BASIN PLAN AMENDMENT

REVISIONS TO
RECREATIONAL STANDARDS FOR INLAND FRESH SURFACE WATERS
IN THE SANTA ANA REGION

Peer Review Comment – K.D. Mena, March 2012

The following is a review of the Basin Plan Amendments prepared by the California Regional Water Quality Control Board, Santa Ana Region (2012). This review was approached as a response to the two issues listed below, yet carefully considered each of the specific amendments described in section 5.0 of the document. This review takes a precautionary approach, and addresses each proposed amendment from a public health perspective that offers the maximum protection to all populations who may be exposed.

Published studies have been somewhat inconsistent regarding the usefulness of coliform bacteria as predictors of human health. While some have shown an increase in health risk associated with recreating in coliform-laden waters, numerous other studies have shown that indicator bacteria (e.g., coliforms) are not adequate predictors of water quality and human health risk. There is no correlation between the occurrence or absence of pathogens – such as protozoa and enteric viruses – and these indicator bacteria. Not only are some members of these pathogen groups able to survive for greater lengths of time than coliforms, their ability to cause illness (at low infectious doses) make them more appropriate indicators of human health. However, as noted in the Basin Plan Amendment document, it is not practical or economical to monitor for all possible pathogens; therefore, coliform bacteria continue to be used as a monitoring trigger to alert regulatory agencies. Because of the limitations associated with coliform bacteria as predictors of human health, it is important when utilizing coliforms as indicators to counter their shortfalls with conservative assumptions regarding exposures in order to be protective of all (potentially) affected populations.

This review will concede that, for practical purposes, coliform bacteria – specifically *E. coli* – is currently the available indicator for recreational water standards. [A review paper by Prüss (1998) describes several studies that associate bacterial indicators in recreational waters with human illness.] Although *E. coli* will be addressed in this peer review as the chosen water quality/human illness indicator, the underlying premise of this review will still consider *E. coli* as an imperfect microorganism to use to target human health and inform policy. The objective will be to highlight areas within the proposed standards that may provide more conservative protection for public health. Below are some references that address the usefulness (or inappropriateness) of using coliform bacteria as water quality indicators:

Craun, G.F., P.S. Berger and R.L. Calderon. 1997. Coliform bacteria and waterborne disease outbreaks. *Journal of the American Water Works Association* 89(3):96-104.

Haile, R.W. 1996. An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay. Santa Monica Bay Restoration Project. Monterey Park, California.

Haile, R.W., J.S. Witte, M. Gold, R. Cressey, C. McGee, R.C. Millikan, A. Glasser, N. Harawa, C. Ervin, P. Harmon, J. Harper, J. Dermand, J. Alamillo, K. Barrett, M. Nides and G.Y. Wang.

1999. The health effects of swimming in ocean water contaminated by storm drain runoff. *Epidemiology* 10(4):355-363.

Kay, D. and C. Fricker. 1997. Coliforms and *E. coli*: Problem or Solution? Royal Society of Chemistry, London.

NRC. National Research Council. 1994. Ground Water Recharge using Waters of Impaired Quality. Groundwater Recharge Committee, National Academy of Science. ISBN 0-309-05142-8. National Academy Press, Washington, D.C., 284 pp.

Prüss, A. 1998. Review of epidemiological studies on health effects from exposure to recreational water. *International Journal of Epidemiology* 27:1-9.

Issue 1: Replacement of established fecal coliform water quality objectives with *E. coli* objectives/targets.

Based on currently available scientific (peer-reviewed) data, *E. coli* is an acceptable water quality indicator in lieu of fecal coliforms as a group. However, as noted above, it does not correlate with the presence/absence of waterborne pathogens – such as protozoa and enteric viruses. Its presence in recreational waters also may or may not reflect risks associated with human health. Although *E. coli* is used as a water quality indicator, risk managers should recognize its limitations when developing policy and in interpreting water monitoring data.

When considering water quality and public health, it is necessary to consider sensitive sub-populations, such as the elderly and children (the latter mentioned in the proposed amendments). Policy-making should have a conservative approach, erring on the side of caution to be protective of all populations. Although it is important to clarify definitions - particularly for terms driving policy - it is not appropriate to sacrifice safety for the sake of clarity. The proposed amendment regarding REC1 Beneficial Use Name and Definition inherently creates a less stringent approach to human health protection.

The rationale stated in section 5.1.1 for these changes in definition is “to assure that it properly reflects the nature of the recreational activity and exposure to water that was assumed in establishing bacteria indicator objectives to protect this use.” However, those “assumptions” and “established bacteria indicator objectives” are more than 25 years-old. In addition, the limitations associated with the epidemiological studies utilized for making standards (Dufour, 1984) result in a targeted illness rate for swimmers that may not be protective of all populations, especially children. First, the way “swimmers” and “non-swimmers” were classified resulted in a lower estimated illness rate for “swimmers” than what would be estimated if all people who immersed themselves in water were included in the “swimmers” group (regardless of exposure time). This resulted in fecal bacteria densities correlating with potentially *lower* estimated illness rates for “swimmers.” Further, “non-swimmers” may still be exposed to and impacted by pathogens, no matter the length of exposure time. Exposure classification should not be based on duration of water contact.

