



Subregional Long-Term Wastewater Project

IRRIGATION/STORAGE STREAMS WATER QUALITY MONITORING RESULTS

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

Prepared for

**City of Santa Rosa
and
U.S. Army Corps of Engineers**

May 1996

Prepared by:

**Merritt Smith Consulting
Environmental Science and Communication**

3675 Mt. Diablo Blvd. #120 Lafayette, CA 94549

For

HARLAND BARTHOLOMEW & ASSOCIATES, INC.

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TABLE OF CONTENTS

1.0 SUMMARY	1
2.0 INTRODUCTION	2
2.1 Irrigation Streams.....	2
2.2 Storage Streams.....	2
3.0 MONITORING PLAN	4
3.1 Irrigation Streams.....	6
3.2 Storage Streams.....	7
4.0 MONITORING RESULTS	8
4.1 Irrigation Streams.....	8
4.1.1 Nutrients.....	8
4.1.2 Conductivity.....	8
4.1.3 Dissolved Oxygen.....	8
4.1.4 Nitrate.....	9
4.1.5 Ammonia	9
4.1.6 TKN (Total Kjeldahl Nitrogen).....	9
4.1.7 Dissolved Orthophosphate.....	9
4.1.8 Chlorophyll <i>a</i>	9
4.1.9 Metals.....	12
4.2 Storage Streams.....	14
4.2.1 Nutrients.....	15
4.2.2 Conductivity.....	15
4.2.3 Dissolved Oxygen.....	15
4.2.4 Nitrate.....	15
4.2.5 Ammonia	15
4.2.6 TKN.....	15
4.2.7 Orthophosphate.....	15
4.2.8 Chlorophyll <i>a</i>	16
4.2.9 Metals.....	16
5.0 REFERENCES.....	18
6.0 APPENDIX.....	19

1.0 SUMMARY

This Technical Report describes water quality in streams potentially affected by the Project through irrigation and water storage. Water quality collections were made during the spring and summer of 1994 and 1995 in irrigation streams, and during May 1995 in streams in potential storage sites. The results are described for nutrients, metals, and other parameters indicative of water quality. Water quality data are not evaluated in this report. Potential project impacts are assessed in the *Water Quality Impact Analysis* Technical Report (MSC 1996).

Water quality data are presented for the following streams potentially affected by irrigation from the Project:

- Atascadero Creek
- Green Valley Creek
- Adobe Creek
- Blucher Creek
- Crane Creek
- Gossage Creek
- San Antonio Creek
- Walker Creek

Water quality data are presented for the following streams flowing through potential storage sites:

- Unnamed stream (Lakeville/Hillside storage site)
- Tolay Creek (Sears Point storage site)
- Tolay Creek (Tolay storage site)
- Unnamed stream (Huntley storage site)
- Unnamed stream (Valley Ford storage site)

The results are described for nutrients (including nitrate, ammonia, and phosphate), metals, and other parameters indicative of water quality (including dissolved oxygen, conductivity, pH, and chlorophyll *a*). Results are also compared to water quality standards for the protection of aquatic life. Dissolved oxygen in Green Valley Creek was below the Regional Board Basin Plan minimum objective (5.0 mg/L for warm waters) on two occasions (July 1995 - 3.7 mg/L, and August 1995 - 4.0 mg/L). The EPA chronic criterion (sensitive species present) for un-ionized ammonia (28.8 µg-N/L) was exceeded in the Valley Ford site stream in May 1995 (176.6 µg-N/L). The concentrations of most metals were below detection and there were no exceedances of EPA criteria for the protection of aquatic life.

2.0 INTRODUCTION

The purpose of this Technical Report is to support impacts evaluation of the Project effects on streams influenced by irrigation and storage. This report provides the following:

- Water quality in streams potentially affected by irrigation from the Project
- Water quality in streams flowing through potential storage sites

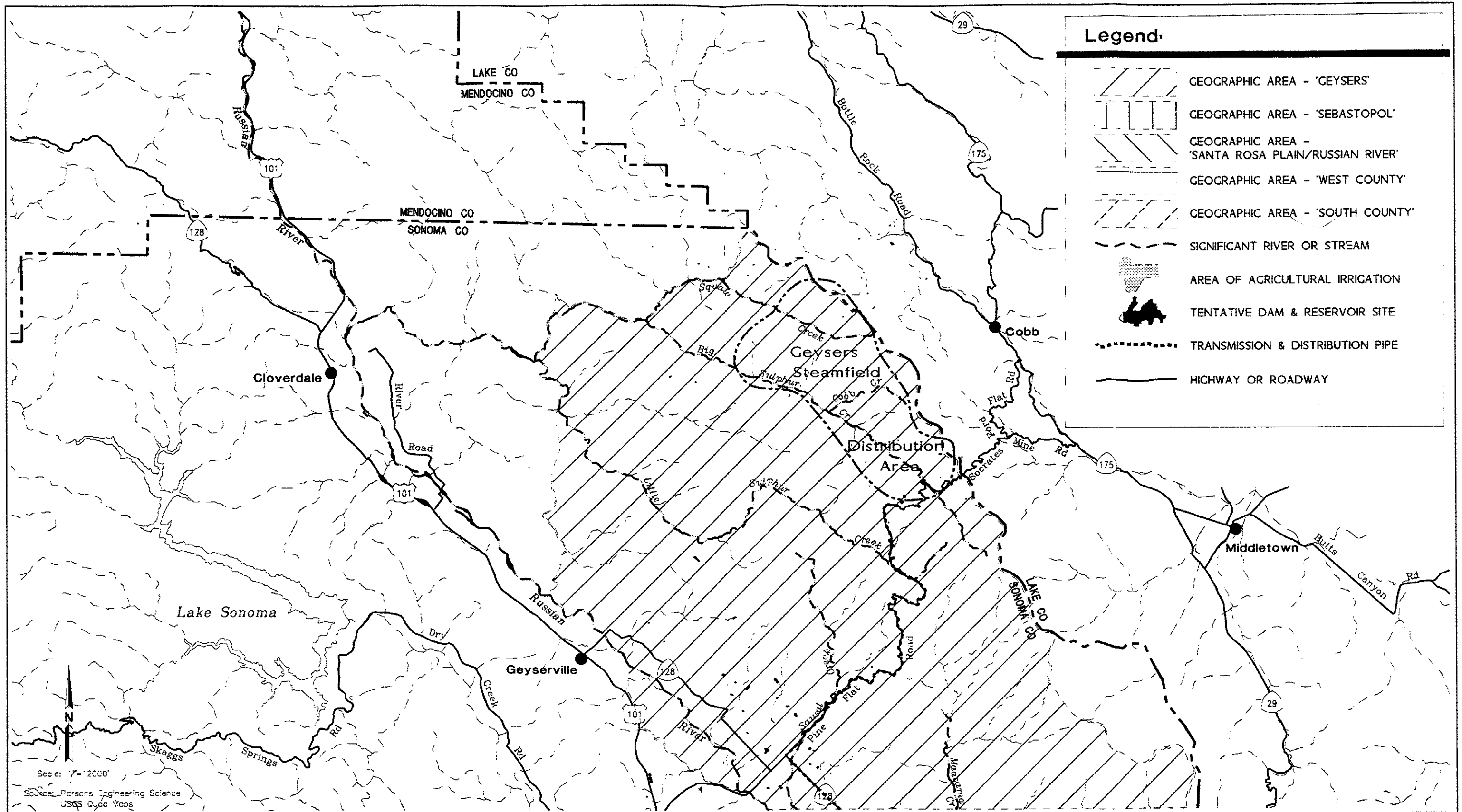
The streams covered in this report are shown in Figure 1. Water quality data are not evaluated in this report. Potential project impacts are assessed in the *Water Quality Impact Analysis* Technical Report (MSC 1996).

