Section 7

Section 7
WATER QUALITY

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Section 7
WATER QUALITY

Basic information on the surface water and groundwater quality of the Tehama West watersheds is presented in this section. Water rights and water use were discussed in section 6, "Hydrology." Supporting information on surface and groundwater hydrology and geomorphology is summarized in Section 6. Supporting information on climate is summarized in Section 5, "Climate."

Demographics and land use can have a pronounced effect on water quality; not only through the addition of contaminants to surface and groundwater, but through the use and management of soil and potential increases in sediment and nutrient loading over background levels. Sediment generation and the relationship between hydrology, geomorphology, and geology were discussed in Section 6. The eastern portions of these watersheds are underlain by rocks of the Great Valley Geomorphic Province. In general, this portion of the watershed is characterized by low elevations, low precipitation, relatively gentle topography, low erosion potential, and a significant groundwater reservoir. The western portion of the watershed is characterized by high elevations, high rainfall, and steep slopes with high erosion potential. Over time the transport of material from these rugged upland areas to the valley floor has resulted in the deposition of large alluvial fans and gravel reserves.

SOURCES OF DATA

Primary sources of data used in the preparation of this section are listed below. Additional information is provided in the references section.

- U.S. Geological Survey (USGS) stations for which water quality data was available
- Department of Water Resources, (DWR) stations for which water quality data was available
- Thomes Creek Watershed Study (DWR 1982)
- Thomes Creek Sediment Budget (CSUC 2004)
- Sacramento Valley Westside Tributary Watershed Erosion Study (DWR 1992)
- Coordinated AB3030 Groundwater Management Plan, Tehama County Flood Control and Water Conservation District (Law 1996)
- Water Inventory and Analysis Report, Tehama County Flood Control and Water Conservation District (CDM 2003)
- Tehama County: A Small Water Systems Drought Vulnerability Study (CDM 2005)
- Thomes Creek Watershed Assessment Analysis Report (USDA 1977)

- Data from the California Department of Pesticide Regulation
- Files from Crane Mills
- Water Quality Control Plan for the Central Valley/Sacramento River Basin.

HISTORICAL CONTEXT

Historical water quality in the watershed is unknown; however the primary constituents of concern would have likely been sedimentation and increases in temperature or dissolved oxygen resulting from drought or natural events.

Native Americans used fire as a tool to manage the landscape and the use of fire may have resulted in increased sedimentation or contribution of ash to watercourses. In the literature reviewed for the project, only the Thomes Creek Watershed Assessment prepared by the United States Forest Service (USFS) in 1997 provides any discussion of historical water quality and the discussion is limited to the impacts of land management on sediment. The USFS estimated that the frequent fires from Native American burning and natural causes "probably resulted in a significant volume of fine grained sediment eroding from the Watershed." The following discussion was extracted from that document.

The first significant increase in erosion and sediment production in the watershed over the moderate levels, believed to have occurred at the time of California Indian use, probably occurred between the 1860s and 1917, with a peak around 1900, coincident with grazing in the watershed. The Thomes Creek Watershed is reported to have been one of the most heavily grazed watersheds in the Mendocino National Forest. Large bands of sheep were grazed on both private and public land by ranchers in the Paskenta and Newville areas (USDA 1977).

When the stockmen left the higher elevations and forested areas in the fall, they set fires to improve the browse for their livestock. The fires removed some of the grasses and herbaceous vegetation that protected the high-elevation soils. Many higher elevation soils lost their "A" horizon during this period, which changed the ability of the soil to support vegetation. The lack of surface vegetation resulted in rapid surface runoff, high soil erosion and sedimentation.

Control of grazing and effective fire suppression began in 1917, following the establishment of the Mendocino National Forest. Since the area of the Thomes Creek Watershed and the Tehama West Watershed as a whole within the forest is quite large, the increasing effectiveness of fire suppression likely had a major impact on total soil erosion and sediments leaving the watershed. Organic matter began to build up on the forest floor, resulting in soils with a higher organic component and lower pH. This change in soil structure and chemistry improved the water-holding capacity of the soil, and the increased organic duff slowed runoff, which helped reduce soil erosion. Currently, soils are believed to be more resistant to erosion than the soils in place when California Indians occupied the region, due to this build-up of organic matter (USDA 1977). The buildup of vegetation, however, also increased the potential for large wildfires in the watershed (USDA 1977).

The greatest and most rapid increase in erosion and sedimentation in the watershed likely occurred from 1950 through about 1970. This increase appears to be correlated with timber harvest and road building. Timber harvest began in the watershed during the 1950s and peaked in the 1960s and 1970s. By the 1960s soil disturbance was extensive over large areas of the watershed. A study conducted in 1982 calculated areas affected by timber harvest for four periods of time between 1952 and 1978 using aerial photographs. They found that while in 1952 only 7 percent of the watershed's area had been cut, by 1978, 38 percent of the watershed had been entered at least once for timber removal.

This was also a period of maximum road building. Roads remain major contributors of sediments in the watershed (USDA 1977). It was also during this time period that the largest recorded flood event in the watershed occurred. The effects of this naturally occurring event were exacerbated by the sharp increase in timber harvest and road building prior to its occurrence (USDA 1977).

The high levels of erosion and sediment production present in the 1960s began to decrease in the 1970s, and are now believed to be similar to those following the grazing period. This drop is due to decreased road construction, stabilization of the existing roadbeds, and decreased timber harvest. Other contributing factors are the partial recovery of streamside vegetation that had been wiped out by the 1964 flood, especially during the flood-free years of 1975 through 1978, and implementation of Best Management Practices (BMPs) and the California Forestry Practices Act during the 1970s and 1980s.

WATER QUALITY STANDARDS

California's water quality standards are based on the anticipated use of the water source. In addition, California has adopted a non-degradation policy (Resolution 68-16), which prohibits anyone from damaging or degrading water to a condition worse than its current status.

Section 303 of the Clean Water Act (CWA) (33 U.S.C. §1313) provides for promulgation of water quality standards by states. The standards consist of designating uses of water and then developing water quality criteria based on the designated uses (40 CFR §131.3(i)). The criteria are "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use" (40 CFR §131.3(b)). Water quality standards for the watershed are presented in the *Water Quality Control Plan for the Sacramento and San Joaquin River Basin Plan* (RWQCB, 1998).

The CWA requires states to protect beneficial uses of waters in the United States within their jurisdictional boundaries. The CWA further requires states to adopt water quality criteria (referred to as "objectives" in California) that protect the designated "beneficial uses" of water bodies. The designated beneficial uses, the water quality criteria to protect those uses, and an anti-degradation policy constitute water quality standards. California adopts standards through the basin planning process. Basin Plans are adopted and amended by the Regional Water Quality Control Board (RWQCB) using a structured process involving peer review, public participation, state environmental review, and state and federal agency review and approval. Designated beneficial uses are listed on Table II-1 of the Basin Plan. Only the Sacramento River and Thomes Creek have designated beneficial uses. If specific beneficial uses for a water body are not identified, the beneficial uses of the water body to which the water body is tributary apply. Beneficial uses applicable to the Tehama West Watershed are shown on Table 7-1.

Table 7-1
BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK

Designation	Definition	Existing Beneficial Use	Potential Beneficial Use	No Beneficial Use
Municipal and Domestic Supply	MUN – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	S		T
Irrigation	AGR – Uses of water for farming, horticulture, or ranching including but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.	S/T		
Stock Watering	As defined for irrigation	S/T		
Process	Proc – Uses of water for industrial activities that depend primarily on water quality.		S	T
Service Supply	IND – Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.	S		T
Power	POW – Uses of water for hydropower generation.	S	T	

Table 7-1 (cont.) BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK				
Designation	**Definition**	**Existing Beneficial Use**	**Potential Beneficial Use**	**No Beneficial Use**
Contact	REC 1 – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, or use of natural hot springs.	S/T		
Canoeing and Rafting	As defined for contact	S		T
Other Noncontact	REC 2 – Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine-life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	S/T		
Warm	WARM – Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife including invertebrates.	S/T		
Cold	COLD – Uses of water that support coldwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	S/T		
Warm (MIGR)	MIGR – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as			T

Table 7-1 (cont.) BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK				
Designation	**Definition**	**Existing Beneficial Use**	**Potential Beneficial Use**	**No Beneficial Use**
	anadromous fish.			
Cold (MIGR)	As defined for Warm (MIGR)	S/T		
Warm (MIGR)	SPWN – Uses of water that support high-quality aquatic habitats suitable for reproduction and early development of fish.	S/T		
Cold (SPWN)	As defined for Warm (MIGR)	S/T		
Wildlife Habitat	WILD – Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	S/T		
	NAV – Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.	S		T

The Basin Plan also establishes water quality objectives as required by the Porter-Cologne Water Quality Control Act. Under this act water quality objectives are defined as "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (Water Code Section 13050(h) as cited by RWQCB, 1998). Water quality objectives are set for a particular body of water, and include maximum and/or minimum allowable levels of several constituents. Water quality objectives are not established for specific tributaries in the watershed; however, certain constituents apply to the upper Sacramento River. These constituents, with their maximum and minimum allowable levels, relative time period, and applicable body of water, are shown in Table 7-2.

For constituents not included in the Basin Plan, water quality limits from other sources may apply. To be defensive, water quality limits should be chosen to implement all predictable water quality objectives and promulgated criteria. Water quality limits are found in many sources. Other sources of water quality limits applicable to the ground and surface water in the Tehama West Watershed follow as summarized from *A Compilation of Water Quality Goals* (RWQCB 2003a).

Table 7-2 WATER QUALITY OBJECTIVES FOR THE SACRAMENTO RIVER WITHIN THE WATERSHED				
Constituent	**Maximum Concentration /Level**	**Minimum Concentration /Level**	**Time Period**	**Applicable Water Body**
Arsenic	0.01 (mg/l)			Sacramento River from Keswick Dam to I Street Bridge at City of Sacramento
Barium	0.1 (mg/l)			As noted for Arsenic
Cadmium	0.00022 (mg/l)			Sacramento River and its tributaries above State Highway 32 bridge at Hamilton City
Cyanide	0.01 (mg/l)			As noted for Arsenic
Iron	0.3 (mg/l)			As noted for Arsenic
Manganese	0.05 (mg/l)			As noted for Arsenic
Silver	0.01 (mg/l)			As noted for Arsenic
Dissolved Oxygen		9.0 mg/l	June 1 to August 31	Sacramento River from Keswick Dam to Hamilton City
PH	8.5	6.5		All
Electrical Conductivity (at 25°C)	230 Micromhos/centimeter (μmhos/cm)			Sacramento River
Temperature	56°F			Sacramento River from Shasta Dam to I Street Bridge
[a]See the Water Quality Control Plan for the Sacramento River and San Joaquin River Basin for a complete listing of all constituents, applicable water bodies, and minimum and maximum levels.				

Drinking Water Standards, Maximum Contaminant Levels (MCLs)

Drinking water MCLs are directly applicable to water supply systems and at the tap and are enforceable by the Department of Health Services (DHS) and local health departments. MCLs are components of the drinking water standards adopted by the Department of Health Services (DHS) pursuant to the California Safe Drinking Water Act. California MCLs may be found in Title 22 of the California Code of Regulations (CCR).

Primary MCLs are derived from health-based criteria. MCLs also include technologic and economic considerations based on the feasibility of achieving and monitoring for these concentrations in drinking water supply systems and at the tap.

Secondary MCLs are derived from human welfare considerations (e.g., taste, odor, laundry staining) in the same manner as Primary MCLs. California MCLs, both Primary and Secondary, are directly applicable to groundwater and surface water resources when they are specifically referenced as water quality objectives.

