Santa Rosa Subregional Long-Term Wastewater Project

RECLAIMED WATER QUALITY UPDATE

SANTA ROSA SUBREGIONAL

LONG-TERM WASTEWATER PROJECT

Prepared for

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

June 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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AUTHORS

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1.0 PURPOSE

The analysis of potential impacts of proposed long-term reclaimed water management alternatives is based upon a draft of the *Reclaimed Water Quality* Technical Report (MSC 1996), which included data gathered from 1988 through January 1995. The process of analyzing potential impacts extended into 1996, by which time reclaimed water quality may have changed. Therefore, this *Reclaimed Water Quality Update* Technical Report was prepared to identify how, if at all, reclaimed water quality had changed such that impact analyses were invalid. Thus, this technical report provides a comparison of reclaimed water quality data collected from 1988 through January 1995 to data collected from February 1995 until 1996 to identify recent data that may need to be addressed in the analysis of impacts.

2.0 SOURCES OF DATA

2.1 RECLAIMED WATER CHEMICAL ANALYSES

Data collected by the City of Santa Rosa and reported to the Regional Water Quality Control Board are evaluated in this report. Monthly total metals data for February through June, and quarterly total and dissolved metals data for the third and fourth quarters of 1995 and the first quarter of 1996 are given in Appendix 1. Appendix 2 contains quarterly data on organic compounds from the second quarter of 1995 through the first quarter of 1996. Monthly data on effluent routine constituents (nutrients, BOD, conductivity, etc.) from February 1995 through February 1996 are given in Appendix 3.

SECOND CYANIDE SPECIAL STUDY

A special collection and analysis for cyanide in fresh reclaimed water (sampled at the treatment plant) and storage ponds was conducted and the results described in the *Reclaimed Water Quality* Technical Report (MSC 1996). This special study was conducted because previous data collected by the City of Santa Rosa did not provide an estimate of potential effects of storage and complex formation on the concentration of total cyanide. The measurement of total cyanide, which is routinely measured in reclaimed water samples, is subject to interference from nitrate and nitrite. This interference results in total cyanide concentrations that are higher than that actual concentration. The measurement of cyanide that is amenable to chlorination is also subject to this interference. For the first special cyanide study, the analytical laboratory was requested to follow Standard Methods analytical procedures, which include a step to remove nitrate interference, but instead used the EPA methodology without this step. Therefore, the results of the special study total cyanide and amenable to chlorination cyanide were suspect. Therefore, a second cyanide special study was conducted in which the appropriate analytical methods were used. The results of this special study are presented in this technical report.

For the second cyanide special study samples were collected on four dates between 1 April and 14 May 1996. 24-hour composite influent and effluent samples were collected as well as spatially composited samples from Delta and Meadowlane Storage Ponds. Samples were analyzed for total cyanide, cyanide amenable to chlorination, and weak dissociable cyanide. Standard Methods analytical procedures, which remove nitrite and nitrate interference, were followed (Methods 4500-CN^-C, 4500-CN^-, G and 4500-CNI.

In addition, the methodology used for the routine cyanide samples in reclaimed water collected by the City of Santa Rosa was reviewed to determine which samples were subject to nitrate interference. The results of the routine cyanide samples known to be free of nitrate interference are presented here.

2.3 RECLAIMED WATER TOXICITY TESTING

Quarterly reclaimed water toxicity testing (3 species, short term sensitive life stage tests) on samples from Meadowlane D Pond and Delta Pond began in December 1995, and the results of the first three sets (Pacific Eco-Risk Labs 1995,1996a, 1996b) are presented below. Prior to the establishment of this regular testing program, three preliminary series of toxicity tests using the same methods were conducted in 1992, 1994, and 1995. These earlier tests were made on fresh plant effluent and effluent after storage in ponds; results are also presented below.

3.0 RESULTS

3.1 RECLAIMED WATER QUALITY

Reclaimed water quality data for February 1995 through February 1996 are presented below. No new analyses are available for a few constituents which have been found previously in detectable concentrations in reclaimed water. These are listed in Table 1.

Table 1.

Reclaimed Water Constituents Not Analyzed in 1995-1996

Metals	Organics	Biological
Aluminum	Adicarb sulfone	Heterotrophic plate count
Dissolved Aluminum	Aldicarb sulfoxide	
Asbestos	DCPA (Dacthal)	
Barium	Radioactivity	
Fluoride		
Dissolved Potassium		

Table 2 compares metals, cyanide and chloride average concentrations for February 1995-1996 with averages for 1988 through January 1995. The overall average is also shown. Three metals (total cadmium, total lead, and total mercury) were not detected in February 1995-1996 (detection limits are given in Appendix 3). Most metals were detected in lower concentrations during February 1995-1996 than in 1988- January 1995, but changes in the overall average values were slight. In two cases, shown in **boldface** in Table 2, higher average values were found. Total sodium was found in higher concentrations in February 1995-1996 than in 1988- January 1995, but the changes in the overall average were slight. Total cyanide in fresh effluent was also was found in higher concentration in 1995-1996 than in 1988-January 1995. Total cyanide concentrations in fresh effluent exceeded the point of significance (0.0052 mg/L) in both data sets. Some of the cyanide samples collected in 1995 were analyzed by a method that may cause interferences with nitrite and nitrate (Lynn Small, Laguna Treatment Plant pers. comm. to M. Commins). These data were not included in the averages. The fate of cyanide in stored reclaimed water is discussed in the Special Cyanide Study section below.

In September 1995, the Sonoma County Water Agency began adjusting the pH in drinking water to reduce the ordinarily slightly corrosive properties of drinking water. This adjustment appears to be reducing the concentration of dissolved copper in tap water (by 50 to 80 percent - pers. comm. Scott Stinebaugh, Laguna Treatment Plant to Dave Smith, MSC 16 May 1996). The concentration of dissolved copper in reclaimed water since the pH adjustment was begun is 0.008 mg/L versus an overall dissolved copper concentration of 0.010 mg/L, indicating that the concentration of dissolved copper in reclaimed water may also be reduced by this pH adjustment. However, the number of samples collected and analyzed for dissolved copper since pH adjustment is small (n = 2) so the full effect of pH adjustment cannot be determined until more samples are collected.

