

# MEMORANDUM



BUILDING A BETTER WORLD

**To:** TMDL Task Force  
**From:** Sarah Garber  
**Subject:** Canyon Lake Bacteria  
Characterization

**Date:** December 1, 2009  
**Reference:** 1343128

## Executive Summary

Water samples were collected weekly from six stations on Canyon Lake from January 30 to March 20, 2009 and then from June 5 to September 4, 2009 and analyzed for bacteria. The range of individual *Escherichia coli* (*E. coli*) values observed <1 to >2419.6 MPN/100 ml. The range of geometric means was 1.6 to 26.4 MPN/100 ml during the 8-week period and 1 to 39.4 MPN/100 ml during the 14-week period. Based on the data collected from these six stations during the wet and dry season sampling periods, the geometric means of *E. coli* densities at each station were consistently below the 126 per 100/ml standard.

## Background

Canyon Lake was formed in 1928 when the Canyon Lake Dam was constructed; the lake has three main sections – the relatively shallow East Bay (depths generally less than 10 ft), the deeper central body of the lake (depths in excess of 40 ft), and the area north of the causeway that connects with the San Jacinto River. The lake encompasses an area of 383 acres, has 14.9 miles of shoreline and a watershed of approximately 780 square miles of southwest Riverside County. Elsinore Valley Municipal Water District (EVMWD) has used the reservoir as a potable water source since 1957 when the Canyon Lake water treatment plant began operation. Allowable recreational activities on Canyon Lake are defined in the lease agreement between EVMWD (lessor) and the Canyon Lake Property Owners Association (POA) (lessee) and include swimming, boating, fishing and water sports. Recreation occurs pursuant to an agreement to ensure that drinking water is not affected by these recreational activities. The POA is also allowed to construct and maintain boat docks, sea walls, bulkheads, launching ramps, bathing beaches, and other improvements necessary or desirable for complete utilization of the lake. The number of people using the lake for recreation is limited since Canyon Lake is a gated community of approximately 4,800 homes.

Per the Santa Ana Regional Water Quality Control Plan (Basin Plan), designated beneficial uses for Canyon Lake are municipal and domestic supply, agricultural supply, groundwater recharge, contact and non-contact recreation, warm freshwater habitat, and wildlife habitat. In the past, bacteria levels in Canyon Lake have exceeded the water quality objectives for body contact recreation specified in the Basin Plan. Based on violation of these water quality objectives, the lake was included on the 2002 Clean Water Act Section 303(d) List of Water Quality Limited Segments (303 (d) List) (approved by EPA July 2003).

## Canyon Lake Bacteria Characterization

Currently, the Basin Plan specifies the use of fecal coliform concentrations as the primary indicator of bacterial pollution. However, EPA has recently recommended using *E. coli* as a more reliable measure of potential risk to swimmers and consequently, the Santa Ana Regional Water Quality Control Board (Regional Board) is in the process of updating the Basin Plan to replace fecal coliform with *E. coli* as the primary indicator of contamination by waterborne pathogens.

A wet weather water quality monitoring program has been underway in Canyon Lake for several years. This program, developed in cooperation with the California Department of Public Health and the Regional Board, is managed by EVMWD. Following significant storm events, the Canyon Lake POA posts warning signs in public access areas of the lake. When runoff from the storm event subsides, water quality sampling for *E. coli* is conducted by EVMWD. Sampling continues on a daily basis Monday through Friday and is discontinued after the first *E. coli* result of less than 235 MPN/100 ml. Determination of whether the bacteria levels warrant closure of the lake is made by the POA.

### Objective

Under this program grab samples of lake water were collected during two periods of the year (winter and summer) on a weekly basis at six locations to determine if Canyon Lake is in continuous compliance with the EPA promulgated water quality objective for *E. coli*.

Question to be answered by this program:

*Does Canyon Lake meet EPA's recommended E. coli criteria during the dry season and wet season?*

Data to be compared to the following standard:

*Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities should not exceed: E. coli 126 per 100 ml.*

### Materials and Methods

#### Sampling

From January to October 2009, Canyon Lake water samples were collected by a team led by Dr. James Noblet and sample analysis was conducted at Dr. Noblet's laboratory at California State University at San Bernardino (CSUSB). The Canyon Lake Marine Patrol provided watercraft and pilots for the sampling team.

Grab samples were collected at six locations on the lake (**Table 1, Figure 1**). Stations CLB2 and CLB3 are open water locations – one sample was collected from the surface on each sampling date. The two mid-lake sites were selected based on water skiing and boating use. Stations CLB1, CLB4, CLB5, and CLB6 are beach locations – three samples were collected from the nearshore surface at each station on each sampling date. Beach sites were selected based on the