Maximum Contaminant Level Goals (MCL Goals or MCLGs)

MCL Goals are promulgated by the United States Environmental Protection Agency (USEPA) as part of the National Primary Drinking Water Regulations. MCL Goals represent the first step in establishing federal Primary MCLs and are required by federal statute to be set at levels that represent no adverse health risks. They are set at "zero" for known and probable human carcinogens, since theoretically a single molecule of such a chemical could present some degree of cancer risk. Threshold levels posing no risk of health effects are used for non-carcinogens and for possible human carcinogens. Because they are purely health-based, non-zero MCL Goals may be useful to interpret narrative water quality objectives which prohibit toxicity to human consumers.

California Public Health Goals (PHGs)

The California Safe Drinking Water Act of 1996 requires the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) to perform risk assessments and to adopt Public health goals for contaminants in drinking water based exclusively on public health considerations. PHGs represent levels of contaminants in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime. For carcinogens, PHGs are based on 10^{-6} incremental cancer risk estimates.

California State Action Levels

Action levels are published by DHS for chemicals for which there is no drinking water MCL. State Action Levels are based mainly on health effects – an incremental cancer risk estimate of 10^{-6} for carcinogens and a threshold toxicity limit for other constituents. As with MCLs, the ability to quantify the amount of the constituent in a water sample using readily available analytical methods may cause action levels to be set at somewhat higher concentrations than purely health-based values.

Drinking Water Health Advisories and Water Quality Advisories

Health Advisories are published by USEPA for short-term (1-day exposure or less or 10-day exposure or less), long-term (7-year exposure or less), and lifetime human exposures through drinking water. Health advisories for non-carcinogens and for possible human carcinogens are calculated for chemicals where sufficient toxicologic data exist. Incremental cancer risk estimates for known and probably human carcinogens are also presented.

Proposition 65 Safe Harbor Levels

Safe harbor levels are established pursuant to the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) for known human carcinogens and reproductive toxins. Proposition 65, an initiative statute, made it illegal to expose persons to significant amounts of these chemicals without prior notification or to discharge significant amounts of these chemicals to sources of drinking water. These "significant amounts" are adopted by the OEHHA in regulations contained in Title 22 of the CCR, Division 2, Chapter 3. For carcinogens, No Significant Risk Levels (NSRLs) are set at concentrations associated with a 1-in-100,000 (10^{-5}) incremental risk of cancer. These are the only California health-based limits derived from risk levels greater than 10^{-6}.

California Toxics Rule (CTR) and National Toxics Rule (NTR) Criteria

The CWA requires all states to have enforceable numerical water quality criteria applicable to priority toxic pollutants in surface waters. USEPA promulgated water quality criteria for priority toxic pollutants for California's inland surface waters and enclosed bays and estuaries in federal regulations called the "California Toxics Rule." Included are criteria to protect both human health and aquatic life, similar to those published in the *National Ambient Water Quality Criteria*, discussed below. The CTR criteria, along with the beneficial use designations in the Basin Plans, are directly applicable water quality standards for toxic pollutants in these waters under Section 304(c) of the federal Clean Water Act. Implementation provisions for these standards may be found in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SWRCB Resolution No. 2000-015), adopted by the State Water board in March 2000. The policy includes time schedules for compliance, provisions for mixing zones, analytical methods and reporting levels.

National Ambient Water Quality Criteria

These criteria, also called the national Recommended Water Quality Criteria, are developed by USEPA under Section 304(a) of the federal Clean Water Act to provide guidance to the states in developing water quality standards under Section 304(c) of the Act and to interpret narrative toxicity standards. These criteria are designed to protect human health and welfare and aquatic life from pollutants in freshwater and marine surface waters. In April 1999 and November 2002, USEPA published tables of *National Recommended Water Quality Criteria*, which summarize criteria from the sources discussed above and more recent updates. Due to their age and changes in methods used to drive the criteria, Blue Book criteria no longer appear in these summary tables.

Agricultural Water Quality Limits

Water Quality for Agriculture, Published by the Food and Agriculture Organization of the United Nations in 1985, contains limits protective of various agricultural uses of water, including irrigation of various types of crops and stock watering. Above these limits, specific agricultural uses of water may be adversely affected. These limits may be used to translate narrative water quality objectives that prohibit chemical constituents in concentrations that would impair agricultural uses of water.

SURFACE WATER QUALITY

The primary sources of surface water data in the watershed are from DWR and USGS monitoring stations. Other data is available on specific tributaries such as the Thomes Creek Sediment Budget (CSUC 2004), Sacramento Valley Watershed Coalition sampling at Burch Creek, and Crane Mills temperature data in Thomes Creek.

Department of Water Resources (DWR)

DWR monitored nine stations on four streams: Elder, Red Bank, Reeds,` and Thomes Creeks. Station locations are shown on Figure 7-1. Downloaded data includes over 2,500 individual samples of nearly 200 analytes over a seven-year period from 1998 to 2005 (DWR data downloaded from http://wdl.water.ca.gov/wq-gst/). Of the nearly 200 analytes sampled only 50 have results that exceed the Reporting Limit (RL) or whose maximum result is greater than zero. Where possible, limits for each analyte were established using the Basin Plan, the Environmental Protection Agency's (EPA) Water Quality criteria, and the CTR. The minimum, maximum, average, and standard deviation of the sample results of each of these analytes was calculated and then compared to the RLs determined by DWR. These limits were exceeded on five analytes at six stations. These included dissolved aluminum, dissolved iron, pH, total dissolved solids, and water temperature. Station information is included in Table 7-3. Results are shown on Tables 7-5 and 7-6 and summarized on Tables 7-7 and 7-8.

US Geological Survey (USGS)

USGS monitored seven stations on three streams including Red Bank, Elder, and Thomes Creeks at different periods from 1958 to 2000. The downloaded data includes over 10,000 individual samples of 94 parameters over the 22-year period (USGS data downloaded from http://nwis.waterdata.usgs.gov/usa/nwis/qwdata). USGS stations are included on Figure 7-2. Of the 94 parameters sampled 88 have results that are greater than the RL. Again, where possible, limits for each parameter were established using the Basin Plan, EPA's Water Quality Criteria, and the CTR. The minimum, maximum, average, and standard deviation of each parameter were calculated and then compared to these limits. These limits were exceeded on five parameters at five USGS stations. These included temperature, turbidity, specific conductance, pH, and chloride. Station information is included as Table 7-4. Results are shown on Tables 7-9 and summarized on Tables 7-10 and 7-11.

Table 7-3
NINE DWR STATIONS IN TEHAMA WEST WATERSHED

Station Number	Station Name	Lat.	Long.	Period of Sampling	Number of Samples
A0332000	Elder Creek at Gerber	40.0511	-122.1514	3/7/2001-7/26/2005	574
A0335000	Elder Creek near Henleyville	40.0322	-122.2900	5/29/1998-5/8/2001	54
A0340500	Red Bank Creek at Rawson	40.1403	-122.2383	3/6/2001-6/28/2005	475
A0346000	Red Bank Creek near Red Bluff	40.0900	-122.4125	5/28/1998-2/7/2001	26
A3471000	Red Bank Creek North Fork at Bell Road	40.1350	-122.5200	5/29/1998-5/29/1998	11
A0025700	Reeds Creek at Red Bluff	40.1686	-122.2369	3/6/2001-6/28/2005	516
A0321800	Thomes Creek at Hall Road	39.9853	-122.1233	3/7/2001-6/28/2005	514
A0325500	Thomes Creek at Henleyville	39.9564	-122.3292	5/19/2004-5/19/2004	31
A0350000	Thomes Creek at Paskenta	39.8878	-122.5281	5/28/1998-4/10/2002	336

Table 7-4 SEVEN USGS STATIONS IN TEHAMA WEST WATERSHED		
Station Number	Station Number	Sampling Period
11378800	Red Bank Creek near Red Bluff	12/5/1960-5/4/1966
11378860	Red Bank Creek at Rawson Rd. Bridge near Red Bluff	12/26/196-34/15/1969
11380500	Elder Creek at Gerber	12/6/1960-3/28/1979
11379500	Elder Creek near Paskenta	10/2/1958-1/19/2000
11382090	Thomes Creek at Rawson Rd. Bridge near Richfield	1/31/1977-4/8/1980
11382100	Thomes Creek near Mouth near Corning	12/6/1960-7/6/1966
11382000	Thomes Creek at Paskenta	10/2/1958-5/4/1983
Note: Table includes stations with > 1 sampling event		

CSUC Sediment Budget

A study completed by California State University, Chico proclaimed the Thomes Creek watershed as "one of the highest sediment-producing streams in the western Sacramento Valley." The objective of the study was to develop a sediment budget for Thomes Creek to determine if gravel extraction operations in the lower reaches of the creek below the I-5 Bridge were depleting the resource. The following four paragraphs were extracted from the executive summary of the report.

The Thomes Creek watershed is one of the highest sediment-producing streams in the western Sacramento Valley of Northern California. Consequently, sand and gravel mining is one of the major land uses in the lower watershed. Mining from the creekbed may not be without impacts, however. According to the California Department of Fish and Game (1993), mining, especially in the reach between the I-5 Bridge and Sacramento River confluence has resulted in local changes in channel cross-section as well as changes in stream stability. These alterations are postulated to have impaired migration of adult salmonids, diminished the availability of suitable spawning sites, altered the movement of spawning gravel, and increased the volume of suspended solids present in the water. In light of these concerns, and to develop effective management strategies for sustainable mining practices of sand and gravel in Thomes Creek, we have constructed a quantitative sediment budget for the Thomes Creek watershed. Our analysis indicates that although average annual bedload discharges are insufficient to replace the volume of sediments either permitted to be or historically mined annually, sediment stored in the channel during high-flow events may be sufficient to maintain mining operations in subsequent years under current permitted volumes and practices.

In the current analysis, we have identified two sources of sediment in the Thomes Creek channel: mass wasting in the upper watershed, especially in the steeply sloped area between the Gorge and the Slab, and remobilization of sediment previously stored in the channel. Slope failures as debris slides, block slides, rotational/translational slides, debris avalanches and rock slides/rock falls are common and widespread. Most of the sediment entering the channel is derived from debris slides fed by large, deep-seated rotational/translational slides located upslope; examination of sequential aerial photographs reveal that the same locations tend to fail year after year. Debris slides deliver all sizes of sediment to the channel, from clay to boulders. Much of the sediment that moves out of the upper watershed during high flow events is trapped in the lower watershed as channel lag, bars and terraces. We estimate that over 309,000,000 yd^3 [cubic yards] of sediment currently reside in the active portion of the Thomes Creek channel. Sedimentologic analysis of modern channel deposits indicate unsystematic downstream fining in pebbles, cobbles and boulders coupled with an increase in the relative proportions of sand, silt and clay in the downstream direction, ranging from approximately 30% in the vicinity of the Slab crossing and Paskenta to 43% at Flournoy and up to 60% at Henleyville and Rawson Road. Flanking the active channel are terraces of various ages whose relative stability is indicated by the presence of soil development.

To construct a sediment budget for the watershed, the estimated 89,700 yd^3/yr of sediment delivered to the Thomes Creek channel in the upper watershed was routed downstream on a reach-by-reach basis utilizing the bedload rating curves derived for each measured cross-section in conjunction with yearly flood flows. Results of our calculations indicate that bedload transport rates are highly variable, both as a function of location and time, and the use of average annual bedload transport rates calculated from yearly estimates tend to disguise the wide variability inherent in the Thomes Creek system. Of the sediment delivered to the channel in the upper watershed, approximately 75,200 yd^3/yr is transported at the Slab, 45,000 yd^3/yr [cubic yards per year] is transported at Paskenta, 24,300 yd^3/yr moves through the Flourney, 25,300 yd^3/yr moves past Henleyville and about 44,000 yd^3/yr passes under the Rawson Road bridge.