Table 3 compares organics data for February 1995-1996 with data for 1988-January 1995. As was the case with metals concentrations, many organic compounds were undetectable (17 compounds) or were detected in lower concentrations during February 1995-1996 than in 1988-January 1995. Again, the changes in the overall average values were in most cases slight. In several cases (which are underlined in Table 3) the overall average value calculated for a compound undetectable in 1995-1996 did not decrease as would be expected. In five cases the average increased slightly. This is because the averages are calculated by assuming a value of half the detection limit for undetectable analyses, and in some cases the detection limits reported in 1995-1996 analyses (listed in Appendix 2) were higher than those reported earlier. Two organic compounds (acetone and butyl benzyl phthalate) were found in higher concentrations during February 1995-1996 than in 1988-January 1995. Each was detected once in 1995-1996. Increases overall averages of these compounds are shown in **boldface** in Table 3. Butyl benzyl phthalate was detected for the first time in February 1995-1996; however three other phthalates detected earlier were undetectable in February 1995-1996. The higher average total phthalates in February 1995-1996 are due in part to higher detection limits. Only sample in 16 analyses for phthalates produced a detectable result.

Table 2.

Comparison of Metals, Cyanide, and Chloride Data

	February 1995-1996			1988-January 1995			
	Average, mg/L[a]	No. of Samples	No. of Detects	Average, mg/L	No. of Samples	No. of Detects	Overall Average[b]
Total Arsenic	0.0015	4	3	0.0024	30	25	0.0023
Dissolved Arsenic	0.0015	3	2	0.0025	8	8	0.0022
Total Boron	0.12	4	1	0.48	18	17	0.42
Total Cadmium	ND	8	0	0.00077	89	6	0.00072
Total Calcium	27	3	3	31	19	19	31
Total Chromium	0.0013	8	2	0.0023	90	49	0.0022
Total Copper	0.013	8	8	0.012	90	88	0.012
Dissolved Copper	0.0091	3	3	0.010	8	8	0.0095
Total Lead	ND	8	0	0.0045	90	19	0.0043
Total Magnesium	20	3	3	19	18	18	19
Total Mercury	ND	8	0	0.00037	91	1	0.00034
Total Nickel	0.0029	8	2	0.0042	90	56	0.0041
Dissolved Nickel	0.0030	3	1	0.0034	8	6	0.0033
Total Potassium	11	3	3	11	28	28	11
Dissolved Silver	0.00016	3	1	0.00072	8	2	0.00057
Total Sodium	85	3	3	80	28	28	**81**
Total Zinc	0.028	8	8	0.031	90	82	0.031
Dissolved Zinc	0.013	3	1	0.032	8	8	0.027
Total Cyanide	0.012	3	1	0.0094	15	10	**0.010**
Total Chloride	70.3	3	3	88.9	24	24	86.2

[a] ND = not detected
[b] Overall averages that are higher than the 1988-January 1995 averages are shown in bold

Table 3.

Comparison of Organics Data

	February 1995-1996			1988- January 1995			
	Average, µg/L[a]	No. of Samples	No. of Detects	Average, µg/L	No. of Samples	No. of Detects	Overall Average[b]
Acetone	5.13	4	1	4.19	14	2	**4.41**
Carbon disulfide	ND	4	0	3.9	14	3	3.5
Chlorobenzene	ND	4	0	0.06	19	1	0.14
1,4 Dichlorobenzene	0.53	4	2	0.64	13	10	0.61
Ethyl benzene	ND	4	0	0.24	19	1	0.24
Methylene chloride	ND	4	0	0.82	19	5	0.88
Tetrachloroethylene	ND	4	0	0.23	19	2	0.23
Toluene	ND	4	0	0.23	19	2	0.23
1,1,1-trichloroethane	ND	4	0	0.21	19	1	0.21
Xylenes	ND	4	0	0.22	18	1	0.23
Bromomethane	ND	4	0	0.26	19	1	0.26
Chloromethane	0.34	4	1	0.46	19	1	0.44
Bromodichloromethane	1.48	4	4	2.16	23	22	2.06
Chloroform	5.9	4	4	9.9	23	23	9.29
Dibromochloromethane	ND	4	0	0.41	22	4	0.38
Total THMs	7.4	4	4	12.9	23	23	8.1
Di-N-butyl phthalate	ND	4	0	1.16	23	2	1.36
Bis (2-ethylhexyl) phthalate	ND	4	0	2.49	23	5	2.49
Diethyl phthalate	ND	4	0	1.93	23	4	1.72
Butyl benzyl Phthalate	3.4	4	1	ND	23	0	**2.07**
Total phthalates	8.88			5.58			**7.64**[c]
Aldrin	ND	4	0	0.0086	19	3	0.0080
Endosulfan II	ND	4	0	0.0059	19	1	0.0057
a-BHC	ND	4	0	0.0094	19	2	0.0086
g-BHC(Lindane)	0.02	4	2	0.02	19	8	0.02
Heptachlor	ND	4	0	0.0083	19	1	0.0077

[a] ND = not detected

[b] Overall averages that are higher than the 1988-1994 averages are shown in bold.

The higher average total phthalate value in February 1995-1996 is due in part to higher detection limits. Only one sample in 16 phthalates analyses produced a detectable result.

Table 4 compares routine constituents data for February 1995-1996 with averages for 1988-1994. Ammonia, nitrate, and nitrite data for 1988-January 1995 (*italicized*) are averages which exclude data collected on a few days when the plant was not nitrifying and therefore were not representative of effluent nitrogen during nitrification.. Again most constituents had lower concentrations in February 1995-1996, but changes to the overall average values were slight. Two categories, pH and conductivity, were higher in the February 1995-1996 data set than in 1988-January 1995, but these differences had very slight effects on the overall average values (shown in **boldface** in Table 4).

Table 4.

