

## Appendix D - Salt and Nutrient Study

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# Merced Integrated Regional Water Management Plan

## Salt and Nutrient Study

Prepared by:



In Association with:



August 2013



**MERCED INTEGRATED REGIONAL WATER  
MANAGEMENT PLAN  
SALT AND NUTRIENT STUDY**

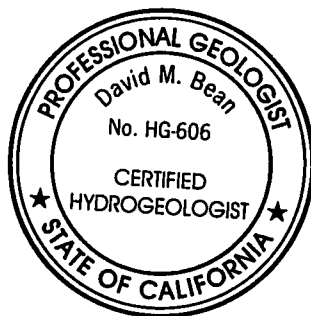
August 12, 2013

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A handwritten signature in black ink that reads "David M. Bean". The signature is written in a cursive style and is positioned above a horizontal line.

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**LIST OF ACRONYMS AND ABBREVIATIONS**

µg/L	microgram per liter
µs/cm	microsiemens per centimeter
111-TCA	1,1,1-Trichloroethane
123-TCP	1,2,3-Trichloropropane
ac-ft	acre-feet
ac-ft/d	acre-feet per day
ac-ft/y	acre-feet per year
bgs	below ground surface
CDPH	California Department of Public Health
CENS	University of California Merced Center for Embedded Networked Sensing Systems
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability initiative
DBCP	Dibromochloropropane
EDB	Ethylene Dibromide
GEA	Grasslands Ecological Area
gpm	gallons per minute
IRWM	Integrated Regional Water Management Plan
MCDEH	Merced County Department of Public Health, Division of Environmental Health
MCL	maximum contaminant level
mg/L	milligrams per liter
MTBE	Methyl Tertiary Butyl Ether
NPDES	National Pollution Discharge Elimination System
OEHHA	California Office of Environmental Health Hazard Assessment
OWTS	onsite wastewater treatment systems
PCE	Tetrachloroethane
RWQCB	California Regional Water Quality Control Board – Central Valley Region
State Water Board	California State Water Resources Control Board
SEC (or EC)	Specific Electrical Conductivity
TCE	Trichloroethane
TDS	Total Dissolved Solids
USGS GAMA	United States Geological Survey's Groundwater Ambient Monitoring and Assessment Program
WDR	Waste Discharge Requirement

## **1 INTRODUCTION**

This salinity and nutrient study is designed to establish the baseline water quality conditions within the Merced IRWM area. As part of this study, various websites and databases were evaluated including those from Merced County Department of Public Health, Division of Environmental Health (MCDEH); the California Department of Water Resources (DWR); the California Regional Water Quality Control Board – Central Valley Region (RWQCB); the Central Valley Salinity Alternatives for Long-Term Sustainability initiative (CV-SALTS); the USGS Groundwater Ambient Monitoring and Assessment (GAMA) Program (Landon, 2010); the University of California Merced Center for Embedded Networked Sensing Systems (CENS); Merced Irrigation District; and many others. A search of these websites and databases indicated no readily discernible salt and nutrient management plans within the Merced IRWM area. However, the RWQCB has issued many waste discharge requirements (WDRs) to municipal, industrial, agricultural users of surface water and groundwater which limit the discharge of salts and nutrients within the Merced IRWM area. These WDRs and local efforts will be integral parts of a future salt and nutrient management plan for the Merced IRWM area.

### **1.1 Related Efforts**

#### **1.1.1 CV-SALTS**

The CV-SALTS initiative is a collaborative effort initiated in 2006 between the California State Water Resources Control Board (State Water Board), the RWQCBs, and various stakeholders in the Central Valley to develop a workable, comprehensive plan to address salinity, including nitrates, throughout the region in a comprehensive, consistent, and sustainable manner. The CV-SALTS participants have established these goals:

- Sustain the Central Valley's lifestyle
- Support regional economic growth
- Retain a world-class agricultural economy
- Maintain a reliable, high-quality urban water supply
- Protect and enhance the environment

CV-SALTS can be an important resource for managing salts and nutrients in the Merced IRWM area. Available materials were reviewed as part of the development of this report. Going forward, participation in CV-SALTS or utilization of materials developed by CV-SALTS can help the Merced IRWM area learn from the efforts of other Central Valley areas facing similar long-term concerns about salts and nutrients in groundwater. Examples available from CV-SALTS include:

- **Documents:** CV-SALTS has developed guidance documents such as *Recommended Approach to Salt and Nutrient Management Plan Development in the Central Valley* (October 2011) and *Conceptual Modeling of Salt and Nutrient Loads* (October 2011).
- **Data:** CV-SALTS has developed or is developing Central Valley-wide data relevant to the management of salts and nutrients, including land use and groundwater basin information.

CV-SALTS is developing a Central Valley-wide Salt and Nutrient Master Plan to provide a basis and process for the future development of area-specific Salt and Nutrient Management Plans (SNMP). This effort will provide information to support a local Salt and Nutrient Management Plan for the Merced Region.

### **1.1.2 Recycled Water Policy**

On May 14, 2009, with support from the CV-SALTS initiative, the State Water Board passed the Recycled Water Policy (Policy) (State Water Board Resolution No. 2009-0011). The Policy requires the development of salt/nutrient management plans for all groundwater basins in California within five years of passage, regardless of whether recycled water is currently being used within the basin. While the schedule for preparing a SNMP for the Merced subbasin is currently unknown, a SNMP must be completed before new recycled water projects in the basin may be permitted. The information developed in this study and the work of CV-SALTS will provide a starting point for stakeholder participation and additional technical analysis needed to complete the SNMP, such as identification of data sources, constituents of concern, and existing groundwater quality conditions.

### **1.1.3 USGS GAMA**

The USGS GAMA Program was created by the State Water Board to provide a comprehensive groundwater-quality baseline for the State of California. The program is a comprehensive assessment of statewide groundwater quality designed to improve ambient groundwater-quality monitoring and to increase the availability of information about groundwater quality to the public. The GAMA program includes the Priority Basin Project, conducted by the USGS in collaboration with the State Water Board and Lawrence Livermore National Laboratory.

The Merced IRWM area falls within the 1,695-square-mile Central Eastside GAMA study unit, which also includes the Modesto and Turlock groundwater subbasins. The GAMA program is designed to provide a statistically robust characterization of untreated-groundwater quality in the primary aquifer at the basin-scale. A total of 82 wells were randomly selected within spatially distributed grid cells across the Central Eastside study unit, with 45 of these located in the Merced IRWP area. Samples were collected from 2003 through 2006 from these grid wells for analysis of 175 to 335 constituents. Using these data, grid-based and spatially-weighted approaches were used to assess proportions (aquifer-scale proportions) of high, moderate, and low relative-concentrations of constituents and constituent classes in the primary aquifer.

On the basis of 3H (tritium), noble gas, and 14C (carbon 14) data, groundwater ages were classified into modern, mixed, and pre-modern categories. Of the GAMA wells for which sufficient data were available for classification, samples from 24 wells were modern, 27 were mixed, and 21 were pre-modern. Most samples from wells perforated entirely within the upper 200 ft of the aquifer were modern. Most samples from wells perforated entirely at depths greater than 200 ft below ground surface were pre-modern. Samples from wells with the top of the perforation less than 200 ft below ground surface, but with the bottom of the well greater than 200 ft below ground surface mostly were mixed.

The GAMA data indicated that the concentrations of many constituents were related to depth and groundwater age. However, concentrations of individual constituents or constituent classes also were sometimes related to geochemical conditions, lateral position in the flow system, or land use.

In general, total dissolved solids (TDS), nitrate, most metals, and volatile organic compounds (VOC) concentrations had higher concentrations in the upper 200 ft than in the deeper parts of the aquifer system. The concentration profiles for multiple constituents suggests that water chemistry generally differs between the upper 200 ft of the aquifer and depths >200 ft. The zonation of water chemistry with depth is consistent with the hydrogeologic setting, in which return flows from agricultural and urban land use are the major source of recharge, and withdrawals for irrigation are the major source of discharge, resulting in substantial vertical components of groundwater flow.

The decrease in concentrations of many constituents with depth reflects, in part, that groundwater generally gets older with depth beneath the Merced IRWP area. Nitrate, VOC, herbicide, and perchlorate concentrations were significantly higher in groundwater having modern and mixed ages than pre-modern ages, indicating that these constituents may be affected by anthropogenic activities in the last 50 years.



The GAMA data indicated that generally, there were many similarities in groundwater quality spatially across the study unit. However, some variations in groundwater quality between study areas were evident, most likely as a result of differences in land use, lateral position, redox, and pH. High concentrations of arsenic and manganese occurred in the western Merced study areas but did not occur in the Uplands study area located in the eastern portion of the study unit; this pattern reflects that groundwater becomes more reducing in the western part of the study unit. Concentrations of uranium and TDS also increased from east to west across the study unit, probably reflecting several processes that vary with valley position, and concentrations of these constituents were lower in the Uplands study area than in the Merced study areas.

At the low concentrations at which they generally were present, VOCs, pesticides, and perchlorate primarily are tracers of groundwater that has recharged in the decades since these compounds began to be used for industrial and commercial purposes. Low-level analyses provide an early awareness of constituents whose presence in groundwater at low concentrations may be important for prioritization of monitoring of water quality in the future.

#### **1.1.4 UC Merced CENS**

The University of California Merced Center for Embedded Networked Sensing Systems (CENS) is an interdisciplinary and multi-institutional venture involving hundreds of faculty, engineers, graduate student researchers, and undergraduate students from multiple disciplines at the partner institutions. UC Merced CENS is currently evaluating the fate and transport of nutrients in riparian areas along the Merced and San Joaquin Rivers. Along the Merced River, studies are being conducted to evaluate stream metabolism as measured by dissolved oxygen, temperature, photosynthesis and respiration. Metabolism estimates will be used as a “real-time” indicator of ecosystem disturbance through strategically placed monitoring stations along the Merced River continuum to identify and characterize the impact of water management and land use practices on the river system.

Groundwater-surface water discharge on the Lower Merced River are being evaluated to assess nonpoint source pollutant inputs and their impacts on stream water quality and biogeochemical cycling. This work uses a series of periodic longitudinal surveys to collect high resolution water quality data longitudinally along a river, and to use that data to delineate spatio-temporally variable groundwater-surface water discharge zones. The Merced River is a perennial river in the San Joaquin watershed characterized by many point (canals, pumps, etc.) and non-point sources associated with adjacent agricultural and municipal land use. The underlying hypothesis is that groundwater (largely impacted by agriculture in this region) feeding the river at low flows increases specific electrical conductance (SEC) over the affected river segments. Using these studies, it may be possible to identify areas of significant SEC loading

to the Merced River from point and non-point sources, and to design some form of remedy to reduce these impacts.

## 1.2 Occurrence of Groundwater

The Merced IRWM area covers the entire Merced Groundwater Subbasin and portions of the adjacent Turlock and Chowchilla groundwater subbasins (as defined by DWR [2003a], see Figure 1). The base of fresh water in the Merced IRWM area is approximately 1,200 feet bgs (Page, 1977). Five aquifer systems have been identified in the Merced IRWM area including a fractured bedrock aquifer, the Mehrten Formation, a confined aquifer, an intermediate “leaky” aquifer, and a shallow unconfined aquifer. These aquifer systems are discussed in the following paragraphs.

**Fractured Bedrock** – Along the northeastern edge of the Merced IRWM area, wells have been completed within the Valley Springs and Lone Formations (Page & Balding, 1973; Page, 1977). These wells appear to be completed in fractured bedrock with limited and variable yields. Because of the limited extent (and poor yields) of the fractured bedrock aquifer, the fractured aquifer is not a significant source of water in the Merced IRWM area. A geologic map of the area is shown in Figure 2.

**The Mehrten Formation** – The Mehrten Formation outcrops over a significant area in the eastern portion of the Merced IRWM area. Many water supply wells in the eastern portion of the Merced IRWM area penetrate the formation, and it is a significant source of groundwater. Where the Mehrten occurs beneath the Corcoran Clay, it is considered a confined aquifer. Where the Mehrten does not underlie the Corcoran Clay, there is insufficient data to determine the degree of confinement of the formation.

**Confined Aquifer** – The confined aquifer occurs in older alluvial (and Mehrten Formation) deposits that underlie the Corcoran Clay. Figure 3 shows the approximate thickness and eastern boundary of the Corcoran Clay in the Merced IRWM area. Many water supply wells in the western portion of the Merced IRWM area penetrate the Corcoran Clay into the confined aquifer and it is a significant source of groundwater.

**Intermediate Leaky Aquifer** – The intermediate aquifer occurs in older alluvial deposits that overlie the Corcoran Clay or are east of the Corcoran Clay (Figure 3). Where the Corcoran Clay is absent, the intermediate aquifer extends to the Mehrten Formation. In the eastern portion of the Merced IRWM area, the intermediate aquifer consists of a series of interbedded coarse-grained (gravel and sand) layers separated by fine grained (silt and clay) layers. The fine grained layers inhibit, but do not prevent, vertical groundwater flow between layers and thus form a leaky-aquifer system. Many water supply wells in the Merced IRWM area are completed

in the intermediate leaky-aquifer and it is a significant source of groundwater. The intermediate leaky-aquifer is the most extensively developed aquifer in the Merced IRWM area.

**Shallow Unconfined Aquifer** – The shallow unconfined aquifer occurs in older and younger alluvium deposited above the shallow clay bed. Because of its shallow depth, fewer water supply wells are completed in the shallow unconfined aquifer. Where water levels in the intermediate leaky aquifer fall below the base of the shallow clay bed, groundwater in the intermediate leaky aquifer becomes unconfined and water in the overlying shallow aquifer becomes perched.

### **1.3 Occurrence of Surface Water**

The Merced River is the primary source of surface water within the Merced IRWM area. The Merced River is impounded by New Exchequer Dam, forming Lake McClure which is located east and outside of the IRWM area. Lake McClure has a storage capacity of over 1 million acre-feet (ac-ft) and is used for flood control and storage of irrigation water. Under agreement with the United States Corps of Engineers, each fall/winter the storage pool in Lake McClure is reduced to a maximum of 675,000 ac-ft for flood control purposes. Figure 4 shows the locations of major surface water features and watersheds.

Since 1994, storage in Lake McClure has ranged from about 243,000 to 1,021,500 ac-ft and averaged about 606,300 ac-ft (Figure 5). Since 1994, daily inflow into Lake McClure has ranged between zero and approximately 67,000 cubic feet per second (cfs) or about 133,000 acre-feet per day (ac-ft/d) and averaged approximately 1,490 cfs (2,590 ac-ft/d). Outflow has ranged between zero and approximately 11,800 cfs (23,400 ac-ft/d) and averaged about 1,520 cfs (2,400 ac-ft/d). The maximum instantaneous inflow recorded was approximately 67,000 cfs in January 1997 and the maximum recorded outflow was approximately 11,800 cfs in December 1996 (DWR, 2012).

Other sources of surface water within the Merced IRWM area include Yosemite Lake and Burns Reservoir, Chowchilla River, San Joaquin River, and permanent and ephemeral streams including Bear Creek, Black Rascal Creek, Burns Creek, Canal Creek, Cottonwood Creek, Deadman Creek, Dutchman Creek, Fahrens Creek, Little Deadman Creek, Mariposa Creek, and Owens Creek. Gauging stations located at flood control structures on several of these creeks (Burns, Bear, Mariposa, and Owens) indicate that since 1993, annual outflow from the creeks has ranged between 15,000 and 238,700 acre-feet per year (ac-ft/y) and averaged about 94,000 ac-ft/y. The Department of Water Resources has estimated that approximately half, or about 47,000 ac-ft/y of this water, infiltrates and recharges groundwater (DWR, 2003b).

#### **1.4 Delivered Water**

The Merced River is the principal renewable surface water supply in the Merced IRWM area. Water is diverted from the Merced River into the Merced Irrigation District distribution system through the Northside Canal from the Merced Falls Dam and through the Main Canal from the Crocker-Huffman Diversion Dam. Between 1994 and 2007, Merced Irrigation District diversions have ranged between 430,600 and 571,400 ac-ft/y and averaged about 499,400 ac-ft/y.

A small amount of surface water is also imported from Millerton Lake on the San Joaquin River into the Chowchilla Water District portion of the Merced IRWM area via the Madera Canal.

The location of the water districts in the Merced IRWM Area is shown in Figure 6.

#### **1.5 Treated Wastewater**

Wastewater reclamation plants are operated by the municipalities to treat and discharge effluent back into the Merced IRWM area. The treated wastewater is discharged under waste discharge requirements (WDRs) issued by the RWQCB. Routine monitoring of wastewater is required by the WDRs and reported to the RWQCB. In general, the wastewater has higher salt loading (as TDS) and nutrients (as nitrate and ammonia) than surface water or groundwater within the Merced IRWM area.

The City of Merced discharges a total of about 8,700 ac-ft/y of tertiary treated effluent (City of Merced, 2008). Approximately 900 ac-ft/y of treated effluent is discharged and reused on about 600 acres of City of Merced owned cropland southeast of Merced. Another 1,400 ac-ft/y of treated effluent is discharged to about 385 acres of wetlands. The remaining treated wastewater (approximately 6,400 ac-ft/y) is discharged to the Hartley Slough where it is utilized for agricultural and environmental purposes within and downstream of the Merced IRWM area.

The cities of Atwater and Winton treat and discharge approximately 4,500 ac-ft/y of secondary (soon to be tertiary) treated municipal and industrial effluent. This treated water is reclaimed for agricultural purposes. The cities of Le Grand, Livingston, and Planada treat and discharge approximately 6,000 ac-ft/y of secondary treated effluent.

## **2 GROUNDWATER QUALITY**

Many constituents, both anthropogenic (man-made) and naturally occurring, are present in the groundwater supply within the Merced IRWM area. The constituents identified in this section either currently impact groundwater usage within the basin or have the potential to impact groundwater usage in the future. Merced IRWM area groundwater data came primarily from three sources. The first source was from MCDEH. These data included periodic measurements from water supply wells from 1984 through 2012 for the following constituents:

arsenic, chloride, iron, manganese, nitrate, electrical conductivity, and DBCP. The second and third sources of groundwater quality data came from the State Water Board's GeoTracker data management system and the USGS GAMA Program website. Data from these sources included 61,543 periodic measurements from water supply wells from 1980 through 2012 for the following constituents: arsenic, benzene, chloride, hexavalent chromium, DBCP, MTBE, nitrate, nitrite, perchlorate, PCE, 111-TCA, TCE, specific conductance, 123-TCP, and TDS, among others.

### ***Evaluation Methodology***

The 61,543 periodic water quality measurements were provided with 3,835 unique latitudes and longitudes and/or the site address that could be used to locate the water supply wells. To protect the privacy of groundwater supply well owners, the data were composited by Township and Range (Figure 7) to create 37 unique locations for generating time-concentration charts. No centroid is shown for T8S R12E as there was no available data for this township, which contains a portion of the Grasslands Ecological Area (GEA) along with agricultural uses. The groundwater quality data were evaluated using map views showing the past 5-year average (2007 through 2012) distribution of constituents and time concentration plots by constituent (Appendix A). The 5-year average (2007 through 2012) distribution map views were prepared using kriging or natural neighbor methods as implemented in SURFER<sup>®</sup> software by Golden Software. The composite time-concentration plots (minimum, average, and maximum) for each constituent by Township and Range were prepared using ArcGIS<sup>®</sup> software by Esri.

For discussion purposes, each constituent was compared to the primary and/or secondary drinking water maximum contaminant level (MCL) published by the California Department of Public Health (CDPH) and/or United States Environmental Protection Agency. In addition, for discussion purposes, the Merced IRWM area has been divided into four quadrants roughly along the lines of Highway 59 and Highway 140 (Figure 7).

It should be noted that well depth information was generally not readily available. Often available depth information is only in hard copy driller's logs, which are further complicated by confidentiality issues. The lack of depth information is a critical data gap that should be addressed in the future (see Section 5 for more detail on data gaps).

### **2.1 Salinity and Nutrient Constituents**

Groundwater salinity is caused by various salts, metals, and inorganic compounds dissolved in groundwater. Salts are composed of positively charged cations and negatively charged anions that disassociate when dissolved in water. Common dissolved salts in groundwater include calcium ( $\text{Ca}^+$ ), sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), chloride ( $\text{Cl}^-$ ), carbonate ( $\text{CO}_3^-$ ), sulfate ( $\text{SO}_4^-$ ) and

perchlorate ( $\text{ClO}_4^-$ ). Common dissolved metals and nutrients in groundwater include arsenic (As), iron ( $\text{Fe}^+$ ), hexavalent chromium ( $\text{Cr}^6$ ), manganese ( $\text{Mn}^+$ ), nitrate ( $\text{NO}_3^-$ ), potassium ( $\text{K}^+$ ), and phosphate ( $\text{PO}_4^{3-}$ ).

Historically, groundwater beneath the Merced IRWM area has ranged primarily between calcium-bicarbonate to sodium-bicarbonate type water due to variability in soil conditions, soil type, geologic structure, irrigation practices, and irrigation water quality, especially in the upper water-bearing zone (Figure 8). Sodium rich groundwater may require the addition of soil amendments (gypsum) in order to percolate through soil, increasing salt loading in the Merced IRWM area. In general, groundwater salinity is lowest in the easterly portion of the Merced IRWM area. Salinity increases westward toward the San Joaquin River and southward toward the Chowchilla River. A small area of predominantly sodium-chloride type water has been identified near the confluence of the Merced and San Joaquin rivers.

### **2.1.1 Total Dissolved Solids**

Salinity levels within the Merced IRWM area range from 130 milligrams per liter (mg/L) to greater than 3,180 mg/L as measured by TDS. The recommended secondary MCL for TDS is 500 mg/L with an upper limit of 1,000 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) TDS in groundwater in the northeastern quadrant of the Merced IRWM area is generally less than 300 mg/L (Figure 9). TDS in the northwestern quadrant is slightly elevated beneath the Atwater and Winton areas. TDS in groundwater also increases in the western quadrants towards the San Joaquin River to as much as 1,000 mg/L. In these areas, high TDS water is found in wells deeper than 350 feet. Better quality groundwater (less than 1,000 mg/L) in these areas is found at shallower depths.

Time concentration plots of TDS are shown in Appendix A, Figures 1a through 1d.

### **2.1.2 Specific Electrical Conductivity**

Specific Electrical Conductivity (SEC or EC) can be used as an indirect measurement of salinity levels in groundwater. Within the Merced IRWM area, SEC ranges from 23  $\mu\text{s}/\text{cm}$  to greater than 5,000  $\mu\text{s}/\text{cm}$  (Figure 10). The secondary MCL for SEC is 900  $\mu\text{s}/\text{cm}$  with an upper limit of 1,600  $\mu\text{s}/\text{cm}$  (CDPH, 2011). The 5-year average (2007 through 2012) SEC in groundwater in the eastern two quadrants of the Merced IRWM area is generally less than 500  $\mu\text{s}/\text{cm}$ , except in the foothill areas (Figure 10). Like TDS, the SEC in groundwater increases in the western quadrants towards the San Joaquin River to as much as 2,000  $\mu\text{s}/\text{cm}$ .

Time concentration plots of SEC are shown in Appendix A, Figures 2a through 2d.

### **2.1.3 Arsenic**

Arsenic (As) is a dissolved metal commonly associated with saline groundwater. Within the Merced IRWM area, As concentrations range from non-detect (less than 1 microgram per liter [ $\mu\text{g/L}$ ]) to as much as 800  $\mu\text{g/L}$ . The primary MCL for As is 10  $\mu\text{g/L}$  (CDPH, 2011). The 5-year average (2007 through 2012) As concentration in groundwater in the northern two quadrants of the Merced IRWM area is generally less than 10  $\mu\text{g/L}$  (Figure 11). There are localized areas where the average As concentrations in shallow groundwater range between 20 and 50  $\mu\text{g/L}$  northeast of Atwater, near Stevenson, and in the southwest Merced IRWM area near the intersection of Sandy Mush Road and Highway 59.

Time concentration plots of As are shown in Appendix A, Figures 3a through 3d.

### **2.1.4 Chloride**

Chloride (Cl) is a dissolved salt commonly associated with saline groundwater. Within the Merced IRWM area, Cl concentrations range from non-detect (less than 2 mg/L) to as much as 1,850 mg/L. The recommended secondary MCL for Cl is 250 mg/L and the upper secondary MCL is 500 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) Cl concentration in groundwater in the northern two quadrants of the Merced IRWM area is generally less than 50 mg/L (Figure 12). Like TDS, Cl in groundwater increases in the southern quadrants towards the San Joaquin River to as much as 500 mg/L.

Time concentration plots of Cl are shown in Appendix A, Figures 4a through 4b.

### **2.1.5 Iron**

Iron (Fe) is a dissolved metal commonly associated with mineralized groundwater. Within the Merced IRWM area, Fe concentrations range from non-detect (less than 1 mg/L) to as much as 600 mg/L. The secondary MCL for Fe is 0.3 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) Fe concentration in groundwater in the eastern two quadrants of the Merced IRWM area ranges from non-detect to over 600 mg/L (Figure 13), while the Fe concentration in groundwater in the western two quadrants is generally less than 100 mg/L. The elevated Fe concentration in the east portion of the Merced IRWM area is a result of leaching of Fe from the subsurface materials in the source area. The Fe in groundwater oxidizes and precipitates as the groundwater moves west towards the San Joaquin River.

Time concentration plots of Fe are shown in Appendix A, Figures 5a through 5d.

### **2.1.6 Hexavalent Chromium**

Hexavalent Chromium ( $\text{Cr}^6$ ) is a dissolved metal that rarely occurs naturally and can be associated with industrial contamination in groundwater. Within the Merced IRWM area,  $\text{Cr}^6$

concentrations range from non-detect (less than 0.01 µg/L) to as much as 370 µg/L. The primary MCL for total chromium is 50 µg/L (CDPH, 2011). The 5-year average (2007 through 2012) Cr<sup>6</sup> concentration in groundwater in the Merced IRWM area is generally less than 1 µg/L, except for a small area of over 100 µg/L in the northwest quadrant (Figure 14).

Time concentration plots of Cr<sup>6</sup> are shown in Appendix A, Figures 6a through 6d.

### **2.1.8 Manganese**

Manganese (Mn) is a dissolved metal commonly associated with mineralized groundwater. Within the Merced IRWM area, Mn concentrations range from non-detect (less than 1 µg/L) to as much as 1,300 mg/L. The secondary MCL for Mn is 0.05 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) Mn concentration in groundwater beneath most of the Merced IRWM area is 50 mg/L or less (Figure 15). Like TDS, the Mn concentration in groundwater increases towards the San Joaquin River to as much as 500 mg/L.

Time concentration plots of Mn are shown in Appendix A, Figures 7a through 7d.

### **2.1.7 Nitrate**

Nitrate (NO<sub>3</sub>) occurs from both natural and anthropogenic sources and is widespread in groundwater in many parts of the San Joaquin Valley. High NO<sub>3</sub> concentrations in groundwater are often associated with the use of fertilizers (commercial/animal waste) and onsite wastewater treatment systems (OWTS or septic systems). Within the Merced IRWM area, NO<sub>3</sub> concentrations range from non-detect (less than 2 mg/L) to as much as 470 mg/L. The primary MCL for NO<sub>3</sub> is 45 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) NO<sub>3</sub> concentration in groundwater in the Merced IRWM area is generally less than 20 mg/L (Figure 16). In the northwest quadrant, there are several small areas where NO<sub>3</sub> concentrations exceed 100 mg/L and several larger areas where NO<sub>3</sub> concentrations range from 20 to 40 mg/L. The elevated NO<sub>3</sub> concentration in these areas may be associated with animal confinement facilities and other agricultural non-point sources. Elevated nitrate in groundwater exists in small areas northeast of Merced and southwest of Atwater among areas where high density OWTSs occur.

Time concentration plots of NO<sub>3</sub> are shown in Appendix A, Figures 8a through 8d. Apparent increases in all quadrants appear to be associated with animal confinement facilities, other agricultural non-point sources, and OWTSs.

### **2.1.8 Perchlorate**

Perchlorate (ClO<sub>4</sub>) occurs from both natural and man-made sources and is widespread in groundwater in many parts of the San Joaquin Valley. High ClO<sub>4</sub> concentrations in groundwater



are often associated with the use of nitrate fertilizer or munitions manufacturing. Within the Merced IRWM area,  $\text{ClO}_4$  concentrations range from non-detect (less than 2 mg/L) to as much as 4  $\mu\text{g/L}$ . The primary MCL for  $\text{ClO}_4$  is 6  $\mu\text{g/L}$  (CDPH, 2011). The 5-year average (2007 through 2012)  $\text{ClO}_4$  concentration in groundwater in the Merced IRWM area is generally less than 1 mg/L (Figure 17).

Time concentration plots of  $\text{ClO}_4$  are shown in Appendix A, Figures 9a through 9d.

## **2.2 Petroleum Hydrocarbon, Pesticides, and Organic Constituents**

Anthropogenic sources of petroleum hydrocarbons, pesticides, and organic compounds can have significant impacts on water quality when present in groundwater. The most commonly found petroleum hydrocarbon compounds of concern are benzene and MTBE. The most commonly found pesticides include DBCP, EDB, and TCP. The most commonly found VOCs include 111-TCA, PCE, and TCE.

### **2.2.1 Benzene**

More than 200 unauthorized releases of petroleum hydrocarbons from underground storage tanks have occurred in the Merced IRWM area. The primary hydrocarbons of concern are benzene and MTBE, both of which are suspected carcinogens. Benzene concentrations in groundwater in the Merced IRWM area range from non-detect (less than 0.5 mg/L) to greater than 15,000 mg/L (Figure 18). The primary MCL for benzene is 1 mg/L (CDPH, 2011). The 5-year average (2007 through 2012) benzene concentration in groundwater in the Merced IRWM area is generally less than 5 mg/L, with elevated concentrations found in localized urban areas along transportation corridors, including Highway 99 and Highway 152.

Time concentration plots of benzene are shown in Appendix A, Figures 10a through 10d.

### **2.2.2 Methyl Tertiary Butyl Ether**

MTBE concentrations in groundwater in the Merced IRWM area range from non-detect (0.2  $\mu\text{g/L}$ ) to greater than 440,000  $\mu\text{g/L}$ . The primary MCL for MTBE is 13  $\mu\text{g/L}$  (CDPH, 2011). The 5-year average (2007 through 2012) MTBE concentration in groundwater in the Merced IRWM area is generally less than 5  $\mu\text{g/L}$  (Figure 19), with elevated concentrations found in localized urban areas along Highway 99.

Time concentration plots of MTBE are shown in Appendix A, Figures 11a through 11d.

### **2.2.3 Dibromochloropropane**

The pesticide Dibromochloropropane (DBCP) was a common pesticide used to control nematodes in vineyards prior to 1977. DBCP concentrations in groundwater in the Merced

IRWM area range from non-detect (0.2 µg/L) to 335 µg/L. The primary MCL for DBCP is 0.2 µg/L (CDPH, 2011). The 5-year average (2007 through 2012) DBCP concentration in groundwater in the Merced IRWM area is generally less than 1 µg/L (Figure 20), with elevated concentrations found in localized areas near the Cities of Atwater, Delhi, Le Grand, Livingston, Merced, Planada, and Winton.

Time concentration plots of DBCP are shown in Appendix A, Figures 12a through 12b.

#### **2.2.4 1,1,1-Trichloroethane**

The volatile organic compound (VOC) 1,1,1-Trichloroethane (111-TCA) is a commonly used solvent utilized in manufacturing facilities, auto repair shops, and various other uses within the Merced IRWM area. 111-TCA concentrations in groundwater in the Merced IRWM area range from non-detect (0.2 µg/L) to 60 µg/L. The primary MCL for 111-TCA is 200 µg/L (CDPH, 2011). The 5-year average (2007 through 2012) 111-TCA concentration in groundwater in the Merced IRWM area is generally less than 1 µg/L (Figure 21), with elevated concentrations found in a localized area beneath the City of Merced.

Time concentration plots of 111-TCA are shown in Appendix A, Figures 13a through 13d.

#### **2.2.5 1,2,3-Trichloropropane**

The VOC 1,2,3-Trichloropropane (123-TCP) is a commonly used solvent in manufacturing facilities and as a carrier solvent for DBCP and other pesticides. 123-TCP concentrations in groundwater in the Merced IRWM area range from non-detect (0.5 µg/L) to over 300 µg/L. CDPH is developing a MCL for 123-TCP, which is expected for release for public comment by 2014. Until the MCL is developed, CDPH is utilizing a Notification Level of 0.005 µg/L (CDPH, 2012). The California Office of Environmental Health Hazard Assessment (OEHHA) has set a Public Health Goal (PHG) for 123-TCP of 0.0007 µg/L (OEHHA, 2009). A notification level is a health-based advisory level established by CDPH for chemicals in drinking water that lack MCLs, while the PHG is a level of drinking water contaminant at which adverse health effects are not expected to occur from a lifetime of exposure. The 5-year average (2007 through 2012) 123-TCP concentration in groundwater in the Merced IRWM area is generally less than 1 µg/L (Figure 22), with elevated concentrations found in localized areas in the northwest quadrant and beneath the City of Merced.

Time concentration plots of 111-TCA are shown in Appendix A, Figures 14a through 14d.

#### **2.2.6 Tetrachloroethylene**

The VOC Tetrachloroethylene (PCE) is a commonly used solvent in manufacturing facilities and dry cleaners. PCE concentrations in groundwater in the Merced IRWM area range from non-

detect (0.5 µg/L) to over 500 µg/L. The primary MCL for PCE is 5 µg/L (CDPH, 2011). The 5-year average (2007 through 2012) PCE concentration in groundwater in the Merced IRWM area is generally less than 5 µg/L (Figure 23), with elevated concentrations found in localized areas in the northwest quadrant, beneath the City of Merced.

Time concentration plots of PCE are shown in Appendix A, Figures 15a through 15d.

### **2.2.7 Trichloroethylene**

The VOC Trichloroethylene (TCE) is a commonly used solvent in manufacturing facilities. TCE concentrations in groundwater in the Merced IRWM area range from non-detect (0.5 µg/L) to over 800 µg/L. The primary MCL for TCE is 5 µg/L (CDPH, 2011). The 5-year average (2007 through 2012) TCE concentration in groundwater in the Merced IRWM area is generally less than 5 µg/L (Figure 24), with elevated concentrations found in localized areas in the northwest quadrant and along Highway 140 beneath a point source.

Time concentration plots of TCE are shown in Appendix A, Figures 16a through 16b.

### **2.3. Emerging Contaminants**

Many chemical and microbial constituents that have not historically been considered as contaminants are occasionally, and in some cases with increasing frequency, detected in groundwater. These newly recognized (or emerging) contaminants are commonly derived from municipal, agricultural, industrial wastewater, and domestic wastewater sources and pathways. These newly recognized contaminants are dispersed to the environment from domestic, commercial, and industrial uses of common household products and include caffeine, artificial sweeteners, pharmaceuticals, cleaning products, and other personal care products. Residual waste products of genetically modified organisms are also of potential concern. A recently completed survey for pharmaceuticals at dairies in the Merced IRWM area by UC Davis and the USGS detected pharmaceuticals in shallow groundwater (Watanabe, Harter, and Bergamaschi, 2008).

## **3 SURFACE WATER AND DELIVERED WATER QUALITY**

As noted in Section 1.3, the Merced River is the primary source of surface water and delivered water within the Merced IRWM area. Samples of Merced River water collected near the Crocker-Huffman Diversion Dam between September 2011 and December 2012 were used to prepare a Piper diagram (Figure 25). The Piper diagram shows that the Merced River water is mostly a calcium-bicarbonate type water. This is typical of most surface water derived from Sierra Nevada sources.

The Merced Irrigation District provides irrigation water to approximately 164,000 acres in the Merced IRWM Area. Most of this water is surface water from the Merced River. During dry periods, the surface water supply is occasionally supplemented with groundwater pumped into open canals and other conveyances.

#### **4 RECYCLED WATER QUALITY**

Wastewater reclamation plants are operated by the municipalities to treat and discharge effluent back into the Merced IRWM area. The cities of Atwater, Merced, and Planada discharge treated wastewater to land under NPDES permits. Treated water from all three treatment plants meet the discharge requirements specified by their respective NPDES permits. A review of available effluent water quality data on the California Integrated Water Quality System Project database indicates that Merced is discharging a sodium-bicarbonate type water and Planada is discharging a calcium-bicarbonate type water (Figure 26). These waters are reused for agricultural purposes.

#### **5 DATA GAPS, LOCAL DATA MANAGEMENT, AND VULNERABILITIES**

As noted above, there were no readily discernible salt and nutrient management plans within the Merced IRWM area. The USGS GAMA program collects groundwater quality samples from selected wells within the Merced IRWM area periodically. The MCDEH also collects groundwater quality data from public water supply wells periodically and from private wells when constructed under local permit, and as some properties are sold. Water users with WDRs also collect water quality data and report it to the RWQCB as part of their WDRs. These data sets cover much of the Merced IRWM area and are useful in evaluating water quality. However, the water quality data collected are inconsistent in the parameters analyzed, frequency of sampling, and quality of reporting. Often the depth of groundwater samples is not known, which is critical to early identification of the impacts of practices at the land surface on groundwater quality. Furthermore, the water quality data collected is stored in a variety of data management methods by a number of agencies, making analysis of the available water quality data complex and time consuming.

It is recommended that as part of the salt and nutrient management plan for the Merced IRWM area, a consistent set of wells and surface water monitoring points should be sampled on a regular basis. These samples should be analyzed for a full suite of constituents periodically with indicator parameters during the other semi-annual sampling events. The water quality data should be stored in an internet based data management system and made publically available. Information on the depth of the screened intervals on groundwater monitoring wells should be included in the system, either through compilation of existing data or through new data collection efforts.

The development of such a monitoring plan should be undertaken through a stakeholder-driven process. To provide a starting point for that process, the following may be considered for such as plan:

- Groundwater Monitoring Wells: Select wells consistent with CASGEM wells. Additional wells may be needed to meet water quality needs, particularly shallow wells.
- Surface Water Monitoring Points: Select locations along the Merced River and smaller streams, plus canal locations in both the upper and lower portions of the conveyance system.
- Frequency: Indicator parameters every 6 months and a full suite of constituents every 2 years.
- Constituents: Indicator parameters include TDS, SEC, and NO<sub>3</sub>. Full suite of constituents includes general minerals, metals, basic nutrients, VOCs, and selected pesticides.

Like much of the Central Valley, most surface and groundwater utilized in the Merced IRWM area is for agricultural purposes, including crop land and animal confinement facilities. Municipal and industrial water uses are a much smaller component. The Merced IRWM area is most vulnerable to salts and nutrients resulting from the over application of fertilizers, application of fertilizers to coarse-grained soils, salts leached from soil in agricultural return water, and wastewater generated by agriculture, residential, municipal, and industrial waste water sources. It should be noted that changes in the regulatory environment related to septic systems (also known as on-site wastewater treatment systems, or OWTS) are occurring through the State Water Board's Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems (State Water Board, 2012). Future salt and nutrient management should be conducted in coordination with these efforts, including the potential development of Local Agency Management Program.

## **6 SUMMARY**

The results of this salt and nutrient study indicate that in general, most of the Merced IRWM area has good surface and groundwater quality as shown using Stiff diagrams and TDS (Figure 27). The monitoring data indicate localized areas where groundwater constituents exceed primary MCLs. These results are consistent with the findings of the USGS GAMA program.

The Merced IRWM area would benefit from implementation of a consistent surface and groundwater monitoring program to evaluate changes in water quality over time. Improved

management of available surface and groundwater quality data in the Merced IRWM area will allow for optimization of available surface and groundwater supplies to minimize over application of fertilizers, reduce salt leaching, and reduce salt and nutrient loading in waste water.

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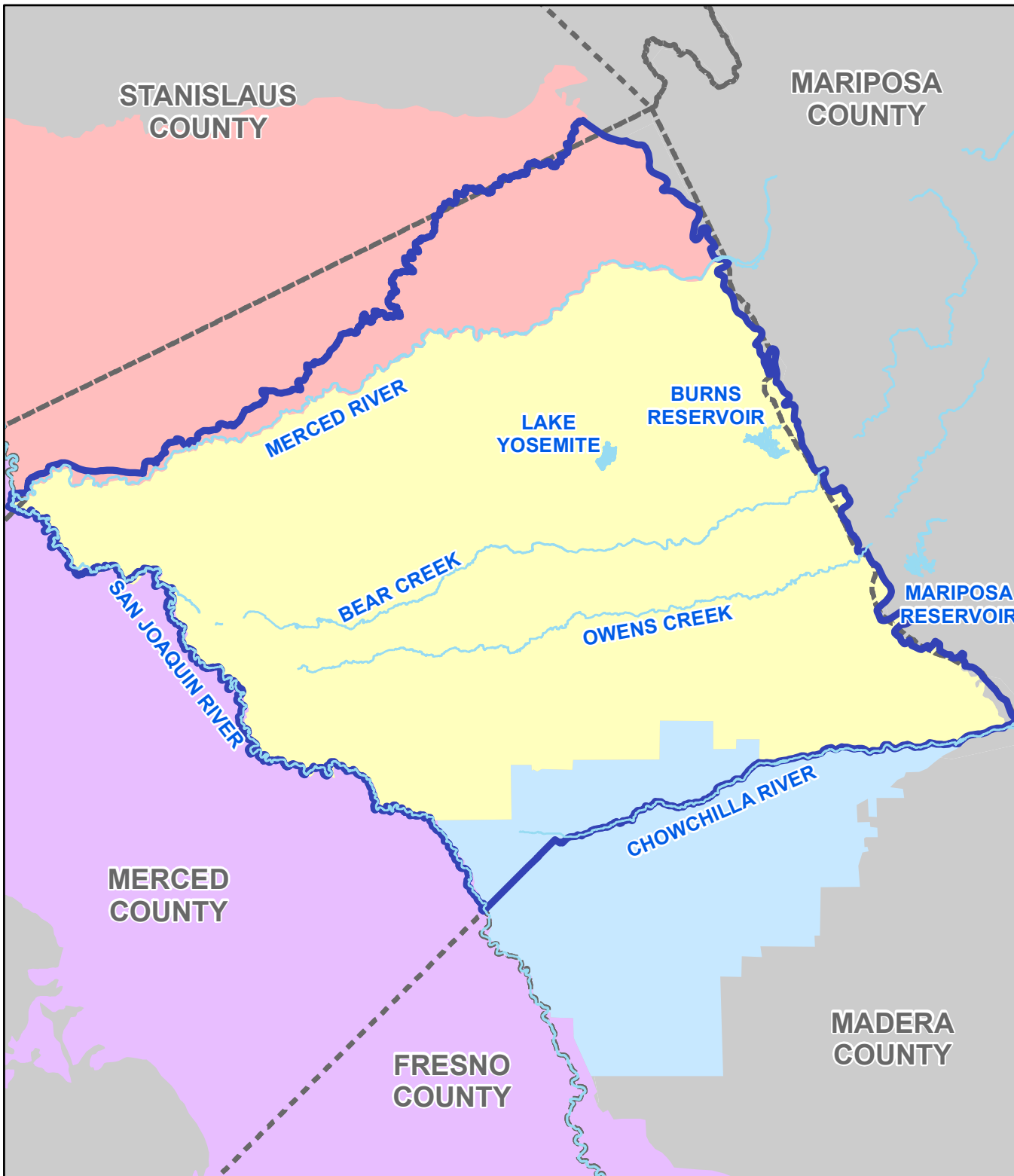
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Explanation

----- Approximate county boundary

— Surface water feature

▭ Merced IRWM Area

Groundwater Subbasins

▭ Chowchilla

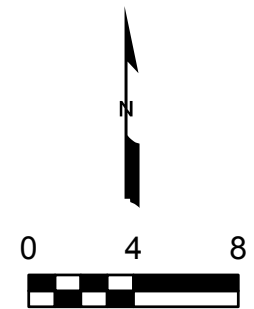
▭ Delta-Mendota

▭ Merced

▭ Turlock

Note:

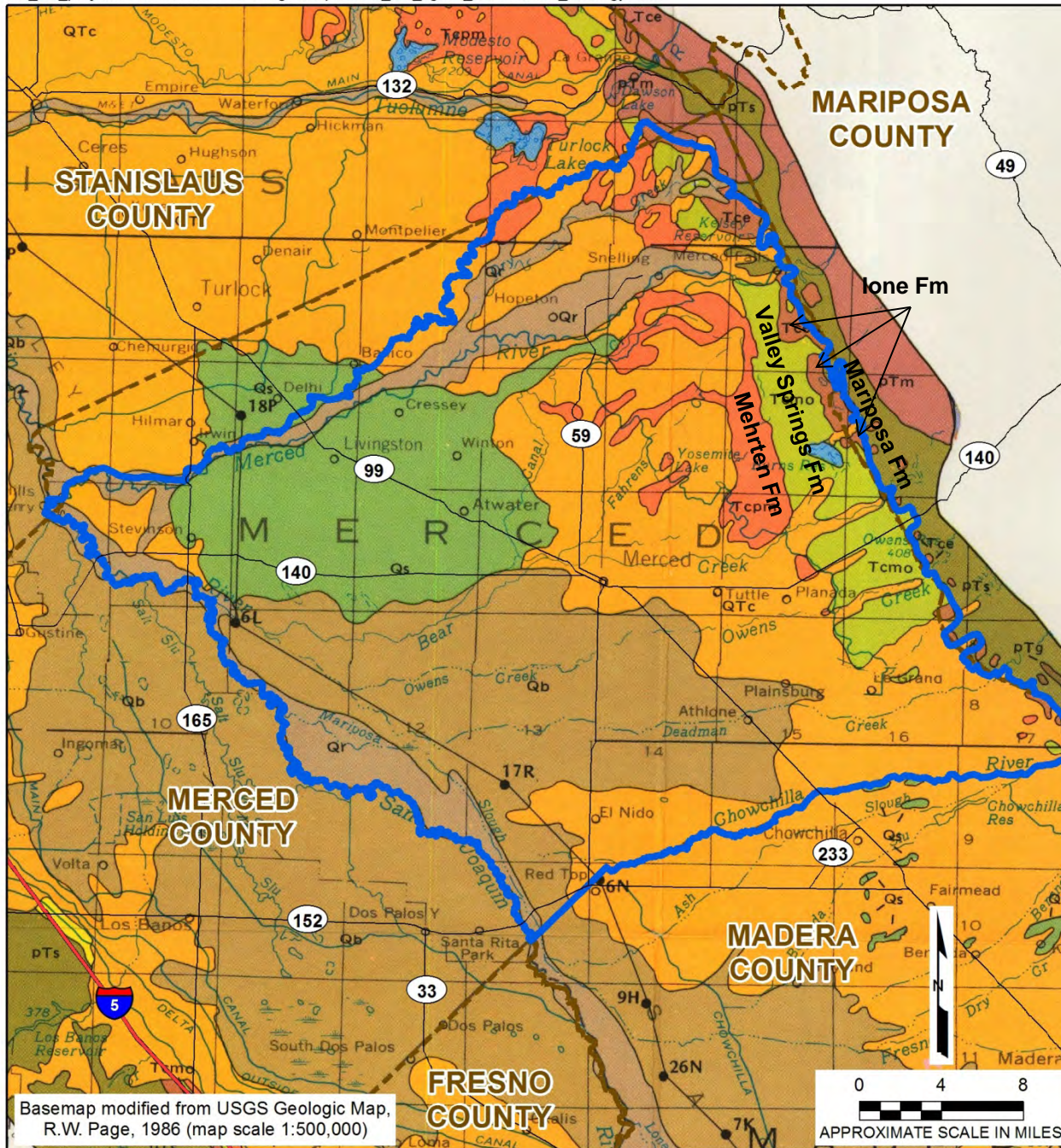
IRWMP = Integrated Regional Water Management Plan.



APPROXIMATE SCALE IN MILES

**GROUNDWATER SUBBASINS WITHIN  
THE MERCED IRWM AREA  
Merced IRWMP  
Merced County, California**





**Explanation**

- Approximate county boundary
- Merced IRWM area

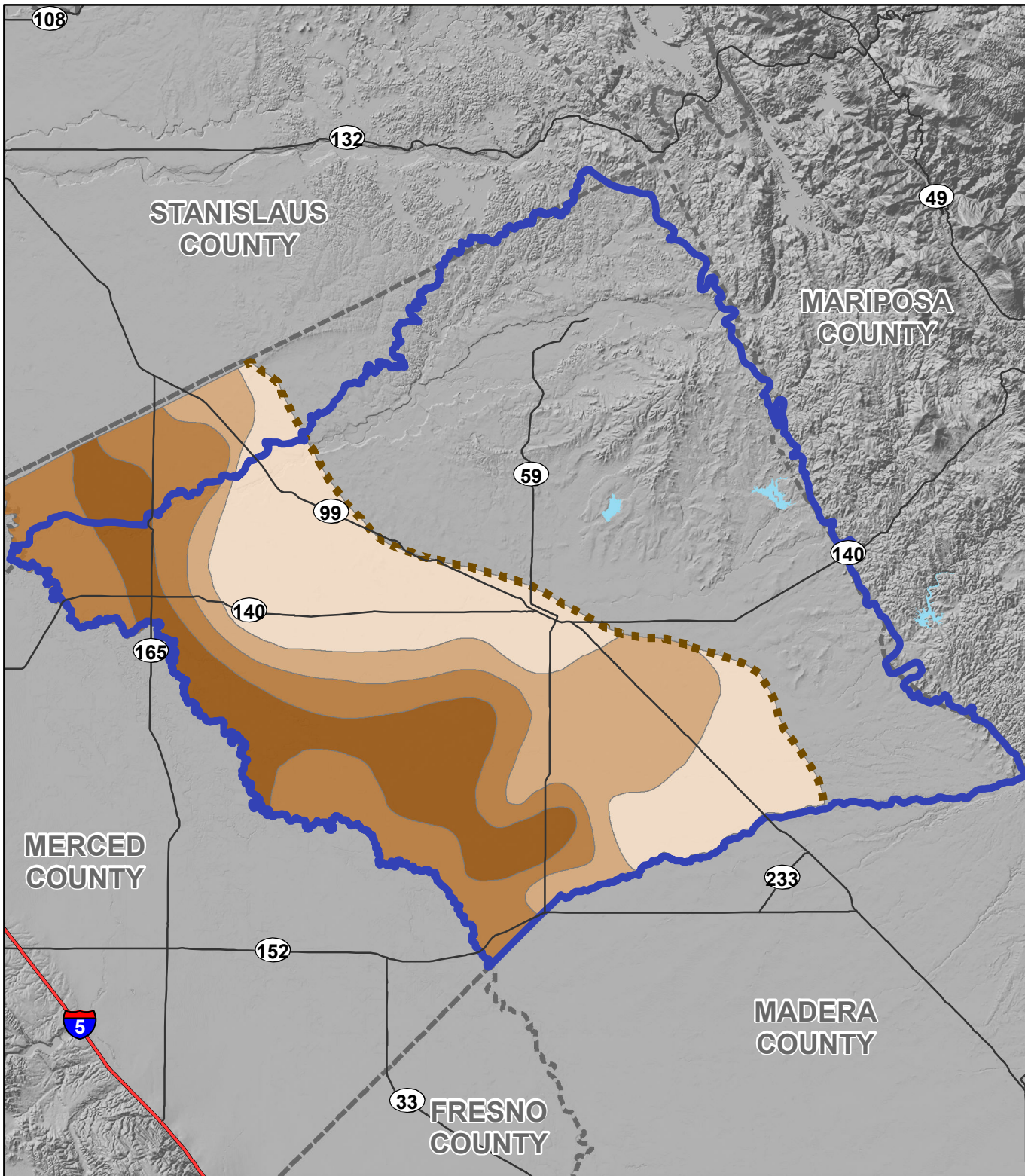
**Geologic Unit Description**

- Qs** Sand Dunes (Holocene): windblown sand and dune sand
- Qb** Flood-basin deposits (Holocene to Pleistocene): Clay, silt, and some sand
- Qr** River deposits (Holocene to Pleistocene): Gravel, sand, silt, and minor amounts of clay, deposited along channels, flood plains, and natural levees of main streams.
- QTI** Lacustrine and marsh deposits (Pliocene to Holocene): Clay, silt, and some sand
- QTc** Continental rocks and deposits (Miocene to Holocene): Heterogeneous mix of generally poorly sorted clay, silt, sand, and gravel, some beds of claystone, siltstone, sandstone, and conglomerate.
- Tcpm** Continental rocks and deposits (Miocene and Pliocene): Gravel, sand, silt, clay, conglomerate, sandstone, siltstone, and claystone, contain andesitic material.
- Tcmd** Continental and marine rocks and deposits (Miocene and Pliocene): Gravel, sand, silt, clay, silty sandstone, and siltstone.
- Tcmo** Continental rocks and deposits (Oligocene and Miocene): Gravel, conglomerate, sand, tuffaceous sand, clay, and sandy clay, contain rhyolitic material on eastern side of valley.
- Tce** Continental rocks and deposits (Eocene): Conglomerate and sandstone; along eastern side of valley contain anaxite. Principally lone Formation (Eocene) on eastern side of valley.
- pTs** Marine rocks (Pre-Tertiary): Sandstone, shale, siltstone, and some limestone, chiefly on western side of valley; in places contain abundant secondary gypsum
- pTg** Granitic rocks (Pre-Tertiary): Chiefly granitic rocks on eastern side of valley; in places consists of mafic intrusive rocks
- pTm** Metamorphic rocks (Pre-Tertiary): Metasedimentary, metavolcanic and other metamorphic rocks on eastern side of valley
- water** Water

**GENERALIZED GEOLOGY  
MERCED IRWM AREA  
Merced IRWMP  
Merced County, California**

Basemap modified from USGS Geologic Map, R.W. Page, 1986 (map scale 1:500,000)

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure 2



Explanation

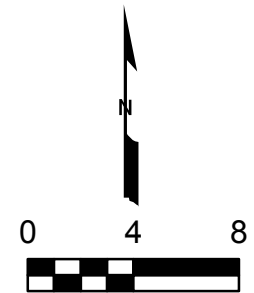
- Approximate county boundary
- Approximate eastern boundary of Corcoran Clay
- ▭ Merced IRWM Area

Corcoran Clay Thickness

- 0' to 20'
- 20' to 40'
- 40' to 60'
- 60' to 80'

Notes:

IRWMP = Integrated Regional Water Management Plan  
 Modified from R.W. Page, 1977

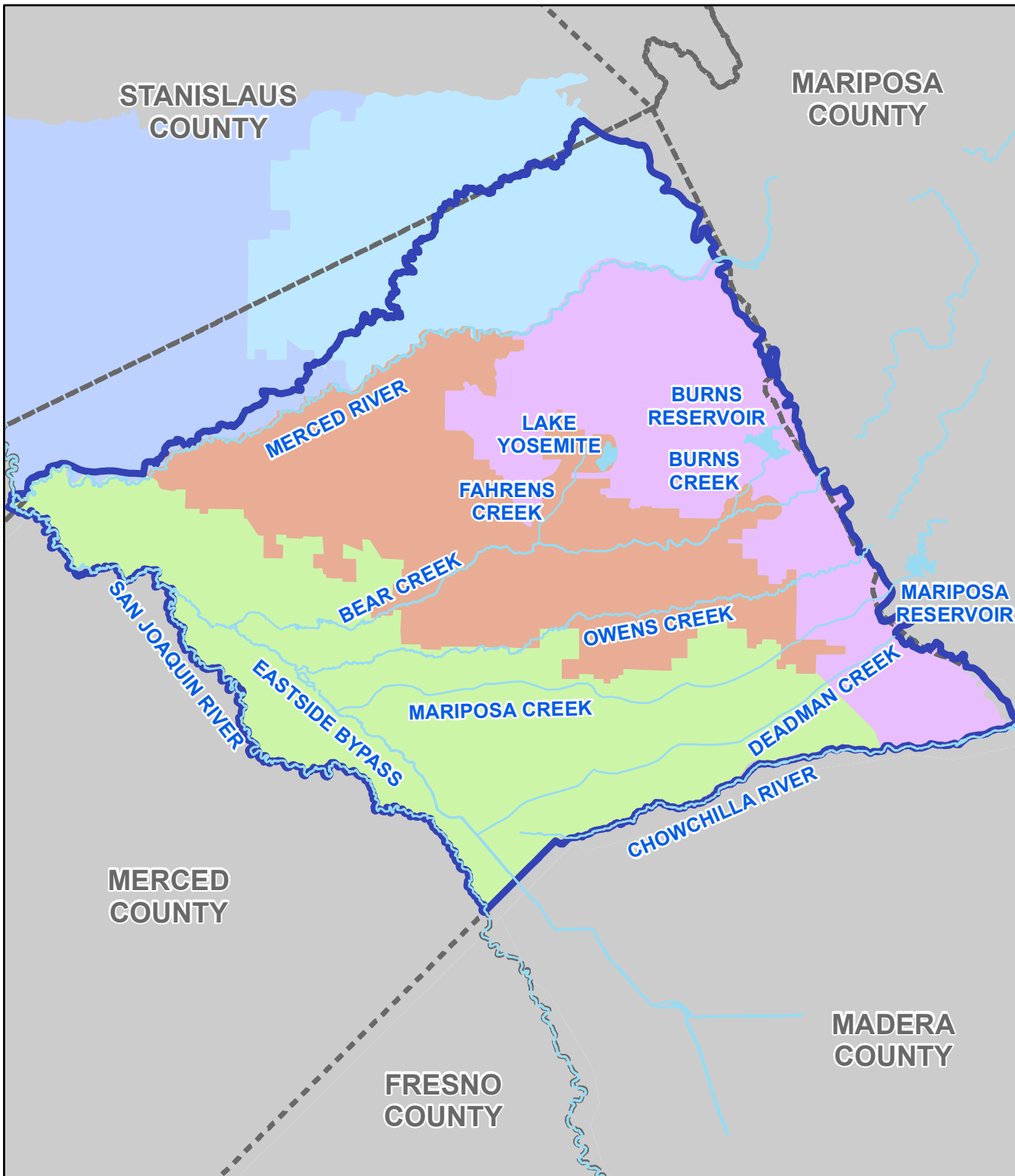


APPROXIMATE SCALE IN MILES  
 Basemap modified from National Elevation Dataset seamless for California.




**LATERAL EXTENT AND THICKNESS OF THE CORCORAN CLAY WITHIN THE MERCED IRWM AREA**  
 Merced IRWMP  
 Merced County, California

2013

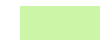


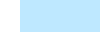

Figure 3



Explanation

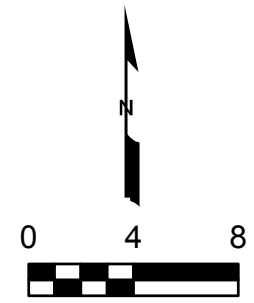
-  Surface water feature
-  Merced IRWM Area
-  Approximate county boundary

Watershed Names

-  El Nido-Stevinson
-  Fahrens Creek
-  Merced
-  Montpelier
-  Turlock

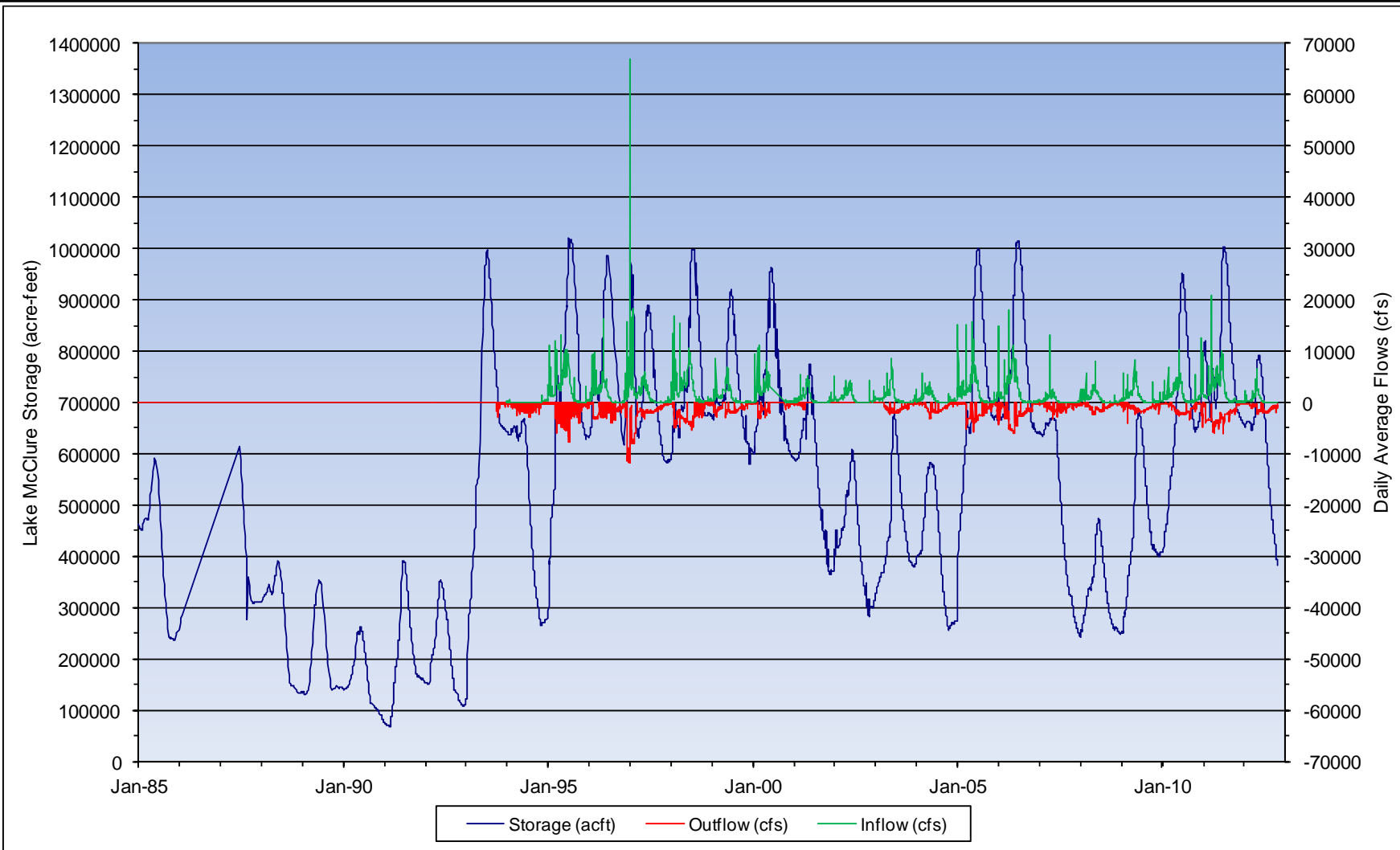
Note:

IRWMP = Integrated Regional Water Management Plan.



