Executive Summary

Review Panel Report: Huntington Beach Phase III Final Draft Report

March 21, 2003

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Sea Grant
University of Southern California

Published by the Sea Grant Program, Wrigley Institute for Environmental Studies, University of Southern California, Los Angeles, California. March 21, 2003.
(USCSG-TR-02-2003)

Copies are available from:
USC Sea Grant Program
Los Angeles, CA 90089-0373
213-740-1961 ~ fax 213-740-5936
email: seagrant@usc.edu
http://www/usc.edu/go/seagrant

This publication has been produced with support from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant number NA 16 RG 2256, by the California State Resources Agency and by the Orange County Sanitation District. The views expressed herein do not necessarily reflect the views of NOAA or any of its sub-agencies. The U.S. Government is authorized to reproduce and distribute copies for governmental purposes.

The Sea Grant Program at the University of Southern California's Wrigley Institute for Environmental Studies, has served the Southern California coastal region for over 25 years, funding research, transferring results to government agencies and user groups, and providing information about marine resources, recreation and education to the public. Sea Grant research and outreach projects cover a broad spectrum of areas, with particular emphasis on topics related to the "Urban Ocean," USC Sea Grant's thematic focus. USC Sea Grant is part of the Pacific Area Sea Grant Network

Executive Summary

Review Panel Report:
Huntington Beach Phase III Final Draft Report

March 21, 2003

Background

High bacteria counts at Huntington State Beach forced a two-month beach closure in the summer of 1999, at significant cost to the community. This occurred immediately upon implementation of the California State AB411 water quality standards. The Orange County Sanitation District (OCSD) conducted a series of studies to determine the source of the bacteria. Initial studies suggested that contamination from the sewage outfall 7 km off the east end of the beach was unlikely, but not impossible. Sewage leakage from beach restrooms, and animal waste from nearby Talbert Marsh have been implicated in tracer studies, but the source of the contamination had not been clearly identified as of spring, 2001.

Scientific Objectives

Phase III of the Huntington Beach Shoreline Contamination Investigation re-focused attention on the OCSD sewage outfall, with specific hypotheses concerning onshore transport of the sewage plume. The study objectives, as originally stated in the Huntington Beach Shoreline Contamination Investigation, Phase III Workplan are: "1) characterize the physical oceanographic processes involved in possible cross-shelf transport of the wastewater plume in the vicinity of the AES thermal discharge outfall; 2) determine if there is a causal link between offshore and surf zone bacteria and related plume constituents; and 3) determine if the conditions during the summer of 2001 are similar to those of 1999 and other years with unusual surf zone bacteria levels."

The Principal Investigators (PIs) in the study, after careful consideration, re-defined the objectives in October, 2002 thus: "The principal objective for this multifaceted measurement program was to determine if there is a causal link between offshore wastewater discharge and significant bacterial contamination at or above state beach sanitation standards (i.e., AB411) along the Huntington Beach shoreline. This objective includes the aim of identifying coastal ocean processes that could explain any observed links. A secondary objective was to determine the principal coastal-ocean circulation patterns in this region, allowing the evaluation of any new ideas that may arise or gain recognition during or following this study. Third, conditions during

the summer of 2001 would be compared to those of 1999 and other years with a high incidence of surf zone bacteria contamination." (Noble, et al) By this statement, the PIs defined the important issue as bacterial contamination coincident with beach closures, rather than a more general question about bacterial transport.

Study Result

In the Phase III Final Draft Report (2003) the project PIs found that:

> …there were no direct observations of either the high bacteria concentrations seen in the OCSD plume at the shelf break reaching the shoreline in significant levels or of an association between the existence of a coastal ocean process and beach contamination at or above AB411 levels. It is concluded that the OCSD plume is not a major cause of beach contamination; no causal links could be demonstrated. This conclusion is based on the absence of direct observation of links between bacteria in the outfall plume and beach contamination, on analysis of spatial and temporal patterns of shoreline contamination and coastal processes, and on the observation of higher levels of contamination at the beach than in the plume (Noble, et al. – Huntington Beach Shoreline Contamination Investigation, Phase III).