Comparison of Routine Constituents Data

	February 1995-1996			1988-January 1995			
	Average	Min	Max	Average	Min	Max	Overall Average
Ammonia[a] (mg N/L)	1.68	0.05	12.4	1.99	0.05	14.9	1.91
Nitrite[a] (mg N/L)	0.018	0.005	0.17	0.22	0.005	3.3	0.17
Nitrate[a] (mg N/L)	16.0	6.1	28.7	18.1	6.1	50.5	17.6
Phosphate (mg P/L)	2.8	0.9	3.9	4.27	0.1	8.4	3.96
Alkalinity (mg/L)	135.8	89	210	138.2	71	303	137.7
TDS (mg/L)	431.1	288	557	444	150	628	441.1
TOC (mg/L)	8.6	1.2	20.4	9.33	2.4	37.1	8.94
Solids (NFR)(mg/L)	1.6	0.2	57	1.77	0.4	27	1.73
pH	7.1	6.3	7.5	6.9	6	7.8	**6.94**
Turbidity (NTU)	0.8	0.3	2.9	0.95	0.2	5.2	0.92
Conductivity (µmhos/cm)	729.2	516	897	724.2	320	1015	**725.4**

[a] Ammonia, nitrate, and nitrite data for 1988-January 1995 are averages when the plant was nitrifying.
TDS = total dissolved solids
TOC = total organic carbon
BOD = biological oxygen demand
NFR = non filterable residue
MPN = most probably number
NTU = nephelometer turbidity unit

Table 5 shows the comparison of biological constituent data from 1988 through January 1995 and February 1995 through 1996. The *Giardia* and *Cryptosporidium* values are much higher in 1996 than in 1994 when samples were collected previously. The data upon which the values in Table 5 are based are provided in Appendix 4. The elevated *Giardia* and *Cryptosporidium* values appear to be related to atypical operation of the treatment plant in general and the filters in particular. The treatment plant has been under construction, which has resulted in key facilities being repeatedly put in and out of service. The filter backwash process was malfunctioning for a six month period ending in April 1996, which resulted in the loss of approximately 25 percent of the filter medium. Once this problem was corrected and the medium was replaced in late April, *Giardia* and *Cryptosporidium* values returned to the level approximating that observed in 1994 with one exception (14 May 1996).

Table 5.

Comparison of Biological Constituents Data

	February 1995-February 1996[a]			1988-January 1995			
	Average / Median	**Min**	**Max**	**Average / Median**	**Min**	**Max**	**Overall Average / Median**
BOD (mg/L)	2.8	2	11.8	3.38	1.5	19	3.26
Total Coliform (MPN/100 ml)	<2(median)	<2	1600	<2(median)	<2	170	<2(median)
Giardia lamblia cysts (# cysts/100 L)[a]	200.6	<1	1013	4.75	<1	13.8	144.6
Cryptosporidium oocysts (# oocysts/100L)	9.0	<1	25	<1	<1	<1	6.4

a The *Giardia* and *Cryptosporidium* data were collected from 6 March through 14 May 1996.
b Average calculated as an arithmetic mean using one half the detection limit (except when the detection limit was 1 in which case zero was used).

The apparent relationship between plant operations and the *Giardia* and *Cryptosporidium* values illustrates that the plant usually removes pathogens effectively, and that consistent plant operations are necessary for full treatment. The filter medium loss during the six month period of filter backwash process malfunction was approximately 1 foot (of a usual total filter medium depth of 4 feet). Treatment plant records show that this loss rate (1 foot/six months or 0.5 ft/yr) is much greater than when the filter backwash process functions properly. The filter medium loss rate under normal conditions is about 0.1 ft/yr. Therefore, the 1996 *Giardia* and *Cryptosporidium* values are not considered representative of long-term effluent quality.

3.2 SPECIAL CYANIDE STUDY

The results of the second special cyanide study are shown in Table 6. Total cyanide, cyanide amenable to chlorination, and weak dissociable cyanide were always detectable in fresh effluent. On one occasion, the a negative concentration value was reported for cyanide amenable to chlorination. According to Standard Methods (1995), some unidentified organic chemicals may oxidize or form breakdown products during chlorination, giving higher results for cyanide after chlorination than before chlorination. The higher results after chlorination than before chlorination lead to the negative value for cyanides amenable to chlorination because the concentration of cyanide amenable to chlorination is calculated by the difference between these two values.

Total cyanide, cyanide amenable to chlorination, and weak dissociable cyanide were always below detection in Delta Pond and Meadowlane Pond. In the first special cyanide study, weak dissociable cyanide was always below detection. Total and amenable cyanide in Delta Pond were found in detectable concentrations, but this was likely due to nitrate and nitrite interference. These preliminary results indicate that cyanide in stored effluent is reduced by volatilization and/or complexation.

Table 6

Results of Second Special Study Cyanide

	Delta Pond	Meadowlane Pond	Effluent	Influent
Total cyanide				
9-Apr-96	5[a]	5[a]	6.7	5[a]
23-Apr-96	5[a]	5[a]	15	50[a]
30-Apr-96	5[a]	5[a]	14	5[a]
14-May-96	5[a]	5[a]	10	50[a]
Cyanide amenable to chlorination				
9-Apr-96	5[a]	5[a]	-20[b]	5[a]
23-Apr-96	5[a]	5[a]	8.3	50[a]
30-Apr-96	5[a]	5[a]	6.8	5[a]
14-May-96	5[a]	5[a]	1	50[a]
Weak dissociable cyanide				
9-Apr-96	5[a]	5[a]	16	50[a]
23-Apr-96	5[a]	5[a]	8.4	50[a]
30-Apr-96	5[a]	5[a]	11	5[a]
14-May-96	5[a]	5[a]	9.6	5[a]

[a] Concentration below detection. Value shown is reporting limit.
[b] Interference suspected

3.3 RECLAIMED WATER TOXICITY TESTING

3.3.1 Toxicity Test Approach

Toxicity testing of reclaimed water follows the US EPA freshwater "three species" short term sensitive life stage toxicity tests (EPA 1991), which consist of the following elements:

- 96-hour algal growth test with the green alga *Selanastrum capricornutum*;
- Three-brood (7-day) survival and reproduction test with the crustacean *Ceriodaphnia dubia*; and,
- 7-day survival and growth test with larval fathead minnows, *Pimephales promelas.*

The algal growth, crustacean reproduction, and fish growth tests measure sublethal toxicity; crustacean and fish survival measure lethal effects. Each test is performed on a series of five effluent concentrations: 100, 50, 25, 10, and 5 percent. A toxic effect is indicated when the test response of a given treatment is significantly (5% t-test) less than a control (a parallel test without effluent).