APPROXIMATE SCALE IN MILES

**WATERSHEDS WITHIN  
THE MERCED IRWM AREA  
Merced IRWMP  
Merced County, California**



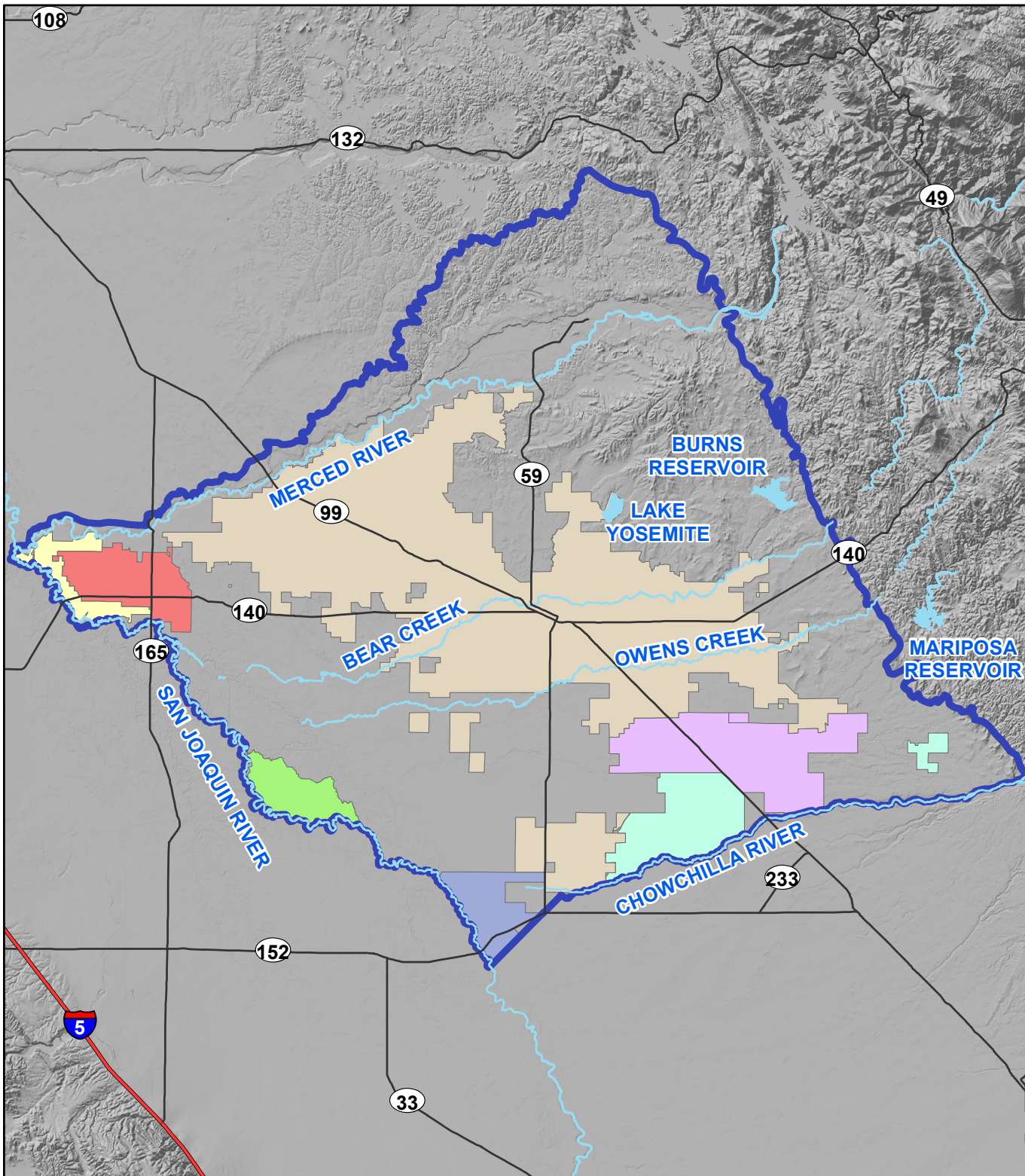
**Notes:**

1) Data downloaded from DWR California Data Exchange Center website  
[http://cdec.water.ca.gov/cgi-progs/stationInfo?station\\_id=EXC](http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=EXC)










**LAKE McCLURE RESERVOIR STORAGE**

Merced IRWMP  
 Merced County, California

By: dmb	Date: 11/05/2012	Project No. FR1216040A
		Figure 5

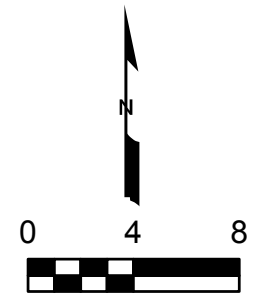


Explanation

-  Surface water feature
-  Merced IRWM Area
- Water Districts
-  Chowchilla Water District
-  Le Grand-Athlone Water District
-  Merquin County Water District
-  Sierra Water District
-  Stevinson Water District
-  Turner Island Water District
-  Merced Irrigation District

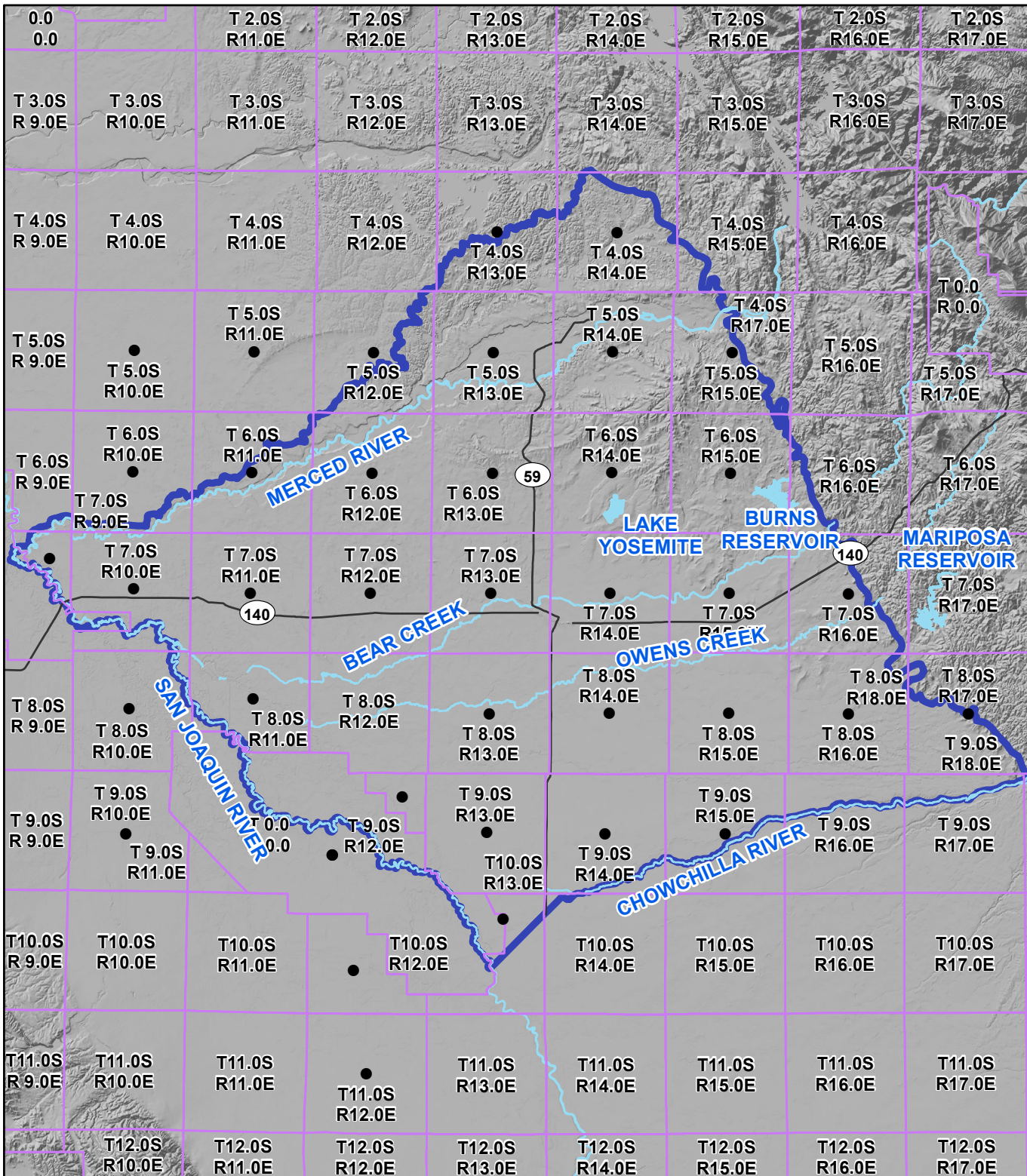
Note:

IRWMP = Integrated Regional Water Management Plan.



APPROXIMATE SCALE IN MILES  
 Basemap modified from National Elevation Dataset seamless for California.

**WATER DISTRICTS WITHIN THE  
 MERCED IRWM AREA  
 Merced IRWMP  
 Merced County, California**

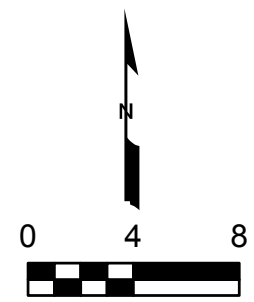


Explanation

- Township/Range centroid
- Surface water feature
- T6.0S  
R16.0E Township/Range
- Merced IRWM Area

Notes:

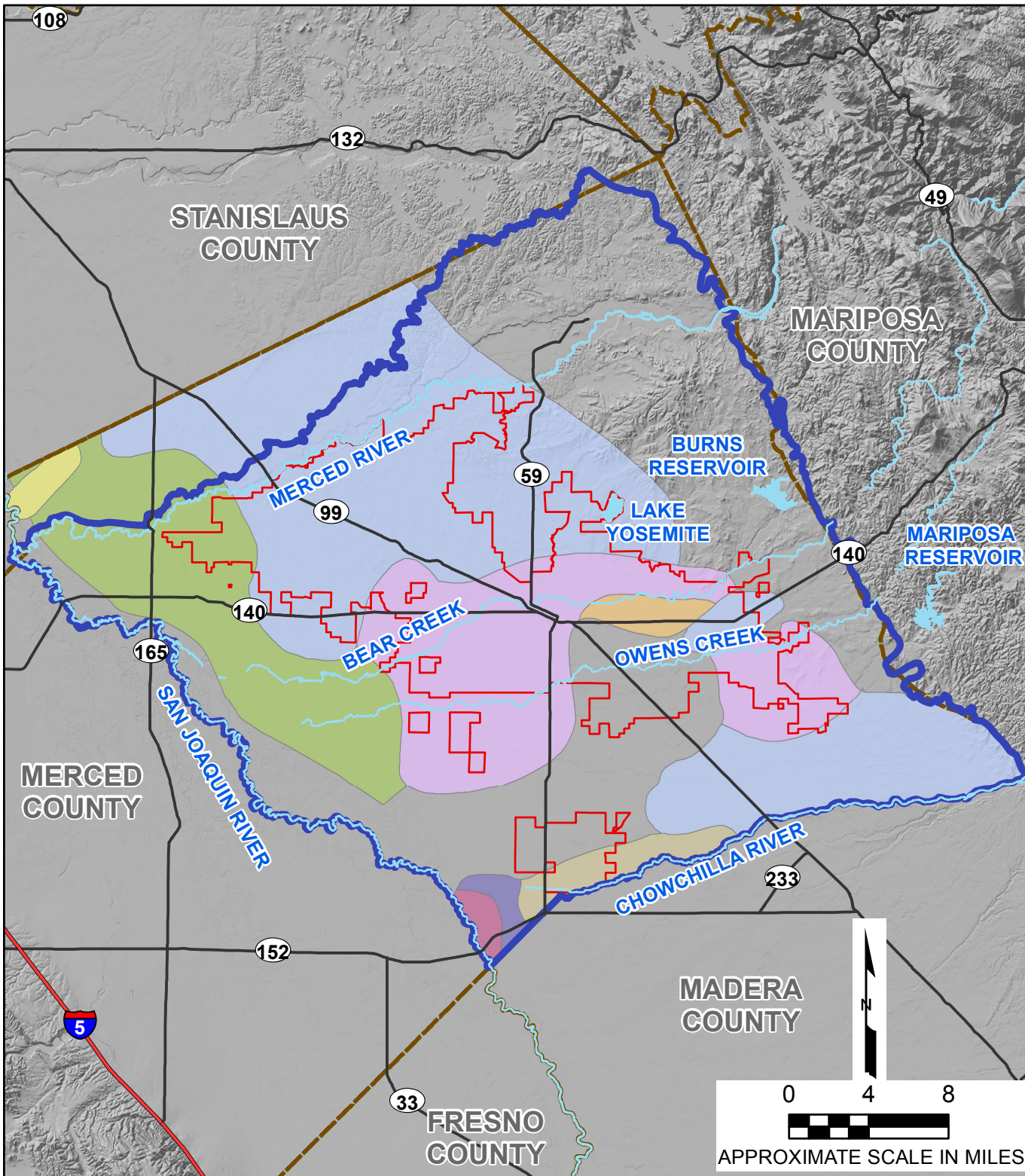
1. Average data collected between 2007 and 2012.
2. Sources: Merced County Division of Environmental Health, USGS GAMA Program, and State Water Board GeoTracker.
3. IRWMP = Integrated Regional Water Management Plan.



APPROXIMATE SCALE IN MILES  
 Basemap modified from National Elevation Dataset seamless for California.

**TOWNSHIP-RANGE CENTROIDS FOR  
 COMPOSITE TIME-CONCENTRATION PLOTS  
 Merced IRWMP  
 Merced County, California**

2013	Figure <b>7</b>
------	-----------------



Explanation

- Approximate county boundary
- Surface water feature
- Merced IRWM Area
- Merced Irrigation District

Groundwater Types

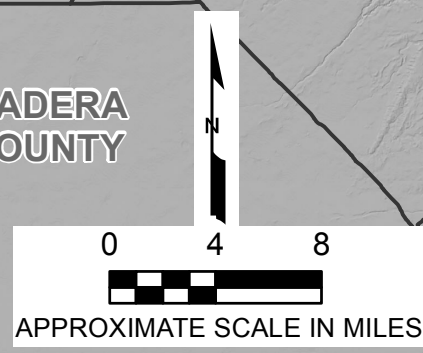
- Calcium Bicarbonate
- Calcium Chloride
- Calcium Magnesium Bicarbonate
- Calcium Sodium Bicarbonate
- Calcium Sodium Chloride
- Magnesium Sodium Bicarbonate
- Sodium Bicarbonate
- Sodium Chloride

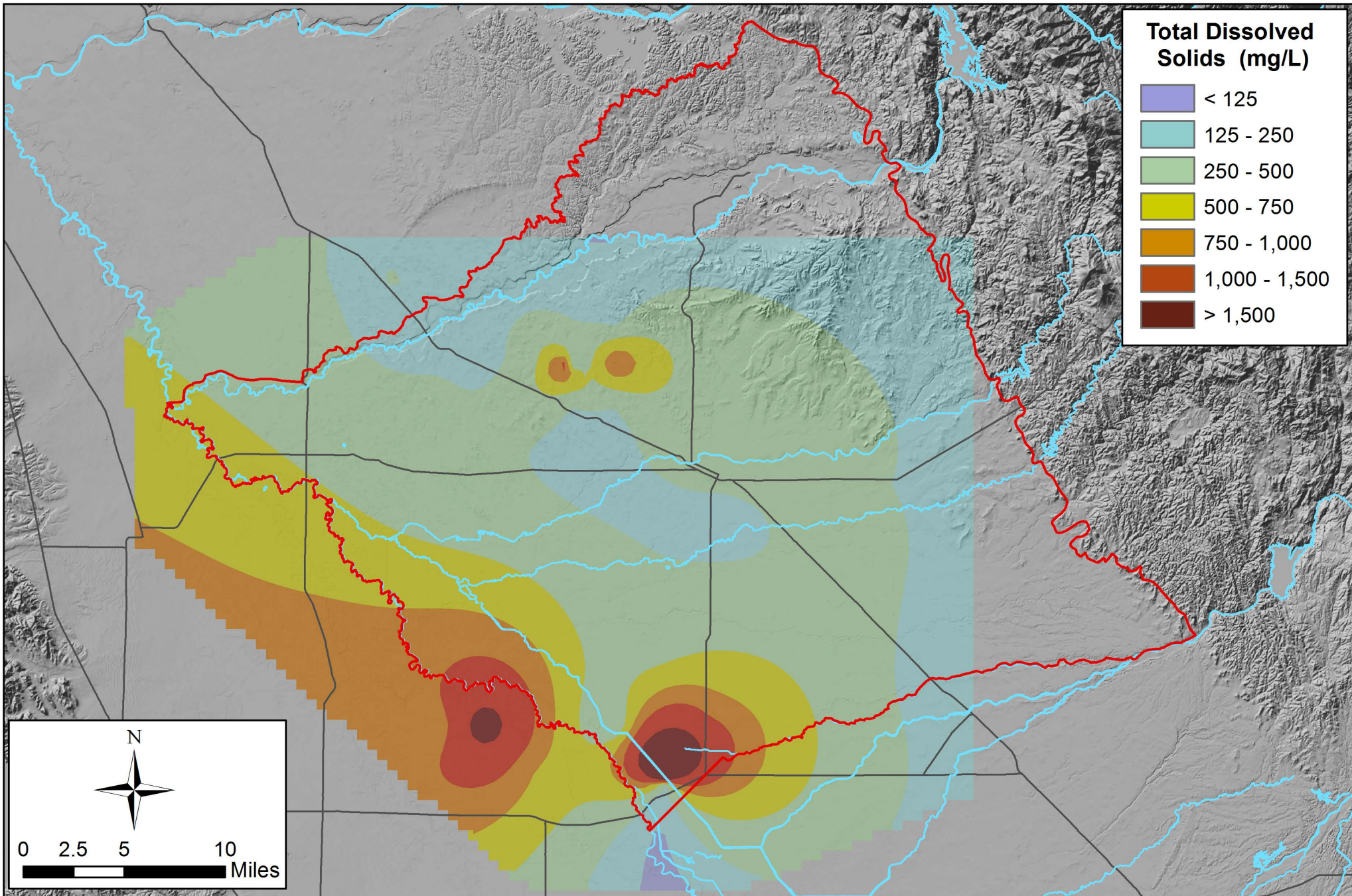
Note:  
IRWMP = Integrated Regional Water Management Plan.

Basemap modified from National Elevation Dataset seamless for California.

**GROUNDWATER QUALITY TYPE  
MERCED IRWM AREA  
Merced IRWMP  
Merced County, California**

2013	Figure <b>8</b>
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**Notes:**

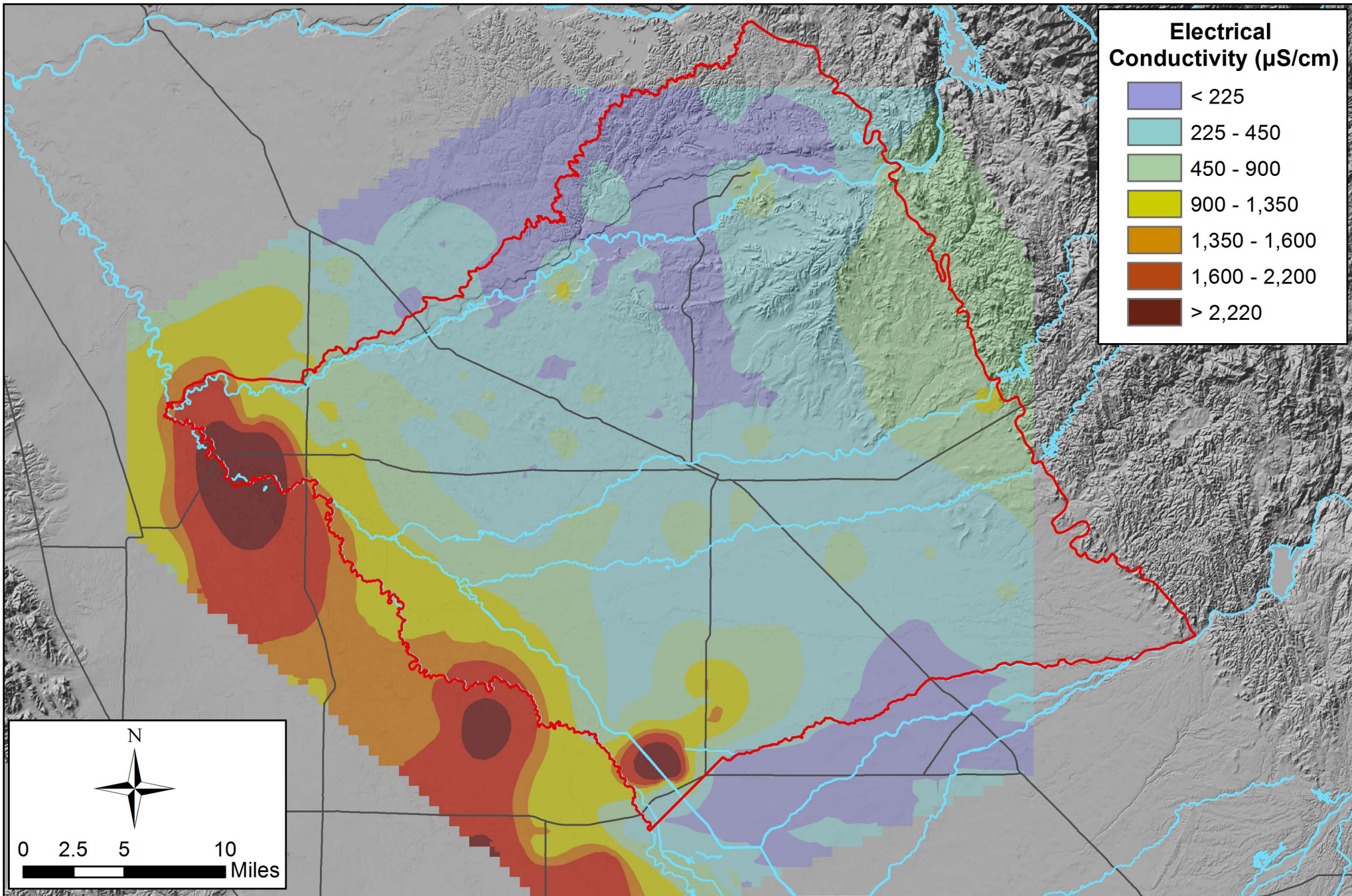
- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) SMCL: Recommended = 500 mg/L, Upper = 1,000 mg/L, Short Term = 1,500 mg/L

**5-Year Average Distribution of  
Total Dissolved Solids in Groundwater**

2013

Figure 9





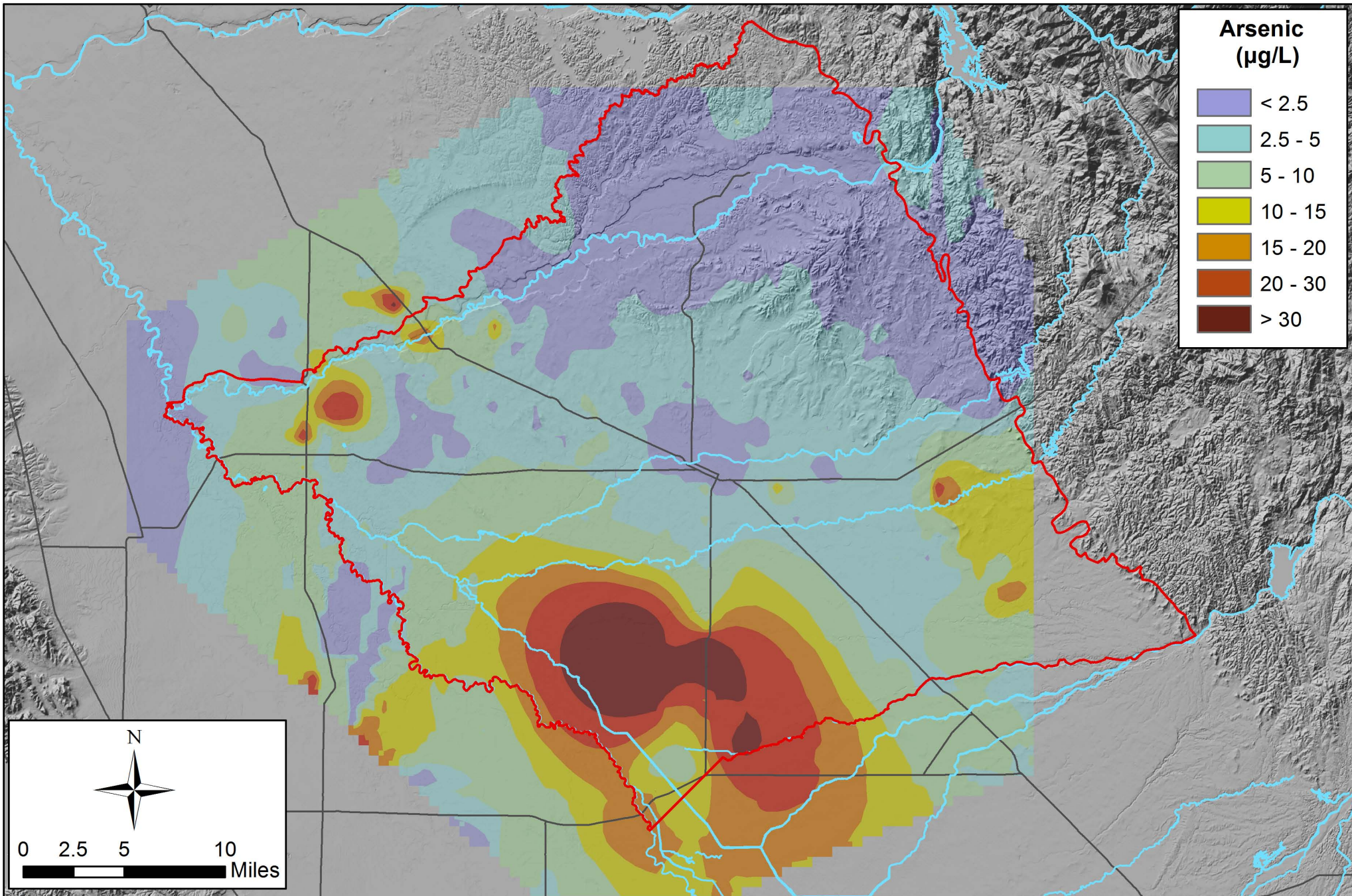
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) SMCL: Recommended = 900  $\mu\text{S}/\text{cm}$ , Upper = 1,600  $\mu\text{S}/\text{cm}$ , Short Term = 2,200  $\mu\text{S}/\text{cm}$

**5-Year Average Distribution of  
Electrical Conductivity in Groundwater**

2013

Figure 10



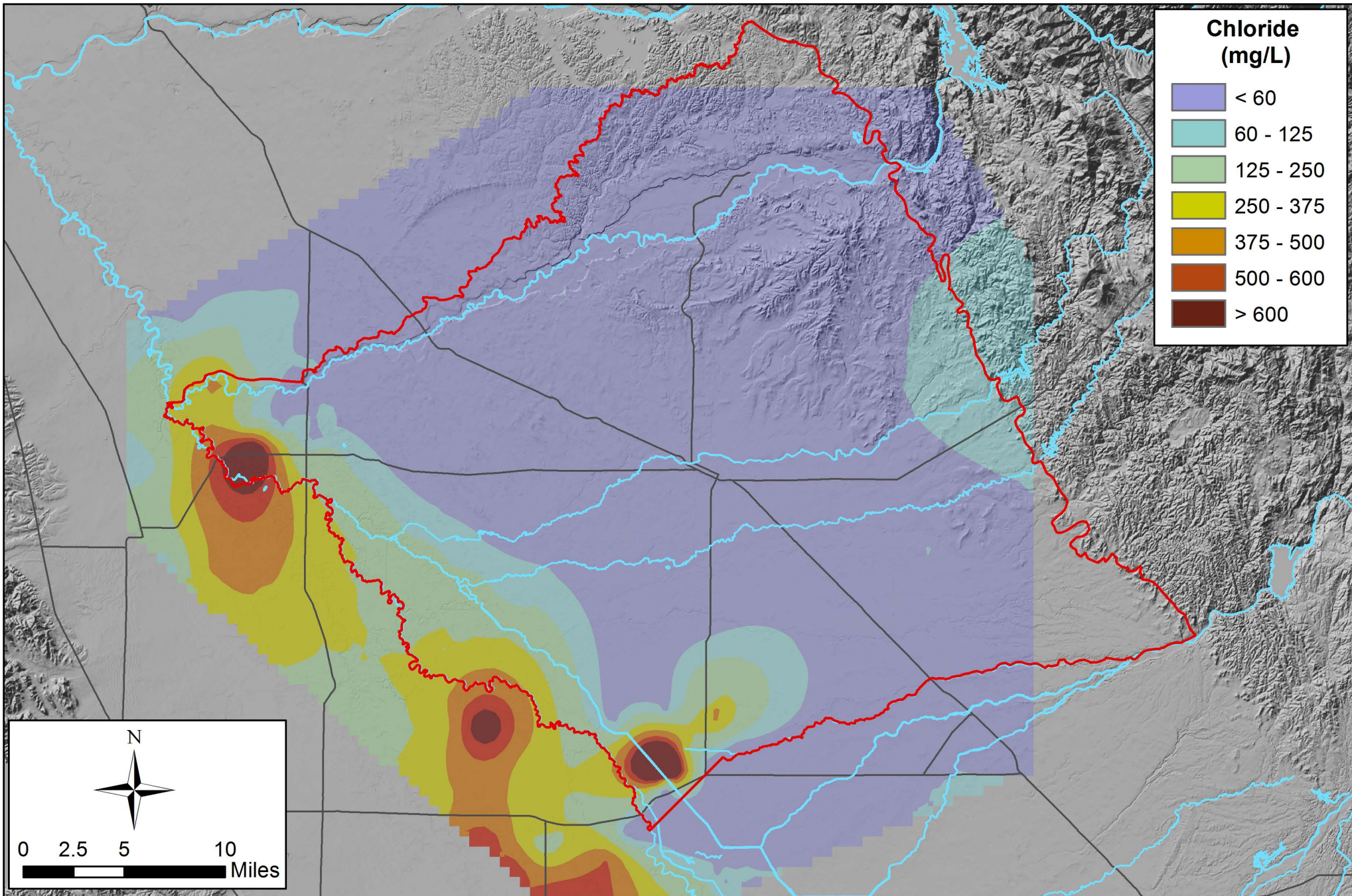
**Notes:**

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 10 µg/L

**5-Year Average Distribution of Arsenic in Groundwater**

2013

Figure 11



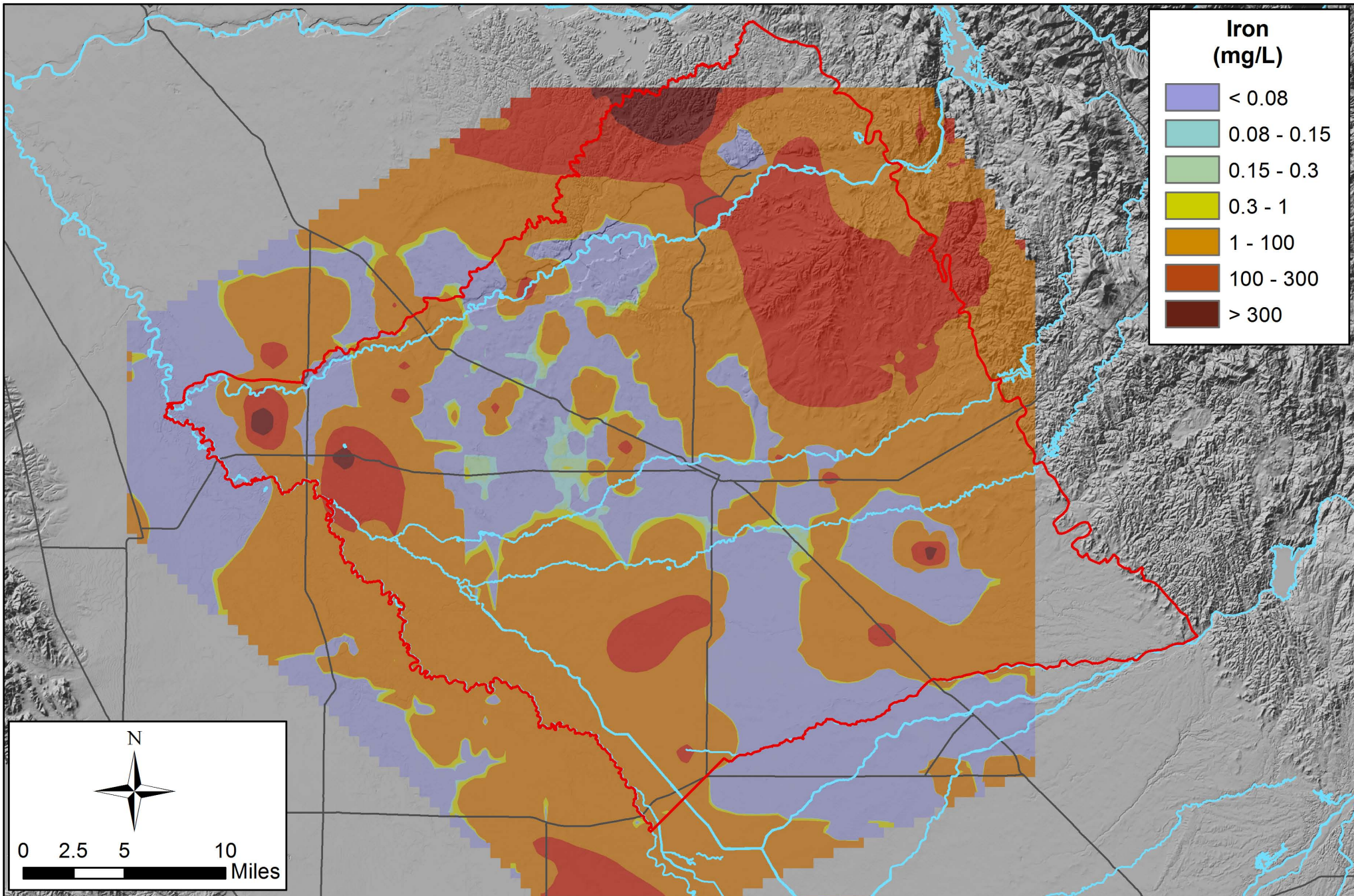
**Notes:**

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) SMCL: Recommended = 250 mg/L, Upper = 500 mg/L, Short Term = 600 mg/L

**5-Year Average Distribution of Chloride in Groundwater**

2013

Figure 12



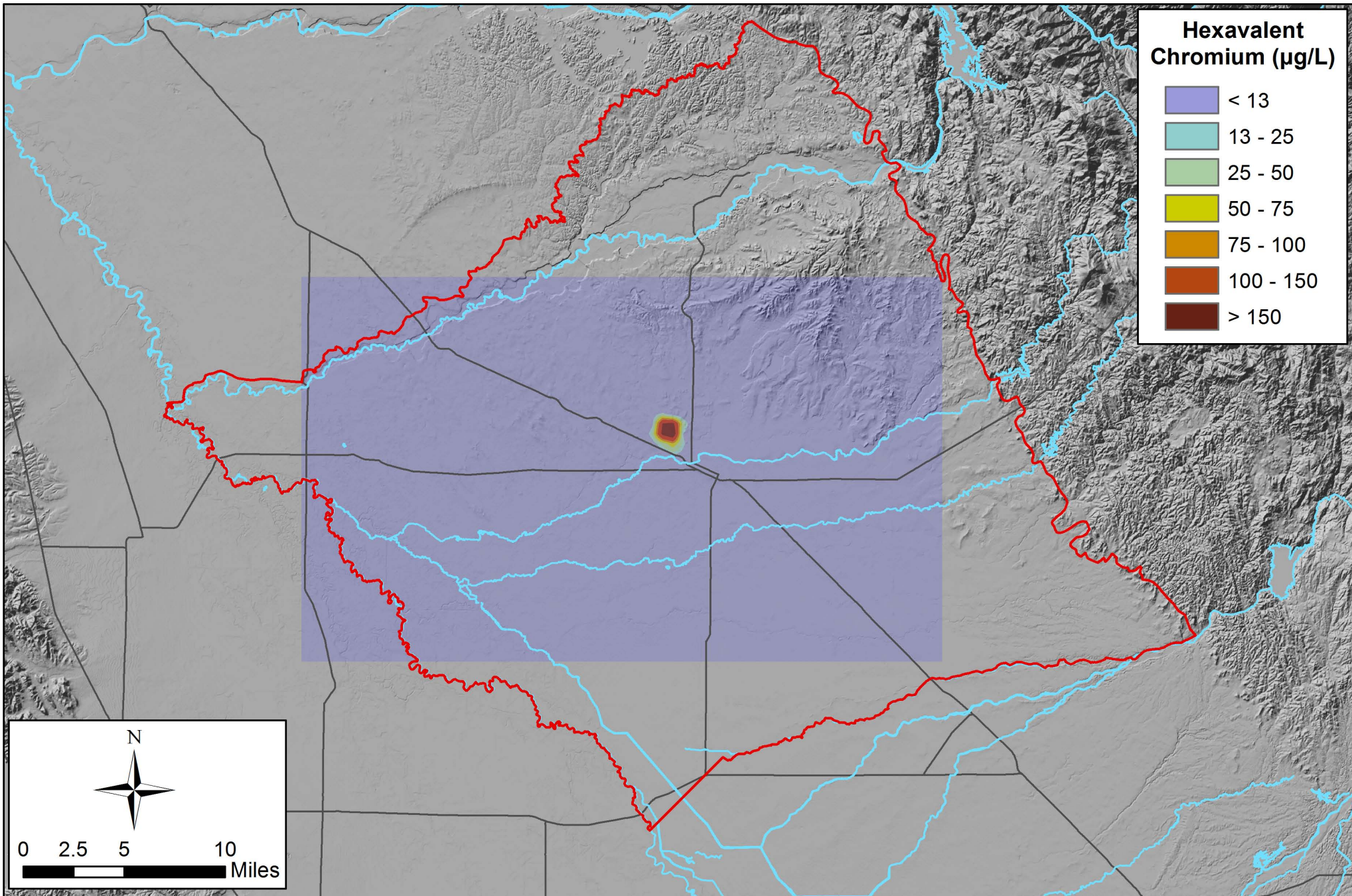
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) SMCL= 0.3 mg/L

**5-Year Average Distribution of  
Iron in Groundwater**

2013

Figure 13

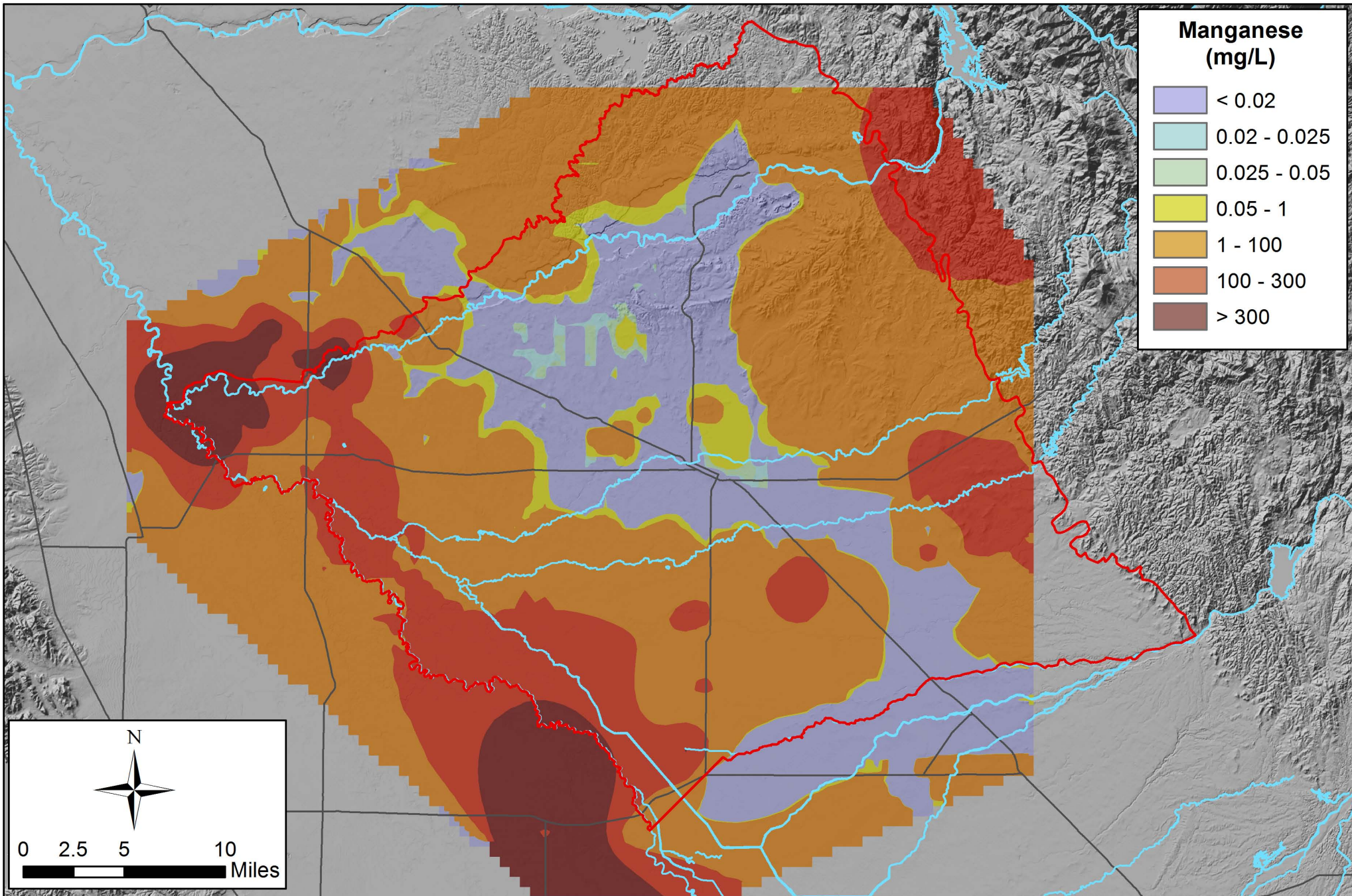


Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL for Total Chromium= 50 µg/L

**5-Year Average Distribution of  
Hexavalent Chromium in Groundwater**

2013  
Figure 14



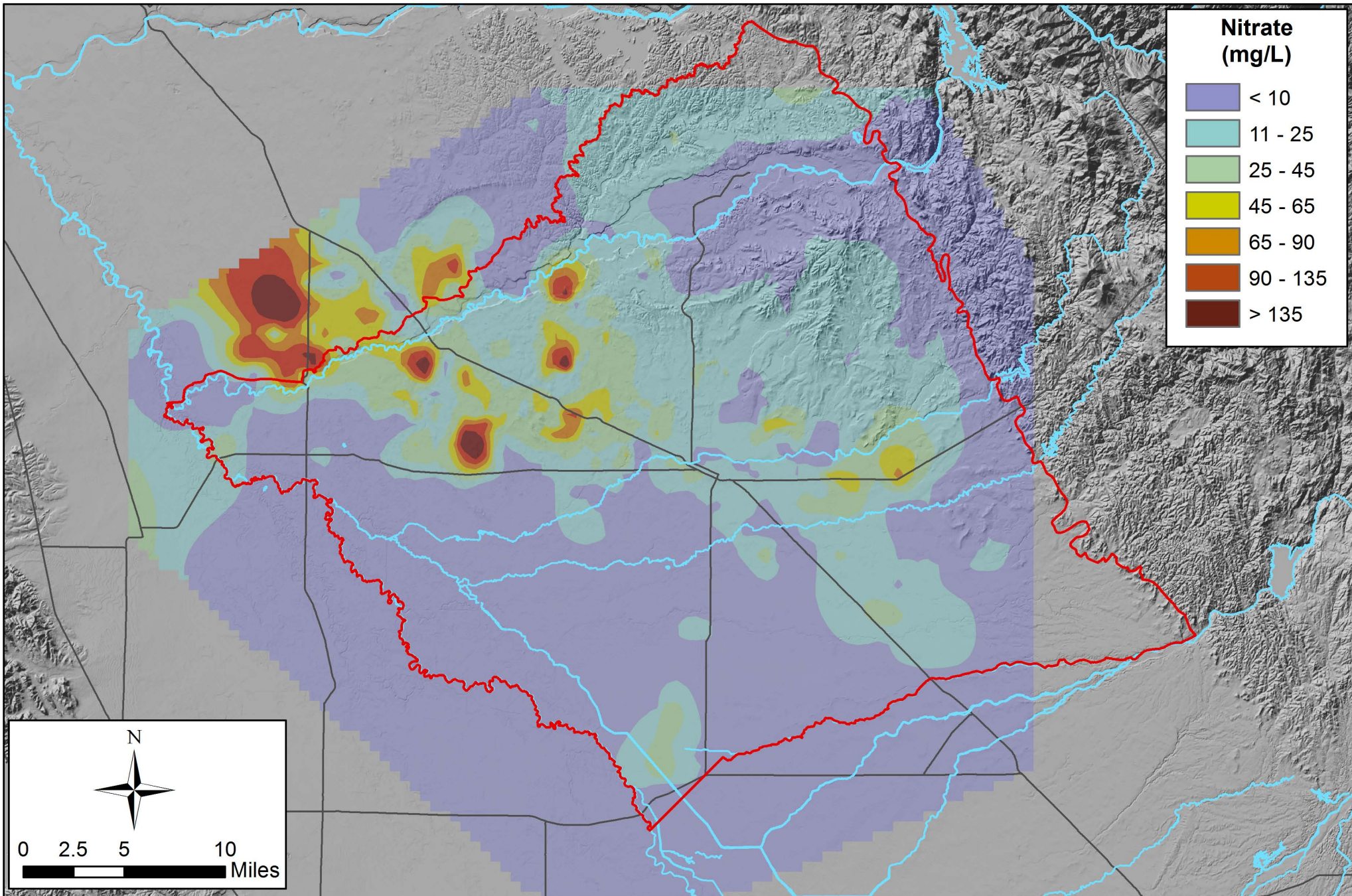
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) SMCL= 0.05 mg/L

**5-Year Average Distribution of Manganese in Groundwater**

2013

Figure 15



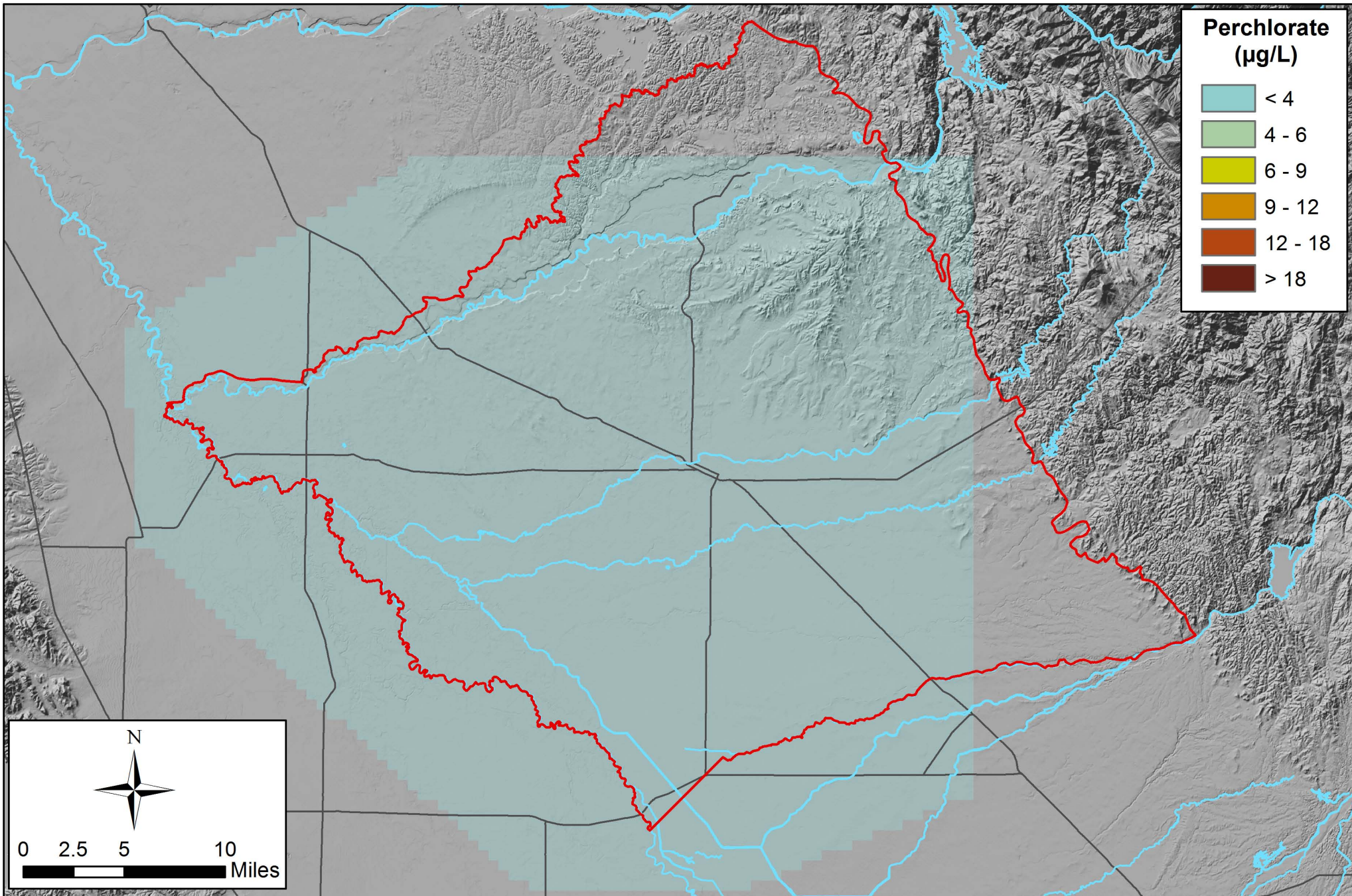
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 45 mg/L

**5-Year Average Distribution of Nitrate (as NO<sub>3</sub>) in Groundwater**

2013

Figure 16



Notes:

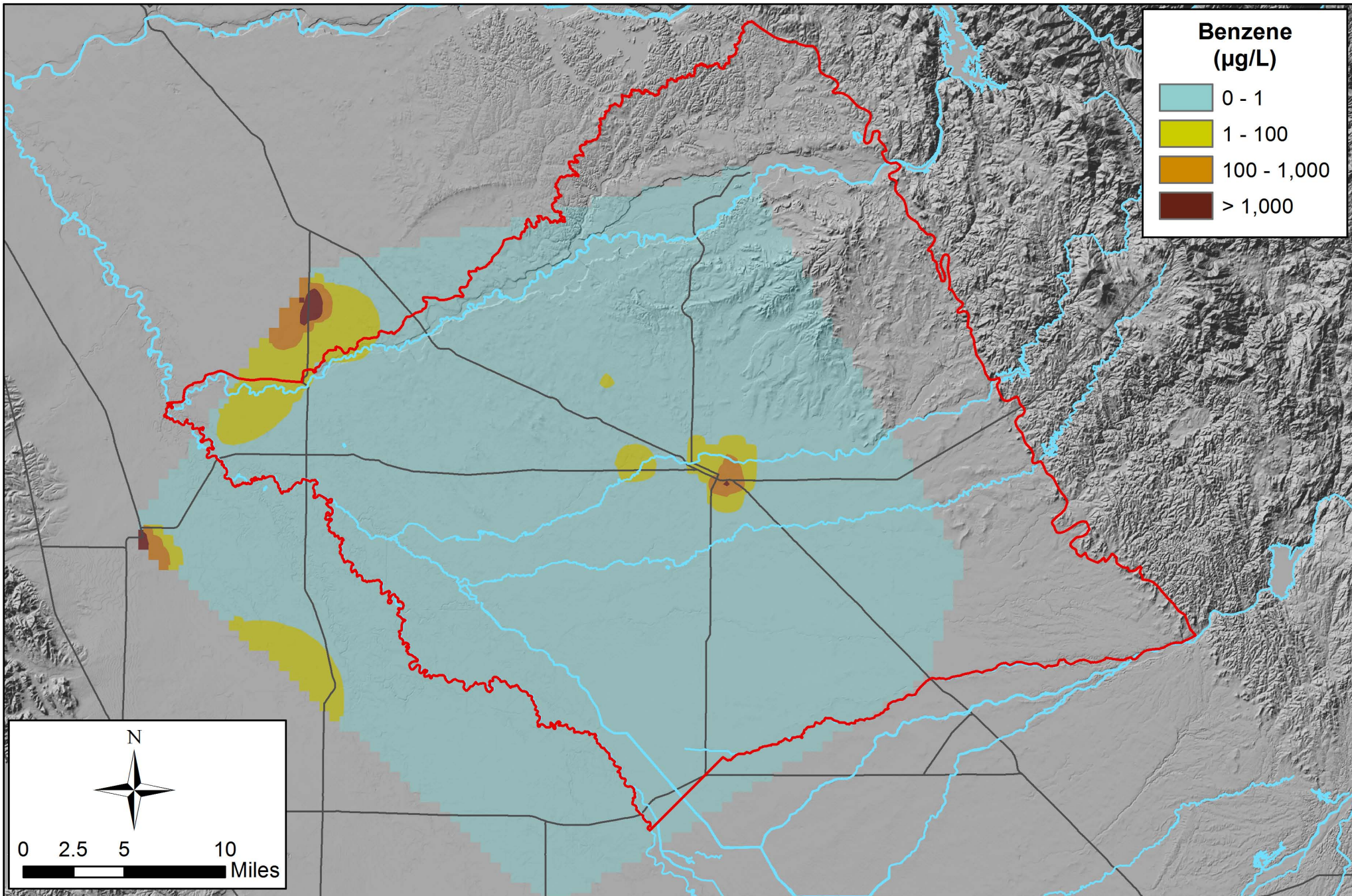
- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 6 µg/L

**5-Year Average Distribution of Perchlorate in Groundwater**

2013

Figure 17





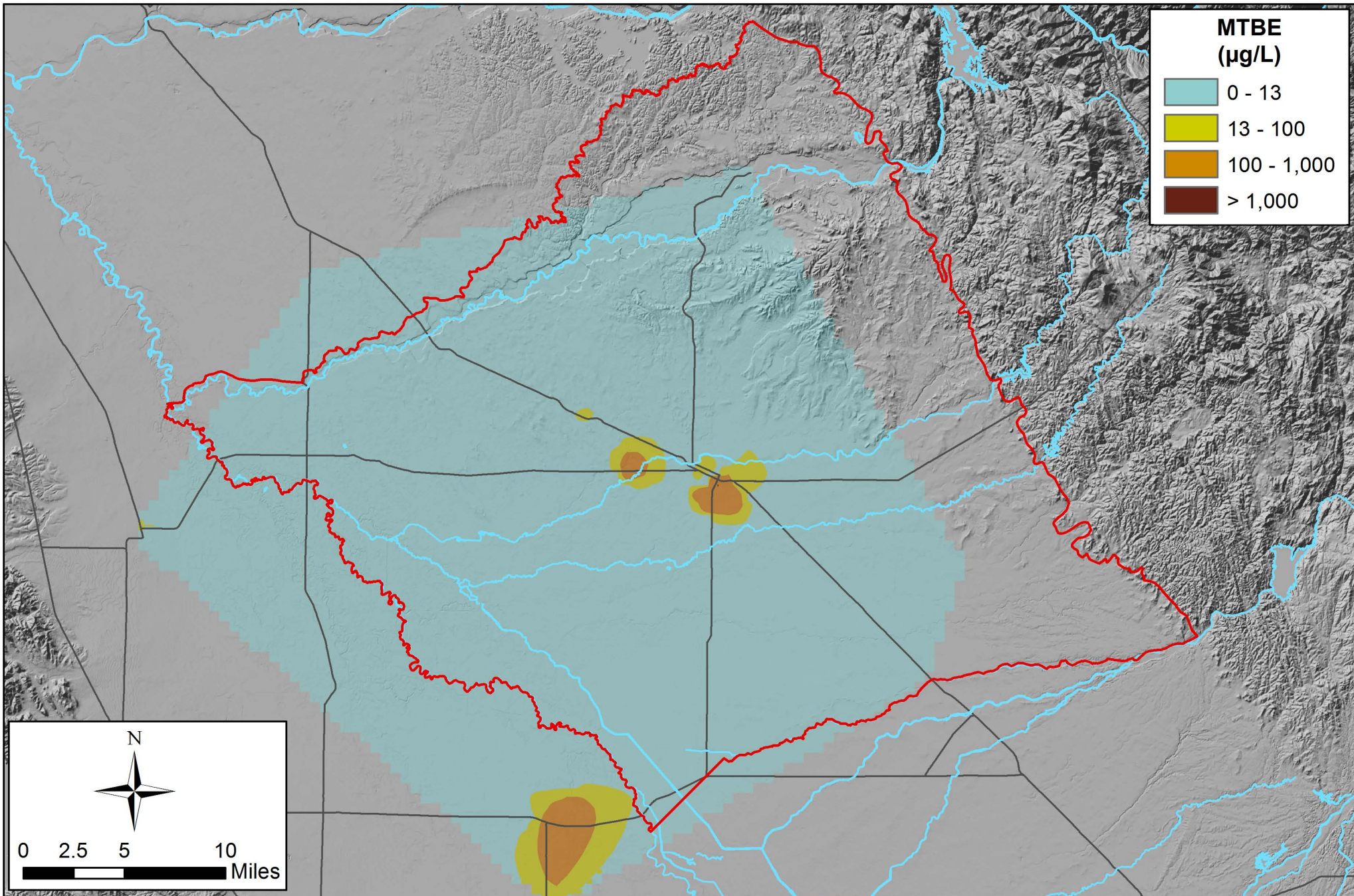
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 1 µg/L