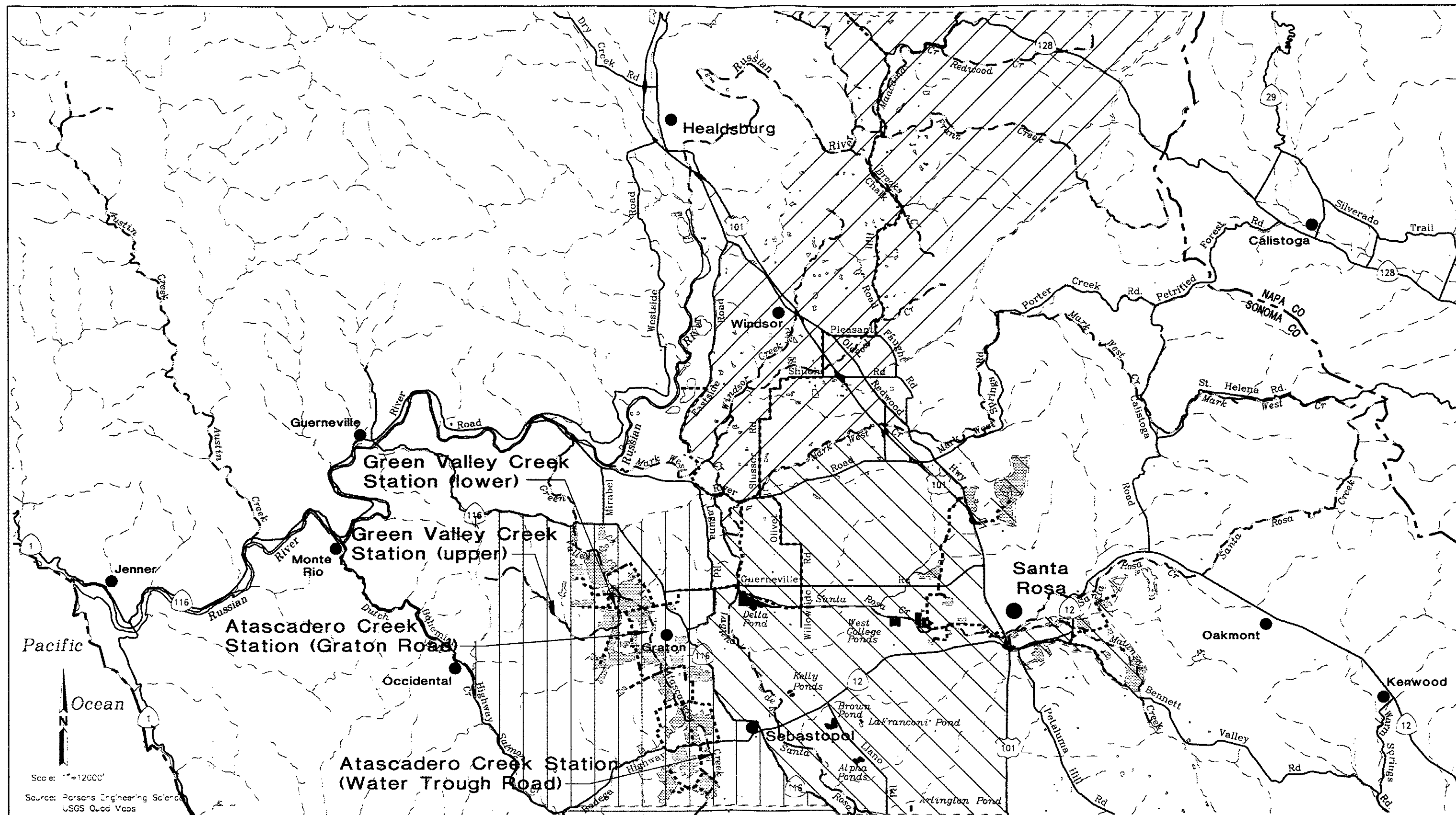
2.1 IRRIGATION STREAMS

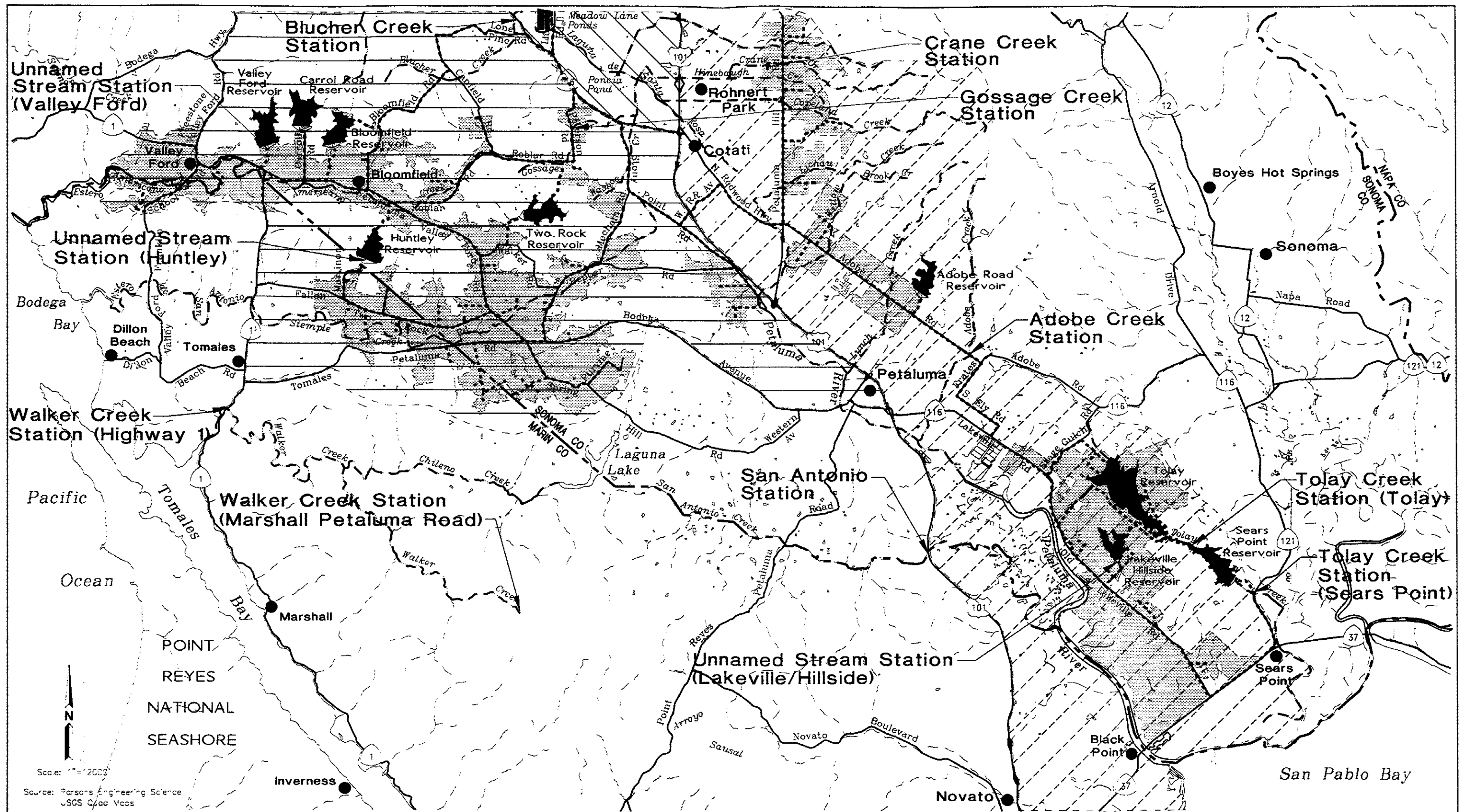
Some streams in Sonoma County are potentially affected by irrigation from the Project. Water quality characterizations are described here for Green Valley, Atascadero Creeks, Blucher, Crane, Gossage, and Adobe Creeks. Water quality characterizations of Estero Americano, Estero de San Antonio, Americano Creek, and Stemple Creek are presented in the *Environmental Conditions in West County Waterways* Technical Report (MSC 1996). Water quality collections were also made in Walker and San Antonio Creeks (West County) in 1994 and are presented here, but further collections were discontinued in 1995 since Chileno Valley irrigation was eliminated from the Project description. Further water quality collections in South County irrigation streams were discontinued pending an evaluation of reservoir and irrigation impacts on surface water in South County. Preliminary analysis indicated that these Project components would not influence surface waters.