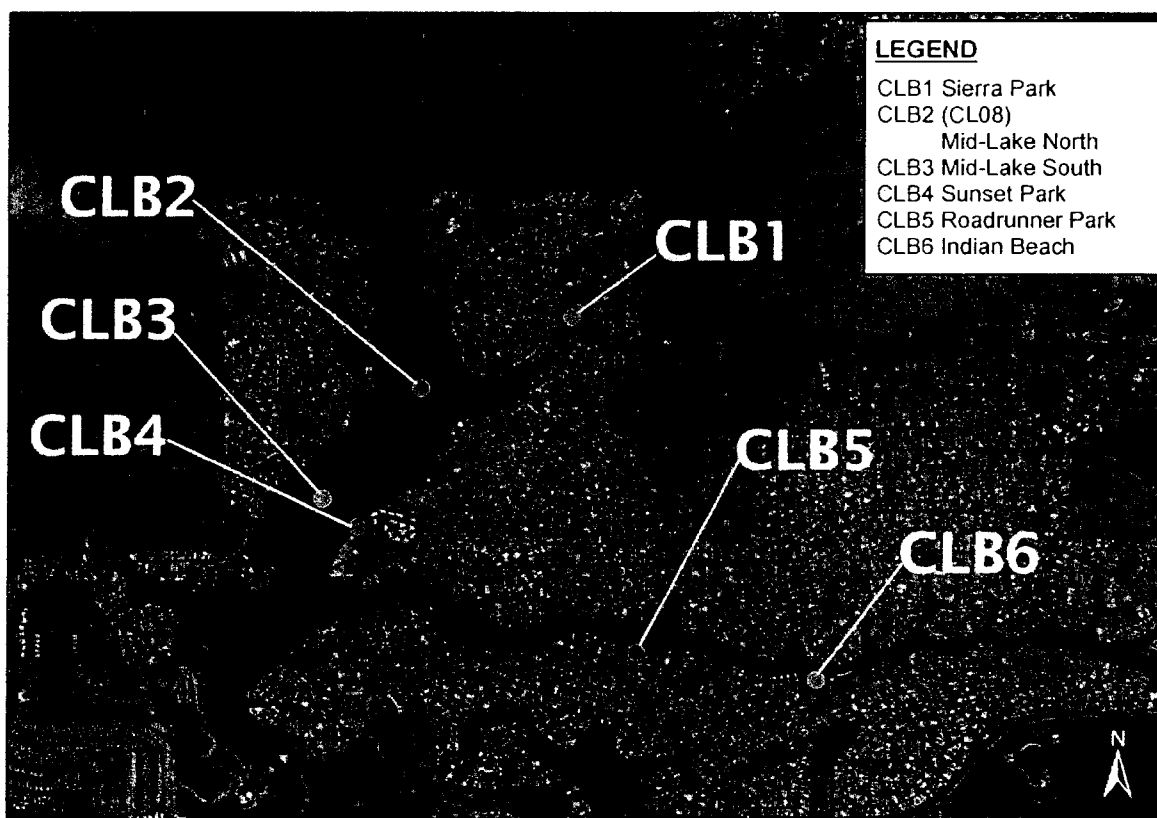
## Canyon Lake Bacteria Characterization

popularity of the beach (and therefore highest use) and include: Roadrunner Park, Indian Beach, Sunset Park, and Sierra Park.

**Table 1**  
**Latitude, Longitude and Altitude of Bacteria Sampling Stations**

Station	Latitude	Longitude	Altitude (feet)
CLB1	N33°41.598'	W117°15.674'	1,403
CLB2	N33°41.300'	W117°16.136'	1,381
CLB3	N33°41.193'	W117°16.272'	1,381
CLB4	N33°41.091'	W117°16.238'	1,394
CLB5	N33°40.815'	W117°15.470'	1,392
CLB6	N33°40.753'	W117°15.056'	1,394

**Figure 1**



**CANYON LAKE SAMPLING STATIONS**  
**2009 BACTERIAL INDICATOR MONITORING PROGRAM**

## Canyon Lake Bacteria Characterization

### Analysis

Sampling and analysis were conducted in accordance with the CSUSB Water Quality Laboratory Standard Operating Procedures (see the Quality Assurance Project Plan (QAPP) for this project, February 2009). Sampling was performed in accordance with the procedures described in section 9060A of *Standard Methods*. All samples were processed as soon as possible upon return to the lab, but in no case was the transport and processing time in excess of 6 hours from the time of collection. Samples were processed by the IDEXX Quanti-Tray Method in a manner consistent with the general description of the Enzyme Substrate Test in section 9223B of *Standard Methods*. Conductivity, pH, and temperature were measured at each station via field meters on all sample dates.

### Results

#### Meteorological Conditions

Sampling was conducted during the mornings on each sample date. **Table 2** summarizes meteorological conditions recorded near Canyon Lake for each date. Air temperatures ranged from 41.1 to 80.3 degrees F and winds were generally calm.

# Canyon Lake Bacteria Characterization

**Table 2**  
**Meteorological Conditions on the Bacteria Sampling Dates**  
**(at approximately 0900)**

Sampling Date (2009)	Air Temperature (degrees F)	Wind Speed/Direction	Precipitation (inches)
January 30	68.6	9 mph W	0
February 6	56.0	8 mph S	0
February 13	41.1	calm	0
February 20	57.1	calm	0
February 27	49.9	calm	0
March 6	49.5	calm	0
March 13	49.5	calm	0
March 20	57.0	calm	0
June 5	63.5	5 mph NE	0
June 12	63.5	2 mph N	0
June 19	76.0	calm	0
June 26	71.3	calm	0
July 3	74.7	calm	0
July 10	73.2	calm	0
July 17	80.3	calm	0
July 24	75.3	calm	0
July 31	69.3	calm	0
August 7	67.3	calm	0
August 14	68.0	calm	0
August 21	73.5	calm	0
August 28	78.7	calm	0
September 4	79.3	calm	0
September 11	79.1	calm	0
September 18	79.4	calm	0
September 25	76.9	calm	0
October 2	69.0	calm	0

Source: weathercurrents.com

## Water Quality Conditions

Conductivity, pH, and temperature were measured at each station on each sample date; results are included in Appendix A and summarized in Table 3.