**5-Year Average Distribution of Benzene in Groundwater**

2013

Figure 18



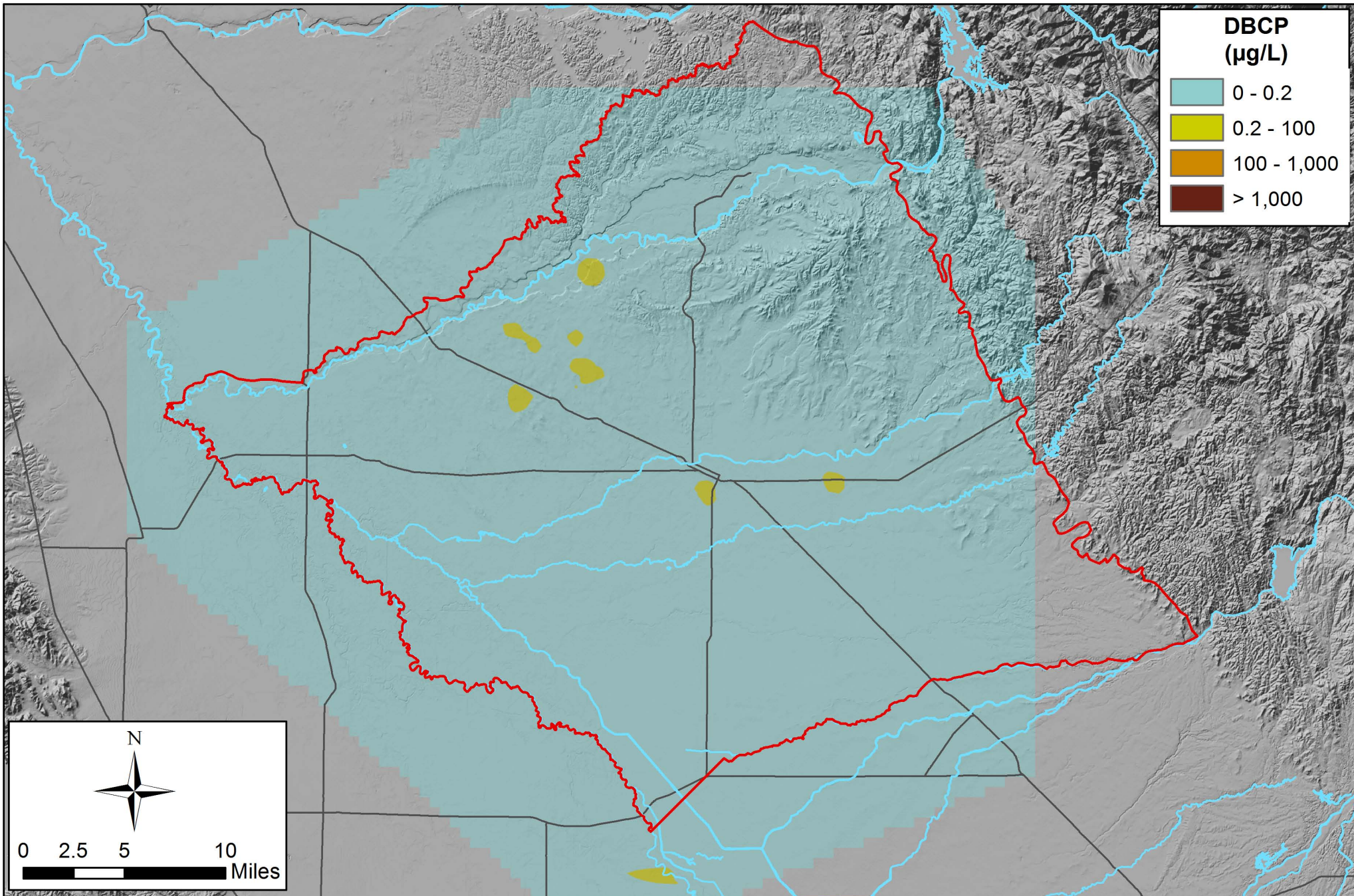
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 13 µg/L

**5-Year Average Distribution of  
MTBE in Groundwater**

2013

Figure 19



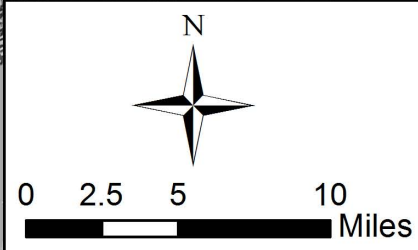
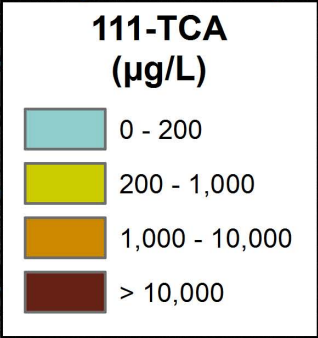
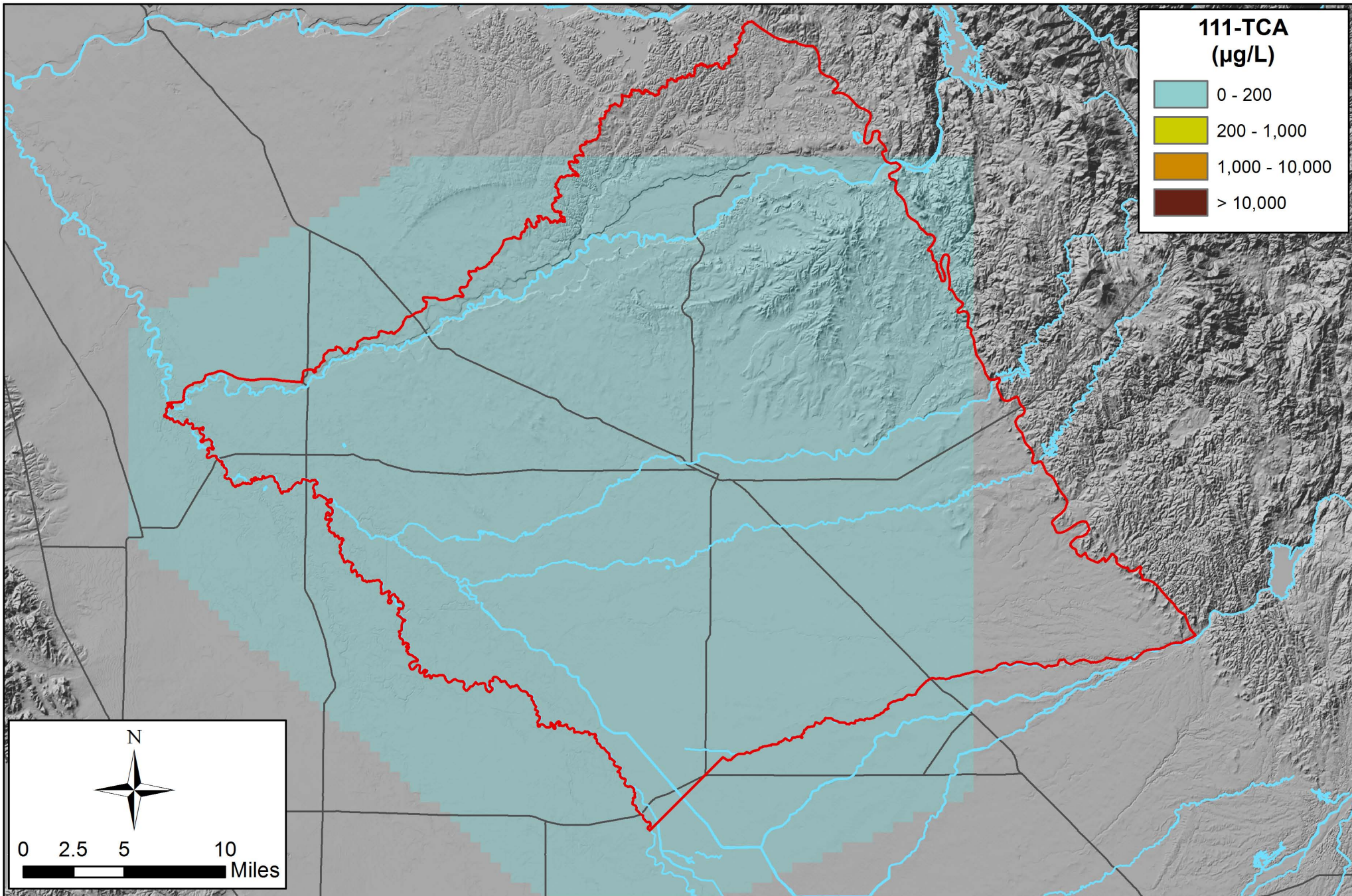
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 0.2 µg/L

**5-Year Average Distribution of DBCP in Groundwater**

2013

Figure 20



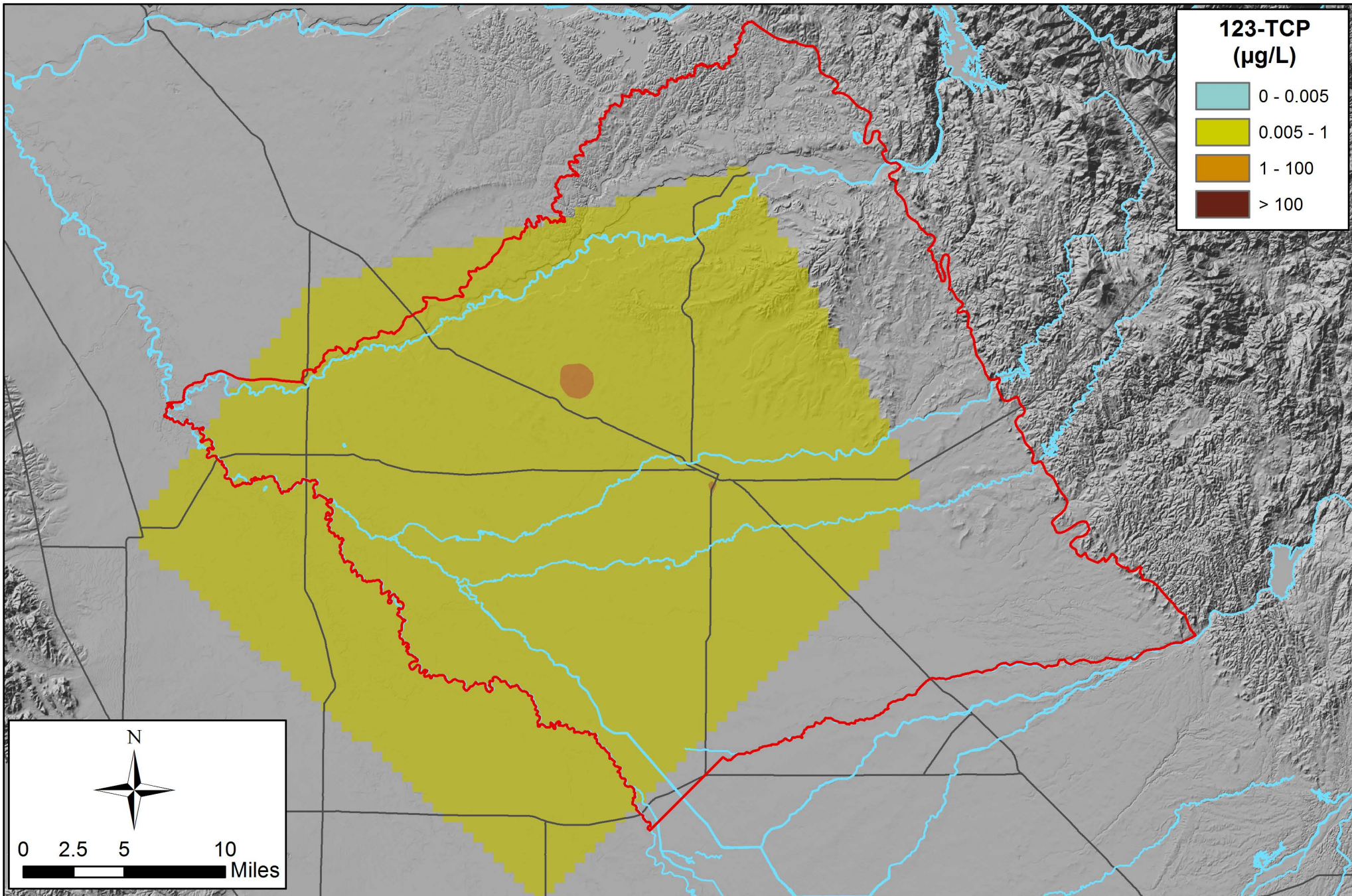
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 200 µg/L

**5-Year Average Distribution of  
111-TCA in Groundwater**

2013

Figure 21



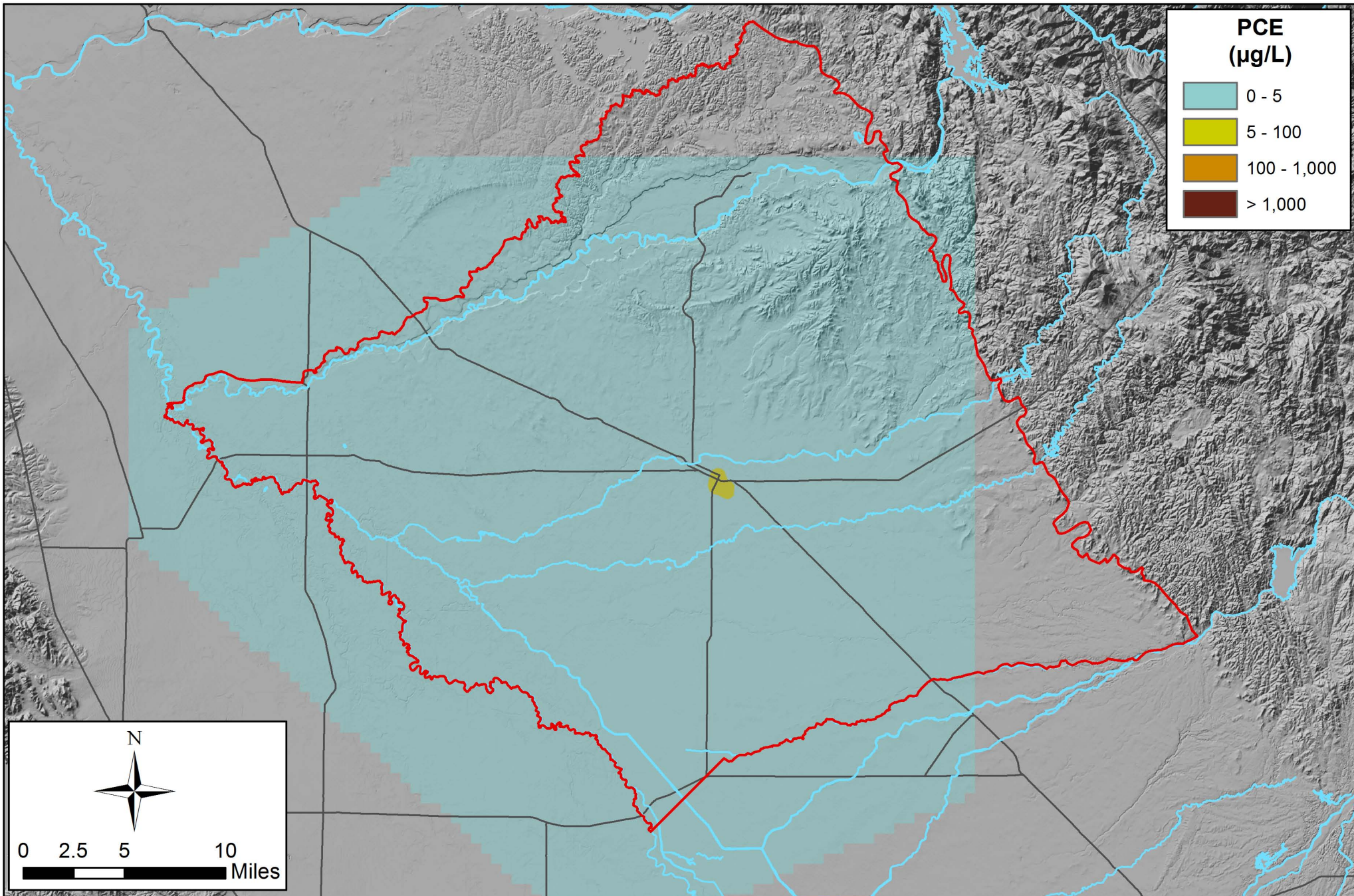
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) Notification Level = 0.005 µg/L

**5-Year Average Distribution of  
123-TCP in Groundwater**

2013

Figure 22



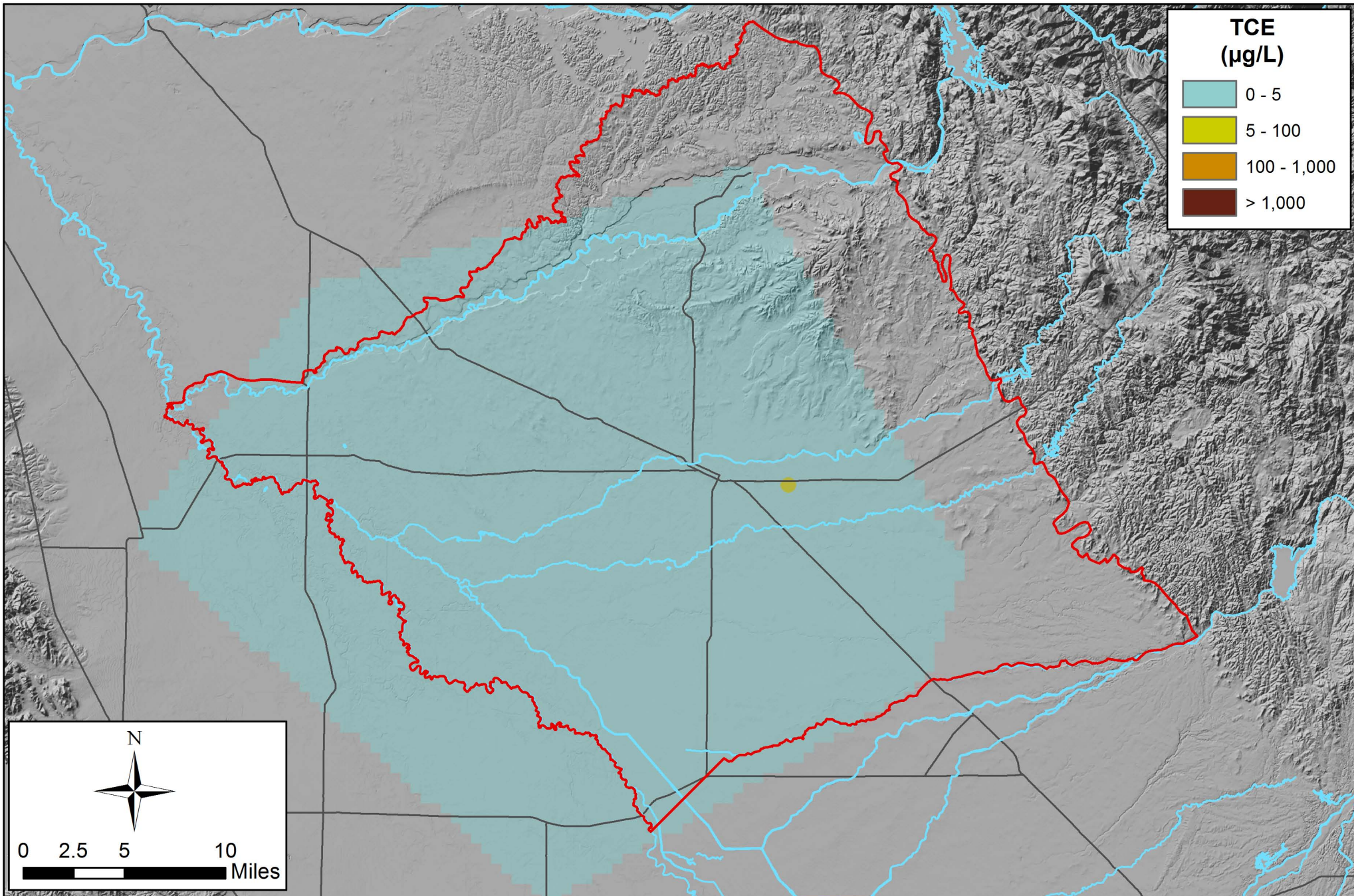
Notes:

- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 5 µg/L

**5-Year Average Distribution of PCE in Groundwater**

2013

Figure 23



Notes:

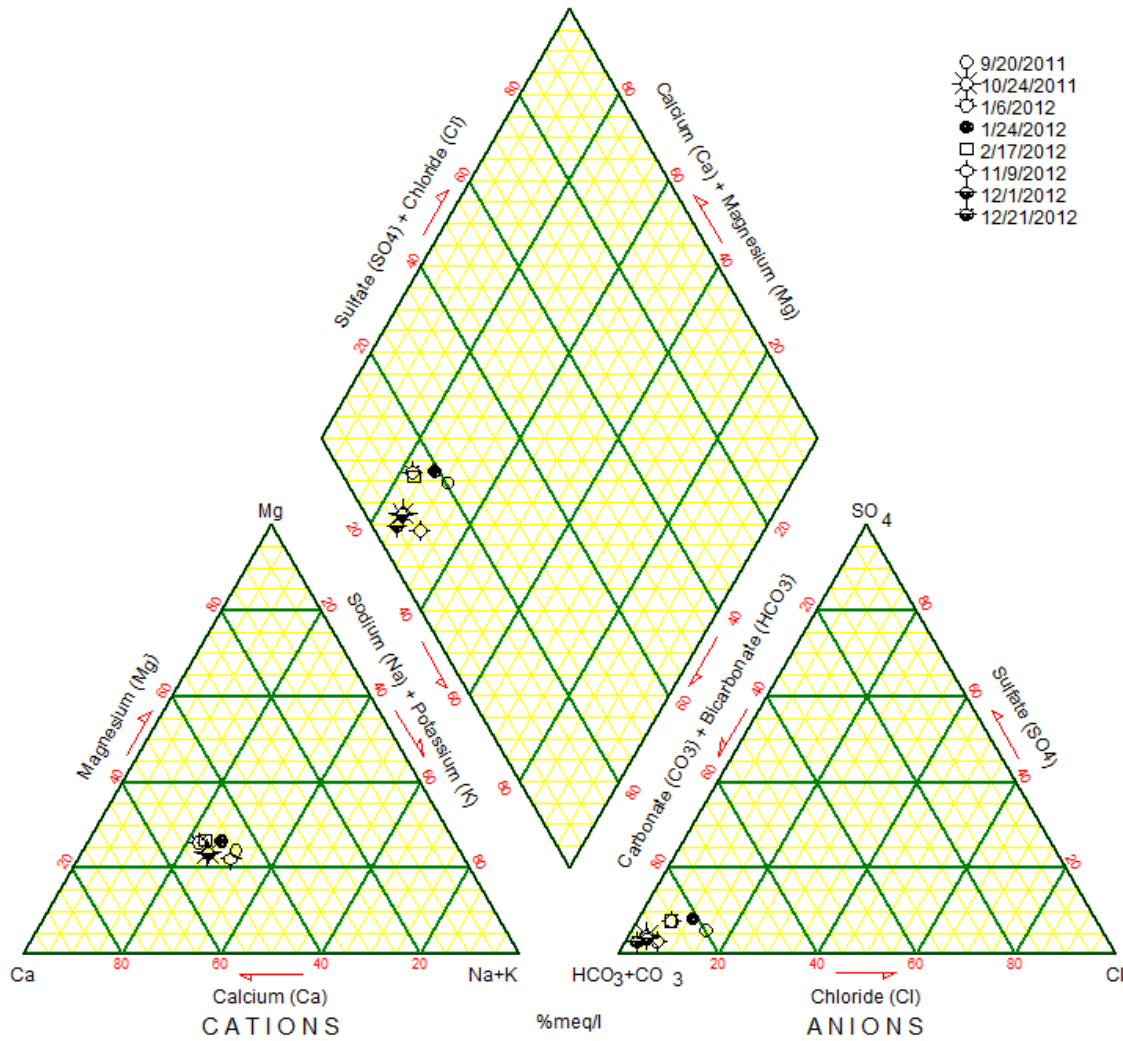
- 1) Refer to Section 2, Evaluation Methodology, for details of spatial and temporal averaging
- 2) Average of data collected between 2007 and 2012
- 3) Sources: Merced County Division of Environmental Health  
USGS GAMA Program  
State Water Board GeoTracker
- 4) MCL = 5 µg/L

**5-Year Average Distribution of  
TCE in Groundwater**

2013

Figure 24

### Piper Diagram

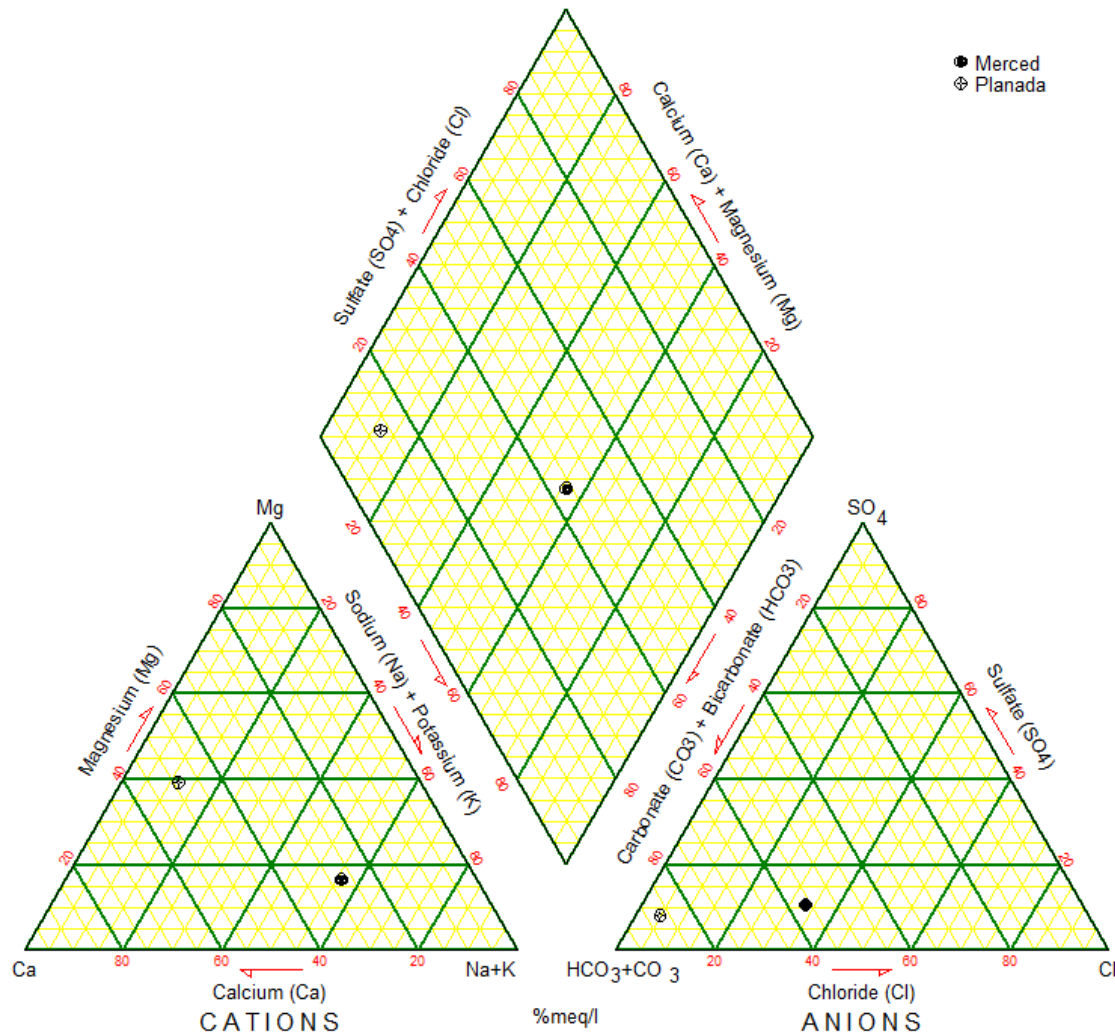


**Notes:**

MERCED RIVER SURFACE WATER PIPER DIAGRAM Merced IRWMP Merced County, California		
By: dmb	Date: 11/05/2012	Project No. FR1216040A
		Figure 25



### Piper Diagram

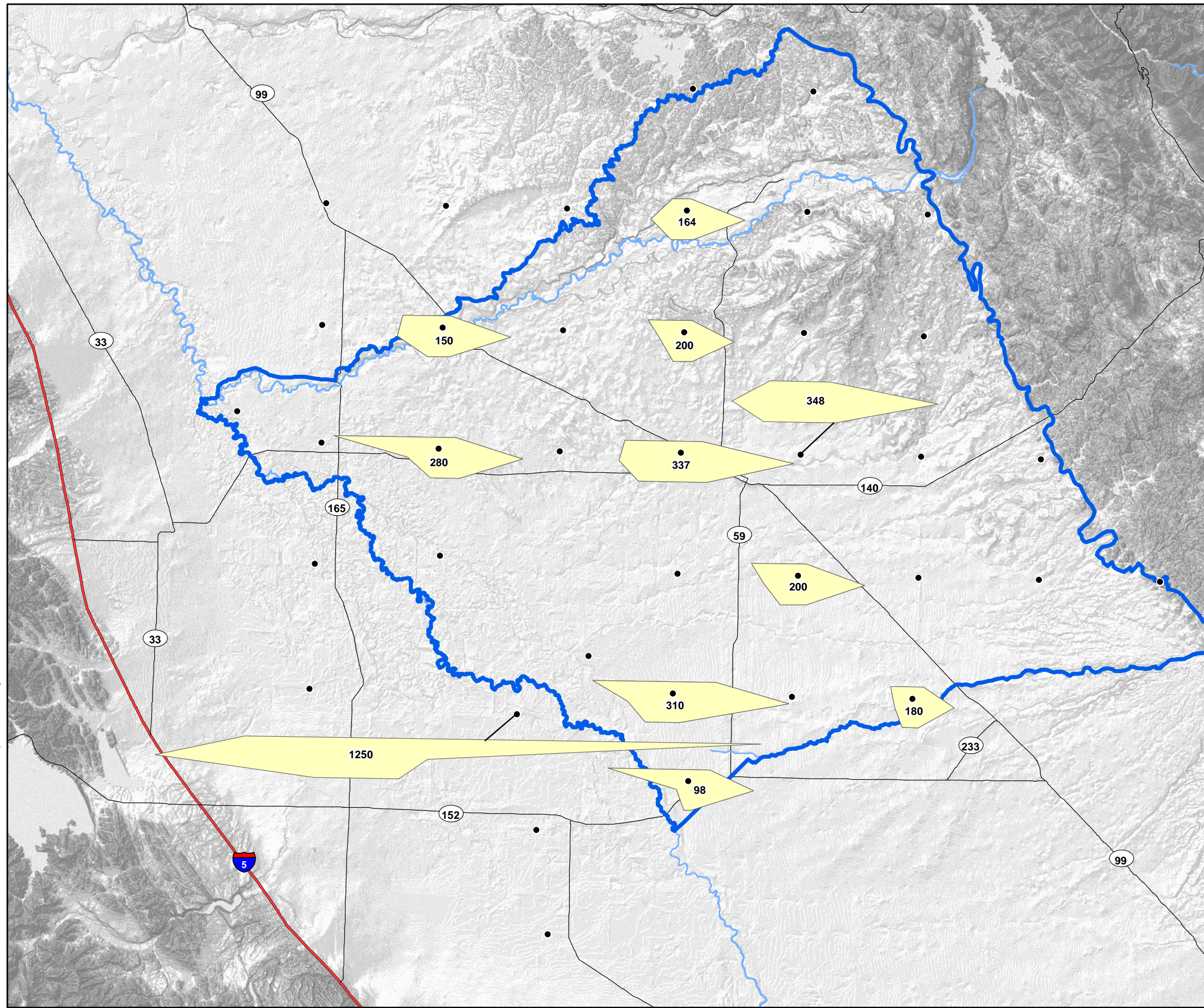


**Notes:**

- Merced
- ⊗ Planada

WASTEWATER TREATMENT PLANT EFFLUENT PIPER DIAGRAM Merced IRWMP Merced County, California		
By: dmb	Date: 11/05/2012	Project No. FR1216040A
		Figure 26

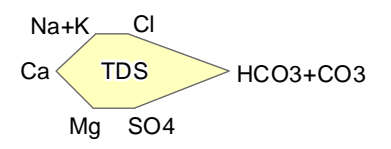
N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\_figX-27\_StiffDiagrams.s.mxd



**Explanation:**

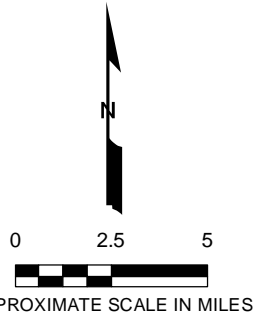
- Township/Range centroid
- Surface water feature
- Merced IRWM area

**Stiff Diagrams:**



**Notes:**

1. Stiff Diagrams: Na = sodium; K = potassium; Cl = chloride; Ca = calcium; HCO3 = bicarbonate; CO3 = carbonate; Mg = magnesium; SO4 = sulfate; and TDS = total dissolved solids.
2. TDS values shown in micrograms per liter.
3. IRWMP = Integrated Regional Water Management Plan.



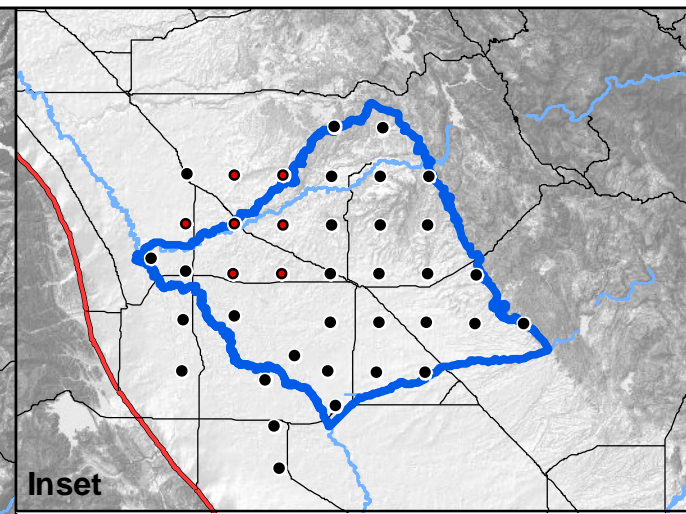
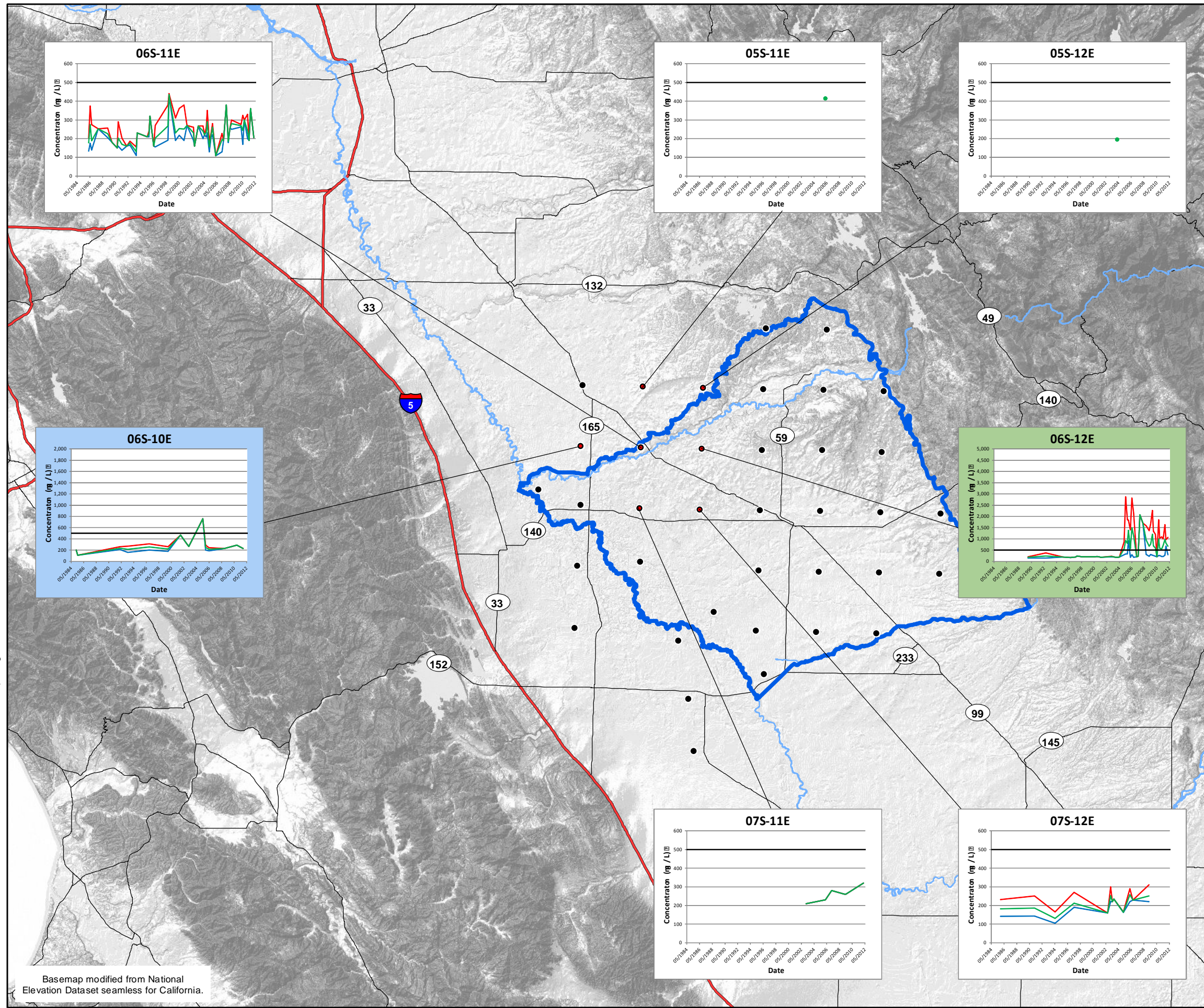
Basemap modified from National Elevation Dataset seamless for California.

**GROUNDWATER QUALITY  
STIFF DIAGRAMS  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
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## Appendix A

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig01a\_TDS.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum TDS concentration
- Mean TDS concentration
- Maximum TDS concentration
- Rec. SMCL for TDS (500 mg/l)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan
2. Total dissolved solids (TDS) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 600 mg/L  
 Blue: 0- 2,000 mg/L  
 Green: 0- 5,000 mg/L

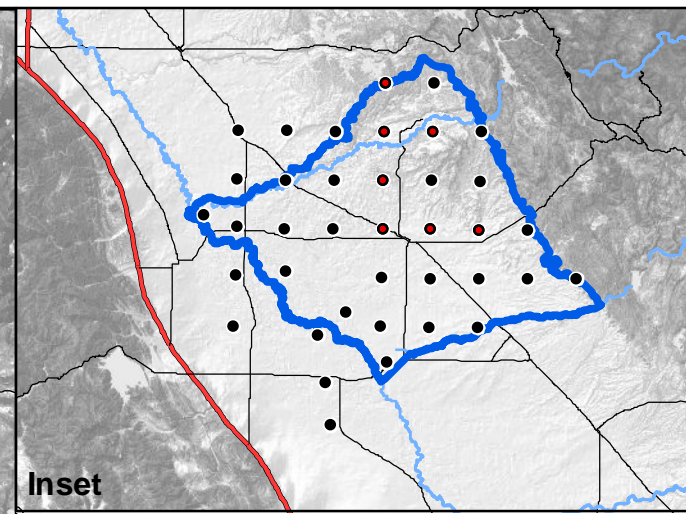
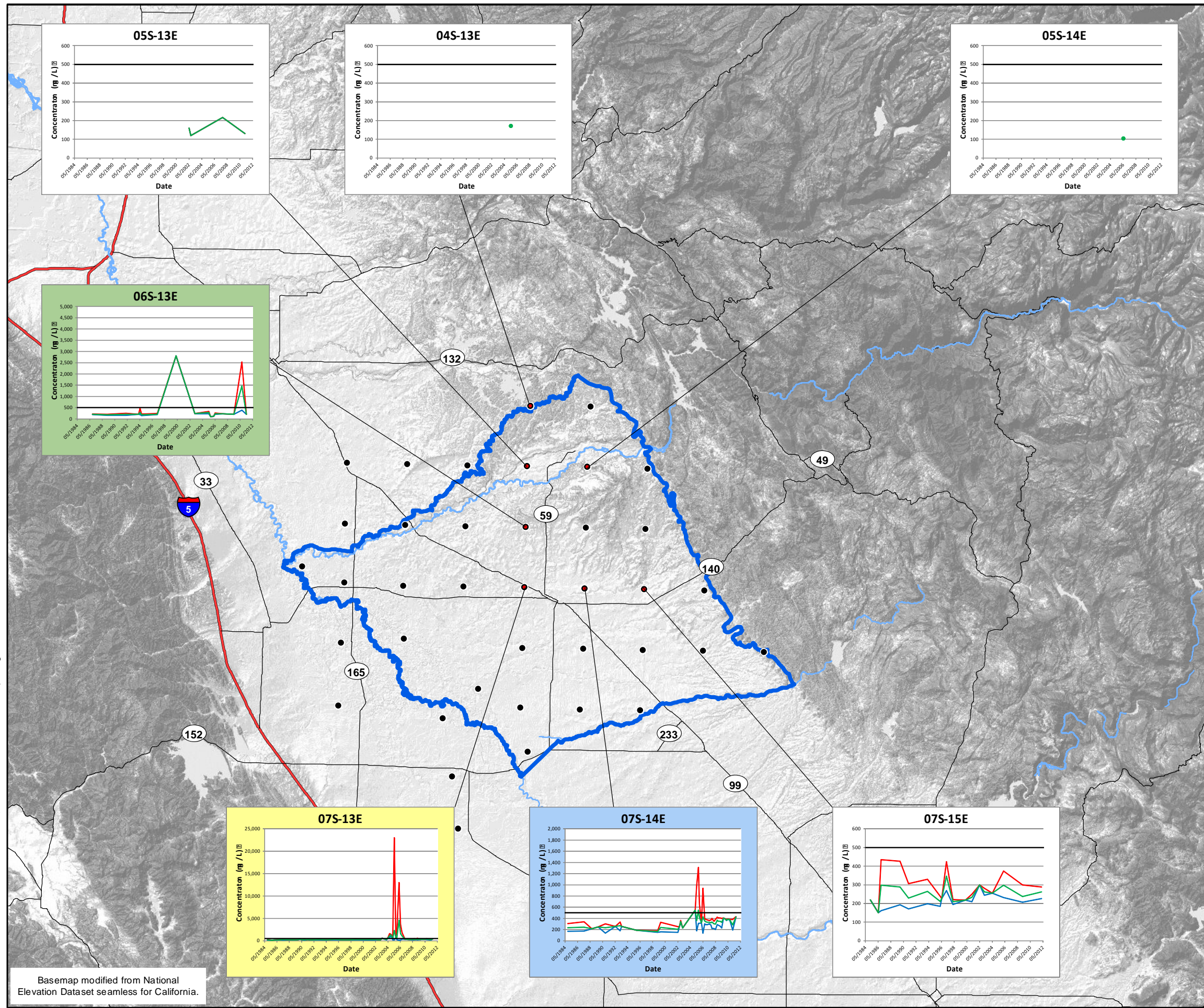
APPROXIMATE SCALE IN MILES

**TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>1a</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig01b\_TDS.mxd



**Explanation:**

- / ● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum TDS concentration
- Mean TDS concentration
- Maximum TDS concentration
- Rec. SMCL for TDS (500 mg/l)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Total dissolved solids (TDS) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 600 mg/L  
 Blue: 0- 2,000 mg/L  
 Green: 0- 5,000 mg/L  
 Yellow: 0- 25,000 mg/L

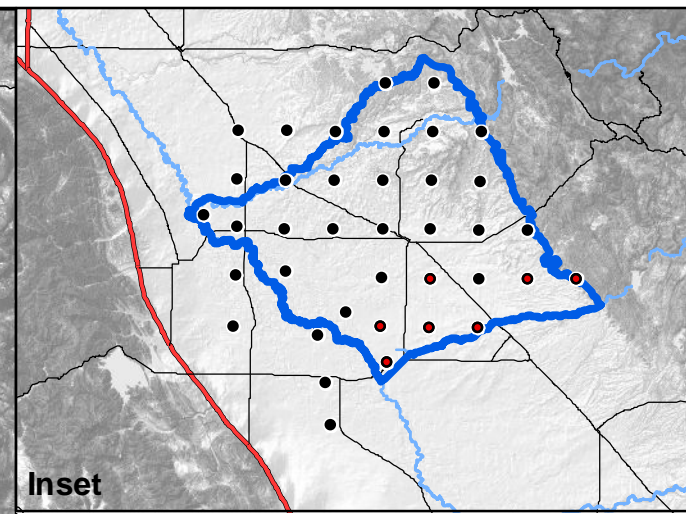
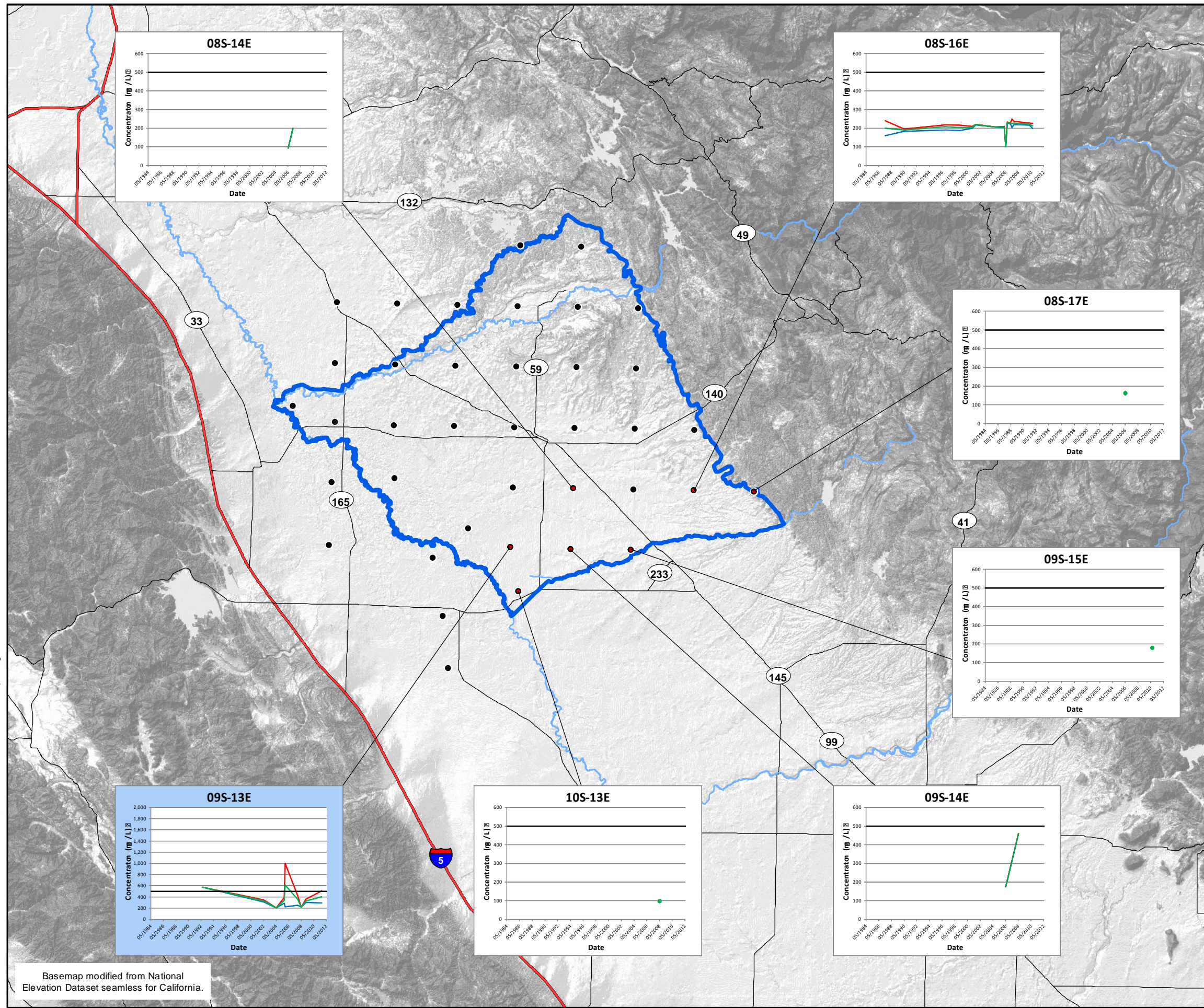
APPROXIMATE SCALE IN MILES

**TOTAL DISSOLVED SOLIDS (TDS)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>1b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig01c\_TDS.mxd



**Explanation:**

- / ● Township/Range centroid
- Surface water feature
- Merced IRWMP area

**Concentration Charts:**

- Minimum TDS concentration
- Mean TDS concentration
- Maximum TDS concentration
- Rec. SMCL for TDS (500 mg/l)

**Notes:**

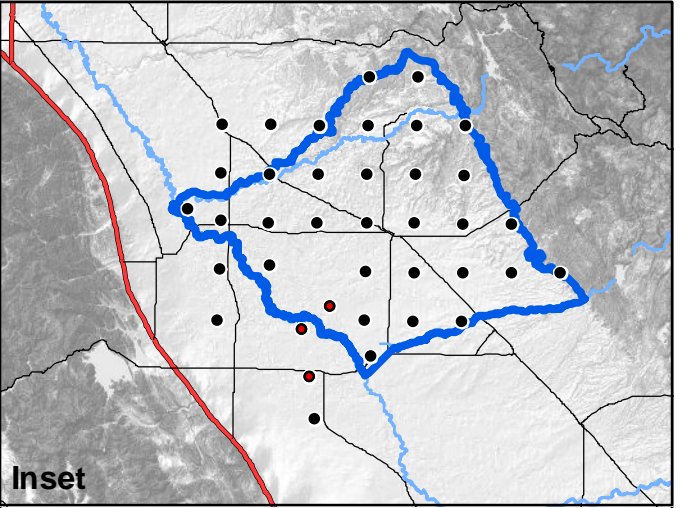
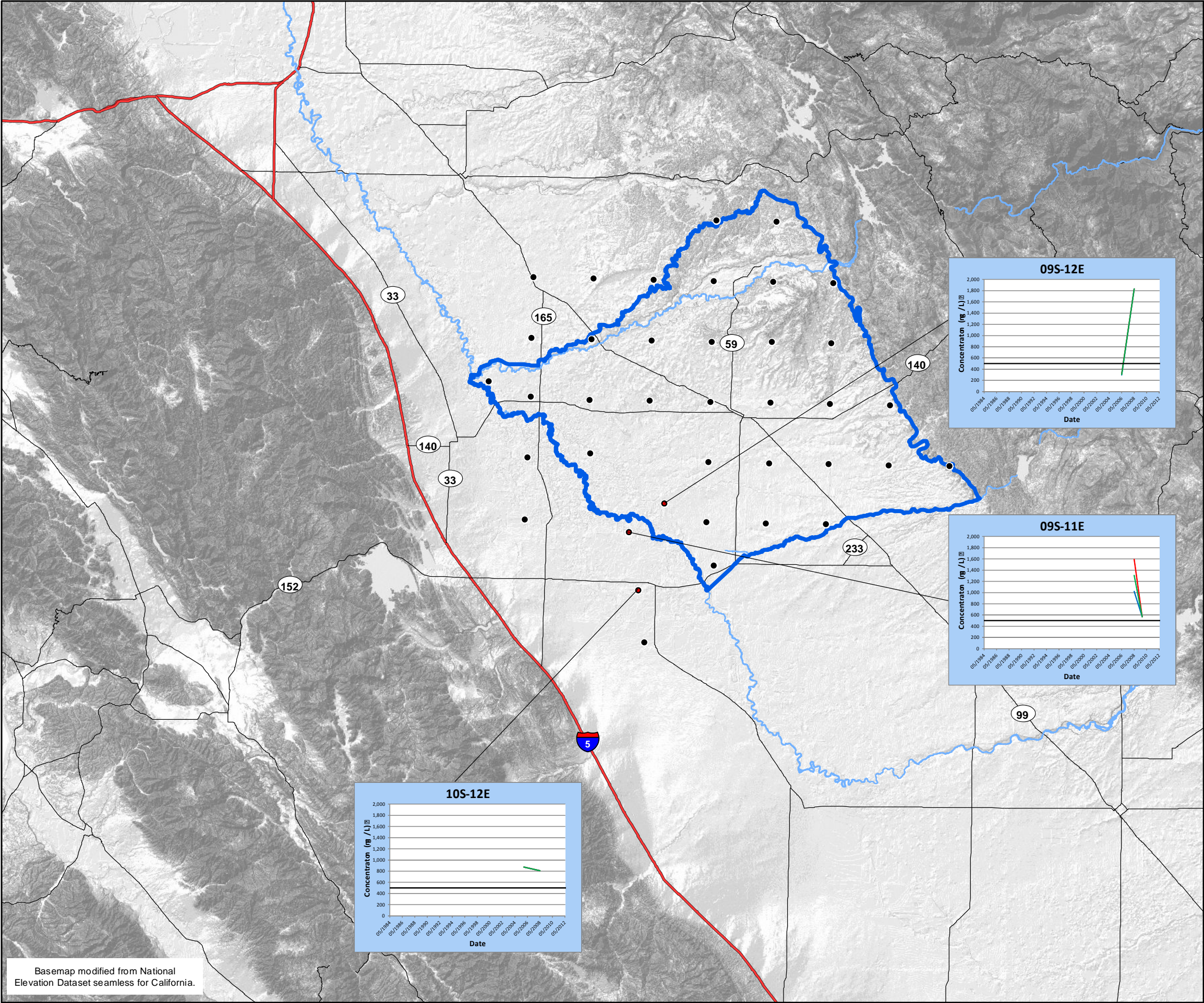
- IRWMP = Integrated Regional Water Management Plan.
- Total dissolved solids (TDS) concentrations shown in milligrams per liter (mg/L).
- Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
- Background color on graphs represent the y-axis range as follows:  
White: 0- 600 mg/L  
Blue: 0- 2,000 mg/L

APPROXIMATE SCALE IN MILES

<b>TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California</b>		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>1c</b>

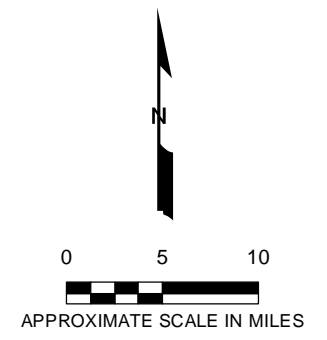
Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\_fig01d\_TDS.mxd



- Explanation:**
- /● Township/Range centroid
  - Surface water feature
  - Merced IRWMP area
- Concentration Charts:**
- Minimum TDS concentration
  - Mean TDS concentration
  - Maximum TDS concentration
  - Rec. SMCL for TDS (500 mg/l)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Total dissolved solids (TDS) concentrations shown in milligrams per liter (mg/L).
  3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health

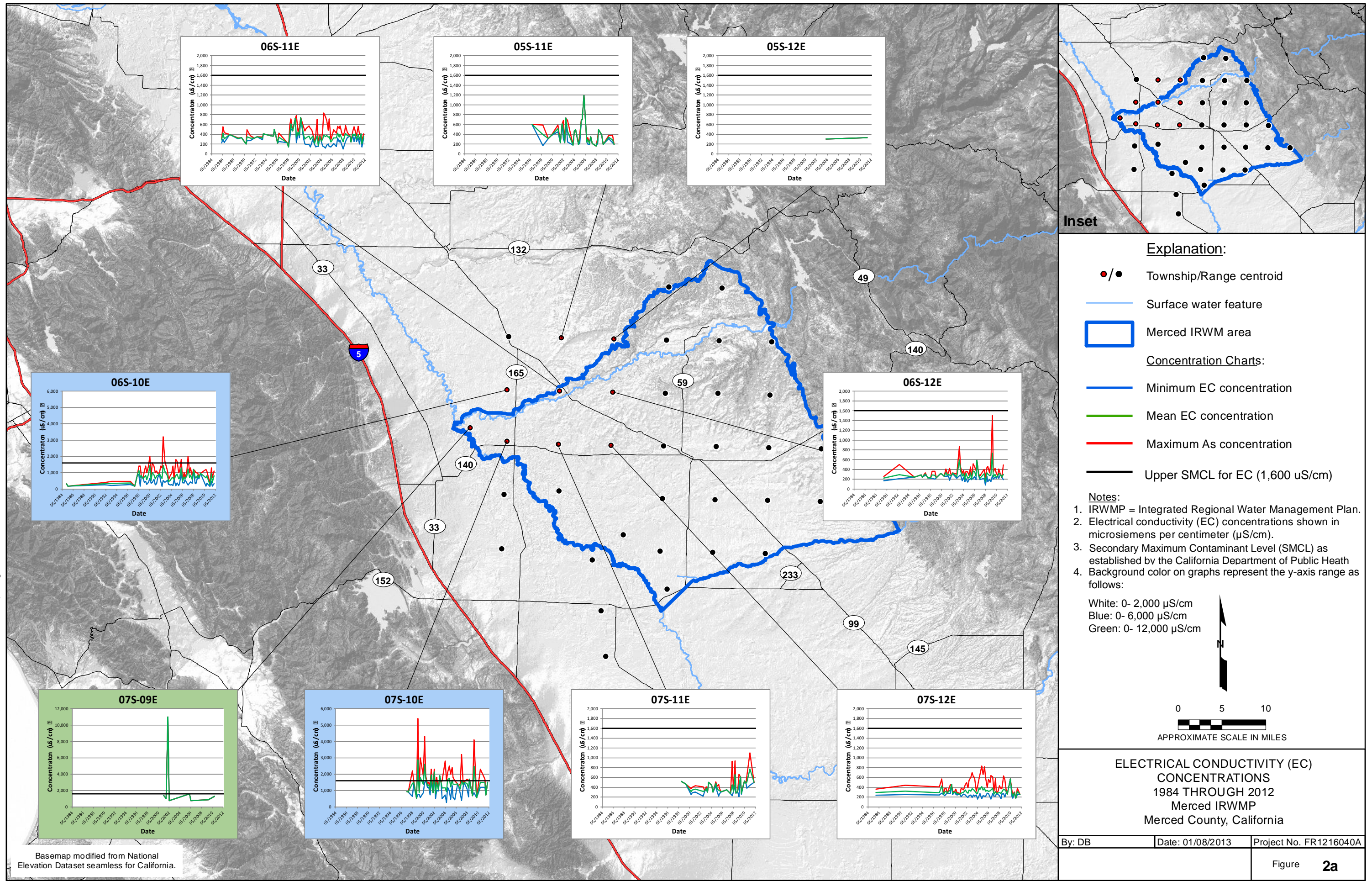


**TOTAL DISSOLVED SOLIDS (TDS)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 12/05/2012	Project No. FR1216040A
		Figure <b>1d</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig02a\_EC.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWMP area

**Concentration Charts:**

- Minimum EC concentration
- Mean EC concentration
- Maximum As concentration
- Upper SMCL for EC (1,600 uS/cm)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Electrical conductivity (EC) concentrations shown in microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 2,000  $\mu\text{S}/\text{cm}$   
 Blue: 0- 6,000  $\mu\text{S}/\text{cm}$   
 Green: 0- 12,000  $\mu\text{S}/\text{cm}$

