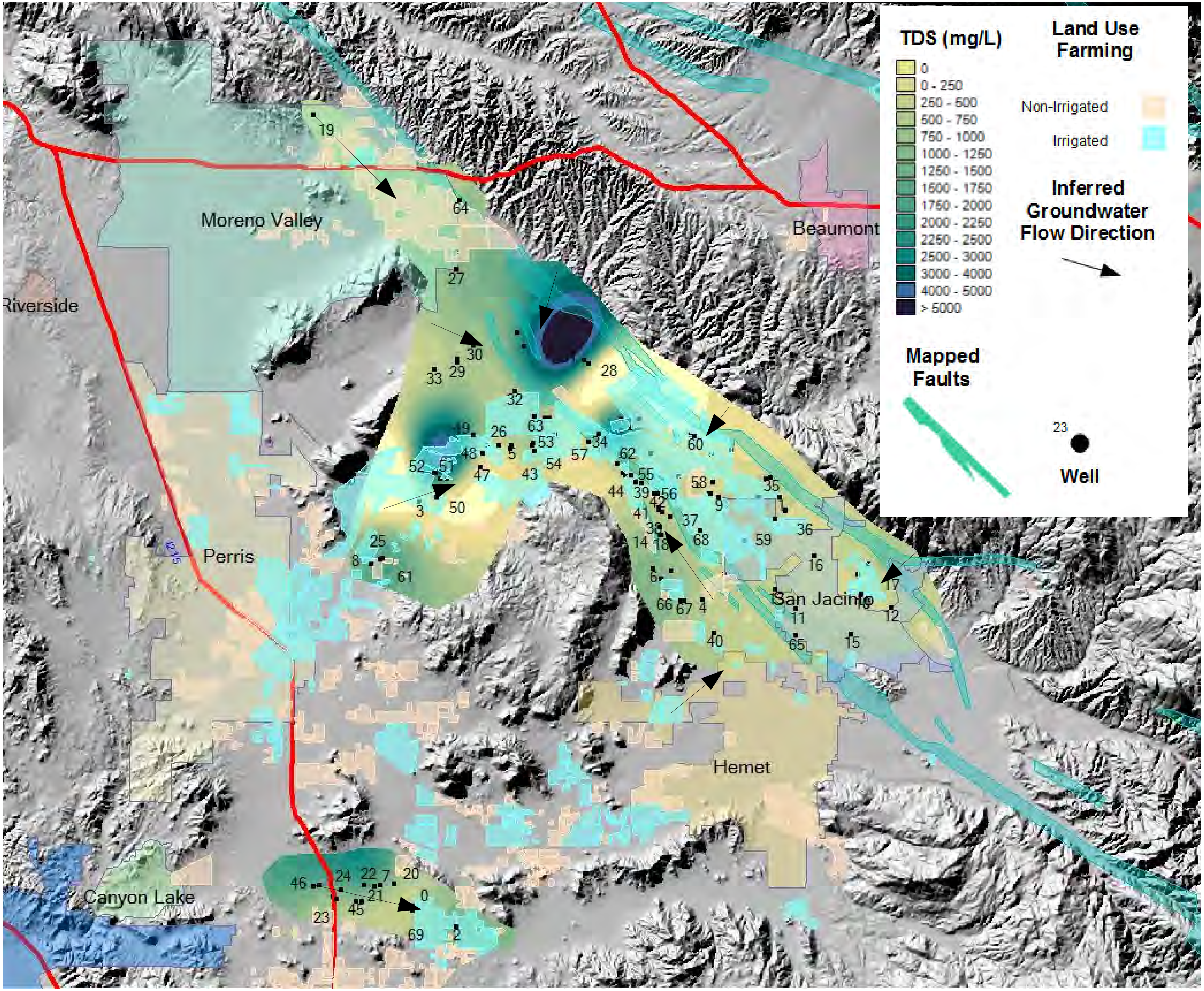

Figure 10b. Average Groundwater TDS Concentrations relative to Irrigation - 2010

