

**To:** CREST Steering Committee and Working Technical Group

**From:** CREST Consulting Team

**Re:** Freshwater Reference Site Conditions, Calculation of Allowable Exceedance Days, and Consideration Points for the LA River Bacteria TMDL

The targets and wasteload allocations used for Bacteria TMDLs in Region 4 are typically based on a reference watershed (RW) approach. The RW approach uses the rates of water quality objective (WQO) exceedance at a reference/undeveloped site to calculate a number of “allowable exceedance days” for impaired watersheds. Specifically, the RW approach uses the product of (1) exceedance rates of water quality objectives (WQOs) at a reference/background site and (2) the number of days during a critical year. Previous TMDLs used 1993 as a critical (90<sup>th</sup> percentile) wet year to determine the number of days during summer dry weather, winter dry weather, and wet weather. To date, exceedance rates have been based on samples collected from the wave wash of Leo Carrillo Beach, as shown in **Table 1**.

**Table 1. Current Allowable Exceedance Days based on Marine Reference Site Leo Carrillo Beach**

Day Type	Number of Days during Critical Year (1)	Single Sample Maximum Exceedance Rate at Leo Carrillo Beach <sup>a</sup> (2)	Allowable Number of Exceedance Days based on Daily Sampling (1 x 2)
Wet	75	22%	17
Winter Dry Weather (Nov. 1 – March 31)	122	3%	3
Summer Dry Weather (April 1 – Oct. 31)	168	0%	0

a – Leo Carrillo Beach never exceeded the geometric mean WQOs.

The use of a marine beach as a reference site for inland watersheds is questionable. The Malibu Creek and Ballona Creek Bacteria TMDLs acknowledged this shortcoming and recommended monitoring of freshwater reference sites. The Southern California Coastal Water Research Program (SCCWRP) has conducted three studies that included bacteria monitoring of freshwater reference sites. Each of the following datasets was compiled into the LA River Bacteria TMDL database:

- **Natural Landscapes Study** (Technical Report 500) – monitored 22 reference sites distributed throughout Southern California, from Ventura County to San Diego County, between spring 2005 and spring 2006. Both dry and wet weather were sampled and analyzed herein.
- **Fecal Indicator Bacteria in Reference Streams** (“FIB Study”; Technical Report 542) – monitored 15 reference sites distributed throughout Southern California, from Ventura County to San Diego County, approximately weekly between spring 2006 and spring 2007. Some samples were collected during wet days, but SCCWRP recommended that we not use these data to represent wet weather conditions. Thus only dry weather samples from this dataset were analyzed herein.
- **Reference Beaches during Wet Weather** (Technical Report 448) – monitored four reference beach sites and nearby freshwater outlets from fall 2004 to winter 2005. Monitoring was only conducted during wet weather and freshwater samples were collected prior to mixing with the ocean. All wet weather data from this dataset were analyzed herein.

These data were compiled from SCCWRP for the LA River Bacteria TMDL database and analyzed using the methodology of previous TMDLs (above). A total of 24 sites were analyzed. A rolling

geometric mean was calculated in cases where five samples were collected from a site within 30 days. The results are shown in **Table 2** (wet weather) and **Table 3** (dry weather).

Overall, when compared to Leo Carrillo Beach, it is clear that freshwater sites are subject to higher exceedance rates during summer dry weather. Exceedances during summer months were much more common than during winter months (**Figure 1**). The rates of exceedance for *Enterococcus* were higher than for *E. coli*. In addition, unlike Leo Carrillo Beach, the freshwater sites are subject to exceedances of geometric mean WQOs, often at rates higher than for the SSM WQO. The fact that the geometric mean exceeded more often than the SSM is due to either (1) the measured concentrations were often above the geometric mean WQO but below the SSM WQO or (2) exceptionally-high single samples led to 30-day geometric mean WQO exceedances.

The following two consideration points highlight site selection characteristics that could affect calculations of allowable exceedance days for the TMDL.