0 5 10  
APPROXIMATE SCALE IN MILES

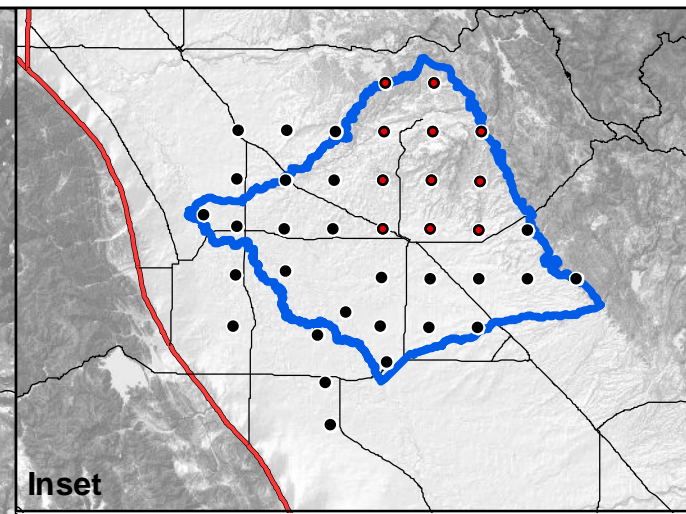
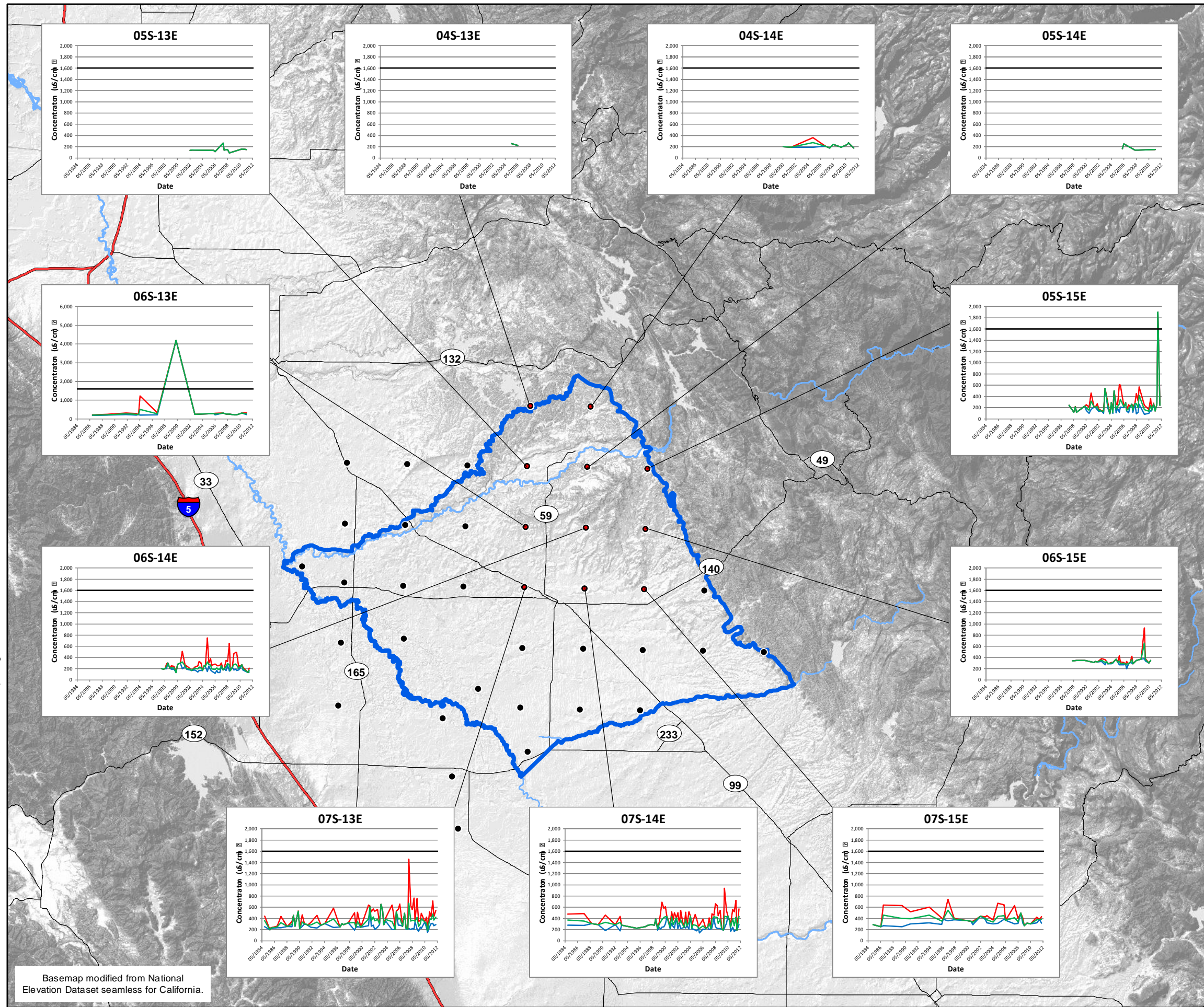
**ELECTRICAL CONDUCTIVITY (EC) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>2a</b>

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig02b\_EC.mxd



**Inset**

**Explanation:**


- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum EC concentration
- Mean EC concentration
- Maximum EC concentration
- Upper SMCL for EC (1,600 uS/cm)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Electrical conductivity (EC) concentrations shown in microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health

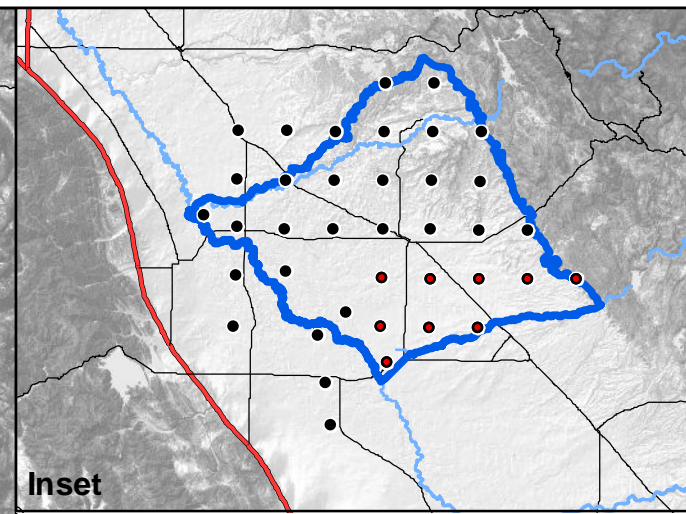
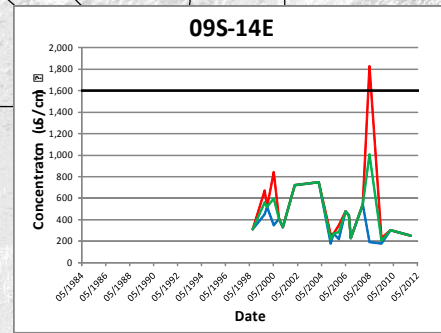
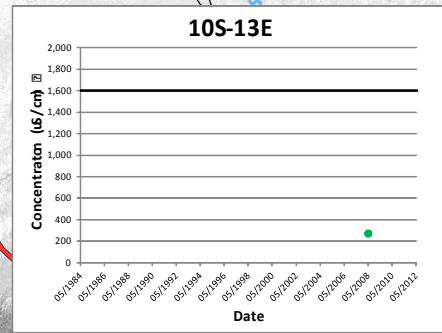
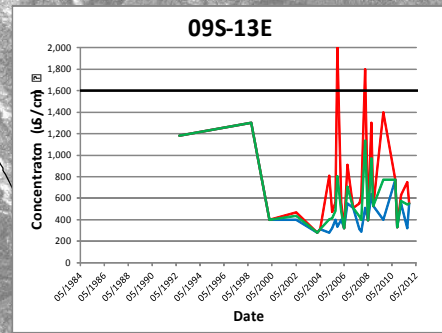
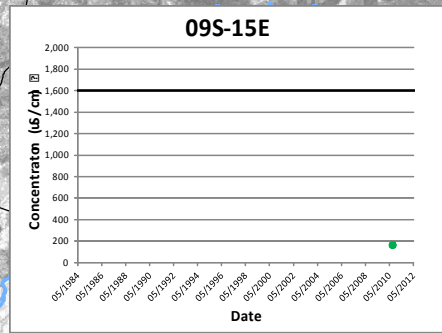
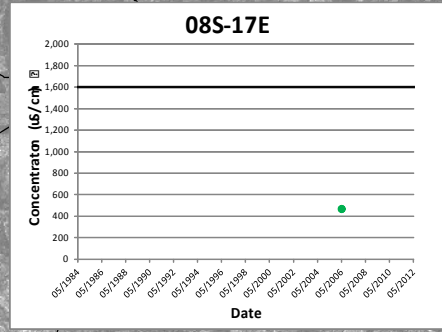
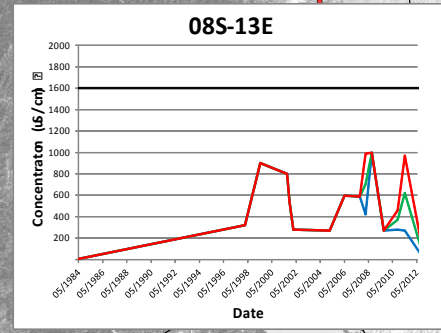
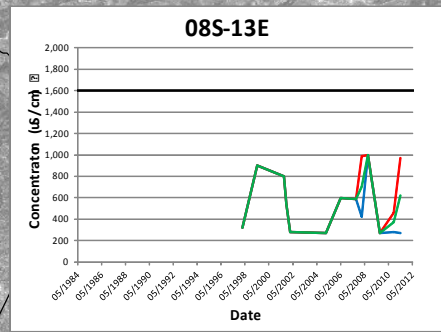
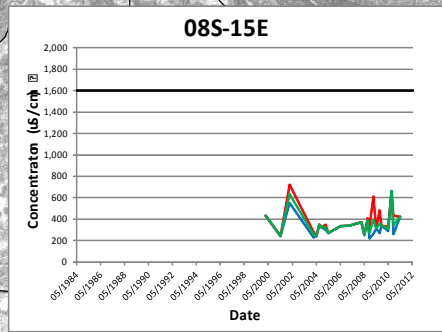
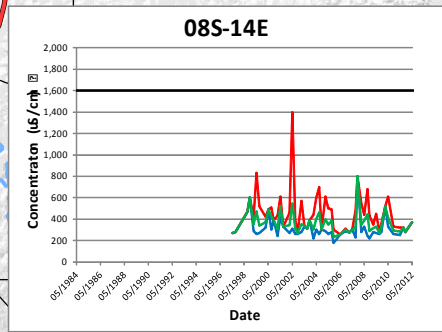
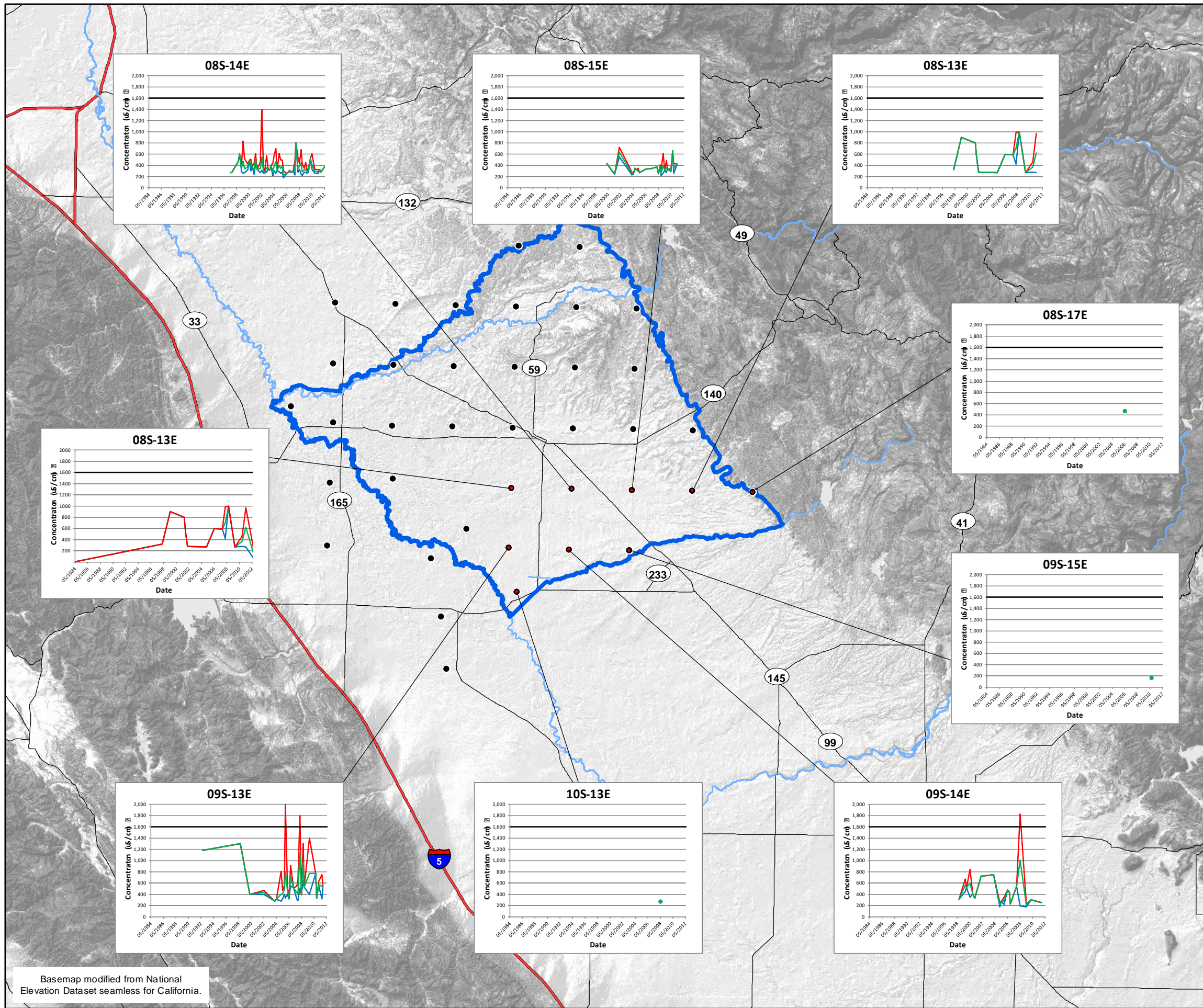
  
 0 5 10  
 APPROXIMATE SCALE IN MILES

**ELECTRICAL CONDUCTIVITY (EC)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>2b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\_fig02c\_EC.mxd



**Inset**

**Explanation:**

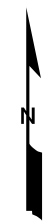
- /● Township/Range centroid
- Surface water feature
- Merced IRWMP area

**Concentration Charts:**

- Minimum EC concentration
- Mean EC concentration
- Maximum EC concentration
- Upper SMCL for EC (1,600 uS/cm)

**Notes:**

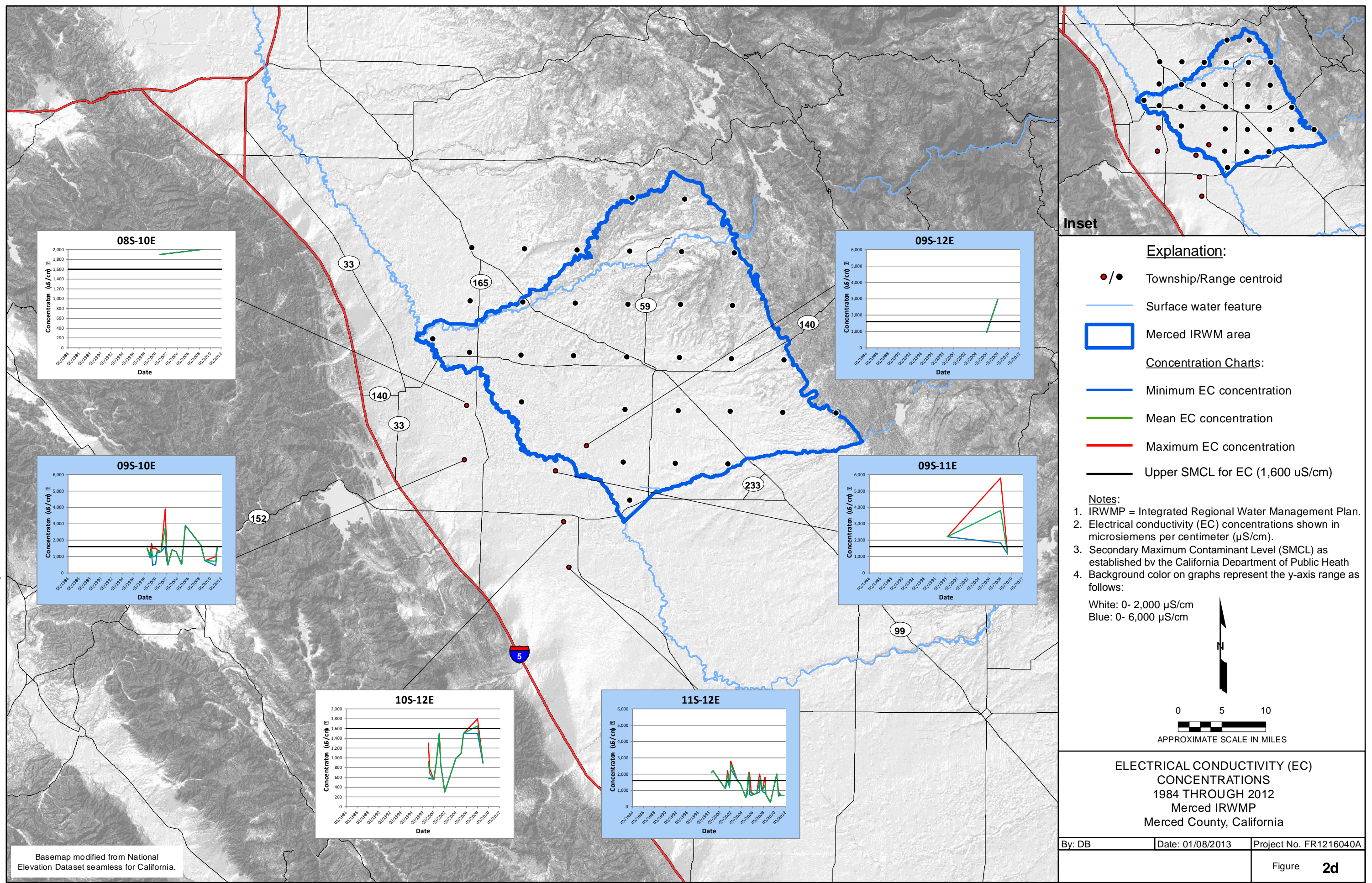
1. IRWMP = Integrated Regional Water Management Plan.
2. Electrical conductivity (EC) concentrations shown in microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>ELECTRICAL CONDUCTIVITY (EC) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California</b>		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>2c</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\_fig02d\_EC.mxd



Inset

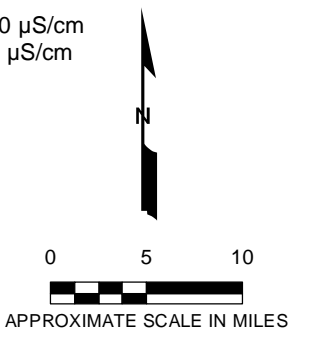
**Explanation:**

- /● Township/Range centroid
  - Surface water feature
  - Merced IRWMP area
- Concentration Charts:**
- Minimum EC concentration
  - Mean EC concentration
  - Maximum EC concentration
  - Upper SMCL for EC (1,600 uS/cm)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Electrical conductivity (EC) concentrations shown in microsiemens per centimeter (µS/cm).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:

White: 0- 2,000 µS/cm  
 Blue: 0- 6,000 µS/cm

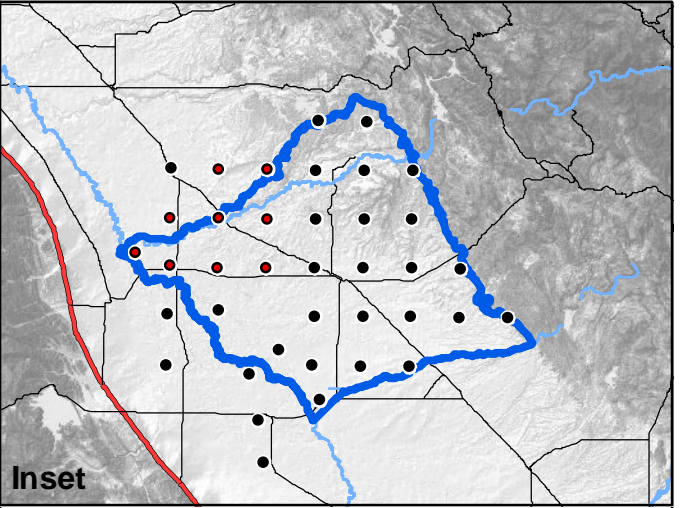
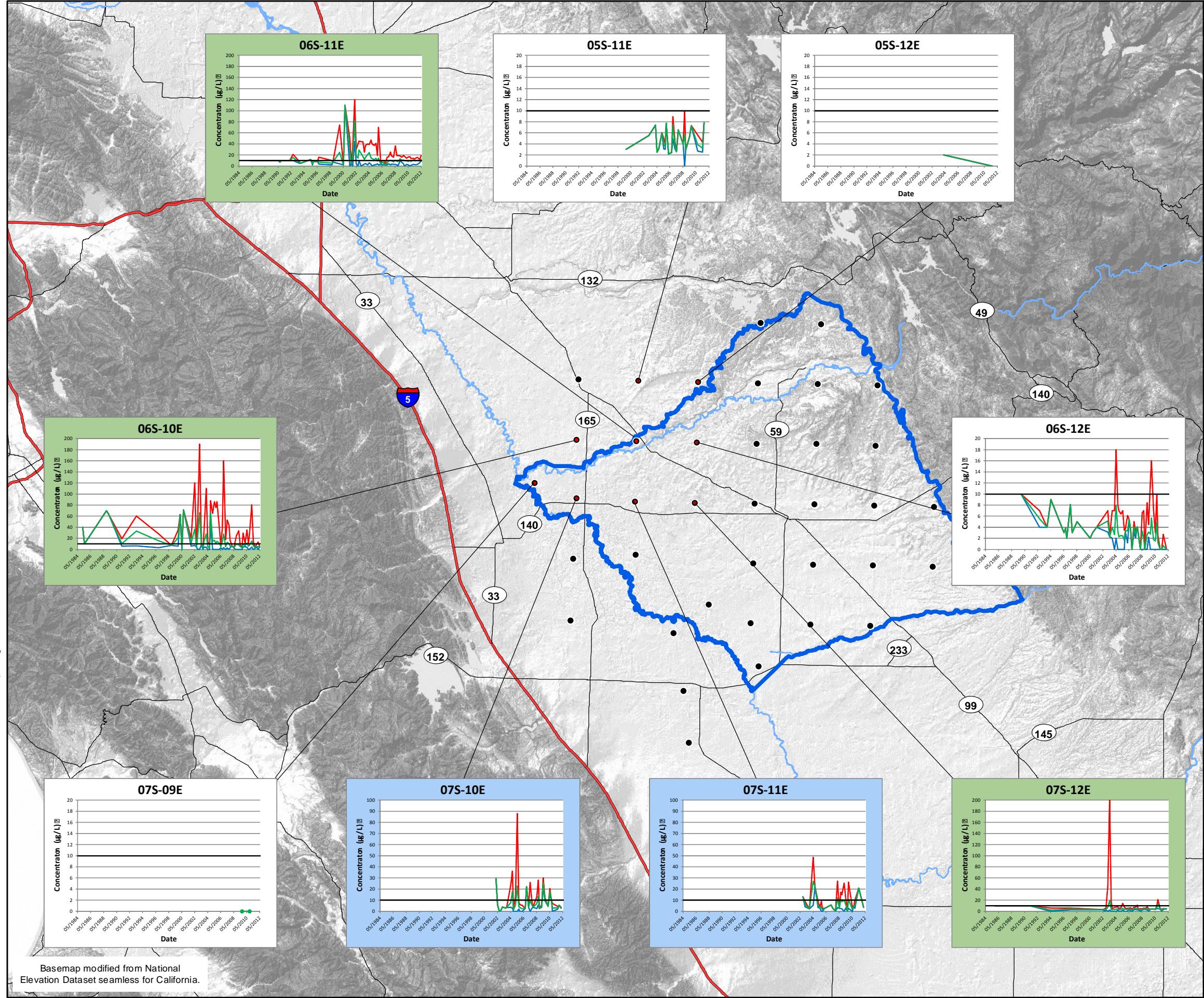


**ELECTRICAL CONDUCTIVITY (EC)  
 CONCENTRATIONS  
 1984 THROUGH 2012  
 Merced IRWMP  
 Merced County, California**

By: DB Date: 01/08/2013 Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig03a\_As.mxd



**Explanation:**

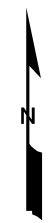
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum As concentration
- Mean As concentration
- Maximum As concentration
- MCL for As (10 µg/L)

**Notes:**

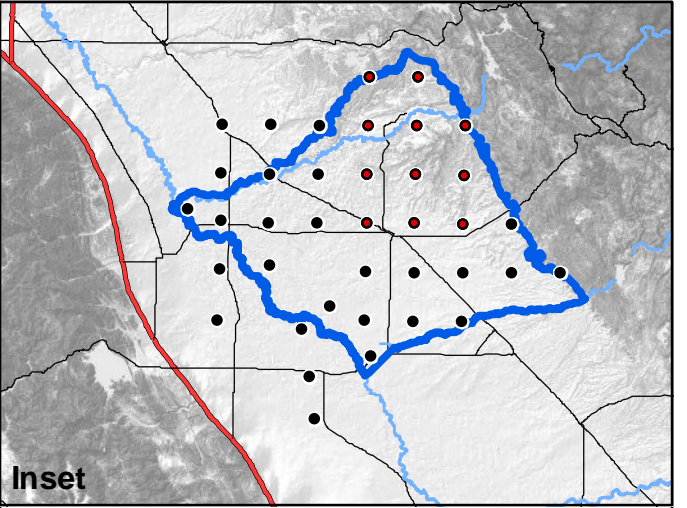
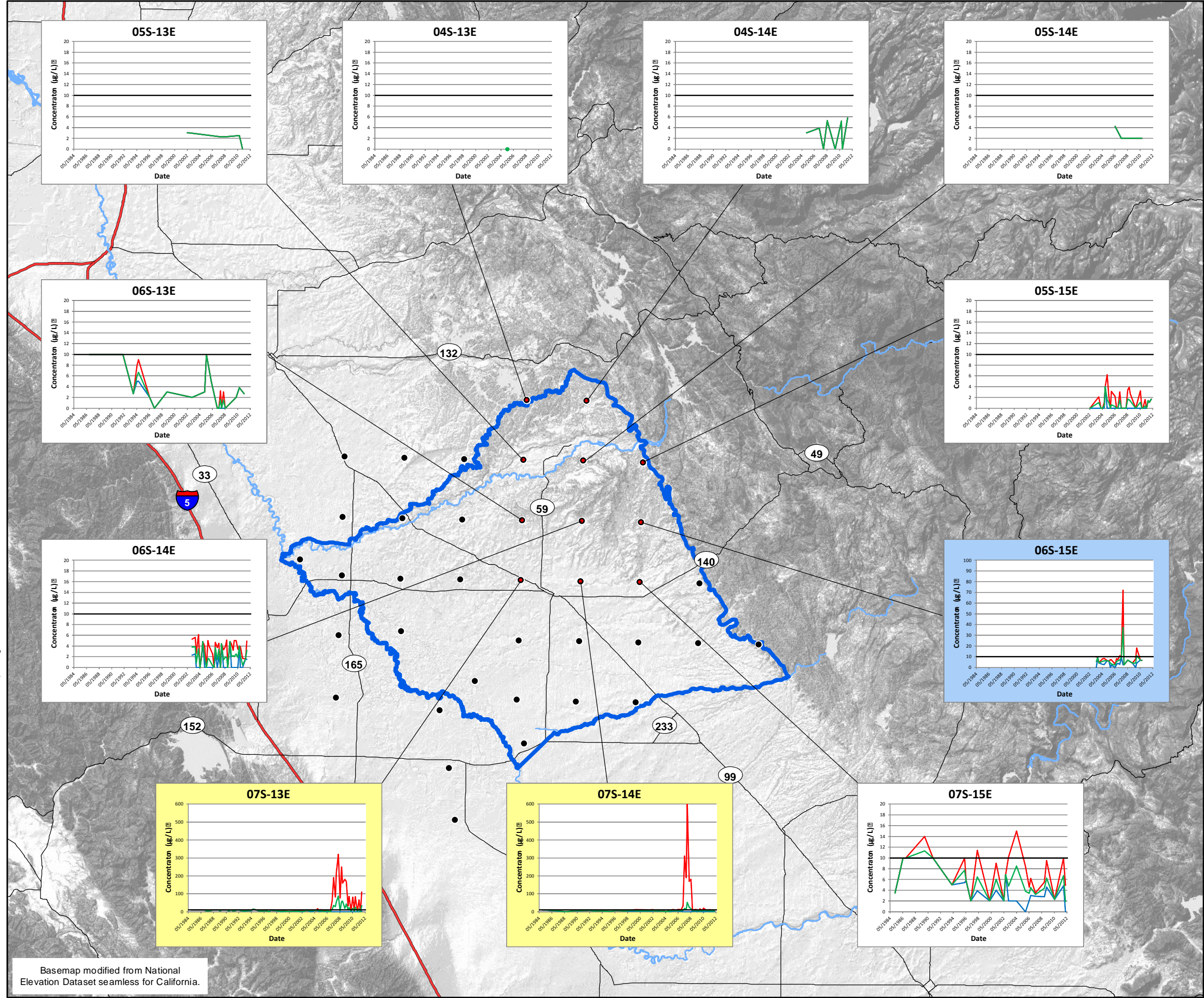
1. IRWMP = Integrated Regional Water Management Plan.
2. Arsenic (As) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 20 µg/L  
 Blue: 0- 100 µg/L  
 Green: 0- 200 µg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>ARSENIC (As) CONCENTRATIONS</b> 1984 THROUGH 2012 Merced IRWMP Merced County, California		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>3a</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig03b\_As.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum As concentration
- Mean As concentration
- Maximum As concentration
- MCL for As (10 µg/L)

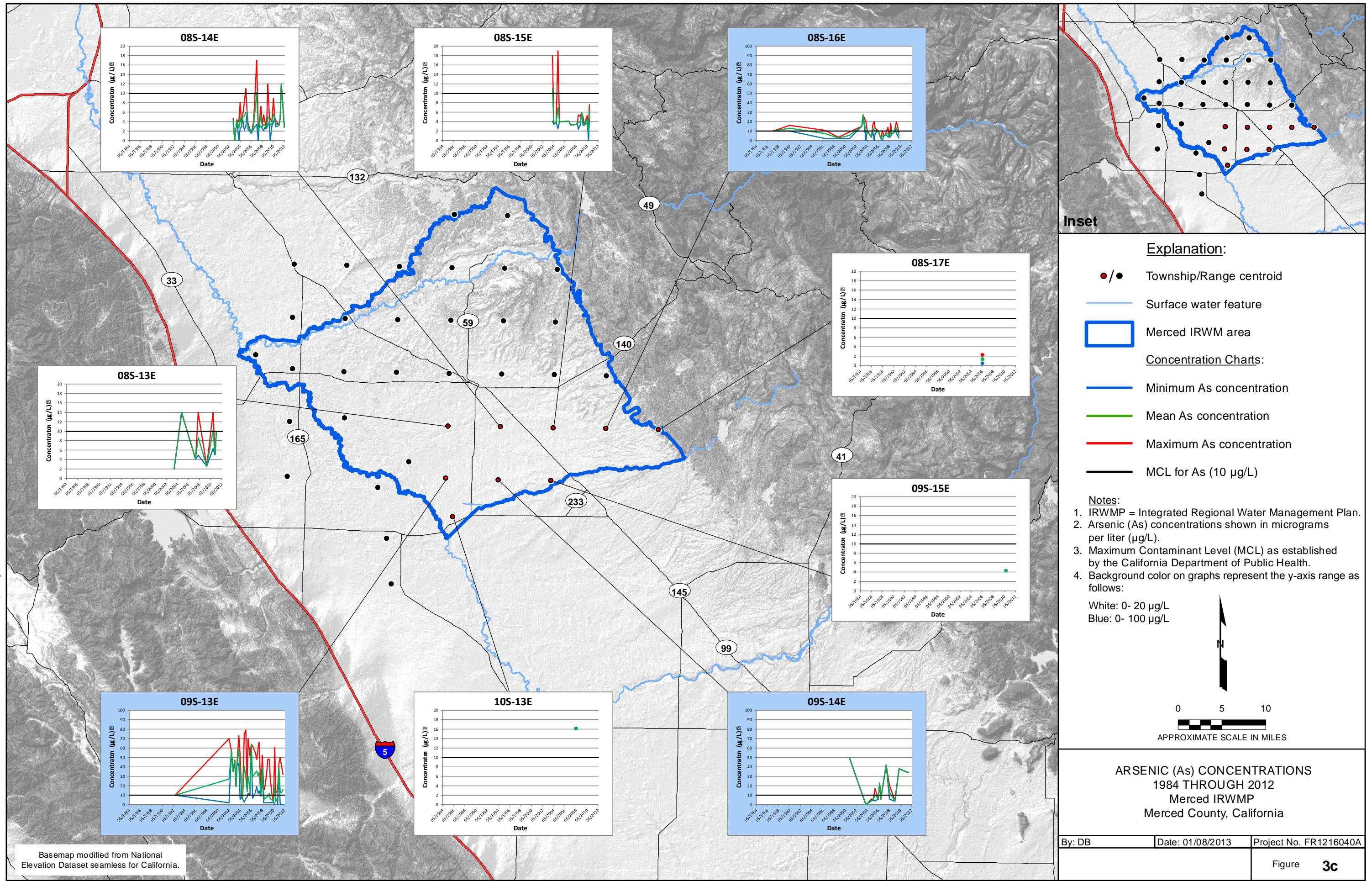
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Arsenic (As) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 20 µg/L  
 Blue: 0- 100 µg/L  
 Yellow: 0- 600 µg/L

0 5 10  
 APPROXIMATE SCALE IN MILES

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig03c\_As.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum As concentration
- Mean As concentration
- Maximum As concentration
- MCL for As (10 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Arsenic (As) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 20 µg/L  
 Blue: 0- 100 µg/L

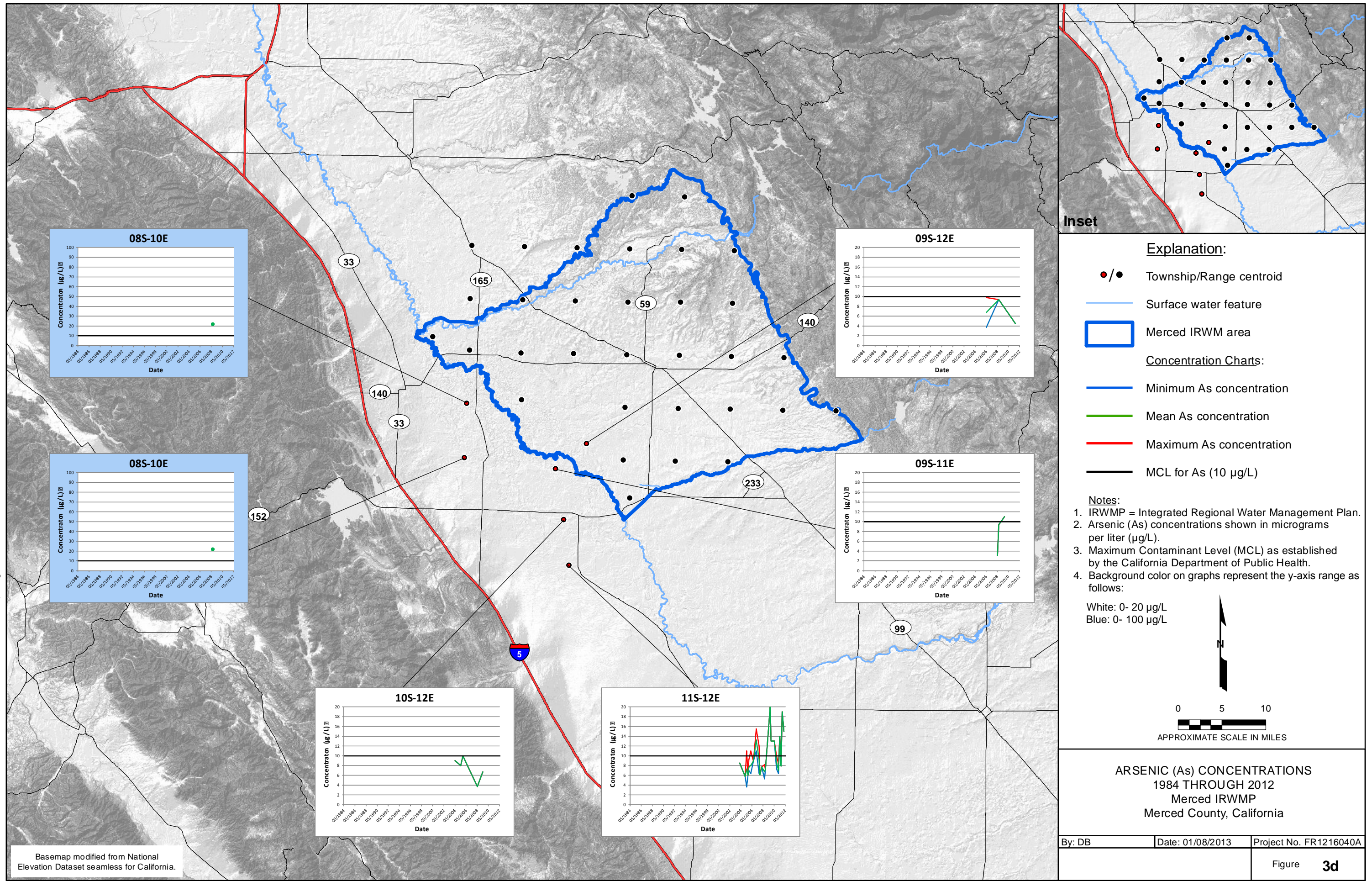
APPROXIMATE SCALE IN MILES

**ARSENIC (As) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>3c</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig03d\_As.mxd



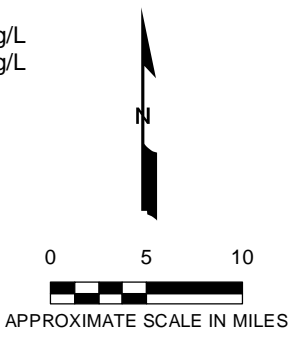
**Inset**

**Explanation:**

- / ● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWMP area
- Concentration Charts:**
- Minimum As concentration
  - Mean As concentration
  - Maximum As concentration
  - MCL for As (10 µg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Arsenic (As) concentrations shown in micrograms per liter (µg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
  4. Background color on graphs represent the y-axis range as follows:

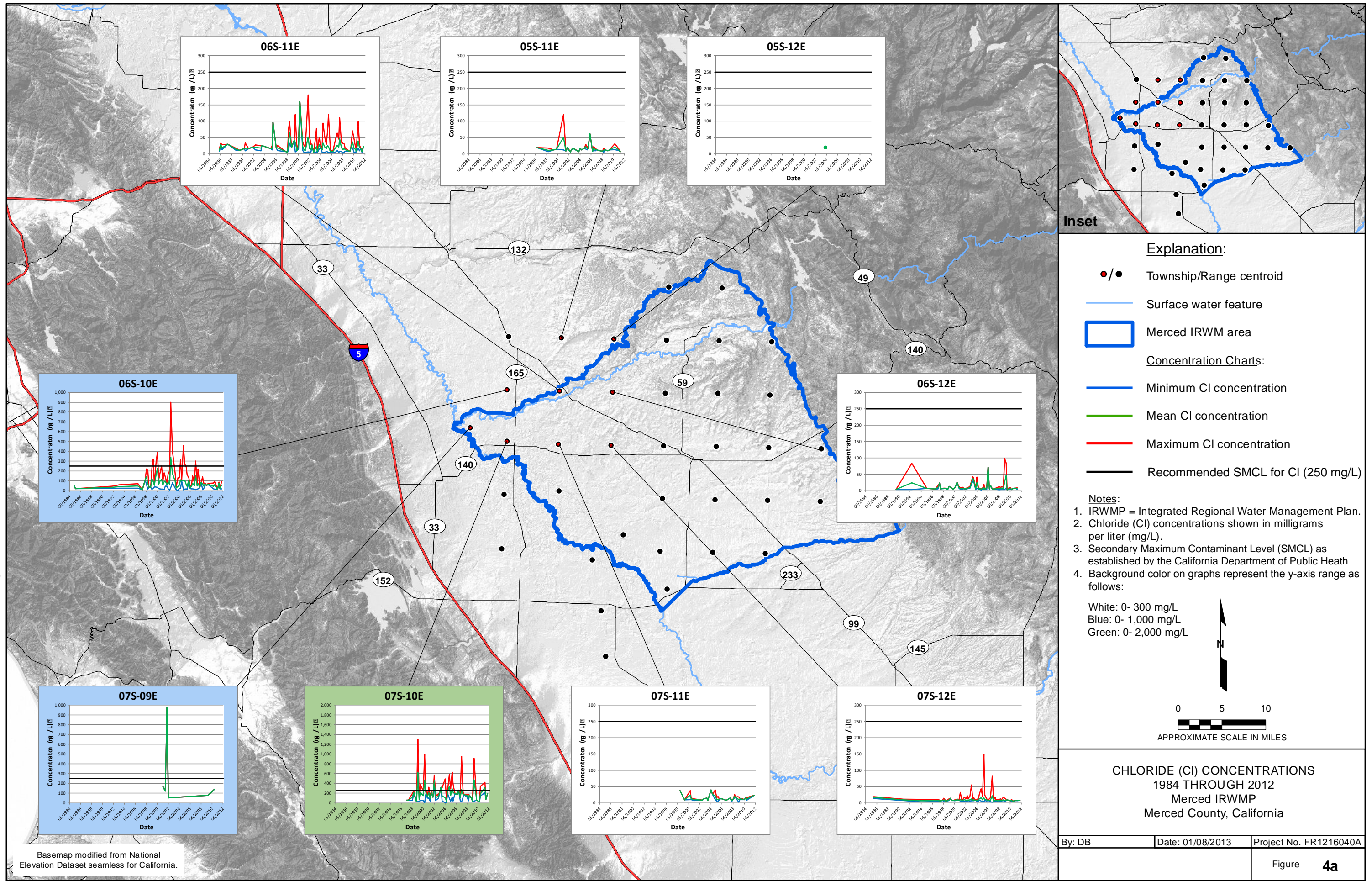
White: 0- 20 µg/L  
 Blue: 0- 100 µg/L



**ARSENIC (As) CONCENTRATIONS  
 1984 THROUGH 2012  
 Merced IRWMP  
 Merced County, California**

By: DB      Date: 01/08/2013      Project No. FR1216040A

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig04a\_Ci.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

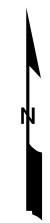
**Concentration Charts:**

- Minimum CI concentration
- Mean CI concentration
- Maximum CI concentration
- Recommended SMCL for CI (250 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Chloride (CI) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:

White: 0- 300 mg/L  
 Blue: 0- 1,000 mg/L  
 Green: 0- 2,000 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

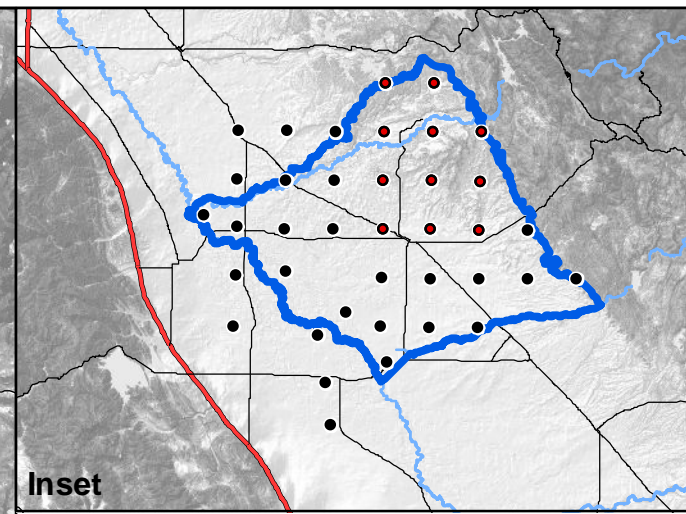
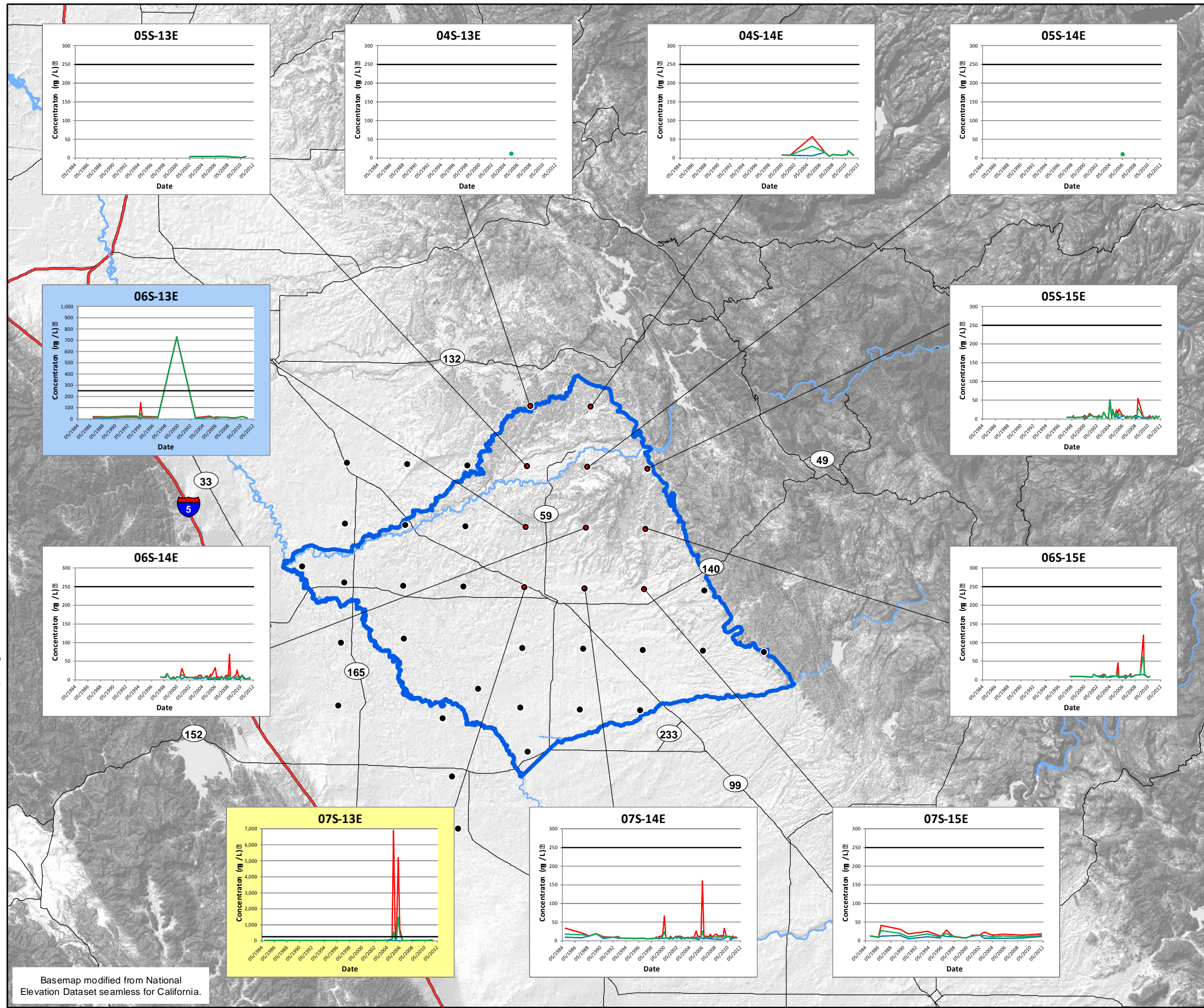
**CHLORIDE (CI) CONCENTRATIONS  
 1984 THROUGH 2012  
 Merced IRWMP  
 Merced County, California**

By: DB      Date: 01/08/2013      Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig04b\_Cl.mxd



**Inset**

**Explanation:**


- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum Cl concentration
- Mean Cl concentration
- Maximum Cl concentration
- Recommended SMCL for Cl (250 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Chloride (Cl) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 300 mg/L  
 Blue: 0- 1,000 mg/L  
 Yellow: 0- 7,000 mg/L

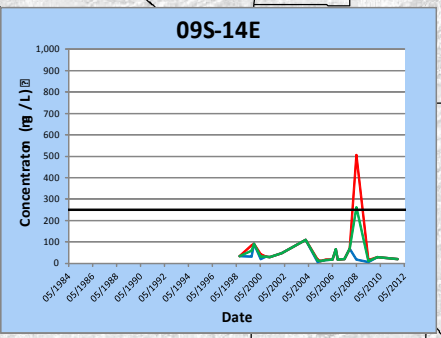
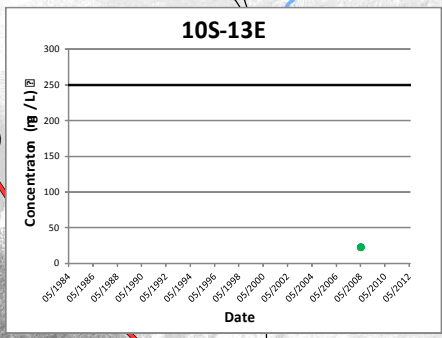
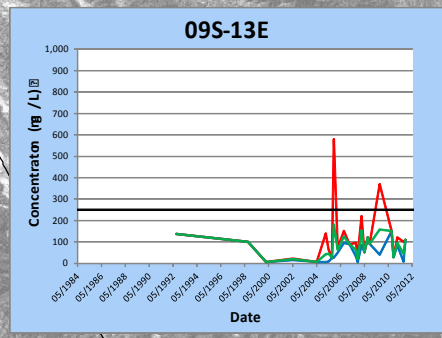
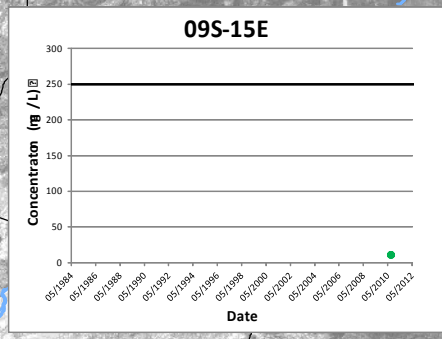
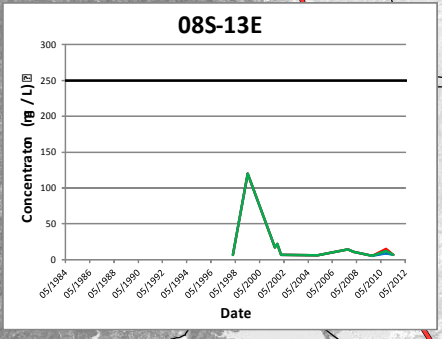
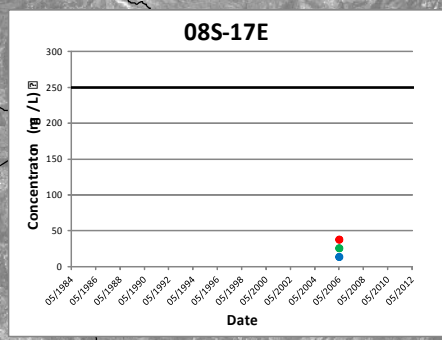
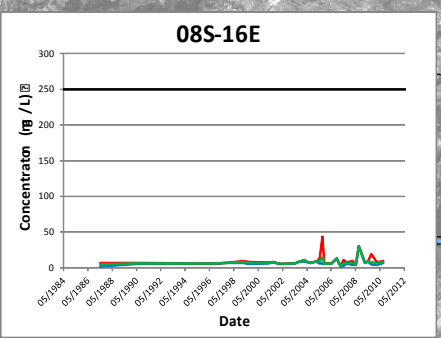
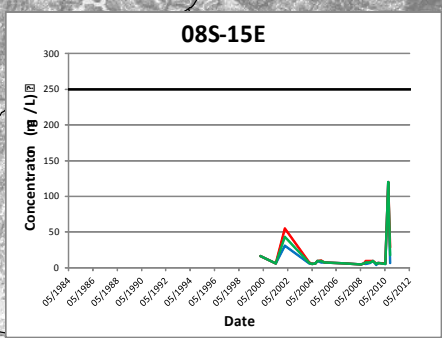
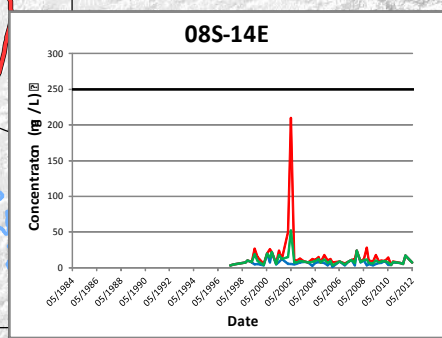
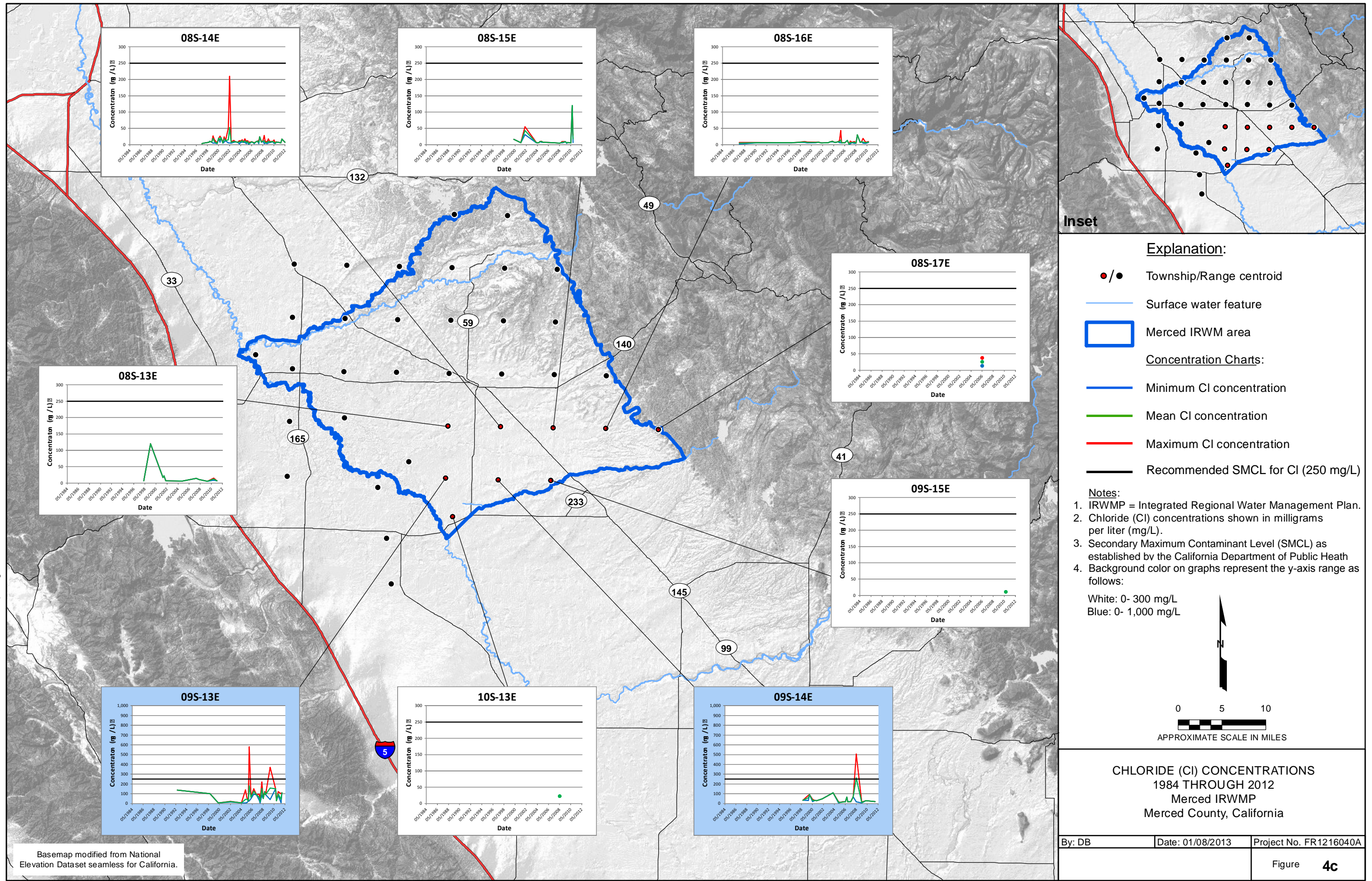
  
 0 5 10  
 APPROXIMATE SCALE IN MILES

**CHLORIDE (Cl) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>4b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\_fig04c\_CI.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum CI concentration
- Mean CI concentration
- Maximum CI concentration
- Recommended SMCL for CI (250 mg/L)

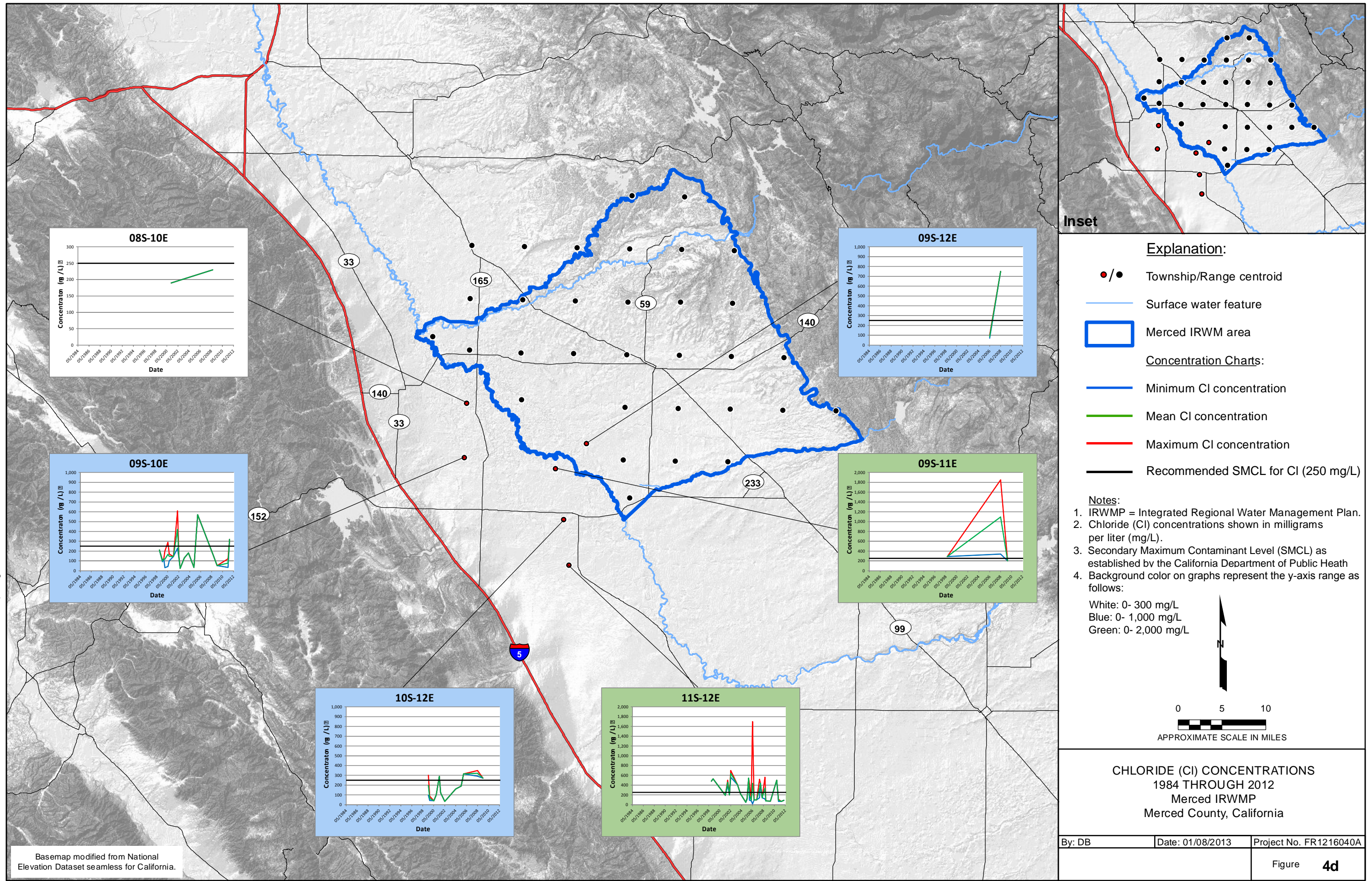
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Chloride (CI) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
White: 0- 300 mg/L  
Blue: 0- 1,000 mg/L

0 5 10  
APPROXIMATE SCALE IN MILES

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig04d\_CI.mxd



Basemap modified from National Elevation Dataset seamless for California.

