Flow Science Incorporated
723 E. Green St., Pasadena, CA 91101
(626) 304-1134 • FAX (626) 304-9427

June 4, 2010

California Regional Water Quality Control Board, Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Attention: Renee Purdy
Man Voong

Subject: Comments prepared in response to the Public Hearing Notice
Proposed amendment to the Water Quality Control Plan for the Los Angeles Region (Basin Plan) to incorporate Total Maximum Daily Load for Bacteria in the Los Angeles River
FSI 037033

Dear Ms. Purdy and Mr. Voong,

Flow Science Incorporated, on behalf of the Cities of Cities of Arcadia, Bellflower, Carson, Cerritos, Claremont, Commerce, Downey, Duarte, Glendora, Hawaiian Gardens, Irwindale, Lawndale, Lynwood, Monterey Park, Paramount, Santa Fe Springs, Signal Hill, Vernon, and Whittier ("Cities"), appreciates the opportunity to submit comments in response to the April 20, 2010 Public Hearing Notice and all related documentation for the above-captioned proposed Basin Plan amendment.

As detailed below, Flow Science urges the Regional Water Quality Control Board (Regional Board) to delay adoption of the proposed TMDL until *after* water quality standards for REC-1 uses are reviewed and amended as appropriate. As detailed herein, this evaluation should include (1) a review of the designated beneficial uses of the Los Angeles River and its tributaries to determine the uses "actually attained," particularly for concrete-lined reaches of the River, including Reaches 1 and 2, and (2) considerations of modifications of the water quality objectives for indicator bacteria to consider "controllable water quality factors."

In addition, and following a proper evaluation of the beneficial uses and water quality objectives, the Regional Board should consider alternative allocation formulations and implementation programs for both wet and dry weather TMDLs. It is unlikely that full implementation of the proposed TMDLs will achieve water quality standards for bacteria in the Los Angeles River; as such, the effectiveness of the TMDL as currently written is questionable.

Bacteria can come from both human (e.g., sewage leaks and human waste) and non-human (e.g., birds and other wildlife) sources, and bacteria also re-grow in the environment, including within stormwater drains. Re-growth and/or natural source contributions within certain sections of Reach 2 of Los Angeles River (LAR) have been demonstrated by data collected by the CREST effort, and are likely to occur in other reaches as well. Bacteria concentrations are likely to exceed water quality objectives even in treated (disinfected) water just downstream of the point where it is discharged to receiving waters due to these natural and uncontrollable sources. In addition, it is unreasonable, and we believe it is not the Regional Board's intent, to require control of non-human sources; control of non-human sources could require removal of wildlife and/or their habitat, thus posing an extraordinary environmental impact.

For these reasons, achieving compliance with existing beneficial uses and objectives will be difficult if not impossible. Thus, it makes sense to evaluate whether changes to those standards are warranted before implementing a TMDL. First, we believe that it is imperative that the Regional Board review the designated uses of the Los Angeles River and its tributaries, and, where appropriate, change the designated beneficial uses, particularly for the concrete-lined portions of the River (e.g., Reaches 1 and 2), to reflect a designation of "uses actually attained" in the water body on or after November 28, 1975. Second, we request that the Regional Board consider, as an alternative, modifying the water quality objectives for indicator bacteria such that the objectives require compliance with *E. coli* concentrations "as a result of controllable water quality factors."

The draft LAR Bacteria TMDLs include allocations for both dry and wet weather conditions. However, it is unclear how "necessary load reductions" based on these allocations were derived, and the allocations are not supported by the available science. Importantly, it is unclear from the TMDLs how compliance will be determined for dischargers. Thus, consistent with the recommendations from the CREST process, we request that the TMDL should be modified so that compliance with the dry weather TMDL is achieved if measures to achieve allocations are implemented.

Further, we recommend that no wet weather TMDL be established at this time, as there are presently no technically feasible means of addressing bacteria in wet weather runoff. Regarding the wet weather TMDL, we note that neither the Regional Board nor stakeholders know of any technical means of complying with the TMDL under wet weather conditions. Even with the proposed high flow suspension and "natural sources exclusion" approach, the volumes of water to be diverted and/or treated are extraordinarily large, and strict compliance with the waste load allocations (as the TMDL is currently written) is technically impossible. For example, the volume of water to be diverted and/or treated within the Arroyo Seco during the 2004-2005 water year would be 570 million gallons per day (570,000,000 gallons per day), enough to fill the Rose Bowl 7 times in a single day. In the Los Angeles River during 2004-2005, approximately 924 million gallons per day (equivalent to 11 Rose Bowls) would require diversion and/or treatment.[1] Thus, we request that the Board defer the Wet Weather TMDL until after the

[1] The high flow suspension does not apply in the Arroyo Seco, which would then be allowed 15 exceedance days. The sixteenth-largest flow rate in the Arroyo Seco during 2004-2005 was 888 cfs. In the Los Angeles River at Wardlow, where the high flow suspension does apply and thus approximately 26 days

designated uses and water quality objectives have been reevaluated and until after additional studies are conducted to develop an appropriate wet weather TMDL. We also recommend, prior to the adoption of any wet weather TMDL, that the Regional Board extend the high flow suspension policy to additional channels and that the Board and evaluate and implement appropriate standards changes, including requiring compliance with objectives "as a result of controllable water quality factors."

In addition to and following conducting the analyses described above, we recommend that the Board, when it does adopt TMDLs for bacteria in the Los Angeles River, should use adaptive management practices and a phased schedule, as has been done for TMDLs in other regions. Details of implementation alternatives and our concerns with the scientific and technical approach of the TMDLs are provided in the remainder of this document.

Finally, we request that the Regional Board consider all of the alternative approaches to the bacteria TMDL discussed herein, per CEQA, for environmental impacts.

Detailed comments are provided in Attachment A, and a copy of my resume is provided as Attachment B, and electronic copies of the references cited in this letter are provided on CD. Additional Attachments C and D are described in these comments, and references will be provided electronically and on CD.

Thank you for the opportunity to provide comments. Please contact me if you have any questions.

Sincerely,

Susan C. Paulsen, Ph.D., P.E.
Vice President and Senior Scientist

---

would be excluded, an additional 10 exceedance days would be allowed (for a total of 36 excluded days). The 37th-largest flow rate is 1430 cfs, or 924 mgd.

ATTACHMENT A

Bacteria originate from both human and non-human sources

Bacteria originate from multiple sources, including birds and wildlife (Bagshaw 2002; CREST 2008b; Grant et al. 2001; Griffith et al. 2009; Stein et al. 2007). Data collected by Los Angeles County demonstrate that storm water runoff from a variety of land use types, including vacant land/open space, exhibits concentrations of indicator bacteria that exceed water quality objectives (see, e.g., Table 4-12 of Los Angeles County Department of Public Works (2001). Recent work (Flow Science Incorporated 2005; Schiff and Kinney 2001; Stein and Yoon 2007) also demonstrates that runoff from open space, natural watersheds exhibits indicator bacteria concentrations that exceed water quality objectives, even when human sources are absent.

Bacteria from non-human sources pose a lesser human health risk

Indicator bacteria are surrogates for the potential presence of human pathogens and do not themselves pose a human health risk. For this reason, and because indicator bacteria come from a wide range of sources, the presence of indicator bacteria does not necessarily indicate a human health risk.

It is well-established that human recreational activity itself (i.e., human sources of pathogens) can result in elevated concentrations of indicator bacteria and increased risk of human illness. For example, an epidemiological study conducted at three Israeli coastal beaches in 1983 (Fattal et al. 1991) suggested that contamination from the bathers themselves was the source of the indicator bacteria (including *E. coli*) and swimming-associated illness at Gordon Beach. In swimming pools, chlorination is used to minimize disease outbreaks from exposure to human pathogens; potable water supplies, typically used to fill swimming pools, contain residual chlorine and thus low concentrations of both indicator bacteria and human pathogens. Numerous studies have reported outbreaks of water-borne diseases in swimming pools due to inadequate chlorination at swimming pools, where the disease-causing pathogens almost certainly arise from people during the swimming activity itself (Keswick et al. 1981; Levine and Stephenson 1990; Mood 1977; Papapetropoulou and Vantarakis 1998; Sinclair et al. 2009; World Health Organization 1999). Mood (1977) concluded that "an average person… might shed approximately $2x10^8$ organisms into the water while swimming."

Available epidemiological studies have typically focused on health effects at marine beaches or, for freshwater recreation areas, have typically focused on lakes and/or recreation areas downstream of treated sewage discharges or other known sources of human waste (Colford et al. 2005; Colford et al. 2007; Ktsanes et al. 1981; Prüss 1998; Woelfel 2006). Likewise, the studies upon which water quality objectives for indicator bacteria are based typically examined swimming exposures (and subsequent incidence of illness) downstream of known human sources (e.g., downstream of sewage treatment plants) (see, e.g., USEPA (1986); Dufour (1984)). The water quality objectives for *E. coli* contained in the Los Angeles Basin Plan are based upon these studies and the observed correlation between indicator bacteria concentrations downstream of human sources and illness resulting from recreational exposures. However, until recently, very little information has been available to indicate whether bacteria from non-human sources pose a similar health risk.

Recent epidemiological work in southern California indicates that, when human sources of indicator bacteria have been minimized or eliminated, indicator bacteria are uncorrelated with human health risk. For example, an extensive cohort epidemiological study of Mission Bay (Colford et al. 2005), where extensive efforts were made to eliminate human sources of bacteria, found that "[t]he risk of illness was uncorrelated with levels of traditional water quality indicators. Of particular note, the state water quality thresholds [including those for *E. coli*] were not predictive of swimming-related illnesses. Similarly, no correlation was found between increased risk of illness and increased levels of most non-traditional water quality indicators."

Other research also indicates that the human health risk posed by swimming exposures to bacteria from non-human sources is likely lower than the risk posed by exposure to bacteria from human sources, including treated and untreated sewage (Schoen and Ashbolt 2010). A number of researchers have concluded that the primary risk to human health from recreational contact most likely comes from exposure to human viruses (Cabelli 1983; Levine and Stephenson 1990; Palmateer et al. 1991; Sinclair et al. 2009; World Health Organization 1999). Because human-specific viruses require a human host for replication, the presence of these viruses indicates that a human source is present, and those viruses are likely to be absent where human sources are absent.

Epidemiological studies typically require large sample sizes to reach statistically significant results. Because existing water quality objectives are based upon a relatively low risk of illness (e.g., the criteria in the Los Angeles Basin Plan are based upon a risk of 8/1000, thus meaning that an exposure to indicator bacteria at the level of the criteria would theoretically lead to 8 gastrointestinal illnesses per 1000 swimmers; see Dufour (1984)), a large number of swimmers must be surveyed in order to form robust conclusions about health risks. The Colford et al. (2005) study surveyed 8800 swimmers. Because there is nowhere near this level of recreational use in the Los Angeles River (see CREST (2008b)), it is infeasible to conduct a site-specific epidemiological survey in the Los Angeles River Watershed.

Bacteria regrow in the environment

The propensity for bacteria to regrow, even in highly treated water, is evidenced by the requirement to maintain a residual level of chlorine in highly treated drinking water within the drinking water distribution system. In fact, the USEPA requires treated tap water to contain a detectable level of chlorine to help protect against pathogens all the way to consumers' taps (American Chemistry Council 2010). Before it enters the distribution system, surface waters used for drinking water are treated through a variety of processes, typically including filtration, flocculation, and disinfection. Drinking water then flows into the distribution system, which is a controlled, low-temperature, dark environment (i.e., not highly conducive to regrowth). Even so, chlorination is required. Chlorine helps eliminate slime bacteria, molds and algae that commonly grow in water supply reservoirs, on the walls of water mains and in storage tanks, and prevents the growth (and regrowth) of indicator bacteria as well.

We are now fortunate to have detailed data on *E. coli* and on human-specific bacteria (bacteroidales) from six dry weather sampling events in the Los Angeles River, which were collected as part of the CREST sampling effort. As shown in **Figure 7-26** of the CREST Bacteria Source Identification (BSI) study report (CREST 2008b) (at p. 7-59, and reproduced below), only about 10-50% of the bacteria measured in Reach 2 of the Los Angeles River during six dry weather sampling events originated from storm drains and tributaries. This indicates that elimination of inflows to this reach, or elimination of bacteria in inflows, would not eliminate the exceedances of the water quality objectives for *E. coli*.