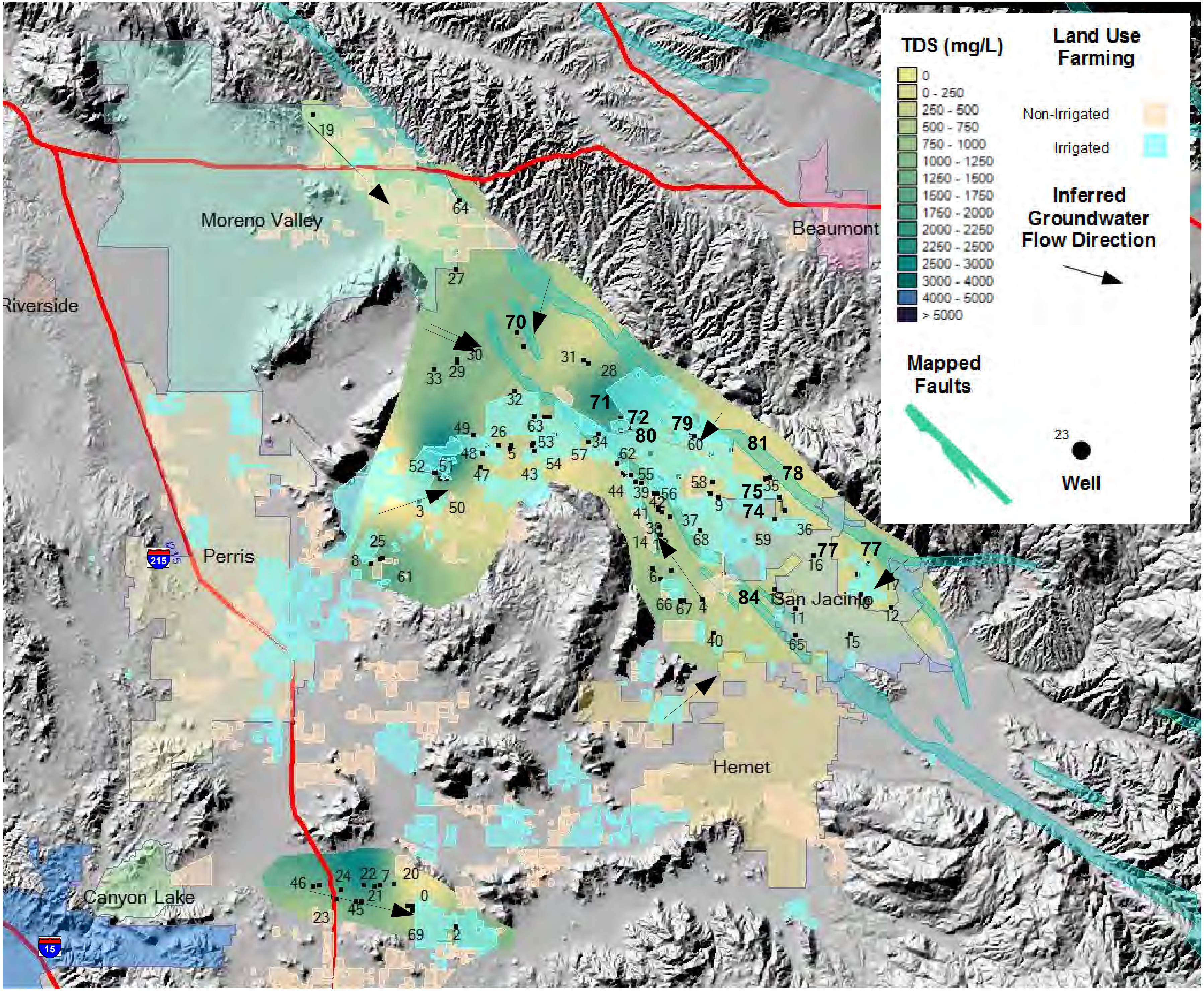

Figure 10c. Average Groundwater TDS Concentrations relative to Irrigation - 2011