The greatest amounts of sand and gravel are transported downstream during high discharge events, which typically have fairly low recurrence intervals. Exceedence probabilities and return periods for Thomes Creek flows recently calculated using 75 years of annual discharge data indicate that discharges of about 10,000 cfs have an average return period of between two and five years. The 10-year flood has an associated discharge of 19,500 cfs, while the 25-year and 50-year floods have discharges of approximately 27,000 cfs and 33,000 cfs, respectively. At 20,000 cfs the Thomes Creek channel on average is capable of transporting nearly 100,000 yd^3 of sediment per day. Because of the proportionate increase in sand in the downstream reaches, much of the sediment that will be transported to the mining sites under higher flood flows will be sand-sized or finer. We estimated the relative sizes of particles transported in each reach as the fraction available, rescaled to preclude the sizes not transported, times the total yearly average bedload discharge. Transport of sand and finer sediment as bedload at Rawson Road may average 30,500 yd^3/yr or more, comprising nearly 70% of the total sediment load (CSUC 2004).

DWR 1982

The most complete assessment of sources and causes of high sediment yield in the Thomes Creek upper watershed was from the two-year study by Howard and Varnum (1982). The authors found that most sediment entering the creek channel in the upper watershed comes from landslides along the main channel and tributaries. The authors identified that the landslides are caused by a combination of unstable geology, (particularly within the South Fork Mountain Schist and Valentine Spring formations), steep slopes, intense precipitation, (including large storm events), snowmelt, or small, late spring storms; and human activities such as timber harvesting and road construction. Movement of unconsolidated material is exacerbated by high flows, generally in excess of 17,600 cfs as gauged at Paskenta. These flows carry high volumes of sediment that aggrade the channel and lead to undercutting of the streambanks, thus initiating sliding. Minor amounts of sediment are delivered to the Thomes Creek channel by rock slides within the gorge, by large, deep-seated translation-rotational slides in the middle watershed, which probably date from the late Pliocene to mid-Quaternary, from gutted stream channels scoured by debris torrents in long, straight, steep tributaries to Thomes Creek, and by soil mantle creep in the upper watershed, especially on south-facing slopes.

United States Forest Service (USFS)

The USFS conducted a landslide inventory in the Mendocino National Forest. Active results of the inventory are shown on Figure7-3. The inventory identified 16,970 acres of active or dormant slides in the Thomes Creek Drainage and 3,221 acres of active or dormant landslides in the Elder Creek drainage.

Crane Mills Temperature Data

Crane Mills has monitored water temperature at two locations in Thomes Creek (Upper Thomes Creek at the bridge and Lower Thomes Creek at the Slab). Data was collected from 1995 through 2002 from approximately June 15 to November 15 of each year. The Data sheets supplied as records of this work are included in an appendix to this section. In general the data reflects seasonal snowmelt in June with average temperatures near 50°F in both upper and lower locations. As the summer progresses and base flow conditions occur, the temperatures rise consistently with average air temperature such that the lower Thomes Creek location temperatures increases from 5° to 10° over the temperature at the upper location.

Surface Water Quality Summary

DWR and USGS monitoring have recorded analytes that have exceeded their limits on Elder, Red Bank, Reeds, and Thomes Creeks for dissolved aluminum, dissolved iron, pH, total dissolved solids, water temperature, turbidity, specific conductance, and chloride. However, overall water quality in the watershed is good.

Sediment loading in Thomes Creek continues to be a problem. Studies conducted by CSUC and DWR attribute sediment loading to landslides and remobilization of sediment. Concerns caused by sediment include changes in channel cross-section, changes in stream stability, impaired salmonid migration and spawning sites, and increased volume of suspended solids.

The potential sources and causes of water quality impairment vary from subwatershed to subwatershed. Table 7-12 lists potential sources and causes of water quality impairment.

Table 7-5
DWR STATION INFORMATION – DISSOLVED ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	CTR (1) (ug/l)		Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation		Contin. Acute	4 Day Chronic	Primary	Secondary	Primary	Secondary
Ammonia (mg/l as N)	54	0	0.04	0.00	0.01							
Arsenic (µg/l)	28	0.349	1.54	0.67	0.30	10	340	150	10		50	
Boron (mg/l)	62	0	0.6	0.01	0.08							
Calcium (mg/l)	62	2	52	26.68	10.05							
Chloride (mg/l)	62	0	74	7.18	10.90					250,000		250,000
Chromium (µg/l)	28	0.37	7.12	1.85	1.37		550	180	100			50
Copper (µg/l)	28	0.46	5.22	1.08	0.93	5.6	13	9	1300	1000	1300	1000
Iron (µg/l)	28	0	1525	97.42	291.60	300				300		300
Lead (µg/l)	28	0	0.647	0.04	0.12		65	2.5	15		15	
Magnesium (mg/l)	62	1	38	14.06	7.99							
Manganese (µg/l)	28	0.21	21.4	2.05	3.96	50				50		50
Nitrate (mg/l)	9	0	2	0.64	0.61				10,000		45,000	
Nitrite + Nitrate (mg/l as N)	62	0	1.1	0.11	0.20				1000		1000	
Organic Nitrogen (mg/l as N)	3	0.1	0.6	0.30	0.26							
Ortho-phosphate (mg/l as P)	48	0	0.14	0.02	0.03							
Potassium (mg/l)	62	0.5	1.9	0.92	0.33							
Sodium (mg/l)	62	2	35	9.39	6.61							
Sulfate (mg/l)	62	2	46	14.34	10.39				500,000	250,000		250,000
Zinc (µg/l)	28	0	3.37	0.38	0.63	16	120	180		5000		5000

Notes: (1) CTR values vary by hardness for freshwater life or lowest shown.
Blank spaces denote no current State or Federal value available.

Table 7-6
DWR STATION INFORMATION – NON- DISSOLVED ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	CTR (ug/l)		Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation		Contin. Acute	4 Day Chronic	Primary	Secondary	Primary	Secondary
Hardness (mg/l as CaCO3)	58	11	262	133.93	53.53							
Ortho-phosphate (mg/l as P)	14	0	0.23	0.05	0.06							
pH (units)	40	6.4	8.8	7.57	0.61	6.5				6.5-8.5		
Alkalinity (mg/l as CaCO3)	30	56	225	136.73	40.77							
Arsenic (μg/l)	30	0.431	2.97	0.81	0.49	10	340	150	10		50	
Cadmium (μg/l)	30	0	0.138	0.01	0.03	0.22	2	0.25	5		5	
Calcium (mg/l)	38	15	50	29.66	9.44							
Chromium (μg/l)	30	0.66	36.4	4.09	7.14		550	180	100		50	
Copper (μg/l)	30	0.47	31.2	2.63	5.74	5.6	13	9	1300	1000	1300	1000
Dissolved Solids (mg/l)	63	38	317	172.49	64.56	125			500		500	
Hardness (mg/l as CaCO3)	8	54	222	108.00	57.45							
Iron (μg/l)	30	0	17775	1169.35	3468.98	300				300		300
Lead (μg/l)	30	0	6.34	0.37	1.18		65	2.5		15		15
Magnesium (mg/l)	38	4	37	15.82	7.48							
Manganese (μg/l)	30	0.23	443	31.11	86.83	50				50		50
Suspended Solids (mg/l)	58	0	680	40.75	111.64							
Zinc (μg/l)	30	0	45	3.11	8.61	16	120	120		5000		5000
Temperature °C	8	6	26	13.58	7.43	21.1						

Notes: (1) CTR values vary by hardness for freshwater life or lowest shown.
Blank spaces denote no current State or Federal value available.

Table 7-7
DWR STATION INFORMATION – ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) BY ANALYTE

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation	Acute	Primary	Secondary	Primary	Secondary
Dissolved Aluminum (μg/L)	28	0.94	2572	151.87	484.78			50 – 200	1000	200
Dissolved Iron (μg/L)	28	0	1525	97.42	291.60	300		300		300
pH(units)	40	6.4	8.8	7.57	0.61	6.5		6.5-8.5		
Total Dissolved Solids (mg/l)	63	38	317	172.49	64.56	125		500,000		500,000
Temperature °C	8	6	26	13.58	7.43	21.1				

Blank spaces denote no current State or Federal value available.

Table 7-8
DWR STATION INFORMATION – ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) BY STATION

Station Name	Parameter	Number of Samples	Minimum	Maximum	Average	Standard Deviation
Elder Creek at Gerber	Dissolved Iron (µg/l)	8	0	398	60.50	137.10
	pH (units)	9	6.6	8.8	7.66	0.73
	Total Dissolved Solids	12	110	317	186.58	52.08
Elder Creek at Henleyville	Total Dissolved Solids (mg/l)	3	148	239	179.67	51.42
Red Bank Creek at Rawson	Total Dissolved Solids (mg/l)	14	165	284	245.57	37.36
Reeds Creek at Red Bluff	Total Dissolved Solids (mg/l)	12	107	210	166.92	36.42
Thomes Creek at Hall Road	Dissolved Aluminus (µg/l)	7	30.5	2572	415.76	951.05
	Dissolved Iron (µg/l)	7	0	1525	246.93	563.91
	pH (Units)	7	6.4	8.1	7.06	.052
	Total Dissolved Solids (mg/l)	11	99	199	134.45	31.39
Thomes Creek at Paskenta	Total Dissolved Solids (mg/l)	9	65	276	112.00	64.82
	Temperature ºC	8	6	26	13.58	7.43

Table 7-9
USGS STATION INFORMATION –ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result			
		Minimum	Maximum	Average	Standard Deviation
Acid neutralizing capacity (mg/l as $CaCO_3$)	112	40	210	99.38	39.59
Ammonia (mg/l as N)	1	0.8	0.8	0.80	
Bicarbonate (mg/l)	399	49	286	143.47	53.57
Boron (mg/l)	399	0	400	62.53	74.98
Carbonate (mg/l)	356	0	19	3.13	3.85
Carbon dioxide (mg/l)	20	1.2	3.4	2.07	0.73
Calcium (mg/l)	95	4.6	99	33.45	15.26
Chloride (mg/l)	399	0	660	30.21	73.14
Dissolved oxygen (mg/l)	143	7.3	15	10.91	1.60
Hardness (mg/l as $CaCO_3$)	400	44	540	152.56	70.78
Iron (µg/l)	5	0	30	6.00	13.42
Magnesium (mg/l)	95	2	70	16.11	12.81
Nitrate (mg/l)	1	0.8	0.8	0.80	
Nitrate, No_3 (mg/l)	131	0	4.9	0.58	0.75
Manganese (µg/l)	30	0.23	443	31.11	86.83
Orthophosphate (mg/l as P)	23	0	0.02	0.01	0.01
pH (units)	439	7.4	8.8	8.22	0.26
Phosphorus (mg/l)	1	2.5	2.5	2.50	
Phosphate (mg/l)	21	0	3.5	0.40	0.94
Potassium (mg/l)	94	0.2	4.4	1.02	0.68
Sodium (mg/l)	401	2	232	17.33	28.52
Sulfate (mg/l)	89	1.9	95	21.87	19.92
Fluoride (mg/l)	29	0	0.2	0.10	0.08