### **Consideration Point #1: Should “Minimally-Impacted” Sites be Included in the Analysis of Allowable Exceedance Days?**

During their data analysis effort, SCCWRP identified three sites from the FIB Study that exhibited exceptionally-high concentrations of *E.coli* and *Enterococcus*: Cheseboro Canyon (LA County), Stone Creek (San Diego County), and Cajon Creek (San Bernardino County). The analysis of the dataset without these sites is shown in **Table 4** (wet weather) and **Table 5** (dry weather). Also, **Figure 1** shows monthly trends with and without minimally impacted sites. Retrospectively, SCCWRP identified conditions that could have led to the exceptionally-high values. For instance, Cajon Creek is nearby a major highway and Cheseboro Canyon was subject to a fire and has heavily-used trails. Based on this analysis, SCCWRP re-categorized these sites as “minimally impacted” as opposed to “reference.” However, it is uncertain whether other “reference” sites also had the aforementioned conditions, and thus it is unclear whether minimally impacted sites should be removed from the dataset used to calculate exceedance days. At the same time, it may be appropriate to strive for “minimally impacted” conditions in highly-urbanized watersheds. Removal of minimally-impacted sites would significantly reduce the number of allowable exceedance days. Ultimately, the determination of whether to remove minimally impacted sites is a regulatory decision for the Regional Board and USEPA.

### **Consideration Point #2: Should Ephemeral Sites be Included in the Analysis of Allowable Exceedance Days?**

During their FIB Study data analysis effort, SCCWRP also noticed that perennial sites typically exhibited lower concentrations than ephemeral sites during dry weather, as shown in **Figure 2**. The LA River and most of its major tributaries are perennial, often due to POTW and/or urban runoff discharges. However, runoff from the open space of the watershed, which comprises over 40% of the watershed area, is predominantly ephemeral. Thus whether to include or exclude ephemeral sites is a consideration moving forward. Ultimately, the determination of whether to remove ephemeral sites is a regulatory decision for the Regional Board and USEPA.

**Table 2. All SCCWRP Freshwater Reference Sites including Minimally Impacted Sites: Wet Weather Exceedance Frequency of Single Sample Maximum WQOs (2004-2006)<sup>1</sup>**

Statistic	Wet Weather Events	
	<i>E. coli</i> Single Samples	<i>Enterococcus</i> Single Samples <sup>3</sup>
<b>% WQO Exceedance</b>	20%	49% (32%)
<b>Number of Exceedance Days<sup>2</sup></b>	15	37 (24)
Number of Data Points	71	71
Number > WQO	14	35
Mean (MPN/100mL)	361	580
Geomean (MPN/100mL)	65	57
Minimum (MPN/100mL)	10	10
10 <sup>th</sup> Percentile (MPN/100mL)	10	10
25 <sup>th</sup> Percentile (MPN/100mL)	10	10
50 <sup>th</sup> Percentile (MPN/100mL)	59	52
75 <sup>th</sup> Percentile (MPN/100mL)	164	165
90 <sup>th</sup> Percentile (MPN/100mL)	870	410
Maximum (MPN/100mL)	6,815	16,743

**1** – This table is based on the wet weather data that were collected during the studies that are summarized in SCCWRP Technical Reports 500 and 448. A total of 12 sites are included.

**2** – The number of exceedances days under daily sampling is calculated as: (% WQO Exceedance x Number of Days during Critical Condition Storm Year [1993]). In 1993, there were 75 wet days.

**3** – This table uses the freshwater SSM WQO for *Enterococcus* (61 MPN/100mL). For direct comparison to currently used exceedance days, the marine SSM WQO (104 MPN/100mL) exceedance rates are shown in parentheses

**Table 3. All SCCWRP Freshwater Reference Sites including Minimally Impacted Sites: Dry Weather Exceedance Frequency of Single Sample Maximum and Geometric Mean WQOs for (2005-2007)<sup>1</sup>**