Second, the epidemiological studies were conducted during dry weather conditions. This – again – is not generating “worst-case scenario” illness rate estimations. Studies have shown

increased pathogen concentrations in recreational waters during wet weather situations (LeChevallier et al., 1991; Craun et al., 1997; Bryan, 1999; Haile et al., 1999).

From a qualitative perspective, this amended definition could drive management toward a less protective policy. Other issues include:

1) The definition that "primary contact" means "ingestion" – what about the health effects associated with skin, eye or ear contact? Gastroenteritis is not the only health outcome of concern. A wide range of illnesses can result from "primary contact." Both acute and chronic sequelae impacting various parts of the body have been associated with recreational water exposures (Heerden et al., 2005; Pond, 2005; Mena and Gerba, 2009a and 2009b);

2) Changing the terminology from "reasonably possible" to "likely to occur" creates a more stringent definition for REC1 water exposure that could lead to less protective policy; and,

3) Is it better to differentiate "forms of wading" or rather take a conservative approach and simply keep "wading" as part of REC1?

As described above, considering only *E. coli* and gastroenteritis as the targets for creating recreational water standards isn't adequate. However, the challenges associated with including pathogens and/or other health endpoints are recognized. For the sake of discussion, the application of a gastrointestinal illness risk level of 8/1000 is appropriate, given the acceptable risk range provided by the USEPA. The geometric mean density of 126 CFU/100mL for REC1- and REC1/REC2-designated areas is also appropriate, and should be based on monthly monitoring (minimum five samples per month).

An issue for clarification: will guidance be provided for each waterbody as to specifically when and where samples should be taken? Will the sampling locations be: a) representative of the microbial quality of the waterbody? and b) representative of where people recreate? How will the sampler know? Each waterbody under consideration should be evaluated to address these points related to sampling.

Regarding REC2-designated waters, is this type of water truly less susceptible to children interaction and/or body contact? Is it appropriate to assume that recreational water associated with boating, camping, and sunbathing would not be used for other purposes involving body contact? The design of the Use Attainability Analysis is critical in accurately categorizing waterbodies as REC1 or REC2. In light of the points mentioned above regarding the definition of exposure, it is recommended that these waterbodies are further evaluated individually to assess all possible ways of human exposure and re-categorized if necessary to offer maximum human health protection.

Bryan, J.J. 1999. Sources of faecal bacteria and viruses in surface water and their impact on recreational water quality. In: Health-Related Water Microbiology, R. Morris et al., Eds. Proc. 1st IAWPRC Symposium, University of Strathclyde, 97-106.

Craun, G.F., P.S. Berger and R.L. Calderon. 1997. Coliform bacteria and waterborne disease outbreaks. *Journal of the American Water Works Association* 89(3):96-104.

Dufour, A.P. 1984. Health Effects Criteria for Fresh Recreational Waters. EPA 600/1-84-004. U.S. Environmental Protection Agency, Cincinnati, Ohio.

Haile, R.W., J.S. Witte, M. Gold, R. Cressey, C. McGee, R.C. Millikan, A. Glasser, N. Harawa, C. Ervin, P. Harmon, J. Harper, J. Dermand, J. Alamillo, K. Barrett, M. Nides and G.Y. Wang. 1999. The health effects of swimming in ocean water contaminated by storm drain runoff. *Epidemiology* 10(4):355-363.

Heerden, J., M.M. Ehlers, J.C. Vivier and W.O. Grabow. 2005. Risk assessment of adenoviruses detected in treated drinking water and recreational water. *Journal of Applied Microbiology* 99(4):926-933.

LeChevallier, M.W., W.D. Norton and R.G. Lee. 1991. Occurrence of *Giardia* and *Cryptosporidium* spp. In surface water supplies. *Applied and Environmental Microbiology* 57(9):2610-2616.

Mena, K.D. and C.P. Gerba. 2009a. Risk assessment of *Pseudomonas aeruginosa* in water. *Reviews in Environmental Contamination and Toxicology* 201:71-115.

Mena, K.D. and C.P. Gerba. 2009b. Waterborne adenovirus. *Reviews in Environmental Contamination and Toxicology* 198:133-167.

Pond, K. 2005. Water Recreation and Disease. Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality. World Health Organization.

Issue 2: Specifying and Implementing Single Sample Maximum *E. coli* Values for REC1-designated waters.

The application of a single sample maximum is appropriate where data are lacking. However, consider whether it is necessary to further delineate REC1-designated waters into tiers based on usage frequency. When considering human health risks, it is the microbial quality of the water that drives illness estimates – not necessarily exposure frequency. Whether a contaminated waterbody is frequented by 10 people or 100 people, individual health risks still exist with any exposure. Risk managers should develop recreational water standards based on microbial quality, and not based on the numbers of people projected to be exposed. A more protective, conservative approach is to address REC1 waterbodies as one group. Further, in considering the default values listed for each tier in Table 5-REC1-ssv, the values for each tier are essentially the same.