Review Process

The University of Southern California Sea Grant Program convened an independent panel of experts in Spring 2002 to conduct a peer review of the Huntington Beach Phase III Study. The purpose of this review was to evaluate the scientific process, data, and interpretation of scientific results, and provide ongoing feedback to help guide the investigators in their analysis of these studies. The Review Panel met with the Principal Investigators in April 2002 for preliminary presentations of the Phase III Study results and analyses. Subsequent to this first meeting, the Panel submitted to OCSD a Preliminary Report on their initial findings of the Phase III Study on May 15, 2002. In August 2002, the Panel and PIs met again to further discuss the analyses of the Phase III data. Following the August meeting, the Panel submitted a second response to the PIs with recommendations for further improvement of the Phase III analyses. The Panel and PIs continued to correspond via phone and email throughout the review process. A written Final Draft report was made available by the PIs in January 2003 for review by the Panel. This Executive Summary is the result of a concerted peer review effort by the Review Panel over the last two months and represents a synopsis of their collective comments on the Phase III Final Draft Report.

Review panel members Jesus Pineda, John Allen and Jack Barth at Huntington Beach with OCSD senior scientist George Robertson

Review Panel

Academic and government experts in oceanography and microbiology comprised the Review Panel, which was assembled by USC Sea Grant and UCSB co-chairs Judy Lemus and Cynthia Cudaback.

John Allen, Ph. D.
Oregon State University
Theoretical geophysical fluid dynamics; Coastal ocean dynamics

Jack Barth, Ph. D.
Oregon State University
Coastal ocean dynamics; Flow-topography interactions

Walter E. Frick, Ph.D.
USEPA Ecosystems Research Division.
Plume models for outfall design and assessment; Low-velocity compressible flow theory

Roger Fujioka, Ph.D.
Water Resources Research Center, University of Hawaii
Environmental water quality; Public health microbiology

Trish Holden, Ph.D.
University of California, Santa Barbara
Microbiology; Bacterial community fingerprinting

Jesus Pineda, Ph.D.
Woods Hole Oceanographic Institution
Cross-shore transport of planktonic larvae; Benthic population ecology

Cynthia Cudaback, Ph. D. (Co-chair)
University of California, Santa Barbara
Inner shelf transport and effect on biological communities

Judy Lemus, Ph.D. (Co-chair)
Sea Grant Program, University of Southern California
Marine Advisory Program Leader

Review Panel Objectives

OCSD initiated Phase III of the Huntington Beach studies to determine whether sewage discharged offshore from Huntington Beach can be transported to the beach and under what conditions it would be likely to do so. Therefore, the Panel focused its analysis on three main questions:

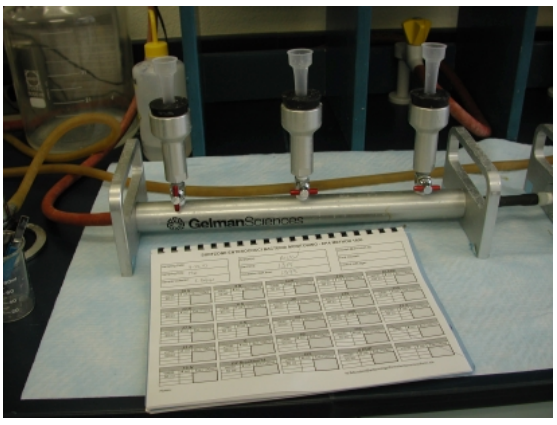
1. Do the studies adequately answer the specific investigatory objectives that were addressed?
2. Were the data properly interpreted and presented in the preliminary reports?
3. Are there other studies that could be conducted to determine the risk of plume insurgency onto the shoreline?

General Comments

The Panel acknowledges that the Phase III field studies conducted during the summer of 2001 were of high quality and represent a commendable undertaking. The size and completeness of the data that this study has generated set is also impressive. Given the amount of time available to the Principal Investigators, the analyses have progressed well. The Panel considers the Final Draft Report to be a good start at analyzing the full complement of data and expect that several new contributions to the field of ocean coastal circulation will be forthcoming from this work.

The main conclusion of the Final Draft Report, "It is concluded that the OCSD plume is not a major cause of beach contamination; no causal links could be demonstrated," is complex, with two separate statements. The second statement, "no causal links could be demonstrated," is based on temporal and spatial disconnects between the outfall, transport processes, and beach contamination. Although events that might drive onshore transport of bacteria were observed (such as cold water entering the surf zone), these events did not coincide with or precede beach contamination events in exceedence of the AB411 standards. High bacterial concentrations were observed near the outfall and at the beach, but measurements also indicated that there was a zone of lower concentration between the two regions. Given the current status of analyses on the Phase III studies and based on the available measurements, this conclusion seems to be reasonable and accurate.