**Table 3**  
**Summary of Water Quality Conditions**  
**During the Bacteria Characterization Sampling Periods**

	8-week period (1/30/09 to 3/20/09)			14-week period (6/5/09 to 9/4/09)		
	Conductivity (us/cm)	pH	Temperature (degrees C)	Conductivity (us/cm)	pH	Temperature (degrees C)
<b>Min</b>	742	7.57	11.1	1,010	8.42	21.3
<b>Max</b>	1,159	9.41	18.1	1,148	9.37	29.6

# Canyon Lake Bacteria Characterization

<b>Avg</b>	963	8.64	13.7	1,069	9.01	26.6
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## Bacteria Characterization

Running geometric means were calculated from each of the sites and from each of the two areas (open water and beaches) sampled (Tables 4 and 5). Sampling was conducted weekly for 8 weeks in January to March 2009, and then weekly for 14 weeks in June to September 2009. All data are included in Appendix A. The Appendix also includes additional results for September 11 to October 2, 2009 – results from the additional 4 weeks are consistent with data from the 8-week and 14-week sampling periods.

**Table 4**  
**Summary of *E. Coli* Geometric Means by Sample Location - Jan to March 2009**  
**(MPN/100 ml)**

Location	Range of Dates for Geometric Means (2009)			
	1/30 – 2/27	2/6 – 3/6	2/13 – 3/13	2/20 – 3/20
CLB1	9.36	8.72	8.96	11.62
CLB2	2.31	1.84	1.84	1.84
CLB3	1.58*	1.66	1.66	1.66
CLB4	2.65	1.91	1.86	1.61
CLB5	12.55	9.82	5.81	4.78
CLB6	26.35	24.51	15.31	10.34
Beach Locations	1.95	1.75	1.75	1.75
Open Water Locations	9.51	7.96	6.20	5.52

Note:

For values <1 MPN/100ml, a value of 1.0 was used for geometric mean calculations.

\*Geometric mean based on 4 data points since no data from this station on 1/30/09 (station added after this date).

**Table 5**  
**Summary of *E. Coli* Geometric Means by Sample Location - June to Sept 2009**  
**(MPN/100 ml)**

Location	Range of Dates for Geometric means (2009)									
	6/5 – 7/3	6/12 – 7/10	6/19 – 7/17	6/26 – 7/24	7/3 – 7/31	7/10 – 8/7	7/17 – 8/14	7/24 – 8/21	7/31 – 8/28	8/7 – 9/4
CLB1	8.95	14.45	15.64	15.69	14.23	7.48	6.59	11.56	8.30	8.72
CLB2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CLB3	1.32	1.32	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CLB4	11.19	6.74	2.95	2.07	1.55	1.36	1.36	1.36	1.30	1.28
CLB5	6.70	5.64	4.23	5.96	5.56	4.52	6.43	6.36	2.86	3.29
CLB6	13.22	10.29	9.67	10.37	18.70	15.03	35.88	39.40	28.86	16.53
Beach Locations	1.15	1.15	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Open Water Locations	9.70	8.67	6.59	6.69	6.93	5.13	6.75	7.93	5.46	4.96

Notes:

For values <1 MPN/100ml, a value of 1.0 was used for geometric mean calculations.

Geometric means including Station CLB6(3) on 7/31/09 are based on a value of 2419.6 (maximum reading possible given the dilution) (actual value is >2419.6).

## Canyon Lake Bacteria Characterization

### Quality Assurance / Quality Control

Quality Assurance / Quality Control procedures for the sampling program are outlined in the QAPP for the project. Results of duplicates, blanks, and the pre-study sampling conducted to develop precision criteria are presented in Appendix A.

### Discussion

A total of 32 geometric means were calculated for the 8-week study (January 30 to March 20, 2009) and 80 geometric means were calculated for the 14-week study (June 5 to September 4, 2009). The range of individual values observed was < 1 to >2419.6 MPN/100 ml. The range of geometric means during the two sampling periods was 1 to 39.4 MPN/100 ml. During both sampling periods, open water locations had lower *E. coli* concentrations than beach locations. Based on the data collected from these six stations during the 8- and 14-week sampling periods, the geometric means of *E. coli* densities at each station were consistently below the 126 per 100/ml standard.

## **Appendix A**

### **Canyon Lake Bacteria Data**



# Canyon Lake Bacteria Characterization

## Canyon Lake Bacteria Study Pre-Study Sampling for Precision Criterion Development (January 16, 2009)

	TC	TC	EC	EC			R <sub>log</sub>
Site	Rep 1	Rep 2	Rep 1	Rep 2	Log EC1	Log EC2	LEC1-LEC2
Sierra Park Beach 1	>2419.6	>2419.6	4.1	6.3	0.6128	0.7993	0.1866
Sierra Park Beach 2	>2419.6	>2419.6	3.1	4.1	0.4914	0.6128	0.1214
Sierra Park Beach 3	>2419.6	>2419.6	3.0	5.2	0.4771	0.7160	0.2389
Station 8 - 1	>2419.6	>2419.6	4.1	2.0	0.6128	0.3010	0.3118
Station 8 - 2	1986.3	>2419.6	1.0	3.0	0.0000	0.4771	0.4771
Station 8 - 3	>2419.6	>2419.6	4.1	2.0	0.6128	0.3010	0.3118
Sunset Beach 1	>2419.6	>2419.6	4.1	1.0	0.6128	0.0000	0.6128
Sunset Beach 2	>2419.6	>2419.6	3.0*	<1*	0.6021	0.0000	0.6021
Sunset Beach 3	>2419.6	>2419.6	4.1	6.3	0.6128	0.7993	0.1866
Road Runner Beach 1	686.7	1553.1	8.6	16.0	0.9345	1.2041	0.2696
Road Runner Beach 2 (Dock)	501.2	436.6	5.2	4.1	0.7160	0.6128	0.1032
Road Runner Beach 3	1986.3	1732.9	11.0	19.5	1.0414	1.2900	0.2486
Indian Beach -1	>2419.6	>2419.6	48.8	47.1	1.6884	1.6730	0.0154
Indian Beach -2	1119.9	770.1	13.4	10.9	1.1271	1.0374	0.0897
Indian Beach -3	1299.7	980.4	11.9	11.0	1.0755	1.0414	0.0342
Small Dock -1 (few blocks down Continental way)	920.8	579.4	21.1	34.1	1.3243	1.5328	0.2085
						ΣR <sub>log</sub> =	4.0181
						Ravg =	0.2511
Precision Criterion = 3.27 Ravg =0.8212							