2.2 STORAGE STREAMS

Some streams are potentially affected by Project storage sites. The purpose of this task is to characterize water quality in these streams to provide the basis for evaluating impacts of reservoir leakage. The water quality data will be used as input to the groundwater analysis to indicate quality of discharging groundwater under current conditions, and to compare to estimated quality under Project conditions. One stream was evaluated for each of the five watersheds proposed for storage sites. These streams include Tolay Creek, one site at the Lakeville/Hillside storage site, and tributary streams at one storage site in each of the Americano and Stemple watersheds. The water quality of the main streams in the Stemple and Americano watersheds (Stemple and Americano Creeks) is described in the *Environmental Conditions in West County Waterways* Technical Report (MSC 1996).







HARLAND BARTHOLOMEW and ASSOCIATES, INC.

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Santa Rosa

Subregional Long-Term
Wastewater Project

IRRIGATION/STORAGE
STREAMS WATER QUALITY
MONITORING STATIONS Figure 1c

3.0 MONITORING PLAN

This section describes the methods and analyses used to determine the irrigation/storage streams water quality. Figure 1 shows locations of sampling stations. Table 1 lists the streams covered in this report, and the dates and constituents sampled.

The component of ammonia that is most toxic to aquatic organisms is the un-ionized fraction. Therefore, ammonia concentrations were converted to un-ionized concentrations using the methods from the San Francisco Bay Regional Water Quality Control Plan (San Francisco Bay Regional Water Quality Control Board 1991).

Table 1.

Irrigation and Storage Streams Sample Collections

Stream/Watershed	Date(s)	Stream Type	Constituents
Atascadero Creek/Russian River	5/6/94, 9/20/94, 5/25/95, 7/20/95, 8/16/95	Sebastopol irrigation	temperature, conductivity, dissolved oxygen (DO), pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total organic carbon (TOC), total dissolved solids (TDS), total suspended solids (TSS), chlorophyll, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). Added in September 1994: dissolved metals, total and dissolved arsenic, mercury, and selenium, total Kjeldahl nitrogen (TKN), hardness, and phaeophytin. Added in May 1995: dissolved organic carbon (DOC).
Green Valley Creek/Russian River	5/6/94, 9/20/94, 5/25/95, 7/20/95, 8/16/95	Sebastopol irrigation	temperature, conductivity, dissolved oxygen (DO), pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total organic carbon (TOC), total dissolved solids (TDS), total suspended solids (TSS), chlorophyll, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). Added in September 1994: dissolved metals, total and dissolved arsenic, mercury, and selenium, total Kjeldahl nitrogen (TKN), hardness, and phaeophytin. Added in May 1995: dissolved organic carbon (DOC).
San Antonio Creek	5/5/94	No longer part of Project	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc).

Table 1.

Irrigation and Storage Streams Sample Collections

Stream/Watershed	Date(s)	Stream Type	Constituents
Walker Creek	5/6/94, 9/20/94	No longer part of Project	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). Added in September 1994: dissolved metals, total and dissolved arsenic, mercury, and selenium, TKN, hardness, and phaeophytin. Salinity measured on 9/20/94
Blucher Creek/Laguna de Santa Rosa	5/4/94	West and South County irrigation	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc).
Crane Creek/Laguna de Santa Rosa	5/4/94	South County irrigation	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc).
Gossage Creek/Laguna de Santa Rosa	5/4/94	South County irrigation	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc).
Adobe Creek/Laguna de Santa Rosa	5/4/94	South County irrigation	temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc).
Unnamed creek in Huntley storage site/Stemple Creek	5/26/95, 8/22/95	West County storage stream	temperature, conductivity, DO, pH, nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophylla, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).
Unnamed creek in Valley Ford storage site/Americano Creek	5/26/95, 8/23/95	West County storage stream	temperature, conductivity, DO, pH, nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophylla, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).
Unnamed creek in Lakeville storage site/Petaluma River	5/23/95, 8/22/95	West County storage stream	temperature, conductivity, DO, pH, nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophylla, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).

Table 1.

Irrigation and Storage Streams Sample Collections

Stream/Watershed	Date(s)	Stream Type	Constituents
Tolay Creek in Sears Point storage site/Tolay Creek	5/24/95, 8/23/95	South County storage stream	temperature, conductivity, DO, pH, nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophylla, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).
Tolay Creek at Highway 121/Tolay Creek	5/4/94, 5/24/95, 8/23/95	South County storage stream	1994: temperature, conductivity, DO, pH, nitrate, ammonia, dissolved orthophosphate, total phosphate, total TOC, TDS, TSS, chlorophylla, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). 1995: temperature, conductivity, DO, pH, nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophyllk, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).

3.1 IRRIGATION STREAMS

Water quality samples were collected from Green Valley, Atascadero, San Antonio, and Walker Creeks in West County. Green Valley Creek and Atascadero Creek samples were collected on 6 May and 20 September 1994 and 25 May, 20 July, and 16 August 1995. Green Valley Creek samples were collected off the Green Valley Road Bridge near Sullivan Road. On 20 September 1994, this location was dry, so samples were collected off the Green Valley Road Bridge near Harrison Grade Road. Atascadero Creek samples were collected off the Graton Road Bridge. When this site was dry on 20 September 1994, samples were collected at Water Trough Road. Samples were collected from San Antonio Creek near San Antonio Road and Highway 101 on 5 May 1994. Attempts were made to sample San Antonio Creek in September 1994, but accessible locations were dry. Walker Creek was sampled at the Marshall Petaluma Bridge on 6 May 1994. This location was dry in September, so Walker Creek was sampled at Highway 1 Bridge on 20 September 1994.