Table 7-9 (cont.)
USGS STATION INFORMATION –ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result			
		Minimum	Maximum	Average	Standard Deviation
Silica (mg/l)	76	8.2	40	14.13	4.67
Specific conductance (ms/cm)	474	96	2420	352.00	250.98
Strontium (mg/l)	1	20	20	20.00	
Suspended sediment (%<0.063 mm) sieve	120	15	100	75.37	17.38
Suspended sediment (%<0.125 mm) sieve	113	18	100	80.99	15.41
Suspended sediment (%<0.25 mm) sieve	105	27	100	87.51	12.96
Suspended sediment (%<0.5 mm) sieve diameter	94	66	100	94.37	7.42
Suspended sediment (%<1 mm) sieve diameter	73	79	100	97.58	4.18
Suspended sediment (%<2 mm) sieve diameter	37	94	100	99.49	1.37
Suspended sediment (%<0.002 mm) fall diameter	138	1	65	22.75	10.50
Suspended sediment (%<0.004 mm) fall diameter	175	5	84	30.06	12.61
Suspended sediment (%<0.008 mm) fall diameter	161	8	94	40.29	14.61
Suspended sediment (%<0.016 mm) fall diameter	175	10	99	51.09	15.02
Suspended sediment (%<0.031 mm) fall diameter	161	11	99	61.01	14.66
Suspended sediment (%<0.063 mm) fall diameter	136	42	100	70.29	14.17
Suspended sediment (%<0.125 mm) fall diameter	133	46	100	79.47	12.20
Suspended sediment (%<0.25 mm) fall diameter	131	57	100	89.14	8.90
Suspended sediment (%<0.5 mm) fall diameter	119	80	100	96.65	4.21
Suspended sediment (%<2 mm) fall diameter	93	97	100	99.67	0.74
Suspended sediment concentration (mg/l)	634	0	44100	1218.62	3332.33
Suspended sediment discharge (tpd)	625	0	1520000	15910.75	79134.68
Temperature °C	816	0	55	11.14	6.35
Turbidity (JTU)	70	0	200	13.76	33.28
Turbidity (mg/l as SiO_2)	37	0	500	59.47	110.31
Turbidity (NTU)	24	0	800	40.54	162.91

Notes: CTR values vary by hardness

Table 7-10
USGS STATION INFORMATION – PARAMETERS EXCEEDING THE REPORTING LIMIT (>RL)

Constituent	Number of Samples	Result				
		Minimum	Maximum	Average	Standard Deviation	Basin Limit
Temperature °C	816	0	55	11.14	6.35	21.1
Turbidity (NTU)	24	0	800	40.54	162.91	150
Specific conductance (mS/cm)	474	96	2420	352.00	250.98	
pH (units)	439	7.4	8.8	8.22	0.26	8.5
Chloride (mg/l)	399	0	660	30.21	73.14	

Table 7-11
USGS STATION INFORMATION – PARAMETERS EXCEEDING THE REPORTING LIMIT (>RL) BY STATION

Station Name	Parameter	Number of Samples	Minimum	Maximum	Average	Standard Deviation
Red Bank Creek near Red Bluff	pH (units)	39	8.1	8.6	8.36	0.13
Red Bank Creek at Rawson Rd. Bridge near Red Bluff	Temperature °C	286	1.7	31.1	10.36	3.09
Elder Creek near Paskenta	Temperature °C	113	1.1	31.1	11.96	6.21
	Specific conductance (mS/cm at 25 °C)	85	166	2420	613.09	444.53
	pH (units)	70	8	8.8	8.44	0.18
	Chloride (mg/l)	85	1.8	660	99.97	136.40
Elder Creek at Gerber	pH (units)	49	7.6	8.8	8.41	0.22
Thomes Creek at Paskenta	Temperature °C	303	0	55	12.07	8.99
	Turbidity (NTU)	24	0	800	40.54	162.91
	pH (units)	227	7.5	8.6	8.09	0.24

Notes: CTR values vary by hardness
Blank spaces indicate no current state or federal value available.

Table 7-12 POTENTIAL SOURCES AND CAUSES OF WATER QUALITY IMPAIRMENT		
Source of Contamination	**Pollutant or Stressor**	**Possible Sources**
General	Dissolved minerals	Mineral deposits, mineralized waters, hot springs, seawater intrusion
	Asbestos	Mine tailings, serpentinite formations
	Hydrogen sulfide	Subsurface organic deposits, such as peat soils in Delta islands
	Metals	Mine tailings
	Microbial agents	Wildlife
	Radon	Geologic formations
Commercial businesses	Gasoline	Service stations' underground storage tanks
	Solvents	Dry cleaners, machine shops
	Metals	Photo processors, laboratories, metal planting works
Municipal	Microbial agents	Sewage discharges, storm water runoff
	Pesticides	Storm water runoff; golf courses
	Nutrients	Storm water runoff
Industrial	SOCs industrial solvents, metals, acids	Electronics manufacturing, metal fabricating and planting, transformers, storage facilities, hazardous waste disposal
	Pesticides	Chemical formulating plants
	Wood preservatives	Plants that pressure treat power poles, wood pilings, railroad ties
Solid waste disposal	Solvents, pesticides, metals, organics, petroleum wastes, microbial agents, household waste	Disposal sites receive waste from a variety of industries, municipal solid wastes, petroleum products
Agricultural	Pesticides, fertilizers, concentrated mineral salts, microbial agents, sediment, nutrients	Tailwater runoff, agricultural chemical applications, fertilizer usage, chemical storage at farms and applicators; air strips, packing sheds and processing plants, dairies, feed lots, pastures
Disasters	Solvents petroleum products, microbial agents, other hazardous materials	Earthquake-caused pipeline and storage tank failures and damage to sewage treatment and containment facilities, major spills of hazardous materials, floodwater contamination of storage reservoirs and groundwater sources
Source: DWR 1998		

GROUNDWATER QUALITY

The primary sources of groundwater data in the watershed are from the RWQCB, DWR and USGS monitoring stations, and various reports compiled by DWR.

The Sacramento River Basinwide Water Management Plan was developed by DWR in 2003 as a comprehensive assessment of the occurrence, movement, and chemistry of groundwater in portions of the Sacramento Valley. The report contains an analysis of groundwater quality in the Sacramento Valley based primarily on existing data collected from DWR's groundwater quality monitoring wells and a generalized characterization by USGS.

In 1993, USGS evaluated the general water quality of the Redding Groundwater Basin. Approximately one-third of the Tehama West Watershed is located within this basin. The report concluded that for the majority of the basin groundwater quality was considered good to excellent for most uses. Areas of poor water quality are largely limited to the margins of the basin. In these areas, shallow wells within marine sedimentary rock of the Great Valley Sequence tend to have high salinity levels. For the central portions of the basin, the groundwater geochemistry is characterized as magnesium-calcium bicarbonate (DWR 2003).

In the Sacramento Valley Groundwater Basin water quality is generally characterized as calcium-magnesium bicarbonate. Isolated areas may contain sodium bicarbonate, calcium bicarbonate, and magnesium bicarbonate water types.

USGS Groundwater Data

Groundwater samples were collected sporadically in the study area from 1957 to 1997. Table 7-13 summarizes the analytical results obtained from these groundwater sampling events, presenting minimum, maximum, and average values for each constituent, as well as EPA, RWQCB, and California domestic limits for these constituents, where applicable. No constituents exceeded the California maximum contamination for drinking water.

DWR Groundwater Data

The groundwater chemistry in the watershed shows little variability. Groundwater samples were collected over a two month period in late 2000. Table 7-14 summarizes the analytical results obtained from these groundwater sampling events, presenting minimum, maximum, and average values for each constituent.

Due to the short time period of the sampling conducted by DWR, it is difficult to determine any water quality trends in the watershed. More studies are recommended so that water quality trends can be established.

RWQCB GeoTracker

GeoTracker is a geographic information system (GIS) maintained by the RWQCB that provides online access to environmental data. GeoTracker is the interface to the Geographic Environmental Information Management System (GEIMS), a data warehouse which tracks regulatory data about underground fuel tanks, fuel pipelines, and public drinking water supplies. GeoTracker and GEIMS were developed pursuant to a mandate by the California State Legislature to investigate the feasibility of establishing a statewide GIS for leaking underground fuel tank (LUFT) sites where groundwater contamination had occurred. GeoTracker contains well, tank, pipeline, and contamination site data from all of California. This makes it an important resource to both regulators and the public (SWRCB 2006). Table 7-15 shows the GeoTracker sites by contamination source located in the watershed.

Table 7-13 USGS GROUNDWATER QUALITY DATA, MULTIPLE LOCATIONS						
Constituent	**Number of Samples**	**Minimum**	**Maximum**	**Average**	**California Primary MCL (ug/l) (c)**	**California Secondary MCL (ug/l) (d)**
Metals (measured in ug/l)						
Aluminum	51	1	250	50	1000	200
Arsenic	70	0	10	1.2	50	
Boron	243	1	2100	163.3		
Chromium (total)	27	1	10	1.2	50	
Copper	39	1	60	11.6	1300	1000
Iron	120	0	610	75.7		300
Manganese	43	0	190	11.1		50
Zinc	38	0	750	78.7		5000
Other Constituents (measured in mg/l unless otherwise noted)						
Bicarbonate	228	74	550	181.1		
Calcium	322	2.5	99	26.3		
Carbon dioxide	228	0.3	152	14.1		
Carbonate	191	1	10	0.6		
Chloride	360	1.1	100	15.4		250,000
Fluoride	162	0	10	0.2	2000	
Hardness (a)	284	36	540	149.1		
Magnesium	321	1.6	106	17.5		
Nitrate	224	0	50	9.6	45,000	
pH (b)	84	6.4	8.3	7.5		6.5 – 8.5
Potassium	272	0.3	8	1.4		
Silica	185	12	74	38		
Sodium	344	4.4	98	18.5		
Sulfate	301	0.2	66	11.9		250,000

Source: USGS 2005
Notes: (a) Hardness is in mg/L CaCO3
(b) pH is measured in pH units
(c) Taste and odor
(d) If not shown, no number or limit available.

Table 7-14 DWR GROUNDWATER QUALITY DATA, MULTIPLE LOCATIONS				
Constituent (a)	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Dissolved Calcium	12	7	67	29.1
Dissolved Chloride	12	3	50	14.2
Dissolved Magnesium	12	7	63	21.3
Dissolved Nitrate	12	3.2	25.8	10.1
Dissolved Potassium	12	0.8	3.4	1.4
Dissolved Sodium	12	8	98	27.3
Dissolved Sulfate	12	<1	54	15.7
Electrical Conductivity (b)	12	179	936	407.8
pH (c)	12	6.8	7.8	7.2
Hardness (c)	12	50	427	160.2
Total Copper	12	0.001	0.072	0.01
Total Dissolved Solids	13	112	520	248.5
Total Iron	12	0.01	0.36	0.08
Total Phosphorus	12	0.03	0.21	0.08
Total Zinc	12	0.007	3.15	0.37

Source: DWR 2005
Notes: (a) Most constituents measured in mg/l, unless otherwise noted
(b) EC measured in uS/cm at 25ºC
(c) pH measured in pH units
(d) Hardness is in mg/l CaCO3

Table 7-15 GEOTRACKER SITE SUMMARY			
Type	**Town**	**Number**	**Status**
LUFT (Leaking Underground Fuel Tank)	Paskenta	1	Open with RWQCB
	Corning	6	Open with RWQCB
	Red Bluff	9	Open with RWQCB
	Proberta	1	Open with RWQCB
	Gerber	1	Open with RWQCB
SLIC (Spills, Leaks, Investigation, and Cleanup)	Corning	5	Open with RWQCB
	Red Bluff	7	Open with RWQCB
	Richfield	1	Open with RWQCB
Landfill	Red Bluff	8	Open with RWQCB
	Corning	4	Open with RWQCB
	Paskenta	1	Open with RWQCB
Source: SWRCB 2006 Note: Open status implies active groundwater contamination without resolution.			

Groundwater Quality Summary

DWR and USGS monitoring stations have recorded constituents that have exceeded their limits at several monitoring sites in the watershed. Overall, groundwater quality in the watershed is good. However, it is recommended that further studies be conducted to monitor groundwater quality.

