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The Fecal Has Hit the Fan

Overview of Efforts in the U.S. to Address Bacterial Contamination in Surface Waters

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Abstract

Correcting impairments in surface water quality in the U.S due to the presence of bacterial pathogens is a key water quality management challenge. Difficulties associated with costs of correcting sewer overflows, uncertainties in the science and human risk from recreation, rapidly changing surface water conditions (physical and bacteriological), limitations in technology, and contributions from unregulated sources collectively make achievement of water quality goals controversial. Among the activities currently underway are municipal long term sewer correction programs, development of regulatory policies to align water quality goals with achievability and programs of scientific study and review. Efforts by the Ohio River Valley Water Sanitation Commission (ORSANCO) for the Ohio River are illustrative of the difficulties in policy development. Public opposition to a perceived downgrading in water quality requirements, combined with a lack of documentation of extent of recreation use, resulted in adoption of a limited wet weather-based Ohio River bacterial standard in 2006. ORSANCO is committed; however, to continuing efforts to enhance public education and better understand Ohio River recreation use. These initiatives, combined with national level efforts in science, should position ORSANCO to refine and enhance its wet weather bacterial standard.

Keywords

U.S.; Water Quality; Pathogens; Sewer Overflows, Regulations; Science

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Addressing bacterial contamination of surface waters in the U.S. is a difficult and controversial issue. While a 2000 national assessment of water quality indicates pathogens to be the third most common cause of water quality impairment (behind sediments and nutrients), dealing with pathogen contamination of surface waters presents high challenges from virtually all perspectives. They include correlating the presence of pathogens to the probability of illness to swimmers, determining the most appropriate pathogen indicators for assessing recreational suitability, rapidly changing water quality conditions - particularly relative to turn-around of sampling results, diversity of sources and their identification and regulation, costs for achieving reductions from discharges associated with combined sewer systems, and misperceptions among the public as to risk-benefits and achievability of goals.

I. Correction of Combined Sewer Overflows (CSOS)

In recent years, activities within the community of interests related to water quality have heightened concerning bacterial contamination of surface waters. A principal driving force is the substantial burden now being imposed on communities with combined sewer overflows to reduce or eliminate discharges to the extent in-stream bacterial standards will not be violated. Estimates are, nationally, the accumulative cost for corrections will be approximately \$55 Billion (USD). Major metropolitan sewer utilities of older cities (principally in the eastern half of the U.S.) are being faced with 20 year plus program commitments costing upwards of \$3 Billion. A United States Map showing the location of communities with CSOs is shown as Figure 1.



Fig. 1. Distribution of CSO Communities in the United States

Aside from the ability of these cities to burden rate payers with several fold increases to rates, it is well documented that in spite of virtual elimination of combined sewer overflows, water quality objectives will not be achieved due to inputs from other sources, including non-point sources that are not subject to regulation.

II. Bringing Stream Bacterial Objectives into Alignment with Achievability

The U.S. Clean Water Act provides the possibility for establishing alternative stream water quality objectives when it can be demonstrated that water quality goals are unachievable (due for example to the imposition of costs that would cause widespread social and economic impact). However, the burden of conducting such a demonstration, termed a “Use Attainability Analysis” (UAA), falls to the discharger. To date relatively few UAAs have been pursued due to cost, complexity, and given uncertainty of their acceptance by state and federal regulators.

Actions have been, or are being, taken by several U.S. States to change their regulations setting water quality standards to address bacterial objectives for CSO impacted waters. The approaches are similar and permit the establishment of revised receiving water quality criteria, or the temporary suspension of criteria, after a community with CSOs completes installation of controls reflecting both or either the best available technology or the limits of affordability and conducts and has received regulatory approval of a UAA.

As a specific example, the State of Indiana adopted legislation which provides for the suspension of receiving water recreational use bacteria criteria for up to three days after a local rainfall if the community has implemented all remedial actions (termed a Long Term Control Plan - LTCP) and has conducted and received regulatory approval of a UAA confirming the extent to which recreational criteria will be achieved. While the Indiana law has been adopted by the state legislature, it has not yet been approved by USEPA. Nevertheless, the Indiana approach has gained attention as a viable approach to reconciling the conflict resulting when the requirements of the U.S. Clean Water Act are unachievable.