Water quality samples were collected from Adobe Creek at Adobe Historic Park, Blucher Creek at Old Gravenstein Road, Crane Creek at Petaluma Hill Road and Gossage Creek at Peterson Road on 4 May 1994 in South County. Attempts were made to also sample Copeland Creek, Lichau Creek, Lynch Creek, and Willow Brook during May 1994, but accessible locations were dry. Tolay Creek was sampled as part of the storage stream study.

When possible, samples were collected by wading into the water and dipping laboratory prepared sample bottles below the surface at three different locations. Many locations were not accessible in this manner so samples were collected from a bridge using a cleaned, acid rinsed bucket. Water was poured from the bucket directly into the sample bottles. At all times, care was taken not to entrain sediment into the samples. The bucket was rinsed with site water between collections. Field measurements of temperature, conductivity, dissolved oxygen (DO), and pH were made at the time of sample collection. Salinity was measured in place of conductivity in Walker Creek at Highway 1 because of the tidal influence at that location. The following parameters were measured by a certified laboratory (NET, Santa Rosa): nitrate, ammonia, dissolved orthophosphate, total phosphate, total organic carbon (TOC), total dissolved solids (TDS), total suspended solids (TSS), chlorophyll *a*, total metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). Other constituents were added in September 1994 (dissolved metals, total and dissolved arsenic, mercury, and selenium, total Kjeldahl nitrogen (TKN), hardness, and phaeophytin) and 1995 (dissolved organic carbon (DOC)).

3.2 STORAGE STREAMS

Water quality samples were collected on Tolay Creek at Highway 121 on 4 May 1994 as part of the initial South County irrigation stream monitoring program described above. Quarterly monitoring of tributary streams that run through potential storage sites was initiated in 1995. Due to delays in obtaining permission to access the storage sites, this monitoring was not begun until May 1995. From 23 May to 26 May 1995, water quality collections were made in the primary unnamed tributaries running through the Valley Ford storage site (Americano watershed), Huntley storage site (Stemple watershed), and Lakeville storage site. These samples were collected near the proposed dam sites. Samples were collected in Tolay Creek at Highway 121 on May 24 1995, and in Tolay Creek at the upper end of the Sears Point storage site on 25 May 1995. These sites were revisited on 23-24 August 1995. All main tributary streams and Tolay Creek were dry except for isolated puddles. Samples were not taken since the water quality of isolated puddles is not representative of the water quality during flow conditions.

Water quality measurements on Tolay Creek were as described above for the irrigation streams. For the May 1995 samples, field measurements of temperature, conductivity, dissolved oxygen, and pH were made at the time of sample collection. The following parameters were measured by a certified laboratory (NET, Santa Rosa): nitrate, ammonia, TKN, dissolved orthophosphate, total phosphate, TOC, DOC, TDS, TSS, chlorophyll *a*, phaeophytin, hardness, and total and dissolved metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, selenium, silver, and zinc).

4.0 MONITORING RESULTS

This section describes the results of the irrigation stream and storage stream water quality collections. Complete data are given in the Appendix.

4.1 IRRIGATION STREAMS

Water quality in irrigation streams in for the period of collection is described in this section. Samples were only collected in May through September which is the dry season. Therefore, the water quality described below is not indicative of year-round water quality.

4.1.1 Nutrients

The concentrations of nutrients, chlorophyll *a*, dissolved oxygen, and conductivity are shown in Table 2 for Atascadero Creek, Table 3 for Green Valley Creek, Table 4 for San Antonio and Walker Creeks , and Table 5 for other irrigation streams.

4.1.2 Conductivity

Conductivity in Atascadero Creek was fairly constant, ranging from 221 to 388 $\mu\text{mhos}/\text{cm}^2$ with an average of 284 $\mu\text{mhos}/\text{cm}^2$. In Green Valley Creek, conductivity was more variable, ranging from 189 to 400 $\mu\text{mhos}/\text{cm}^2$ with an average of 284 $\mu\text{mhos}/\text{cm}^2$. In the other irrigation streams, conductivity ranged from 147 to 710 $\mu\text{mhos}/\text{cm}^2$ in Walker Creek and San Antonio Creek, respectively. Salinity measurements were taken at the downstream station for Walker Creek sampling (at Highway 1) since it is tidally influenced. The 20 September 1994 salinity reading was 10.7 ppt.

4.1.3 Dissolved Oxygen

Dissolved oxygen in Atascadero Creek averaged 5.7 mg/L and was usually less than 6.0 mg/L. Although salmonids are found in Atascadero Creek, the spawning grounds are further upstream and the lower part of the stream represented by these samples serves as a migration corridor. Therefore, the Water Quality Control Plan for the North Coast Region (Basin Plan) warm water objective for dissolved oxygen (5 mg/L) applies to Atascadero Creek. The dissolved oxygen did not fall below the Basin Plan objective.

The concentration of dissolved oxygen in Green Valley Creek was less than the Basin Plan objective for warm waters (5.0 mg/L) on two occasions (July and August 1995). Dissolved oxygen was greater than 8 mg/L in the remaining samples and averaged 7.0 mg/L. Dissolved oxygen in other irrigation streams ranged from 5.5 to 10.5 mg/L. Dissolved oxygen concentrations in Blucher, Gossage, and Crane Creeks (warm water, non-salmonid streams) did not fall below the Basin Plan objective for warm waters. Dissolved oxygen concentrations in San Antonio and Walker Creeks did not fall below the Basin Plan objectives for spawning streams or spawning streams during spawning and egg incubation periods. The dissolved oxygen in Adobe Creek, a salmonid spawning creek, was measured once in May 1994. At this time dissolved oxygen was 8.7 mg/L which is above the Basin Plan objective for spawning streams but below the Basin Plan for spawning streams during critical spawning and egg incubation periods. It is

unlikely, though not impossible, that egg incubation was still occurring during this time and the dissolved oxygen in Adobe Creek did not meet the Basin Plan objective.

4.1.4 Nitrate

The concentration of nitrate in Atascadero Creek ranged from below detection (detection limit=0.03 mg-N/L) to 0.17 mg-N/L with an average of 0.11 mg-N/L. The concentration of nitrate in Green Valley Creek ranged from below detection to 0.27 mg-N/L with an average of 0.09 mg-N/L. The concentration of nitrate in other irrigation streams ranged from below detection to 1.40 mg-N/L in Crane Creek in May 1994.

4.1.5 Ammonia

The concentration of total ammonia in Atascadero Creek ranged from below detection (detection limit=0.05 mg-N/L for total ammonia) to 0.12 mg-N/L. Green Valley Creek ammonia concentrations ranged from below detection to 0.16 mg-N/L. The concentration of total ammonia was below detection in all other irrigation stream samples.