WATER QUALITY ISSUES

Ag Waivers

The RWQCB regulates discharges of waste primarily though issuance of Waste Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permits.

The requirement for WDRs may be waived by a RWQCB for a specific discharge or type of discharge where such a waiver is not against the public interest. On March 26, 1982 the RWQCB adopted Resolution No. 82-036, *Waiving Waste Discharge Requirements for Specific Types of Discharge*. The resolution listed 23 categories of waste discharges, including irrigation return flows and stormwater runoff from agricultural lands, and the conditions required to comply with the waiver. In 1999, Senate Bill 390 was adopted and changed waiver authorizations. As a result of the changes, all waivers in place on January 1, 2000 would sunset January 1, 2003 if the Regional Board had not readopted them. This change in the law meant that the 1982 waiver, which included irrigation return flows and stormwater runoff from agricultural lands in the Central Valley, would sunset. Additionally, waivers could no longer exceed five years in duration. In November 2000, an environmental organization submitted a petition asking the RWQCB to rescind the waiver and use WDRs to control discharges of pesticides from irrigated lands (RWQCB 2003b). In December 2002 the RWQCB adopted a revised waiver. The waiver is based on a watershed approach that depends on coalition groups to evaluate risks and conduct surface water sampling. The Tehama West Watershed lies within the area of the Sacramento Valley Coalition Group headed up by Northern California Water User

Association (Coalition). The Coalition has completed the submittal of initial watershed information, and conducted sampling. Only one sampling location was located in the Tehama West Watershed. The sample was taken on Burch Creek at Woodson Avenue.

Coalition and subwatershed monitoring data collected from July 2004 through January 2005 were compared to applicable narrative and numeric water quality objectives in the Basin Plan and the California Toxics Rule. Statistically significant toxicity was observed in four water quality samples collected during the January 2005 sample event including Burch Creek at Woodson. The observations of toxicity to *Ceriodaphnia* and *Selenastrum* were considered exceedances of the Basin Plan narrative objective for toxicity. The results were reported to the RWQCB by the Coalition in two Communication Reports dated February 3 and February 9, 2005, as required by the Conditional Waiver and the Coalition's Monitoring and Reporting Program Plan (MRPP). Each of the three samples was retested to determine whether toxicity was persistent in the original sample, and new samples were collected from the same sites and retested to evaluate the duration of toxicity in the water body. The retested samples did not reveal significant or persistent toxicity. The results of the testing of the Burch Creek Samples are summarized in Table 7-16. Diazinon was detected at 0.316 μg/l in the Burch Creek January 26, 2005 sample. No other pesticides were detected in the Burch Creek sample.

Although the results for Burch Creek do not provide definitive proof that diazinon was the cause of toxicity to *Ceriodaphnia* in the initial Burch Creek sample, the data support diazinon as a likely cause of at least some portion of the toxicity. Application of dormant spray pesticides in this drainage in the dry period prior to sampling are a probable source of the diazinon detected in the Burch Creek sample collected January 26, 2006. The more rapid and complete mortality observed in the February 2, 2005 follow up sample, suggests that diazinon concentrations may have been higher in the later sample, although other causes of toxicity cannot be ruled out in this case. Other potential sources of toxicants (in addition to agricultural sources) in this drainage include runoff from a fairly dense area of rural housing, a solid waste management facility and truck stop facilities. These other sources complicate the process of identifying the primary source of toxicity in samples from the current Burch Creek site.

In response to Burch Creek toxicity, growers in the Burch Creek drainage were contacted and participated in reviewing drafts of the Coalition's initial reports. Growers in the subwatershed have surveyed the drainage area upstream of the Burch Creek monitoring site to better understand the nature of the current land uses. This survey revealed a mixed-use landscape, including rural residential housing, a waste management facility and a truck stop facility. The survey also identified a potential alternative upstream sampling site that may be used if needed to isolate potential sources of toxicity or exceedances of numeric objectives. The Tehama County Agricultural Commissioner's Department also performed a qualitative analysis of land and typical pesticide use trends in this drainage area.

Because pesticide usage is a likely source of the observed toxicity, the Coalition evaluated pesticide use trends in the subwatershed (including Tehama West). These are shown in Table 7-17.

Table 7-16 EXCEEDANCES FOR TOXICITY BURCH CREEK AT WOODSON AVE				
Site and Sample Description	**Sample Date**	**Parameter**	**Result [1]**	**Objective Exceeded**
Initial sample	01/26/05	Ceriodaphnia	20% survival*	Toxicity (Narrative)
Initial sample	01/26/05	Diazinon	0.316 μg/l	Non-regulatory limit
Retest of initial sample at 5 days	01/26/05	Ceriodaphnia	85% survival	Toxicity (Narrative)
Follow-up sample	02/02/05	Ceriodaphnia	0% survival	Toxicity (Narrative)
Note: An asterisk indicates that the result is statistically significant at the 95% confidence level.				

Table 7-17 TRENDS IN SHASTA/TEHAMA SUBWATERSHEDS 2000-2003					
Applied Pesticide	**2000[1]**	**2001**	**2002**	**2003**	**Trend**
Azinphos-methyl	1,580	1,182	167	350	Down
Carbofuran	0	0	0	0	No trend
Chlorpyrifos	11,820	11,640	15,301	12,099	No trend
Diazinon	3,233	3,864	5,006	5,051	Up
Malathion	3,420	3,332	10,561	5,390	No trend
Methyl Parathion	0	262	0	0	No trend
Note: Tabled values are total annual pounds of active ingredient applied per Coalition Subwatershed, as reported in the California Department of Pesticide Regulation PUR Database (2004).					

Landslides

Although BMP and general land use practices have improved significantly, sediment continues to be generated for the upland areas and from bank instability in the transition zones. USFS landslide mapping was included as Figure 7-3.

Pesticide Use

Based on the increasing interest in pesticide use and potential for water quality impacts, the Department of Pesticide regulation databases were queried for the Tehama West Watershed. The pesticide data is available on a county and section basis. Actual field tracking is not yet implemented in Tehama County. Pesticide use by watershed sub-unit for the year 2003 is included on Table 7-19 and shown on Figure 7-4. The purported source of contaminated stormwater runoff under the Ag Waiver program is dormant spray from orchard croplands. A summary of cropland acres (irrigated acres) by watershed sub-unit from 2004 Tehama County parcel records is included as Table 7-20 and shown on Figure 7-5.

The top 50 crops by pesticide use, in gross pounds and acres treated, from the DPR PAN data set for Tehama County in 2003 are shown in Table 7-20. Non–agricultural uses are included and marked as (non-ag). The top 50 pesticides in Tehama County are included in Table 7-21 in order of amount used (gross pounds) from a DPR PAN data set for Tehama County, 2003. Both data sets are for the County of Tehama, not just the Tehama West Watershed area.

Municipal Stormwater Runoff

Municipal runoff from roads, parking facilities, sidewalks, buildings, rooftops, and other impervious surfaces can transport trash, debris, metals, hydrocarbons, and fecal matter that pollute receiving streams. Lawns and other landscaped areas may also contaminate runoff with nutrients, fertilizers, and suspended solids. Agricultural runoff may carry nutrients, animal wastes, sediment, salts, pesticides, fertilizers, and other ingredients that may be harmful in high concentrations. High concentrations of nutrients, for example, can stimulate excessive or undesirable forms of aquatic growth such as algae and noxious weeds. These plants may consume oxygen faster than natural processes can produce it, and as a result, fish and lower species in the food chain may be destroyed. Nutrient enrichment can also drive up the pH levels in water through increased photosynthetic activity. Animal wastes can accelerate the production of algae and contaminate water used for fishing, swimming, and drinking with related microorganism pathogens (Office of Infrastructure 2006).

The most common contaminants in runoff are heavy metals, inorganic salts, aromatic hydrocarbons and suspended solids that accumulate on the road surface as a result of regular highway operation and maintenance activities. Salting and sanding practices, for example, may leave concentrations of chloride, sodium, and calcium on the roadway surface. Ordinary operations and the wear and tear of our vehicles also result in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and other solid materials on the highway surface. These materials are often washed off the highway during rain or snow storm events.

Receiving surface and groundwaters are susceptible to contamination from all these sources. Contamination of groundwater tends to occur gradually because contaminants percolate downward through the soil at slow rates. Highway runoff that soaks into soil with or without the presence of any type of vegetation, channel, or basin is usually harmless to the environment. Surface waters (streams, rivers, ponds, and lakes) are particularly vulnerable because they are directly exposed to contaminants released into the air and to direct discharges from point or non-point sources. Excessive concentrations of these microorganisms can prevent receiving waters from being used for certain water supply and/or recreational activities.

Table 7-18
APPLICABLE WATER QUALITY OBJECTIVES AND METHOD DETECTION LIMITS FOR ANALYTES MONITORED IN THE AGRICULTURAL WAIVER PROGRAM AT THE BURCH CREEK SITE

Basin Plan Objectives					
Analyte	**Units**	**MDL**	**WQO**	**WQO Basis**	**Application**
Temperature	°F	NA	narr.	<°F increase above natural	All waters designated WARM or COLD
Dissolved Oxygen	mg/l	NA	7.0 5.0 7.0	Minimum Minimum Minimum	Sacramento River below the I Street Bridge waters designated WARM waters designated COLD
PH	-log[H^+]	NA	6.5-8.5	"appropriate averaging period" protective of beneficial uses	All waters
Conductivity	µmhos/cm	NA	230 235	50^{th} percentile 95^{th} percentile	Sacramento River above Colusa Basin Drain
			240 340	50^{th} percentile 95^{th} percentile	Sacramento River at I Street Bridge
			150	90^{th} percentile	Feather River Basin
Color	CU	2	narr.	NA	All waters
Hardness as $CaCO_3$	mg/l	3	none	NA	NA
Nitrate	mg/las N		10	Maximum	All waters designated MUN
Turbidity	NTU	0.1	narr.	NA	All waters
Total Dissolved Solids (TDS)	mg/l	6	125	90^{th} percentile	American River basin
Total Suspended Solids (TSS)	mg/l	2	narr.	NA	All waters
E. Coli bacteria	MPN/100ml	2	126 235	5-sample geo. Mean; Single sample max	Waters designated REC-1 Waters designated REC-1

Table 7-18 (cont.)
APPLICABLE WATER QUALITY OBJECTIVES AND METHOD DETECTION LIMITS FOR ANALYTES MONITORED IN THE AGRICULTURAL WAIVER PROGRAM AT THE BURCH CREEK SITE

Analyte	Units	MDL	WQO	WQO Basis	Application
Other Objectives					
Ammonia	mg/l			PH and temperature dependent; 30-day avg., 4-day avg., and 1-hour avg.	USEPA 1999
Azinphos-methyl	µg/l	0.01	0.01	Instantaneous max	USEPA 1976
Carbofuran	µg/l	0.25	0.5	Instantaneous max	Menconi and Gray 1992 (CDFG)
Chlorpyrifos	µg/l	0.005	0.014 0.02	4-day average 1-hour maximum	Siepmann and Finlayson 2000 (CDFG)
Diazinon	µg/l	0.005	0.05(1) 0.08(1)	4-day average 1-hour maximum	Siepmann and Finlayson 2000 (CDFG)
Malathion	µg/l	0.005	0.1	Instantaneous max	USEPA 1999
Parathion, Methyl	µg/l	0.01	0.08	Instantaneous max	Menconi and Harrington 1992 (CDFG)
Monitored Analytes Without Objectives					
Analyte	**Units**	**MDL**	**WQO**	**WQO Basis**	**Application**
Total Organic Carbon (TOC)	mg/l	0.3	none	NA	NA
Dissolved Organic Carbon (DOC)	mg/l	0.3	none	NA	NA
Ultraviolet Absorbance at 254nm	cm^{-1}	NA	none	NA	NA

Notes: MDL – Method Detection Limit
WQO – Water Quality Objective

Table 7-19 PESTICIDE USE BY SUB-UNIT	
Watershed Sub-unit	**Pesticide Use (pounds/acre/year)**
Burch	78,567
Dibble	237
Elder	31,643
Jewett	67,853
Oat	122,428
Red Bank	11,949
Reeds	30
Spring	17,863
Thomes	56,595

Table 7-20 IRRIGATED ACRES BY SUB-UNIT	
Watershed Sub-unit	**Acres**
Burch	11,414
Dibble	139
Elder	15,410
Jewett	12,978
Oat	40
Red Bank	6,146
Reeds	10,685
Spring	650
Thomes	12,654

CONCLUSIONS AND RECOMMENDATIONS

- Encourage voluntary landowner participation in educational opportunities such as water quality short courses, field demonstrations, participation in citizen monitoring program activities, and distribution of water quality "fact sheets."