Statistic	<i>E. coli</i>						<i>Enterococcus</i> <sup>3</sup> (w/ marine WQO)					
	All Dry Weather Dates		Summer Dry Weather (April 1 – Oct.31)		Winter Dry Weather (Nov. 1 – March 31)		All Dry Weather Dates		Summer Dry Weather (April 1 – Oct. 31)		Winter Dry Weather (Nov. 1 – March 31)	
	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans
<b>% WQO Exceedance</b>	7%	16%	9%	20%	5%	5%	31% (20%)	44% (42%)	38% (26%)	52% (50%)	16% (10%)	23% (22%)
<b>Number of Exceedance Days<sup>2</sup></b>	21	46	15	33	6	6	89 (59)	128 (123)	65 (43)	88 (85)	19 (12)	28 (26)
Number of Data Points	598	346	399	252	199	94	598	349	398	252	200	97
Number > WQO	44	55	35	50	9	5	184	154	153	132	31	22
Mean (MPN/100mL)	144	72	194	85	44	35	94	66	120	82	41	24
Geomean (MPN/100mL)	21	---	26	---	14	---	31	---	41	---	18	---
Minimum (MPN/100mL)	1	1	1	1	1	1	1	3	1	4	1	3
10 <sup>th</sup> Percentile (MPN/100mL)	10	10	10	10	10	10	10	11	10	13	10	10
25 <sup>th</sup> Percentile (MPN/100mL)	10	10	10	10	10	10	10	15	10	20	10	11
50 <sup>th</sup> Percentile (MPN/100mL)	10	16	10	19	10	11	20	26	31	35	10	13
75 <sup>th</sup> Percentile (MPN/100mL)	52	52	74	90	20	20	74	64	110	89	30	31
90 <sup>th</sup> Percentile (MPN/100mL)	173	222	202	234	75	64	223	179	280	231	87	53
Maximum (MPN/100mL)	18,600	1,262	18,600	1,262	882	441	7,270	590	7,270	590	1,408	94

**1** – This table is based on the dry weather data collected during the studies that are summarized in SCCWRP Technical Reports 500 and 542. A total of 24 sites are included.

**2** – The number of exceedances days under daily sampling is calculated as: (% WQO Exceedance x Number of Days during Critical Condition Storm Year [1993]). In 1993, there were 365 days, 122 winter dry weather days, and 168 summer dry weather days. The geometric mean exceedance day calculation is based on a rolling average; note this calculation is not utilized under the current RW approach and could be performed a number of ways.

**3** – This table uses freshwater WQOs for *Enterococcus* (61 MPN/100mL for SSM and 33 MPN/100mL for the geometric mean). For direct comparison to currently used exceedance days, marine WQO exceedance rates are shown in parentheses.

**Table 4. SCCWRP Freshwater Reference Sites without Minimally Impacted Sites: Wet Weather Exceedance Frequency of Single Sample Maximum WQOs (2004-2006)<sup>1</sup>**

Statistic	Wet Weather Events	
	<i>E. coli</i> Single Samples	<i>Enterococcus</i> Single Samples <sup>3</sup>
<b>% WQO Exceedance</b>	19%	49% (31%)
<b>Number of Exceedance Days<sup>2</sup></b>	14	36 (24)
Number of Data Points	70	70
Number > WQO	13	34 (22)
Mean (MPN/100mL)	349	559
Geomean (MPN/100mL)	62	54
Minimum (MPN/100mL)	10	10
10 <sup>th</sup> Percentile (MPN/100mL)	10	10
25 <sup>th</sup> Percentile (MPN/100mL)	10	10
50 <sup>th</sup> Percentile (MPN/100mL)	55	52
75 <sup>th</sup> Percentile (MPN/100mL)	156	155
90 <sup>th</sup> Percentile (MPN/100mL)	703	383
Maximum (MPN/100mL)	6,815	16,743

**1** – This table is based on the wet weather data that were collected during the studies that are summarized in SCCWRP Technical Reports 500 and 448 but does not include “minimally impacted sites” discussed previously in this memo. A total of 11 sites are included.

**2** – The number of exceedances days under daily sampling is calculated as: (% WQO Exceedance x Number of Days during Critical Condition Storm Year [1993]). In 1993, there were 75 wet days.