The concentration of un-ionized ammonia in Atascadero Creek ranged from below detection to 0.513 µg-N/L. The concentration of ammonia in Green Valley Creek ranged from below detection to 16.649 µg-N/L. Un-ionized ammonia was calculated using guidelines developed by RWQCB (San Francisco Bay Regional Water Quality Control Board 1991). The un-ionized form of ammonia is toxic to aquatic life. These concentrations of un-ionized ammonia in Atascadero and Green Valley Creeks did not exceed the EPA chronic and acute criteria for ammonia (sensitive species present)(USEPA 1986).

4.1.6 TKN (Total Kjeldahl Nitrogen)

The concentration of TKN in Atascadero Creek ranged from 0.26 to 12.00 mg/L with an average of 3.27 mg/L. The concentration of TKN in Green Valley Creek ranged from 0.10 to 1.10 mg/L with an average of 0.54 mg/L. TKN in Walker Creek was 0.20 mg /L.

4.1.7 Dissolved Orthophosphate

The concentration of dissolved orthophosphate in Atascadero Creek ranged from 0.05 to 0.21 mg-P/L with an average of 0.15 mg-P/L. The concentration of dissolved orthophosphate in Green Valley Creek ranged from 0.04 to 0.18 mg-P/L with an average of 0.09 mg-P/L. The concentration of dissolved orthophosphate in other irrigation streams ranged from 0.04 to 0.32 mg-P/L and averaged 0.16 mg-P/L.

4.1.8 Chlorophyll *a*

Chlorophyll *a* was below the level of detection in all samples except Atascadero Creek on 20 September 1994. In this sample chlorophyll *a* was 1.4 mg/L.

Table 2.

Water Quality in Atascadero Creek

Station	Date	Conductivity (μ mhos/cm ²)	DO (mg/L)	Nitrate (mg-N/L)	Total Ammonia (mg-N/L)	Un-ionized Ammonia (μ g-N/L)	TKN (mg/L)	Ortho- phosphate (mg-P/L)	Chloro- phyll <i>a</i> (mg/L)
Atascadero Creek	6-May-94	279	5.0	0.11	0.05 ^a	ND ^a	NA ^b	0.13	0.01 ^a
Atascadero Creek	20-Sep-94	388	5.6	0.03 ^a	0.12	0.513	12.00	0.05	1.40
Atascadero Creek	25-May- 95	269	5.5	0.17	0.09	0.071	0.52	0.17	0.01 ^a
Atascadero Creek	20-Jul-95	265	6.9	0.16	0.05 ^a	ND ^a	0.30	0.17	0.01 ^a
Atascadero Creek	16-Aug- 95	221	5.7	0.07	0.05 ^a	ND ^a	0.26	0.21	0.01 ^a
Averages		284	5.7	0.11	0.06	-	3.27	0.15	0.28

^a The concentration was below the reporting limit. The value shown is the reporting limit. Half the reporting limit was used for calculating averages.

^b Not available

Table 3.

Water Quality in Green Valley Creek

Station	Date	Conductivity (μ mhos/cm ²)	DO (mg/L)	Nitrate (mg-N/L)	Total Ammonia (mg-N/L)	Un- ionized ammonia (μ g-N/L)	TKN (mg/L)	Ortho- phosphate (mg-P/L)	Chloro- phyll <i>a</i> (mg/L)
Green Valley Creek	6-May- 94	232	8.8	0.27	0.05 ^a	ND ^a	NA ^b	0.07	0.01 ^a
Green Valley Creek	20-Sep- 94	232	9.3	0.03 ^a	0.05 ^a	ND ^a	0.10	0.04	0.01 ^a
Green Valley Creek	25- May-95	189	9.4	0.09	0.05 ^a	ND ^a	0.11	0.04	0.01 ^a
Green Valley Creek	20-Jul- 95	349	3.7	0.04	0.07	0.509	0.85	0.18	0.01 ^a
Green Valley Creek	16- Aug-95	400	4.0	0.03 ^a	0.16	16.649	1.10	0.14	0.01 ^a
Averages		280	7.0	0.09	0.06	-	0.54	0.09	0.01

^a The concentration was below the reporting limit. The value shown is the reporting limit. Half the reporting limit was used for calculating averages.

^b Not available

Table 4.

Water Quality in San Antonio Creek and Walker Creek

Station	Date	Conductivity (µmhos/cm ²)	Salinity (ppt)	DO (mg/L)	Nitrate (mg-N/L)	Total Ammonia (mg-N/L)	Un- ionized ammonia (µg-N/L)	TKN (mg/L)	Ortho- phosphate (mg-P/L)	Chloro- phyll <i>a</i> (mg/L)
San Antonio Creek at San Antonio Road	5-May- 94	710	-	10.5	0.14	0.05 ^a	ND ^a	NA ^b	0.26	0.01 ^a
Walker Creek at Marshall Petaluma Bridge	6-May- 94	147	-	10.1	0.30	0.05 ^a	ND ^a	NA ^b	0.04	0.01 ^a
Walker Creek at Highway 1	20-Sep- 94	NA ^b	10.7	8.6	0.03 ^a	0.05 ^a	ND ^a	0.20	0.07	0.01 ^a

^a The concentration was below the reporting limit (which is shown). Half the reporting limit was used for calculating averages.
^b Not available

Table 5.

Water Quality in South County Irrigation Streams

Station	Date	Conductivity (µmhos/cm ²)	DO (mg/L)	Nitrate (mg-N/L)	Total Ammonia (mg-N/L)	Un- ionized ammonia (µg-N/L)	Ortho- phosphate (mg-P/L)	Chloro- phyll <i>a</i> (mg/L)
Blucher Creek	4-May-94	332	6.3	0.29	0.05 ^a	ND ^a	0.32	0.01 ^a
Crane Creek	4-May-94	345	7.4	1.40	0.05 ^a	ND ^a	0.08	0.01 ^a
Gossage Creek	4-May-94	520	5.5	0.11	0.05 ^a	ND ^a	0.12	0.01 ^a
Adobe Creek	4-May-94	335	8.6	0.03 ^a	0.05 ^a	ND ^a	0.24	0.01 ^a

^a The concentration was below the reporting limit. The value shown is the reporting limit.

4.1.9 Metals

Metals found in detectable concentrations are shown in Table 6 for Atascadero Creek, Table 7 for Green Valley Creek, and Table 8 for San Antonio, Walker, and Gossage Creeks. The average

concentrations of these metals (using half the detection limit for concentrations below detection) are shown for Atascadero and Green Valley Creeks. Since the toxicity of many metals is dependent on hardness, the hardness in each sample is also shown. Metals analyzed but not included in these tables were never in detectable concentrations (Atascadero: Ag, As, Cd, Cu, Hg, Pb, Se; Green Valley: Ag, Cd, Cu, Hg, Se; San Antonio, Walker, and Gossage: Ag, As, Cd, Cr, Cu, Hg, Pb, Se). Complete tables are included in the Appendix. Only the five irrigation streams shown in Tables 6-8 had metals in detectable concentrations. The dissolved metals concentrations were compared to the EPA freshwater criterion continuous concentration (CCC)(a measure of chronic toxicity) for each parameter which is based on dissolved metals concentrations (USEPA 1995). For the hardness based objectives, the CCCs were calculated using the hardness of the sample in which the metal occurred. If the hardness was unknown, the metals concentrations in the sample were compared to the CCC for a hardness of 100 mg/L. None of the detectable dissolved metal concentrations exceeded the CCC with the possible exception of dissolved zinc in Atascadero Creek in May 1995. However, the concentration of dissolved zinc in this sample is questionable since it greatly exceeds the total zinc concentration. By definition, dissolved plus particulate contributions equal total concentration. The analytical laboratory has re-analyzed this sample with the same results, so the reason for this discrepancy is unknown (although the lab has suggested that a contaminated filter may be responsible for the discrepancy). While other zinc samples also reflect dissolved values that are higher than total values, these values are nearly equivalent and probably within the range of analytical error.