- Develop a strong road design and management element to assist landowner recognition of road erosion problems and their solutions

- Pursue grant funding or cost-share payments for landowners to inventory, prepare plans, and implement best-management practices that reduce water quality impacts.

- Evaluate the effectiveness of vegetation management alternatives to manage seasonal surface runoff and underflow. Evaluate the effectiveness of reducing brush to increase flows in springs and creeks.

- Offer livestock and small animal operators increased opportunities to participate in voluntary cooperative water quality short courses to help livestock operators understand the possible sources of livestock impacts to water quality.

Table 7-21 TOP 50 CROPS AND SITES FOR ALL CHEMICALS USED IN TEHAMA COUNTY					
Crop or Site	**Gross Pounds**[1]	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**	**Number of Applications**
All Sites	630,900	2.27	80,919	245,292	10,807
Walnuts	253,764	2.45	16,066	97,341	4,214
Prunes	122,475	2.96	8,744	41,312	1,096
Almonds	89,030	1.74	7,755	51,308	1,062
Outdoor Propagation Nursery	31,155	49.2	256.7	632.8	100
Right of Way (non-ag)	27,038	0.86	180.0	290.0	455
Wine Grapes	21,621	13.1	191.1	1,645	68
Aquatic Area (non-ag)	17,997	8.76	1.50	273.8	20
Olives	17,502	0.98	4,930	17,908	743
Commodity Fumigation (non-ag)	8,235	-	-	-	28
Alfalfa for Forage	7,752	0.71	3,688	10,963	204
Public health pest Control (non-ag)	5,634	-	-	-	61
Forests	4,970	1.70	24,675	2,881	70
Rice	3,366	11.1	358.1	304.1	6
Beans	3,102	1.10	1,160	2,828	53
Figs	3,038	20.2	150.0	150.0	2
Wheat	2,332	0.55	2,282	4,203	59
Oats	1,941	0.66	3,122	2,954	71
Structural Pest Control (non-ag)	1,160	-	-	-	1,864
Uncultivated Agricultural Area (non-ag)	1,133	0.77	803.0	1,475	105
Other Fumigation (non-ag)	1,021	-	-	-	6
Sunflowers	1,003	2.45	245.0	409.0	7
Landscape (non-ag)	947.5	-	-	-	234
Peaches	732.1	4.50	50.5	162.8	39
Oranges	708.5	7.09	25.0	100.0	10
Corn for Forage	705.4	0.55	790.5	1,286	34
Barley	536.5	0.73	796.0	738.0	8
Pistachios	382.5	0.59	138.5	645.0	31

Table 7-21 TOP 50 CROPS AND SITES FOR ALL CHEMICALS USED IN TEHAMA COUNTY					
Crop or Site	**Gross Pounds**[1]	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**	**Number of Applications**
Squash	302.8	4.92	31.0	61.5	6
Rangeland	286.9	0.07	2,951	4,006	16
Pasture	283.7	0.75	796.0	376.0	13
Dried Beans	143.8	0.55	123.0	261.0	6
Pecans	142.2	0.81	136.0	176.0	10
Nectarines	135.8	5.22	4.00	26.0	10
Apples	97.6	3.88	11.9	25.2	14
Plums	70.7	0.42	187.6	170.1	9
Grains	46.9	0.47	60.0	100.0	5
Sudangrass for Forage	38.4	1.92	20.0	20.0	1
Non-Agricultural Areas	31.1	0.70	8.00	44.5	10
Apricots	21.2	2.65	4.00	8.00	2
Greenhouse Propagation	18.4	-	-	-	17
Irrigation Systems	16.3	-	-	-	2
Melons	10.9	0.23	30.0	48.0	3
Outdoor Flower Nursery	8.91	1.75	7.50	5.10	4
Watermelons	6.15	0.09	66.0	66.0	2
Strawberries	5.86	0.41	9.10	14.2	7
Cucumbers	5.12	0.09	56.0	55.0	1
Blueberries	5.01	1.25	4.90	4.00	1
Pumpkins	1.58	0.26	3.00	6.00	1
Cherries	0.75	0.75	1.00	1.00	1
[1] Includes: herbicides, pesticides, rodenticides and fungicides					

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
All Chemicals		630,900	2.27	80,919	245,292
Copper hydroxide Uses: Fungicide, Microbiocide, Nematicide	Inorganic-Copper	140,006	4.83	15,501	28,962
Mineral oil Uses: Insecticide, Adjuvant	Petroleum derivative	88,081	20.7	4,390	4,265
Glyphosate, isopropylamine salt Uses: Herbicide	Phosphonoglycine	47,602	0.84	46,021	49,475
Sulfur Uses: Fungicide, Insecticide	Inorganic	46,981	11.1	3,102	4,230
Maneb Uses: Fungicide	Dithiocarbamate	45,664	1.76	13,503	25,937
Methyl bromide Uses: Fumigant, Insecticide, Herbicide, Nematicide	Halogenated organic	39,026	34.1	2,476	648.3
Petroleum oil, unclassified Uses: Insecticide, Herbicide, Fungicide, Adjuvant	Petroleum derivative	28,357	10.1	3,851	2,797
Copper sulfate (pentahydrate) Uses: Algaecide, Fungicide, Insecticide, Water Treatment, Molluscicide	Inorganic-Copper	27,002	16.0	401.1	347.1
1.3-dichloropropene Uses: Fumigant, nematicide	Halogenated organic	18,757	319.5	194.0	58.7
Diuron Uses: Herbicide	Urea	14,198	1.56	5,911	2,866
Chloropicrin Uses: Fumigant, Nematicide	Unclassified	11,619	20.2	1,204	573.9
Chlorpyrifos Uses: Insecticide, Nematicide	Organophophorus	11,497	1.30	10,622	8,863
Propargite Uses: Insecticide	Unclassified	9,982	1.57	9,482	6,370
Ziram Uses: Fungicide, Microbiocide, Dog and Cat Repellent	Dithiocarbamate, Inorganic-Zinc	9,312	5.26	2,152	1,769
2,4-D, dimethylamine salt Uses: Herbicide	Clorophenoxy	8,494	0.70	12,924	10,830
Captan Uses: Fungicide	Thiophthalimide	7,607	2.47	4,223	3,076
Propylene oxide Uses: Fumigant	Alcohol/Ether	7,240	-	-	-
Paraquat dichloride Uses: Herbicide	Bipyridylium	6,372	0.91	9,726	7,002
Malathion Uses: Insecticide	Organophosphorus	5,564	2.19	3,330	2,452

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
Petroleum distillates Uses: Insecticide, Adjuvant, Solvent	Petroleum derivative	5,371	-	-	-
Diazinon Uses: Insecticide	Organophosphorus	5,331	1.44	4,652	3,602
Simazine Uses: Herbicide	Triazine	4,805	1.68	5,651	2,605
Phosmet Uses: Insecticide	Organophosphorus	3,448	1.97	3,473	1,747
Hexazinone Uses: Herbicide	Triazinone	3,289	1.37	10,982	2,402
Solvent naphtha (petroleum), light aromatic Uses: Solvent, Insecticide	Petroleum derivative	3,284	1.20	3,589	2,729
Lime-sulfur Uses: Insecticide, Fungicide	Inorganic	3,060	25.5	144.2	120.2
Dicofol Uses: Insecticide	Organocholorine	2,159	1.22	2,826	1,767
Oryzalin Uses: Herbicide	2,6-Dinitroaniline	1,747	2.16	1,587	620.5
Ethephon Uses: Plant Growth Regulator	Organophosphorus	1,738	1.01	2,480	1,709
Cyrodinil Uses: Fungicide		1,597	0.23	8,333	7,070
Oxyfluorfen Uses: Herbicide	Diphenyl ether	1,538	0.10	17,442	14,315
Acrolein Uses: Algaecide	Aldehyde	1,397	-	-	-
Pendimethalin Uses:Herbicide	2,6-Dinitroaniline	1,289	1.74	1,721	668.6
Methidathion Uses: Insecticide	Organophosphorus	1,077	1.53	905.9	705.9
Sodium chlorate Uses: Defoliant, Herbicide, Micorbiocide	Inorganic	996.5	3.57	279.0	279.0
MCPA, dimethylamine salt Uses: Herbicide	Chlorophenoxy acid or ester	870.1	0.82	1,231	1,055
Iprodione Uses: Fungicide	Dicarboximide	844.6	0.49	1,951	1,7147
Norflurazon Uses: Herbicide	Pyridazinone	737.6	0.93	963.1	783.8
Triclopyr, butoxyethyl ester Uses: Herbicide	Chloropyridinyl, Glycol Ether	716.6	0.18	2,715	885.0
Thiophanate-methyl Uses: Fungicide	Benzimidazole precursor	646.7	0.85	765.9	745.0
Azoxystrobin Uses: Fungicide	Strobin	611.2	0.15	3,911	4,170

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
Carbon dioxide Uses: Fumigant, Insecticide, Rodenticides	Inorganic	583.1	-	-	-
Trifuralin Uses: Herbicide	2,6-Dinitroaniline	571.7	1.87	653.7	306.0
Permethrin Uses: Insecticide	Pyrethroid	551.6	0.18	3,230	2,518
Aluminum phosphide Uses: Fumigant, Fungicide	Inorganic	495.1	0.06	2,206	451.6
EPTC Uses: Herbicide	Thiocarbamate	476.0	2.60	183.0	183.0
Methomyl Uses: Insecticide, Breakdown product	N-Methyl Carbamate	475.1	0.47	1,605	1,010
Metam-soldium Uses: Fumigant, Herbicide, Fungicide, Microbiocide, Algaecide	Dithiocarbamate	414.6	-	-	-
2,4-D,2-ethylhexyl ester Uses: Herbicide	Chlorophenoxy acid or ester	394.5	1.85	3,239	213.0