**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum CI concentration
- Mean CI concentration
- Maximum CI concentration
- Recommended SMCL for CI (250 mg/L)

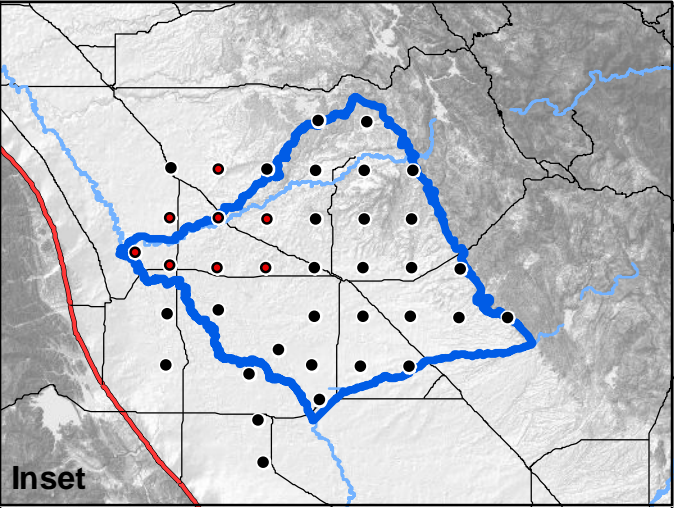
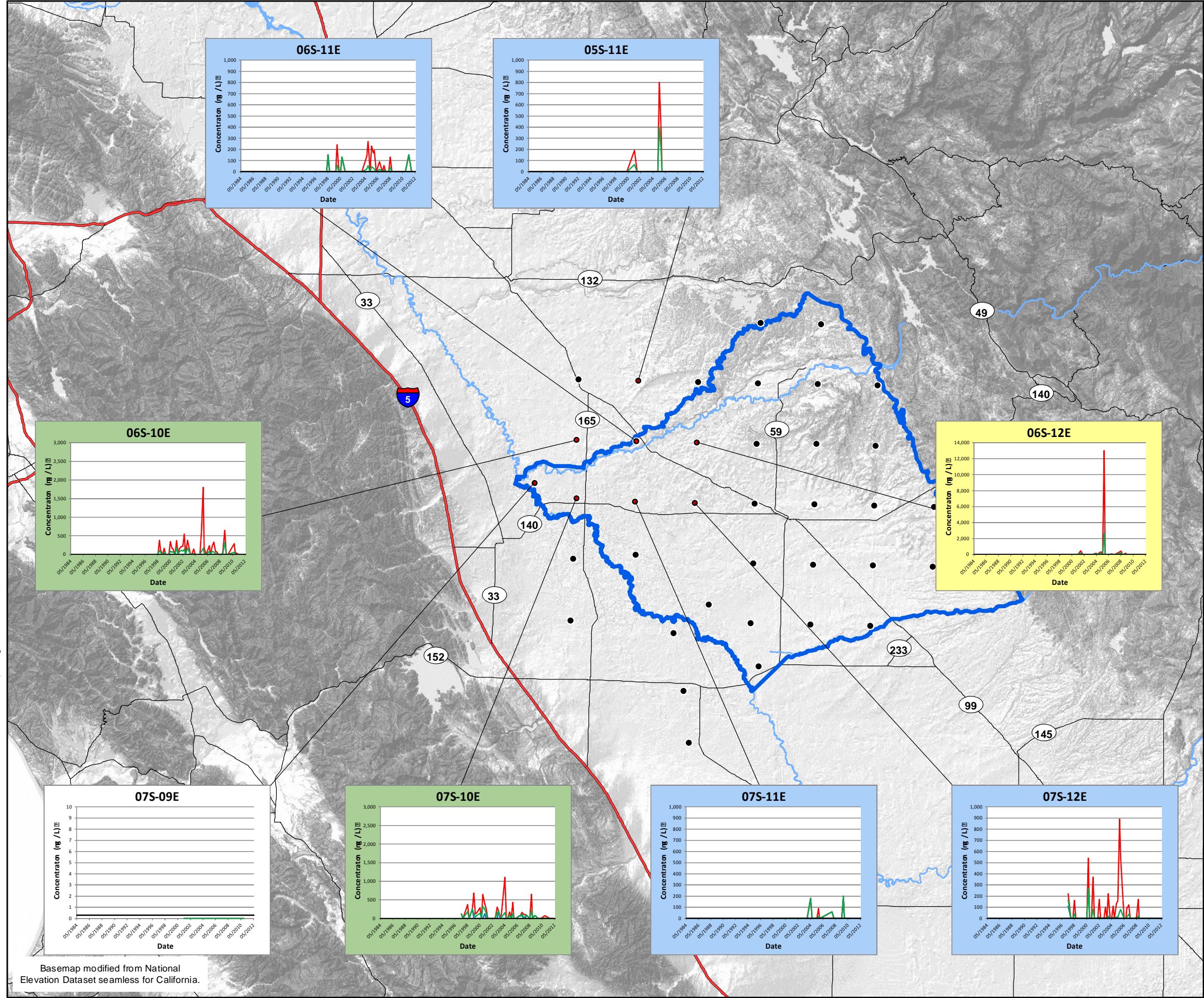
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Chloride (CI) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 300 mg/L  
 Blue: 0- 1,000 mg/L  
 Green: 0- 2,000 mg/L

0 5 10  
 APPROXIMATE SCALE IN MILES

<b>CHLORIDE (CI) CONCENTRATIONS</b>		
1984 THROUGH 2012		
Merced IRWMP		
Merced County, California		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>4d</b>

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig05a\_Fe.mxd



**Explanation:**

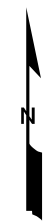
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Fe concentration
- Mean Fe concentration
- Maximum Fe concentration
- SMCL for Fe (0.3 mg/L)

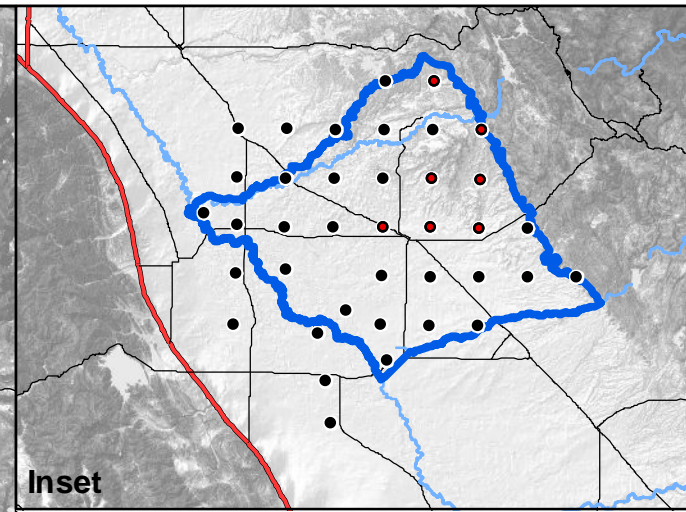
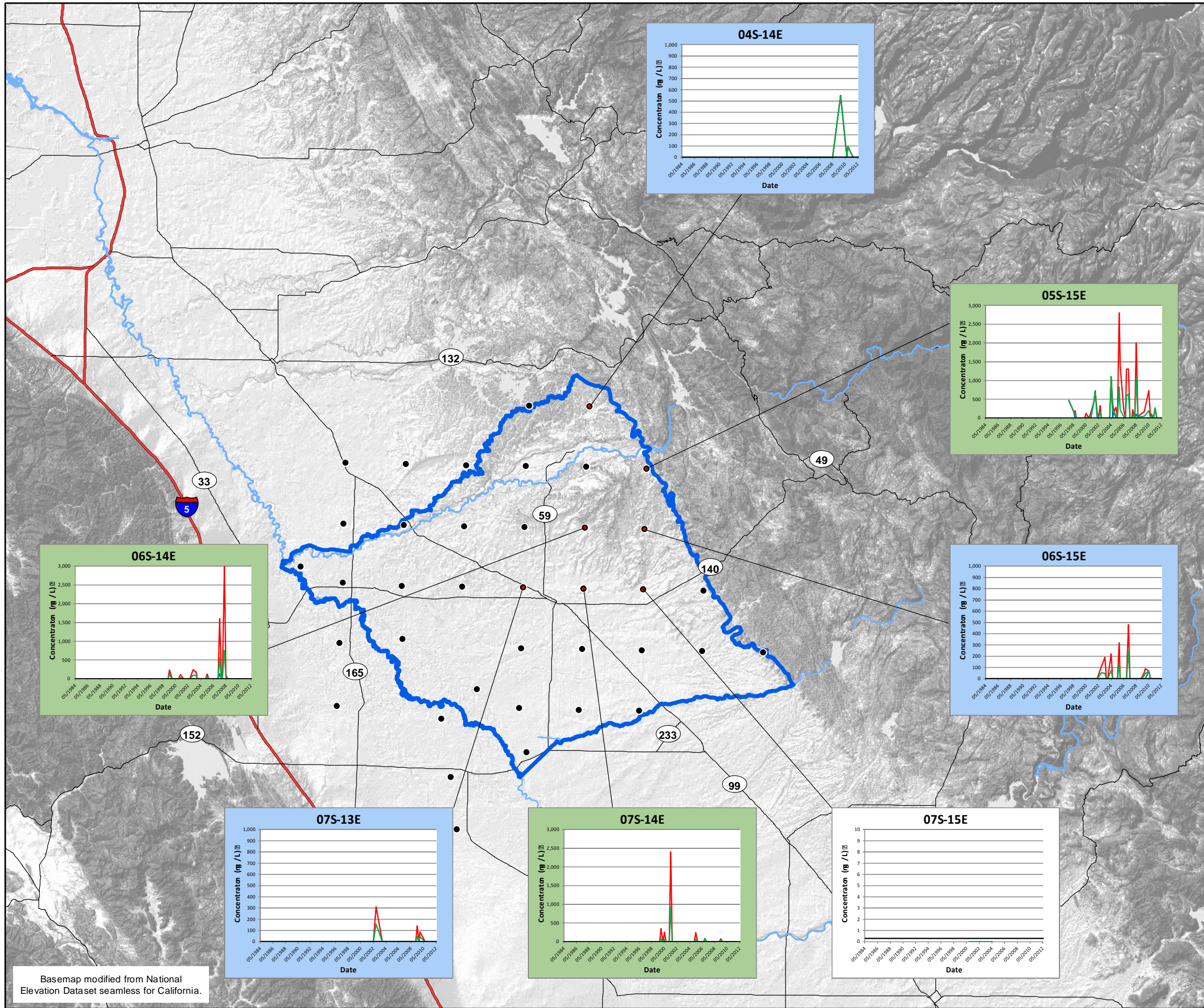
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Iron (Fe) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:
  - White: 0- 10 mg/L
  - Blue: 0- 1,000 mg/L
  - Green: 0- 3,000 mg/L
  - Yellow: 0- 14,000 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig05b\_Fe.mxd



**Inset**

**Explanation:**

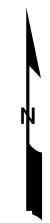
- /● Township/Range centroid
- Surface water feature
- Merced IRWMP area

**Concentration Charts:**

- Minimum Fe concentration
- Mean Fe concentration
- Maximum Fe concentration
- SMCL for Fe (0.3 mg/L)

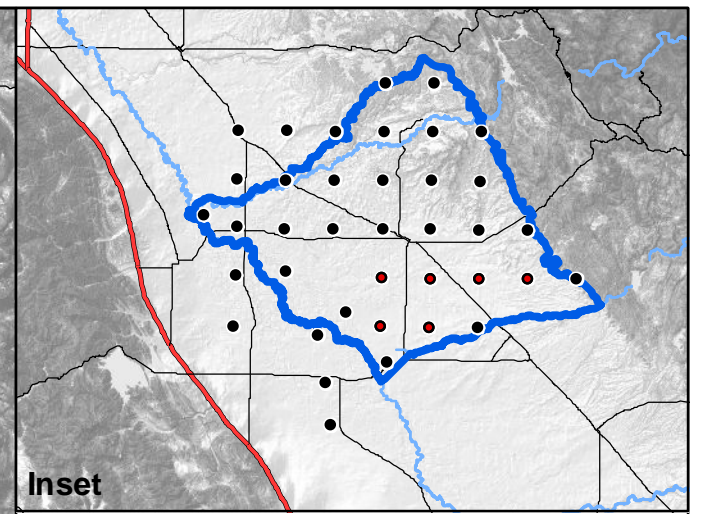
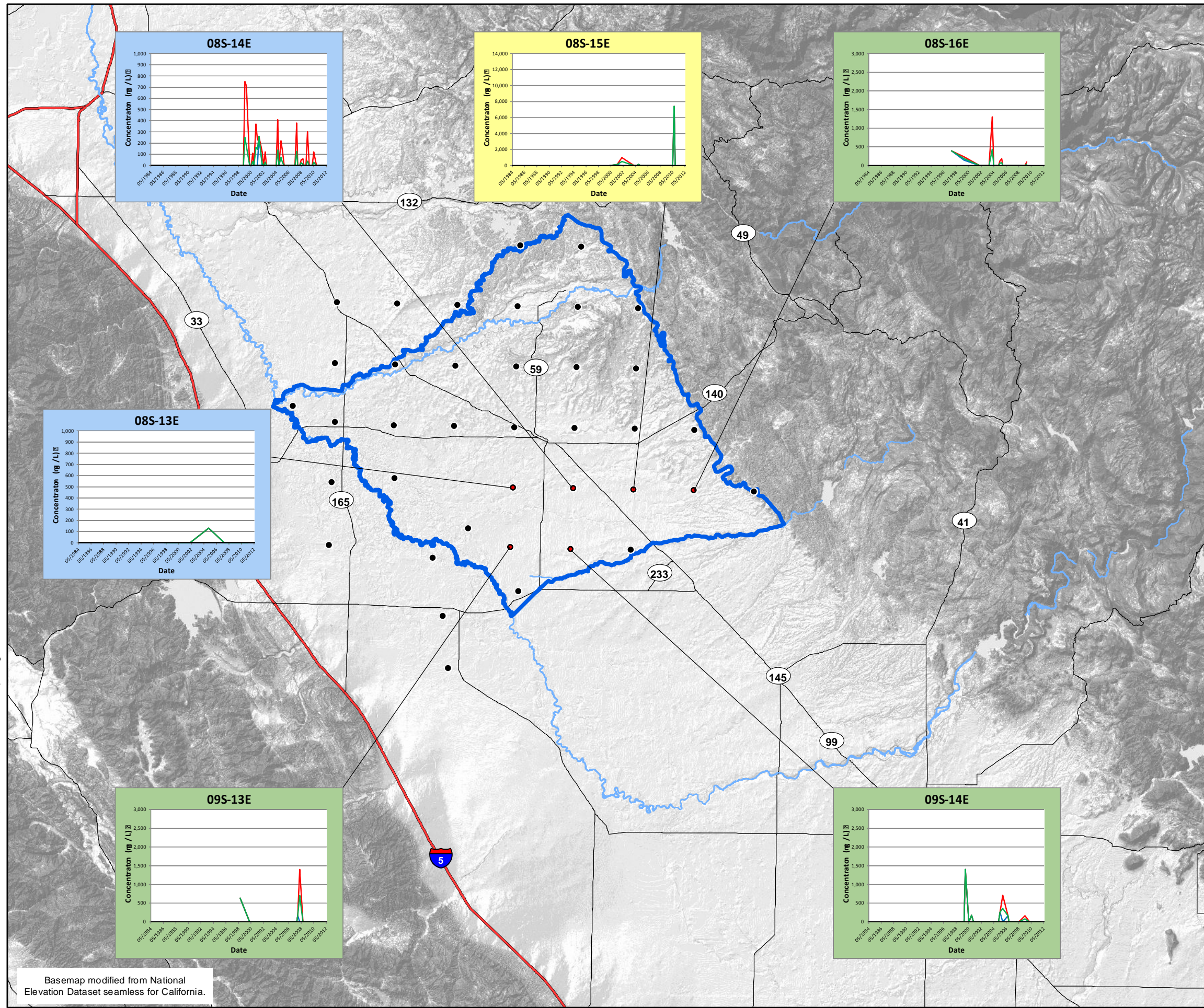
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Iron (Fe) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 10 mg/L  
 Blue: 0- 1,000 mg/L  
 Green: 0- 3,000 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig05c\_Fe.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Fe concentration
- Mean Fe concentration
- Maximum Fe concentration
- SMCL for Fe (0.3 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Iron (Fe) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 Blue: 0- 1,000 mg/L  
 Green: 0- 3,000 mg/L  
 Yellow: 0- 14,000 mg/L

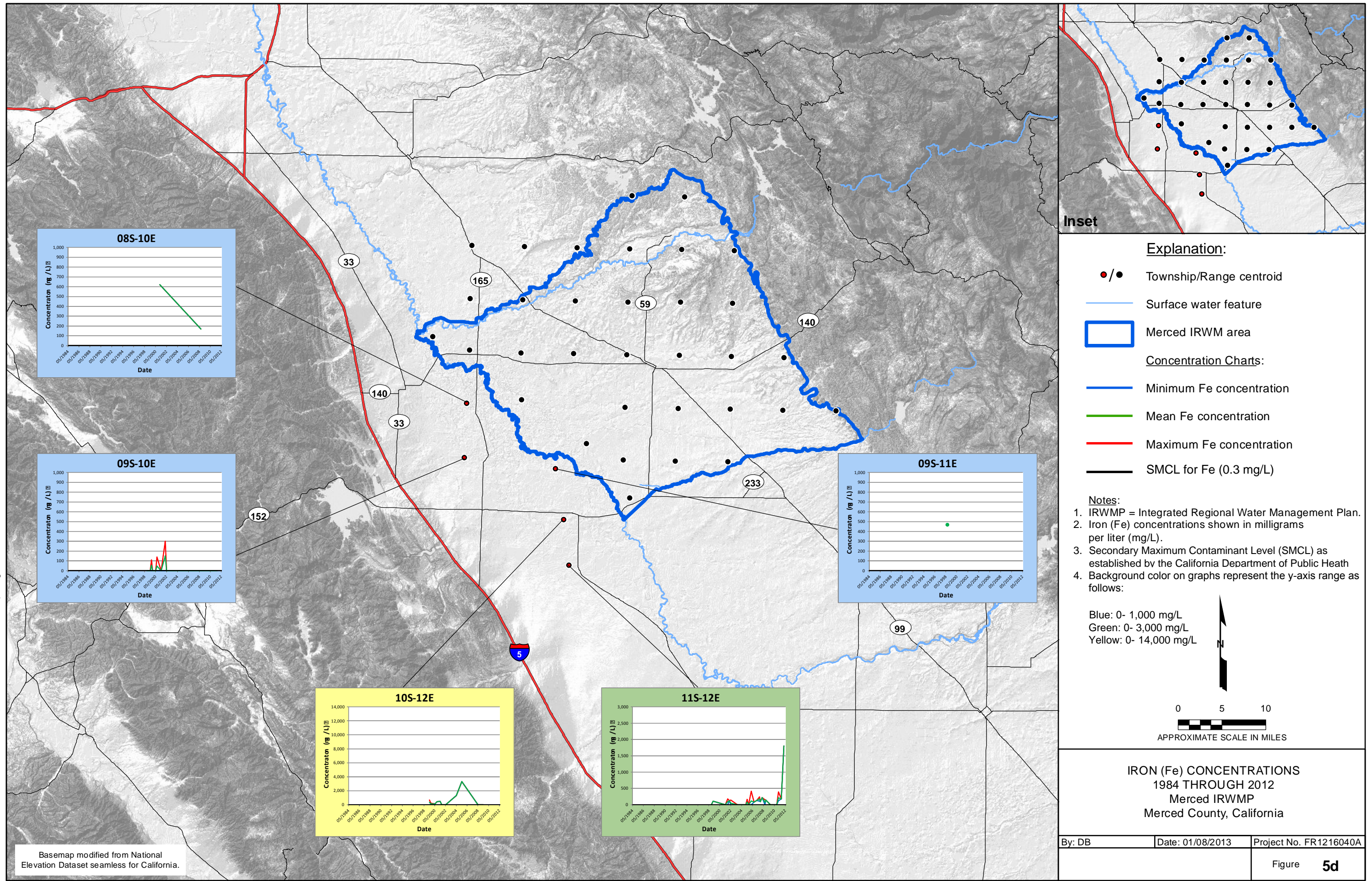
0 5 10  
 APPROXIMATE SCALE IN MILES

**IRON (Fe) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>5c</b>

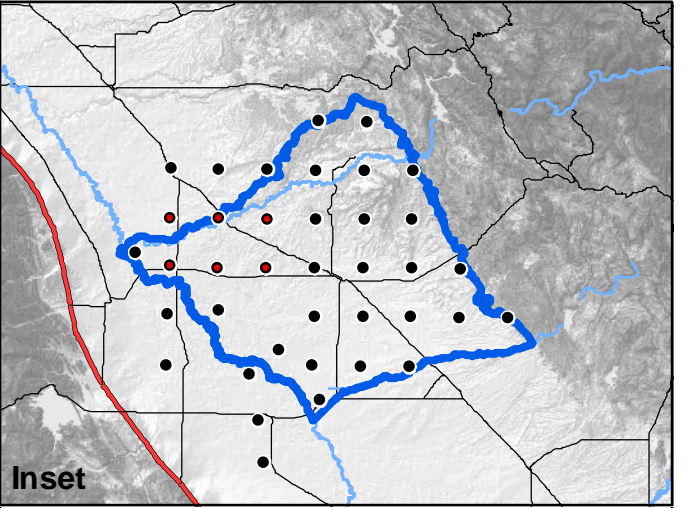
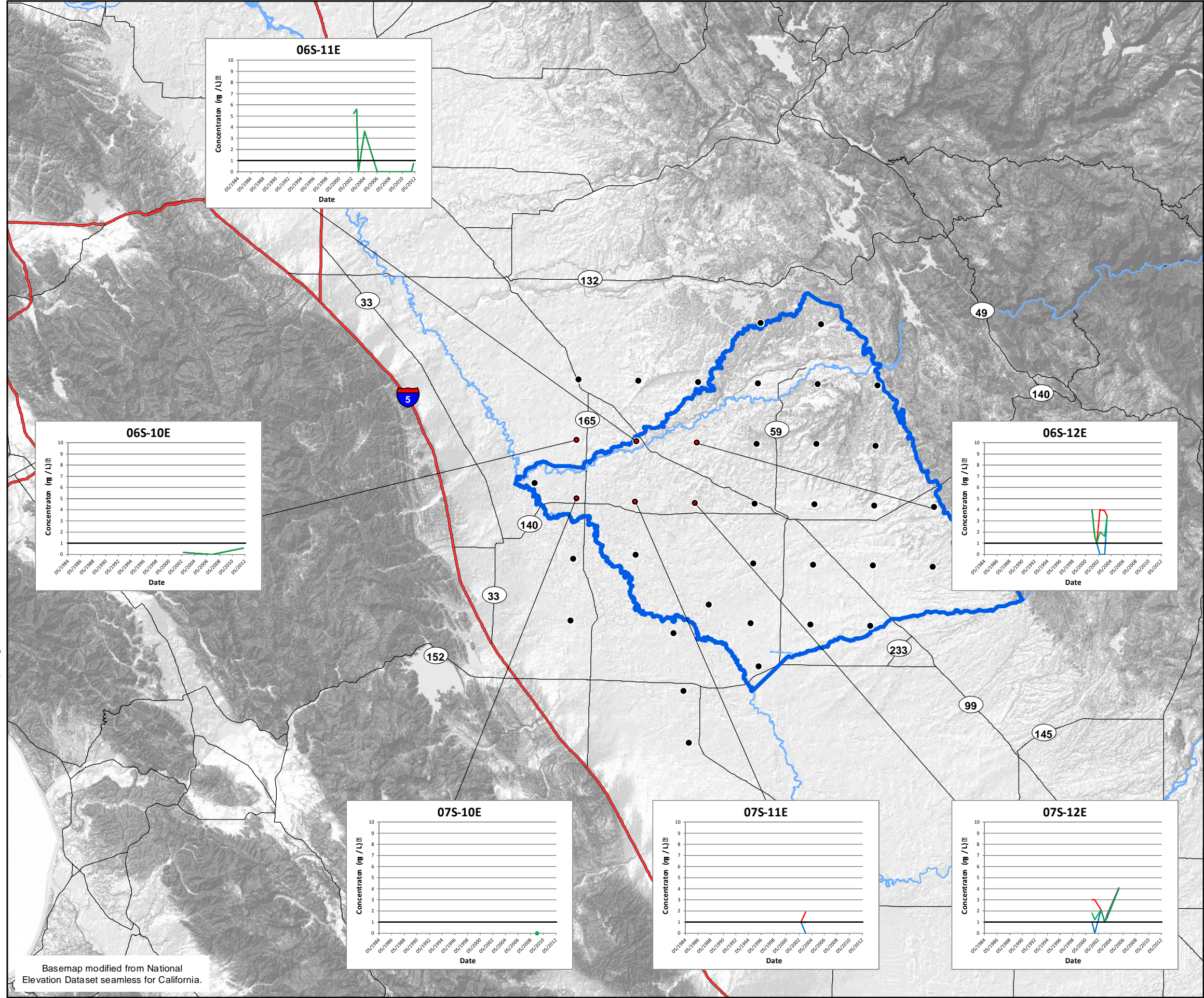
Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig05d\_Fe.mxd



Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig06a\_Cr6.mxd



**Explanation:**

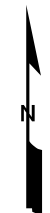
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Cr6 concentration
- Mean Cr6 concentration
- Maximum Cr6 concentration
- MCL for Cr6 (1 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Hexavalent chromium (Cr6) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

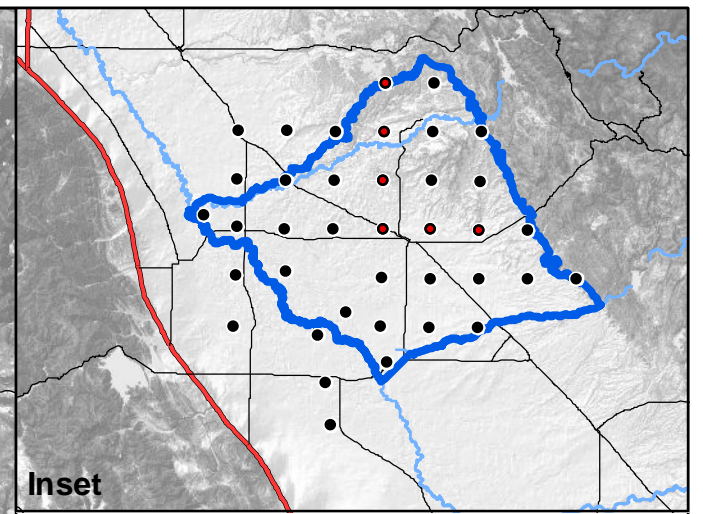
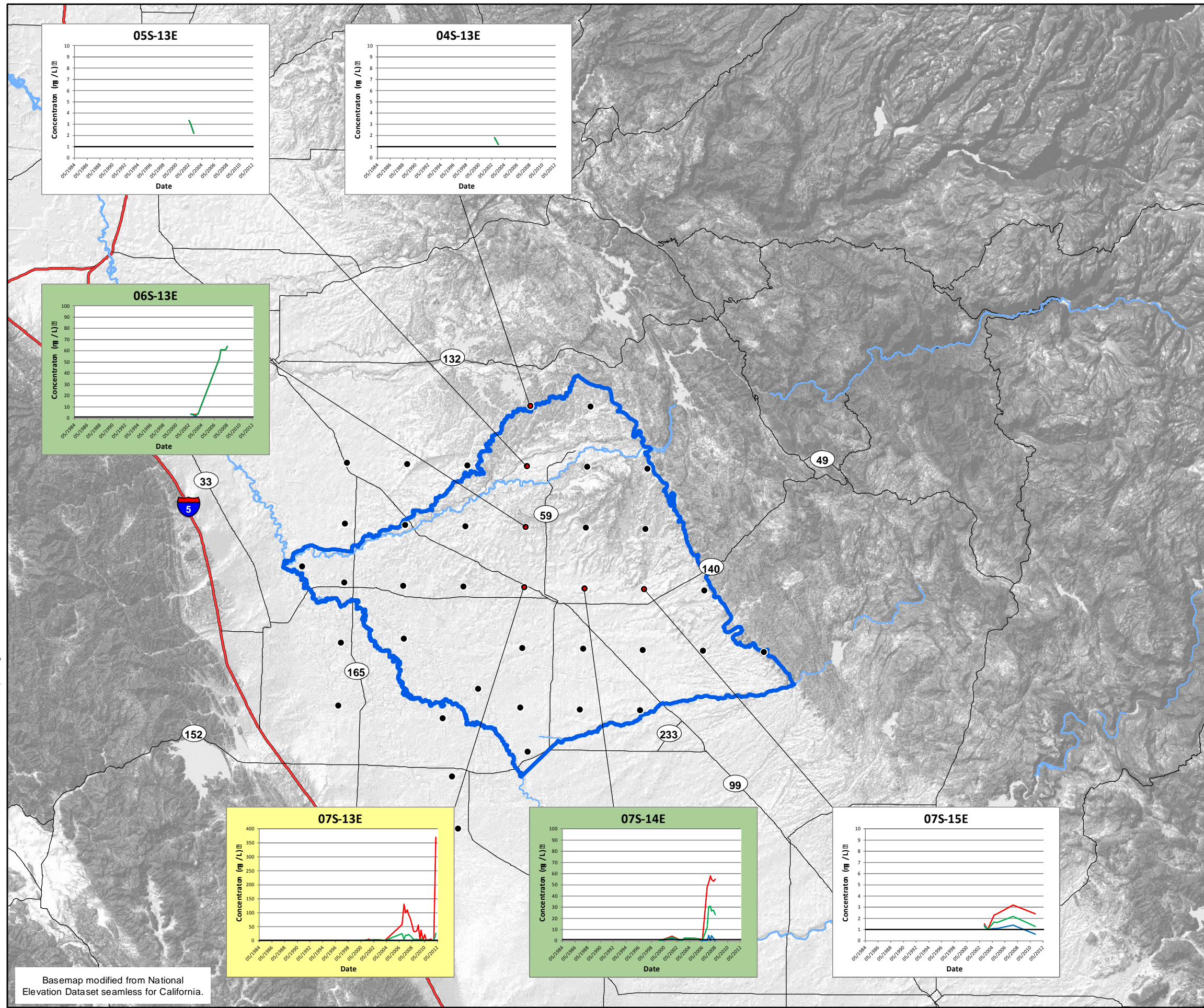
**HEXAVALENT CHROMIUM (Cr6)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>6a</b>

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig06b\_Cr6.mxd



**Inset**

**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum Cr6 concentration
- Mean Cr6 concentration
- Maximum Cr6 concentration
- MCL for Cr6 (1 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Hexavalent chromium (Cr6) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0 - 10 mg/L  
 Green: 0- 100 mg/L  
 Yellow: 0- 400 mg/L

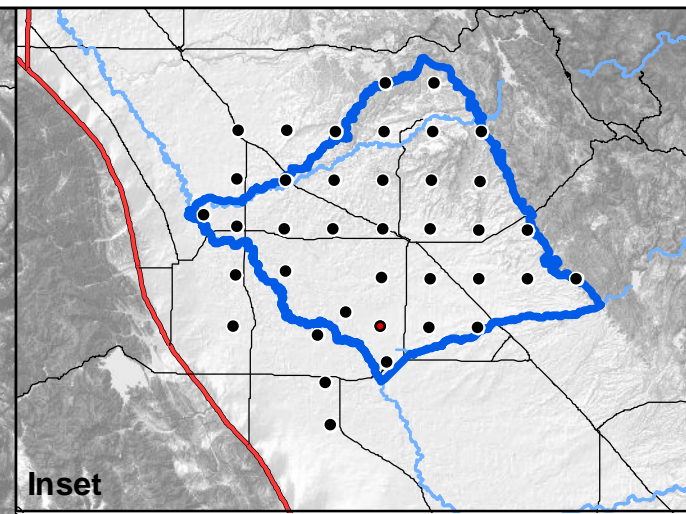
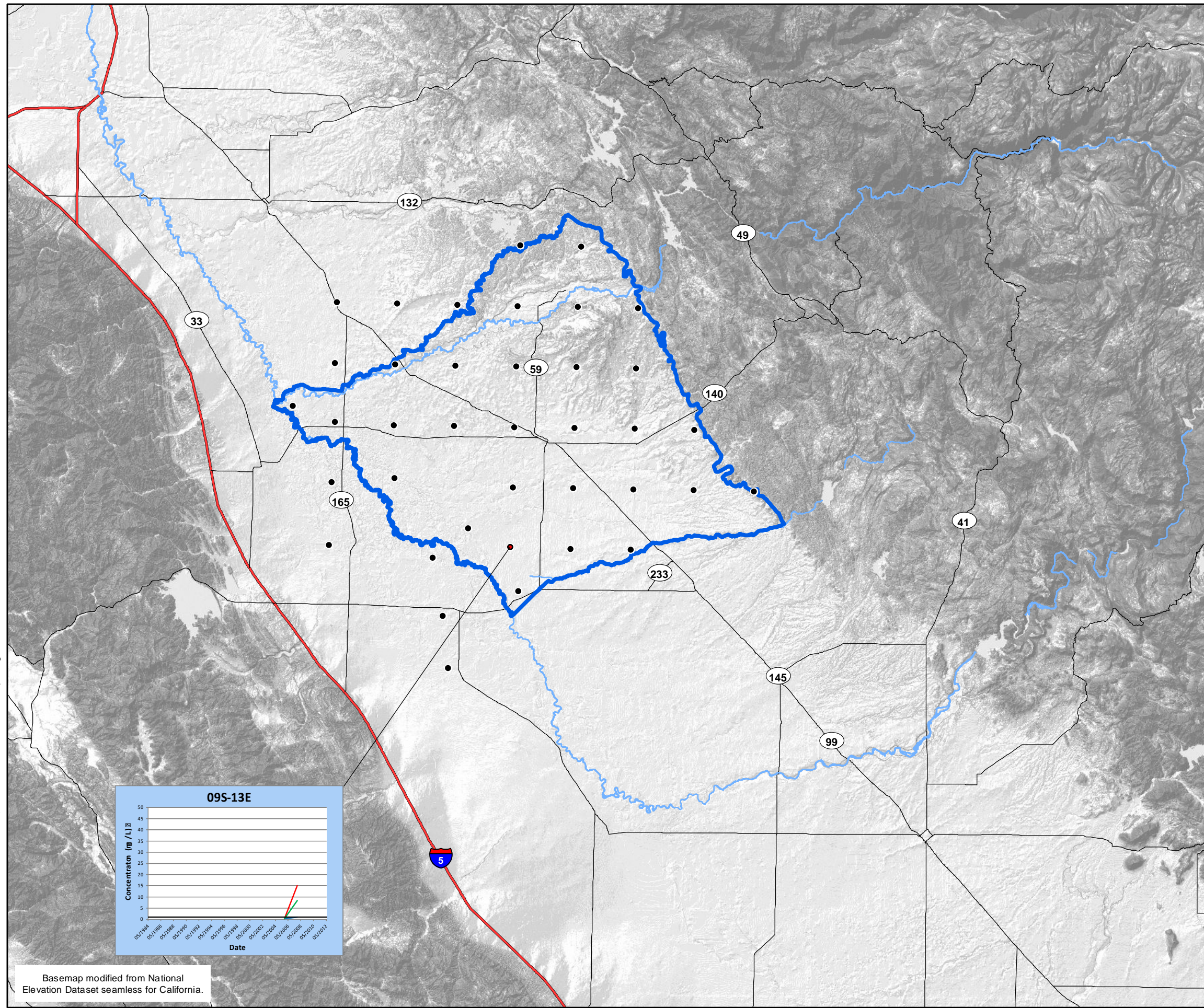
0 5 10  
 APPROXIMATE SCALE IN MILES

**HEXAVALENT CHROMIUM (Cr6)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>6b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig06c\_Cr6.mxd



**Inset**

**Explanation:**


- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

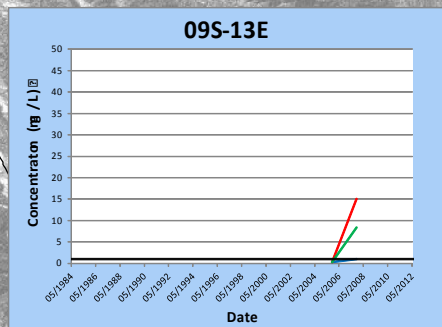
**Concentration Charts:**

- Minimum Cr6 concentration
- Mean Cr6 concentration
- Maximum Cr6 concentration
- MCL for Cr6 (1 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Hexavalent chromium (Cr6) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

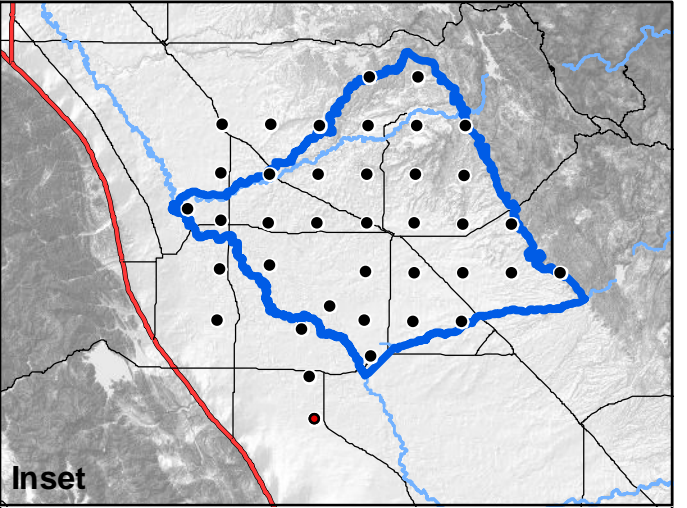
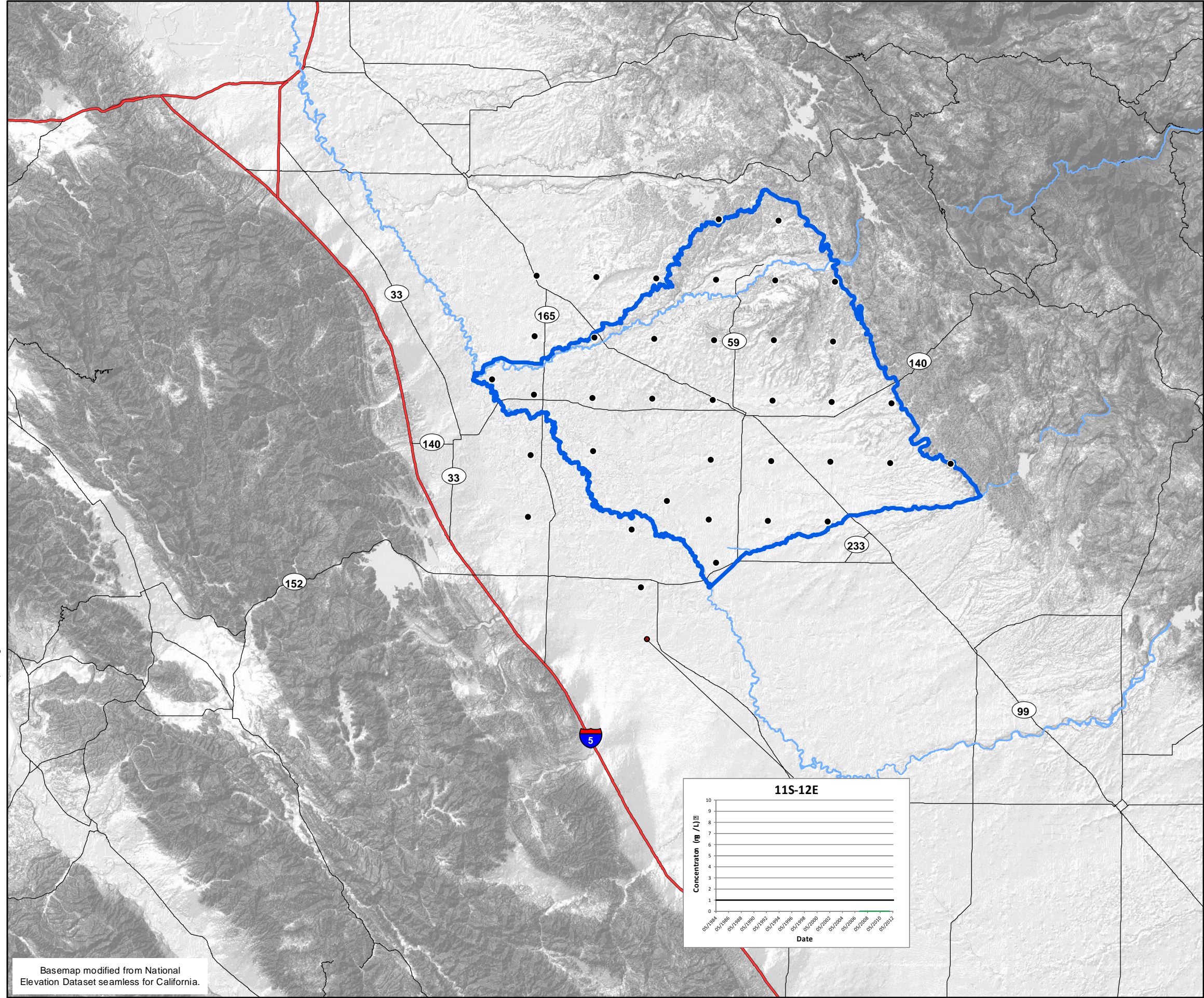


Basemap modified from National Elevation Dataset seamless for California.

**HEXAVALENT CHROMIUM (Cr6)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>6c</b>

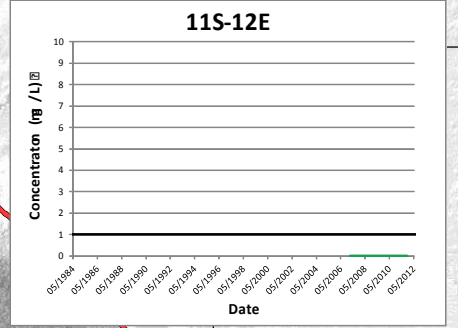
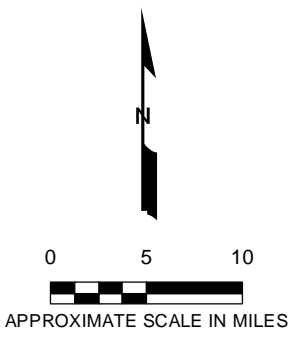
N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\_fig06d\_Cr6.mxd



**Explanation:**

- / ● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum Cr6 concentration
  - Mean Cr6 concentration
  - Maximum Cr6 concentration
  - MCL for Cr6 (1 mg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Hexavalent chromium (Cr6) concentrations shown in milligrams per liter (mg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.



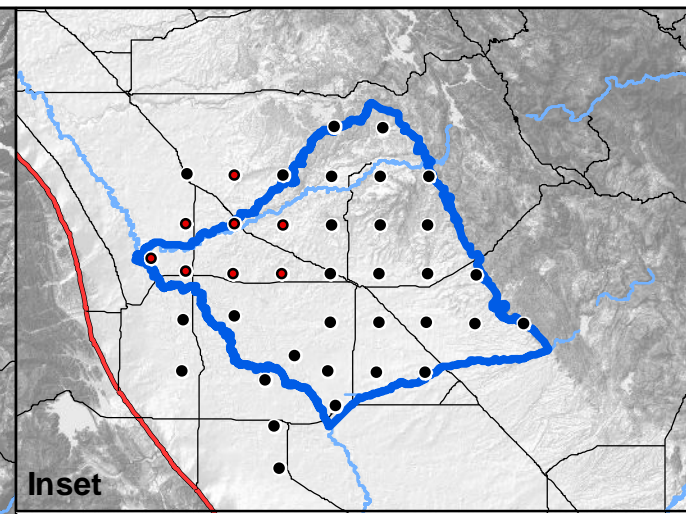
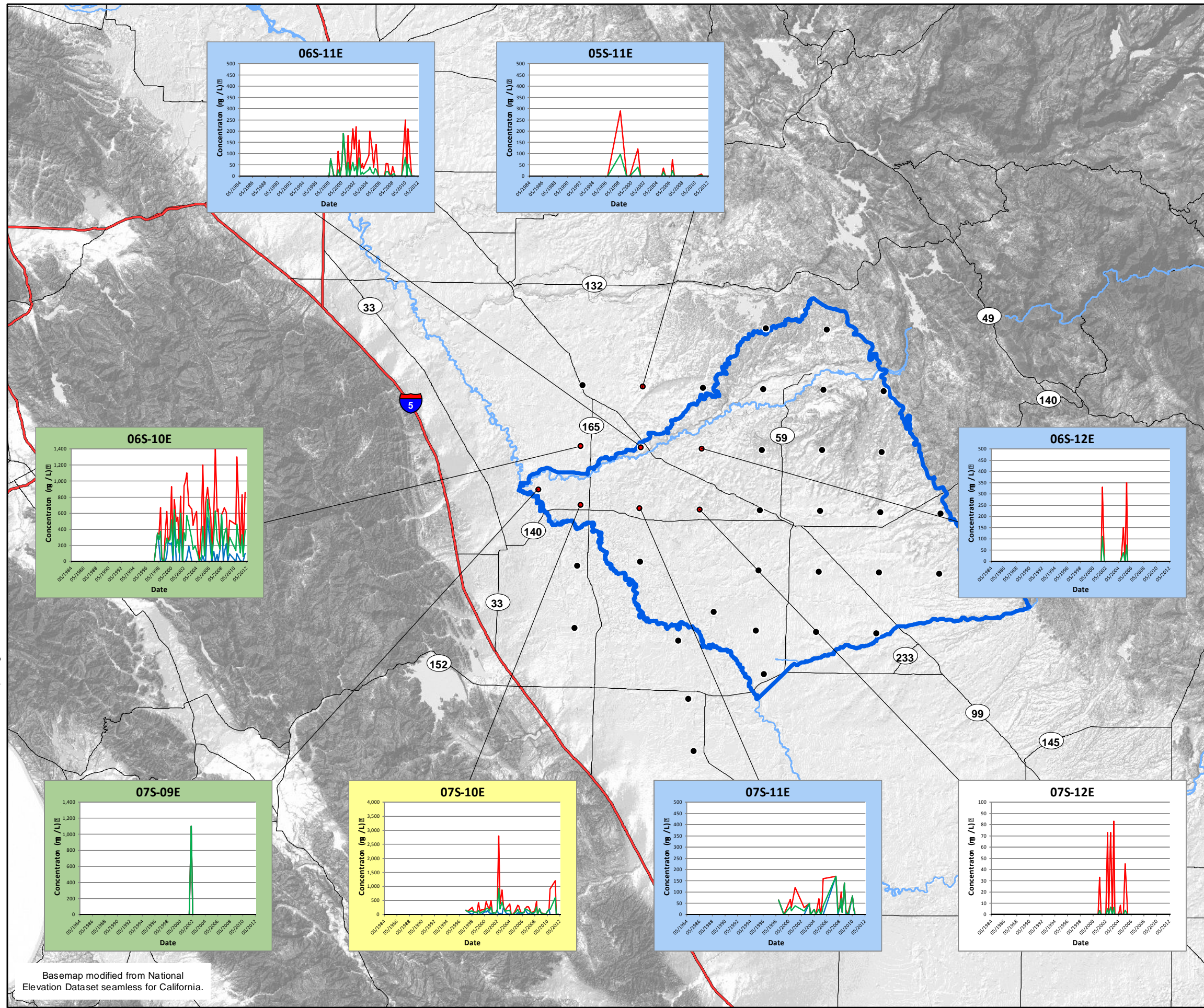
Basemap modified from National Elevation Dataset seamless for California.

HEXAVALENT CHROMIUM (Cr6)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California

By: DB Date: 01/08/2013 Project No. FR1216040A

Figure **6d**

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig07a\_Mn.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Mn concentration
- Mean Mn concentration
- Maximum Mn concentration
- SMCL for Mn (0.05 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Manganese (Mn) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 100 mg/L  
 Blue: 0- 500 mg/L  
 Green: 0- 1,400 mg/L  
 Yellow: 0- 4,000 mg/L

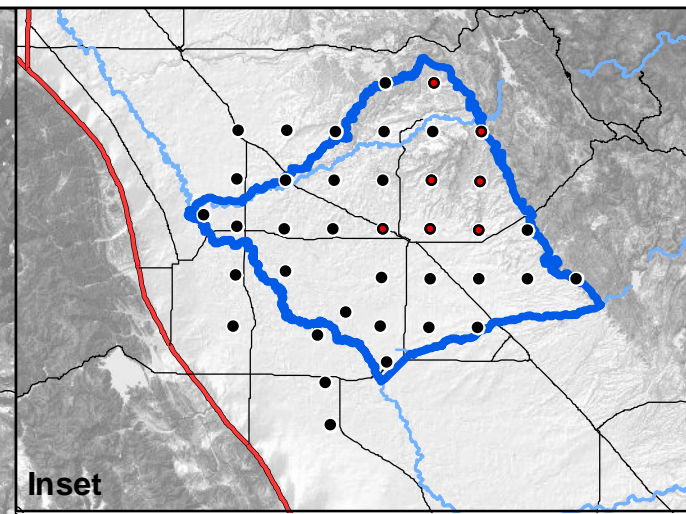
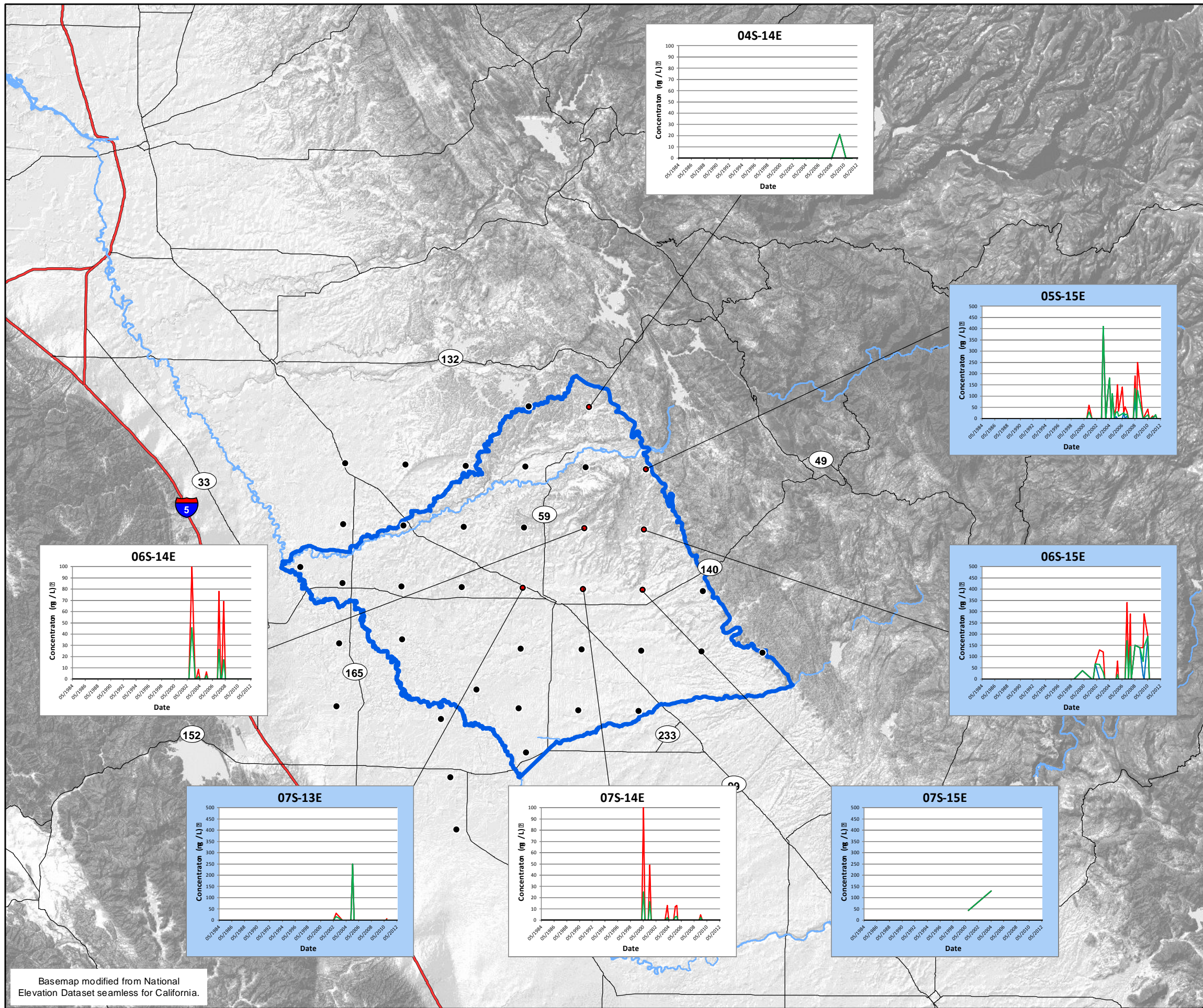
0 5 10  
APPROXIMATE SCALE IN MILES

**MANGANESE (Mn) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>7a</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig07b\_Mn.mxd



**Explanation:**

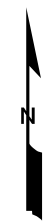
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Mn concentration
- Mean Mn concentration
- Maximum Mn concentration
- SMCL for Mn (0.05 mg/L)

**Notes:**

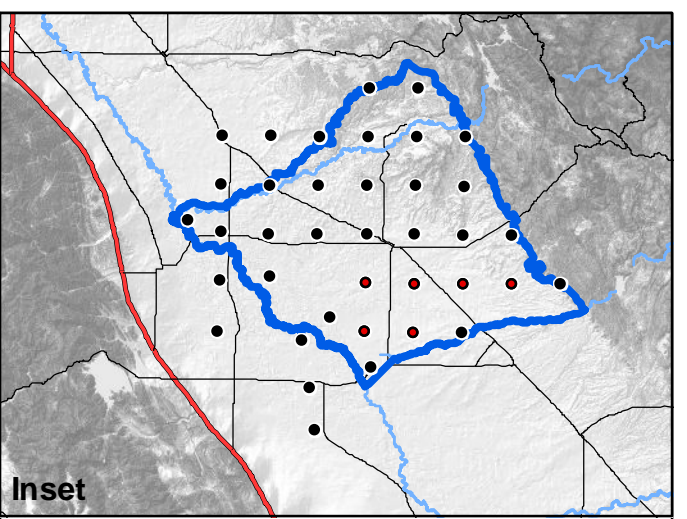
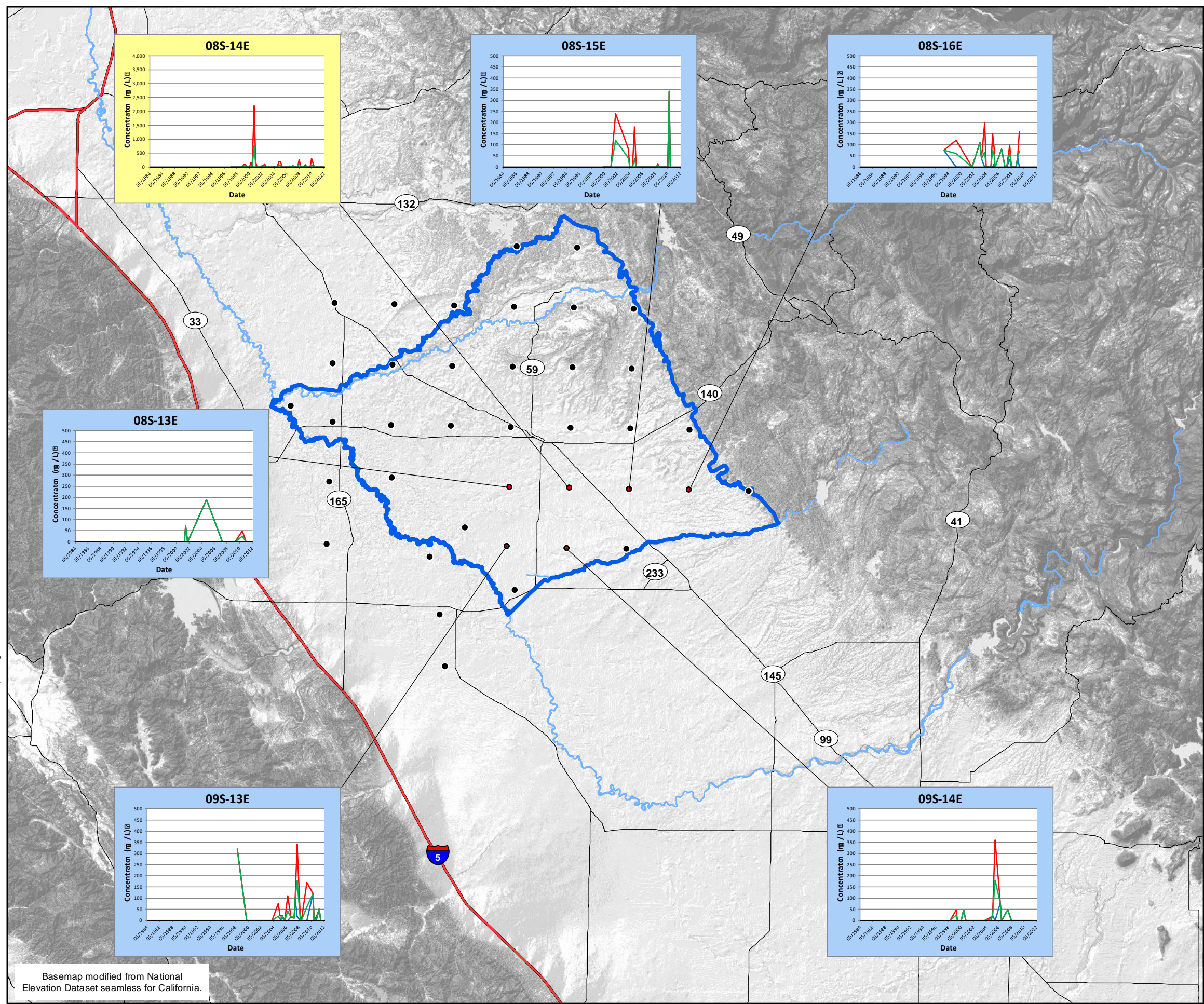
1. IRWMP = Integrated Regional Water Management Plan.
2. Manganese (Mn) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
White: 0- 100 mg/L  
Blue: 0- 500 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>MANGANESE (Mn) CONCENTRATIONS</b>		
1984 THROUGH 2012		
Merced IRWMP		
Merced County, California		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>7b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig07c\_Mn.mxd



**Inset**

**Explanation:**

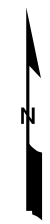
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Mn concentration
- Mean Mn concentration
- Maximum Mn concentration
- SMCL for Mn (0.05 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Manganese (Mn) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 Blue: 0- 500 mg/L  
 Yellow: 0- 4,000 mg/L

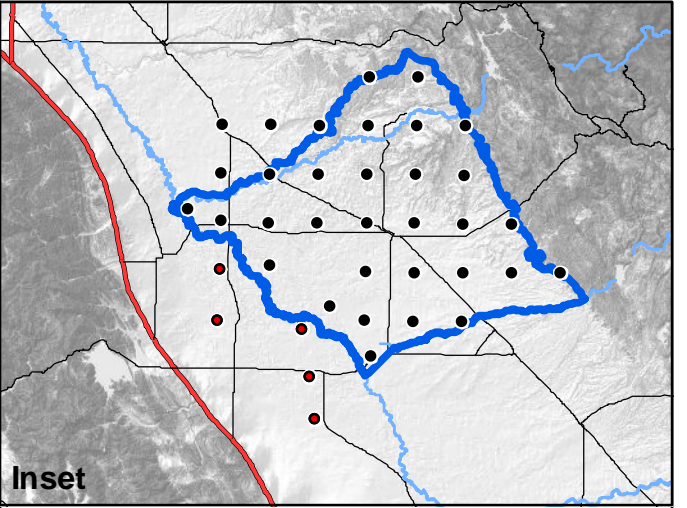
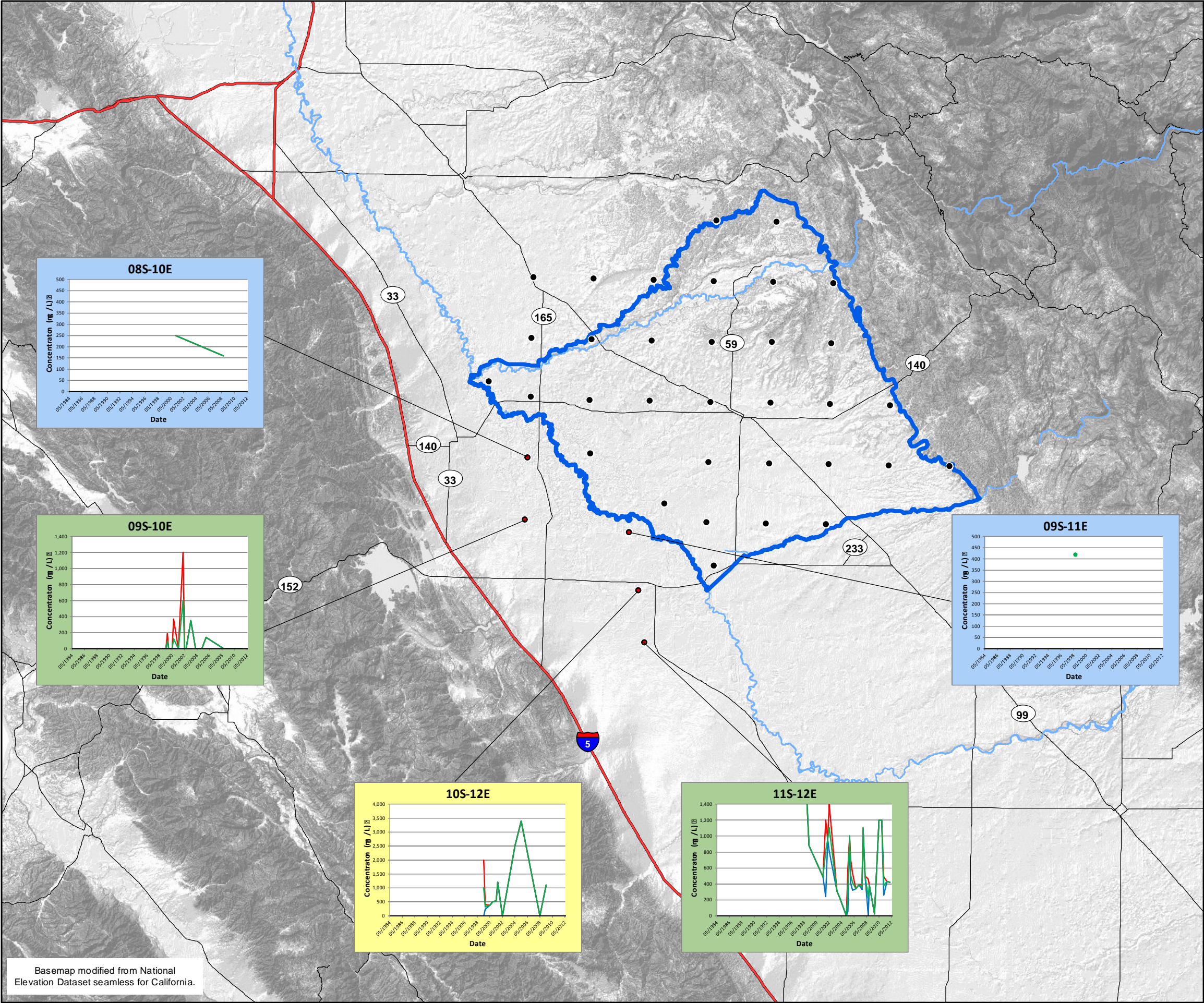
  