With respect to the first statement of the conclusion, "the OCSD plume is not a major cause of beach contamination," the Panel finds that this statement is not supportable because of the incomplete nature of the analyses and because of limitations in the spatial and temporal resolution of the Phase III sampling. While a connection between the OCSD outfall and beach contamination has not been found, a lack of understanding of some key parameters warrants caution; categorical dismissal of the OCSD plume as a major cause of beach contamination is not scientifically justifiable at this point. Several variables that remain in question are discussed below.



1) **Bacterial sampling**

The Panel recognizes the difficulty of collecting and analyzing bacterial data, but notes that the spatial and temporal resolution of sampling in this study was heavily weighted towards hydrographic data. While these field experiments

far exceeded previous studies in sampling intensity, and the number of bacterial samples processed by OCSD was extraordinary, the bacterial monitoring data remain a limitation. Accordingly, the transport and behavior of bacteria in the coastal ocean is not adequately understood. Another limitation of the surfzone bacterial analyses is that a large percentage of the data are not graphically represented because samples with less than 20 MPN total or fecal coliform or less that 10 MPN enterococci, are not included (HB-III Final Draft Report, Figs. 2a, 2b, 2c).

2) **Spatial disconnection**

The argument that the OCSD outfall plume is not a major source of beach contamination relies on the spatial gap between high bacterial concentrations in the core of the plume and the high bacterial concentrations measured at the beach. Given that the transport properties of bacteria in the coastal ocean are not well understood, it seems prudent to allow for the possibility of a range of plausible behaviors. A possible mechanism for bridging the observed spatial disconnect could be in the reconcentration of bacteria either within the surfzone or during transport. If the beach is considered to be the end of the transport pathway, and bacteria transported to shore remain on shore or trapped in the surfzone, possibly adsorbed to sediment particles, then low concentrations of bacteria just offshore can be reconcentrated at the beach. The potential for resuspension of fecal indicator bacteria within the surfzone was not addressed in the Phase III study and therefore cannot be ruled out as a possible source of beach contamination. Another explanation involves the gravitational collapse of the plume, which tends to limit its vertical extent. As a vertically collapsed lens, the plume could penetrate coarse vertical sampling grids, and thereby lead to substantial bacteria maxima being missed.

3) **Patchiness**

The spatial discontinuity between high concentrations of bacteria in the outfall plume and high concentrations of bacteria at the beach may be due to a patchy distribution of bacteria and other plume tracers. The Phase III data clearly demonstrate that the plume field can be patchy (HB-III Final Draft Report Volume II, Fig. 5-12), and that patches of the plume can sometimes come close to shore (HB-III Final Draft Report Volume II, Figs. 3-11 and 6-12). Although the region between the plume signature and the beach contains low bacterial concentrations, the distance between the two is sufficiently close to warrant careful consideration of sampling adequacy. Additionally, these high values at shallow depths are coincident in time with high bacterial concentrations near the beach.

4) **Surface transport**

The wind-driven surface transport of buoyant particles should be examined as a possible_pathway for the transport of plume bacteria onto shore. The possibility of this mechanism was acknowledged in the Final Draft Report, but not included in the design of the Phase III studies for several reasons involving the unlikely association of bacteria with grease and oil particles, both offshore and at the beach. Indeed, the Phase III data indicate that the plume is almost always submerged beneath the thermocline. Independent modeling by one member of the Panel (W. Frick) supports these results. However, low concentrations of bacteria have been measured at the surface by OCSD personnel, and features of the plume were occasionally observed at the surface during the Phase II investigations (HB-III Final Draft Report, Figs. 3-14 and 4-13). Finally, the accumulation of buoyant particles at onshore propagating fronts associated with an internal tide has been observed in Southern California (Pineda, 1999).