Policy Development for the Ohio River

The Ohio River Valley Water Sanitation Commission (ORSANCO) an agency established in 1948 to abate interstate water pollution in the Ohio River Valley, also has attempted to address this issue applicable to communities along the Ohio River with CSOs. ORSANCO serves as the mechanism through which 8 U.S. States (Indiana, West Virginia, Ohio, New York, Illinois, Kentucky, Pennsylvania and Virginia) and the United States cooperate to abate water pollution that has interstate impacts. Operating under the authorities provided in a legislatively adopted interstate compact, ORSANCO’s powers include examining pollution problems, recommending state legislation to achieve desired water quality, conferring and cooperating with individuals and/or organizations, and the setting of wastewater discharge standards for interstate streams.

Much of ORSANCO’s attention over its 60 year history has been focused on the Ohio River, which spans six U.S. States and three regions of USEPA, traverses a length of 1,500 Km, is regularly used for body contact recreation, and receives episodic discharges of untreated sewage from 1,045 CSO structures (approximately 10% of all documented overflow structures in the U.S.). The Ohio River and the States comprising ORSANCO is shown as Figure 2. Shown as Figure 3 are the locations of communities with, and the respective number of, CSO structures. Because of the interstate and inter-EPA jurisdictional nature of the Ohio River, and ORSANCO’s regulatory authority and functional service to the river’s bordering states and USEPA, efforts to develop better science and appropriate bacterial water quality regulatory policy that balances limitations of technology, cost and environmental improvement were encouraged by EPA, several of its member states and the affected communities.

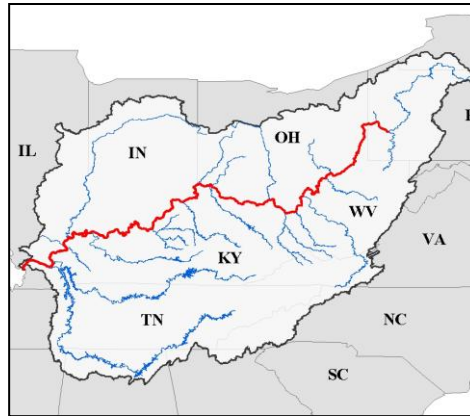


Fig. 2. Ohio River Catchment

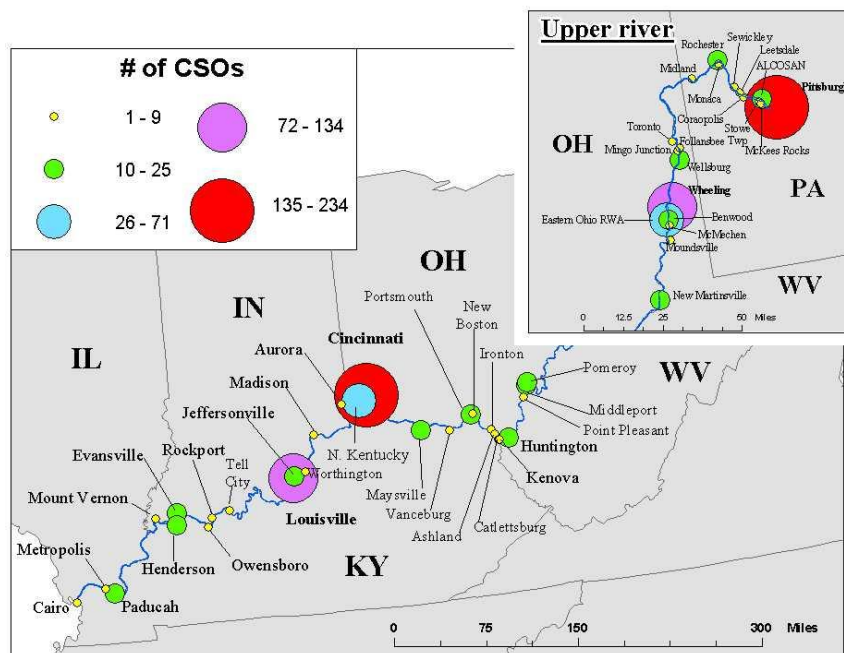


Fig. 3. Ohio River CSO Communities

In September 2006, ORSANCO adopted revisions to its effluent discharge regulations for the Ohio River that, for the first time, incorporates wet weather-based bacterial objectives. The public debate on the proposed regulation was robust and controversial, leading to changes and omissions to the policy initially proposed. The proposed policy was developed by a work group of representatives of the states and USEPA and attempted to reflect the following principals, as established by the work group:

- A reasonable target must be established for control of wet weather pollution sources; this target must be as fixed as possible and not subject to periodic change.
- Pathogen water quality criteria established to protect water supply should be met at all times.
- Pathogen water quality criteria to protect recreation should be met at all times when the Ohio River is otherwise safe for contact recreation.
- All sources of pathogens should be required to provide a reasonable level of control.
- The public needs to receive clear information regarding risks of contact recreation in the Ohio River.