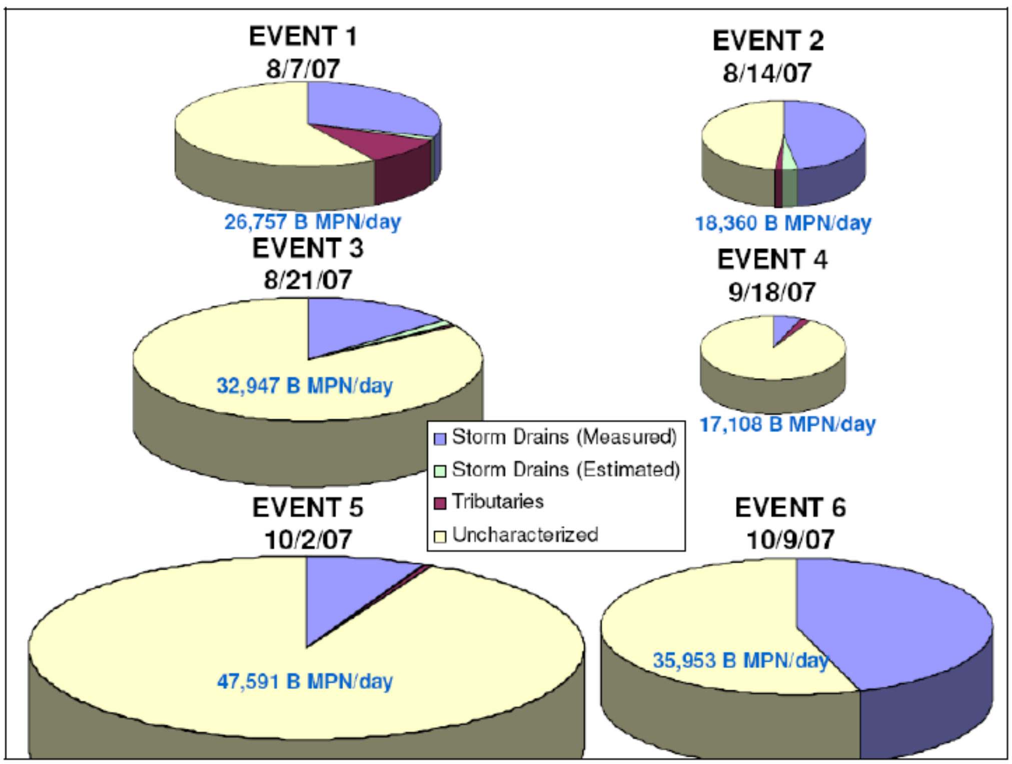


Figure 7-26. Reach 2 Event-by-Event *E. coli* Mass Balance

This figure is a graphical representation of **Table 7-24**. The diameter of the pie charts is proportional to the upstream-downstream loading increase measured along the LA River reach (i.e., the net loading from all sources), which is also detailed with text. The scale is unique to Reach 2 monitoring events (i.e., the figure for Reach 4 uses a different scale). The calculated vs. measured loading difference in **Table 7-24** is represented by "uncharacterized".

Figure reproduced from CREST (2008b)

The BSI study conducted by CREST also found that the largest dry weather *E. coli* loading increase occurred along the downstream portion of Reach 2 of Los Angeles River (CREST 2008b), while a majority of the storm drain loading occurred along the upstream portion of this reach. As shown in **Figure 6-3** of the CREST report (at p. 6-11 and reproduced below), concentrations of *E. coli* fell to levels mostly below water quality objectives for *E. coli* downstream of sewage treatment plants. Highly purified wastewater enters the Los Angeles River between river miles 5 and 8, and between river miles 14 and 26, and dilutes ambient concentrations of indicator bacteria. However, downstream of those locations, *E. coli* concentrations rose again. Note in particular the rise in *E. coli* concentrations between 6th St. and Slauson Ave.

The CREST BSI study also measured concentrations of human-specific bacteroidales as shown in **Figure 6-12** (at p. 6-25 of the CREST report and reproduced below) in the same samples from which the *E. coli* measurements (shown in **Figure 6-3**) were obtained. Concentrations of human bacteroidales were essentially flat (did not increase) in Reach 2 of the river between 6th Street and Slauson Ave. The fact that *E. coli* concentrations in this river segment increased by more than an order of magnitude while human-specific bacteroidales concentrations did not indicates that the *E. coli* in this segment are from non-human sources. These data indicate that non-human sources (which may include wildlife and birds, or re-growth in sediments) are likely responsible for the exceedances of water quality criteria in this river segment.

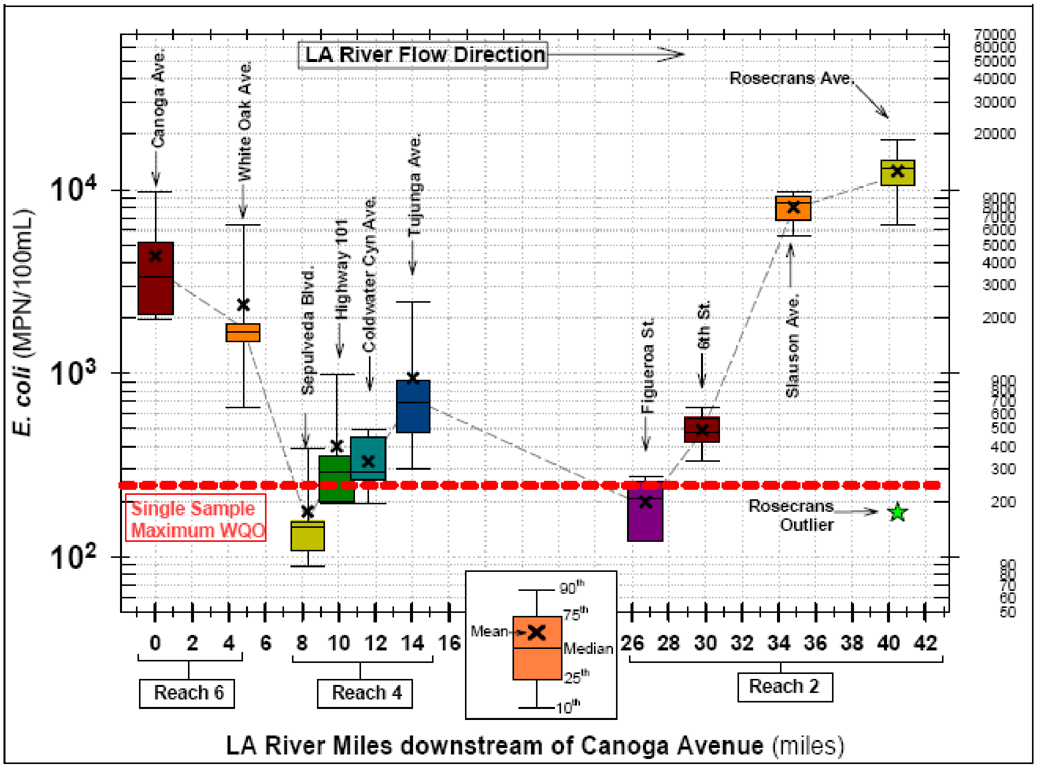


Figure 6-3. Measured *E. coli* Concentrations along the LA River

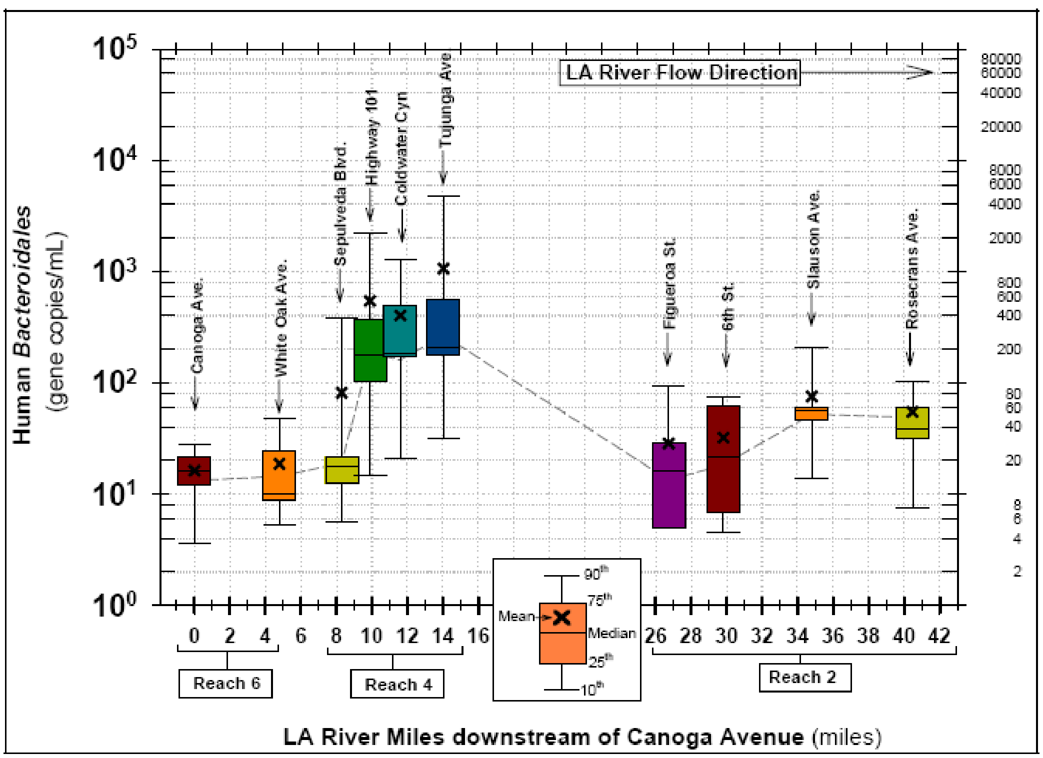


Figure 6-12. Measured Human-specific *Bacteroidales* Concentrations along the LA River

Figures reproduced from CREST (2008b).

Other studies have also shown that indicator bacteria also re-grow in storm drains and in the environment. For example, Jones (2005) analyzed for fecal coliforms, *E. coli* and enterococci in influent and effluent from urban storm drains and receiving water samples in New Hampshire and found "possible re-growth of bacteria between storms, especially during warmer weather. Re-growth or illicit connections appear to impact effluent bacterial levels in many urban storm drains." Weekly monitoring conducted at Baby Beach at Dana Point Harbor, CA, indicates "sediments/sands may serve as a reservoir of fecal indicator bacteria from multiple sources...The organic nutrients in sediment enhance persistence and/or re-growth to levels that may exceed standards in the overlying water" (Ferguson et al. 2003).

A study in Huntington Beach (Grant et al. 2001) showed that "urban runoff appears to have relatively little impact on surf zone water quality …enterococci bacteria generated in a tidal saltwater marsh [e.g., from non-human sources and/or re-growth] located near the beach [were found to] significantly impact surf zone water quality." A bacterial source identification study at Santa Monica Pier (Heal the Bay 2006) showed that extensive re-growth of bacteria in the pond in front of the pier storm drain might be a chronic source of fecal bacteria to the sand and surfzone.

In laboratory experiments that simulated tidally influenced storm drains, fecal coliforms and enterococci reproduced rapidly under conditions typical of coastal storm drains (Martin and Gruber 2005). A laboratory study using marine and estuarine sediments from Georgia, New Hampshire, and Puerto Rico showed that fecal enterococci survived desiccation and re-grew in rewetted sediment (Hartel et al. 2005).

Even treated water often has bacteria concentrations that exceed water quality objectives just downstream of the point where it is discharged to receiving waters. For example, Orange County recently studied BMPs for reducing bacteria concentrations in Aliso Creek. The study found that a BMP that included multimedia filtration and ultraviolet (UV) disinfection greatly reduced concentrations of indicator bacteria in urban runoff, but bacteria levels rebounded within a short distance downstream of the BMPs (County of Orange 2005). Effluent from the filtration/sterilization BMP exhibited geometric mean fecal coliform concentrations of 317 cfu/100 mL at the BMP outlet, but concentrations increased to 2575 cfu/100 mL in a natural channel at a distance of 35 ft downstream of the BMP. Similarly, dry weather flow in Cottonwood Creek, which flows to Moonlight State Beach, was treated through a UV facility with removal efficiency of greater than 99%. However, bacteria concentrations increased between the UV facility and the mouth of the creek due to re-growth of bacteria (City of Encinitas 2006). Thus, it appears likely that even if stormwater or urban runoff were treated to meet water quality objectives for indicator bacteria, bacteria concentrations in those flows likely would increase due to natural sources even at short distances downstream of the treatment facility.

In the Staff Report for the Los Angeles River Bacteria TMDL, the Regional Board acknowledges that "regrowth in sediments was considered [by the CREST studies] to have a moderate likelihood of being a significant component of the in-channel *E. coli* loading to Reach 2" (Staff Report at p. 29) and states that CREST BSI study results highlight regrowth/resuscitation "as a potential source that could be further evaluated."

In spite of this, and in spite of the data and information summarized in this document, the Regional Board asserts that meeting interim wasteload and load allocations will result in compliance within receiving waters (e.g., Staff Report at p. 65: "it is expected that the River will be largely in compliance by the time the first phase of implementation is complete"). Clearly, this assertion is without support, and the weight of scientific evidence leads to the opposite conclusion, particularly in Reach 2: it is unlikely that the allocations and implementation measures proposed in the draft TMDL will result in compliance in the Los Angeles River. Likewise, it cannot be concluded (as in the SED for the LAR Bacteria TMDL at p. 11) that the proposed TMDL alternative "will restore water contact recreational uses to the Los Angeles River Watershed by attaining water quality standards…"

It is unreasonable to require control of non-human sources

The Los Angeles Regional Board historically has recognized that control of certain non-human sources (e.g., birds, wildlife) is undesirable. The Board has proposed a "natural sources exclusion approach" so that control of these sources is not required. The Los Angeles Basin Plan (as amended by Resolution No. 2002-022) states "These [natural sources exclusion] approaches recognize that there are natural sources of bacteria, which may cause or contribute to exceedances of the single sample objectives for bacterial indicators. They also acknowledge that it is not the intent of the Regional Board to require treatment or diversion of natural water bodies or to require treatment of natural sources of bacteria from undeveloped areas. Such requirements, if imposed by the Regional Board, could adversely affect valuable aquatic life and wildlife beneficial uses supported by natural water bodies in the Region."

Under a "reference" or "natural" watershed approach, an "allowable exceedance frequency" is determined using monitoring data for indicator bacteria in an undeveloped watershed; the subject watershed is then allowed to exceed standards at the same frequency as the natural watershed. However, this approach is problematic for several reasons. For example, dry weather flows in urban watersheds come from many sources, including POTW effluent, overland flows, and flows through storm drains (including NPDES-permitted flows), while dry weather flows in natural watersheds in southern California are often comprised mainly of groundwater inflow. Thus, there is less opportunity for the dry weather flows in natural watersheds to be exposed to natural sources of bacteria. In addition, the highly engineered environment of the storm drain/flood control system may be more conducive to bacteria growth and regrowth, as detailed above.