5) **Cross-shelf transport mechanisms**

A thorough consideration of cross-shelf transport of physical water properties and plume material is not yet complete. For example, additional analyses should be directed at quantifying the nature of the across-shelf transport of the temperature field as a function of spatial location on the shelf and as a function of frequency. In addition, internal solitary waves, which are often associated with the internal tide and capable of transporting particles onshore, are not adequately addressed in the Final Draft Report. Likewise, the association of at least one cold water intrusion into the nearshore indicates the plausibility, if not probability, of this mechanism and deserves further analysis. A third mechanism that could also be investigated is transport in the bottom boundary layer by breaking internal waves near a sloping boundary.

Future Studies

There are two main areas of concern that could benefit from further research: cross-shelf transport and circulation mechanisms, and accurate tracking of plume bacteria.

Cross-shelf transport and circulation mechanisms

1) The spatial and temporal variability of the internal tide must be investigated in order to better understand the role of internal tidal motions in across-shelf transport. Field observations are needed to conclusively discard internal solitary waves as a mechanism for onshore transport of plume effluent bacteria.

2) Further dye tracking experiments, with a release outside the surfzone, may be useful to determine whether water-borne particles can be transported from the 15m isobath to the surfzone. If possible, adding dye to the effluent after the 200:1 dilution near the outfall may also yield profitable results. This latter experiment would need to be timed with the occurrence of spring tides.

3) The nature of the across-shelf circulation could be further explored by examining in more detail the coupled behavior of the temperature and velocity field. This analysis should include calculations of the mean across-shelf and along-shelf fluxes of temperature (uT and vT) as a function of depth and spatial location on the shelf, including a breakdown into contributions from different frequency bands.

4) A comprehensive model of plume rise, ocean circulation, and very possibly bottom and sea-surface atmospheric interaction is necessary to help synthesize the complex processes and interactions involved in the transport and fate of the OCSD effluent. Such a model, including the AES Power Plant plume and other sources, will likely be the only way to reach definitive conclusions about what proportion of beach contamination is due to the OCSD effluent.

Tracking of plume bacteria

1) One important issue that remains unanswered, and should be addressed in future studies, is the question of which chemical and physical oceanographic measurements are suitable tracers for fecal indicator bacteria and for pathogens directly.

2) Good high-resolution time series data of some plume indicator other than temperature and salinity would be beneficial. This will not be possible for bacteria, but could be done for tracers, such as nutrients, as one of the PIs (J. Largier) has used in other areas. Commercially available moored nutrient sensors could be deployed along the potential pathway to provide high-temporal resolution measurements of a chemical signature of the plume.

3) Although the objective of the current study was to demonstrate whether the ocean outfall was responsible for *high* bacterial counts in the surfzone, the probability that measurable but *low* levels (1-50 MPN/100 ml) of fecal bacteria in ocean effluent do reach the surfzone remains an important question to answer for all ocean outfalls.

4) The possibility of beach contamination due to local sources on the beach should be further addressed. Land based sources of bacteria are not restricted to restrooms, Talbert Marsh or the Santa Ana River. Bird feces, dog feces, seaweed, and soil on the beach, and marine mammals are other known sources of fecal indicator bacteria. While bird counts and marine mammal observations have been performed in previous Huntington Beach contamination studies, this contingency could be more thoroughly explored.

5) A good model of bacterial transport and die-off would be useful. However, bacterial die-off is a difficult issue and quantitative die-off models are rare. One such model is the Mancini model (1978) that expresses a decay coefficient as a function of light intensity, salinity, and temperature. A review of Mancini's data reveal considerable scatter, testifying to the uncertainty implicit in the decay rates derived from the model. However, the Mancini model does at least allow one to determine the sensitivity of coliform bacteria to sunlight intensity. A more complete model of bacterial die-off would necessarily be considerably more complex than the Mancini model.

References

Noble, M., J. Xu, L. Rosenfeld, J. Largier, P. Hamilton, B. Jones, and G. Robertson (2003). Huntington Beach Shoreline Contamination Investigation, Phase III. *U.S. Geological Survey Open-fileReport 03-62* (http://geopubs.wr.usgs.gov/open-file/of03-62/)

Note: references to the "Phase III Final Draft Report" are to a preliminary draft of the Noble, et. al. report.

Mancini, J.L. (1978). Numerical estimates of coliform mortality rates under various conditions. *Journal of the Water Pollution Control Federation* Nov:2477-2484.

Pineda, J. (1999). Circulation and larval distribution in internal tidal bore warm fronts. *Limnology and Oceanography* 44:1400-1414