- Decisions that involve the balancing of risk to the public in recreational use of the river versus cost to the public in order to control pathogens need to be made with considerable public input.
- The approach taken to develop wet weather standards for the Ohio River should be appropriate for use on other waterbodies in the Ohio River Basin and across the U.S. that are affected by wet weather sources of pollution.

These principals were presented to the public in a series of meetings, along with an overview of the challenge in achieving water quality suitable at all times and places for whole body contact recreation. The purpose of the public meetings was to educate the citizens on the issue and receive their feedback on the goals of a wet weather policy (e.g. spend whatever is necessary to achieve a swimmable river vs. accept that there will be times that swimming will not be supported by water quality conditions). In spite of efforts to advertise the meetings, most were poorly attended and, as such, feedback was minimal.

Subsequently, a proposed regulation was drafted for formal public comment that contained the following features:

- Bacterial criteria for the protection of swimmers would be suspended when the river is unsafe for the swimming use; defined as flow velocities reaching or exceeding 2.6 Km/hr (2.0 miles/hr).
- Established criteria for the protection of water supplies of 2,000 CFU/100 ml will be retained at all times.
- The single sample maximum E-Coli criteria for recreational use would be changed from 235 CFU/100ml to 409 CFU/100ml. This maximum value corresponds to USEPA’s recommended maximum criteria for waters subject to “light use.”
- Communities with CSOs and which, after implementation of their Long Term Control Plan, will be unable to achieve recreational bacterial criteria, can apply to ORSANCO and the respective state agency for an alternative water quality standard as supported by an approved UAA.

The proposed policy received the strong opposition of environmental groups who concluded that the policy would permit additional untreated sewage to be discharged. Also, they disagreed with the concept of suspending the swimming use and the relaxation of criteria. Most notably, a postcard campaign was mounted urging the recipient to “vote no to sewage in the Ohio River” and claiming that ORSANCO’s proposed policy “permits more sewage in the Ohio River when it rains.” This assertion was entirely inaccurate as the pathogen criteria to protect water supplies would remain in place, thus requiring all bacteria sources to continue to fully disinfect. Eventually, over 4,000 such postcards were received during the public comment period from as far away as Texas and South Carolina! Table 1. provides a summary of the numbers of responses received in favor and against:

Table 1. Talley of Comments Received during Formal Comment Period For or Against ORSANCO’s Proposed Ohio River Wet Weather Bacterial Policy

	<i>Number in Favor</i>	<i>Number Against</i>
Environmental Advocate NGO Post Card Campaign	0	4,476
Letters	42	855
Speakers at Public Hearings	24	106
Received to Website	10	139

Upon consideration of the comments, both written and presented verbally in the public hearings, the Commission formally adopted revisions to its regulations in October 2006. With respect to wet weather based bacterial objectives, the proposal for the suspension of recreational criteria under conditions of high flow, and for a higher single sample maximum criterion for E-Coli, were not adopted. However, the availability for a community to apply to ORSANCO and the state regulatory agency for alternative stream criteria after installation of long term controls and approval of a UAA was adopted.

This process served to inform the Commissioners of ORSANCO of the need for further efforts in three areas:

Better Information on the Extent of Recreational Use. In accordance with the guiding principle that any wet weather policy be risk-based, adequate information is necessary to determine the population at risk from body contact exposure. Insufficient information exists as to the number of swimmers and when swimming is occurring both related to time of day, week and year and as related to local river conditions (e.g. river flows and appearance). No such survey data is currently available.

More Effective Public Education Efforts. Comments received during public hearings illustrated a fundamental lack of understanding of the proposed policy's rationale. Bacterial science concepts, such as use of geometric mean values, are difficult for non water professionals to comprehend. Thus, stepped up efforts are needed to assure that the interested and engaged public has a better understanding.

Better Science on Human Risk Related to Recreational Exposure. The ability of environmental protection agencies to develop public policy is constrained by poor and imprecise science. In the U.S. there is an unsettled state of the science and the correlation between bacterial standards and the occurrence of illness of exposed swimmers is tenuous at best. Better and more definitive science is needed, without which development of publicly acceptable policy will continue to be difficult.

III. Actions by ORSANCO and Nationally to Support Better Policy on Recreational Water Quality

Subsequent to its October 2006 action to adopt, in part, the wet weather policy originally proposed, ORSANCO formally reaffirmed the importance of this issue and declared its intention to continue efforts to refine and expand on the adopted regulation. As such, a strategy has been identified for each follow up area.