Toxicity results are described in terms of the concentration of effluent in which "no effect" is observed, and the concentration in which the "lowest effect" is observed. For example, if in a test the 100 percent effluent sample had a toxic effect (was significantly less than control), but the other dilutions (50, 25, 10, and 5 percent) had no effect (no significant difference from control), the "lowest effect" level would be 100 percent, and the "no effect" level would be 50 percent (the actual threshold of toxic effect could be 75 percent--or even 99 percent--but since no dilutions between 100 percent and 50 percent were tested, it can only be concluded that the lowest no-effect level *tested* was 50 percent. The "no effect" concentration is also called the NOEC (no observed effect concentration). and the "lowest effect" concentration is also called the LOEC (lowest observed effect concentration).

3.3.2 Toxicity Test Results

The available toxicity test results are presented in Table 7. Three series of preliminary tests (fourteen tests in all) were made between 1992 and 1995. Final effluent (collected downstream of chlorine contact chamber) toxicity was tested eight times, and effluent storage pond water six times. No effects on fish survival or growth were found in any of these tests, although fish tests were not included in every trial. *Ceriodaphnia* survivorship was impaired in the two 1992 final effluent tests. With these two exceptions, no lethal animal toxicity was found in either effluent or storage pond samples. Most of the preliminary tests showed some sublethal toxicity to algal growth, typically in undiluted samples. Sublethal toxicity to algal (*Selanastrum*) growth was also found in two algal growth potential (AGP) tests done on Delta Pond water; a third AGP test made on "D" Pond water was not toxic to algae (Merritt Smith 1995). Sublethal effects on

Ceriodaphnia (decreased reproduction) were found once in Delta Pond and three times in final effluent samples. An examination of the treatment plant operations during the time when the toxicity lethal to *Ceriodaphnia* was found (Merritt Smith 1995) concluded that an increase in belt press sludge feed rate associated with a one-time event (cleaning the sludge lagoons at the Meadowlane Ponds) was likely the cause of the lethal effects.

The results of the first three of the regular quarterly toxicity tests (made in December 1995, January 1996, and April 1996) now included in Santa Rosa's NPDES monitoring are also shown in Table 7. Tests were done on samples from D Pond and Delta Pond. In the December 1995 trial, D Pond water was lethally toxic to fathead minnows in both 100 percent and 50 percent dilutions (i.e., NOEC = 25, LOEC = 50). No effects on fish or *Ceriodaphnia* were found on the same date in Delta Pond, or from either of the ponds in the next sampling a few days later (2 January 1996) nor in the April 1996 sampling. . Slight sublethal toxicity to algal growth was found in two of the four trials, in D Pond in December, and in Delta Pond in January.

The lethal fish toxicity found in D Pond in December 1995 is an exceptional result, considering that no sublethal or lethal fish effects have been found previously, and final effluent is routinely subjected to fish survivorship testing. The source of toxicity is unknown, but evidently not persistent. None of the chemical analyses made on plant effluent during this period indicate a source of toxicity. However, during the April 1996 tests on Delta Pond water several fish developed a fungal infection. Some of these fish died. This mortality occurred randomly among treatment replicates (did not show dose-response). Review of test conditions during the tests on D Pond water in December 1995 (J. Cotsifas, *pers. comm*.) indicates that some of the fish in those tests also developed fungal infections, although the observed toxic response appeared to be dose-related. Future toxicity testing on effluent storage pond water should include sterilization to eliminate biological effects (such as fungal infections), which can mask toxic effects.

Table 7 shows that lethal toxicity to *Ceriodaphnia* was found in two out of 20 tests (10 percent of the tests). Lethal toxicity to fish was found once in 11 tests (9 percent). Further regular toxicity testing, as required in the existing discharge permit, will indicate whether these data are representative of reclaimed water quality.

Table 7.

Results of 1992-1996 Toxicity Testing

		Selenastrum		***Ceriodaphnia***				***Pimephales***			
		Cell Growth		**Survival**		**Reproduction**		**Survival**		**Growth**	
Date	**Source**	**NOEC**	**LOEC**	**NOEC**	**LOEC**	**NOEC**	**LOEC**	**NOEC**	**LOEC**	**NOEC**	**LOEC**
6-Jul-92[a]	Final Effluent	25	50	25	50	25	>25	100	>100	100	>100
23-Jul-92[a]	Final Effluent	50	100	50	100	10	25				
23-Jul-92[a]	Delta Pond	50	100	100	>100	100	>100				
23-Jul-92[a]	Kelly Marsh	100	>100	100	>100	100	>100				
7-Dec-93[b]	Final Effluent	50	100	100	>100	100	>100	100	>100	100	>100
7-Dec-93[b]	Delta Pond	50	100	100	>100	50	100	100	>100	100	>100
4-Jan-94[b]	Final Effluent	50	100	100[e]	>100[e]	50[e]	100[e]	100[f]	>100[f]	100[f]	>100[f]
4-Jan-94[b]	Delta Pond	50	100	100[e]	>100[e]	100[e]	>100[e]	100[f]	>100[f]	100[f]	>100[f]
26-Jan-94[b]	Final Effluent	50	100	100	>100	100	>100				
26-Jan-94[b]	Delta Pond	50	100	100	>100	100	>100				
1-Feb-94[b]	Final Effluent	100	>100	100	>100	100	>100				
1-Feb-94[b]	Alpha Pond	25	50	100	>100	100	>100				
7 Dec 1994[c]	Final Effluent	100	>100	100	>100	100	>100				
1-May-95[c]	Final Effluent	100	>100	100	>100	100	>100				
19 Dec 1995[d]	D Pond	50	100	100	>100	100	>100	25	50	25	>25
26 Dec 1995[d]	Delta Pond	100	>100	100	>100	100	>100	100	>100	100	>100
2 Jan 1996[d]	D Pond	100	>100	100	>100	100	>100	100	>100	100	>100
2 Jan 1996[d]	Delta Pond	50	100	100	>100	100	>100	100	>100	100	>100
1 Apr 1996[d]	D Pond	100	>100	100	>100	100	>100	100	>100	100	>100
1 Apr 1996[d]	Delta Pond	100	>100	100	>100	100	>100	100	>100	100	>100