As shown in the example of the CREST BSI study, natural sources are likely responsible for the exceedances in Reach 2 of the Los Angeles River, and natural sources may contribute significant amounts of indicator bacteria to other river reaches as well. It would be infeasible and undesirable to control wildlife or eliminate habitat to avoid or reduce those exceedances. Controlling natural sources could also require actions contrary to "the Los Angeles River Revitalization Master Plan," which was adopted by the Los Angeles City Council in May 2007 and was also mentioned in the Draft TMDL Staff Report (at p. 1). Objectives of the Master Plan include, for instance, revitalizing the river via enhancing flood storage, enhancing water quality, enabling safe public access, and restoring a functional ecosystem (City of Los Angeles 2007). One of goals of the Master Plan is to increase in-channel habitat; this action would likely consequently increase potential non-human and natural sources (birds and wildlife) of bacteria to the LAR. As detailed below, we recommend that the Regional Board consider revising water quality objectives for bacteria to require compliance with *E. coli* objectives "as a result of controllable water quality factors."

The proposed "natural sources exclusion approach" is flawed

Under the natural sources exclusion approach of the Draft TMDL, an "allowable exceedance frequency" was determined using SCCWRP monitoring data for indicator bacteria in an undeveloped watershed (Tiefenthaler et al. 2008); the Draft TMDL then allows the Los Angeles River watershed to exceed standards at the same frequency as the natural watershed (at p. 38-40 of the draft staff report).

The estimated exceedance probabilities (Table 6-2 at p. 40 of the draft staff report) were, however, calculated after data from "three" natural background sites were excluded. As stated in the Staff Report for the Draft TMDL, "[o]f the sites sampled in the Reference Stream Study [Tiefenthaler et al. 2008], three sites were deemed minimally impacted [i.e., including some minor level of impact from human activity]. As such, data from these three sites were excluded. The resulting data was [sic] compiled and used as the basis for determining the reference watershed exceedance probability." (at p. 39 of the draft staff report).

However, the methods used to arrive at the exceedance frequency are very unclear. The cited SCCWRP study (Tiefenthaler et al. 2008) states that four sites (instead of three sites) were excluded from the calculation of exceedance probabilities; "four sites originally considered, but later rejected from the study…[because these sites were] subject to agricultural or transportation related runoff…in one instance, a portion of the contributing watershed was affected by a recent fire" (p. 9 of Tiefenthaler et al. 2008). It is impossible to find out which sites were excluded in the cited SCCWRP study, which provides neither explanation nor a complete dataset. The complete dataset should be available to the public for review because reference exceedance probabilities could change significantly if the excluded three (or four) sites are instead included in the reference dataset. In fact, a memorandum prepared as part of the CREST study process

(CREST 2008a) indicated that exceedance probabilities for *E. coli* were between 7% (for single samples) and 16% (for geometric means) for all dry weather based on all data (no exclusion of sites) from the same SCCWRP study. "When [the dataset] does not include the three [sic] 'minimally impacted' sites," exceedance probabilities fell to 1.6% (at p. 6 of CREST 2008a).

Perhaps most importantly, the SCCWRP study (Tiefenthaler et al. 2008) used bacteroidales analysis to demonstrate that exceedances at the reference sites were due to non-human sources. It is inappropriate and scientifically unsound to exclude sites where exceedances were due to non-human sources and to estimate exceedance probabilities based on the rest of the sites. Thus, the method used to calculate an "allowable exceedance frequency" for the Draft TMDL was flawed.

While use of the complete dataset (including 'minimally impacted' sites) from the SCCWRP study would provide a more appropriate and relevant measure of the exceedance frequency due to non-human sources, the use of a "natural reference approach" is itself inherently flawed. This can be seen by examining the exceedance frequency for reaches of LAR (e.g., the section between 6th St. and Slauson Ave., shown above) where non-human sources were responsible for increases in *E. coli* concentrations for 100% (6 of 6) dry weather sampling events (CREST 2008b).

As suggested in a letter to the Regional Board on April 19, 2010 (included as Attachment C to this letter), and in a presentation to the Regional Board on April 1, 2010 (included as Attachment D to this letter), a more scientifically appropriate approach would be to amend the objectives for indicator bacteria such that they require compliance with *E. coli* concentrations "as a result of controllable water quality factors." Under this concept, if it were demonstrated, using appropriate scientific techniques, that bacteria in excess of criteria were from "uncontrollable" factors (such as wildlife) the presence of those bacteria would not be considered a violation of water quality objectives. It is likely that this alternative would have a far less significant environmental and economic impact than the proposed implementation plan contained in the Draft TMDL. Most importantly, the CEQA alternative proposed for consideration here would allow the presence of wildlife and associated habitat without considering those wildlife and habitat to cause or contribute to an exceedance of water quality standards. Further, we believe that this proposed amendment of the water quality objective for *E. coli* would be protective of water quality and human health and would meet the objectives of the proposed CEQA project.

Compliance with dry weather TMDL requirements may be impossible

We begin the discussion of compliance with a clear statement: control and/or elimination of chronic human sources of indicator bacteria (and associated pathogens) is reasonable and should be pursued in waters with routine swimming and other contact activities. Human sources of indicator bacteria pose a well-substantiated, clear risk to human health, and are a direct result of human activity within the watershed.

However, as detailed above, non-human sources such as birds, wildlife, and bacteria growth within the environment are also important—and in some reaches, dominant—sources of indicator bacteria. These sources are far more difficult to control and are much less likely to pose a human health risk. These sources are present in both dry and wet weather conditions, and the "natural source exclusion" approach of the TMDL (implemented in terms of an allowable exceedance frequency) fails to fully address these sources.

The Implementation Plan detailed in the Draft TMDL for dry weather conditions contemplates use of an MS4 Load Reduction Strategy (LRS) that would involve structural methods at specific outfalls (per p. 53 of the Staff Report, including dry weather diversions of storm drains to POTWs or localized infiltration); source control, including runoff management and minimization measures; and/or downstream treatment. Dischargers that implement an LRS strategy are afforded a longer implementation timeframe (Draft TMDL Staff Report at p. 53). However, as detailed in the Draft TMDL Staff Report (at p. 54), downstream methods are likely infeasible. While source control methods are promising and should be pursued, they are unlikely to eliminate all dry weather flows within the storm drain system, particularly when one acknowledges that other NPDES permits allow discharges to the system during dry weather. Thus, the most feasible implementation measures involved either diversion and/or infiltration.

Dry weather diversions are often discouraged, as publicly owned treatment works (POTWs) have limited capacity for conveyance, storage, and treatment. The times of year, and times of day, during which diversions are allowed are often stringently regulated and restricted. For example, the Sanitation Districts of Los Angeles County (Maguin 2007) require dry weather diversion programs to be regulated via an Industrial Wastewater Discharge Permit. Dry weather diversions including flows from industrial facilities discharged under an NPDES permit are discouraged, and dry weather runoff discharge permits generally limit diversions to May 1-September 30 (Maguin 2007). The Districts do have discretion to allow year-round discharge provide the sewerage system is not adversely impacted and for an identified environmental benefit. Permits for dry weather diversions are issued for duration of 5 years or less, off-peak discharge is generally required (necessitating storage at the diversion location), the discharge must be pumped, and trash and sediment must be removed (Maguin 2007). Discharge during wet weather conditions is not allowed, and discharge is currently only allowed to the Districts' Joint Water Pollution Control Plant in Carson (Maguin 2007). To be feasible, the proposed dry weather diversion must be located near a sewerage conveyance system with adequate capacity to handle increased flows. Thus, dry weather diversions will likely not be feasible at all outfall locations.

Like diversions, infiltration of dry weather flows is likely not feasible in all locations. For example, the soft-bottom sections of the Los Angeles River are typically areas of rising groundwater (see Draft TMDL Staff Report at p. 6), and infiltration will be infeasible in areas of rising groundwater. Likewise, infiltration will be infeasible in areas of "tight" soils comprised predominantly of clay or silt.

For MS4 permittees, the Draft TMDL includes interim waste load allocations (WLAs) in the form of allowable *E. coli* loadings to a given river segment or tributary. However, final WLAs are expressed in terms of an allowable number of exceedance days, based upon a reference watershed approach. The Draft TMDL Staff Report states (at p. 53) that "in the first phase of implementation, a segment must meet the interim WLA expressed as *E. coli* loading and the **LRS must be designed to meet the final WLA expressed as exceedance days** of the numeric targets in the river segment or tributary, but due to the highly variable nature of bacterial sources, a full second phase of implementation is scheduled to ensure achievement of final WLAs." (emphasis added) Outfall monitoring is required by the Draft TMDL (at p. 60) to "evaluate whether the LRS resulted in attainment of the WLAs."

This poses particular difficulty for dischargers to Reach 2, where CREST (2008b) established that tributaries and storm drains contribute only about 10-50% of the bacteria loading; thus, an LRS strategy that eliminated <u>all</u> inputs to that reach (at far greater cost than is contemplated in the Draft TMDL Staff Report) could at best eliminate 10-50% of the bacteria loading to the reach, far too little to result in attainment of the final WLA (expressed as in-stream allowable exceedance days). In this reach, it should be fully expected that a "full second phase of implementation" would be required, and that even a second phase of implementation would be insufficient to achieve the final WLAs. For other reaches of the river (e.g., Reach 1), no data are available to indicate the relative contribution of storm drains v. in-stream bacteria sources, but the situation is likely to be similar, based on the similar physical characteristics of the channel in Reaches 1 and 2 and on the likely similar nature of bacteria sources in flows to these reaches.

Thus, dischargers to these reaches are in a difficult position: they are allowed to pursue an LRS approach with a 25-year implementation timeframe only if they are able to demonstrate that the LRS approach will result in attainment of the final WLA, measured in terms of allowable exceedance days. Yet the best available data, as detailed above, indicate that even elimination of all inflows to these reaches will not result in in-stream attainment of final WLAs. Thus, dischargers to these reaches can design and implement LRS programs to meet interim WLAs (expressed as *E. coli* loadings) but cannot meet the Draft TMDL requirement to provide assurance that these same actions will achieve the final WLAs.

The Draft TMDL does appear to provide some allowance for this situation in Table 9-5 (at pp. 68-72), which includes the following language in the schedule for compliance: "Achieve final WLAs in Segment B or demonstrate that non-compliance is only due to upstream contributions." However, this provides no relief for in-stream sources within the reach to which they discharge (e.g., in-stream, non-human sources within Reach 2 between 6th St. and Slauson Ave.), and similar language is not included in the text of the Draft TMDL Staff Report.

Thus, we respectfully suggest that the water quality objectives for indicator bacteria be amended to require compliance "due to controllable water quality factors."

The monitoring requirements for permittees conducting LRS implementation are significant and onerous. The Draft TMDL Staff Report specifies (at p. 73) that outfall monitoring (a minimum of 9 samples per outfall) for each LRS shall take place at all outfalls discharging to the segment or tributary. The Draft TMDL Staff Report (at p. 74) states that 51 outfalls were observed to be flowing within Reach B overall all BSI study monitoring events; thus, within Reach B, a minimum of 459 samples would be required to be collected from the outfalls, in addition to the required in-stream monitoring. The Draft TMDL Staff Report also specifies (at p. 24) that the City of Los Angeles has estimated that there are 1,980 storm drain outfalls within the City that discharge to segments and tributaries of the Los Angeles River, and as many as 1,735 such outfalls outside the City; the Draft TMDL Staff Report also notes that many of these outfalls flow only in wet weather (when individual outfall monitoring would not be required).

Of significant concern is how implementation would proceed, and how compliance with the TMDL will be determined. Frequently, both dry and wet weather flows from multiple jurisdictions drain to a single storm drain to the River, and water frequently flows serially through drains in multiple cities before entering the County Flood Control system and finally the Los Angeles River. MS4 permittees in these jurisdictions may choose to implement different measures to control bacteria, and thus may be subject to different compliance schedules. It is unclear how compliance would be determined for these jurisdictions. Complicating matters is the fact that bacteria often behave erratically, and high concentrations of bacteria may be observed only once in a given location, yet the potential exists with the current TMDL that these "outlier" or "anomaly" occurrences of high bacteria concentrations may lead to exceedances of objectives, and consequently to permit violations or TMDL non-attainment.

Finally, permitted discharges to the storm drain system may augment dry weather flows, and have the potential to result in exceedances where the storm drain enters the River, even if those flows were "clean" (i.e., had bacteria concentrations below objectives) when the left the permitted facility. This is likely, as regrowth in storm drains is well-documented (see above). In this situation, it may not be possible to divert the full flow to a POTW, as dry weather diversion rules typically preclude acceptance of NPDES-permitted discharges (see Maguin 2007).

Need to protect beach water quality

The cities that drain into Reaches 1 and 2 recognize the need to protect water quality at beaches within the City of Long Beach, where high levels of recreation occur. The City of Long Beach has conducted a breakwater study to identify water quality issues exacerbated by reduced circulation (reduced flushing) in the Long Beach area. The Army Corps of Engineers is currently conducting at $8 million study to evaluate modifications to or removal of sections of the breakwater, or construction of new breakwaters to reroute Los Angeles River flows away from beach areas.

The Cities in Reaches 1 and 2 support these approaches and plan to work with the City of Long Beach to improve beach water quality through these and other measures. The Cities wish to make recreation safe at the beaches, where swimming is legal and encouraged, rather than to spend resources to attempt to meet the REC-1 water quality standards in the lower reaches of the river, where swimming is dangerous and illegal.

The Draft TMDL would have significant environmental impacts

The way the Draft TMDL is currently crafted, significant treatment processes, including ultraviolet (UV) sterilization or other disinfection treatment methods, could be required in order to meet the TMDL targets in-stream. As noted above, it is unlikely that eliminating, minimizing, or treating flows entering a reach will result in compliance, likely necessitating treatment of flows within a reach. Treatment processes have the potential to greatly increase energy use within the watershed, to introduce chemicals for treatment, to require construction of significant volumes of on-site storage, and/or to alter flow patterns of runoff within the River. These measures could yield potentially significant environmental impacts whose harm could outweigh any purported benefit, especially given the available evidence that indicator bacteria concentrations likely would rebound after treated water is discharged to natural channels.