Table 6.

The Concentrations of Detectable Metals in Atascadero Creek

Station	Date	Total chromium (mg/L)	Total nickel (mg/L)	Dissolved nickel (mg/L)	Total zinc (mg/L)	Dissolved zinc (mg/L)	Hardness (mg/L)
Atascadero Creek	20-Sep-94		0.011	0.006	0.03	0.05	150
Atascadero Creek	25-May-95	0.087	0.097	0.006	0.02	0.10	100
Atascadero Creek	16-Aug-95	-	0.005	-	-	-	70
Average ^a		0.024	0.029	0.004	0.03	0.05	105

^a Averages calculated from all data with half the detection limit used for concentrations below detection.

Table 7

The Concentrations of Detectable Metals in Green Valley Creek

Station	Date	Total arsenic (mg/L)	Total chromium (mg/L)	Total lead (mg/L)	Total nickel (mg/L)	Dissolved nickel (mg/L)	Total zinc (mg/L)	Dissolved zinc (mg/L)	Hardness (mg/L)
Green Valley Creek	20-Sep-94	-	-	-	-	-	-	0.08	110
Green Valley Creek	25-May-95	-	0.007	-	0.005	-	0.10	0.01	92
Green Valley Creek	20-Jul-95	-	-	0.005	0.012	0.011	-	-	150
Green Valley Creek	16-Aug-95	0.18	-	0.006	0.013	0.009	-	-	150
Average ^a		0.06	0.004	0.003	0.008	0.006	0.04	0.03	126

^a Averages calculated from all data with half the detection limit used for concentrations below detection.

Table 8.

The Concentrations of Detectable Metals
in San Antonio, Walker, and Gossage Creeks.

Station	Date	Total nickel (mg/L)	Dissolved nickel (mg/L)	Dissolved zinc (mg/L)	Hardness (mg/L)
San Antonio Creek	5-May-94	0.007	NA ^a	NA	NA
Walker Creek	20-Sep-94	0.006	0.005	0.01	NA
Gossage Creek	4-May-94	0.006	NA	NA	NA

^a NA = not available

4.2 STORAGE STREAMS

This section describes water quality in proposed storage site streams. Samples were collected at these locations to provide a basis for evaluating potential Project impacts on these streams immediately below dam sites (*Water Quality Impact Analysis* Technical Report MSC 1996). Samples were collected only in May and therefore not representative of year-round water quality.

4.2.1 Nutrients

The concentrations of nutrients, chlorophyll *a*, dissolved oxygen, and conductivity in streams in West County and South County storage sites are shown in Table 9.

4.2.2 Conductivity

Conductivity in storage site streams ranged from 320 $\mu\text{mhos}/\text{cm}^2$ in the Huntley stream to 990 $\mu\text{mhos}/\text{cm}^2$ in the Lakeville stream.

4.2.3 Dissolved Oxygen

The concentration of dissolved oxygen in storage site streams ranged from 7.4 mg/L in Tolay Creek at Highway 121 on 4 May 1994 to 16.9 mg/L in the Lakeville stream on 23 May 1995. The high dissolved oxygen concentrations recorded in the Lakeville stream and in Valley Ford storage site stream on 26 May 1995 (13.6 mg/L) are supersaturation and likely due to high planktonic or attached algae productivity.

4.2.4 Nitrate

The concentration of nitrate was below detection in all storage site streams except the Valley Ford stream where it was 0.43 mgN/L.

4.2.5 Ammonia

The total ammonia concentration in storage streams ranged from 0.06 mg-N/L in Tolay Creek at Sears Point to 0.40 mg-N/L in the Valley Ford stream.

The concentration of un-ionized ammonia in storage streams ranged from 0.47 $\mu\text{g-N/L}$ in the Huntley stream to 177 $\mu\text{g-N/L}$ in the Valley Ford stream. The concentration of un-ionized ammonia in the Valley Ford stream (177 $\mu\text{g-N/L}$) exceeded the un-ionized ammonia EPA criteria for the protection of freshwater organisms. Both the EPA criteria for salmonids and sensitive species present (28.8 $\mu\text{g-N/L}$), and for salmonids and sensitive species not present (41 $\mu\text{g-N/L}$), were exceeded (USEPA 1986).

4.2.6 TKN

The concentration of TKN in storage streams ranged from 0.51 mg/L in Tolay Creek in the Sears Point storage site to 1.9 mg/L in the Valley Ford stream.

4.2.7 Orthophosphate

The concentration of orthophosphate in storage streams ranged from 0.03 mg-P/L in the Huntley stream to 0.41 mg-P/L in Tolay Creek at Highway 121 (May 1995).

4.2.8 Chlorophyll *a*

The concentration of chlorophyll *a* in all storage site streams was below detection. However, the elevated dissolved oxygen concentrations at some locations indicates the presence of photosynthetic activity.

Table 9.

Water Quality in Storage Site Streams

Station	Date	Conductivity (µmhos/cm ²)	DO (mg/L)	Nitrate (mg-N/L)	Un-ionized ammonia (µg-N/L)	TKN (mg/L)	Ortho- phosphate (mg-P/L)	Chlorophyll <i>a</i> (mg/L)
Huntley Storage Site	26-May-95	320	9.5	0.15 ^a	0.473	0.81	0.03	0.01 ^a
Lakeville Storage Site	23-May-95	990	16.9	0.03 ^a	17.398	0.64	0.07	0.01 ^a
Tolay Creek at Highway 121	4-May-94	900	7.4	0.03 ^a	1.216	NA ^b	0.11	0.01 ^a
Tolay Creek at Highway 121	24-May-95	800	10.6	0.03 ^a	11.733	0.56	0.41	0.01 ^a
Tolay Creek in Sears Point Storage Site.	25-May-95	570	9.9	0.03 ^a	0.719	0.51	0.36	0.01 ^a
Valley Ford Storage Site	26-May-95	354	13.6	0.43	176.621	1.90	0.17	0.01

^a The concentration was below the reporting limit. The value shown is the reporting limit.

^b Not available

4.2.9 Metals

Metals found in detectable concentrations are shown in Table 10 for streams in storage sites. Metals analyzed but not included in these tables were never in detectable concentrations. They are included in the Appendix. Since the toxicity of many metals is related to hardness, the hardness in each sample is also shown in Table 10. The dissolved metals concentrations were compared to the EPA CCC for each metal at the hardness of each sample. When the hardness was not known, the metal concentration was compared to the CCC at a hardness of 100. None of the detectable dissolved metal concentrations exceeded the CCC (USEPA 1995).