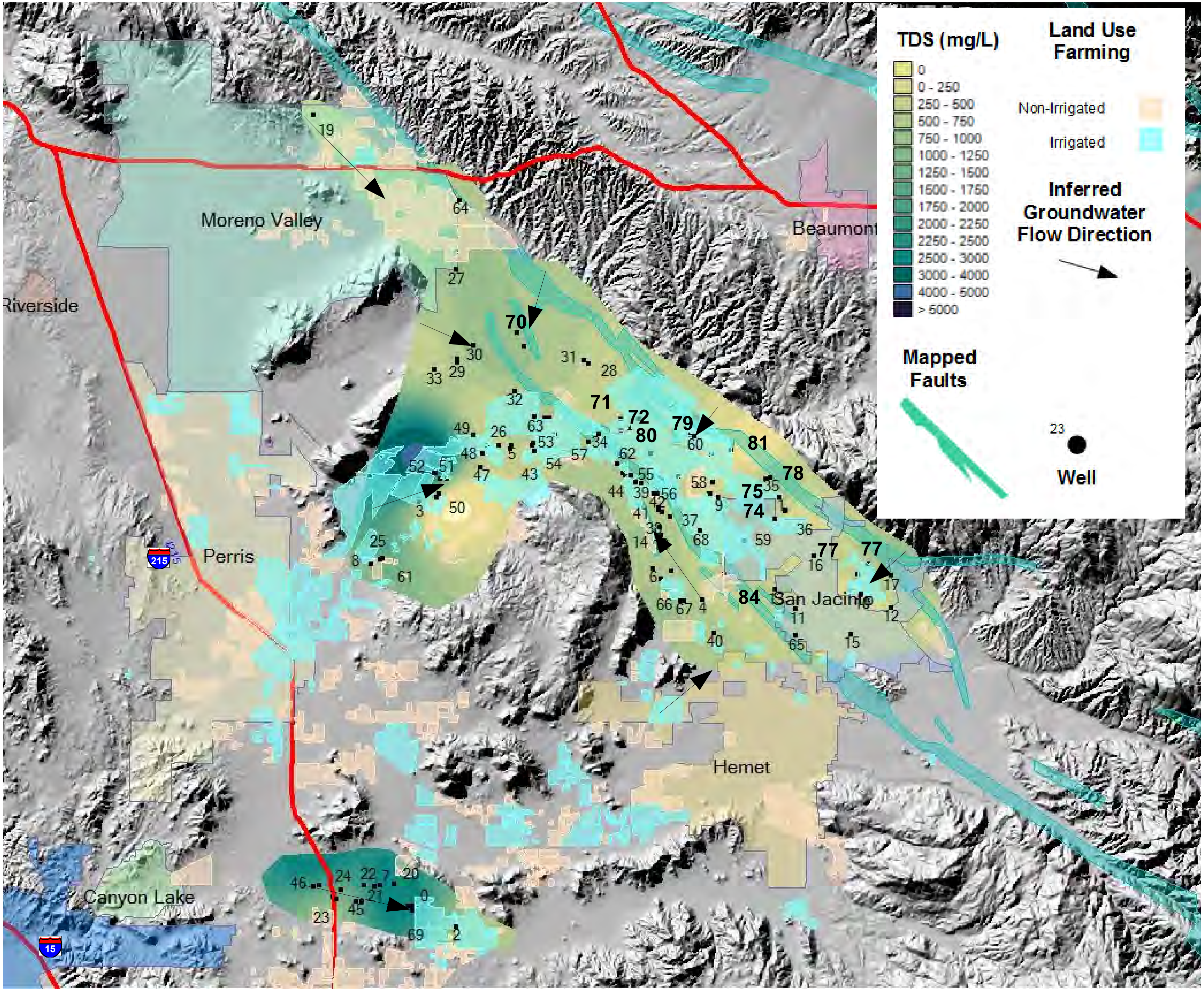

Figure 10d. Average Groundwater TDS Concentrations relative to Irrigation - 2012