Summary of Concerns with the Draft TMDL for Dry Weather Flows

As detailed above, concerns with the Draft TMDL for dry weather flows include:

- Available data indicate that storm drains and tributaries contribute only a fraction of the bacteria load within the River itself. For example, within Reach 2, the CREST BSI study (CREST 2008b) found that storm drains and tributaries contributed only about 10-50% of bacteria within the receiving water, and that the rest may have resulted from birds, regrowth and persistence in sediments, and/or regrowth or resuscitation in the water column (Draft TMDL Staff Report at p. 29-30).

- It is unclear how, or if, compliance with the Draft TMDL as currently written could be achieved. While Load Reduction Strategies (LRS) can be implemented to reduce loads of bacteria from storm drains to the river and its tributaries, it is unlikely that LRS will achieve the final WLAs (expressed in terms of allowable exceedance days) due to non-human, natural sources of bacteria to the system.

- The natural source exclusion approach as implemented in this TMDL is flawed. First, the exceedance frequency is calculated following an improper exclusion of data from the SCCWRP study. Second, use of a natural source exclusion approach based on reference watersheds consisting of open space is flawed, as water enters receiving waters via different means, and from different sources, in the urban storm drain and flood control system. Available data for the Los Angeles River indicate that bacteria from natural sources may result in exceedances up to 100% of the time in some reaches.

- It is undesirable to control all sources of bacteria. Control of natural sources of bacteria is infeasible, undesirable, and in direct opposition to restoration plans for the river. However, it appears that the Draft TMDL will require this if the final WLAs (expressed in terms of exceedance days) are to be met.

- It is unclear how compliance could be achieved. Frequently, land within multiple jurisdictions drains to the River via a single storm drain outlet, and many storm drains receive NPDES-permitted flows. The presence of even one "bad actor" failing to implement control measures could lead to an exceedance at that storm drain. A single "hit" of high bacteria in a storm drain not targeted for diversion could also result in non-compliance with interim WLAs. Thus, it appears that the TMDL, as currently crafted, would put MS4 dischargers in significant jeopardy with respect to permit and TMDL compliance.

A Wet Weather TMDL is not feasible at this time

Many of the scientific issues concerning the Dry Weather TMDL also affect the Wet Weather TMDL. For example, bacteria in wet weather flows arise from a wide variety of sources, including both "controllable" and "uncontrollable" sources, as discussed above. Regrowth and erosion of sediment containing indicator bacteria are a concern during both wet and dry weather conditions.

What sets compliance during wet weather apart is the sheer volume of water that could potentially require treatment. In addition, conditions within the River are unsafe during wet weather flows, a fact that is acknowledged in part by the application of the high flow suspension to engineered channels within the Region. However, the volumes of water that would potentially require treatment are large, and it is unknown how compliance with these flows could be achieved.

To gauge the volumes of flow that could potentially require treatment, consider water year 2004-2005, the most recent wet year for which flow and rainfall data have been published by the Los Angeles County Department of Public Works. The Draft TMDL uses a high flow suspension approach, so that bacteria objectives would not apply during days with more than 0.5 inches of rain, and an exceedance days approach, which would allow 19% of wet weather flows to exceed objectives.

Using the 2004-2005 record of daily flows in the Los Angeles River at Wardlow (Los Angeles County Department of Public Works 2006), we evaluated diversion and/or treatment requirements. The high flow suspension would apply here, so that objectives would not apply for approximately 26 days (see Draft TMDL Staff Report at p. 42) and an additional 10 allowable exceedance days. Thus, we eliminated the 36 highest flow days from consideration. The 37th-highest daily flow in the Los Angeles River at Wardlow was 1430 cfs, equivalent to 924 million gallons of water per day. This volume is enough water in a single day to fill the Rose Bowl[1] 11 times, and more than twice the design flow rate of the City of Los Angeles Hyperion Treatment Plant.

In the Arroyo Seco, where the high flow suspension does not apply, 15 exceedance days would be allowed. The sixteenth-largest daily flow rate during the 2004-2005 water year in the Arroyo Seco was 888 cfs, equivalent to 570 million gallons per day (570,000,000 gallons per day), enough to fill the Rose Bowl 7 times in a single day.

If the sixteenth-largest daily flow rate in the Los Angeles River at Wardlow required diversion and/or treatment, for the 2004-2005 water year, 7,740 cfs, equivalent to 5 billion gallons of water per day. This volume is about 10 times the design flow rate of the City of Los Angeles Hyperion Treatment Plant, or enough water in a single day to fill the Rose Bowl 59 times.

These conclusions are consistent with the findings of an economic evaluation performed by USC in 2002. USC scientists and engineers evaluated the long-term record of rain data, and found that "on average, the Los Angeles area experiences about 32 days of rainfall per annum" (Gordon et al. 2002). The study found that 10 days, on average, experienced rainfall events of 0.5 inches or greater (Gordon et al., 2002). Gordon et al. (2002) also concluded that rain-driven storm water treatment facilities would be idle for approximately 333 of 365 days (91%) of the average year, further indicating the difficulty and complexity of treating storm flows. Of course, wetter years would experience a far larger number of rainfall events of 0.5 inches or larger.

The Draft TMDL Staff Report requires that MS4 Permittees achieve wet weather wasteload allocations (expressed in terms of exceedance days measured in the River itself) "by employing any viable and legal implementation strategy" (Draft TMDL at p. 64). We are unaware of any viable strategy that could be used to treat storm flow volumes on the order of one billion gallons per day.

Further, the costs of compliance with the wet weather TMDL would be extraordinary. The Regional Board staff report's estimate of $5.4 billion is at best a guess, and does not examine feasible methods of compliance.

In any case, facilities to store and treat volumes of water this large would undoubtedly have a tremendous environmental impact. Treatment facilities for wet weather volumes of flow would have a very large footprint, requiring land acquisition and likely requiring

---

[1] "It would take approximately 84,375,000 gallons of water to fill the Rose Bowl to the rim." (http://www.rosebowlstadium.com/RoseBowl_general-info.htm)

condemnation of existing facilities. The facilities themselves would have very significant energy usage requirements and create new waste streams that do not exist today and that would require disposal. Flows from storage and/or treatment facilities would alter the natural flow patterns in the river.

Recommendations:

1. Make standards changes prior to TMDL adoption

Amend objectives to require control of bacteria "as a result of controllable water quality factors. Because of concerns with the proposed "natural background exceedance frequency" approach of the draft TMDL, we request that the Board consider, prior to TMDL adoption, amending the objectives for indicator bacteria such that they require compliance with *E. coli* concentrations "as a result of controllable water quality factors."

Under this concept, if it were demonstrated, using appropriate scientific techniques such as Bacteroidales analysis (see CREST 2008b), that bacteria in excess of criteria were from "uncontrollable" factors, the presence of those bacteria would not be considered a violation of water quality objectives. Drains that would be targeted for management actions would include those that have high loadings of *E. coli* and a persistent, elevated level of bacteria demonstrably from human sources.

Uncontrollable bacteria sources could be defined to refer to contributions of bacteria within the watershed from nonpoint sources that are not readily managed and that may result in exceedances of objectives for indicator bacteria. Uncontrollable sources may include wildlife activity and waste; bacteria regrowth within sediment; resuspension of bacteria from disturbed sediment; vegetation present in or near the channel; concentrations of water fowl; and/or shedding during swimming.

By contrast, controllable bacteria sources would include those sources for which reasonable actions can be taken, to the maximum extent practicable, through BMPs or other mechanisms to reduce or eliminate the contribution of these sources within the watershed. Controllable sources would be predominantly anthropogenic in nature. Controllable sources that may be present in the Los Angeles River watershed may include sources already controlled by existing regulations, such as cross-connections between the sanitary and storm sewer systems; leaky sanitary sewer conveyances; discharges from POTWs; improper management of CAFO waste and washwater. Other controllable sources may include improper handling of pet waste; runoff from yards containing fertilizers, pet waste, and/or lawn trimmings; improper use of fertilizers; improper handling and disposal of food waste; and homeless encampments.

It is likely that this alternative would have a less significant environmental impact than the proposed TMDL alone, and that implementation costs would be a fraction of the estimated implementation costs of the current TMDL. (Although we do not know exactly how such a plan would be implemented, we estimate that costs would be roughly 10% or less of those estimated for the current TMDL.) Most importantly, the proposed amendment to objectives would allow the presence of wildlife and associated habitat without considering those wildlife and habitat to cause or contribute to an exceedance of water quality standards. Further, and based on the scientific evidence detailed in this letter, we believe that this proposed alternative would be protective of water quality and human health.

Re-evaluate REC-1 and REC-2 uses. Reaches 1 and 2 of the Los Angeles River are highly modified, such that recreational use is infrequent, dangerous, and illegal. The channel along Reaches 1 and 2 and tributaries are fenced and public access is restricted. It is unsafe during dry weather to be in the low flow channel due to high water velocities, the hardened nature of the channel, and slippery conditions caused by the growth of algae. The entire channel is unsafe during rain events (see, e.g., Regional Board Resolution No. 2003-010 (the High Flow Suspension Basin Plan Amendment), which notes that channel modifications "create life-threatening 'swiftwater' conditions during and immediately following significant storm events").

The River has been extensively modified for flood control purposes; as recently as 2002, the Army Corps of Engineers and Los Angeles County Flood Control District completed $212 million in improvements to Reaches 1 and 2 of the River to eliminate flood insurance mandates imposed by FEMA. These improvements to the River will make it impractical and expensive to attain the REC-1 use. Although the Los Angeles River Master Plan envisions some restoration of the areas adjacent to the river, the plan is limited to the River areas in the City of Los Angeles, will cost over $2 billion to implement, and is currently unfunded. There is no adopted Master Plan for the River south of the City of Vernon.

Because of the extensive hardening and channelization of the river, the designated beneficial uses of the river should be re-evaluated. This is necessary prior to TMDL adoption to ensure that resources are spent where the risk to human health is greatest – i.e., at the beaches and other designated swimming areas that have significant levels of legal water contact recreation.

2. Consider alternative implementation measures for the Dry Weather TMDL

In light of the concerns above, alternative implementation measures should be considered for Reaches 1 and 2 for the Dry Weather TMDL. The implementation alternative suggested here would involve the following key components:

1. Use adaptive management and a phased schedule, and consider continuing the CREST working group process to conduct special studies, address outstanding scientific issues, and recommend changes to water quality standards and/or the Los Angeles River Bacteria TMDL, as support by available information.

FLOW SCIENCE®

This approach has been taken before in other regions; for example, the Newport Bay Organochlorine TMDL included convening a working group, convening an independent expert panel to review the TMDL and its targets, and a process to conduct additional scientific study and amend the TMDL targets, allocations, and implementation measures and schedule. See http://www.swrcb.ca.gov/santaana/board_decisions/adopted_orders/orders/2007/07_024.pdf for additional detail.

2. Use available scientific methods (e.g., Bacteroidales analysis) to identify drains that have both a high *E. coli* loading rate and a persistent, reproducible human source of bacteria. Where feasible, implement diversions to eliminate these flows. Otherwise, implement source reduction and source control measures to minimize flow and bacteria loadings in these watersheds.
3. Implement water conservation measures throughout the areas draining to Reaches 1 and 2.
4. Continue implementation of BMPs to address bacteria in dry weather runoff.
5. Evaluate the feasibility, environmental impacts, and permitting concerns related to implementation of two water runoff collection and diversion facilities along the Rio Hondo before this tributary flows into the Los Angeles River. These plants would be used to divert and reuse dry weather flows.
6. Conduct additional data collection and scientific studies to evaluate bacteria in the river (e.g., to evaluate the importance of regrowth and natural sources such as birds and wildlife) and to evaluate potential new BMPs as pilot studies in defined sub-watersheds (e.g., catch basin bacteria sponges, aggressive water conservation efforts, street sweeping, etc.).
7. Assist the City of Long Beach with the federal study of the Long Beach Breakwater, and with implementation of measures to improve beach water quality.

3. Convene a working group process to develop a Wet Weather TMDL and associated program of implementation

As detailed herein, a Wet Weather TMDL is not feasible at this time, largely because the volumes of water during wet weather conditions, even after the High Flow Suspension and Exceedance Days approaches are applied, are enormous, and because the Los Angeles River and its tributaries have been modified to perform an essential flood control function that makes capture and treatment difficult if not impossible.

Thus, we recommend that the following approach be used to develop a TMDL for Wet Weather:

1. Consider continuing the CREST working group process to conduct special studies, address outstanding scientific issues, and recommend changes to water quality standards as support by available information. Conduct analyses of standards and potential implementation measures as required by the

California Water Code Sections 13000, 13241, and 13242, for wet weather conditions.

2. Continue application of current SUSMP and BMP-based implementation measures for wet weather conditions.
3. Conduct feasibility studies to determine how and/or if wet weather flows could be treated. For example, studies could be conducted to evaluate the size of wet weather event that could be treated with traditional treatment measures (e.g., filtration and disinfection) and/or to evaluate the effectiveness of various BMPs and/or source control measures for wet weather flows. The Regional Board should then evaluate a range of measures for wet weather bacteria control for CEQA purposes.

References

American Chemistry Council. (2010). "Chlorine and drinking water FAQs." Retrieved May 17, 2010, from http://www.americanchemistry.com/s_chlorine/sec_content.asp?CID=2183&DID=9227&CTYPEID=109.

Bagshaw, C. S. (2002). Factors influencing direct deposition of cattle fecal material in riparian zones. MAF Technical Paper No: 2002/19 Wellington, New Zealand, University of Auckland, Department of Psychology.