NOEC = no observable effects concentration (percent).
LOEC = lowest observable effects concentration (percent).
[a]Data reported in Merritt Smith 1992.
[b]Data reported in Merritt Smith 1994.
[c]Data reported in Merritt Smith 1995.
[d]Test made as part of regular quarterly toxicity testing. Data reported to RWQCB.
[e]A second test made with *Ceriodaphnia reticulata* gave identical results.
[f]Twenty-eight day test made with rainbow trout, *Onchorhyncus mykiss*

4.0 CONCLUSIONS AND RECOMMENDATIONS

The results of chemical analyses of Santa Rosa's treatment plant final effluent made from February 1995 through February 1996 are similar to results obtained in the years 1988 through 1994. The data from 1988-1994 that were used as the basis for the EIR/S are representative of current effluent quality.

Giardia and *Cryptosporidium* values observed in 1996 are much greater than those observed previously and upon which the EIR/S analysis is based. However, the 1996 data are not considered representative of long-term reclaimed water quality because of a treatment plant malfunction that appears to have caused the elevated *Giardia* and *Cryptosporidium*values in 1996.

Two instances of lethal effects to *Ceriodaphnia* in 20 tests and one instance of lethal effects to fish in 11 tests have been observed over 4 years. These toxicity data have been incorporated into the *Water Quality Impact Analysis* Technical Report (MSC 1996). Future toxicity testing on effluent storage pond water should include sterilization to eliminate biological effects, which can mask toxic effects.

5.0 REFERENCES

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6.0 APPENDICES

Appendix 1. Santa Rosa Reclaimed Water Metals, Cyanide, and Chloride, mg/L. * indicates below detection; number shown is the detection limit.

	Aluminum		Antimony		Arsenic		Barium		Beryllium		Boron	Cadmium	
Date	tot	diss	tot	diss	tot	diss	tot	diss	tot	diss	tot	tot	diss
21-Feb-95												0.0002 *	
5-Mar-95												0.0003 *	
5-Apr-95					0.001 *						0.1 *	0.0003 *	
4-May-95												0.0003 *	
5-Jun-95												0.0003 *	
3-Jul-95			0.01 *	0.005 *	0.0024	0.0021			0.005 *	0.005 *	0.1 *	0.0003 *	0.0003 *
5-Oct-95			0.005 *	0.005 *	0.0019	0.0019			0.005 *	0.005 *	0.1 *	0.001 *	0.001 *
2-Jan-96			0.005 *	0.005 *	0.001	0.001 *			0.0002 *	0.0002 *	0.32	0.0002 *	0.0002 *

Appendix 1. Santa Rosa Reclaimed Water Metals, Cyanide, and Chloride, mg/L. * indicates below detection; number shown is the detection limit.

	Calcium	Chromium			Cobalt		Copper		Iron	Lead		Magnesium	Manganese
Date	tot	tot	diss	hexaval	tot	diss	tot	diss	tot	tot	diss	tot	tot
21-Feb-95		0.001 *					0.012			0.002 *			
5-Mar-95		0.0019					0.014			0.005 *			
5-Apr-95	26.6	0.001 *					0.0102			0.005 *		21.9	
4-May-95		0.002 *					0.0134			0.005 *			
5-Jun-95		0.002 *					0.016			0.005 *			
3-Jul-95	23	0.0024	0.002 *				0.0137	0.0115		0.005 *	0.005 *	21	
5-Oct-95	30	0.005 *	0.005 *				0.015	0.0089		0.005 *	0.005 *	18	
2-Jan-96	28	0.001 *	0.001 *	0.01 *			0.007	0.007	0.06	0.002 *	0.002 *	17	

Appendix 1. Santa Rosa Reclaimed Water Metals, Cyanide, and Chloride, mg/L. * indicates below detection; number shown is the detection limit.

	Mercury		Molybdenum		Nickel		Potassium		Selenium		Silver	
Date	tot	diss	tot	diss	tot	diss	tot	diss	tot	diss	tot	diss
21-Feb-95	0.0002 *				0.004						0.0002 *	
5-Mar-95	0.0002 *				0.005 *						0.0004 *	
5-Apr-95	0.000001 *				0.005 *		8.57				0.0004 *	
4-May-95	0.000001 *				0.005 *						0.0004 *	
5-Jun-95	0.000001 *				0.005 *						0.0004 *	
3-Jul-95	0.0002 *	0.0002 *			0.005 *	0.005 *	11		0.005 *	0.005 *	0.0004 *	0.0004 *
5-Oct-95	0.02 *	0.0002 *			0.005 *	0.005 *	14		0.005 *	0.005 *	0.0001 *	0.0002
2-Jan-96	0.0002 *	0.0002 *			0.004	0.004	10		0.001 *	0.001 *	0.0002 *	0.0002 *

Appendix 1. Santa Rosa Reclaimed Water Metals, Cyanide, and Chloride, mg/L. * indicates below detection; number shown is the detection limit.

	Sodium		Thallium		Vanadium		Zinc		Cyanide	Chloride
Date	tot	diss	tot	diss	tot	diss	tot	diss	tot	tot
21-Feb-95							0.02			
5-Mar-95							0.01			
5-Apr-95	84.4						0.023			68
4-May-95							0.0093			
5-Jun-95							0.031			
3-Jul-95	87		0.03 *	0.03 *			0.051	0.02 *	0.1 *	85.7
5-Oct-95	88		0.03 *	0.03 *			0.052	0.02 *	0.0001 *	69.5
2-Jan-96	81		0.005 *	0.005 *			0.03	0.02	0.012	58.1

Appendix 2. Santa Rosa Reclaimed Water Organics, µg/L (except dioxins). *indicates below detection; number shown is the detection limit. Detectable values are **Bold/Underline**.