**3** –This table uses the freshwater SSM WQO for *Enterococcus* (61 MPN/100mL). For direct comparison to currently used exceedance days, the marine SSM WQO (104 MPN/100mL) exceedance rates are shown in parentheses

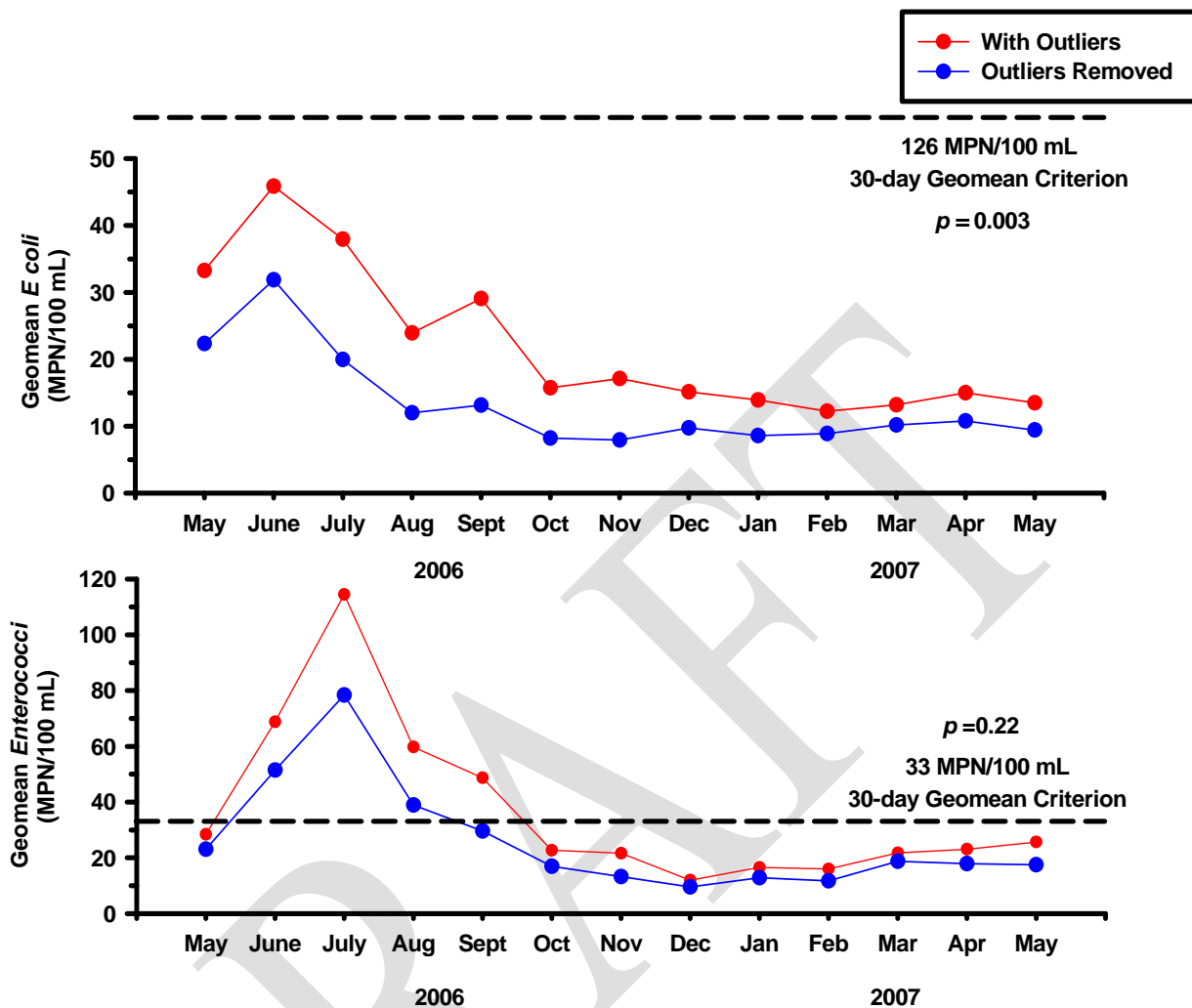
Table 5. SCCWRP Freshwater Reference Sites without Minimally Impacted Sites Dry Weather Exceedance Frequency of Single Sample Maximum and Geometric Mean WQOs (2005-2007)<sup>1</sup>