A. Reviewing the Science

Regarding the need for an improvement to the underlying science, ORSANCO has concluded that this is outside the scope of its expertise and resources and should be left to the national government or research institutions, such as the research arm of USEPA or the Water Environment Research Foundation. Fortunately, action to address the science needs is indeed taking place.

USEPA has recently embarked on a program of research to revisit the pathogen science associated with recreation use. The current national recommended criteria are now over twenty years old and it is recognized there have been significant scientific advances in molecular biology, virology and analytical chemistry that need to be considered and evaluated for feasibility and applicability.

Accordingly, in August, 2007, USEPA issued a "Critical Path Science Plan for the Development of New or Revised Recreational Water Quality Criteria" which articulates the suite of studies to be

completed over the period 2007-2010 designed to establish the foundation for new or revised criteria. Goals of the Plan are:

- Assess Human Health Risk – Assess the potential human health risk in the general population, including children, from swimming-related exposure to different sources of fecal contamination (human and non-human).
- Development of Indicators – Identify indicators that allow for reliable correlation between indicator concentrations and health effects.
- Development of Methods – Develop, evaluate and validate appropriate methods to measure indicators of fecal contamination to allow for reliable correlation between indicator concentrations and health effects.
- Extrapolation of Research Results for Developing New or Revised Criteria – Assess the influence of variability in geographic and aquatic conditions on indicator and method performance.

It is the Agency's goal to issue such criteria in 2012. This document can be accessed at www.epa.gov/waterscience.

Another study with significant potential to inform the science is being conducted by the Metropolitan Water Reclamation District of Greater Chicago. The District is conducting an epidemiological study of Chicago area waterways, and specifically, a comparative risk assessment of the human health impact of not disinfecting versus disinfecting the effluents from the District's three water reclamation plants, including its Stickney plant that treats over a billion gallons of wastewater daily. Additional information on this study can be accessed at www.mwrdgc.dst.il.us.

Further, the Water Environment Research Foundation (WERF) has established, as a long-range research challenge, wastewater microbes and public health, including the evaluation of technology, risk and needed improvements in the development of new pathogen indicators and methods to evaluate public health risks from wastewater microbes. WERF will strive to coordinate its work with that of USEPA and others such that its research agenda will serve to fill important gaps.

B. Better Information on Ohio River Recreation Use

ORSANCO is taking action to acquire statistically valid information on the extent of Ohio River recreation use and has employed a contractor to design and execute the necessary surveys. The objectives of the study are to quantify the extent to which the river is used for body contact recreation, as well as determine when and under what conditions the river is not used for recreation. Results of the study will be used to assess the risks associated with alternative pathogen criteria during and following wet weather events. Results of a telephone survey of 5,000 respondents as well as observational surveys and in-person interviews being conducted in the summer, 2008 will be available by the end of 2008.

C. Better Public Understanding

ORSANCO conducted a "Roundtable" agency discussion in February 2008 titled "Strategically Thinking ORSANCO Efforts in Public Awareness/Understanding of Water Pollution Abatement Issues and Challenges." From that discussion, certain concepts and realizations were identified that, collectively, will guide ORSANCO's public education activities in the future. With particular applicability to the issue of bacterial water quality policy and its technical, economic, science aspects, the suggestions advanced can be summarized as:

- Get out front with information, including the rationale and “balancing,” that forms the policy (e.g. affordability, limitations of science and uncertainty).
- If possible, create a positive “branding” of the initiative (such as “Clean River Initiative”).
- Form alliances that, strategically, are critical for support and success.
- Visit river communities to explain programs and gain credibility and trust.
- There will always be controversial issues and those that will criticize no matter what you do. Stick with the truth and facts.

IV. Summary Discussion

In the United States, and with the completion of installation of base-line technology controls for municipal wastewater (i.e. secondary treatment), attention and resources are now being focused on additional controls to address the third leading water quality impairment of receiving water quality – bacterial pathogens. Given the massive cost to many municipalities, the limitations of technology, the inability to achieve bacterial water quality targets, and the uncertain and outdated science on which the targets are based, the “fecal has hit the fan,” causing actions on many fronts. States and interstate agencies are developing policies to bring water quality targets into alignment with achievability, major efforts are underway to evaluate recent science and develop better scientific understandings, and communities have combined sewer overflows are embarking on 20-year programs to reduce bacterial inputs with costs to rate payers doubling and even tripling.

With respect to establishing a responsive “wet weather” water quality policy for the Ohio River, ORSANCO entered this controversial issue. From its efforts and experience, studies on extent of recreational use are being undertaken and new public education efforts are being considered. These initiatives, along with the benefit of incorporation of new epidemiological, analytical and source tracking science, should provide the basis for further refinement of its policy adopted in October 2006.