	5-Apr-95	3-Jul-95	5-Oct-95	2-Jan-96
EPA Method 624/8260: Purgeables				
Acetone	10 *	10 *	1 *	**10**
Acrolein			20 *	10 *
Acrylonitrile			20 *	10 *
Benzene	0.5 *	0.5 *	0.5 *	0.5 *
Bromodichloromethane	**1.2**	**2.3**	**1.2**	**1.2**
Bromoform	0.5 *	0.5 *	0.5 *	0.5 *
Bromomethane	0.5 *	0.5 *	0.5 *	0.5 *
2-Butanone	5 *	5 *	5 *	5 *
Carbon Disulfide	5 *	5 *	0.5 *	5 *
Carbon Tetrachloride	0.5 *	0.5 *	0.5 *	0.5 *
Chlorobenzene	0.5 *	0.5 *	0.5 *	0.5 *
Chloroethane	0.5 *	0.5 *	0.5 *	0.5 *
2-Chloroethylvinyl Ether	1 *	1 *	1 *	1 *
Chloroform	**4.5**	**9.1**	**5.8**	**4.2**
Chloromethane	0.5 *	**0.6**	0.5 *	0.5 *
Dibromochloromethane	0.5 *	0.5 *	0.5 *	0.5 *
1,2-Dichlorobenzene	0.5 *	0.5 *	0.5 *	0.5 *
1,3-Dichlorobenzene	0.5 *	0.5 *	0.5 *	0.5 *
1,4 Dichlorobenzene	**0.6**	**1**	0.5 *	0.5 *
Dichlorodifluoromethane	0.5 *	0.5 *	0.5 *	0.5 *
1,1-Dichlorethane	0.5 *	0.5 *	0.5 *	0.5 *
1,2-Dichlorethane	0.5 *	0.5 *	0.5 *	0.5 *
1,1-Dichlorethene	0.5 *	0.5 *	0.5 *	0.5 *
Cis-1,2-Dichlorethene	0.5 *	0.5 *	0.5 *	0.5 *
Trans-1,2-Dichlorethene	0.5 *	0.5 *	0.5 *	0.5 *
1,2-Dichloropropane	0.5 *	0.5 *	0.5 *	0.5 *
Cis-1,3-Dichloropropene	0.5 *	0.5 *	0.5 *	0.5 *
Trans-1,3-Dichloropropene	0.5 *	0.5 *	0.5 *	0.5 *
Dichlorotrifluoroethane	0.5 *	0.5 *	0.5 *	0.5 *
Ethyl Benzene	0.5 *	0.5 *	0.5 *	0.5 *
2-Hexanone	5 *	5 *	5 *	5 *
Methylene Chloride	3 *	3 *	0.5 *	3 *
4-Methyl-2-Pentanone	5 *	5 *	5 *	5 *
Styrene	0.5 *	0.5 *	0.5 *	0.5 *
1,1,2,2-Tetrachloroethane	0.5 *	0.5 *	0.5 *	0.5 *
Tetrachloroethene (PCE)	0.5 *	0.5 *	0.5 *	0.5 *
Toluene	0.5 *	0.5 *	0.5 *	0.5 *
1,1,1-Trichloroethane	0.5 *	0.5 *	0.5 *	0.5 *
1,1,2-Trichloroethane	0.5 *	0.5 *	0.5 *	0.5 *
Trichloroethene	0.5 *	0.5 *	0.5 *	0.5 *
Trichlorofluoromethane	0.5 *	0.5 *	0.5 *	0.5 *
Trichlorotrifluoroethane	0.5 *	0.5 *	0.5 *	0.5 *
Vinyl Acetate	5 *	5 *	10 *	5 *
Vinyl Chloride	0.5 *	0.5 *	0.5 *	0.5 *
Total Xylenes	0.5 *	0.5 *	0.5 *	0.5 *
Total THMs	**5.7**	**11.4**	**7**	**5.4**

Appendix 2. Santa Rosa Reclaimed Water Organics, µg/L (except dioxins). *indicates below detection; number shown is the detection limit. Detectable values are **Bold/Underline**.

	5-Apr-95	3-Jul-95	5-Oct-95	2-Jan-96
EPA Method 608: Organochlorine Pesticides and PCBs				
Aldrin	0.01 *	0.01 *	0.01 *	0.01 *
a-BHC	0.01 *	0.01 *	0.01 *	0.01 *
b-BHC	0.01 *	0.01 *	0.01 *	0.01 *
d-BHC	0.01 *	0.01 *	0.01 *	0.01 *
g-BHC	0.01 *	0.01 *	**0.03**	**0.04**
Chlordane	0.02 *	0.02 *	0.02 *	0.02 *
4,4'-DDD	0.01 *	0.01 *	0.01 *	0.01 *
4,4'-DDE	0.01 *	0.01 *	0.01 *	0.01 *
4,4'-DDT	0.01 *	0.01 *	0.01 *	0.01 *
Dieldrin	0.01 *	0.01 *	0.01 *	0.01 *
Endosulfan I	0.01 *	0.01 *	0.01 *	0.01 *
Endosulfan II	0.01 *	0.01 *	0.01 *	0.01 *
Endosulfan Sulfate	0.01 *	0.01 *	0.01 *	0.01 *
Endrin	0.01 *	0.01 *	0.01 *	0.01 *
Endrin Aldehyde	0.01 *	0.01 *	0.01 *	0.01 *
Endrin Ketone				
Heptachlor	0.01 *	0.01 *	0.01 *	0.01 *
Heptachlor Epoxide	0.01 *	0.01 *	0.01 *	0.01 *
Methoxychlor	0.01 *	0.01 *	0.01 *	0.01 *
Toxaphene	0.1 *	0.1 *	1 *	0.1 *
PCB-1016	0.1 *	0.1 *	1 *	0.1 *
PCB-1221	0.2 *	0.2 *	0.2 *	0.2 *
PCB-1232	0.1 *	0.1 *	0.1 *	0.1 *
PCB-1242	0.1 *	0.1 *	0.1 *	0.1 *
PCB-1248	0.1 *	0.1 *	0.1 *	0.1 *
PCB-1254	0.1 *	0.1 *	0.1 *	0.1 *
PCB-1260	0.1 *	0.1 *	0.1 *	0.1 *
EPA Method 625: Base Neutral Extractables				
Acenaphthene	1 *	1 *	1 *	1 *
Acenaphthylene	1 *	1 *	1 *	1 *
Anthracene	1 *	1 *	1 *	1 *
Benzo (A) Anthracene	1 *	1 *	1 *	1 *
Benzo (B) Fluoranthene	3 *	3 *	3 *	1 *
Benzo (K) Fluoranthene	3 *	3 *	3 *	2 *
Benzo (A) Pyrene	3 *	3 *	3 *	3 *
Benzo (G,H,I) Perylene	3 *	3 *	3 *	3 *
Benzidene	5 *	5 *	5 *	20 *
Bis (2-Chloroethyl) Ether	5 *	5 *	1 *	1 *
Bis (2-Chloroethoxy) Methane	1 *	1 *	1 *	1 *
Bis (2-Ethylhexyl) Phthalate	5 *	5 *	5 *	5 *
Bis (2-Chloroisopropyl) Ether	5 *	5 *	5 *	2 *
4-Bromophenyl Phenyl Ether	1 *	1 *	5 *	1 *
Butyl Benzene Phthalate	5 *	5 *	**6**	5 *
2-Chloronaphthalene	1 *	1 *	1 *	1 *
4-Chlorophenyl Phenyl Ether	1 *	1 *	1 *	1 *
Chrysene	1 *	1 *	1 *	1 *