Statistic	<i>E. coli</i>						<i>Enterococcus</i> <sup>3</sup> (w/ marine WQO)					
	All Dry Weather Dates		Summer Dry Weather (April 1 – Oct.31)		Winter Dry Weather (Nov. 1 – March 31)		All Dry Weather Dates		Summer Dry Weather (April 1 – Oct. 31)		Winter Dry Weather (Nov. 1 – March 31)	
	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans	Single Samples	30-day Geomeans
% WQO Exceedance	1.6%	1.5%	2.3%	2.1%	0.0%	0.0%	20% (13%)	33% (32%)	27% (17%)	41% (40%)	6.2% (4.8%)	14% (14%)
Number of Exceedance Days <sup>2</sup>	5	4	4	4	0	0	59 (37)	96 (94)	46 (28)	68 (67)	8 (6)	17 (17)
Number of Data Points	450	263	306	189	144	74	450	266	305	189	145	77
Number > WQO	7	4	7	4	0	0	92 (58)	88 (86)	83 (51)	77 (75)	9 (7)	11 (7)
Mean (MPN/100mL)	80	20	111	23	14	14	57	43	73	52	23	20
Geomean (MPN/100mL)	13	---	16	---	9	---	23	---	30	---	13	---
Minimum (MPN/100mL)	1	1	1	1	1	1	1	3	1	4	1	3
10 <sup>th</sup> Percentile (MPN/100mL)	5	10	6	8	1	10	10	10	10	11	10	10
25 <sup>th</sup> Percentile (MPN/100mL)	10	10	10	10	10	10	10	13	10	17	10	11
50 <sup>th</sup> Percentile (MPN/100mL)	10	12	10	13	10	10	20	21	23	24	10	12
75 <sup>th</sup> Percentile (MPN/100mL)	20	21	26	26	10	14	41	48	63	56	20	18
90 <sup>th</sup> Percentile (MPN/100mL)	52	41	75	46	10	18	131	90	185	109	31	48
Maximum (MPN/100mL)	18,600	157	18,600	157	180	81	2,098	445	2,098	445	450	94

1 – This table is based on the dry weather data collected during the studies that are summarized in SCCWRP Technical Reports 500 and 542 but does not include the three “minimally impacted” sites discussed previously in this memo. A total of 21 sites are included.

2 – The number of exceedances days under daily sampling is calculated as: (% WQO Exceedance x Number of Days during Critical Condition Storm Year [1993]). In 1993, there were 365 days, 122 winter dry weather days, and 168 summer dry weather days. The geometric mean exceedance day calculation is based on a rolling average; note this calculation is not utilized under the current RW approach and could be performed a number of ways.