Table 10.

Detectable Metals in Storage Site Streams

Station	Date	Total arsenic (mg/L)	Dissolved arsenic (mg/L)	Total chromium (mg/L)	Total nickel (mg/L)	Dissolved nickel (mg/L)	Total zinc (mg/L)	Dissolved zinc (mg/L)	Hardness (mg/L)
Huntley storage site	26-May-95	-	-	0.005	-	-	-	-	130
Lakeville storage site	23-May-95	0.006	0.006	-	0.009	0.008	-	-	380
Tolay Creek at Highway 121	4-May-94	-	-	-	0.015	-	-	-	NA ^a
Tolay Creek at Highway 121	24-May-95	0.010	0.010	-	0.006	0.007	0.04	-	290
Tolay Creek in Sears Point storage site.	25-May-95	0.007	0.007	-	-	-	-	0.02	240
Valley Ford storage site	26-May-95	-	-	0.005	-	-	-	-	130

^a NA = not available

5.0 REFERENCES

- Merritt Smith Consulting 1996. *Environmental Conditions in West County Waterways* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.
- Merritt Smith Consulting 1996. *Water Quality Impact Analysis* Technical Report. Santa Rosa Subregional Long-Term Wastewater Project.
- San Francisco Bay Regional Water Quality Control Board 1991. Instructions for calculating the unionized fraction of ammonia from total ammonia concentrations. Appendix B of the Water Quality Control Plan. San Francisco Bay Basin Region (2).
- U.S. Environmental Protection Agency 1986. Quality Criteria for Water 1986. Update #1.
- U.S. Environmental Protection Agency 1995. 40 CFR Part 131. Interim Final Rule: Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance-Revision of Metals Criteria. Vol. 60, No. 086, Part IV, 60 FR 22229.

6.0 APPENDIX

Appendix
Water Quality in Irrigation and Storage Streams

Station	Date	Temp deg C	Conductivity µmhos/cm2	Salinity ppt	DO mg/L	pH	TDS mg/L	TSS mg/L	Nitrate mg-N/L	Nitrite mg-N/L	total NH3 mg-N/L	Un-ion Am ug-N/L
Irrigation Streams												
Atascadero Creek Graton	6-May-94	13.0	279		5.0	5.8	260	4.0	0.11		0.05 *	
Atascadero Creek Water Trough	20-Sep-94	16.1	388		5.6	7.2	350	120.0	0.03 *		0.12	0.5
Atascadero Creek Graton	25-May-95	15.0	269		5.5	6.5	260	4.0 *	0.17		0.09	0.0
Atascadero Creek Water Trough	20-Jul-95	17.0	265		6.9	7.5	220	4.0 *	0.16		0.05 *	
Atascadero Creek Water Trough	16-Aug-95	19.5	221		5.7	6.7	180	3.2	0.07	0.03 *	0.05 *	
Green Valley Creek lower	6-May-94	13.0	232		8.8	6.5	200	4.0 *	0.27		0.05 *	
Green Valley Creek upper	20-Sep-94	17.2	232		9.3	7.6	180	4.0 *	0.03 *		0.05 *	
Green Valley Creek lower	20-Jul-95	17.0	349		3.7	7.4	290	8.0	0.04		0.07	0.5
Green Valley Creek lower	16-Aug-95	17.2	400		4.0	8.6	320	56.0	0.03 *	0.03 *	0.16	16.6
Green Valley Creek lower	25-May-95	15.5	189		9.4	6.4	180	4.0 *	0.09		0.05 *	
Adobe Creek Adobe Hist. Park	4-May-94	17.9	335		8.7	7.5	260	4.0 *	0.03 *		0.05 *	
Blucher Creek Old Gravenstein Rd	4-May-94	15.0	332		6.3		310	4.4	0.29		0.05 *	
Crane Creek Petaluma Hill Rd	4-May-94	17.0	345		7.4	7.5	260	4.0 *	1.40		0.05 *	
Gossage Creek Peterson Rd	4-May-94	15.2	520		5.5	6.7	380	4.0 *	0.11		0.05 *	
San Antonio Creek San Antonio Rd	5-May-94	17.0	710		10.5	7.4	510	4.4	0.14		0.05 *	
Walker Creek Marshall Petaluma Br	6-May-94	12.1	147		10.1	6.5	130	4.8	0.30		0.05 *	
Walker Creek Hwy 1	20-Sep-94	19.8		10.7	8.6	7.8	11800	4.0 *	0.03 *		0.05 *	
Storage Streams												
Lakeville Storage Site	23-May-95	25.5	990		16.9	8.8	600	11.0	0.03 *		0.07	17.3
Tolay Creek Hwy 121	4-May-94	17.9	900		7.4	7.4	610	25.0	0.03 *		0.16	1.2
Tolay Creek Hwy 121	24-May-95	25.0	800		10.6	8.6	480	4.4	0.03 *		0.07	11.7
Tolay Creek/Sears Pt.	25-May-95	17.7	570		9.9	7.6	450	5.0	0.03 *		0.06	0.7
Huntley Storage Site	26-May-95	16.0	320		9.5	7.4	240	4.0 *	0.15 *		0.07	0.4
Valley Ford Storage Site	26-May-95	17.9	354		13.6	9.4	270	8.0	0.43		0.40	176.6
* Indicates below reporting limit.												
Number shown is reporting limit.												

Appendix
Water Quality in Irrigation and Storage Streams

Station	TKN mg/L	ortho P mg-P/L	total P mg-P/L	TOC mg/L	DOC mg/L	Chlor a mg/L	Phaeophytin mg/L	Hardness (CaCO3) mg/L	total As mg/L	diss As mg/L
Irrigation Streams										
Atascadero Creek Graton		0.13	0.27	8.7		0.01 *				
Atascadero Creek Water Trough	12.00	0.05	1.50	23.0		1.40	0.50	150		
Atascadero Creek Graton	0.52	0.17	0.23	6.0	6.0	0.01 *	0.01 *	100	0.005 *	0.005 *
Atascadero Creek Water Trough	0.30	0.17		4.1	4.3	0.01 *	0.01 *	100	0.005 *	0.005 *
Atascadero Creek Water Trough	0.26	0.21		6.0	5.0	0.01 *	0.01 *	70	0.005 *	0.005 *
Green Valley Creek lower		0.07	0.13	2.0		0.01 *				
Green Valley Creek upper	0.10	0.04	0.07	1.7		0.01 *	0.01 *	110		
Green Valley Creek lower	0.85	0.18		12.0	12.0	0.01 *	0.01 *	150	0.005 *	0.005 *
Green Valley Creek lower	1.10	0.14		17.0	15.0	0.01 *	0.01 *	150	0.18	0.005 *
Green Valley Creek lower	0.11	0.04	0.04	1.0	1.0	0.01 *	0.01 *	92	0.005 *	0.005 *
Adobe Creek Adobe Hist. Park		0.24	0.05	2.2		0.01 *				
Blucher Creek Old Gravenstein Rd		0.32	0.46	10.0		0.01 *				
Crane Creek Petaluma Hill Rd		0.08	0.10	1.5		0.01 *				
Gossage Creek Peterson Rd		0.12	0.11	6.6		0.01 *				
San Antonio Creek San Antonio Rd		0.26	0.29	6.3		0.01 *				
Walker Creek Marshall Petaluma Br		0.04	0.11	5.5		0.01 *				
Walker Creek Hwy 1	0.20	0.07	0.10	3.1		0.01 *	0.01 *	1800		
Storage Streams										
Lakeville Storage Site	0.64	0.07	0.07	6.0	4.0	0.01 *	0.01 *	380	0.006	0.006
Tolay Creek Hwy 121		0.11	0.21	10.0		0.01 *				
Tolay Creek Hwy 121	0.56	0.41	0.41	4.0	4.0	0.01 *	0.01 *	290	0.01	0.010
Tolay Creek/Sears Pt.	0.51	0.36	0.39	4.0	4.0	0.01 *	0.01 *	240	0.007	0.007
Huntley Storage Site	0.81	0.03	0.03	7.0	7.0	0.01 *	0.01 *	130	0.005 *	0.005 *
Valley Ford Storage Site	1.90	0.17	0.23	11.0	11.0	0.01	0.01 *	130	0.005 *	0.005 *
* Indicates below reporting limit.										
Number shown is reporting limit.										