Cabelli, V. J. (1983). "Public Health and Water Quality Significance of Viral Diseases Transmitted by Drinking Water and recreational Water " Wat. Sci.Technol. **15**(5): 1-15.

California Regional Water Quality Control Board (2002). Resolution No. 2002-022 Amendment to the water quality control plan (Basin Plan) for the Los Angeles Regionto incorporate implementation provisions for the region's bacteria objectives and to incorporate a wet-weather total maximum daily load for bacteria at Santa Monica Bay Beaches . Available at http://63.199.216.6/larwqcb_new/bpa/docs/2002-022/2002-022_RB_RSL.pdf.

California Regional Water Quality Control Board (2003). Resolution No. 2003-010 Amendment to the water quality control plan for the Los Angeles Region to suspend the recreational beneficial uses in engineered channels during unsafe wet weather conditions. Available at http://63.199.216.6/larwqcb_new/bpa/docs/2003-010/2003-010_RB_RSL.pdf.

City of Encinitas (2006). Moonlight Beach urban runoff treatment facility - final report -Prepared for State Water Resources Control Board, City of Encinitas**:** 48.

City of Los Angeles (2007). Los Angeles River Revitalization Master Plan. Available at http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm Los Angeles, CA.

Colford, J. M., Wade, T. J., Schiff, K. C., Wright, C., Griffith, J. F., Sandhu, S. K. and Weisberg, S. B. (2005). Recreational water contact and illness in Mission Bay, California. Westminster, CA, Southern California Coastal Water Research Project**:** 42.

Colford, J. M. J., Wade, T. J., Schiff, K. C., Wright, C. C., Griffith, J. F., Sandhu, S. K., Burns, S., Sobsey, M., Lovelace, G. and Weisberg, S. B. (2007). "Water Quality Indicators and the Risk of Illness at Beaches With Nonpoint Sources of Fecal Contamination." Epidemiology **18**(1): 27-35.

County of Orange (2005). Final Report, Agreement: 01-227-550-0, Aliso Beach Clean Beaches Initiative. J01P28 Interim Water Quality Improvement Package Plant Best Management Practices. City of Orange, CA, County of Orange.

CREST (2008a). Freshwater reference site conditions, calculation of allowable exceedance days and consideration points for the LA River Bacteria TMDL.

CREST (2008b). LA River bacteria source identification study: Final Report. Nov 2008. Available at http://www.crestmdl.org/studies/BSI%20STUDY%20REPORT.pdf.

Dufour, A. P. (1984). Health Effects Criteria for Fresh Recreational Waters. USEPA 600/1-84-004. Cincinnati, OH, USEPA**:** 42.

Fattal, B., Peleg-Olevsky, E. and Cabelli, V. J. (1991). "Bathers as a possible source of contamination for swimming-associated illness at marine bathing beaches." International Journal of Environmental Health Research **1**(4): 204 - 214.

Ferguson, D. M., Zhowandai, M. H., Getrich, M. A., Moore, D. F., Lissner, A., Haimann, R. and Linger, D. W. (2003). Bacteriological monitoring studies to identify sources of fecal pollution at Baby Beach, Dana Point Harbor, California. OCEANS 2003. Proceedings.

Flow Science Incorporated (2005). Review of bacteria data from southern California watersheds. Pasadena, CA**:** 101.

Gordon, P., Kuprenas, J., Lee, J.-J., Moore, J. E., Richardson, H. W. and Williamson, C. (2002). An economic impact evaluation of proposed storm water treatment for Los Angeles County, School of Engineering and School of Policy, Plannning, and Development, University of Southern California

Grant, S. B., Sanders, B. F., Boehm, A. B., Redman, J. A., Kim, J. H., Mrse, R. D., Chu, A. K., Gouldin, M., McGee, C. D., Gardiner, N. A., Jones, B. H., Svejkovsky, J., Leipzig, G. V. and Brown, A. (2001). "Generation of Enterococci Bacteria in a Coastal Saltwater Marsh and Its Impact on Surf Zone Water Quality." Environ. Sci. Technol. **35**(12): 2407-2416.

Griffith, J. F., Schiff, K. C., Lyon, G. S. and Fuhrman, J. A. (2009). "Microbiological water quality at non-human influenced reference beaches in southern California during wet weather." Marine Pollution Bulletin **60**(4): 500-508.

Hartel, P. G., Rodgers, K., Fisher, J. A., McDonald, J. L., Gentit, L. C., Otero, E., Rivera-Torres, Y., Bryant, T. L. and Jones, S. H. (2005). Survival and regrowth of fecal enterococci in desiccated and rewetted sediments. 2005 Georgia Water Resources Conference, Athens, Georgia.

Heal the Bay (2006). Santa Monica Pier Bacterial Source Identification Study. Santa Monica, CA, Heal the Bay**:** 14.

Keswick, B. H., Gerba, C. P. and Goyal, S. M. (1981). "Occurrence of enteroviruses in community swimming pools." American Journal of Public health **71**(9): 1026-1030.

Ktsanes, V. K., Anderson, A. C. and Diem, J. E. (1981). Health Effects of Swimming in Lake Pontchartrain at New Orleans EPA- 600/S1-81-027. Washington, DC, United States Environmental Protection Agency. Center for Environmental Research Information.

LACDPW (2006). Hydrologic report 2004-2005. Los Angeles, CA, Los Angeles County Department of Public Works**:** 697.

Levine, W. C. and Stephenson, W. T. (1990). Waterborne disease outbreaks, 1986-1988. MMWR 39(SS-1), CDC**:** 1-9.

Los Angeles County Department of Public Works (2001). Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, http://dpw.lacounty.gov/wmd/NPDES/report_directory.cfm. Los Angeles, CA, County of Los Angeles Department of Public Works.

Los Angeles County Department of Public Works (2006). Hydrologic report 2004-2005. Los Angeles, CA, Los Angeles County Department of Public Works**:** 697.

Martin, A. and Gruber, S. (2005). Amplification of indicator bacteria in organic debris on southern California beaches: Technical paper 0507. Orlando, FL, Weston Solutions, Inc.**:** 7.

Mood, E. (1977). Bacterial indicators of water quality in swimming pools and their role. Health hazards associated with water, ASTM STP 635. Hoadley, A. and Dutka, B., American Society for Testing and Materials**:** 239-246.

Palmateer, G. A., Dutka, B. J., Janzen, E. M., Meissner, S. M. and Sakellaris, M. G. (1991). "Coliphage and bacteriophage as indicators of recreational water quality." Water Reasearch **25**(3): 355-357.

Papapetropoulou, M. and Vantarakis, A. C. (1998). "Detection of adenovirus outbreak at a municipal swimming pool by nested PCR amplification." Journal of Infection **36**(1): 101-103.

Prüss, A. (1998). "Review of epidemiological studies on health effects from exposure to recreational water." Int. J. Epidemiol. **27**(1): 1-9.

Schiff, K. and Kinney, P. (2001). "Tracking Sources of Bacterial Contamination in Stormwater Discharges to Mission Bay, California." Water Environment Research **73**(5): 534-542.

Schoen, M. and Ashbolt, N. (2010). "Assessing Pathogen Risk to Swimmers at Non-Sewage Impacted Recreational Beaches." Environ Sci Technol **44**: 2286-2291.

Sinclair, R. G., Jones, E. L. and Gerba, C. P. (2009). "Viruses in recreational water-borne disease outbreaks: a review." Journal of Applied Microbiology **107**(6): 1769-1780.

Stein, E. D., Tiefenthaler, L. L. and Schiff, K. (2007). Understanding sources, patterns, and mechanisms of pollutant loading from urban, arid watersheds and land-uses of the greater Los Angeles, California, USA. Westminster, CA, SCCWRP.

Stein, E. D. and Yoon, V. K. (2007). Assessment of water quality concentrations and loads from natural landscapes. Costa Mesa, CA, Southern California Coastal Water Research Project.

Tiefenthaler, L. L., Stein, E. D. and Lyon., G. S. (2008). Fecal Indicator Bacteria (FIB) levels during dry weather from southern California reference streams: Technical Report 542 (ftp://ftp.sccwrp.org/pub/download/PDFs/542_FIB_ReferenceBacti.pdf). Costa Mesa, CA., Southern California Coastal Water Research Project.

USEPA (1986). Ambient Water Quality Criteria for Bacteria - 1986. USEPA 440/5-84-002. Washington, DC, USEPA.

Woelfel, D. (2006). Review of epidemiological studies for fresh waters (http://www.sawpa.org/documents/stormwater/PhaseII/freshwaterepidemiology.pdf): 30.

World Health Organization (1999). Health Based Monitoring of Recreational Waters: The Feasibility of a New Approach (The 'Annapolis Protocol'), WHO/SDE/WSH/99.1 Geneva, Switzerland.

ATTACHMENT B

SUSAN C. PAULSEN

Vice President and Senior Scientist, Flow Science Incorporated

Years of Experience

16

Education

Ph.D. Environmental Engineering Science, California Institute of Technology, 1997
M.S. Civil Engineering, California Institute of Technology, 1993
B.S. Civil Engineering (with honors), Stanford University, 1990

Professional Affiliations

Registered Professional Engineer in California (C66554)

Key Qualifications

Dr. Paulsen has been employed at Flow Science since 1997, where she has project responsibility for work involving environmental fate and transport. Dr. Paulsen has particular expertise in the analysis of fate, transport, and water quality in estuarine systems, including the San Francisco Bay-Delta system, where she developed a unique fingerprinting method for the analysis of mixing patterns and the sources of salinity in the Delta. At Flow Science she has been involved in projects combining hydrodynamics, aquatic chemistry, and the environmental fate of various constituents. Dr. Paulsen also oversees water quality regulatory and policy analysis for Flow Science.

Experience

Dr. Paulsen has designed and implemented field studies in reservoir, river, estuarine, and ocean environments using both dye and elemental tracers to evaluate the impact of treated wastewater, thermal, and agricultural discharges on receiving waters and drinking water intakes. Dr. Paulsen has expertise designing and managing modeling studies to evaluate transport and mixing, including the siting and design of diffusers, and she has conducted water quality analyses for storm water runoff, NPDES permitting, irrigation, and wastewater and industrial process water treatment facilities.

Dr. Paulsen has designed studies utilizing the Fischer Delta Model (FDM), three-dimensional CFD modeling, longitudinal dispersion modeling, and Monte Carlo modeling to evaluate water quality impacts, to develop proposed NPDES permit limits, and to analyze and develop TMDLs. She has designed and implemented tracer and/or modeling studies for a number of agencies including Contra Costa Water District, CALFED, DWR, Irvine Ranch Water District, and the Sacramento Regional County Sanitation District. Dr. Paulsen has also managed and designed studies to investigate the disposal of brines from salt production and reverse osmosis (RO) facilities, and she has participated in several intensive multi-disciplinary studies of the fate and transport of both organic and inorganic pollutants, including DDT, copper, and selenium, in surface and ground waters and sediments. Dr. Paulsen has also studied the use of indicator bacteria as water quality objectives and the behavior of bacteria in the environment.

Dr. Paulsen has extensive expertise with water quality regulation in California and served as primary author for a comprehensive review of the administrative record of the Los Angeles Basin Plan. She has worked on temperature compliance models, NPDES permitting, permit compliance, master planning and EIR/EIS processes, and TMDL development. She has expertise regarding the importance of atmospheric deposition, soil erosion, and wildfires on storm water quality, the development of numeric limits for storm flows, and the use of indicator bacteria as a measure of water quality. Dr. Paulsen has also provided testimony to the California State Water Resources Control Board and Regional Boards in water rights and permitting issues, has spoken extensively on regulatory issues, and currently serves on the State Board's Sediment Quality Objective Advisory Committee.

ATTACHMENT C

Flow Science Incorporated
723 E. Green St., Pasadena, CA 91101
(626) 304-1134 • FAX (626) 304-9427

April 19, 2010

California Regional Water Quality Control Board, Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Attention: Renee Purdy
Ginachi Amah

Subject: Comments prepared in response to the CEQA Scoping Meeting Notice
Proposed amendment to the Water Quality Control Plan for the Los Angeles Region (Basin Plan) to update the bacteria objectives for freshwaters designated for contact recreation by removing the fecal coliform objectives
FSI 037033

Dear Ms. Purdy and Dr. Amah,

Flow Science, on behalf of the City of Signal Hill, appreciates the opportunity to submit comments in response to the April 6, 2010 CEQA Scoping Meeting Notice for the above-captioned proposed Basin Plan amendment.

As detailed below, Flow Science supports the proposed change (removal of objectives for fecal coliform) and urges the Regional Water Quality Control Board (Regional Board) to consider additional changes to the objectives at the same time. We also urge the Regional Board to delay the adoption of bacteria TMDLs until the standards for indicator bacteria are reconsidered.

Support for removal of fecal coliform objectives. The original water quality objectives for fecal coliform were established in 1968 on the basis of epidemiological studies conducted in 1948, 1949, and 1950 (NTAC 1968[1]). However, fecal coliform has since been shown to be a poor indicator of the presence of pathogens and human health risk. As early as 1972, a Committee formed by the National Academy of Science-National Academy of Engineers noted the deficiencies in the study design and data used to establish the recreational fecal coliform criteria, and stated that it could not recommend a recreational water criterion because of a paucity of valid epidemiological data.[2] Studies initiated in 1972 by USEPA found that fecal coliform densities showed "little or no

[1] Water Quality Criteria, a Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration: Washington, D.C. April 1, 1968, at p. 8 and p. 12.
[2] Committee on Water Quality Criteria. National Academy of Sciences-National Academy of Engineering. Water Quality Criteria. USEPA R3-73-033, Washington, D.C., 1972.

correlation" to gastrointestinal illness rates in swimmers.[3] Based upon these studies, EPA in 1986 proposed section 304(a) criteria for full body contact recreation based upon *E. coli* and/or enterococci.[4]

Although the Regional Board adopted criteria for *E. coli* consistent with USEPA's recommendations in 2001, fecal coliform criteria remained in the Basin Plan following that amendment. The current proposed Basin Plan Amendment to remove fecal coliform is consistent with USEPA's directives and consistent with scientific studies showing the fecal coliform is at best a poor indicator of human health risk. For this reason, we support the proposed Basin Plan amendment.