\* Added 1 to both values before log transforming as per Standard Methods when one of the two replicate values is <1.

## Canyon Lake Bacteria Characterization

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) Preliminary 2-Week Period Prior to Start of the Study Period

	12/19/2008*		12/23/2008*	
Station	TC	EC	TC	EC
CLB1-1	>2419.6	547.5 (1)	>24219.6	28.7
CLB1-2				
CLB1-3				
CLB2	>2419.6	275.5	>24219.6	12.1
CLB3				
CLB4-1	>2419.6	152.9	>24219.6	12.1
CLB4-2				
CLB4-3				
CLB5-1	>2419.6	1986.3	579.4	10
CLB5-2				
CLB5-3				
CLB6-1	>2419.6	>2419.6	1986.3	27.1
CLB6-2				
CLB6-3				
Dup1		648.8		
Dup2				
Blank	<1	<1	<1	<1

\* Sampling was conducted on these two preliminary dates prior to completion of the sampling plan.

(1) duplicate

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 8-Week Sampling Period

Station	1/30/2009		2/6/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	8.6	>2419.6	3
CLB1-2	>2419.6	10.9	>2419.6	5.2
CLB1-3	>2419.6	10.9	>2419.6	90.9
CLB2	>2419.6	3.1 (1)	>200.1	1.0
CLB3			>200.1	1.0
CLB4-1	>2419.6	6.3	>2419.6	3
CLB4-2	>2419.6	5.2	>2419.6	<1
CLB4-3	>2419.6	4.1 (2)	>2419.6	<1
CLB5-1	>2419.6	7.5	>2419.6	10.8
CLB5-2	>2419.6	4.1	>2419.6	149.7
CLB5-3	>2419.6	5.2	>2419.6	13.4 (1)
CLB6-1	>2419.6	19.9	>2419.6	8.5
CLB6-2	>2419.6	21.6	>2419.6	29.5
CLB6-3	>2419.6	24.3	>2419.6	28.8 (2)
Dup1	>2419.6	5.2	>2419.6	7.5
Dup2	>2419.6	3.1	>2419.6	29.5
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.4914		1.1271
	Log ECD1-2	0.7160		0.8751
	$R_{log}$ ECD1	0.2246		0.2520
	Log ECD2-1	0.6128		1.4594
	Log ECD2-2	0.4914		1.4698
	$R_{log}$ ECD2	0.1214		0.0104
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 8-Week Sampling Period (continued)

Station	2/13/2009		2/20/2009*	
	TC	EC	TC	EC
CLB1-1	>2419.6	5.2	>2419.6	6.3
CLB1-2	>2419.6	3.1	>2419.6	1
CLB1-3	>2419.6	22.3	>2419.6	6.3 (1)
CLB2	>2419.6	1.0	>2419.6	4.1 (2)
CLB3	>2419.6	1.0	>2419.6	<1
CLB4-1	>2419.6	2.0	>2419.6	4.1
CLB4-2	>2419.6	4.1	>2419.6	4.1
CLB4-3	>2419.6	1.0	>2419.6	1
CLB5-1	>2419.6	18.7	>2419.6	29.2
CLB5-2	>2419.6	18.5 (1)	>2419.6	41
CLB5-3	>2419.6	16.0	>2419.6	26.2
CLB6-1	>2419.6	13.4	>2419.6	25.6
CLB6-2	>2419.6	25.3 (2)	>2419.6	24.6
CLB6-3	>2419.6	21.3	>2419.6	43.2
Dup1	>2419.6	24.1	>2419.6	7.4
Dup2	>2419.6	18.7	>2419.6	<1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	1.2672		0.7993
	Log ECD1-2	1.3820		0.8692
	$R_{log} ECD1$	0.1148		0.0699
	Log ECD2-1	1.4031		0.6128
	Log ECD2-2	1.2718		0.0000
	$R_{log} ECD2$	0.1313		0.6128
	Both Passed?	yes		yes

\* Station CLB6 was sampled on 2/21/09 due to restricted access on 2/20/09.