 0 5 10  
 APPROXIMATE SCALE IN MILES

**MANGANESE (Mn) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>7c</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig07d\_Mn.mxd



**Explanation:**

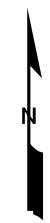
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum Mn concentration
- Mean Mn concentration
- Maximum Mn concentration
- SMCL for Mn (0.05 mg/L)

**Notes:**

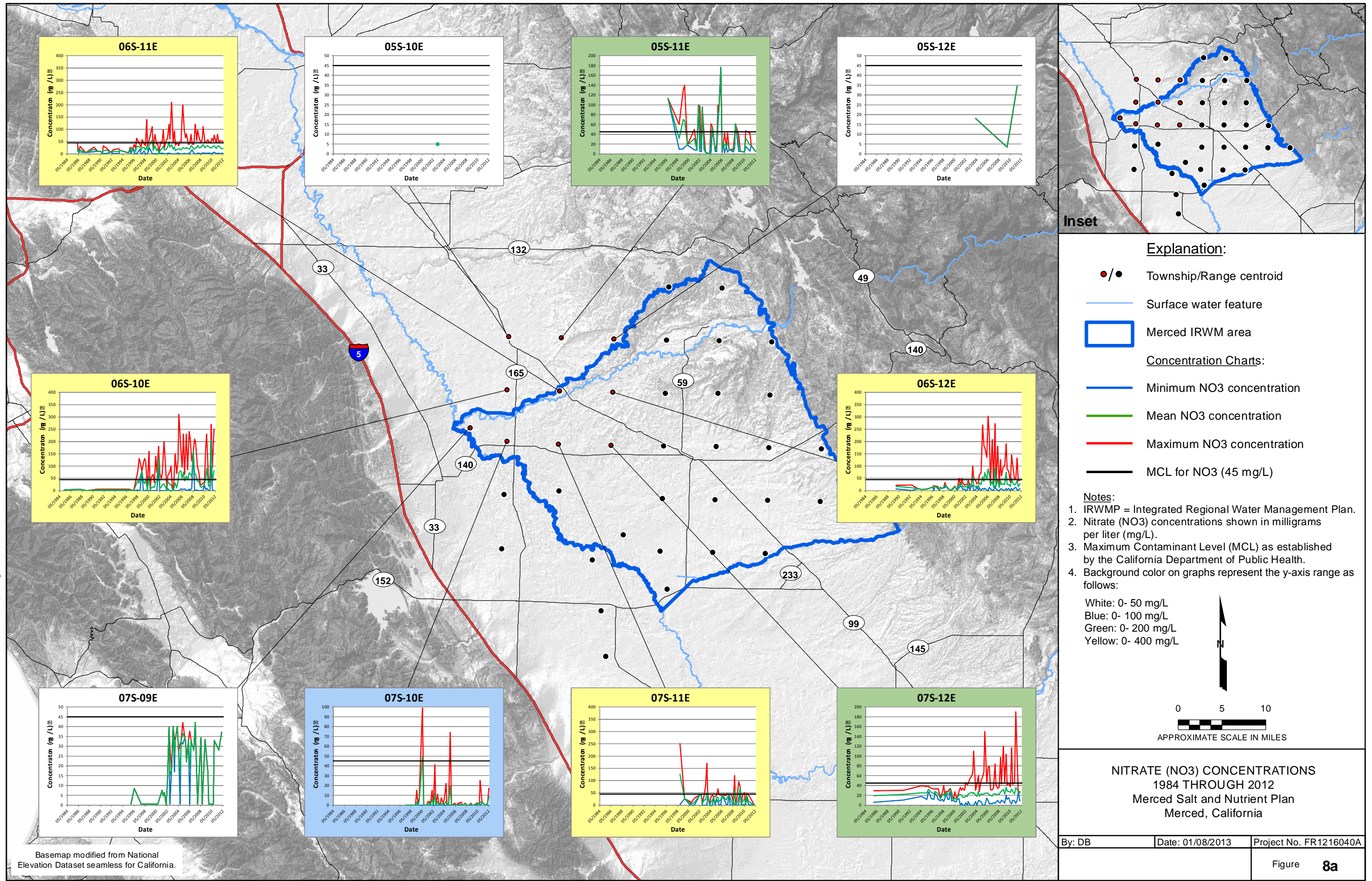
1. IRWMP = Integrated Regional Water Management Plan.
2. Manganese (Mn) concentrations shown in milligrams per liter (mg/L).
3. Secondary Maximum Contaminant Level (SMCL) as established by the California Department of Public Health
4. Background color on graphs represent the y-axis range as follows:  
 Blue: 0- 500 mg/L  
 Green: 0- 1,400 mg/L  
 Yellow: 0- 4,000 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>MANGANESE (Mn) CONCENTRATIONS</b>		
1984 THROUGH 2012		
Merced IRWMP		
Merced County, California		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>7d</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig08a\_NO3.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum NO3 concentration
- Mean NO3 concentration
- Maximum NO3 concentration
- MCL for NO3 (45 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Nitrate (NO3) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 50 mg/L  
 Blue: 0- 100 mg/L  
 Green: 0- 200 mg/L  
 Yellow: 0- 400 mg/L

0 5 10  
APPROXIMATE SCALE IN MILES

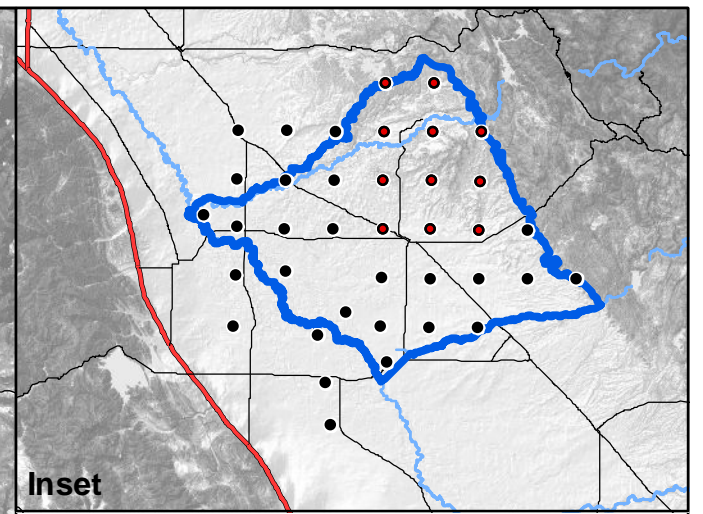
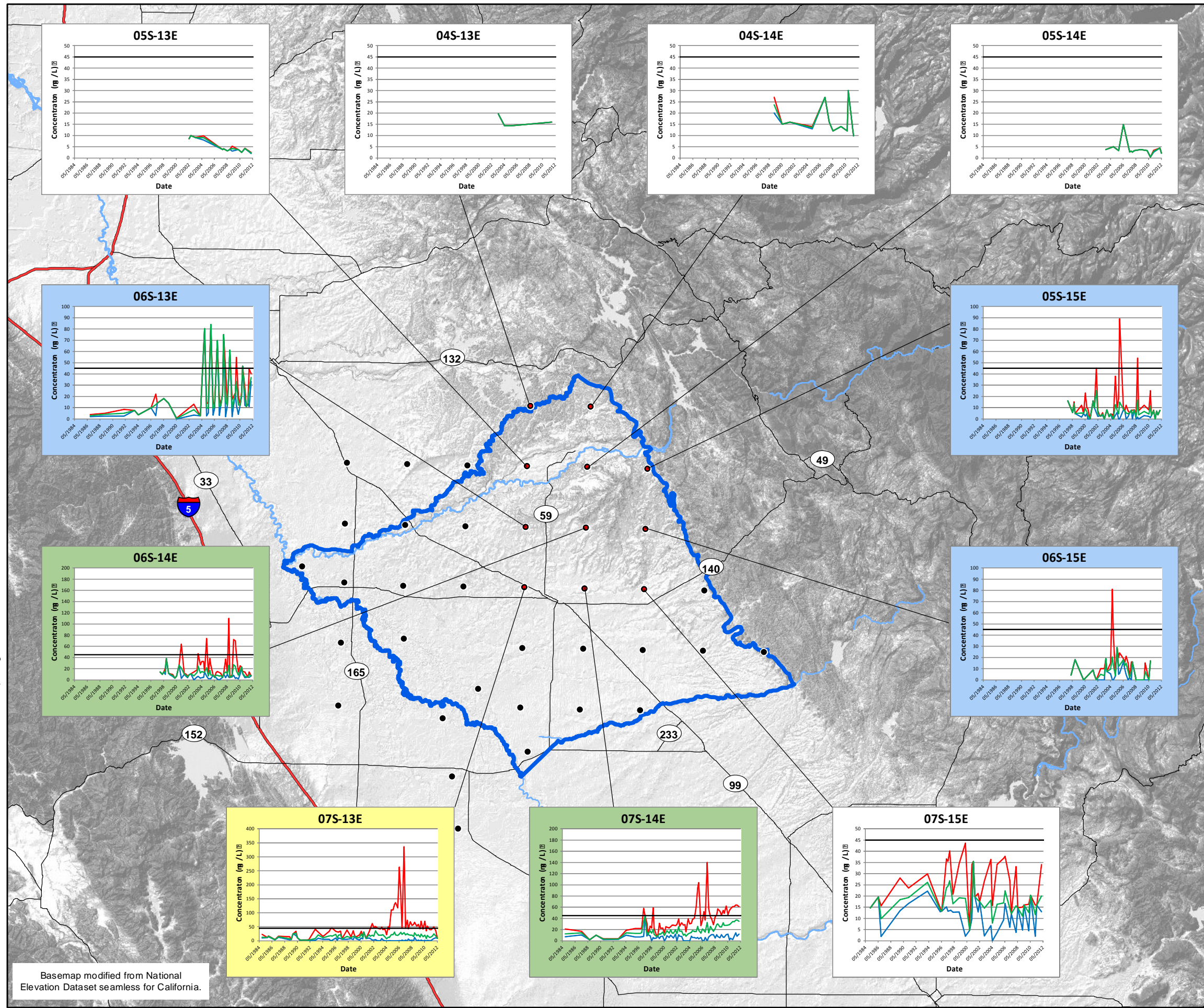
**NITRATE (NO3) CONCENTRATIONS  
1984 THROUGH 2012  
Merced Salt and Nutrient Plan  
Merced, California**

By: DB Date: 01/08/2013 Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig08b\_NO3.mxd



**Inset**

**Explanation:**


- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum NO3 concentration
- Mean NO3 concentration
- Maximum NO3 concentration
- MCL for NO3 (45 mg/L)

**Notes:**

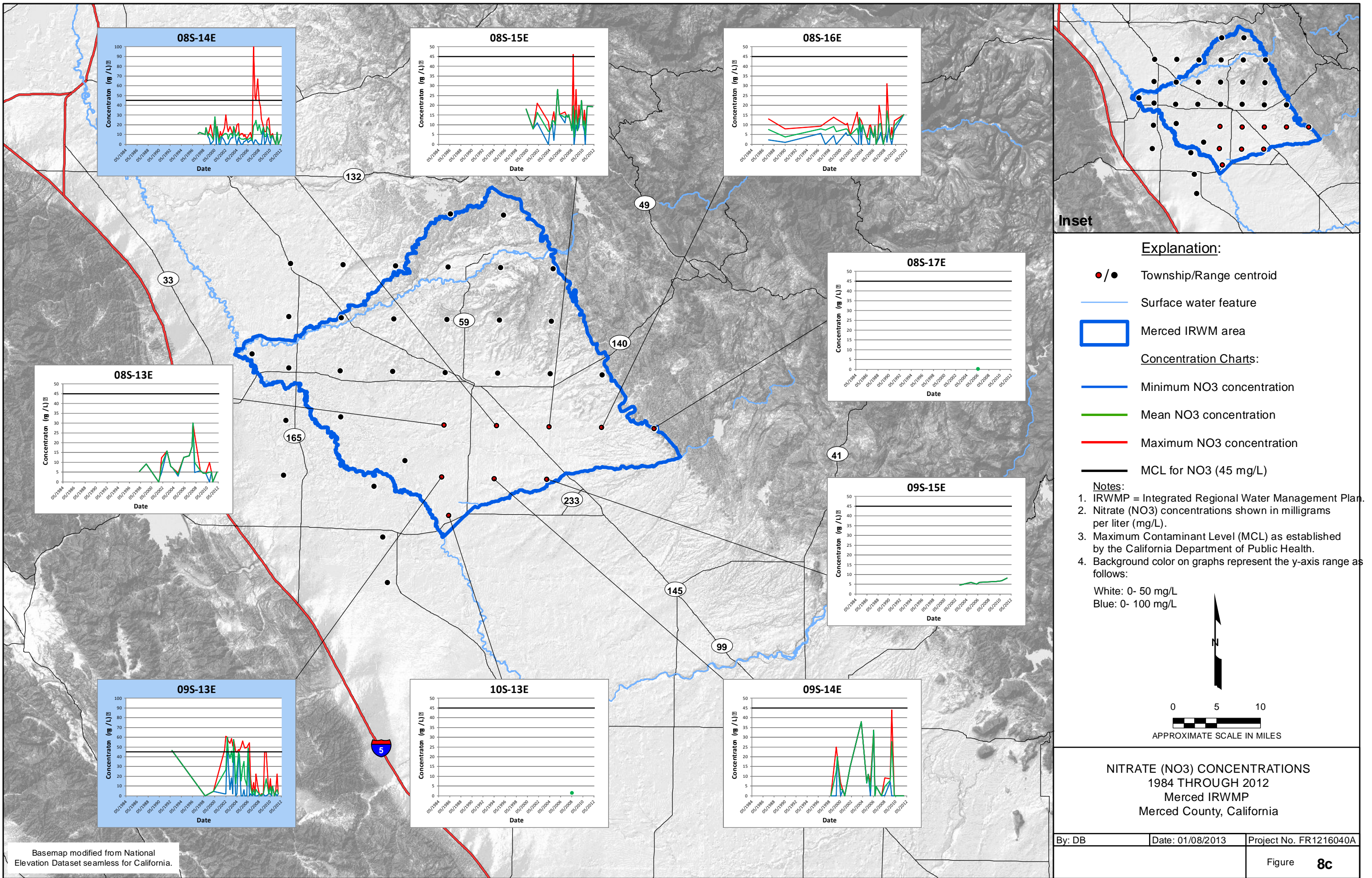
1. IRWMP = Integrated Regional Water Management Plan.
2. Nitrate (NO3) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 50 mg/L  
 Blue: 0- 100 mg/L  
 Green: 0- 200 mg/L  
 Yellow: 0- 400 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

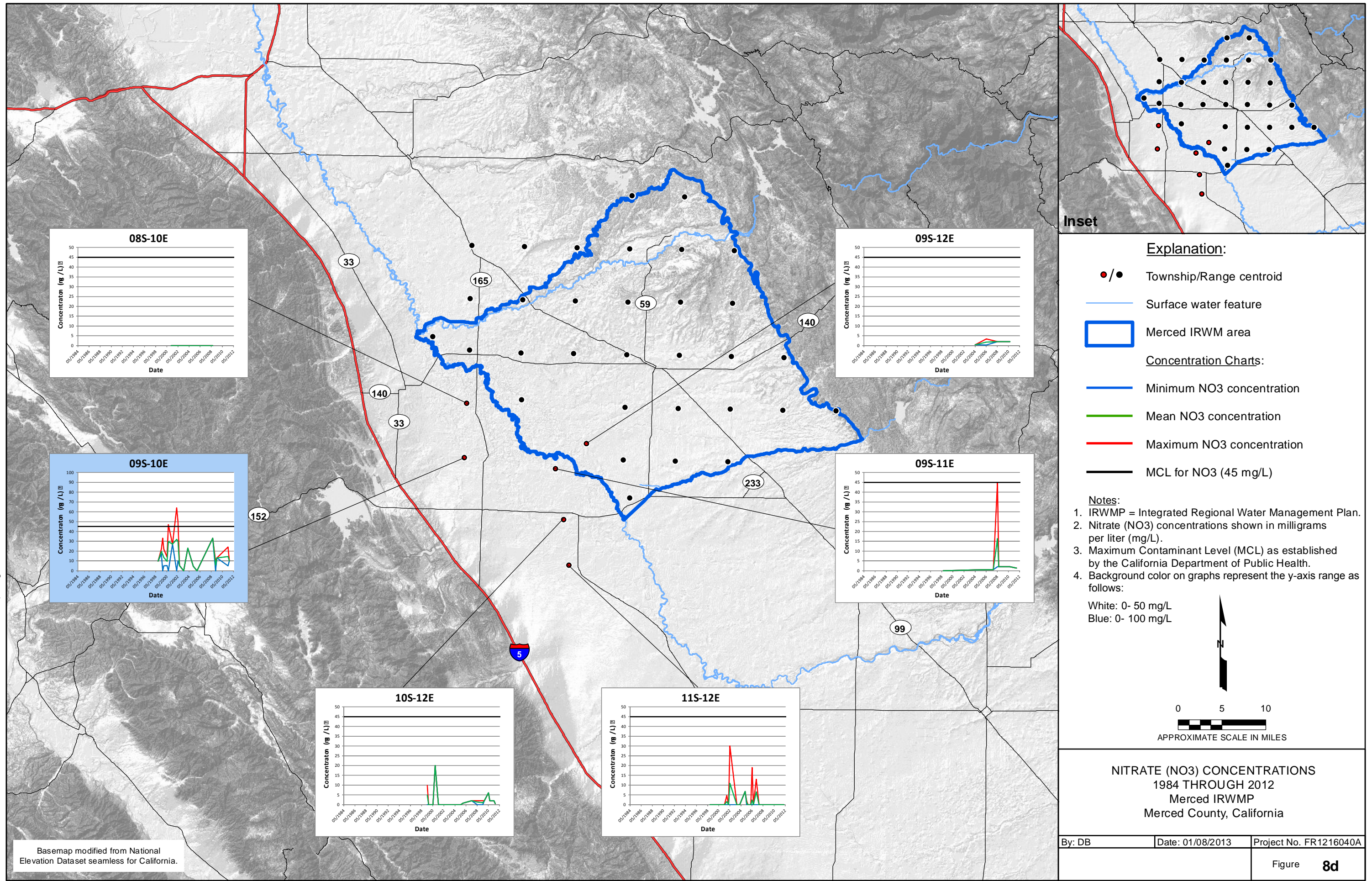
**NITRATE (NO3) CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>8b</b>

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig08d\_NO3.mxd



Basemap modified from National Elevation Dataset seamless for California.

**Explanation:**

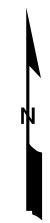
- / ● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum NO3 concentration
- Mean NO3 concentration
- Maximum NO3 concentration
- MCL for NO3 (45 mg/L)

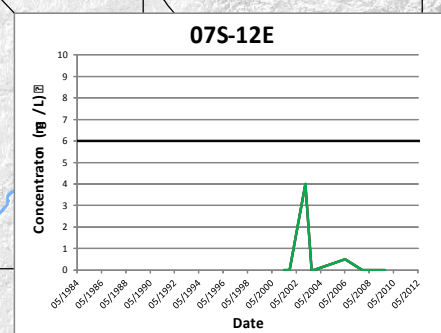
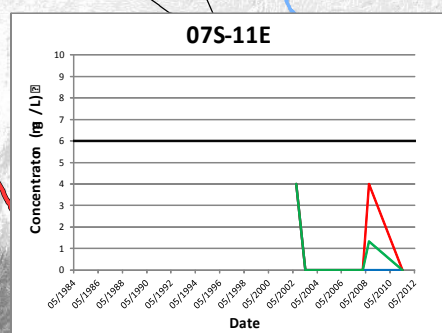
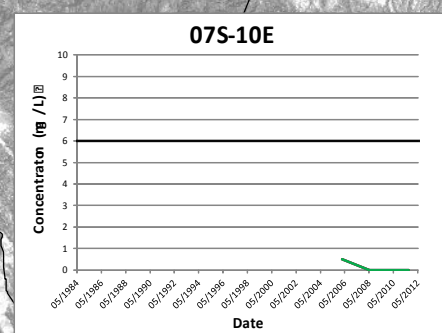
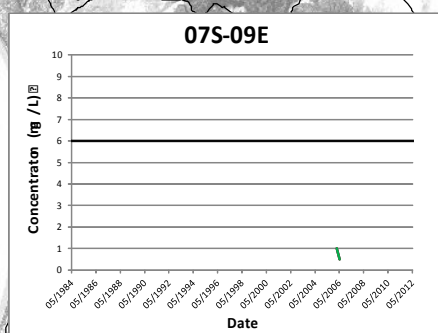
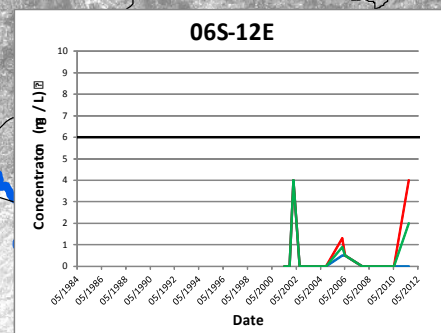
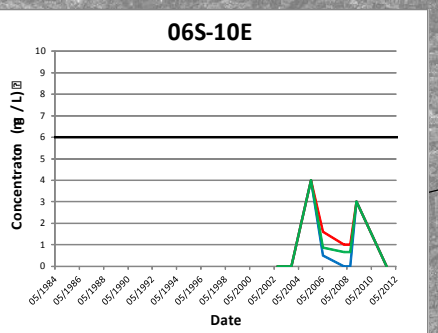
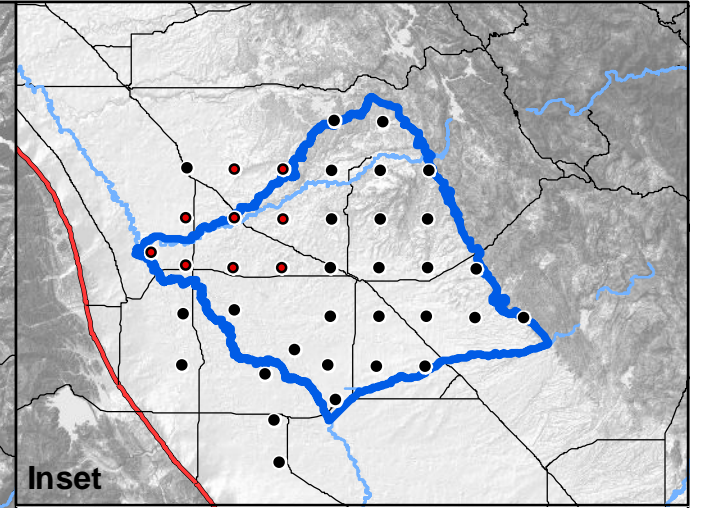
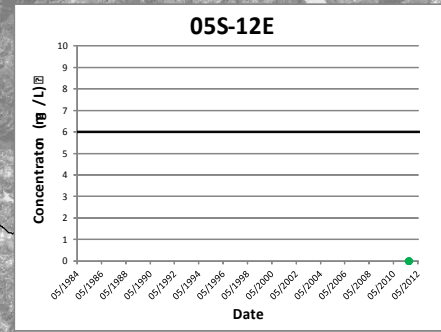
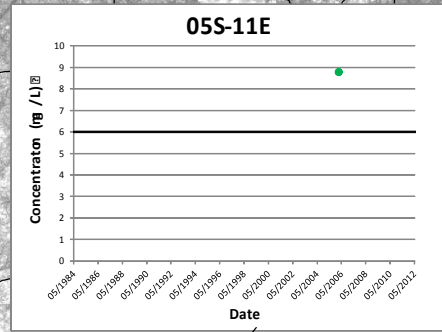
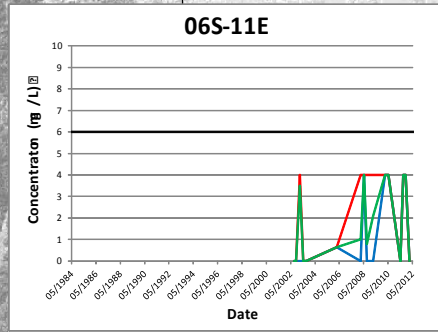
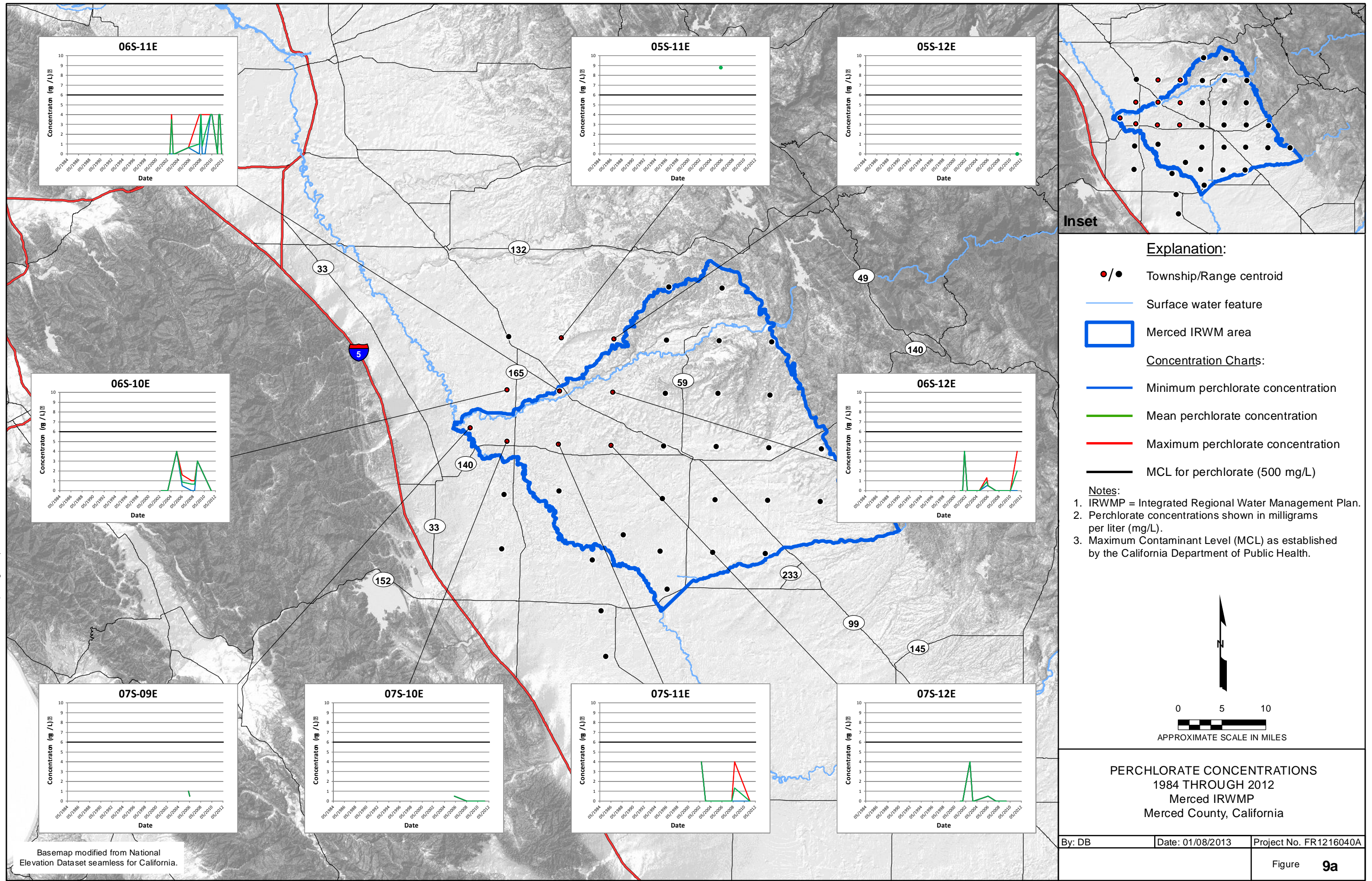
**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Nitrate (NO3) concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0- 50 mg/L  
 Blue: 0- 100 mg/L

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>NITRATE (NO3) CONCENTRATIONS</b>		
1984 THROUGH 2012		
Merced IRWMP		
Merced County, California		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>8d</b>

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig09a\_perchlorate.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

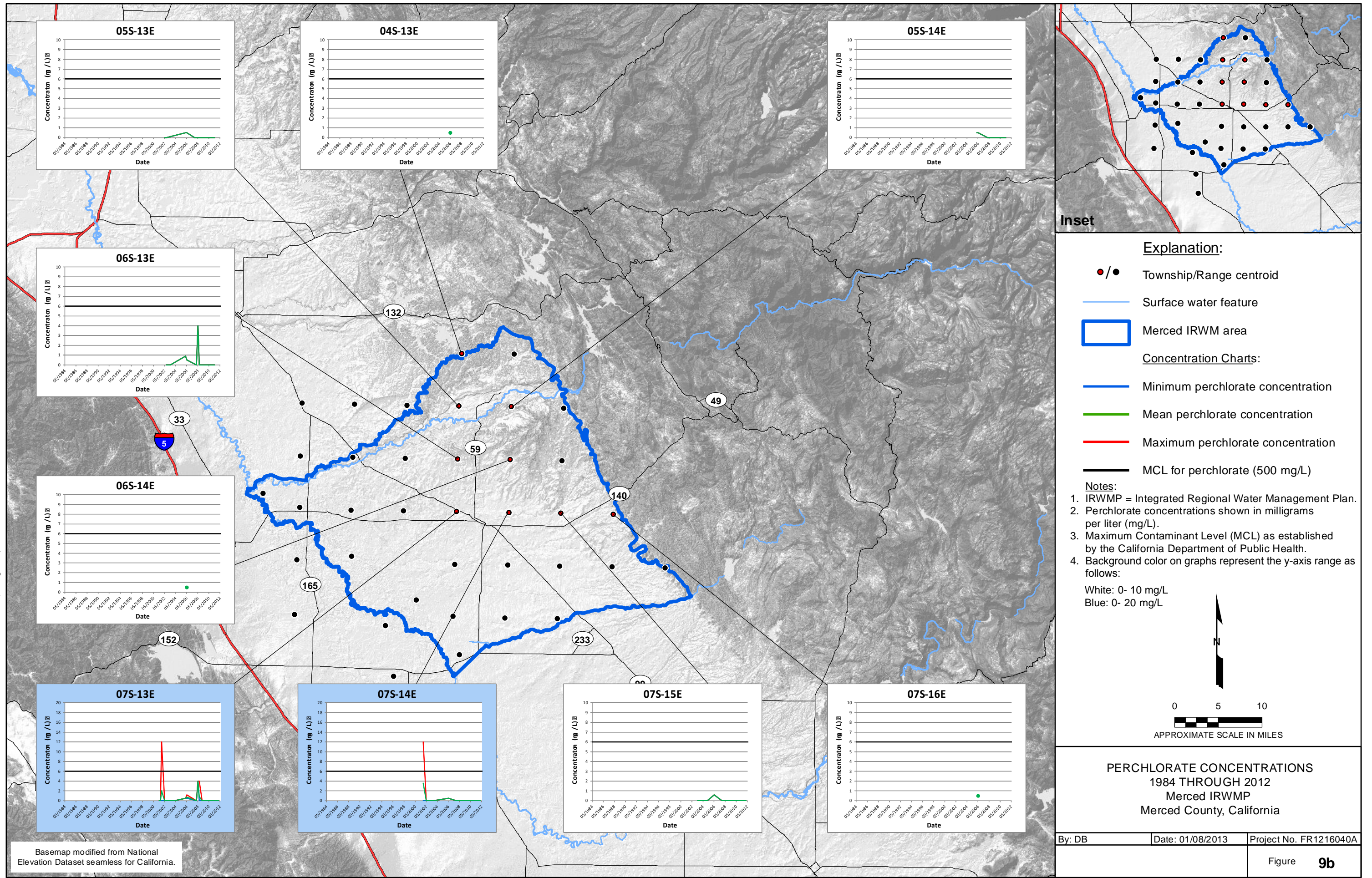
- Minimum perchlorate concentration
- Mean perchlorate concentration
- Maximum perchlorate concentration
- MCL for perchlorate (500 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Perchlorate concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

0 5 10  
APPROXIMATE SCALE IN MILES

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig09b\_perchlorate.mxd



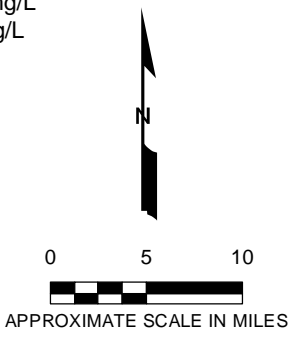
**Inset**

**Explanation:**

- /● Township/Range centroid
  - Surface water feature
  - Merced IRWM area
- Concentration Charts:**
- Minimum perchlorate concentration
  - Mean perchlorate concentration
  - Maximum perchlorate concentration
  - MCL for perchlorate (500 mg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Perchlorate concentrations shown in milligrams per liter (mg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
  4. Background color on graphs represent the y-axis range as follows:

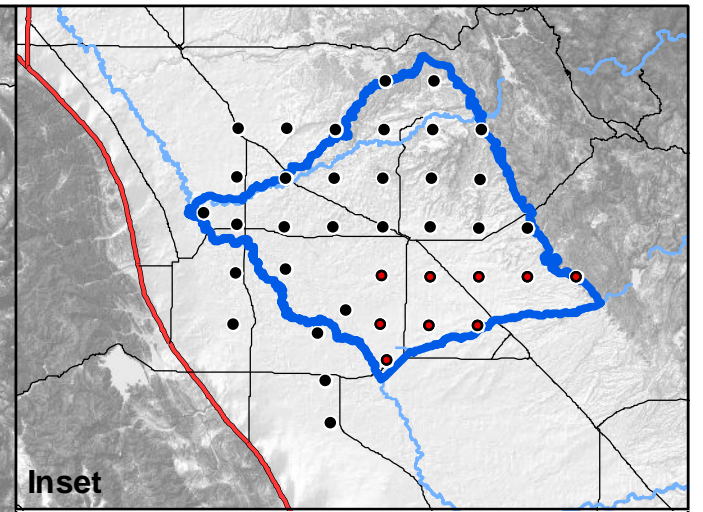
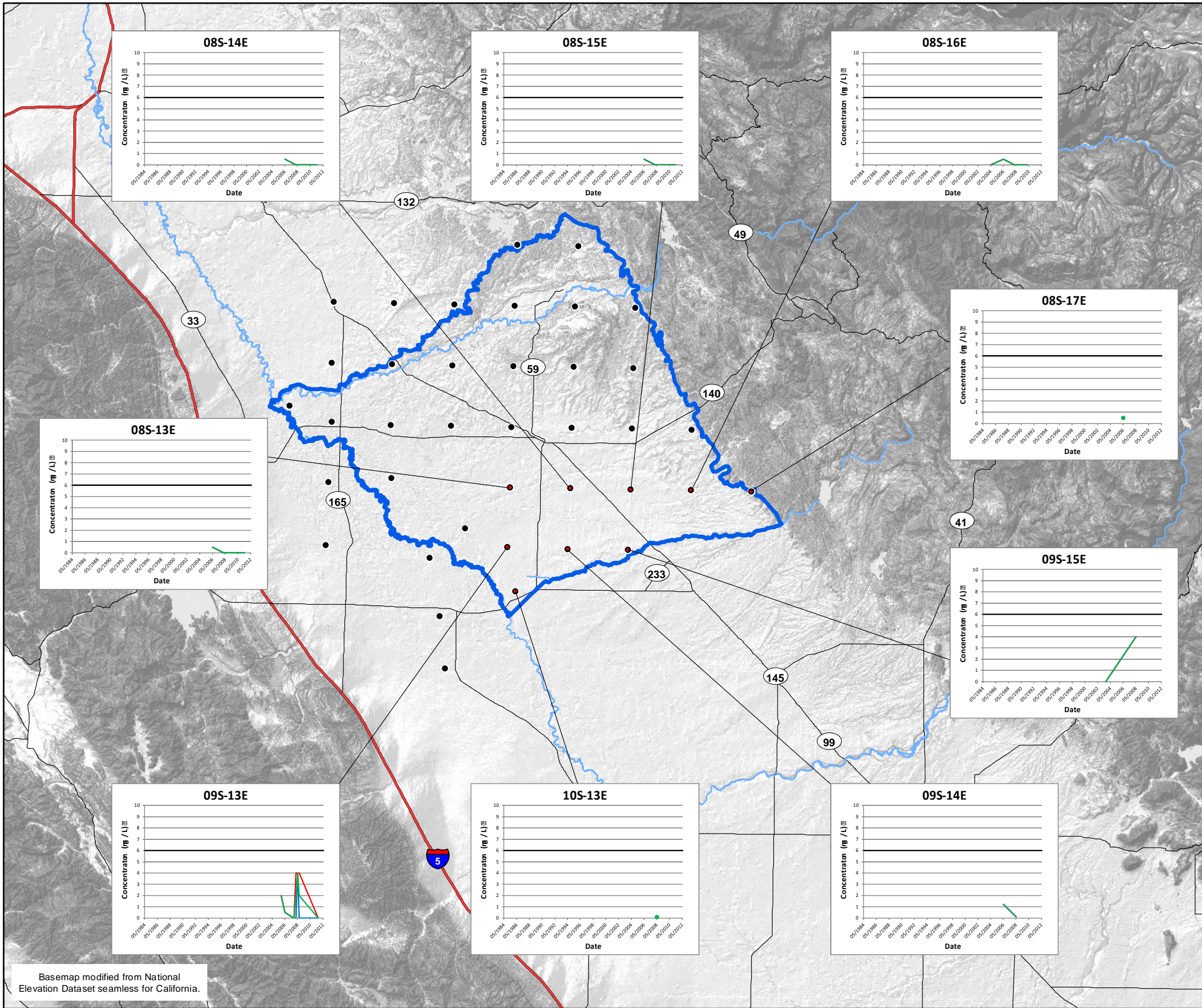
White: 0- 10 mg/L  
Blue: 0- 20 mg/L



**PERCHLORATE CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB      Date: 01/08/2013      Project No. FR1216040A

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig09c\_perchlorate.mxd



**Inset**

**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum perchlorate concentration
- Mean perchlorate concentration
- Maximum perchlorate concentration
- MCL for perchlorate (500 mg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Perchlorate concentrations shown in milligrams per liter (mg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

N

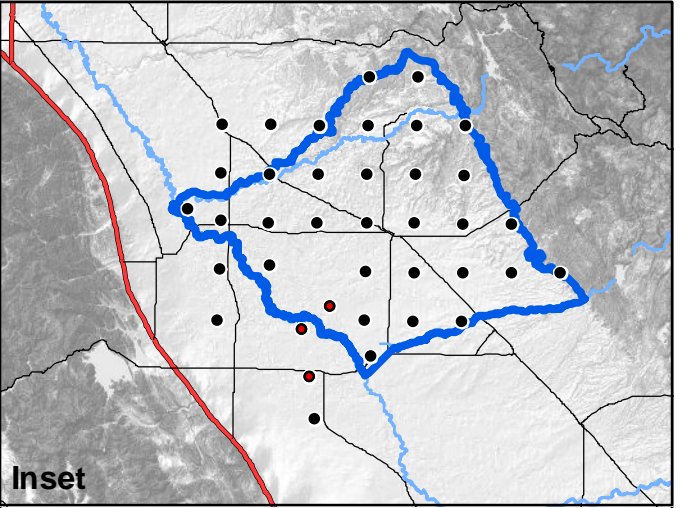
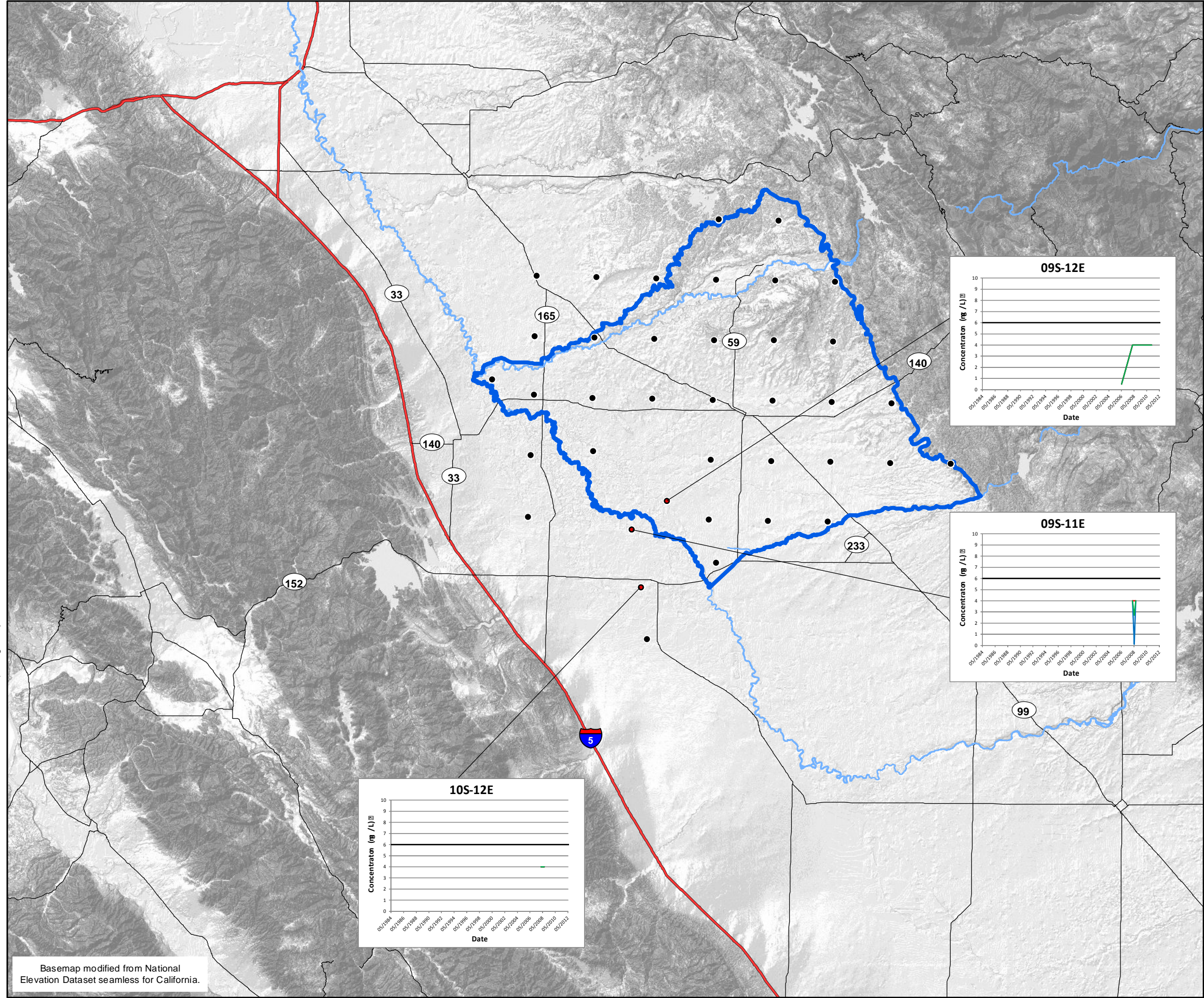
0 5 10  
APPROXIMATE SCALE IN MILES

**PERCHLORATE CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>9c</b>

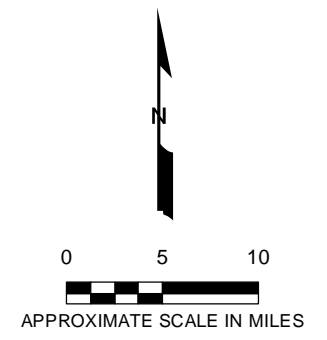
Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig09d\_perchlorate.mxd



- Explanation:**
- /● Township/Range centroid
  - Surface water feature
  - Merced IRWM area
- Concentration Charts:**
- Minimum perchlorate concentration
  - Mean perchlorate concentration
  - Maximum perchlorate concentration
  - MCL for perchlorate (500 mg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Perchlorate concentrations shown in milligrams per liter (mg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

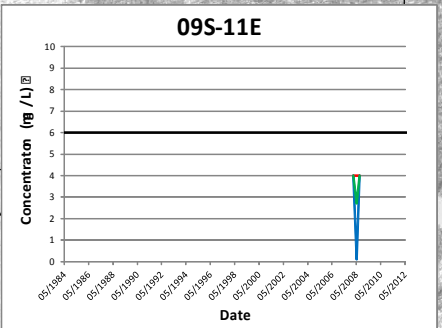
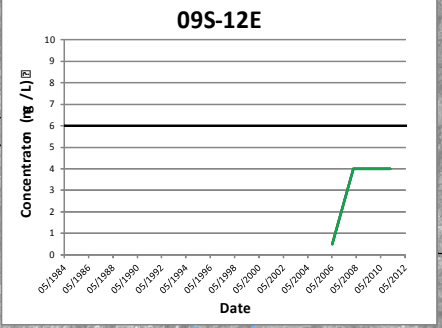
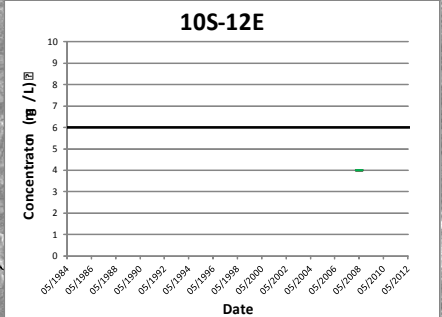


**PERCHLORATE CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

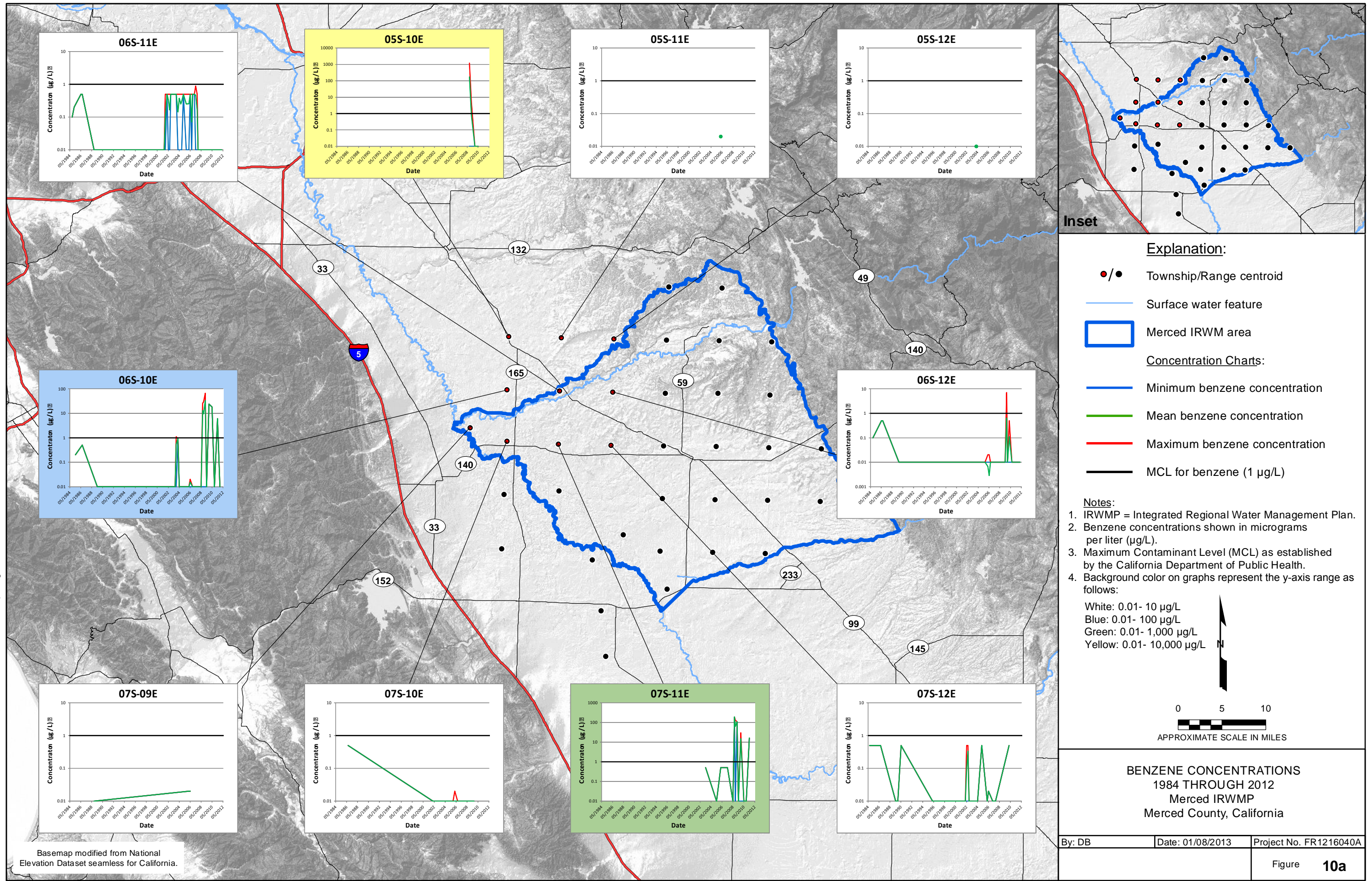
By: DB	Date: 01/08/2013	Project No. FR1216040A
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Figure **9d**

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig10a\_Benzene.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum benzene concentration
- Mean benzene concentration
- Maximum benzene concentration
- MCL for benzene (1 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Benzene concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0.01- 10 µg/L  
 Blue: 0.01- 100 µg/L  
 Green: 0.01- 1,000 µg/L  
 Yellow: 0.01- 10,000 µg/L

0 5 10  
APPROXIMATE SCALE IN MILES

**BENZENE CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

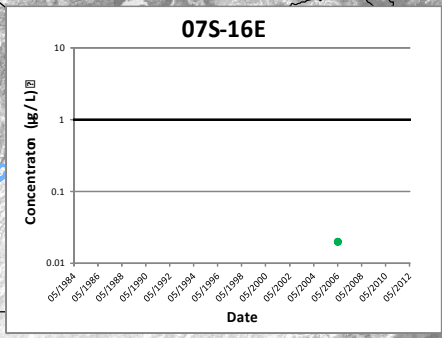
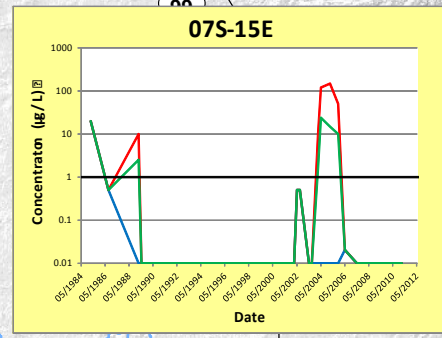
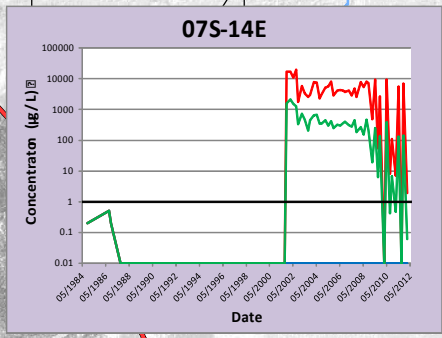
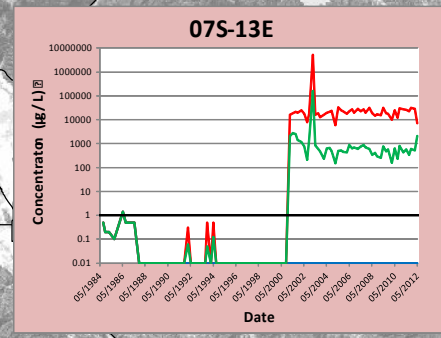
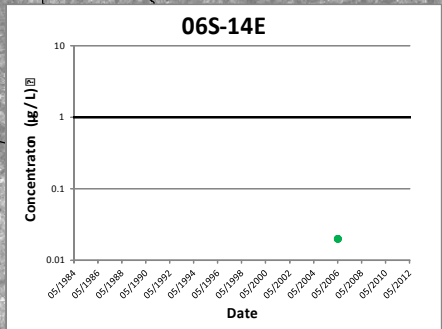
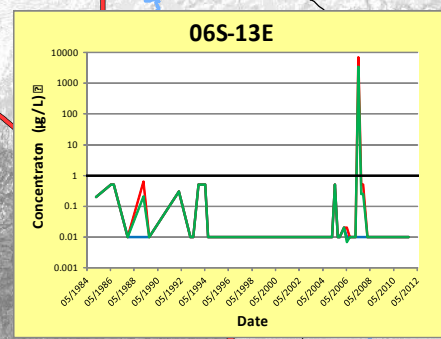
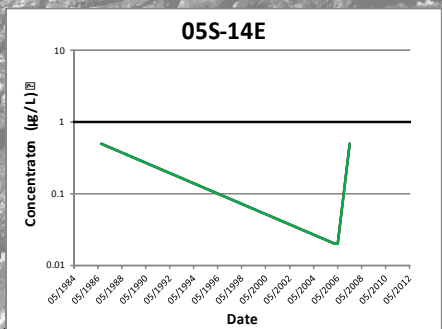
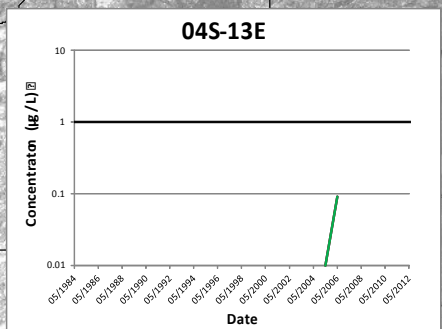
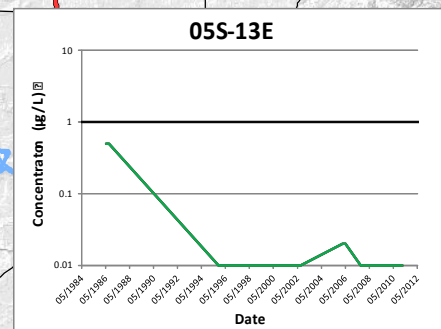
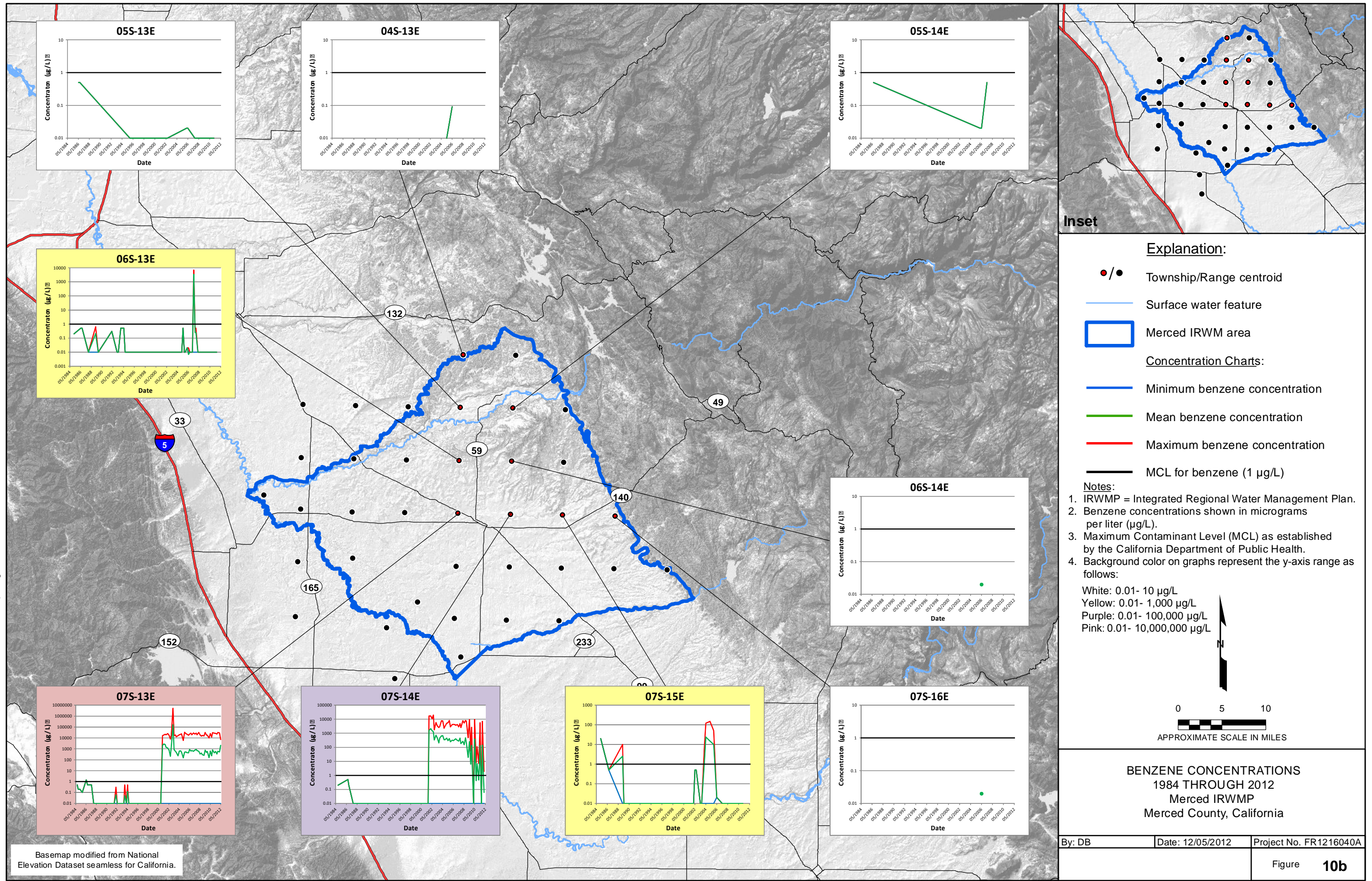
By: DB      Date: 01/08/2013      Project No. FR1216040A

Figure **10a**

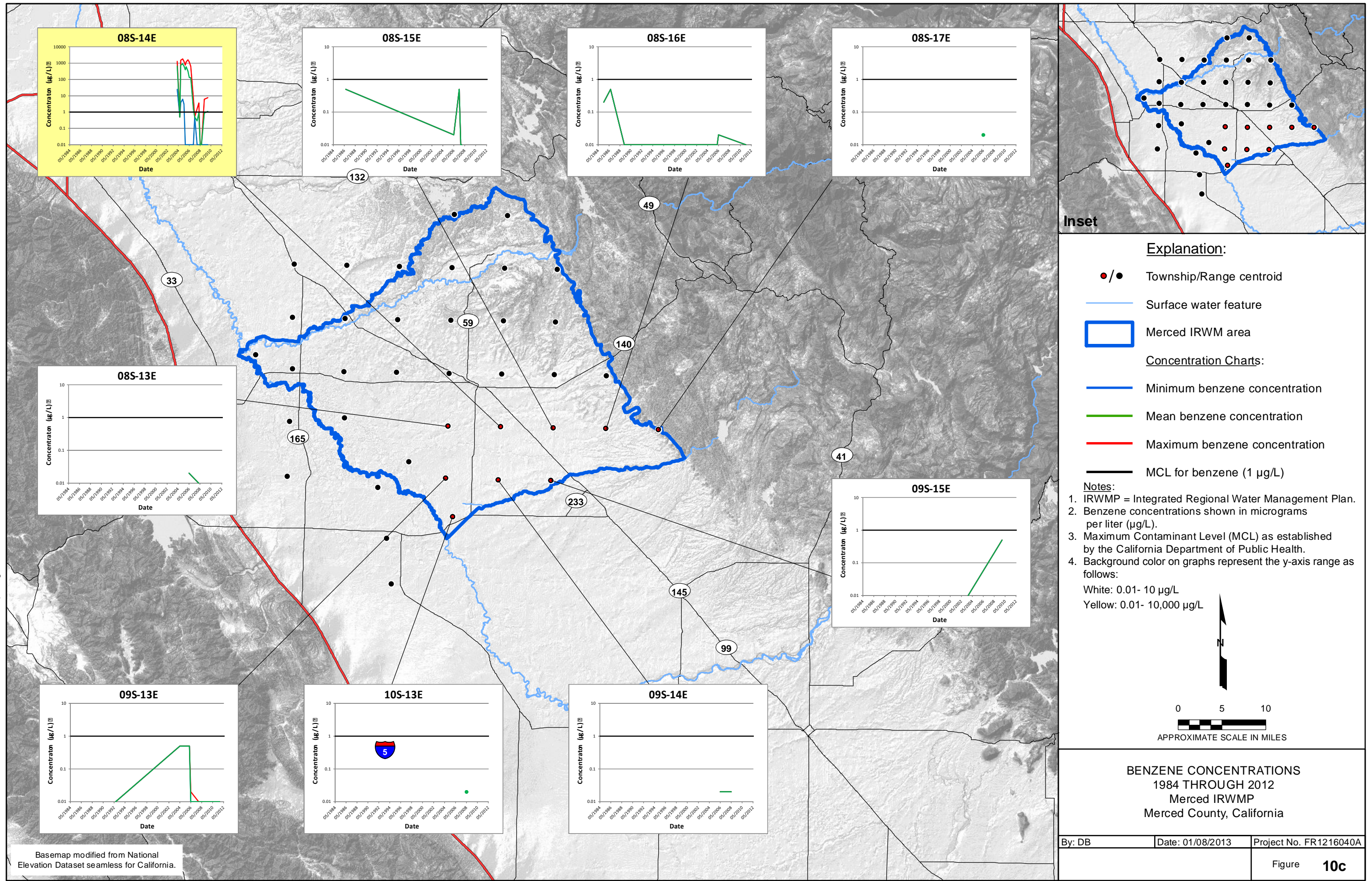
Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig10b\_Benzene.mxd