Request to consider "controllable water quality sources" language as a CEQA alternative. However, the best available science indicates that *E. coli* are far from a perfect indicator of human health risk. *E. coli* originate from multiple sources, including birds and wildlife, and can regrow in sediments and biofilms. Further, recent epidemiological work in southern California indicates that, when human sources of indicator bacteria have been minimized or eliminated, indicator bacteria are uncorrelated with human health risk. An extensive cohort epidemiological study of Mission Bay[5], where extensive efforts were made to eliminate human sources of bacteria, found that "[t]he risk of illness was uncorrelated with levels of traditional water quality indicators. Of particular note, the state water quality thresholds [including those for *E. coli*] were not predictive of swimming-related illnesses. Similarly, no correlation was found between increased risk of illness and increased levels of most non-traditional water quality indicators."

We are now fortunate to have detailed data on *E. coli* and on a human-specific bacteria (bacteroidales) from six dry weather sampling events in the Los Angeles River, which were collected as part of the CREST sampling effort.[6] As shown in **Figure 7-26** of the CREST study (at p. 7-59, and reproduced below), only about 10-50% of the bacteria measured in Reach 2 of the Los Angeles River during six dry weather sampling events originated from storm drains and tributaries. This indicates that elimination of inflows, or elimination of bacteria in inflows, to this reach would not eliminate the exceedances of the water quality objectives for *E. coli*.

---

[3] Dufour, A.P. Health Effects Criteria for Fresh Recreational Waters. USEPA 600/1-84-004, August 1984.
[4] Ambient Water Quality Criteria for Bacteria – 1986, USEPA 440/5-84-002, January 1986.
[5] Colford, J.M. Jr, T.J. Wade, K.C. Schiff, C. Wright, J.F. Griffith, S.K. Sandhu, S.B. Weisberg. Recreational water contact and illness in Mission Bay, California. 2005. Technical Report 449. Southern California Coastal Water Research Project. Westminster, CA
[6] CREST (2008). Los Angeles River Bacteria Source Identification Study: Final Report. November.

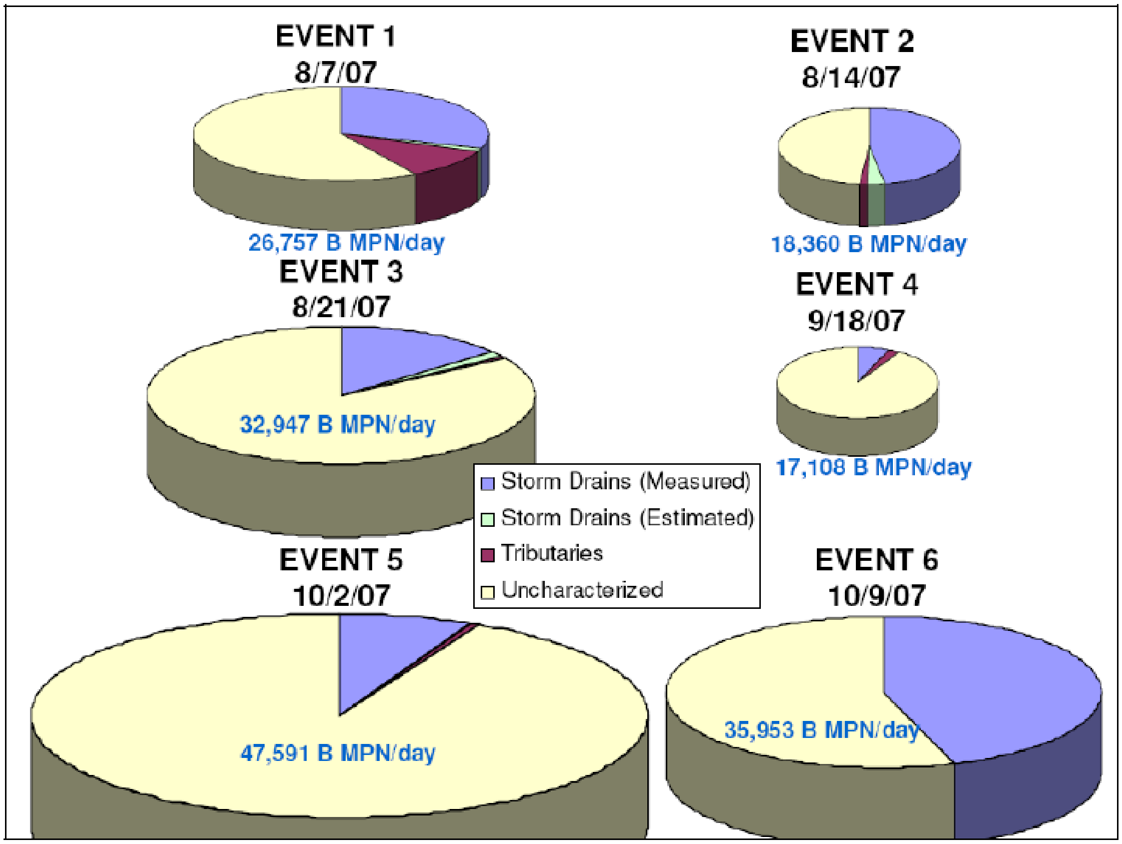


Figure 7-26. Reach 2 Event-by-Event *E. coli* Mass Balance

This figure is a graphical representation of **Table 7-24**. The diameter of the pie charts is proportional to the upstream-downstream loading increase measured along the LA River reach (i.e., the net loading from all sources), which is also detailed with text. The scale is unique to Reach 2 monitoring events (i.e., the figure for Reach 4 uses a different scale). The calculated vs. measured loading difference in **Table 7-24** is represented by "uncharacterized".

Additional information is provided by reviewing **Figures 6-3** and **6-12** of the CREST report (at p. 6-11 and 6-25, respectively, and reproduced below), which show measured concentrations of *E.coli* and human bacteriodales from six dry weather sampling events along the length of the river. As shown in **Figure 6-3**, concentrations of *E. coli* fall to levels mostly below water quality objectives for E. coli downstream of sewage treatment plants. Highly purified wastewater enters the Los Angeles River between river miles 5 and 8, and between river miles 14 and 26. However, downstream of those locations, *E. coli* concentrations rise again. Note in particular the rise in *E. coli* concentrations between 6th St. and Slauson Ave.

Figure 6-12 presents concentrations of human bacteroidales, measured in the same samples from which the *E. coli* measurements (shown in Figure 6-3) were obtained. Note the concentrations of human bacteroidales increase only slightly in Reach 2 of the river between 6th Street and Slauson Ave. The increase in *E. coli* concentrations in this river segment is far greater (more than one order of magnitude) than the corresponding increase in bacteroidales, indicating that the *E. coli* in this segment is from non-human sources. These data indicate that non-human sources (which may include wildlife and birds, or regrowth in sediments) are likely responsible for the exceedances of water quality criteria in this river segment.

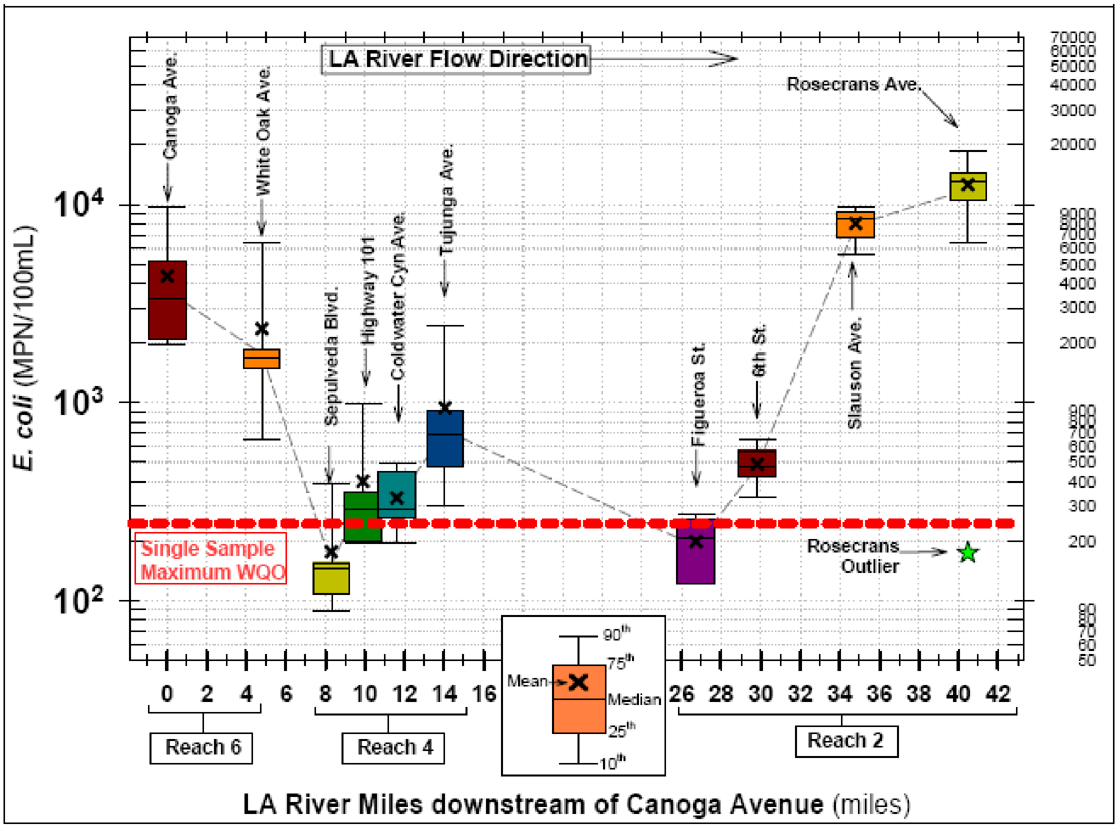


Figure 6-3. Measured *E. coli* Concentrations along the LA River

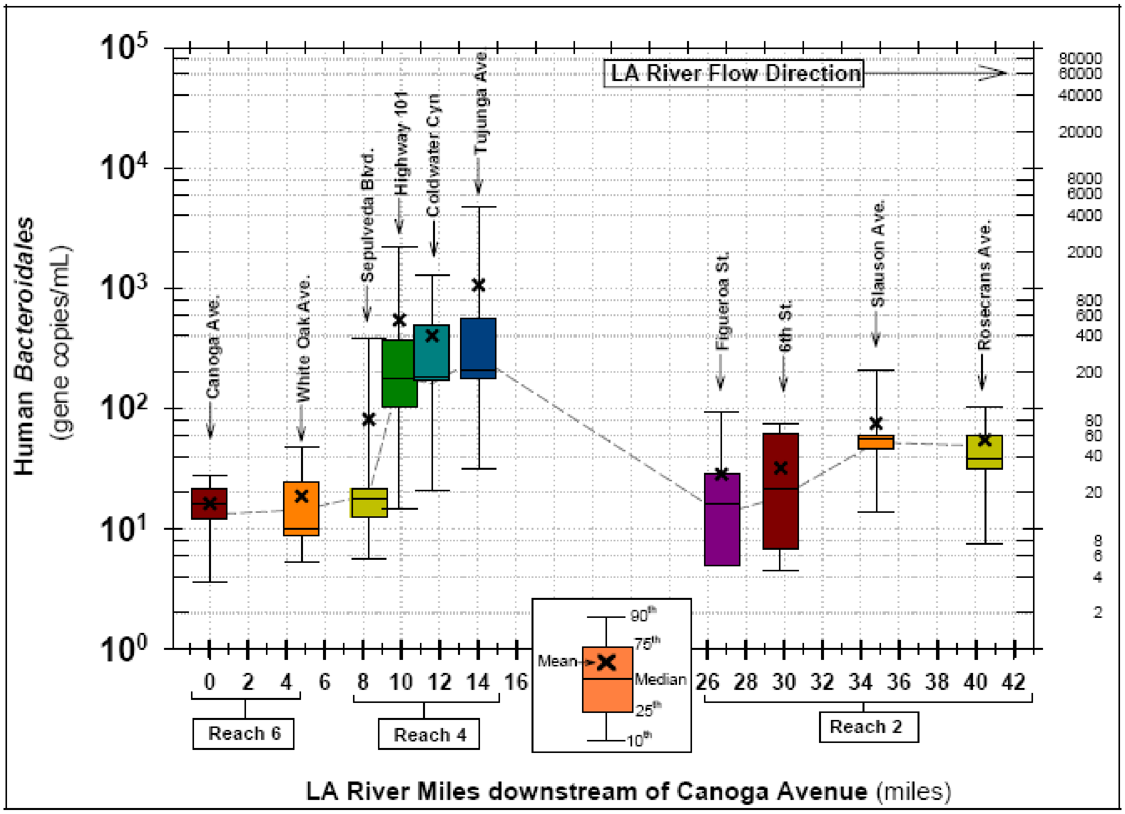


Figure 6-12. Measured Human-specific *Bacteroidales* Concentrations along the LA River

In the past, the Los Angeles Regional Board has used a "reference" or "natural" watershed approach to try to address natural sources. Under this approach, an "allowable exceedance frequency" is determined using monitoring data for indicator bacteria in an undeveloped watershed; the subject watershed is then allowed to exceed standards at the same frequency as the natural watershed. However, this approach is problematic for several reasons. For example, dry weather flows in urban watersheds come from many sources, including POTW effluent, overland flows, and flows through storm drains (including NPDES-permitted flows), while dry weather flows in natural watersheds are often comprised mainly of groundwater inflow. Thus, there is less opportunity for the dry weather flows in natural watersheds to be exposed to natural sources of bacteria. Data from the CREST study process[7] indicate exceedance rates for *E. coli* of between 7% (for single samples) and 16% (for geomeans) for all dry weather data from a natural watersheds study completed by SCCWRP. When two of the undeveloped watersheds in the SCCWRP study were excluded from the analysis because they were "minimally impacted" (i.e., had higher rates of exceedances and were nearer to urban development), exceedance rates fell to <2%. However, as shown in **Figures 6-3** and **6-12**, it appears that non-human sources were responsible for increases in *E. coli* concentrations between 6th St. and Slauson Avenue for 100% (6 of 6) dry weather sampling events. Thus, it

[7] CREST Consulting Team, Freshwater Reference Site Conditions, Calculation of Allowable Exceedance Days, and Consideration Points for the LA River Bacteria TMDL. December 2008.