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 8-Week Sampling Period (continued)

Station	2/27/2009		3/6/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	69.1	>2419.6	6.3
CLB1-2	>2419.6	4.1 (1)	>2419.6	3
CLB1-3	>2419.6	63.1	>2419.6	18.7
CLB2	>2419.6	5.2	>2419.6	<1
CLB3	>2419.6	6.3 (2)	>2419.6	2 (1)
CLB4-1	>2419.6	4.1	>2419.6	<1 (2)
CLB4-2	>2419.6	3.1	>2419.6	1
CLB4-3	>2419.6	3.1	>2419.6	1
CLB5-1	>2419.6	5.2	>2419.6	1
CLB5-2	>2419.6	1	>2419.6	2
CLB5-3	>2419.6	9.7	>2419.6	2
CLB6-1	>2419.6	291	>2419.6	38.4
CLB6-2	>2419.6	27.5	>2419.6	14.8
CLB6-3	>2419.6	17.3	>2419.6	6.2
Dup1	>2419.6	1	>2419.6	1
Dup2	>2419.6	13.5	>2419.6	<1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.6128		0.3010
	Log ECD1-2	0.0000		0.0000
	$R_{log}ECD1$	0.6128		0.3010
	Log ECD2-1	0.7993		0.0000
	Log ECD2-2	1.1303		0.0000
	$R_{log}ECD2$	0.3310		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 8-Week Sampling Period (continued)

Station	3/13/2009		3/20/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	23.9	>2419.6	97.1
CLB1-2	>2419.6	3	>2419.6	18.1
CLB1-3	>2419.6	29.6 (1)	>2419.6	10.2
CLB2	>2419.6	<1 (2)	>2419.6	<1 (1)
CLB3	>2419.6	<1	>2419.6	<1 (2)
CLB4-1	>2419.6	1	>2419.6	<1
CLB4-2	>2419.6	<1	>2419.6	<1
CLB4-3	>2419.6	2	>2419.6	<1
CLB5-1	>2419.6	1	>2419.6	25
CLB5-2	>2419.6	2	>2419.6	1
CLB5-3	>2419.6	4.1	>2419.6	12
CLB6-1	>2419.6	3.1	>2419.6	20.1
CLB6-2	>2419.6	1	>2419.6	1
CLB6-3	>2419.6	2	>2419.6	1
Dup1	>2419.6	43.5	>2419.6	<1
Dup2	>2419.6	1	>2419.6	<1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	1.4713		0.0000
	Log ECD1-2	1.6385		0.0000
	$R_{log} ECD1$	0.1672		0.0000
	Log ECD2-1	0.0000		0.0000
	Log ECD2-2	0.0000		0.0000
	$R_{log} ECD2$	0.0000		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period

	6/5/2009		6/12/2009	
Station	TC	EC	TC	EC
CLB1-1	>2419.6	<1	>2419.6	3.1
CLB1-2	>2419.6	2	>2419.6	1
CLB1-3	>2419.6	1	>2419.6	8.4
CLB2	>2419.6	<1	>2419.6	<1
CLB3	>2419.6	<1	>2419.6	2
CLB4-1	>2419.6	86.5	>2419.6	57.3
CLB4-2	>2419.6	6.3	>2419.6	86.5
CLB4-3	>2419.6	7.3	>2419.6	49.6
CLB5-1	>2419.6	4.1	>2419.6	25.3
CLB5-2**	>2419.6	<1	>2419.6	8.4
CLB5-3	>2419.6	9.8	>2419.6	49.6
CLB6-1	>2419.6	15.8	>2419.6	17.4
CLB6-2	>2419.6	4.1	>2419.6	20.1
CLB6-3	>2419.6	8.4	>2419.6	8.3
Dup1	>2419.6	--	>2419.6	--
Dup2	>2419.6	--	>2419.6	--
Blank	<1	<1	<1	<1



# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	6/19/2009		6/26/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	15.5	>2419.6	10.8
CLB1-2	>2419.6	3.1	>2419.6	12.1
CLB1-3	>2419.6	47.3	>2419.6	13.2 (1)
CLB2	>2419.6	<1 (1)	>2419.6	<1 (2)
CLB3	>2419.6	2 (2)	>2419.6	1
CLB4-1	>2419.6	12.1	>2419.6	12.2
CLB4-2	>2419.6	33.6	>2419.6	24.1
CLB4-3	>2419.6	<1	>2419.6	6.3
CLB5-1	>2419.6	9.5	>2419.6	14.8
CLB5-2	>2419.6	15.6	>2419.6	1
CLB5-3	>2419.6	6.3	>2419.6	3.1
CLB6-1	>2419.6	5.2	>2419.6	7.4
CLB6-2	>2419.6	8.2	>2419.6	67.7
CLB6-3	>2419.6	7.3	>2419.6	11
Dup1	>2419.6	<1	>2419.6	11
Dup2	>2419.6	<1	>2419.6	<1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.0000		1.1206
	Log ECD1-2	0.0000		1.0414
	$R_{log}ECD1$	0.0000		0.0792
	Log ECD2-1	0.3010		0.0000
	Log ECD2-2	0.0000		0.0000
	$R_{log}ECD2$	0.3010		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	7/3/2009		7/10/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	9.8	>2419.6	13.4
CLB1-2	>2419.6	72.3	>2419.6	10.9
CLB1-3	>2419.6	1299.7	>2419.6	18.3
CLB2	547.5	1.0 (1)	613.1	<1 (1)
CLB3	579.4	<1	435.2	<1 (2)
CLB4-1	648.8	7.3 (2)	686.7	<1
CLB4-2	488.4	1	920.8	<1
CLB4-3	461.1	1	>2419.6	2
CLB5-1	>2419.6	4.1	>2419.6	3.1
CLB5-2	>2419.6	6.3	1986.3	1
CLB5-3	>2419.6	5.2	>2419.6	1
CLB6-1	>2419.6	84.2	>2419.6	6.3
CLB6-2	>2419.6	19.9	>2419.6	2
CLB6-3	>2419.6	14.5	>2419.6	1
Dup1	686.7	1	387.3	<1
Dup2	727	13	648.8	1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.0000		0.0000
	Log ECD1-2	0.0000		0.0000
	$R_{log} ECD1$	0.0000		0.0000
	Log ECD2-1	0.8633		0.0000
	Log ECD2-2	1.1139		0.0000
	$R_{log} ECD2$	0.2506		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	7/17/2009		7/24/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	1	>2419.6	38.6
CLB1-2	>2419.6	3.1	>2419.6	6.3 (1)
CLB1-3	>2419.6	27.5	>2419.6	9.8
CLB2	727	<1	410.6	<1
CLB3	579.4	<1	228.2	<1
CLB4-1	770.1	<1 (1)	866.4	2
CLB4-2	1046.2	<1	1732.9	1
CLB4-3	209.8	<1	1119.9	<1
CLB5-1	>2419.6	11	>2419.6	6.3 (2)
CLB5-2	>2419.6	2	>2419.6	14.6
CLB5-3	>2419.6	6.3	>2419.6	1732.9
CLB6-1	>2419.6	9.6	>2419.6	6.1
CLB6-2	>2419.6	16.1 (2)	>2419.6	3
CLB6-3	>2419.6	7.4	>2419.6	49
Dup1	866.4	<1	>2419.6	10.7
Dup2	>2419.6	10.9	2419.6	6.3
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.0000		0.7993
	Log ECD1-2	0.0000		1.0294
	$R_{log}ECD1$	0.0000		0.2300
	Log ECD2-1	1.2068		0.7993
	Log ECD2-2	1.0374		0.7993
	$R_{log}ECD2$	0.1694		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	7/31/2009		8/7/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	2	>2419.6	14.6 (1)
CLB1-2	>2419.6	6.1 (1)	>2419.6	<1
CLB1-3	>2419.6	32.7	>2419.6	4.1
CLB2	686.7	<1	866.4	<1
CLB3	488.4	<1	727	<1
CLB4-1	2419.6	4.1 (2)	2419.6	<1
CLB4-2	1732.9	2	1986.3	1
CLB4-3	770.1	3.1	>2419.6	<1
CLB5-1	>2419.6	2	>2419.6	1
CLB5-2	>2419.6	2	>2419.6	2 (2)
CLB5-3	>2419.6	4.1	>2419.6	3
CLB6-1	>2419.6	51.2	>2419.6	4.1
CLB6-2	>2419.6	307.6	>2419.6	9.5
CLB6-3	>2419.6	>2419.6	>2419.6	23.5
Dup1	>2419.6	4.1	>2419.6	20.1
Dup2	1986.3	5.2	2419.6	1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.7853		1.1644
	Log ECD1-2	0.6128		1.3032
	$R_{log} ECD1$	0.1725		0.1388
	Log ECD2-1	0.6128		0.3010
	Log ECD2-2	0.7160		0.0000
	$R_{log} ECD2$	0.1032		0.3010
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	8/14/2009		8/21/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	2	>2419.6	71.7
CLB1-2	>2419.6	18.7	>2419.6	6.3
CLB1-3	>2419.6	10.6	>2419.6	866.4
CLB2	1299.7	<1	>2419.6	<1 (1)
CLB3	1119.9	<1	>2419.6	<1
CLB4-1	>2419.6	<1	>2419.6	<1
CLB4-2	1413.6	<1	>2419.6	<1
CLB4-3	1203.3	2	>2419.6	1
CLB5-1	>2419.6	35	>2419.6	19.7 (2)
CLB5-2	>2419.6	<1	>2419.6	2
CLB5-3	>2419.6	17.5 (1)	>2419.6	3
CLB6-1	>2419.6	66.3	>2419.6	9.7
CLB6-2	>2419.6	122.2	>2419.6	16
CLB6-3	>2419.6	727 (2)	>2419.6	29.9
Dup1	>2419.6	8.6	1553.1	1
Dup2	>2419.6	579.4	>2419.6	16.1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	1.2430		0.0000
	Log ECD1-2	0.9345		0.0000
	$R_{log}$ ECD1	0.3085		0.0000
	Log ECD2-1	2.8615		1.2945
	Log ECD2-2	2.7630		1.2068
	$R_{log}$ ECD2	0.0986		0.0876
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) 14-Week Sampling Period (continued)

Station	8/28/2009		9/4/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	2	>2419.6	13.2
CLB1-2	>2419.6	2	>2419.6	3
CLB1-3	>2419.6	4.1	>2419.6	21.3
CLB2	>2419.6	<1 (1)	>2419.6	<1 (1)
CLB3	1732.9	<1	>2419.6	1
CLB4-1	>2419.6	<1	>2419.6	<1
CLB4-2	>2419.6	<1	>2419.6	<1
CLB4-3	>2419.6	<1	>2419.6	19.7
CLB5-1	>2419.6	1	>2419.6	5.2
CLB5-2	>2419.6	<1	>2419.6	4.1
CLB5-3	>2419.6	1 (2)	>2419.6	6.2 (2)
CLB6-1	>2419.6	8.4	>2419.6	20.1
CLB6-2	>2419.6	<1	>2419.6	6.3
CLB6-3	>2419.6	1	>2419.6	70.5
Dup1	>2419.6	<1	>2419.6	<1
Dup2	>2419.6	<1	>2419.6	8.5
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{\log} < 0.8212$	Log ECD1-1	0.0000		0.0000
	Log ECD1-2	0.0000		0.0000
	$R_{\log}$ ECD1	0.0000		0.0000
	Log ECD2-1	0.0000		0.7924
	Log ECD2-2	0.0000		0.9294
	$R_{\log}$ ECD2	0.0000		0.1370
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) Additional Data After the 14-Week Sampling Period