Appendix 2. Santa Rosa Reclaimed Water Organics, µg/L (except dioxins). *indicates below detection; number shown is the detection limit. Detectable values are **Bold/Underline**.

	5-Apr-95	3-Jul-95	5-Oct-95	2-Jan-96
Dibenzo (A,H) Anthracene	3 *	3 *	3 *	1 *
Di-N-Butyl Phthalate	5 *	5 *	5 *	5 *
1,3-Dichlorobenzene	1 *	1 *	1 *	1 *
1,4-Dichlorobenzene	1 *	1 *	1 *	1 *
1,2-Dichlorobenzene	1 *	1 *	1 *	1 *
3,3'-Dichlorobenzidene	5 *	5 *	5 *	5 *
Diethyl Phthalate	1 *	1 *	1 *	1 *
Dimethyl Phthalate	1 *	1 *	1 *	1 *
2,4-Dinitrotoluene	1 *	1 *	1 *	1 *
2,6-Dinitrotoluene	1 *	1 *	1 *	1 *
Dioctyl Phthalate	1 *	1 *	1 *	1 *
Fluoranthene	1 *	1 *	1 *	1 *
Fluorene	1 *	1 *	1 *	1 *
Hexachlorobenzene	5 *	5 *	5 *	5 *
Hexachlorobutadiene	5 *	5 *	5 *	5 *
Hexachloroethane	1 *	1 *	1 *	1 *
Hexachlorocyclopentadiene	5 *	5 *	5 *	5 *
Indeno (1,2,3-CD) Pyrene	3 *	3 *	3 *	1 *
Isophorone	5 *	5 *	5 *	5 *
Naphthalene	1 *	1 *	1 *	1 *
Nitrobenzene	5 *	5 *	5 *	1 *
N-Nitrosodimethylamine	5 *	5 *	5 *	5 *
N-Nitrosodi-N-Propylamine	1 *	1 *	1 *	1 *
N-Nitrosodiphenylamine	5 *	5 *	5 *	1 *
Phenanthrene	1 *	1 *	1 *	1 *
Pyrene	1 *	1 *	1 *	1 *
1,2,4-Trichlorobenzene	5 *	5 *	5 *	5 *
Acid Extractables				
4-Chloro-3-Methylphenol	1 *	1 *	1 *	1 *
2-Chlorophenol	1 *	1 *	1 *	1 *
2,4-Dichlorophenol	1 *	1 *	1 *	1 *
2,4-Dimethylphenol	5 *	5 *	5 *	1 *
2,4-Dinitrophenol	5 *	5 *	5 *	5 *
2-Methyl-4,6-Dinitrophenol	5 *	5 *	5 *	5 *
2-Nitrophenol	1 *	1 *	1 *	1 *
4-Nitrophenol	5 *	5 *	5 *	5 *
Pentachlorophenol	1 *	1 *	1 *	1 *
Phenol	1 *	1 *	1 *	1 *
2,4,6-Trichlorophenol	1 *	1 *	1 *	1 *
Dioxin (TCDD) ng/L		2 *	2 *	2 *
1,2-Diphenylhydrazine		1 *	1 *	1 *

Appendix 3. Santa Rosa Reclaimed Water-Routine Constituents, mg/L except as noted. *indicates below detection; number shown is the detection limit.

	Ammonia (mg N/L)			TKN (mg/L)	Nitrite (mg N/L)			Nitrate (mg N/L)			Phosphate (mg P/L)		
Month	Avg	Min	Max	compos.	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Feb-95	2.2	2	2.9		0.02	0.01	0.03	18.3	13.1	28.7	2.4	2.1	2.7
Mar-95	2.4	0.1 *	4		0.02	0.01 *	0.06	13.4	8.1	26.5	1.7	1.3	2.4
Apr-95	3	1.5	7.2	122	0.02	0.01 *	0.07	15.5	10.7	19	2.5	2.4	2.5
May-95	2.2	0.1 *	8		0.03	0.01 *	0.17	14.9	8.3	18.7	2.2	1.1	2.9
Jun-95	1.3	0.4	12.4		0.02	0.01 *	0.1	16.3	6.1	21.1	2.9	2.7	3.2
Jul-95	0.9	0.4	1.4	120	0.01	0.01 *	0.01	18	10.1	21.6	3.4	2.9	3.8
Aug-95	1.1	0.1 *	2.7		0.01	0.01 *	0.06	16.8	10.2	20	3.7	3.6	3.9
Sep-95	0.9	0.5	2.6		0.01	0.01 *	0.05	14.7	11.4	17.6	3.6	3.4	3.7
Oct-95	0.8	0.5	1.5	66	0.01	0.01 *	0.02	16.7	13	19	3.7	3.3	3.9
Nov-95	1.6	0.6	4.6		0.02	0.01	0.03	19.4	17.1	22	3.5	3.3	3.7
Dec-95	1.7	1.1	2.9		0.02	0.01 *	0.07	18.2	9.8	23.3	2.8	2.6	3.2
Jan-96	1.8	0.2	4.9	2.4	0.02	0.01 *	0.03	15.6	9.9	24.8	2.3	1.4	3.1
Feb-96	2	0.4	4.5		0.02	0.01 *	0.05	10.3	8.5	14.2	1.5	0.9	1.7

Appendix 3. Santa Rosa Reclaimed Water-Routine Constituents, mg/L except as noted. *indicates below detection; number shown is the detection limit.