FLOW SCIENCE®

appears that a reference or natural watershed approach would be ineffective for at least certain reaches of the Los Angeles River.

Because of bacteria regrowth in streams, compliance with water quality objectives in-stream may not be achievable, even when extensive treatment measures are implemented to minimize bacteria concentrations in inflows. For example, Orange County recently studied the efficacy of several BMPs for reducing bacteria concentrations in Aliso Creek, Orange County, California. Results of this study were summarized by the County of Orange (2005)[8]. The BMPs that were evaluated included a multimedia filtration and UV sterilization system. The study, which was conducted during dry weather, found that these BMPs greatly reduced concentrations of indicator bacteria, but that bacteria levels rebounded within a short distance downstream of the BMPs. For the filtration/sterilization BMP, the geometric mean concentration of fecal coliform increased from 317 cfu/100mL at the outlet of the BMP to 2575 cfu/100mL (i.e., in excess of water quality objectives) in a natural channel at a distance of 35 feet downstream of the BMP.

The draft implementation plan prepared by the CREST consulting team[9] includes several options for the "first iteration" of implementation. (The CREST work product was developed assuming that E. coli would be the only targeted bacteria [i.e., the proposed alternative in the subject proposed Basin Plan amendment], and considering implementation measures for dry weather compliance only.) One of the concepts evaluated would focus on meeting TMDL waste load allocations (WLAs) by diverting and/or treating dry weather flows from storm drains and tributaries to the mainstem of the Los Angeles River. The cost estimate for this approach, assuming 3% escalation of costs per year, is $ 1.112 billion for dry weather flows only. Expenditures of this magnitude will undoubtedly impact other municipal services, potentially including health and safety services, environmental restoration measures, and a wide range of other public services. In addition, the construction of diversions to the sewer system will have environmental impacts at the point of diversion, and increasing flows to POTWs will impact their capacity and treatment and energy costs. Treatment at the point flows enter the mainstem of the river will also potentially have significant environmental impacts, including construction impacts, noise, and energy use. The energy requirements of multiple treatment systems could potentially impact public utilities and energy consumption, and could result in increased regional CO_2 emissions. Finally, it is reasonably foreseeable the strict compliance with the *E. coli* objectives could require control and/or elimination of wildlife and associated habitat, as wildlife is a significant source of bacteria to receiving waters.

For these reasons, we request that the Board consider as a CEQA alternative amending the objectives for indicator bacteria such that they require compliance with *E.*

[8] Final Report, Agreement: 01-227-550-0, Aliso Beach Clean Beaches Initiative. J01P28 Interim Water Quality Improvement Package Plant Best Management Practices. County of Orange, February 2005.
[9] DRAFT Los Angeles River Watershed Bacteria TMDL Technical Report Section 7: Dry Weather Implementation Plan. Prepared for CREST by the CREST consulting team. February 2010.

FLOW SCIENCE®

coli concentrations "as a result of controllable water quality factors." Under this concept, if it were demonstrated, using appropriate scientific techniques, that bacteria in excess of criteria were from "uncontrollable" factors (such as wildlife), the presence of those bacteria would not be considered a violation of water quality objectives. It is likely that this alternative would have a less significant environmental impact than the proposed alternative (i.e., removal of fecal coliform from the water quality objectives) alone. Most importantly, the CEQA alternative proposed for consideration here would allow the presence of wildlife and associated habitat without considering those wildlife and habitat to cause or contribute to an exceedance of water quality standards. Further, we believe that this proposed CEQA alternative would be protective of water quality and human health and would meet the objectives of the proposed CEQA project.

Project timing. Because of the potentially large expenditures of public resources associated with the proposed project, we urge the Regional Board to delay the adoption of bacteria TMDLs until the standards for indicator bacteria are further reconsidered, as detailed above.

Thank you for the opportunity to provide comments. Please contact me if you have any questions.

Sincerely,

Susan C. Paulsen

Susan C. Paulsen, Ph.D., P.E.
Vice President and Senior Scientist

ATTACHMENT D

Example of Importance of Basin Plan Revisions

Susan Paulsen, Ph.D., P.E.
Vice President, Senior Scientist
Flow Science Incorporated

Flow Science Incorporated
723 E. Green St., Pasadena, CA 91101
(626) 304-1134 FAX (626) 304-9427

FLOW SCIENCE®

Example: Los Angeles River Bacteria TMDL

- Los Angeles River Bacteria TMDL will come forward soon (scoping session was held in March 2010)
- Standards are deficient
- First "iteration" of dry weather implementation may cost >$1.1 billion, may not attain standards in receiving water
- Consequences of not considering Basin Plan changes first are significant
- Need to evaluate standards *before* implementing via TMDLs, permits

FLOW SCIENCE®

Basin Plan

- Contains water quality standards
  - Beneficial uses
  - Water quality objectives
  - Anti-degradation
- Contains implementation requirements
- Should be developed in accordance with Porter-Cologne Sections 13000, 13241, and 13242

FLOW SCIENCE®

Water Quality Standards:
Beneficial Uses

- REC-1
  - *"Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible…"*
- REC-2
  - *"Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible…"*
    - RWQCB Los Angeles Region Basin Plan

FLOW SCIENCE®

Headwaters of Los Angeles River
(Arroyo Calabasas and Bell Creek)

Source: www.you-are-here.com/location/la_river.html

Los Angeles River
(at Canoga Ave)

Source: www.you-are-here.com/location/la_river.html

Los Angeles River
(Soft-bottom section)

Source:
http://commons.wikimedia.org/wiki/File:Los_Angeles_River_Anas_platyrhynchos.jpg

Los Angeles River
(at Main Street Bridge)

Source: www.you-are-here.com/location/la_river.html

Los Angeles River
(at 4th St. Bridge and in Vernon)

Source: www.you-are-here.com/location/la_river.html

Los Angeles River
(During wet weather conditions)

Source: www.you-are-here.com/location/la_river.html

Water Quality Standards

Example: indicator bacteria objectives in LA Basin Plan

Bacteria	Freshwater (number/100 mL)		Marine Waters (number/100 mL)	
	Geometric Mean	Single Sample	Geometric Mean	Single Sample
E. coli	126	235		
Fecal coliform	200	400	200	400
Total coliform			1,000	10,000*
Enterococcus			35	104

* Total coliform not to exceed 1,000 if fecal-to-total coliform ratio > 0.1

FLOW SCIENCE®

Concerns with application of standards

Compliance approaches for bacteria

Some sources are controllable, clearly pose risk

- Human Sewage
- POTW Discharges
- Confined Animal Feeding Operations (CAFOs) and Washwater

(These sources are highly regulated and largely controlled.)

FLOW SCIENCE®

Compliance challenges for bacteria

…but most others are not controllable, or likely pose much less risk

- Pet waste
- Wildlife activity and waste

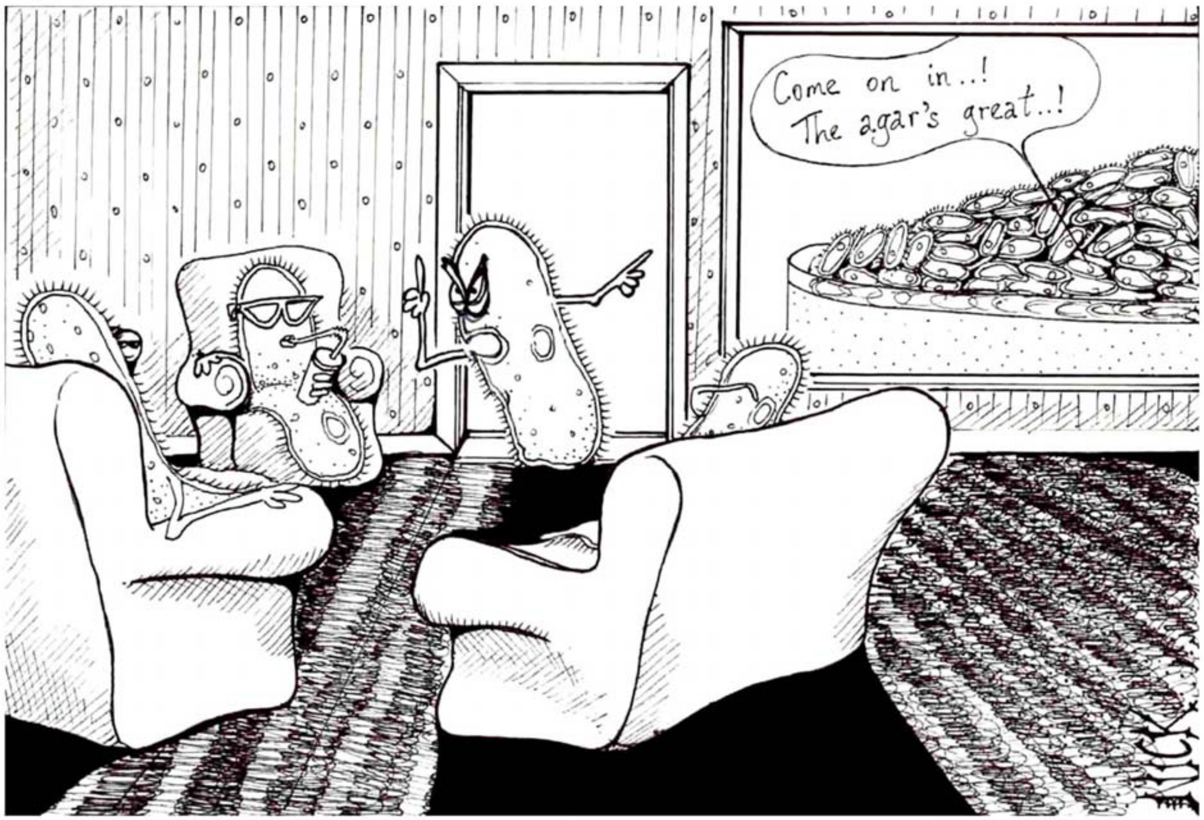
Birds in Rio Hondo

Birds in Los Angeles River

- Homeless encampments
- Bacteria re-growth in sediment
- Resuspension from disturbed sediment
- Shedding during swimming

FLOW SCIENCE®

Compliance challenges for bacteria
Bacteria are prolific



"I wish you'd learn to put the lid on your Petri dish, Harry! We came here with four kids, and now it looks like we've got twenty millon..!!"

FLOW SCIENCE®

Compliance challenges for bacteria

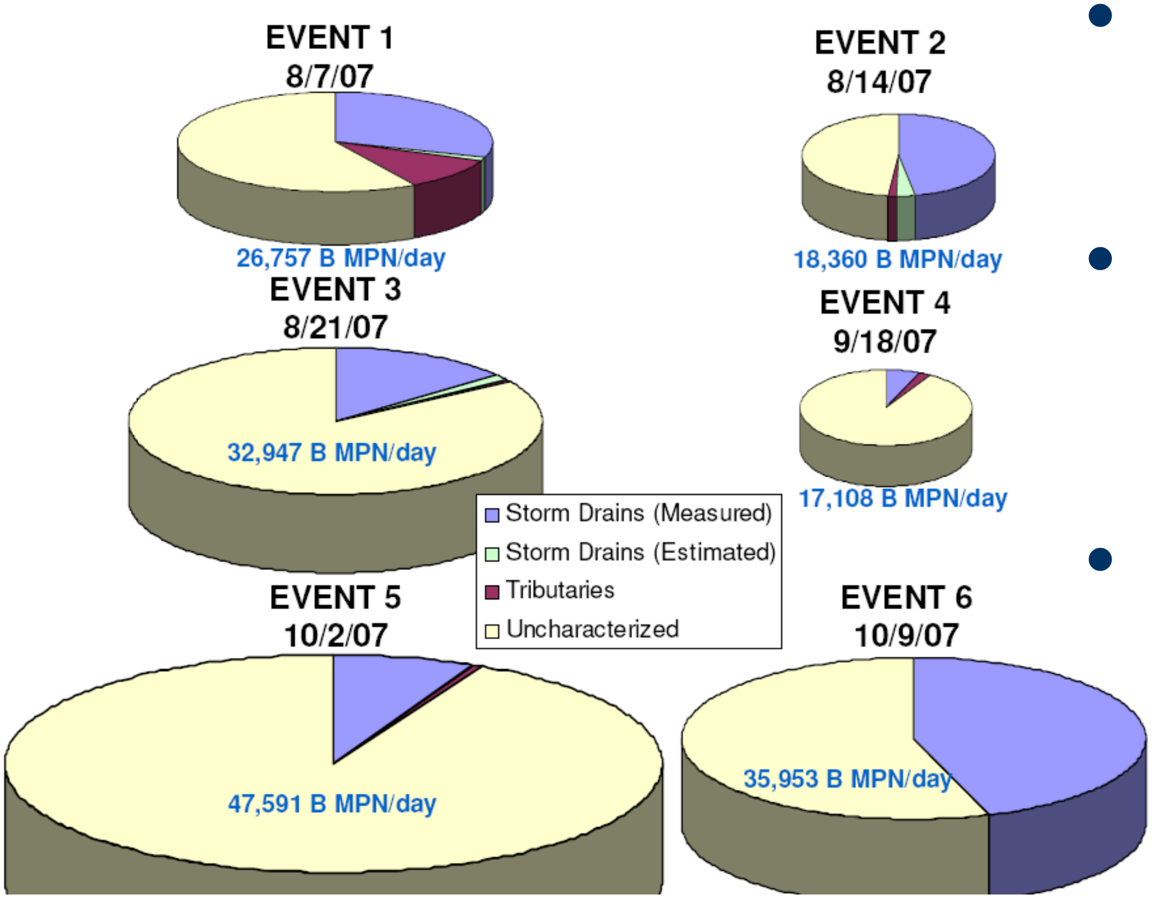
Regrowth of treated water occurs quickly

- Aliso Creek study (Orange County 2005) showed quick re-growth in natural channels after BMP treatment
  - UV filtration/disinfection produced >99% removal in urban runoff entering Aliso Creek
  - But fecal coliform increased from 317 cfu/100mL at BMP outlet to 2575 cfu/100mL in natural receiving water channel only 35 feet downstream of the BMP
- Regrowth also occurs in storm drains, stream sediments, and biofilms
- Consider the need to add chlorine to drinking water!