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**Inset**

**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum benzene concentration
- Mean benzene concentration
- Maximum benzene concentration
- MCL for benzene (1 µg/L)

**Notes:**

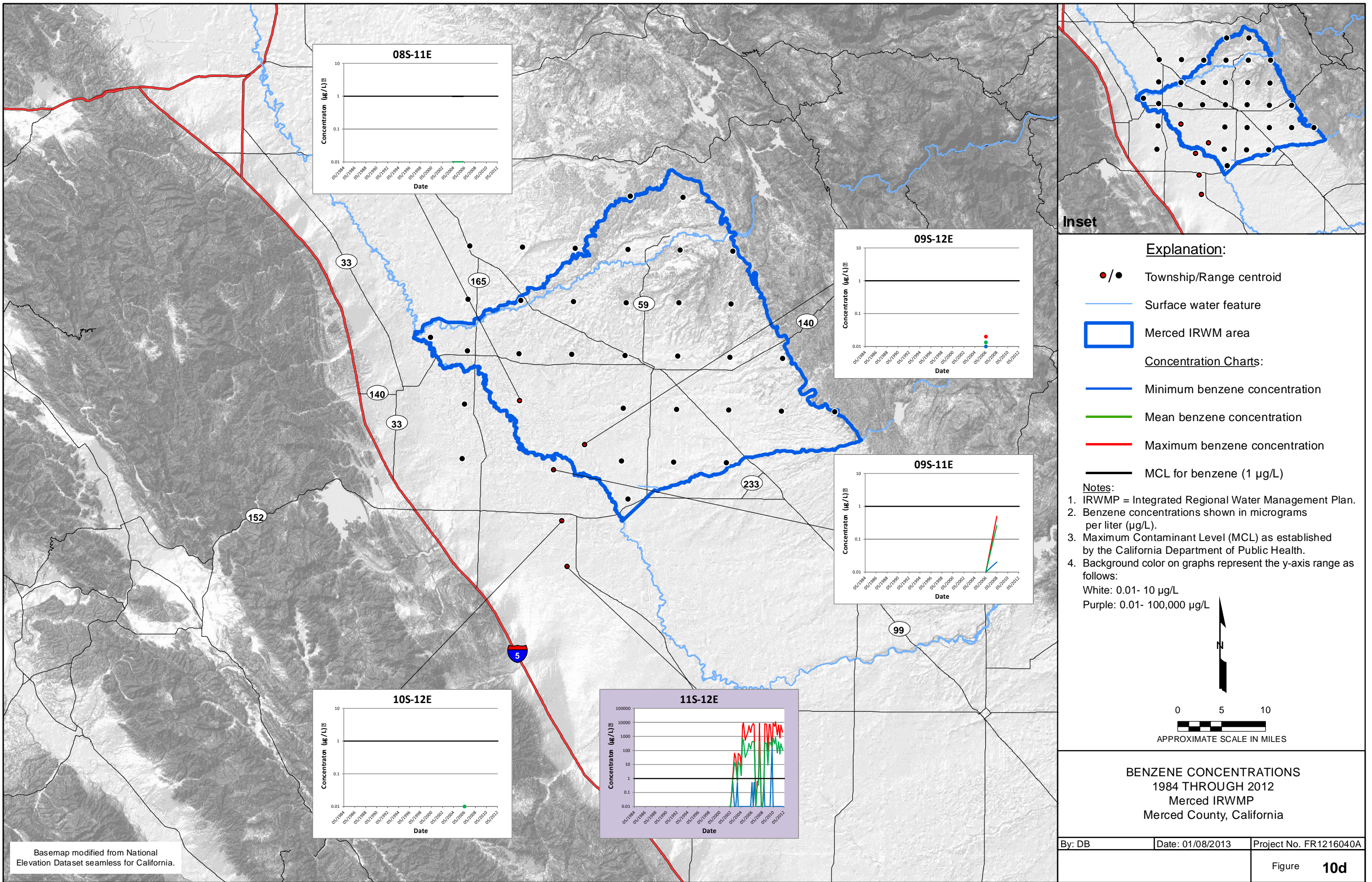
1. IRWMP = Integrated Regional Water Management Plan.
2. Benzene concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
White: 0.01- 10 µg/L  
Yellow: 0.01- 10,000 µg/L

0 5 10  
APPROXIMATE SCALE IN MILES

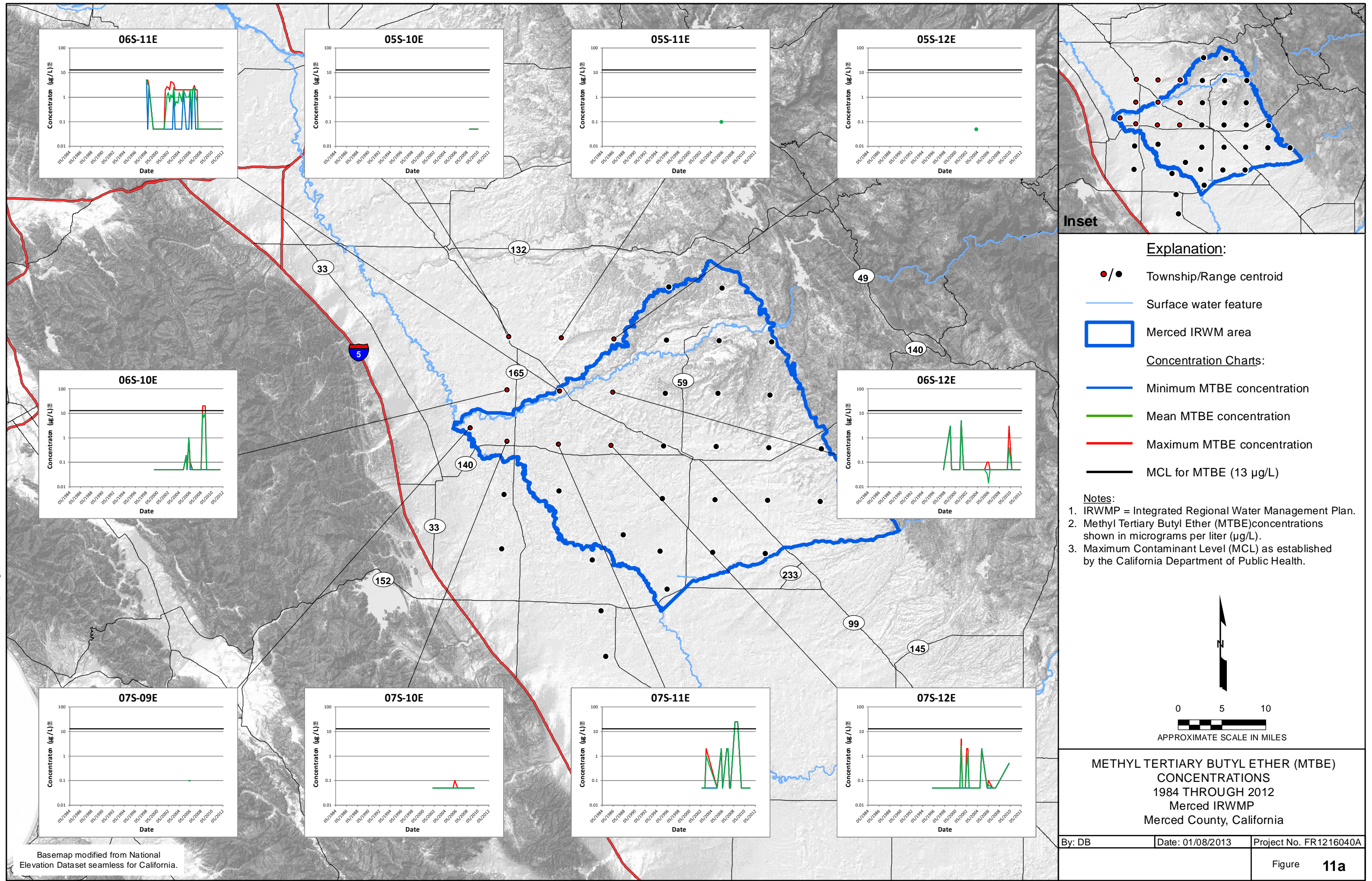
**BENZENE CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>10c</b>

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N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig11a\_MTBE.mxd



Basemap modified from National Elevation Dataset seamless for California.

**Explanation:**

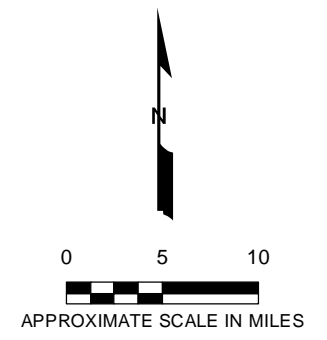
- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum MTBE concentration
- Mean MTBE concentration
- Maximum MTBE concentration
- MCL for MTBE (13 µg/L)

**Notes:**

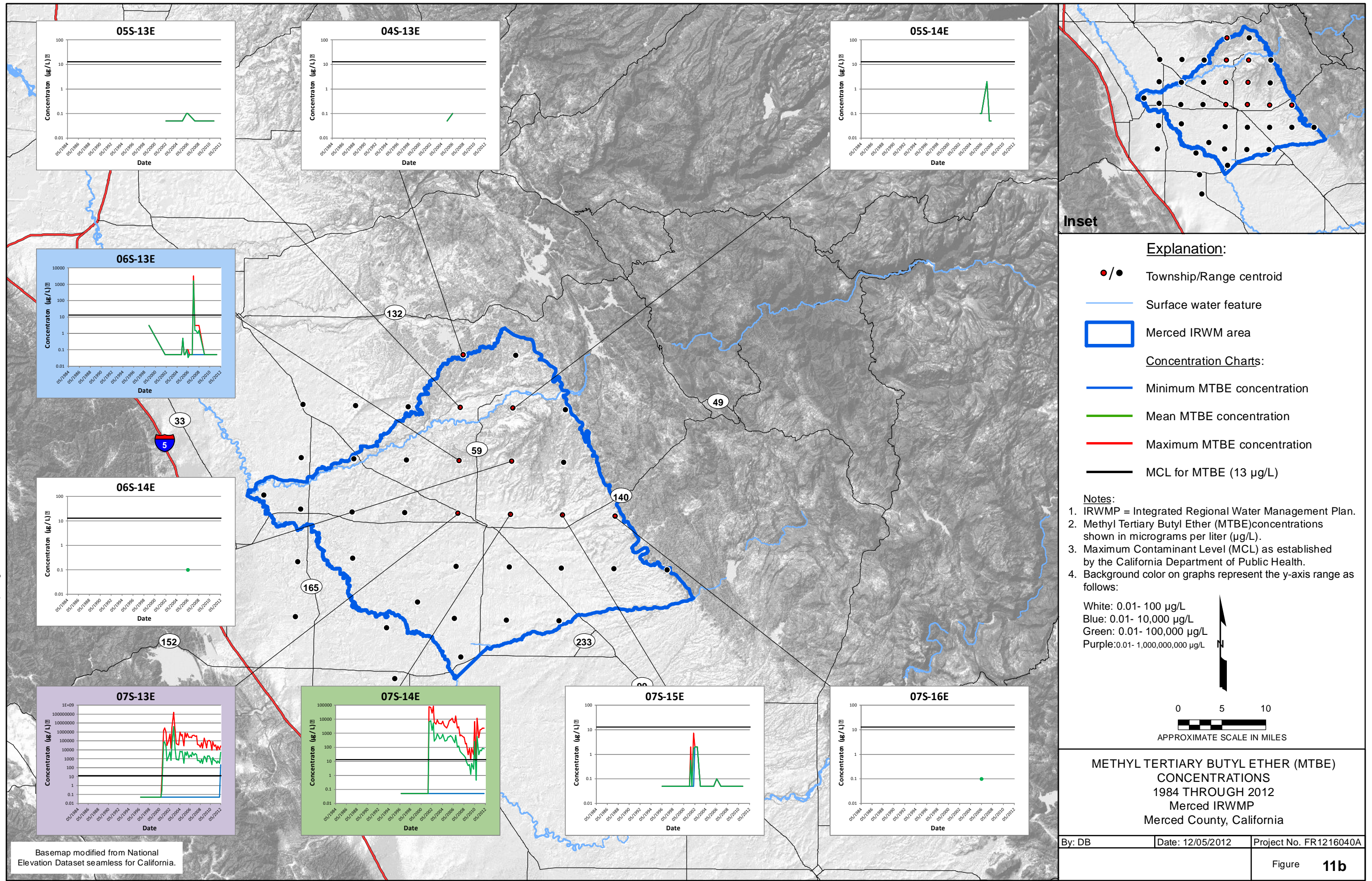
1. IRWMP = Integrated Regional Water Management Plan.
2. Methyl Tertiary Butyl Ether (MTBE) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.



**METHYL TERTIARY BUTYL ETHER (MTBE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

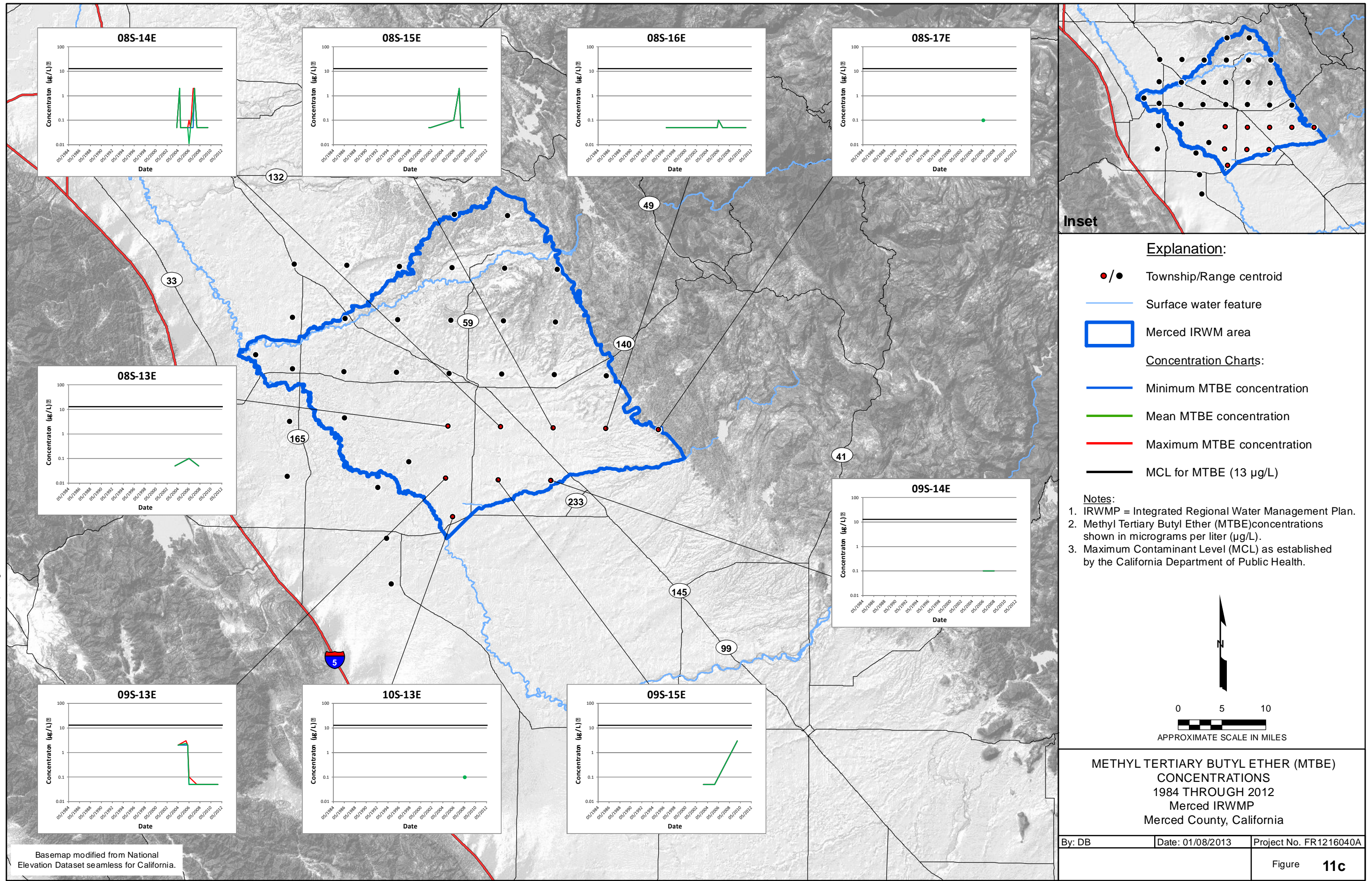
By: DB Date: 01/08/2013 Project No. FR1216040A

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Basemap modified from National Elevation Dataset seamless for California.

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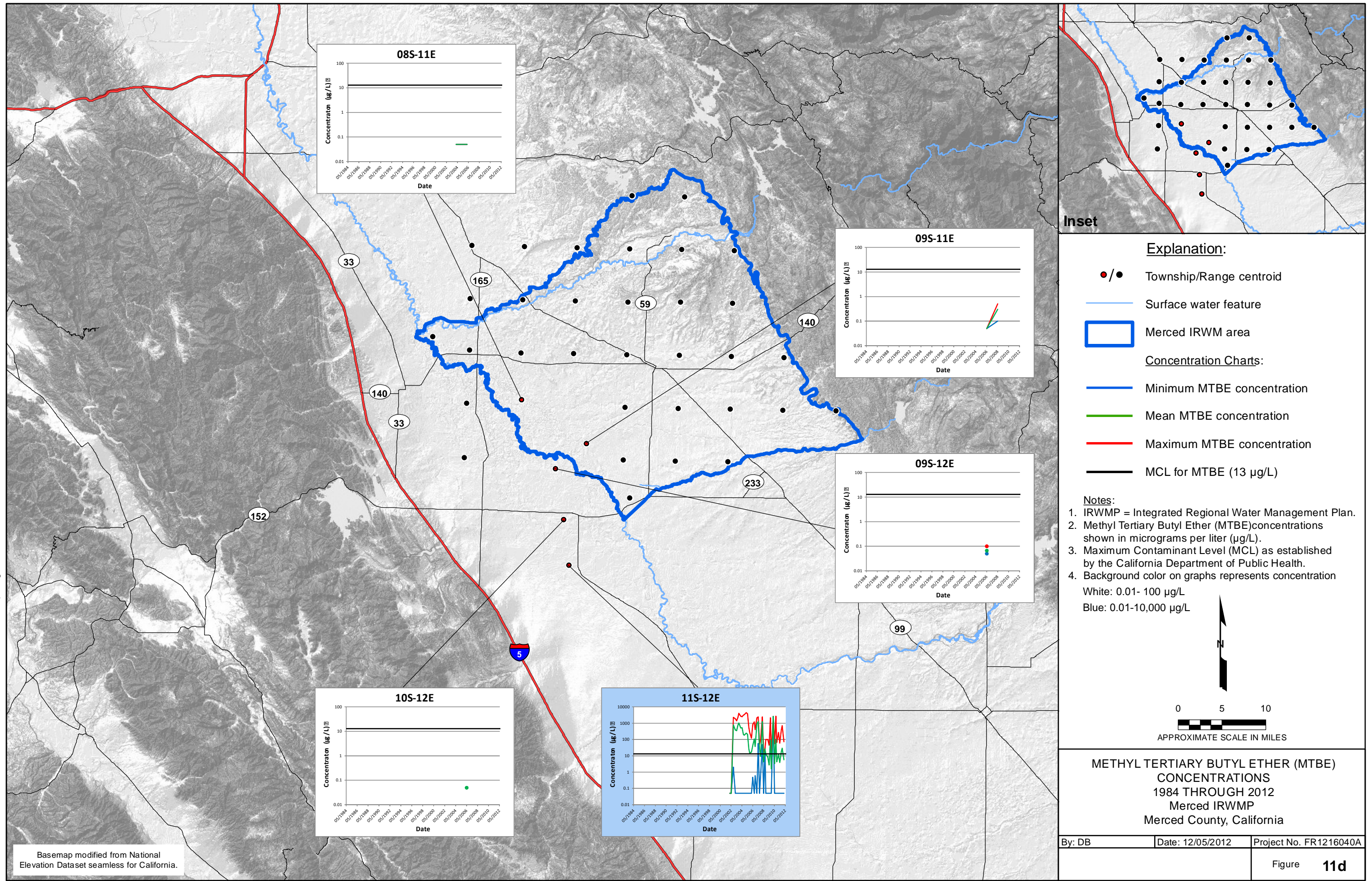
Basemap modified from National Elevation Dataset seamless for California.

By: DB	Date: 01/08/2013	Project No. FR1216040A
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Figure **11c**

**METHYL TERTIARY BUTYL ETHER (MTBE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig11d\_MTBE.mxd



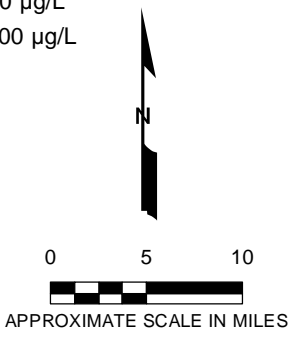
Basemap modified from National Elevation Dataset seamless for California.

**Inset**

**Explanation:**

- / ● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum MTBE concentration
  - Mean MTBE concentration
  - Maximum MTBE concentration
  - MCL for MTBE (13 µg/L)

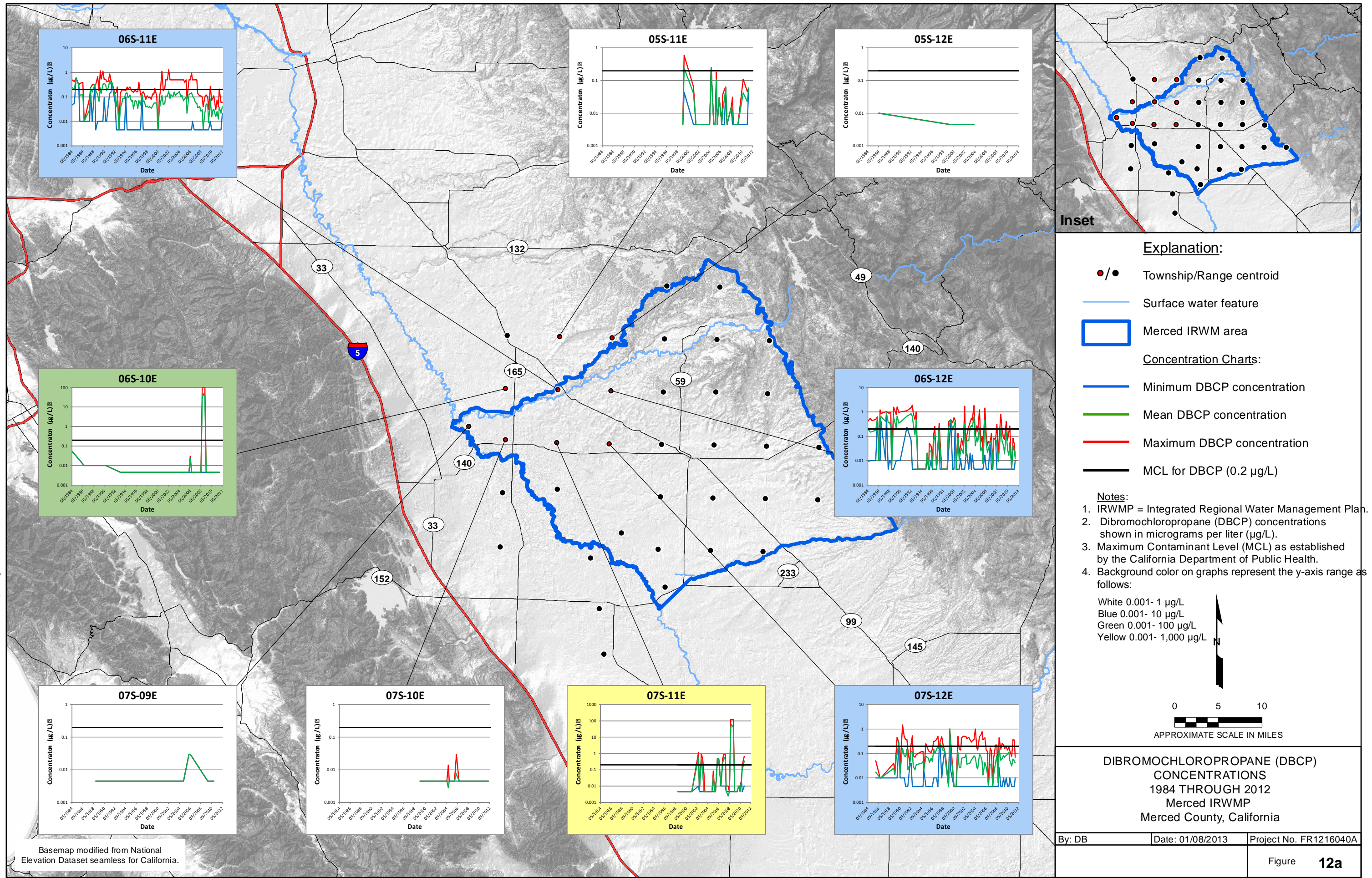
- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Methyl Tertiary Butyl Ether (MTBE) concentrations shown in micrograms per liter (µg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
  4. Background color on graphs represents concentration
- White: 0.01- 100 µg/L  
Blue: 0.01-10,000 µg/L



**METHYL TERTIARY BUTYL ETHER (MTBE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB Date: 12/05/2012 Project No. FR1216040A

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**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum DBCP concentration
- Mean DBCP concentration
- Maximum DBCP concentration
- MCL for DBCP (0.2 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Dibromochloropropane (DBCP) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:

- White 0.001- 1 µg/L
- Blue 0.001- 10 µg/L
- Green 0.001- 100 µg/L
- Yellow 0.001- 1,000 µg/L

0 5 10  
APPROXIMATE SCALE IN MILES

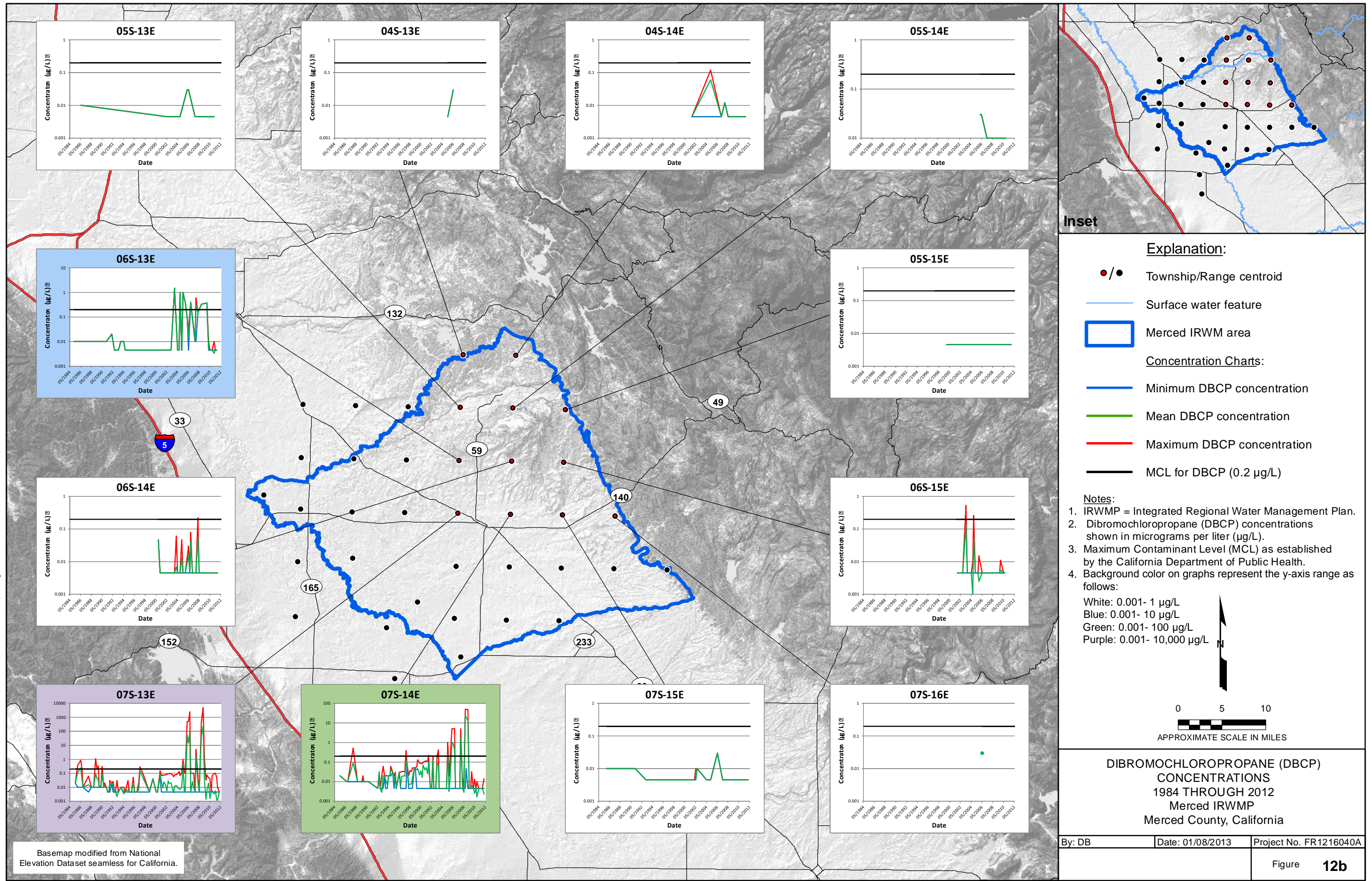
**DIBROMOCHLOROPROPANE (DBCP) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>12a</b>

Basemap modified from National Elevation Dataset seamless for California.



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Basemap modified from National Elevation Dataset seamless for California.

**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum DBCP concentration
- Mean DBCP concentration
- Maximum DBCP concentration
- MCL for DBCP (0.2 µg/L)

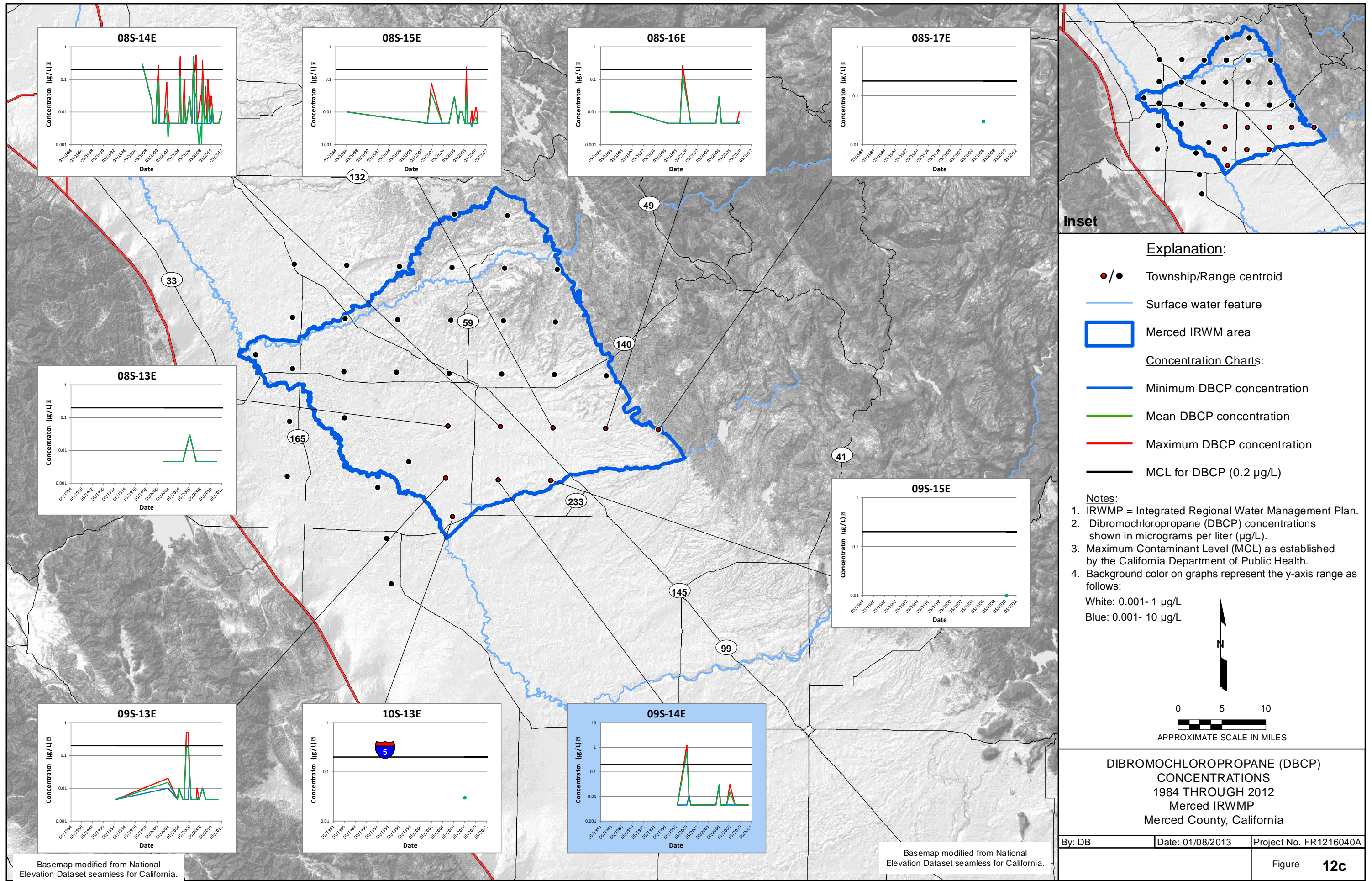
**Notes:**

- IRWMP = Integrated Regional Water Management Plan.
- Dibromochloropropane (DBCP) concentrations shown in micrograms per liter (µg/L).
- Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
- Background color on graphs represent the y-axis range as follows:  
 White: 0.001- 1 µg/L  
 Blue: 0.001- 10 µg/L  
 Green: 0.001- 100 µg/L  
 Purple: 0.001- 10,000 µg/L

0 5 10  
APPROXIMATE SCALE IN MILES

**DIBROMOCHLOROPROPANE (DBCP) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig12c\_DBCP.mxd



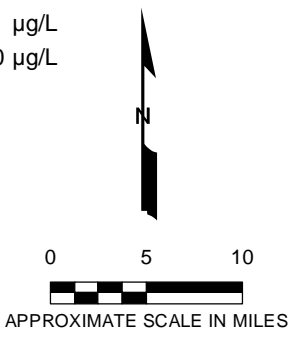
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**Explanation:**

- /● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum DBCP concentration
  - Mean DBCP concentration
  - Maximum DBCP concentration
  - MCL for DBCP (0.2 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Dibromochloropropane (DBCP) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
 White: 0.001- 1 µg/L  
 Blue: 0.001- 10 µg/L

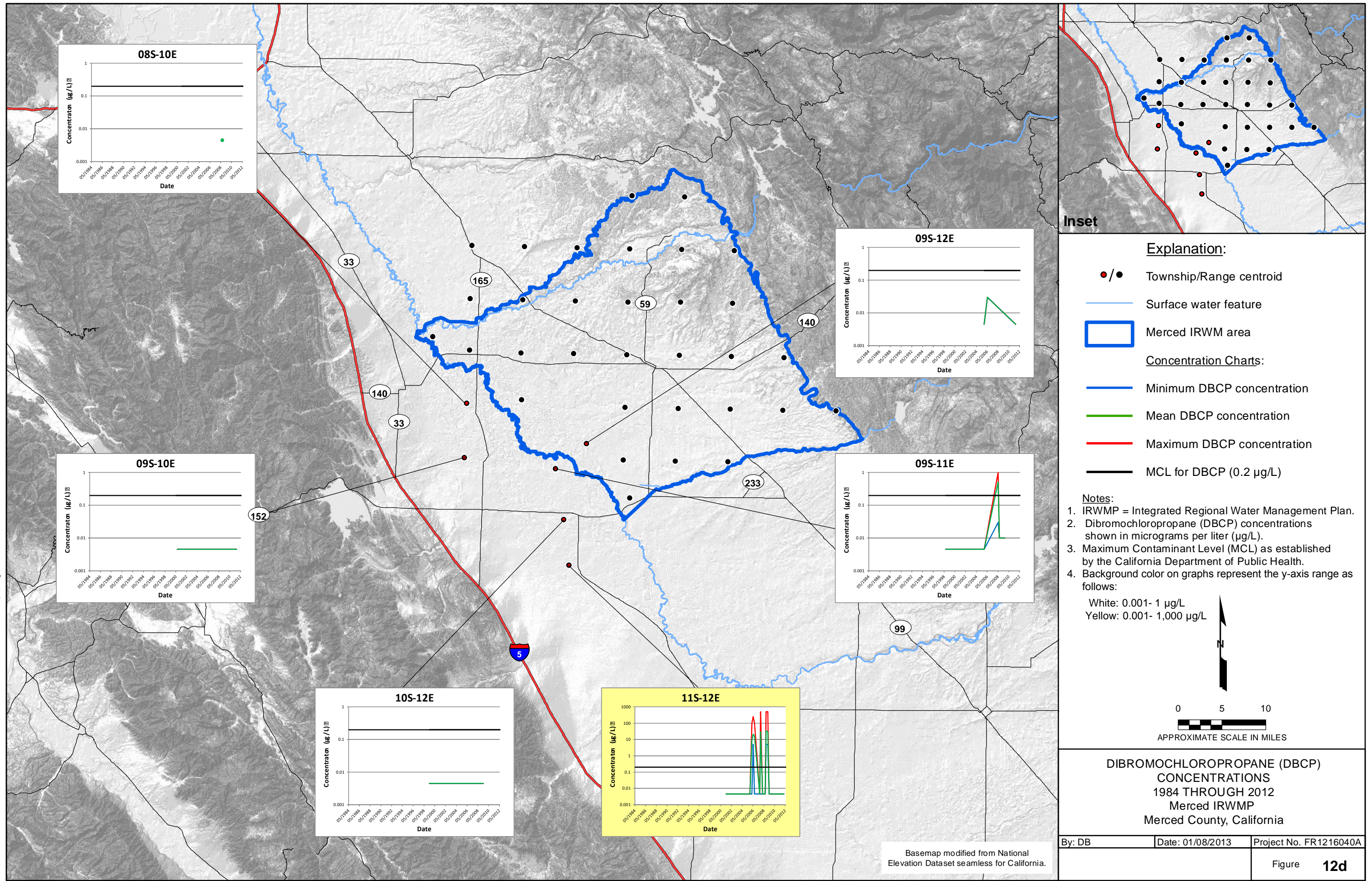


**DIBROMOCHLOROPROPANE (DBCP) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

By: DB Date: 01/08/2013 Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.

Basemap modified from National Elevation Dataset seamless for California.



**Inset**

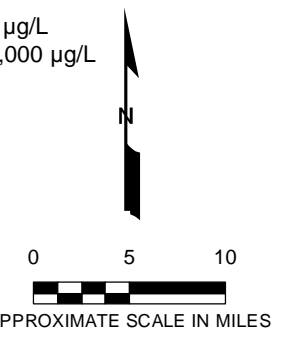
**Explanation:**

- / ● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum DBCP concentration
  - Mean DBCP concentration
  - Maximum DBCP concentration
  - MCL for DBCP (0.2 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Dibromochloropropane (DBCP) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:

White: 0.001- 1 µg/L  
 Yellow: 0.001- 1,000 µg/L

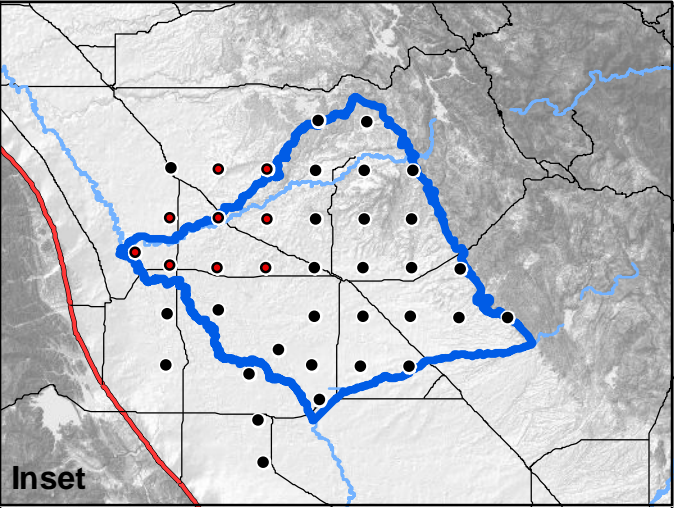
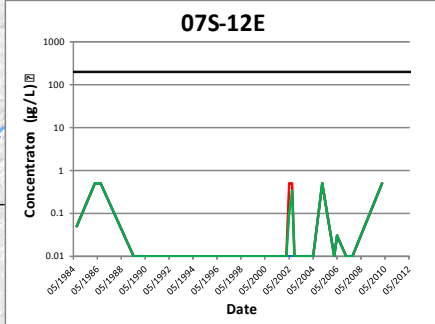
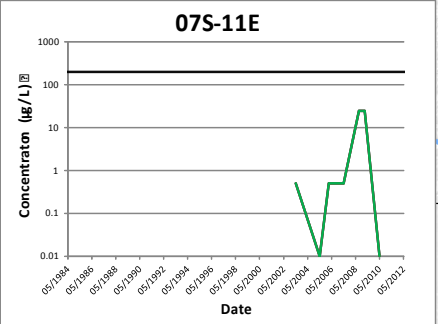
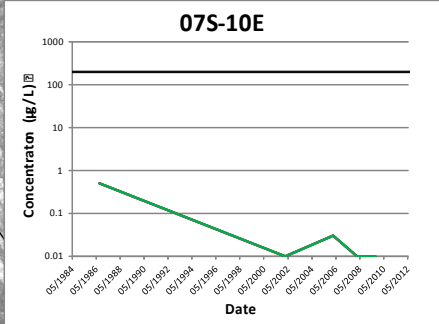
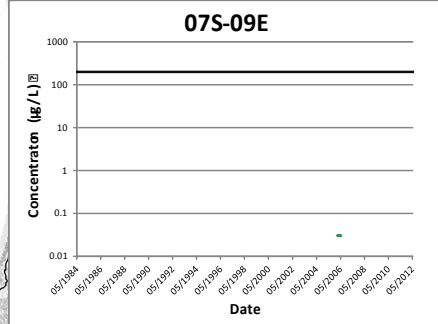
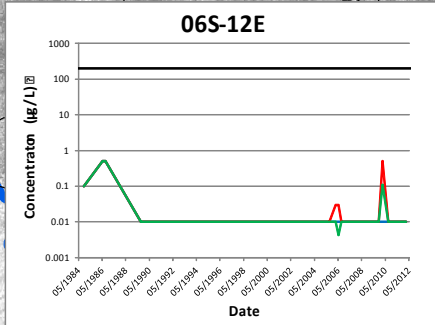
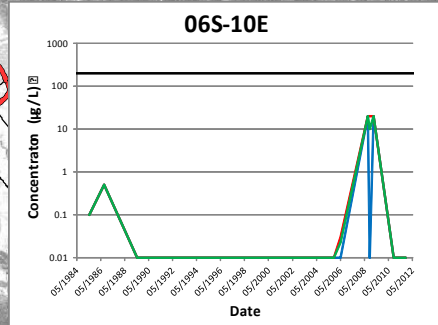
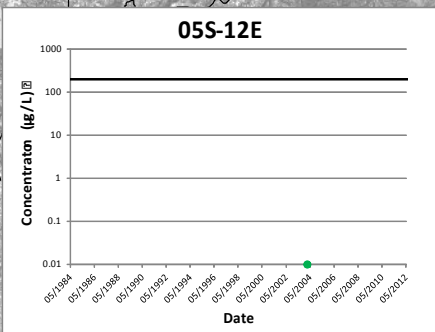
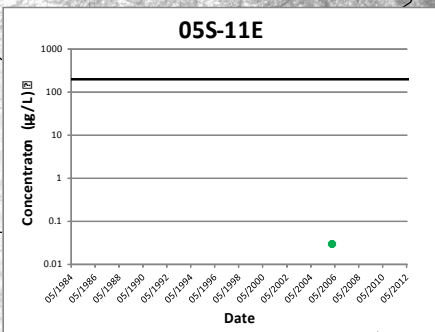
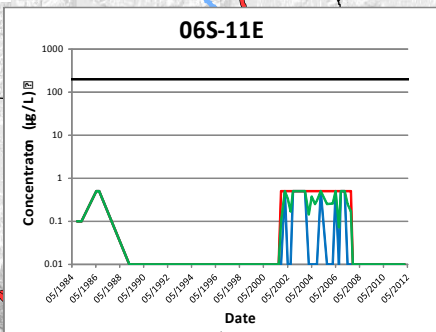


**DIBROMOCHLOROPROPANE (DBCP) CONCENTRATIONS 1984 THROUGH 2012 Merced IRWMP Merced County, California**

By: DB Date: 01/08/2013 Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.

Basemap modified from National Elevation Dataset seamless for California.



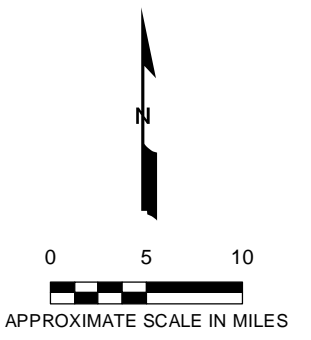
**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum 111TCA concentration
- Mean 111TCA concentration
- Maximum 111TCA concentration
- MCL for 111TCA (200 µg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. 1,1,1-Trichloroethane (111TCA) concentrations shown in micrograms per liter (µg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

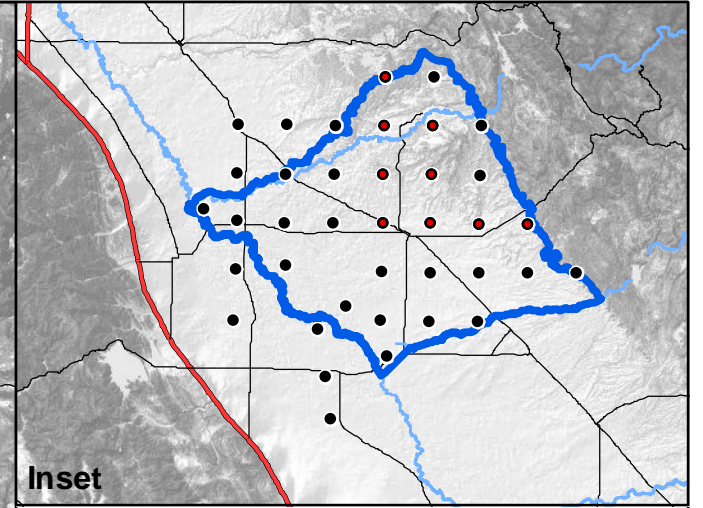
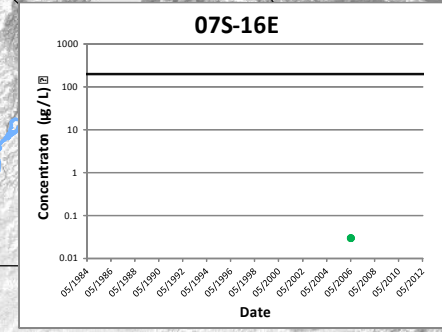
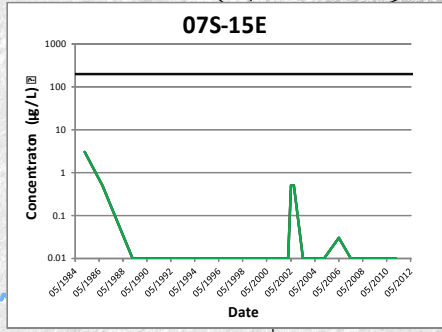
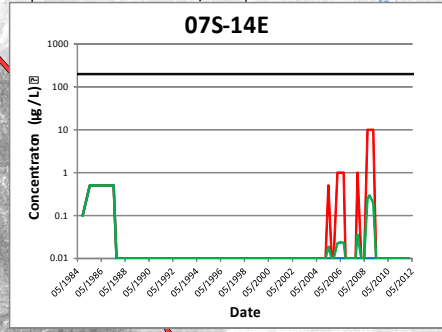
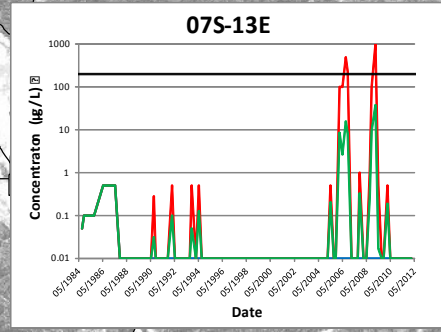
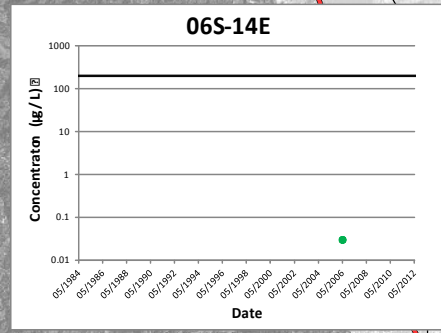
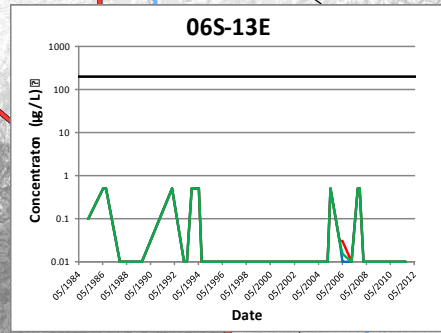
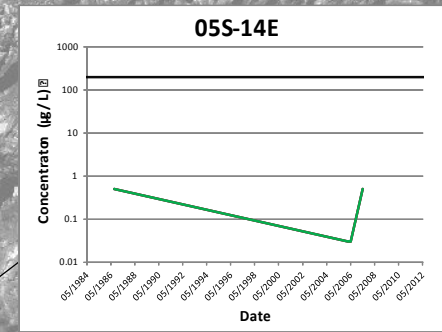
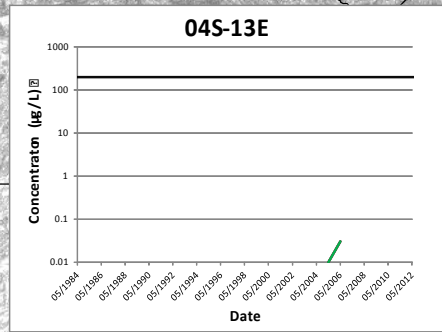
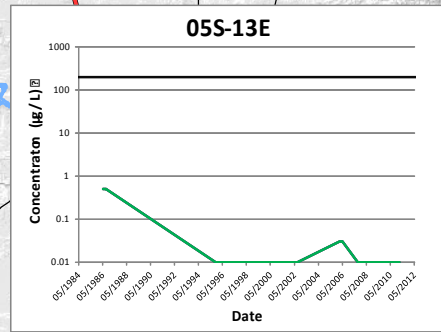


1,1,1-TRICHLOROETHANE (111TCA)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California

By: DB Date: 01/08/2013 Project No. FR1216040A

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Basemap modified from National Elevation Dataset seamless for California.



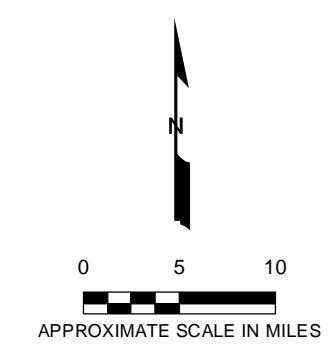
**Explanation:**

- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum 111TCA concentration
- Mean 111TCA concentration
- Maximum 111TCA concentration
- MCL for 111TCA (200 µg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. 1,1,1-Trichloroethane (111TCA) concentrations shown in micrograms per liter (µg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

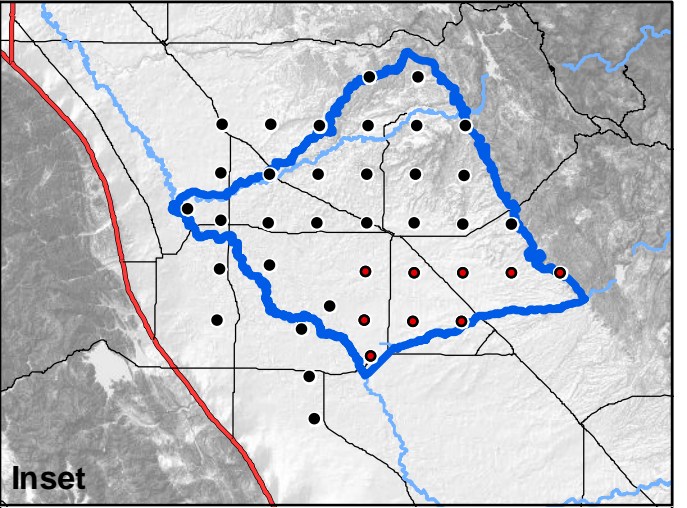
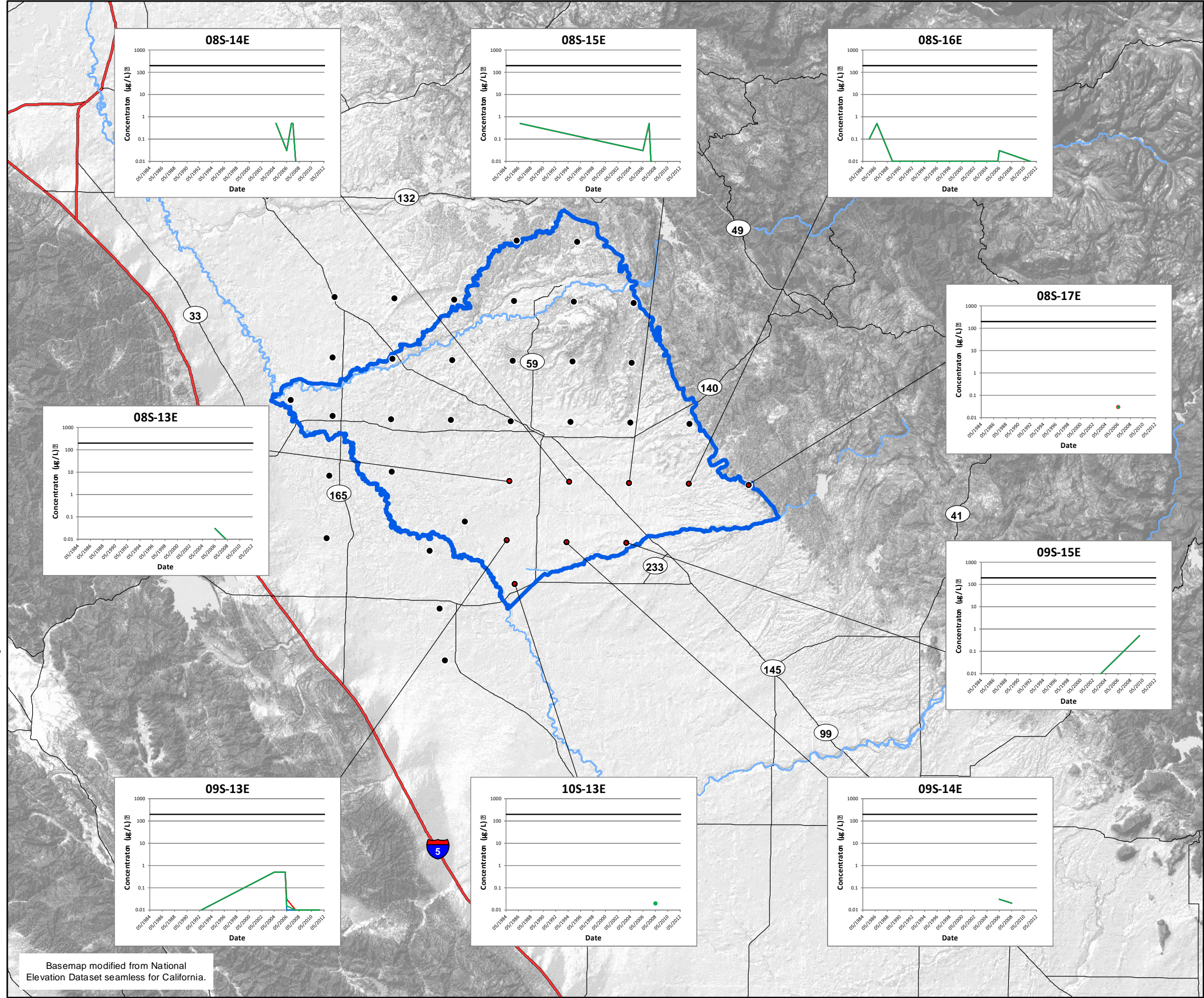


**1,1,1-TRICHLOROETHANE (111TCA)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB      Date: 01/08/2013      Project No. FR1216040A

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N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig13c\_111TCA.mxd



**Explanation:**

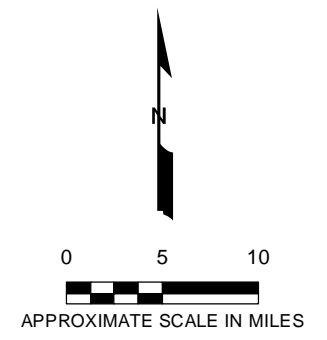
- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum 111TCA concentration
- Mean 111TCA concentration
- Maximum 111TCA concentration
- MCL for 111TCA (200 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan
2. 1,1,1-Trichloroethane (111TCA) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

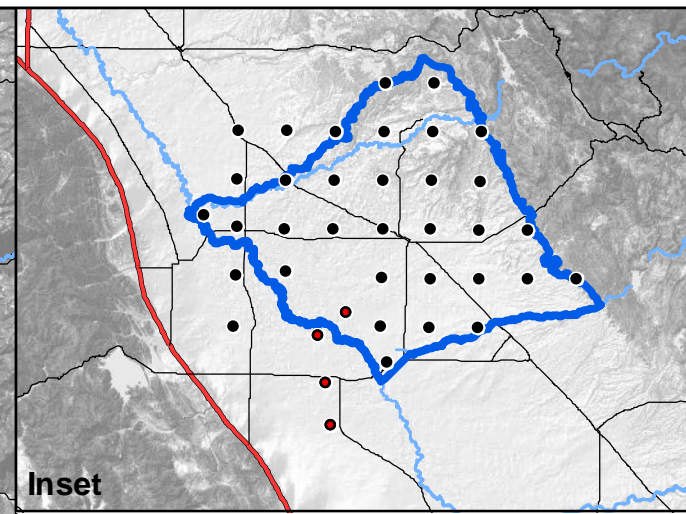
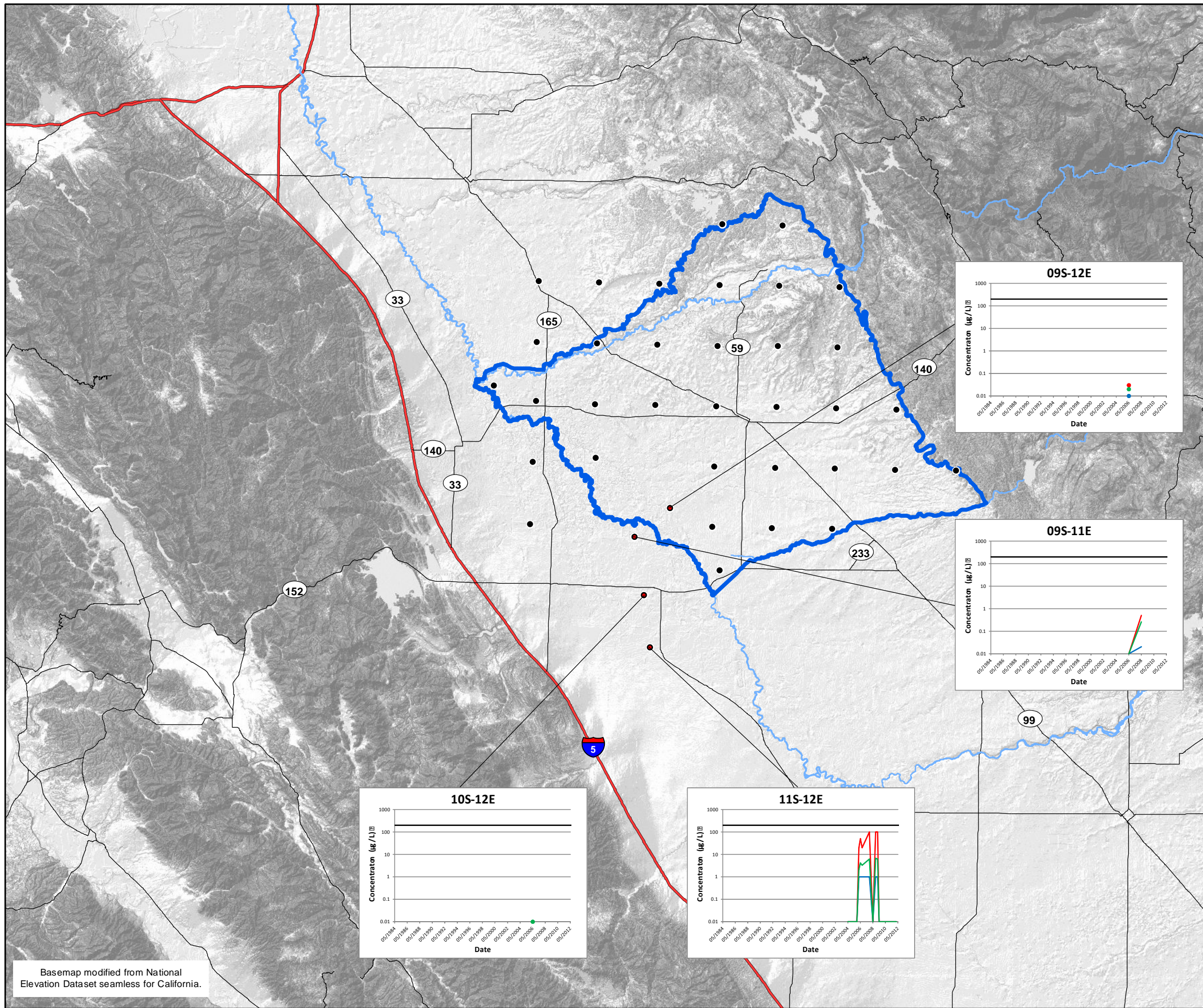


**1,1,1-TRICHLOROETHANE (111TCA)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>13c</b>

Basemap modified from National Elevation Dataset seamless for California.