Appendix
Water Quality in Irrigation and Storage Streams

Station	total Cd mg/L	diss Cd mg/L	Ca mg/L	total Cr mg/L	diss Cr mg/L	total Cu mg/L	diss Cu mg/L	total Pb mg/L	diss Pb mg/L	total Mg mg/L
Irrigation Streams										
Atascadero Creek Graton										
Atascadero Creek Water Trough	0.0005 *	0.0005 *	30	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	18
Atascadero Creek Graton	0.0005 *	0.0005 *	20	0.087	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	13
Atascadero Creek Water Trough	0.0005 *	0.0005 *	21	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	12
Atascadero Creek Water Trough	0.0005 *	0.0005 *	14	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	7.9
Green Valley Creek lower										
Green Valley Creek upper	0.0005 *	0.0005 *	15	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	18
Green Valley Creek lower	0.0005 *	0.0005 *	30	0.005 *	0.005 *	0.005 *	0.005 *	0.005	0.002 *	18
Green Valley Creek lower	0.0005 *	0.0005 *	30	0.005 *	0.005 *	0.005 *	0.005 *	0.008	0.002 *	18
Green Valley Creek lower	0.0005 *	0.0005 *	12	0.007	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	15
Adobe Creek Adobe Hist. Park	0.0005 *			0.005 *		0.005 *		0.002 *		
Blucher Creek Old Gravenstein Rd	0.0005 *			0.005 *		0.005 *		0.002 *		
Crane Creek Petaluma Hill Rd	0.0005 *			0.005 *		0.005 *		0.002 *		
Gossage Creek Peterson Rd	0.0005 *			0.005 *		0.005 *		0.002 *		
San Antonio Creek San Antonio Rd	0.0005 *			0.005 *		0.005 *		0.002 *		
Walker Creek Marshall Petaluma Br										
Walker Creek Hwy 1	0.0005 *	0.0005 *	120	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	370
Storage Streams										
Lakeville Storage Site	0.0005 *	0.0005 *	59	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	56
Tolay Creek Hwy 121	0.0005 *			0.005 *		0.005 *		0.002 *		
Tolay Creek Hwy 121	0.0005 *	0.0005 *	46	0.005 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	42
Tolay Creek/Sears Pt.	0.0005 *	0.0005 *	47	0.010 *	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	29
Huntley Storage Site	0.0005 *	0.0005 *	26	0.005	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	16
Valley Ford Storage Site	0.0005 *	0.0005 *	24	0.005	0.005 *	0.005 *	0.005 *	0.002 *	0.002 *	16
* Indicates below reporting limit.										
Number shown is reporting limit.										

Appendix
Water Quality in Irrigation and Storage Streams

Station	total Hg mg/L	diss Hg mg/L	total Ni mg/L	diss Ni mg/L	total Se mg/L	diss Se mg/L	total Ag mg/L	diss Ag mg/L	total Zn mg/L	diss Zn mg/L
Irrigation Streams										
Atascadero Creek Graton										
Atascadero Creek Water Trough			0.011	0.006			0.001 *	0.001 *	0.03	0.05
Atascadero Creek Graton	0.0002 *	0.0002 *	0.097	0.006	0.005 *	0.005 *	0.001 *	0.001 *	0.02	0.10
Atascadero Creek Water Trough	0.0002 *	0.0002 *	0.005 *	0.005 *			0.001 *	0.001 *	0.05 *	0.01 *
Atascadero Creek Water Trough	0.0002 *	0.0002 *	0.005	0.005 *			0.001 *	0.001 *	0.05 *	0.05 *
Green Valley Creek lower										
Green Valley Creek upper			0.005 *	0.005 *			0.001 *	0.001 *	0.01 *	0.08
Green Valley Creek lower	0.0002 *	0.0002 *	0.012	0.011			0.001 *	0.001 *	0.05 *	0.01 *
Green Valley Creek lower	0.0002 *	0.0002 *	0.013	0.009			0.001 *	0.001 *	0.05 *	0.05 *
Green Valley Creek lower	0.0002 *	0.0002 *	0.005	0.005 *	0.005 *	0.005 *	0.001 *	0.001 *	0.10	0.01
Adobe Creek Adobe Hist. Park			0.005 *				0.001 *		0.01 *	
Blucher Creek Old Gravenstein Rd			0.005 *				0.001 *		0.01 *	
Crane Creek Petaluma Hill Rd			0.005 *				0.001 *		0.01 *	
Gossage Creek Peterson Rd			0.006				0.001 *		0.01 *	
San Antonio Creek San Antonio Rd			0.007				0.001 *		0.01 *	
Walker Creek Marshall Petaluma Br										
Walker Creek Hwy 1			0.006	0.005			0.001 *	0.001 *	0.01 *	0.01
Storage Streams										
Lakeville Storage Site	0.0002 *	0.0002 *	0.009	0.008	0.005 *	0.005 *	0.001 *	0.001 *	0.01 *	0.01 *
Tolay Creek Hwy 121			0.015				0.001 *		0.01 *	
Tolay Creek Hwy 121	0.0002 *	0.0002 *	0.006	0.007	0.005 *	0.005 *	0.001 *	0.001 *	0.04	0.01 *
Tolay Creek/Sears Pt.	0.0002 *	0.0002 *	0.005 *	0.005 *	0.005 *	0.005 *	0.001 *	0.001 *	0.05 *	0.02
Huntley Storage Site	0.0002 *	0.0002 *	0.005 *	0.005 *	0.005 *	0.005 *	0.001 *	0.001 *	0.01 *	0.01 *
Valley Ford Storage Site	0.0002 *	0.0002 *	0.005 *	0.005 *	0.005 *	0.005 *	0.001 *	0.001 *	0.01 *	0.01 *
* Indicates below reporting limit.										
Number shown is reporting limit.										