Other Issues

Regarding 5.5 High Flow Suspension of REC1 and REC2 Standards:
REC1 and REC2 standards should not be stopped (even temporarily) during high flow conditions. Although, those waterbodies may not be used during those particular time periods due to safety, water quality monitoring should continue. The point of routine water quality

monitoring is to get a sense of the overall quality of the water at any point in time, noting the times where quality is high and low. It is critical to obtain data during high flow conditions when water quality is more likely to be compromised. This contributes to the interpretation of the remaining monitoring data, as well as provides "worst-case" scenario information that is important when developing policy.

Regarding 5.7 Delete the Total Coliform Objective for Surface Waters Designated MUN:
It is not recommended to delete this objective. Even minimal total coliform monitoring could trigger an action or alert to those individuals using the water. It is not appropriate to assume the property owners know not to consume the water, or state "such individuals do so at their own risk" (including children?).

In summary . . .

It is stated in Attachment 2, Scientific Issues for Peer Review Comment that " . . . the assignment of REC1 freshwaters to the appropriate use tiers is a risk-management rather than scientific decision." It is critical that science inform risk management decisions whenever possible. Policy developed from arbitrary judgments should be avoided. Where data are lacking or available scientific input has inherent limitations, it is even more important for risk managers to take a cautious, conservative approach when developing standards. There are several places within the proposed Basin Plan Amendments that call for subjectivity, from describing what constitutes a significant exposure to administering an Use Attainability Analysis. With our ever-growing immunocompromised sub-populations, it is critical that decisions are made to protect the health of these susceptible individuals.

Memorandum

TO: Joanne E. Schneider, Environmental Program Manager, SARWQCB
FR: Patricia A. Holden, Professor, Bren School, UCSB
Date: 2-29-12
RE: Peer review of proposed Basin Plan Amendments Modifying Recreational Water Quality Standards for Freshwaters in the Santa Ana Region

This review is in response to the information transmitted for review on January 18, 2012. As per the document "Scientific Issues for Peer Reviewer Comment", the scope of this review is to evaluate the scientific basis of two Issues: 1) Replacement of established fecal coliform water quality objectives with *E. coli* objectives/targets; 2) Specifying and implementing single sample maximum *E. coli* values for REC1-designated waters. Additionally, in the "Big Picture" section of these instructions, the charge is to a) describe other scientific issues that are not addressed, and b) comment upon the soundness of the science upon which the reports are based.

Replacement of established fecal coliform water quality objectives with *E. coli* objectives / targets

The report uses U.S.EPA sources as the basis. This appears appropriate in light of the objectives.

Specifying and implementing single sample maximum *E. coli* values for REC1-designated waters

The report uses U.S. EPA sources as the basis. This appears appropriate in light of the objectives.

"Big Picture"
Other scientific issues not addressed/considered

Issue 2 includes defining "use tiers" that, according to the review charge, involve "the application of the appropriate statistical confidence factor" whose basis is "discretionary" and not "a scientific one". Thus, the charge would suggest that the definitions of use tiers are not invited for scientific review. Still, as "other scientific issues" are allowed for comment, it seems appropriate in the context of this review to comment. One comment regards use type, and if historical use is the most conservative predictor of use type. Erring on the side of conservatism (i.e. expecting use type could change to a higher tier from a lower tier) would be more protective of public health, unless waters within a use tier are inaccessible or otherwise unlikely to change in their use. Another comment concerns subdivision of water bodies and the consideration for hydrologic connections that would allow one water body affecting another (e.g. a stream discharging into a river): in those cases, it would seem less protective to not consider influences (upstream to downstream)

that a water body of one use tier could have on another. It is not apparent how this was taken into consideration, and thus is raised here.

A broader scientific issue, which is not discussed as a basis or consideration for the amendments, concerns the specificity of indicator bacteria for the purposes of indicating human health risks. As described in Section 4, appropriate and relevant epidemiological studies are limited. Other factors not discussed are the multiple origins of indicator bacteria in surface waters, including from various wastes and from natural sources. The state of the art in microbial source tracking includes discovering, particularly where indicator bacterial concentrations would suggest public health risk, what fecal sources (as these are likely pathogen carriers) are present. Discoveries as such are then used to prioritize management or remediation investment. In the absence of understanding sources of fecal indicator bacteria, and their relationships to potential human pathogens, there remain broader and longstanding questions regarding how protective of human health indicator based "targets" or "objectives" really are.

Soundness of science upon which the report is based

As the scientific basis stems from U.S. EPA documentation, the soundness rests on the scientific basis of the source documents, and the applicability of the EPA study results to other settings. The relationship between public health risk and indicator organisms depends on the origin of the contamination, which is not addressed in these amendments.