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**Inset**

**Explanation:**

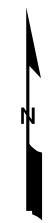
- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum 111TCA concentration
- Mean 111TCA concentration
- Maximum 111TCA concentration
- MCL for 111TCA (200 µg/L)

**Notes:**

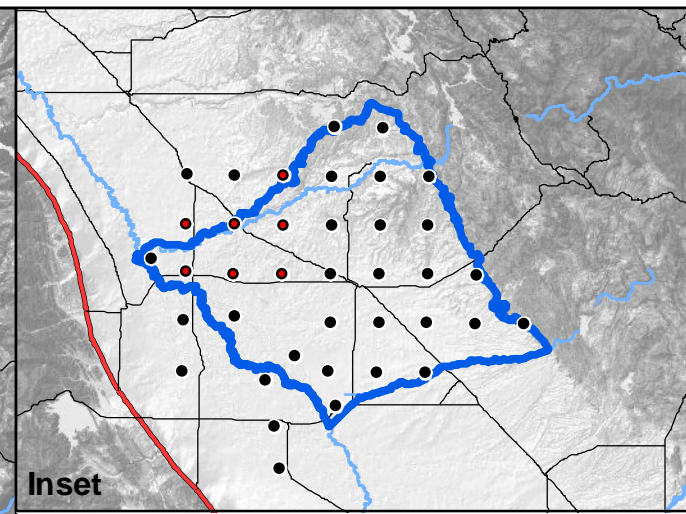
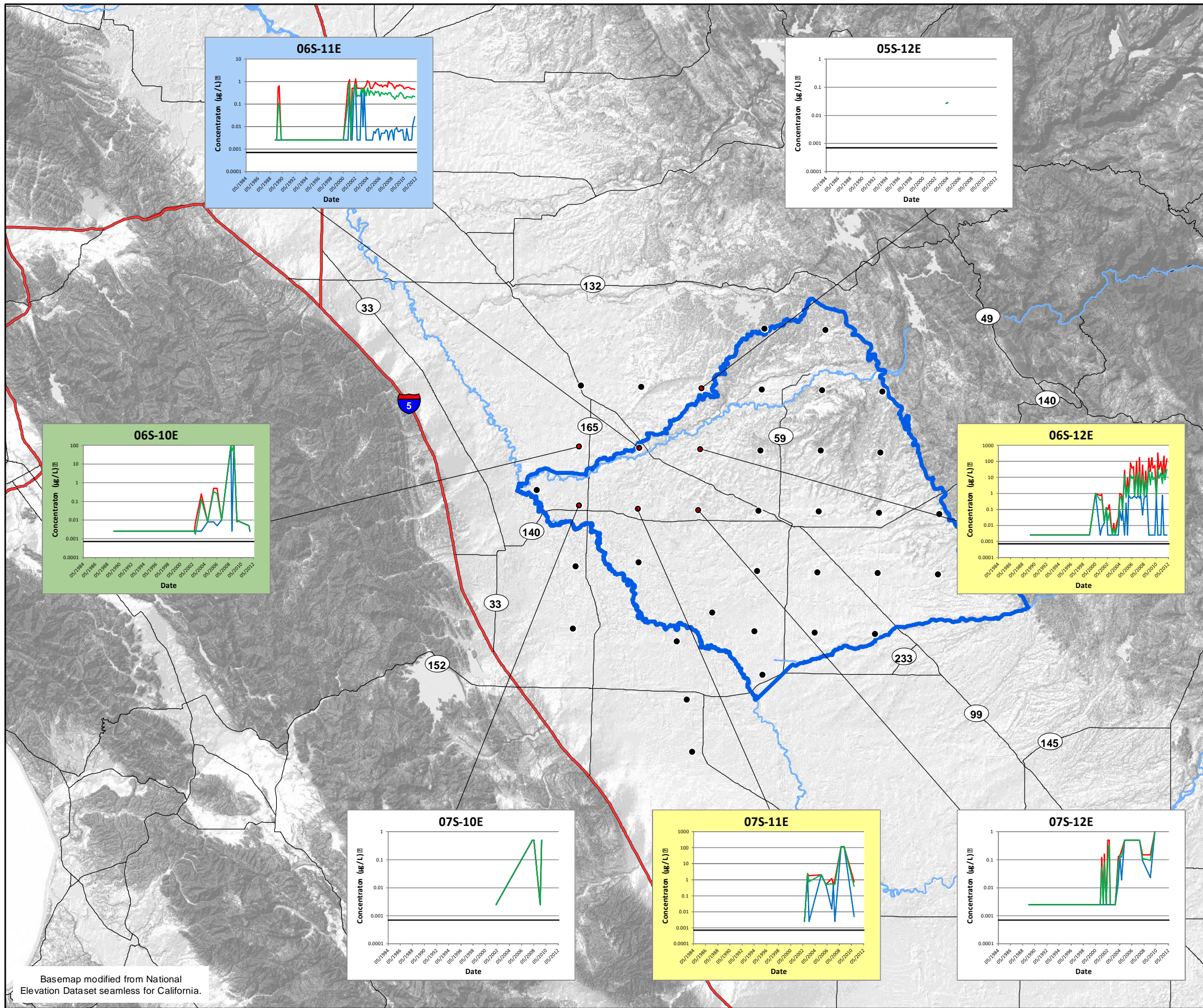
1. IRWMP = Integrated Regional Water Management Plan.
2. 1,1,1-Trichloroethane (111TCA) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

  
 0 5 10  
 APPROXIMATE SCALE IN MILES

<b>1,1,1-TRICHLOROETHANE (111TCA)          CONCENTRATIONS          1984 THROUGH 2012          Merced IRWMP          Merced County, California</b>		
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>13d</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig14a\_123TCP.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum 123TCP concentration
- Mean 123TCP concentration
- Maximum 123TCP concentration
- PHG for 123TCP (0.0007 ug/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. 1,2,3-Trichloropropane (123TCP) concentrations shown in micrograms per liter (µg/L).
3. Public Health Goal (PHG) as established by the California Office of Environmental Health Hazard Assessment
4. Background color on graphs represent the y-axis range as follows:  
 White: 0.0001- 1 µg/L  
 Blue: 0.0001- 10 µg/L  
 Green: 0.0001- 100 µg/L  
 Yellow: 0.0001- 1,000 µg/L

APPROXIMATE SCALE IN MILES

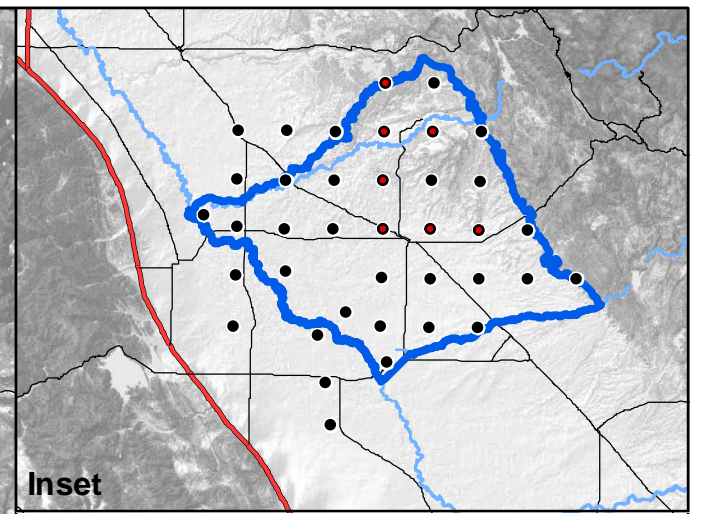
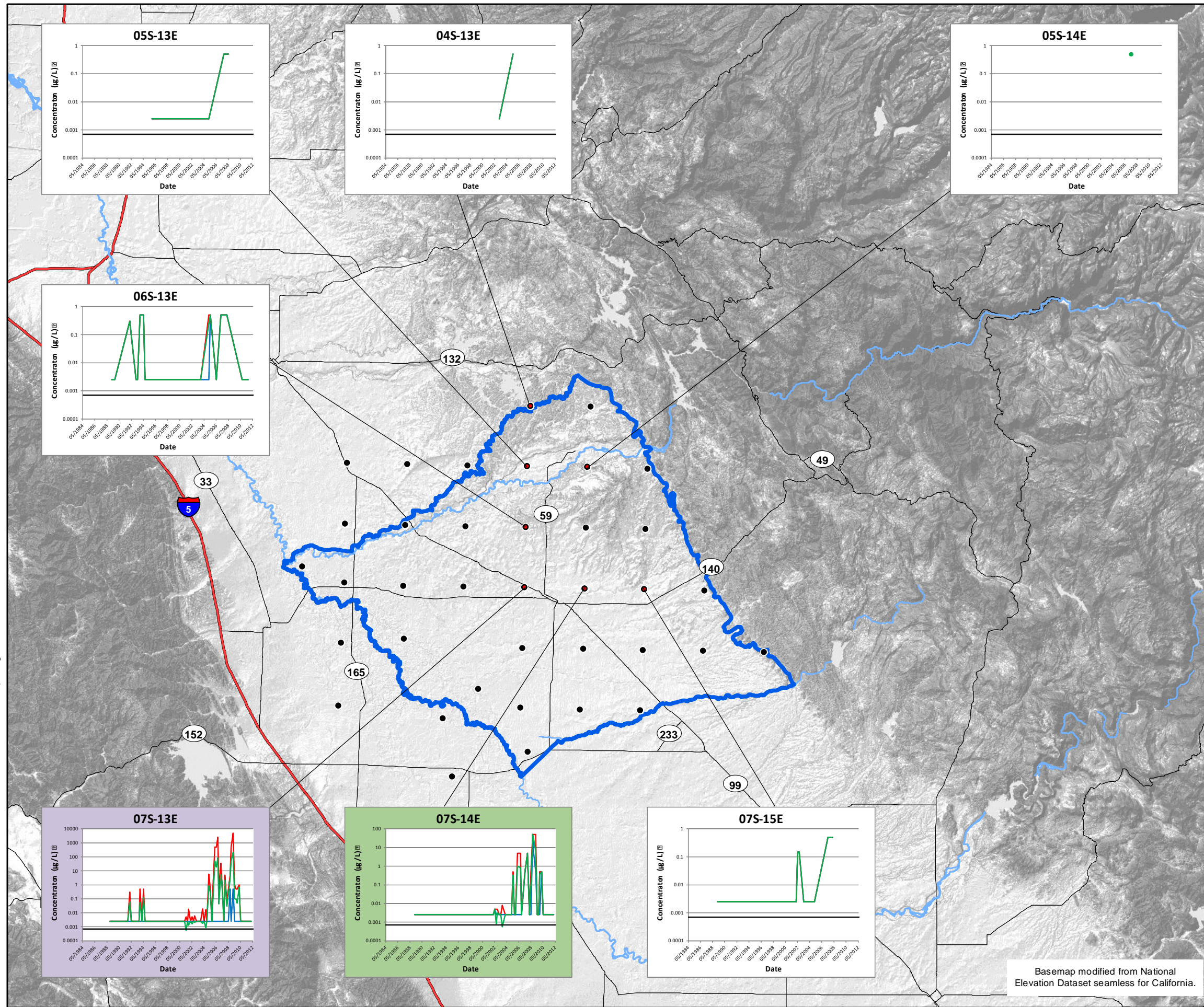
**1,2,3-TRICHLOROPROPANE (123TCP)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>14a</b>

Basemap modified from National Elevation Dataset seamless for California.



N:\FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig14b\_123TCP.mxd



**Inset**

**Explanation:**


- /● Township/Range centroid
- Surface water feature
- Merced IRWM area

**Concentration Charts:**

- Minimum 123TCP concentration
- Mean 123TCP concentration
- Maximum 123TCP concentration
- PHG for 123TCP (0.0007 ug/L)

**Notes:**

- IRWMP = Integrated Regional Water Management Plan.
- 1,2,3-Trichloropropane (123TCP) concentrations shown in micrograms per liter (µg/L).
- Public Health Goal (PHG) as established by the California Office of Environmental Health Hazard Assessment
- Background color on graphs represent the y-axis range as follows:  
 White: 0.0001- 1 µg/L  
 Green: 0.0001- 100 µg/L  
 Purple: 0.0001- 10,000 µg/L

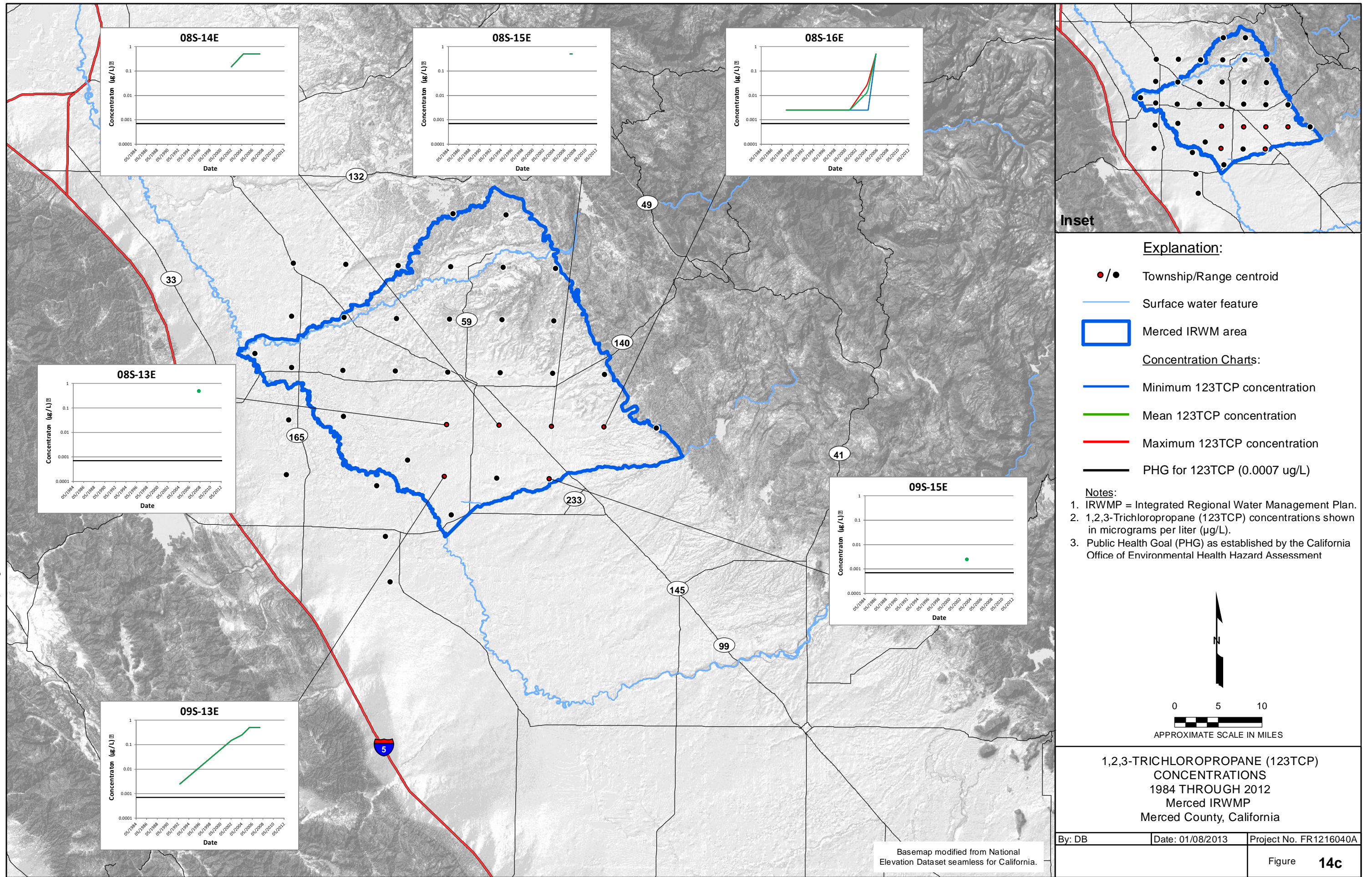
  
 0 5 10  
 APPROXIMATE SCALE IN MILES

**1,2,3-TRICHLOROPROPANE (123TCP)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

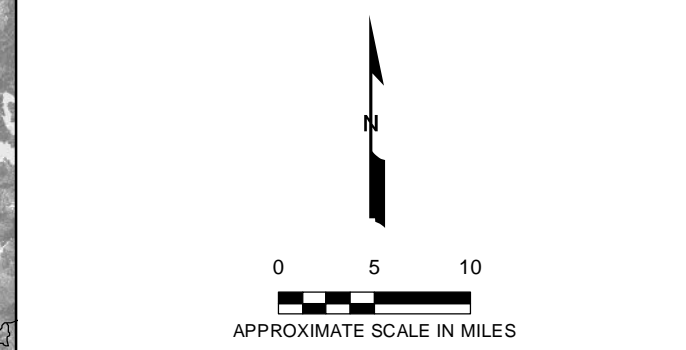
By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>14b</b>

Basemap modified from National Elevation Dataset seamless for California.

N:\FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig14c\_123TCP.mxd

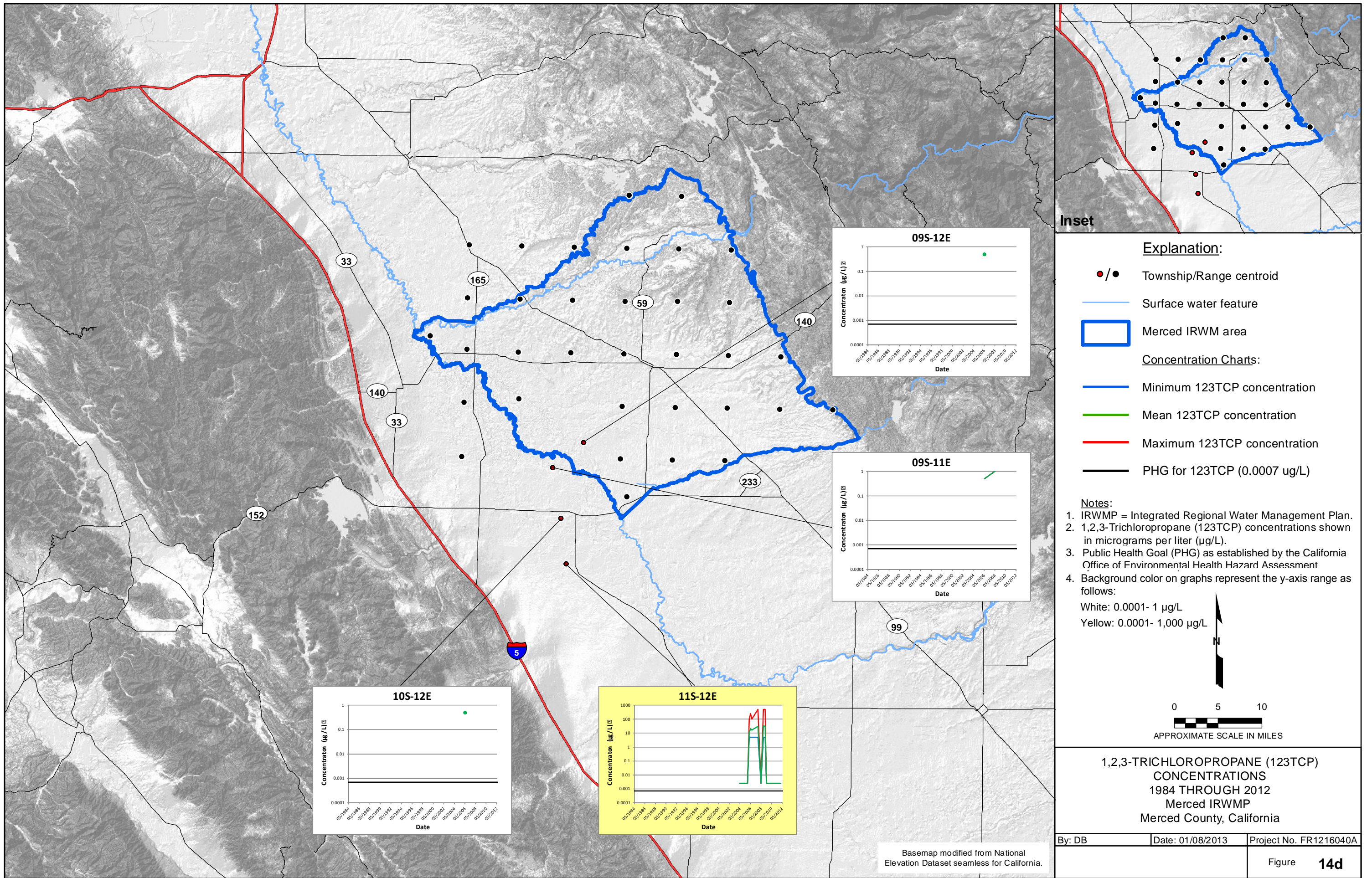


- Explanation:**
- /● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum 123TCP concentration
  - Mean 123TCP concentration
  - Maximum 123TCP concentration
  - PHG for 123TCP (0.0007 ug/L)
- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. 1,2,3-Trichloropropane (123TCP) concentrations shown in micrograms per liter (µg/L).
  3. Public Health Goal (PHG) as established by the California Office of Environmental Health Hazard Assessment

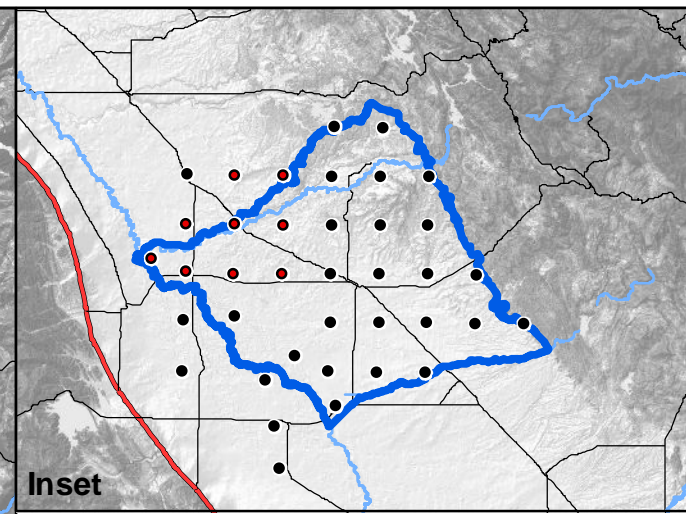
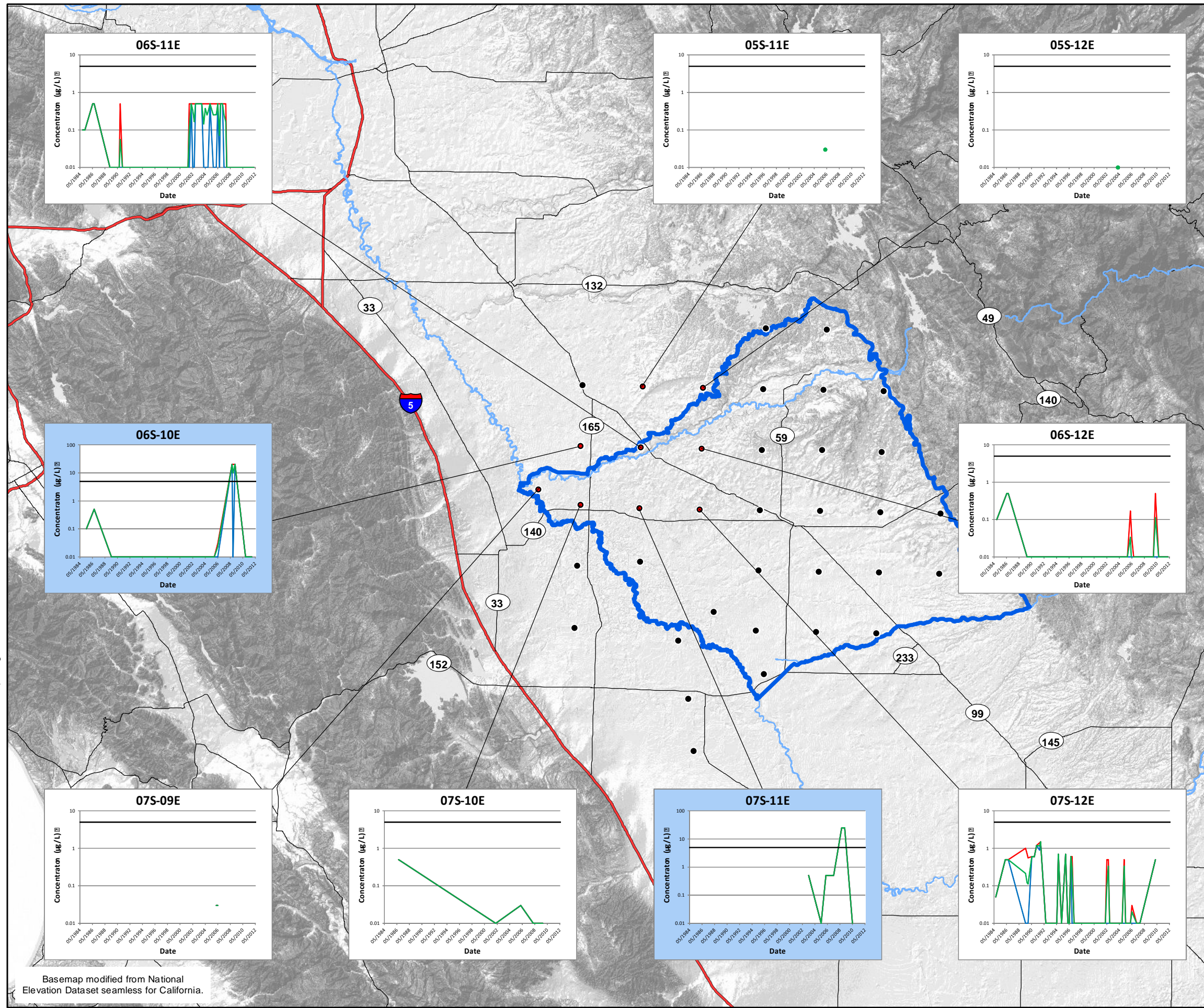


1,2,3-TRICHLOROPROPANE (123TCP)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California

Basemap modified from National Elevation Dataset seamless for California.



N:\\_FR\_projects\FR12s\FR1216040A\gis\maps2013\_01\ConcentrationMaps\fig15a\_PCE.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum PCE concentration
- Mean PCE concentration
- Maximum PCE concentration
- MCL for PCE (5 µg/L)

**Notes:**

- IRWMP = Integrated Regional Water Management Plan.
- Tetrachloroethylene (PCE) concentrations shown in micrograms per liter (µg/L).
- Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
- Background color on graphs represent the y-axis range as follows:  
White: 0.01- 10 µg/L  
Blue: 0.01- 100 µg/L

N  
0 5 10  
APPROXIMATE SCALE IN MILES

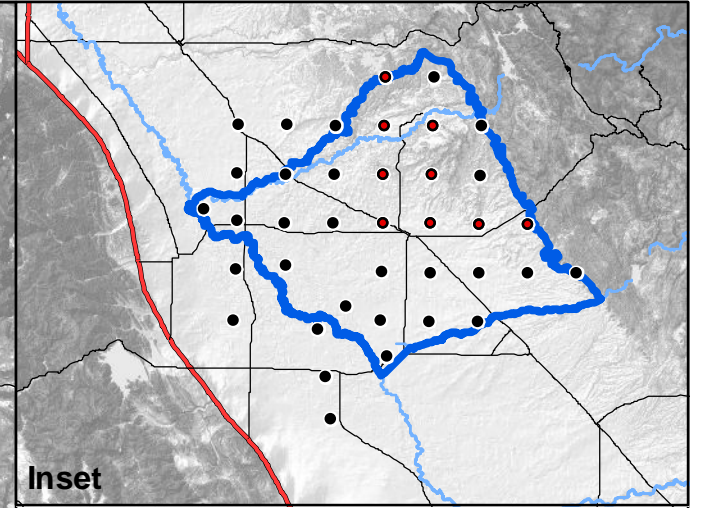
**TETRACHLOROETHYLENE (PCE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>15a</b>

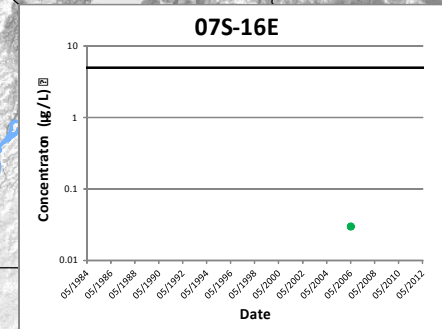
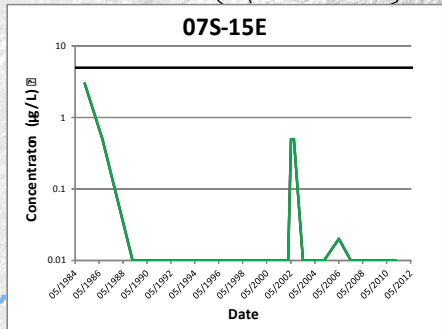
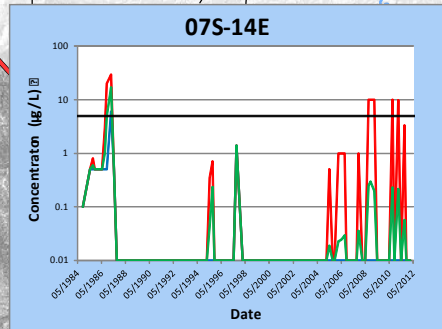
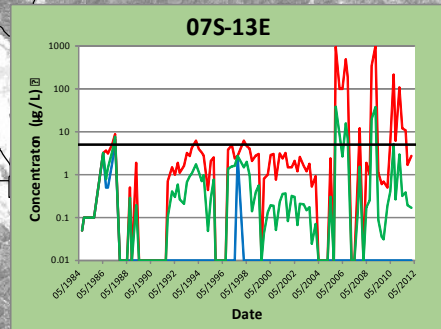
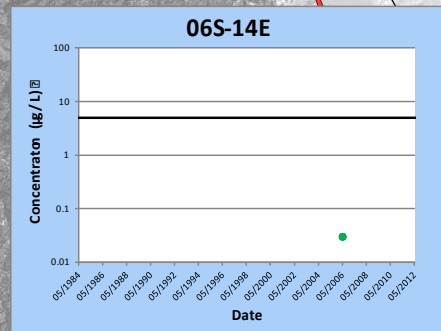
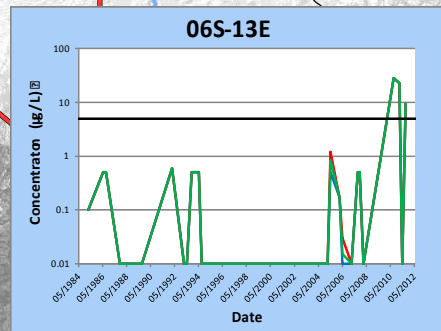
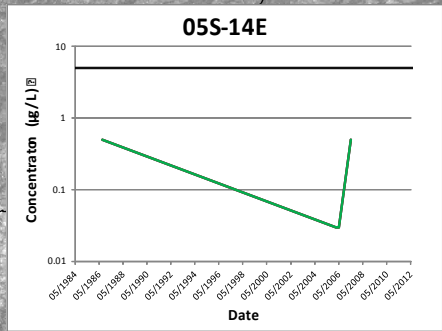
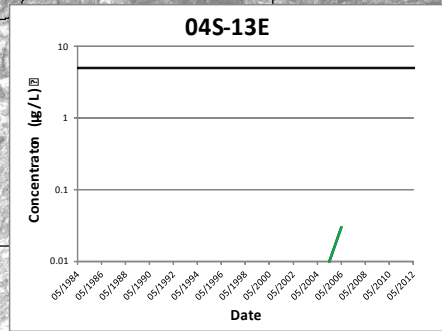
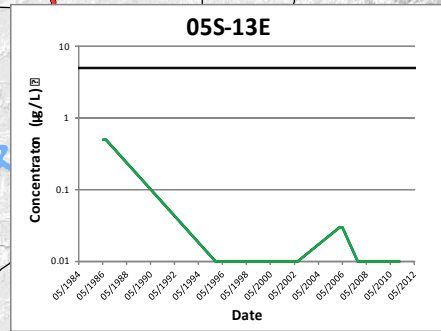
Basemap modified from National Elevation Dataset seamless for California.

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Basemap modified from National Elevation Dataset seamless for California.



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**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

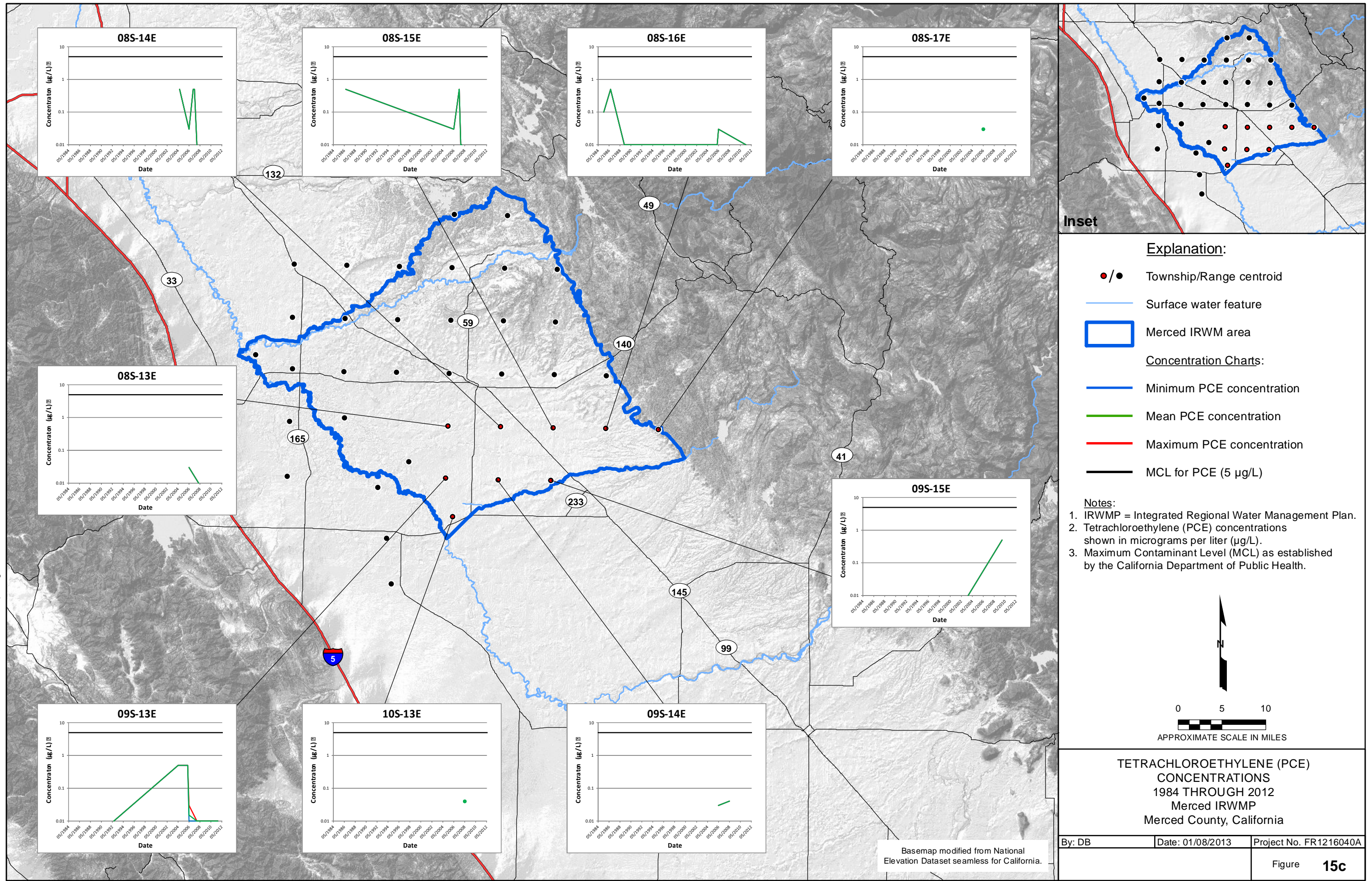
- Minimum PCE concentration
- Mean PCE concentration
- Maximum PCE concentration
- MCL for PCE (5 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Tetrachloroethylene (PCE) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
White: 0.01- 10 µg/L  
Blue: 0.01- 100 µg/L  
Green: 0.01- 1,000 µg/L

0 5 10  
APPROXIMATE SCALE IN MILES

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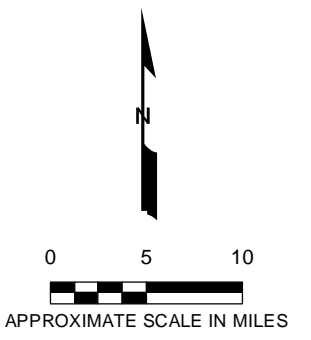


**Inset**

**Explanation:**

- /● Township/Range centroid
  - Surface water feature
  - Merced IRWMP area
- Concentration Charts:**
- Minimum PCE concentration
  - Mean PCE concentration
  - Maximum PCE concentration
  - MCL for PCE (5 µg/L)

- Notes:**
1. IRWMP = Integrated Regional Water Management Plan.
  2. Tetrachloroethylene (PCE) concentrations shown in micrograms per liter (µg/L).
  3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

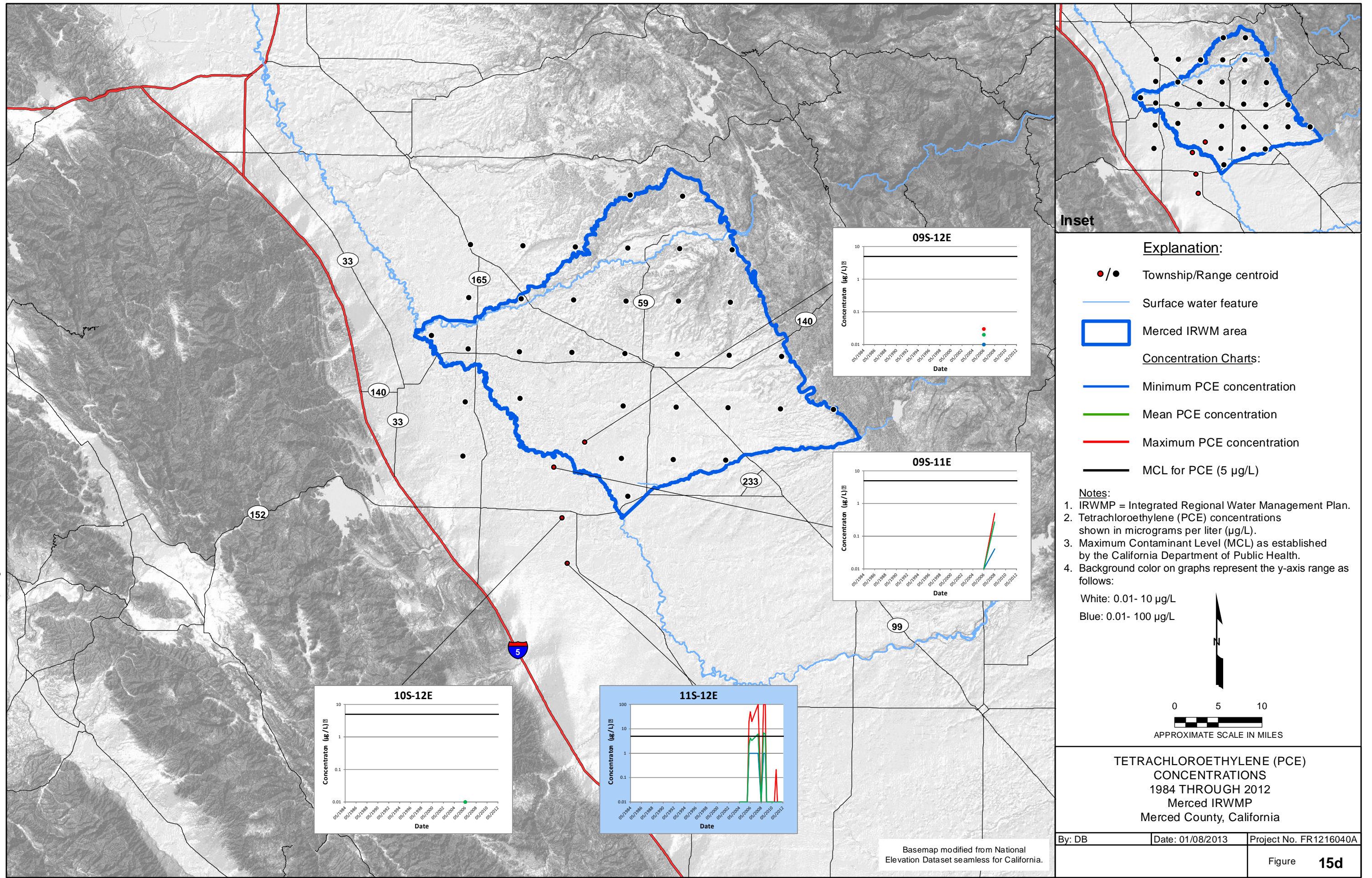


**TETRACHLOROETHYLENE (PCE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California**

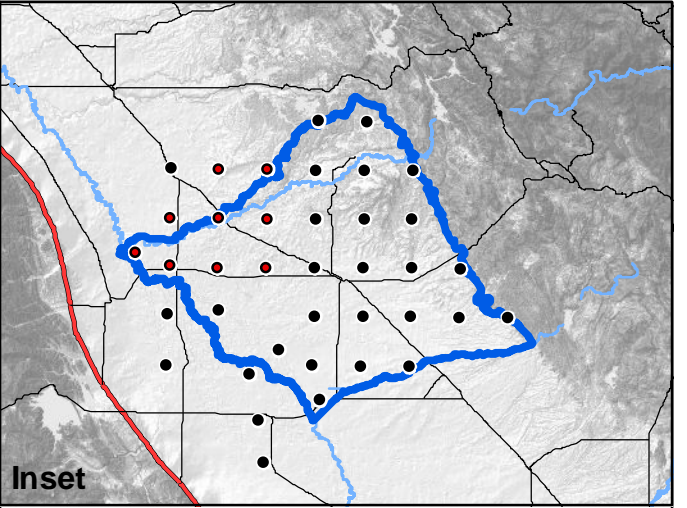
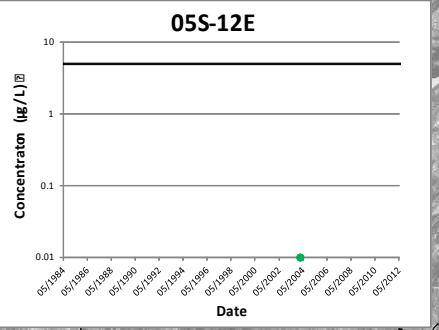
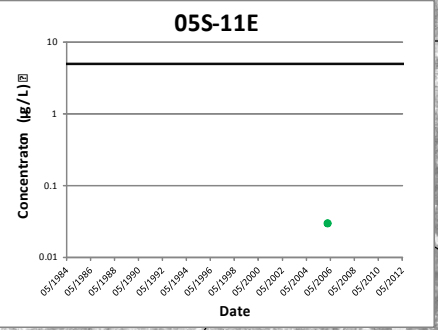
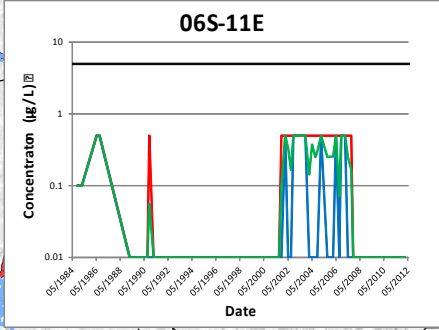
By: DB Date: 01/08/2013 Project No. FR1216040A

Basemap modified from National Elevation Dataset seamless for California.

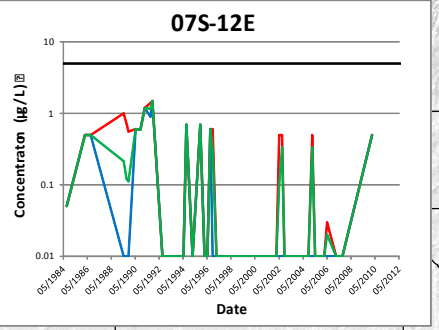
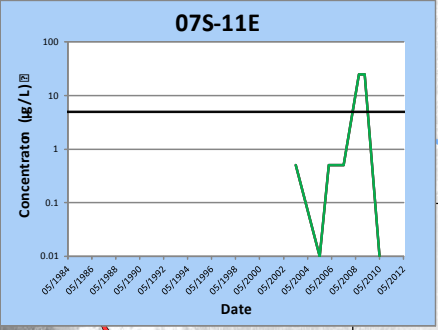
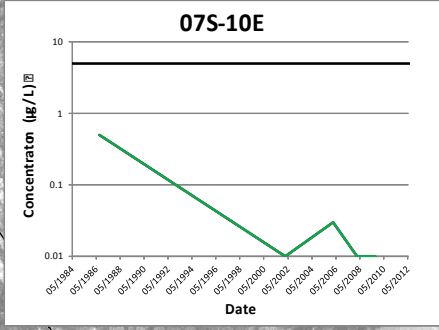
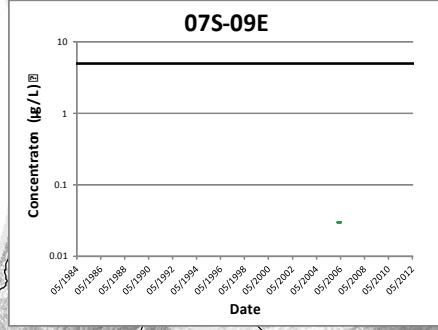
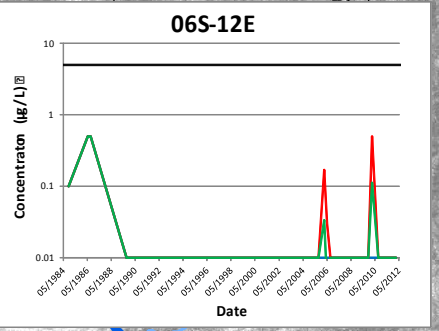
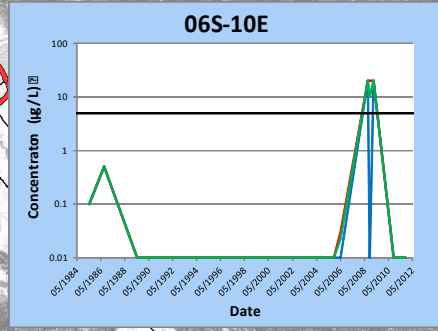
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Basemap modified from National Elevation Dataset seamless for California.



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**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWM area

**Concentration Charts:**

- Minimum TCE concentration
- Mean TCE concentration
- Maximum TCE concentration
- MCL for TCE (5 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Trichloroethylene (TCE) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:  
White: 0.01- 10 µg/L  
Blue: 0.01- 100 µg/L

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APPROXIMATE SCALE IN MILES

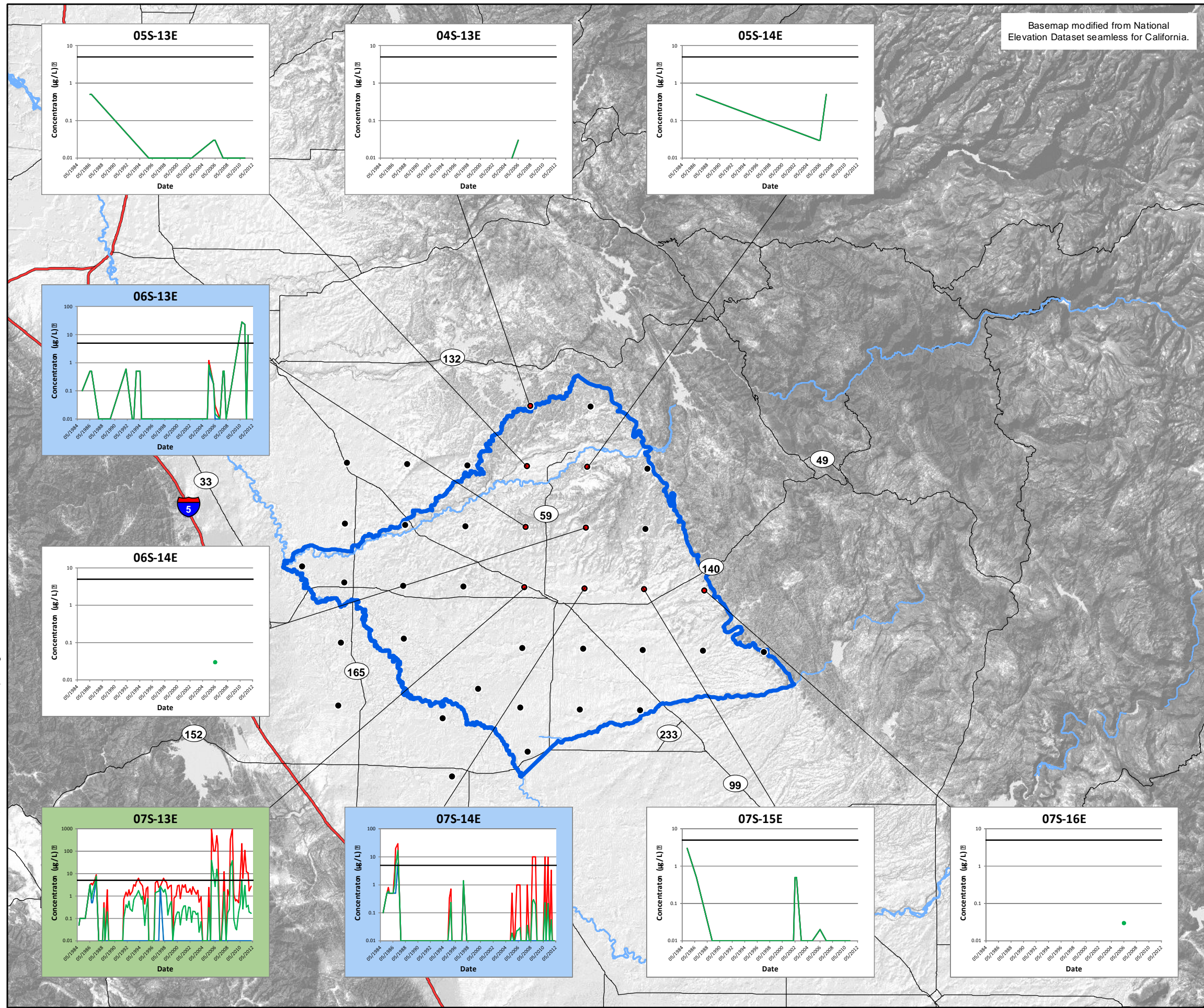
TRICHLOROETHYLENE (TCE)  
CONCENTRATIONS  
1984 THROUGH 2012  
Merced IRWMP  
Merced County, California

By: DB Date: 01/08/2013 Project No. FR1216040A

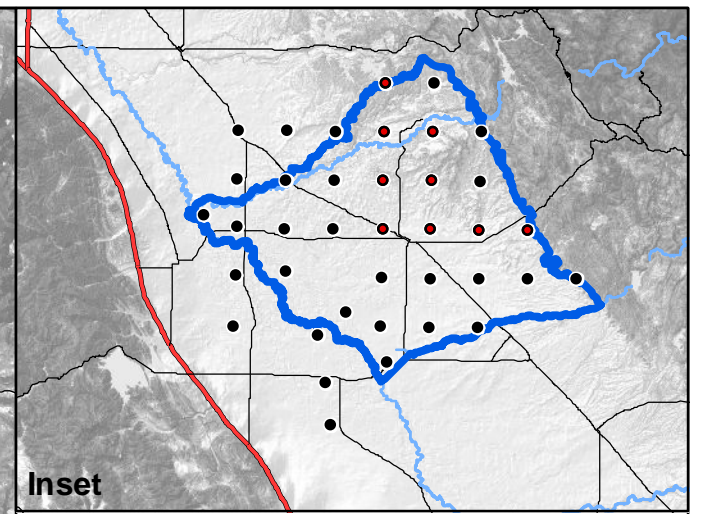
N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig16a\_TCE.mxd



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Basemap modified from National Elevation Dataset seamless for California.



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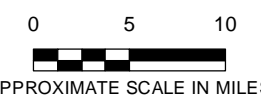
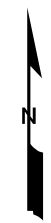
**Explanation:**

- /● Township/Range centroid
  - Surface water feature
  - ▭ Merced IRWM area
- Concentration Charts:**
- Minimum TCE concentration
  - Mean TCE concentration
  - Maximum TCE concentration
  - MCL for TCE (5 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Trichloroethylene (TCE) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.
4. Background color on graphs represent the y-axis range as follows:

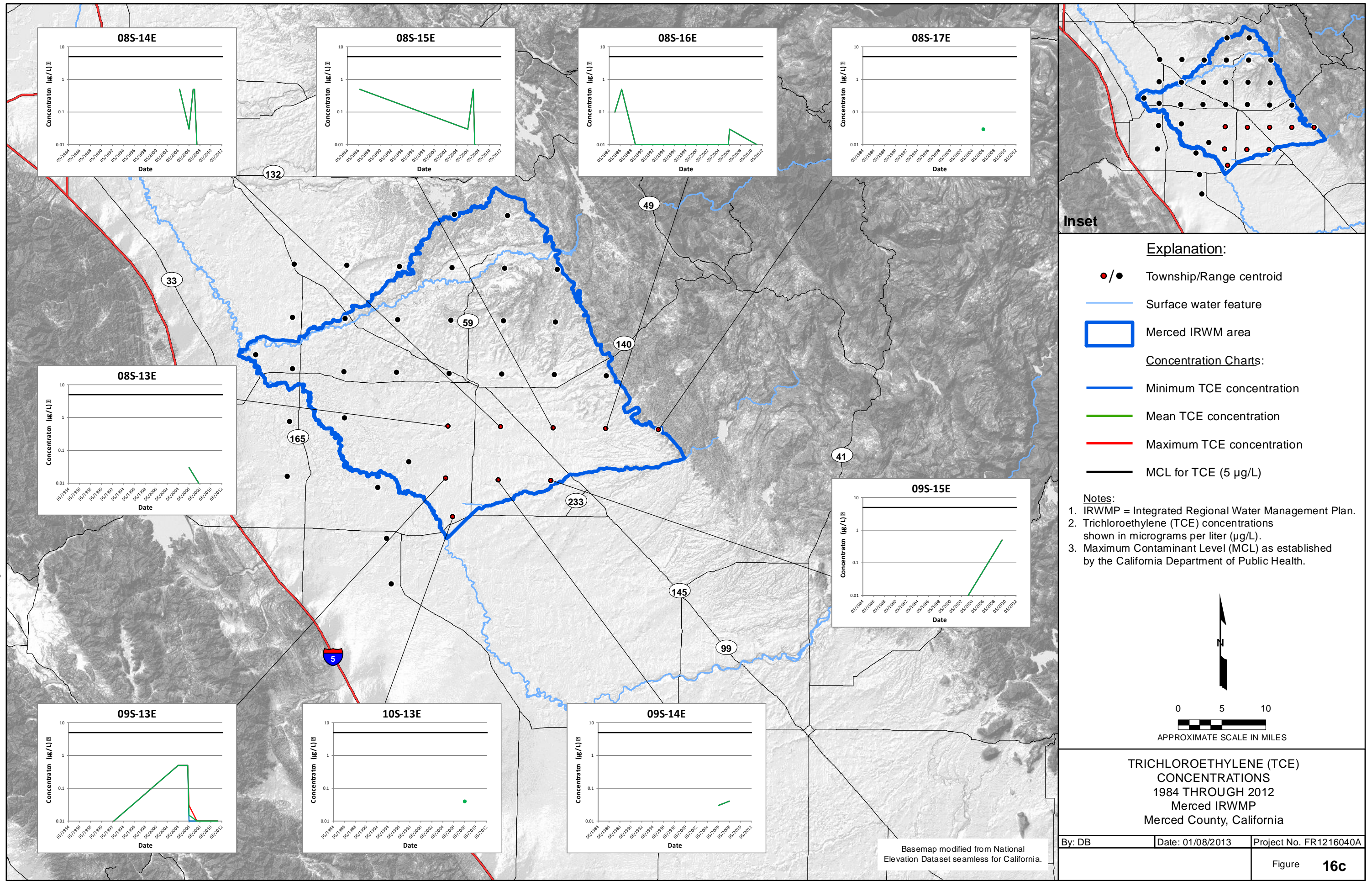
White: 0.01- 10 µg/L  
 Blue: 0.01- 100 µg/L  
 Green: 0.01- 1,000 µg/L



**TRICHLOROETHYLENE (TCE)  
 CONCENTRATIONS  
 1984 THROUGH 2012  
 Merced IRWMP  
 Merced County, California**

By: DB	Date: 01/08/2013	Project No. FR1216040A
		Figure <b>16b</b>

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig16c\_TCE.mxd



**Explanation:**

- /● Township/Range centroid
- Surface water feature
- ▭ Merced IRWMP area

**Concentration Charts:**

- Minimum TCE concentration
- Mean TCE concentration
- Maximum TCE concentration
- MCL for TCE (5 µg/L)

**Notes:**

1. IRWMP = Integrated Regional Water Management Plan.
2. Trichloroethylene (TCE) concentrations shown in micrograms per liter (µg/L).
3. Maximum Contaminant Level (MCL) as established by the California Department of Public Health.

0 5 10  
APPROXIMATE SCALE IN MILES

Basemap modified from National Elevation Dataset seamless for California.

N:\\_FR\_projects\FR12s\FR1216040A\gis\maps\2013\_01\ConcentrationMaps\fig16d\_TCE.mxd