FLOW SCIENCE®

Compliance challenges for bacteria

Only 10-50% of bacteria enter LAR R2 from storm drains, tributaries

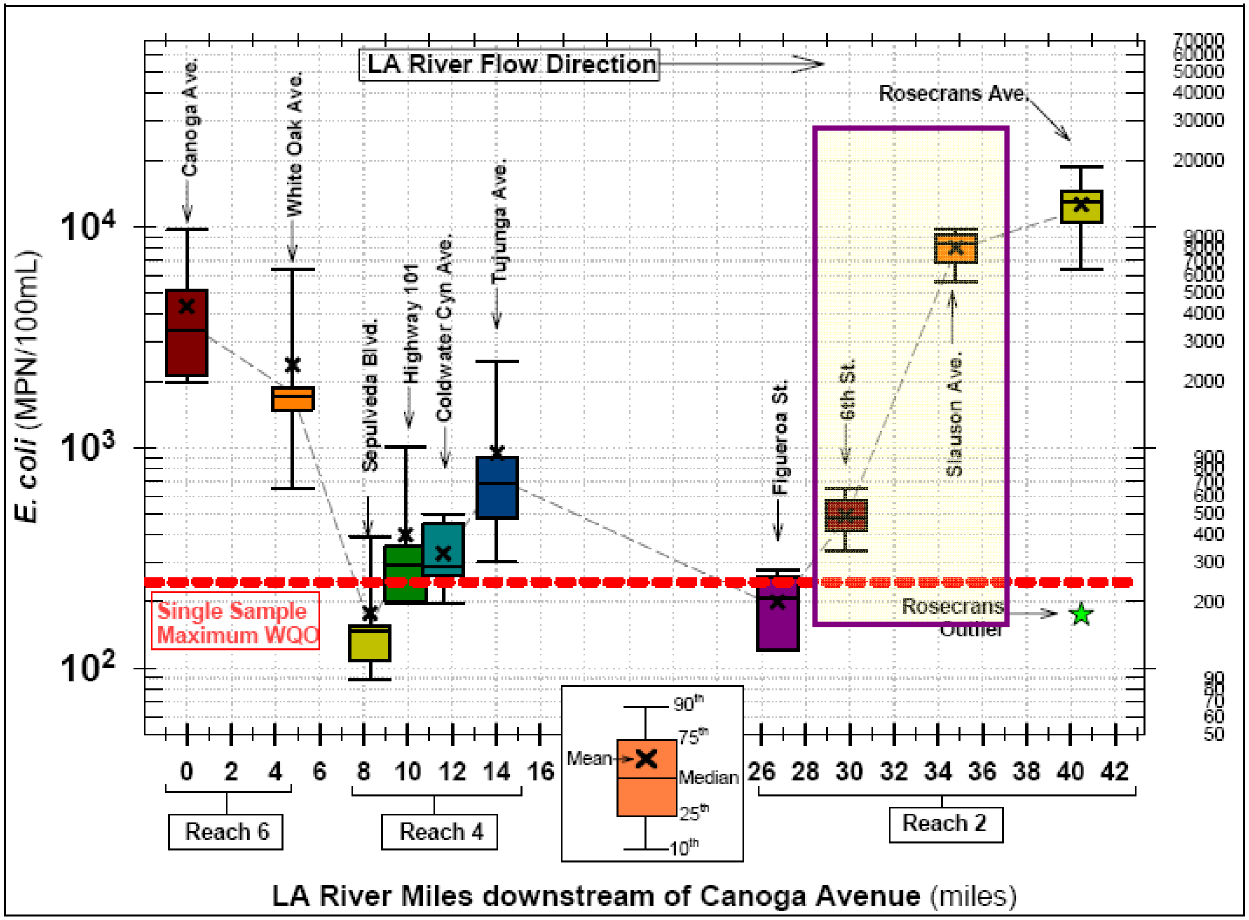


- Dry weather monitoring, 6 events, LA River Reach 2
- Controlling inputs will likely not result in attaining standards in the river
- Unclear how compliance can be achieved

From CREST (2008)

FLOW SCIENCE®

Compliance challenges for bacteria
Large increase in E. coli between 6th and Slauson



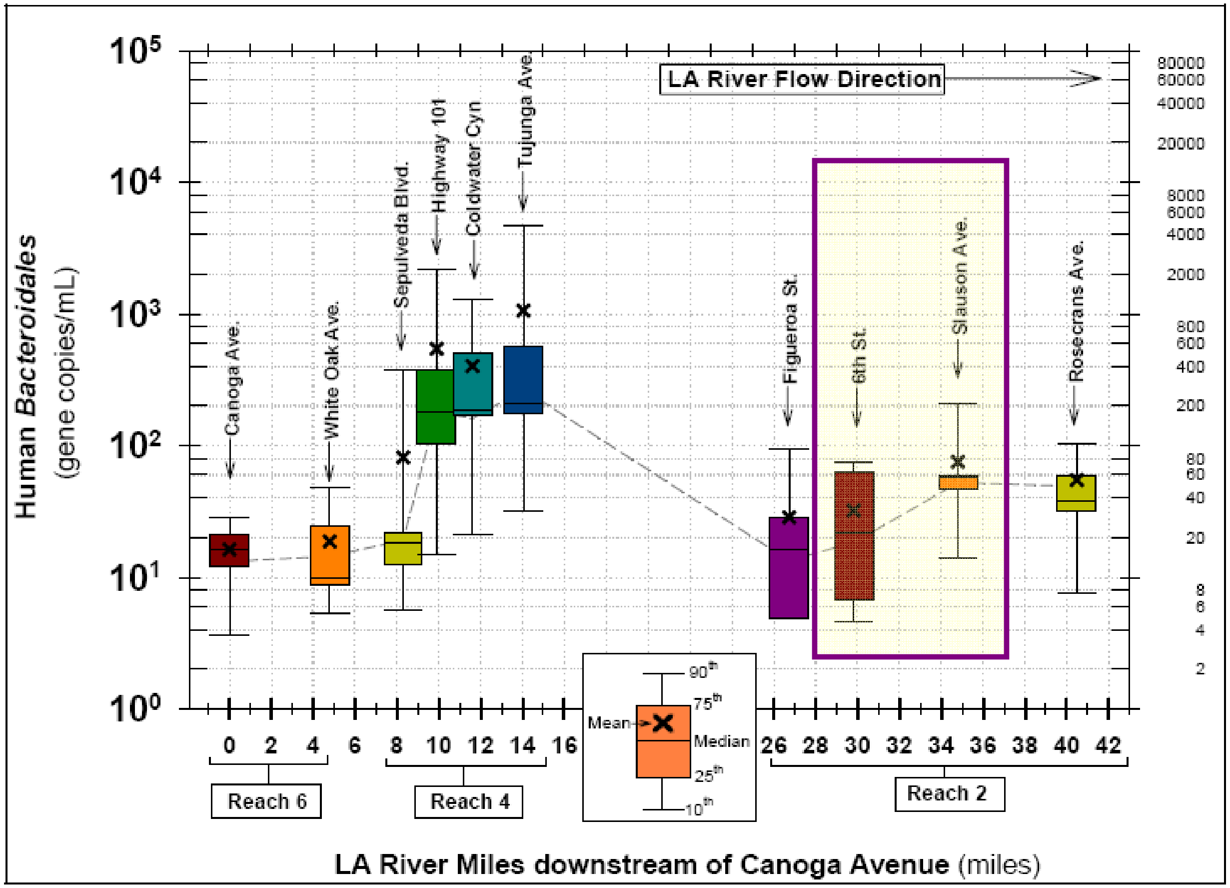
- POTW discharges dilute bacteria in river, then concentrations rise
- Standards exceeded in 6/6 dry weather monitoring events at 6th St. and at Slauson

From CREST (2008)

FLOW SCIENCE®

Compliance challenges for bacteria

But source of bacteria there is mostly non-human



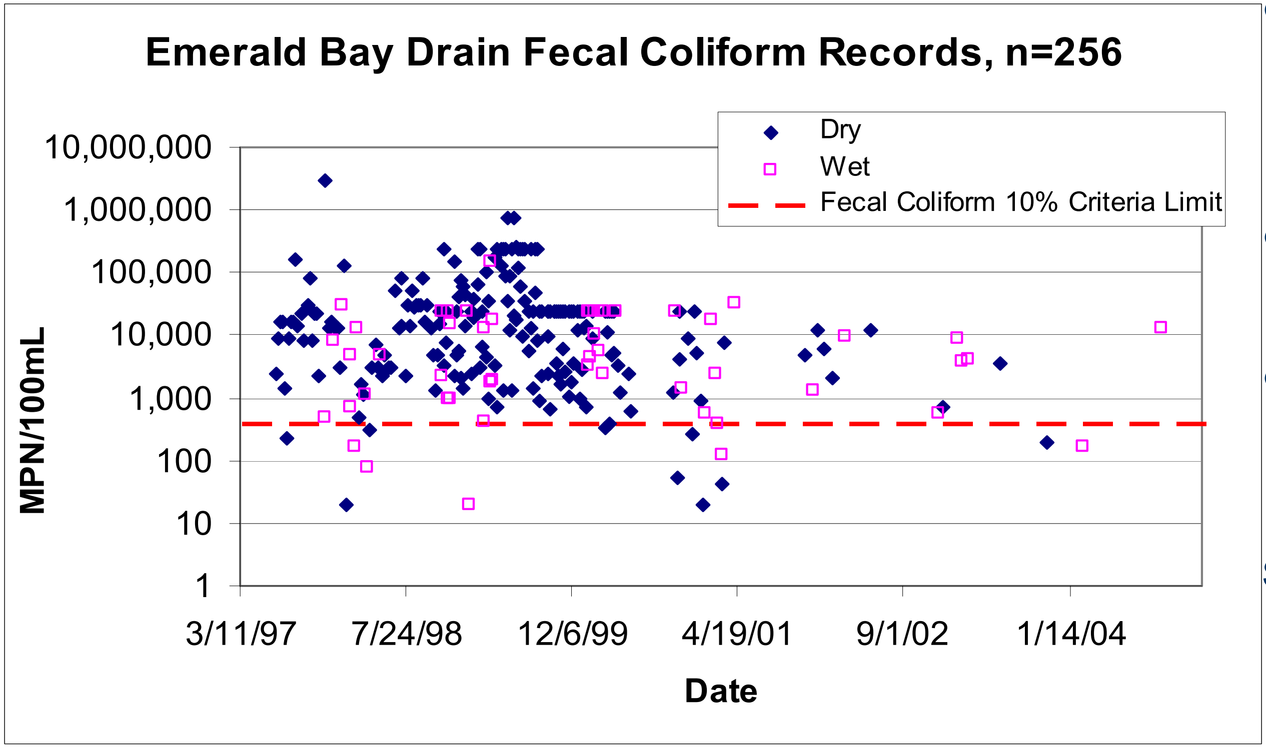
- Data indicate increase in E. coli between 6th St. and Slauson is from non-human sources

From CREST (2008)

FLOW SCIENCE®

Compliance challenges for bacteria

"Reference" watershed approach is inappropriate



- Emerald Bay Drain (OC) watershed is 3% developed but exceeds standards 95% of time
- Standards exceeded in wet and dry weather
- Urban watersheds function differently than open space

Source: Flow Science (2005), using data collected by Orange County

FLOW SCIENCE®

Recommendations for bacteria

Example of bacteria: consider Basin Plan changes

- Require standards to be met as a result of "controllable water quality factors"
- Remove objectives for fecal coliform
- Extend high flow suspension to non-engineered channels (when REC-1 and REC-2 uses are unsafe)
- Prioritize implementation
  - Aim for greatest risk reduction
  - Focus resources where exposures are greatest
  - ID and eliminate human sources
- Continue research to improve objectives

FLOW SCIENCE®

Recommendations

- Review and revise water quality standards to be applied to storm water/urban runoff
  - Evaluate beneficial use designations
  - Environmental and physical characteristics of water bodies
  - Water quality conditions that could reasonably be achieved through coordinated control of all factors
  - Economic considerations
- Specify details of program of implementation
  - Actions to be taken by any entity, public or private
  - Time schedule
- Conduct review before TMDL and permit implementation (consistent with NRC 2001 & 2008)

FLOW SCIENCE®

Questions?