Station	09/11/09		9/18/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	2	>2419.6	39
CLB1-2	>2419.6	6.3	>2419.6	18.5
CLB1-3	>2419.6	5.1 (1)	>2419.6	128.1
CLB2	>2419.6	<1	>2419.6	1 (1)
CLB3	>2419.6	<1	2419.6	<1
CLB4-1	>2419.6	1	1986.3	<1
CLB4-2	>2419.6	4.1 (2)	2419.6	1
CLB4-3	>2419.6	3.1	1986.3	<1
CLB5-1	>2419.6	6.1	>2419.6	4.1 (2)
CLB5-2	>2419.6	5.2	>2419.6	<1
CLB5-3	>2419.6	8.1	>2419.6	3
CLB6-1	>2419.6	54.3	>2419.6	2
CLB6-2	>2419.6	18.1	>2419.6	17.1
CLB6-3	>2419.6	15.8	>2419.6	7.4
Dup1	>2419.6	6.1	2419.6	<1
Dup2	>2419.6	1	>2419.6	4.1
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	0.7076		0.0000
	Log ECD1-2	0.7853		0.0000
	$R_{log} ECD1$	0.0778		0.0000
	Log ECD2-1	0.6128		0.6128
	Log ECD2-2	0.0000		0.6128
	$R_{log} ECD2$	0.6128		0.0000
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2

# Canyon Lake Bacteria Characterization

## Bacteria Results (Total Coliform and *E. coli*) Additional Data After the 14-Week Sampling Period (continued)

Station	9/25/2009		10/2/2009	
	TC	EC	TC	EC
CLB1-1	>2419.6	31.6	>2419.6	17.1
CLB1-2	>2419.6	<1	>2419.6	1
CLB1-3	>2419.6	10.9 (1)	>2419.6	2
CLB2	1986.3	1	>2419.6	1
CLB3	1986.3	<1	>2419.6	<1
CLB4-1	770.1	<1	>2419.6	<1
CLB4-2	1119.9	<1	>2419.6	<1
CLB4-3	>2419.6	<1 (2)	>2419.6	2 (1)
CLB5-1	>2419.6	2	>2419.6	23.1
CLB5-2	>2419.6	1	>2419.6	1
CLB5-3	>2419.6	<1	>2419.6	4.1
CLB6-1	>2419.6	3	>2419.6	5.2
CLB6-2	>2419.6	6.1	>2419.6	37.2
CLB6-3	>2419.6	2	>2419.6	24.3 (2)
Dup1	>2419.6	12	>2419.6	2
Dup2	>2419.6	<1	>2419.6	9.5
Blank	<1	<1	<1	<1
QA Precision Analysis Precision Criterion $R_{log} < 0.8212$	Log ECD1-1	1.0374		0.3010
	Log ECD1-2	1.0792		0.3010
	$R_{log}ECD1$	0.0418		0.0000
	Log ECD2-1	0.0000		1.3856
	Log ECD2-2	0.0000		0.9777
	$R_{log}ECD2$	0.0000		0.4079
	Both Passed?	yes		yes

(1) – duplicate #1

(2) – duplicate #2



# Canyon Lake Bacteria Characterization

## Water Quality Conditions During the 8-Week Sampling Period

Date	Location	Conductivity μS/cm	pH	Temp °C
1/30/2009	CLB1	1159	8.25	11.3
	CLB2	1122	8.22	11.8
	CLB3	1129	8.23	11.8
	CLB4	1117	8.59	12.1
	CLB5	936	7.92	11.8
	CLB6	911	8.02	12.8
2/6/2009	CLB1	1146	8.80	13.0
	CLB2	1118	8.70	12.5
	CLB3	1118	8.58	12.3
	CLB4	1124	8.57	12.3
	CLB5	900	8.85	12.7
	CLB6	791	8.63	13.2
2/13/2009	CLB1	1034	8.41	12.1
	CLB2	952	8.57	11.9
	CLB3	1009	8.58	11.9
	CLB4	1031	8.56	11.8
	CLB5	896	8.14	11.3
	CLB6	870	8.41	11.1
2/20/2009	CLB1	1040	7.87	11.6
	CLB2	1007	8.25	12.2
	CLB3	1010	8.25	12.1
	CLB4	1002	8.28	12.2
	CLB5	819	7.81	11.6
	CLB6	742	7.57	13.0
2/27/2009	CLB1	970	8.64	14.3
	CLB2	901	8.67	14.2
	CLB3	982	8.69	14.2
	CLB4	984	8.71	13.9
	CLB5	811	8.43	14.1
	CLB6	984	8.71	13.9
3/6/2009	CLB1	973	8.70	14.2
	CLB2	963	8.90	14.6
	CLB3	977	8.91	14.6
3/6/2009	CLB4	991	8.89	14.6
	CLB5	808	9.01	14.3
	CLB6	752	9.02	14.6
3/13/2009	CLB1	992	8.66	14.4
	CLB2	982	9.06	14.9
	CLB3	954	9.07	14.9
	CLB4	985	9.14	15.4
	CLB5	824	9.24	15.7
	CLB6	808	9.05	15.6
3/20/2009	CLB1	996	9.06	17.1