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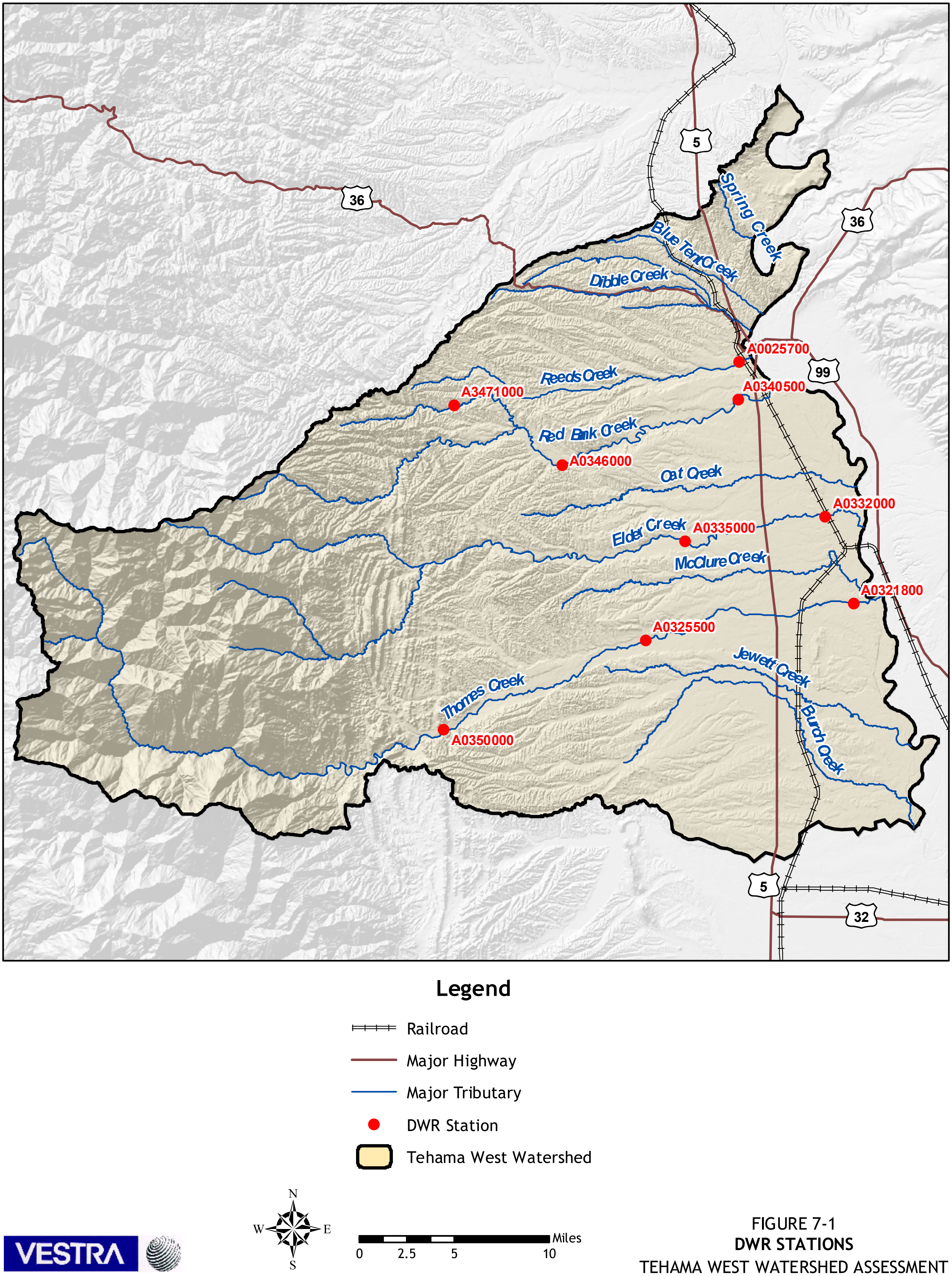

FIGURE 7-1
DWR STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005

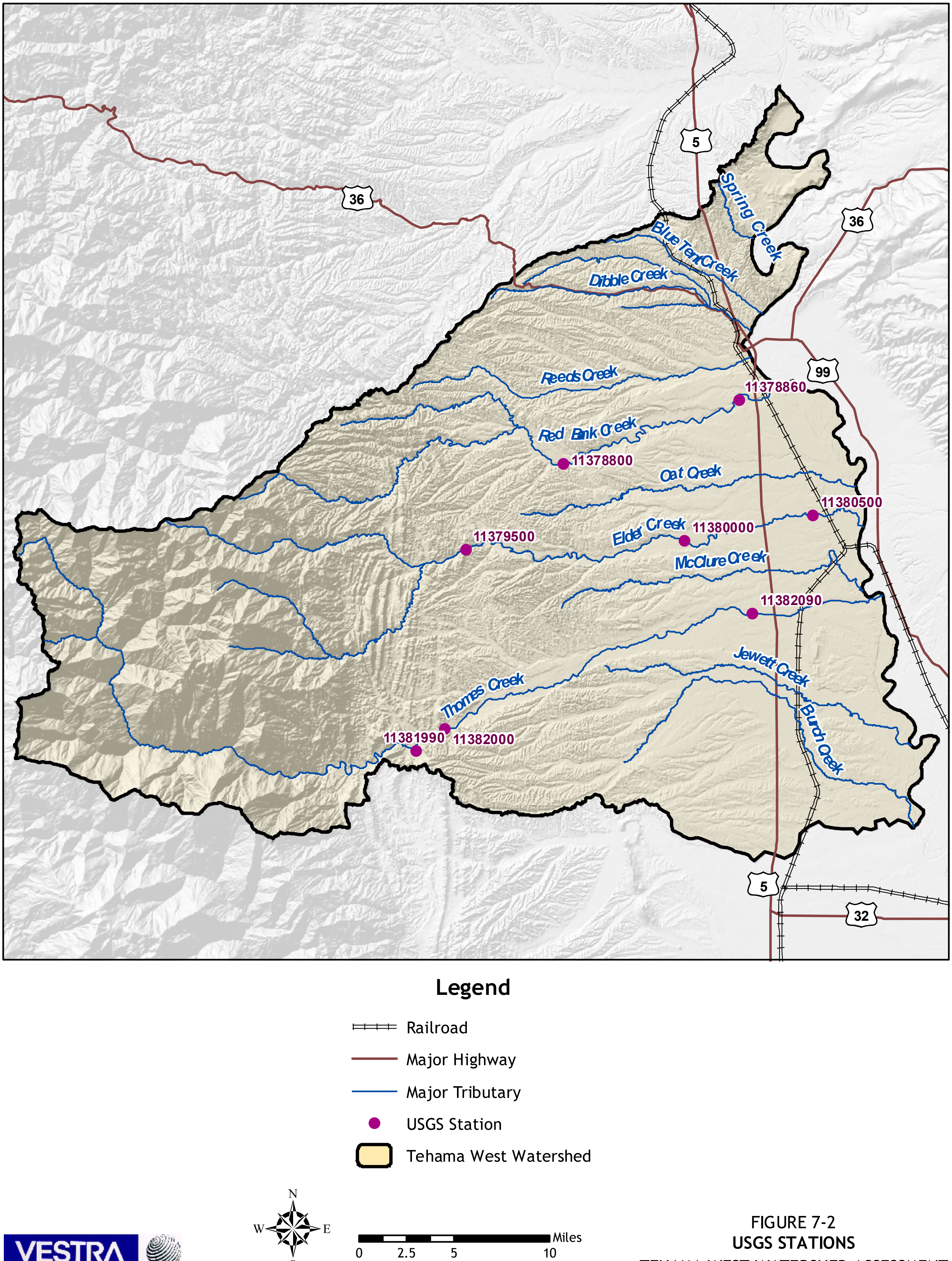

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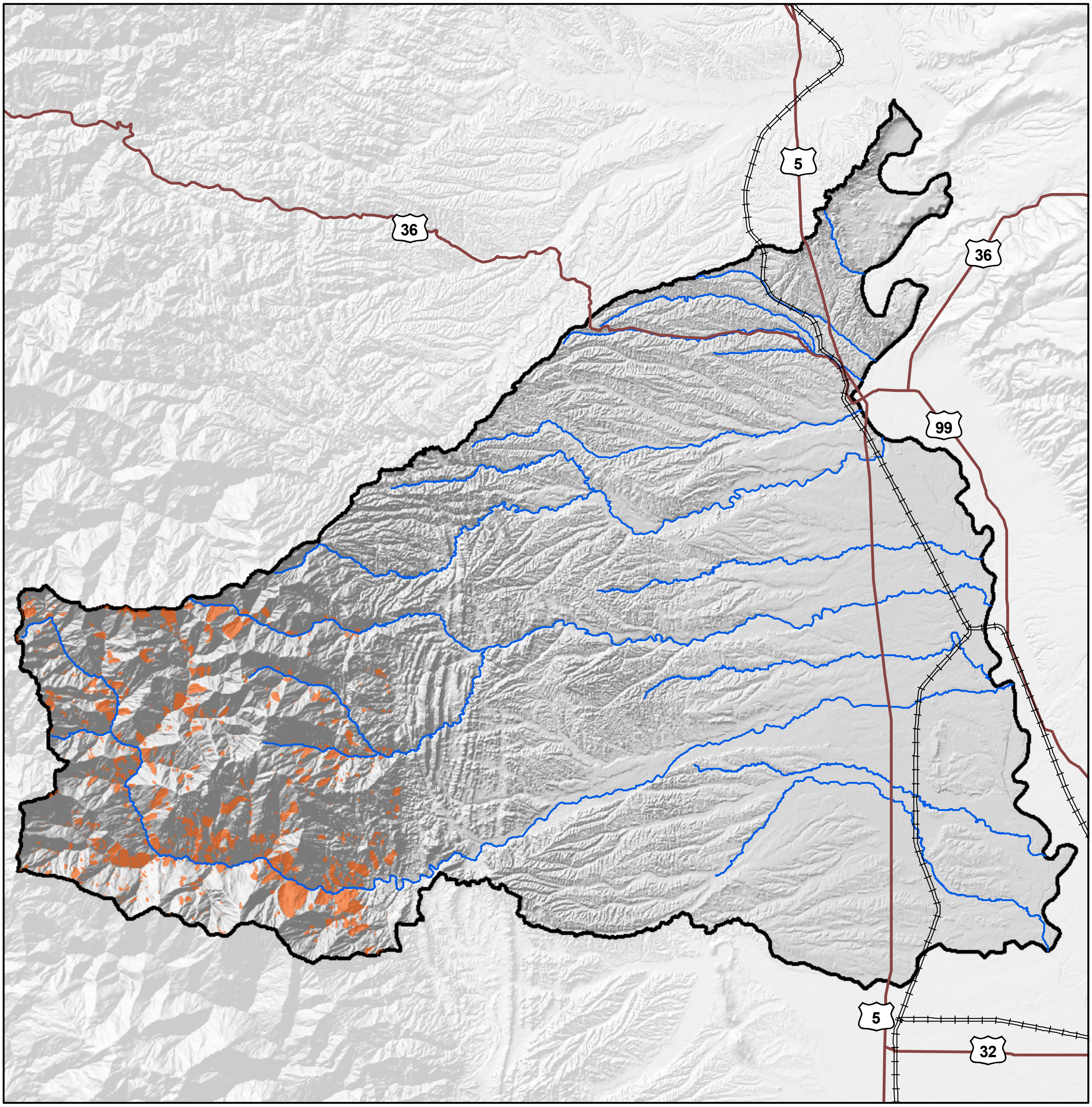
FIGURE 7-2
USGS STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- Landslide Boundary (Mendocino National Forest only)

VESTRA

N
W E
S

0 2.5 5 10 Miles

FIGURE 7-3
LANDSLIDES - MENDOCINO NATIONAL FOREST
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNITED STATES FOREST SERVICE, MENDOCINO NATIONAL FOREST, 2003