	Alkalinity (mg/L)			TDS (mg/L)			TOC			BOD (mg/L)		
Month	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Feb-95	145	128	163	393.9	352	426	6.3	3.2	14.8	3.2	2	4.3
Mar-95	138	89	162	368.8	296	440	2.6	1.2	4.2	4.4	2	11.8
Apr-95	141	122	168	402.6	367	448	2.2	2.2	2.2	4.3	2.3	6.4
May-95	141	122	187	422.4	342	468				2.9	2	4.1
Jun-95	133	121	210	456.8	425	497	11.5	9.2	15	2.4	2	3.9
Jul-95	135	115	151	484.3	433	551	12.3	8	20.4	2.1	2	2.5
Aug-95	127	113	147	469.4	437	494	9.1	8.7	9.8	2.1	2	2.6
Sep-95	125	112	152	489.8	434	557	13.5	7.3	19.6	2.6	2	3.9
Oct-95	142	126	158	457.3	437	483	8.6	3.5	13	2	2	2
Nov-95	128	114	144	475.8	461	512				2	2	2
Dec-95	126	103	147	442.8	337	538	13.2	9.5	19.6	2.1	2	2.4
Jan-96	135	111	166	379.5	288	463	6.8	3.3	9.5	3	2.2	4
Feb-96	149	122	172	360.5	289	438	8.6	7.4	11.2	3.4	2.3	4.3

Appendix 3. Santa Rosa Reclaimed Water-Routine Constituents, mg/L except as noted. *indicates below detection; number shown is the detection limit.

	Solids (NFR)(mg/L)			pH			Total Coliform (MPN)			Virus	Turbidity (NTU)		
Month	Avg	Min	Max	Avg	Min	Max	Median	Min	Max	(PFU)	Avg	Min	Max
Feb-95	1.4	0.8	2.2	7	6.7	7.2	2 *	2 *	2		0.83	0.4	1.5
Mar-95	3.9	1	57	7	6.7	7.3	2 *	2 *	1600		0.95	0.5	2.9
Apr-95	1.5	1	2.2	7	6.6	7.2	2 *	2 *	4		0.8	0.6	1.2
May-95	1.6	0.8	2.6	7	6.6	7.4	4 *	2 *	4		0.73	0.5	1.1
Jun-95	1.4	0.6	1.9	7.2	6.9	7.4	2 *	2 *	2		0.75	0.5	1.1
Jul-95	1.1	0.6	1.7	7.2	6.5	7.5	2 *	2 *	2		0.71	0.6	1
Aug-95	1.1	0.5	1.9	7.2	6.8	7.4	2 *	2 *	2		0.71	0.3	1
Sep-95	1.1	0.2	2	7.2	7	7.3	2 *	2 *	2		0.79	0.4	1.6
Oct-95	1	0.4	1.8	7.1	6.9	7.4	2 *	2 *	11		0.78	0.5	1.2
Nov-95	1.5	0.7	4.3	7.1	6.8	7.4	2 *	2 *	2		0.92	0.5	2.1
Dec-95	1.8	1	4.7	7.1	6.3	7.3	2 *	2 *	8		0.92	0.5	2.1
Jan-96	1.5	0.9	2.9	7.1	6.9	7.4	2 *	2 *	8		0.89	0.5	1.4
Feb-96	1.8	0.9	4.6	7	6.6	7.5	2 *	2 *	4		0.84	0.5	2.1

Appendix 3. Santa Rosa Reclaimed Water-Routine Constituents, mg/L except as noted. *indicates below detection; number shown is the detection limit.

	Conductivity (umhos/cm)		
Month	Avg	Min	Max
Feb-95	700.3	640	732
Mar-95	664.1	569	773
Apr-95	715.6	666	779
May-95	766.8	652	854
Jun-95	788	721	897
Jul-95	763.4	692	829
Aug-95	750.9	698	804
Sep-95	742.3	692	802
Oct-95	756.3	727	775
Nov-95	771.6	734	851
Dec-95	690.4	575	804
Jan-96	691.5	610	786
Feb-96	678.9	516	808

Appendix 4. Santa Rosa Reclaimed Water *Giardia lamblia* and *Cryptosporidium*

Final Effluent		Results	
Date	Volume	*Giardia lamblia* [a]	*Cryptosporidium*
10/27/94	488	<1 cysts/100L	<1 oocysts/100L
11/8/94	420	<1 cysts/100L	<1 oocysts/100L
11/30/94	468	5 cysts/100L	<1 oocysts/100L
12/14/94	406	14 cysts/100L	<1 oocysts/100L
3/6/96	757	<1 cysts/100L	<1 oocysts/100L
3/14/96	548	145 cysts/100L	<9 oocysts/100L
3/21/96	382	113 cysts/100L	<13 oocysts/100L
3/29/96	431	111 cysts/100L	11 oocysts/100L
4/3/96	382	236 cysts/100L	<9 oocysts/100L
4/9/96	379	350 cysts/100L	<13 oocysts/100L
4/16/96	416	1013 cysts/100L	<13 oocysts/100L
4/24/96	382	<25 cysts/100L	<25 oocysts/100L
5/1/96	379	<25 cysts/100L	<25 oocysts/100L
5/14/96	386	<25 cysts/100L	25 oocysts/100L

[a] This data is specific for *Giardia lamblia*, not including other giardia cysts