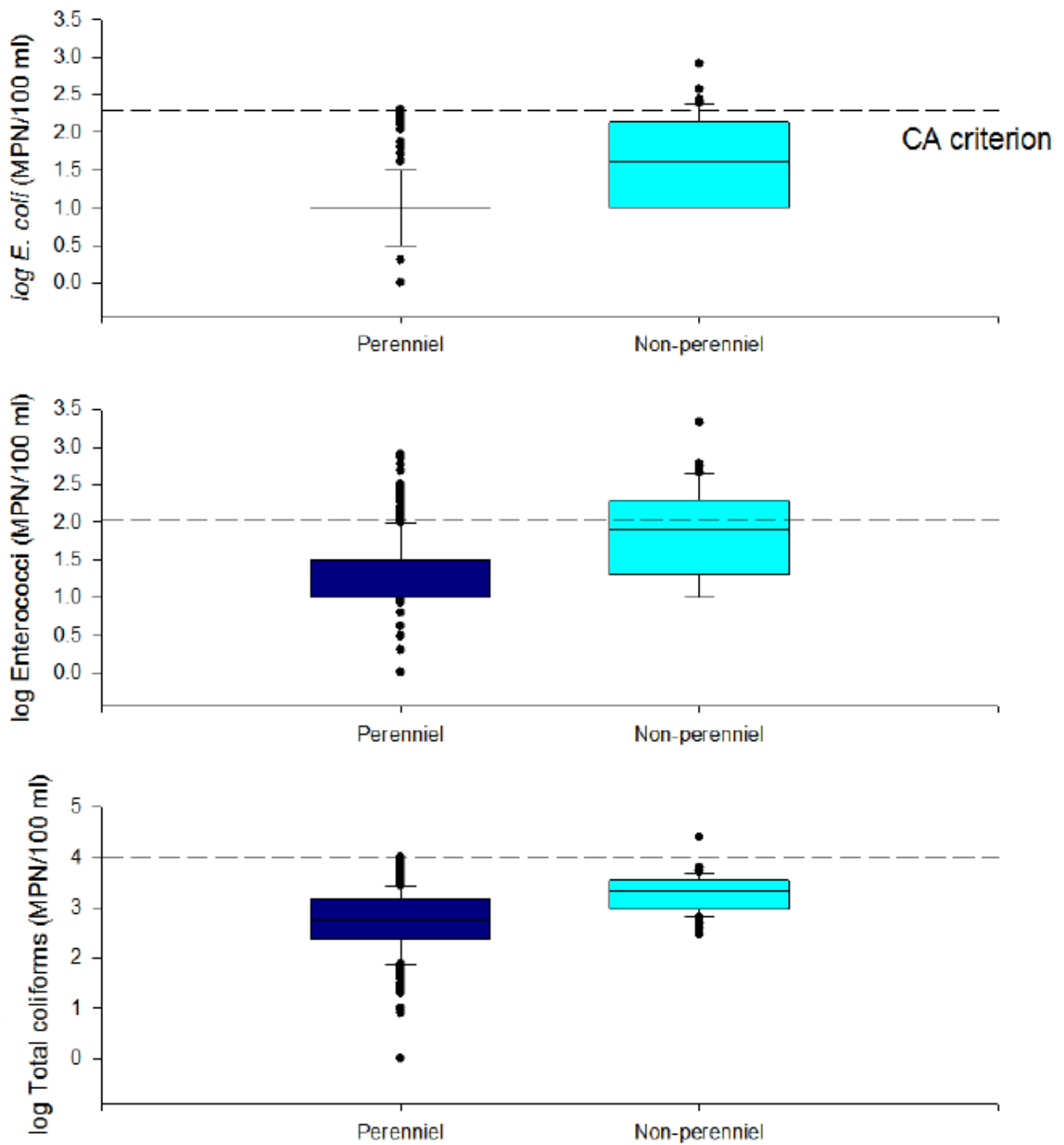
3 – This table uses freshwater WQOs for *Enterococcus* (61 MPN/100mL for SSM and 33 MPN/100mL for the geometric mean). For direct comparison to currently used exceedance days, marine WQO exceedance rates are shown in parentheses.



**Figure 1. Seasonal Trends in Dry Weather *E. coli* (top) and *Enterococcus* (bottom) Concentrations at Freshwater Reference Sites and Effect of Minimally-Impacted Sites (“Outliers”)**

(copied directly from a SCCWRP presentation to the Malibu TAC)

(Notes: (1) this figure includes only the sites that were sampled during the SCCWRP FIB Study, (2) samples from mixed dry/wet weather that were not included in Tables 1 thru 4 are shown here, (3) and each data point represents a single monthly geomean calculated across all sites)



**Figure 2. Dry Weather Comparison of Perennial and Ephemeral Freshwater Reference Sites**  
 (copied directly from a SCCWRP presentation to CTAG)

(Notes: (1) this figure includes only the sites that were sampled during the SCCWRP FIB Study and  
 (2) samples from mixed dry/wet weather that were not included in Tables 1 thru 4 are shown here)