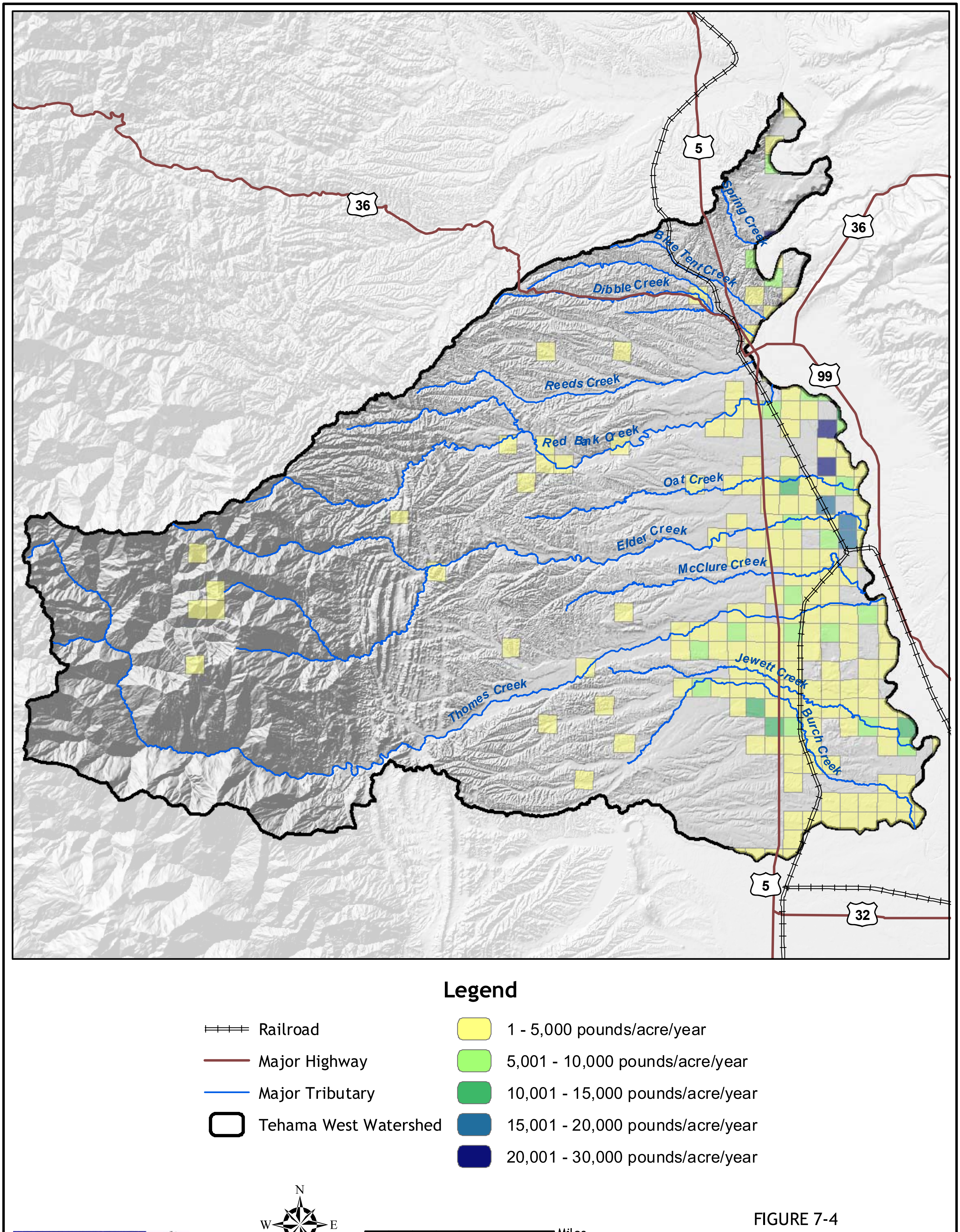


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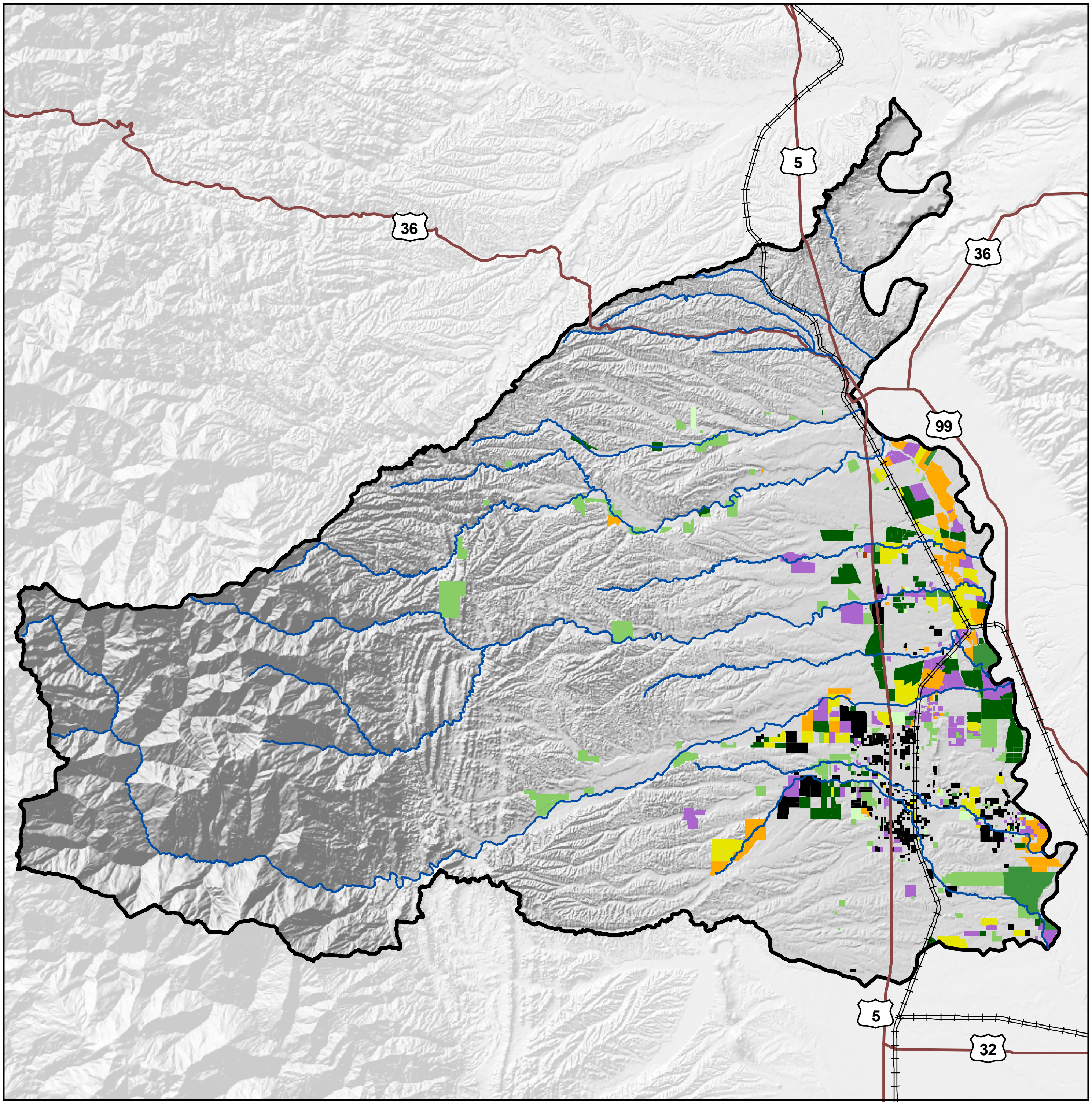
FIGURE 7-4
PESTICIDE USE
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION, 2004



Legend

Railroad	Field Crops - Irrigated
Major Highway	Row Crops - Irrigated
MajorTributary	Irrigated Olive Orchard
Field Crops	Irrigated Prune Orchard
Orchard	

Irrigated Walnut Orchard
Irrigated Almond Orchard
Irrigated Misc. Orchard
Vine and Bush Fruits - Irrigated

N W E S

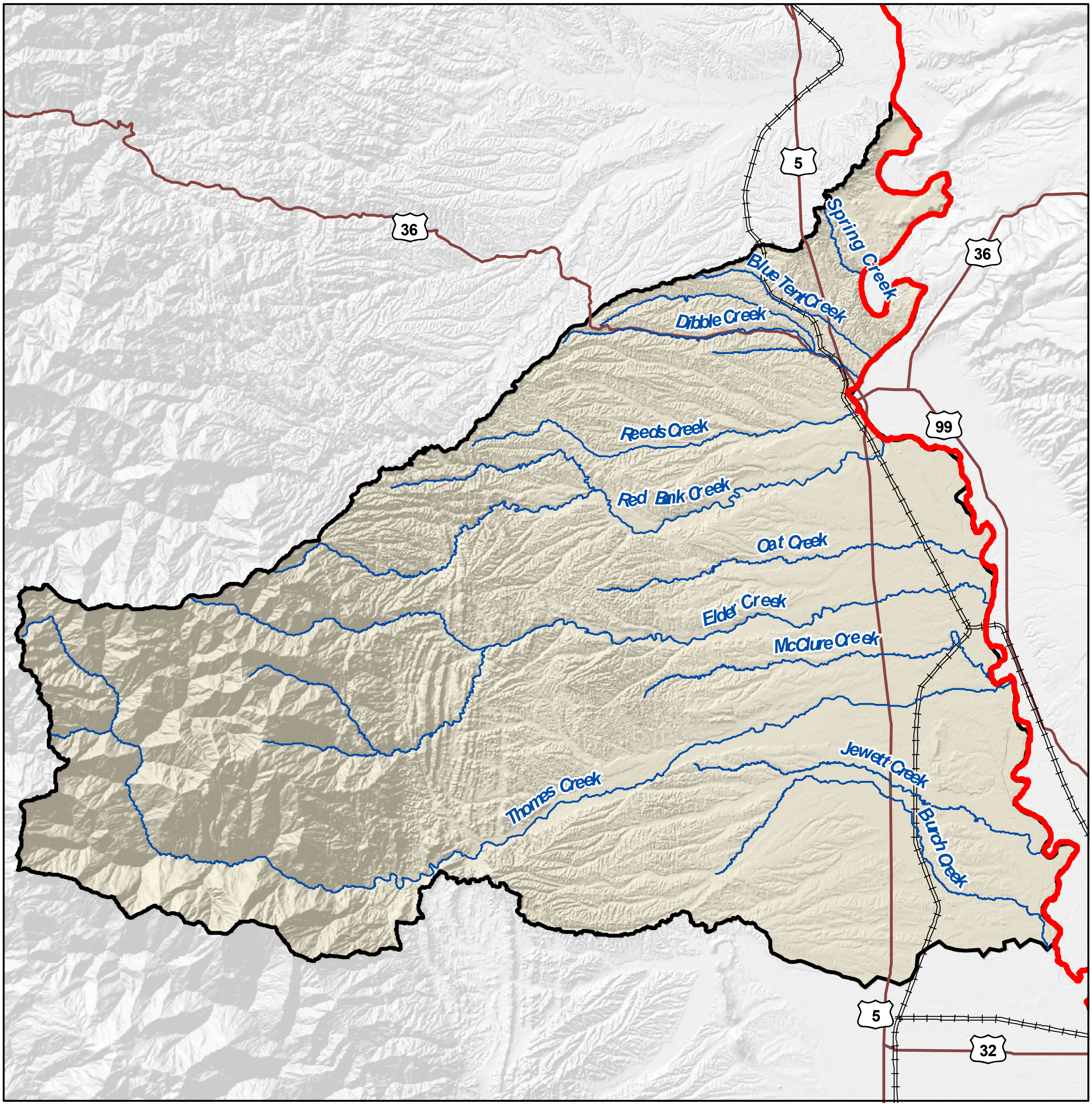
0 2.5 5 10 Miles

VESTRA

FIGURE 7-5
IRRIGATED ACRES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005

OCTOBER 2005



Legend

- Railroad
- Major Highway
- MajorTributary
- Tehama West Watershed
- 303(d) Listing

N W E S

Miles 0 3 6 12

VESTRA

FIGURE 7-6
303 (d) LISTED STREAMS AND RIVERS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA STATE WATER RESOURCES CONTROL BOARD, 2005