# Canyon Lake Bacteria Characterization

Date	Location	Conductivity μS/cm	pH	Temp °C
	CLB2	973	9.13	17.6
	CLB3	974	9.14	17.6
	CLB4	984	9.17	17.6
	CLB5	836	9.41	18.1
	CLB6	842	9.32	18.1

## Water Quality Conditions During the 14-Week Sampling Period (plus additional 4-week period 9/11/09 to 10/2/09)

Date	Location	Conductivity μS/cm	pH	Temp °C
6/5/2009	CLB1	1010	9.19	23.9
	CLB2	1076	9.00	24.0
	CLB3	1077	9.07	23.8
	CLB4	1020	9.22	24.0
	CLB5	1023	9.19	23.8
	CLB6	1028	9.18	24.3
6/12/2009	CLB1	1036	9.04	21.6
	CLB2	1038	9.05	21.9
	CLB3	1036	9.13	21.8
	CLB4	1021	9.16	21.9
	CLB5	1036	9.00	21.8
	CLB6	1053	9.03	22.2
6/19/2009	CLB1	1035	9.19	24.3
	CLB2	1051	9.21	24.4
	CLB3	1015	9.22	24.2
	CLB4	1036	9.19	25.4
	CLB5	1048	9.24	24.5
	CLB6	1062	9.24	25.5
6/26/2009	CLB1	1041	9.18	25.6
	CLB2	1039	9.21	25.8
	CLB3	1050	9.21	25.7
	CLB4	1039	9.20	25.8
	CLB5	1054	9.37	25.4
	CLB6	1066	9.33	26.9
7/3/2009	CLB1	1046	9.07	27.1
	CLB2	1057	9.17	27.4
	CLB3	1043	9.18	26.7
	CLB4	1072	9.18	27.2
	CLB5	1037	9.17	27.3
	CLB6	1076	9.10	27.8
7/10/2009	CLB1	1035	8.94	26.8

# Canyon Lake Bacteria Characterization

Date	Location	Conductivity μS/cm	pH	Temp °C
	CLB2	1094	9.13	25.8
	CLB3	1051	9.06	25.7
	CLB4	1071	9.03	23.6
	CLB5	1056	9.09	26.8
	CLB6	1066	9.09	26.4
7/17/2009	CLB1	1075	8.95	28.3
	CLB2	1060	9.03	28.4
	CLB3	1063	9.03	28.3
	CLB4	1061	9.05	28.4
	CLB5	1067	9.10	28.5
	CLB6	1085	9.05	28.8
7/24/2009	CLB1	1061	8.94	29.1
	CLB2	1141	8.86	29.3
	CLB3	1085	8.98	29.1
	CLB4	1083	8.99	28.9
	CLB5	1075	9.04	29.6
	CLB6	1140	8.99	29.6
7/31/2009	CLB1	1065	8.86	28.4
	CLB2	1060	8.98	28.5
	CLB3	1062	8.99	28.5
	CLB4	1065	9.00	28.4
	CLB5	1061	8.92	28.1
	CLB6	1065	8.84	27.9
8/7/2009	CLB1	1081	8.96	27.5
	CLB2	1071	9.01	27.5
	CLB3	1090	9.00	27.5
	CLB4	1071	9.00	27.2
	CLB5	1093	8.57	27.2
	CLB6	1094	8.60	27.5
8/14/2009	CLB1	1060	8.93	27.5
	CLB2	1066	9.02	27.6
	CLB3	1067	9.02	27.7
	CLB4	1071	9.03	27.4
	CLB5	1068	8.65	27.2
	CLB6	1092	8.42	27.3
8/21/2009	CLB1	1095	8.88	27.3
	CLB2	1148	8.97	27.3
	CLB3	1077	9.00	27.3
	CLB4	1079	9.00	27.3
	CLB5	1095	8.79	27.0
	CLB6	1104	8.71	27.4
8/28/2009	CLB1	1092	8.85	27.0
	CLB2	1093	8.93	27.1
	CLB3	1088	8.95	27.0

# Canyon Lake Bacteria Characterization

Date	Location	Conductivity μS/cm	pH	Temp °C
	CLB4	1093	8.92	21.3
	CLB5	1112	8.72	26.6
	CLB6	1117	8.69	28.1
9/4/2009	CLB1	1091	8.88	27.9
	CLB2	1086	8.99	28.1
	CLB3	1104	8.96	28.0
	CLB4	1095	8.95	27.9
	CLB5	1107	8.70	28.4
	CLB6	1136	8.59	28.7
9/11/2009	CLB1	1074	8.66	26.4
	CLB2	1094	8.77	26.5
	CLB3	1094	8.80	26.5
	CLB4	1098	8.82	26.5
	CLB5	1114	8.62	26.3
	CLB6	1141	8.62	26.6
9/18/2009	CLB1	1093	8.63	25.9
	CLB2	1104	8.79	26.0
	CLB3	1103	8.85	26.3
	CLB4	1095	8.85	26.2
	CLB5	1155	8.64	25.8
	CLB6	1194	8.74	26.8
9/25/2009	CLB1	1080	8.66	24.9
	CLB2	1089	8.78	25.6
	CLB3	1095	8.78	25.4
	CLB4	1099	8.77	25.2
	CLB5	1160	8.54	25.2
	CLB6	1186	8.54	25.3
10/2/2009	CLB1	1166	8.39	23.0
	CLB2	1113	8.53	23.8
	CLB3	1115	8.58	23.8
	CLB4	1114	8.64	24.0
	CLB5	1174	8.28	23.4
	CLB6	1202	8.59	23.4