Swimmable River

Towards Better Water Quality Monitoring in the Hudson River Estuary

RIVERKEEPER.

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ACKNOWLEDGMENTS

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The author wishes to acknowledge the following individuals for their contributions to this report:

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Funding for this ongoing collaborative project between Riverkeeper and Lamont-Doherty Earth Observatory is provided by a grant from the ***Wallace Research Foundation****. We are extremely grateful to have benefited from the foundation's generosity and look forward to continued collaboration in our shared commitment to shape more environmentally sound public policy through scientific research.*

Riverkeeper also wishes to thank the ***Brinson Foundation*** *(www.brinsonfoundation.org),* ***Lamont-Doherty Earth Observatory*** *(www.ldeo.columbia.edu) and the* ***Columbia Earth Microbiology Initiative*** *(www.ldeo.columbia.edu/emi) for providing critical funding to purchase necessary equipment and collect data for the 2006-2007 pilot study.*

Riverkeeper also wishes to thank our over 10,000 members without whom our work would not be possible.

Riverkeeper is an independent environmental organization dedicated to protecting the Hudson River, and its tributaries, and the New York City drinking water supply. Riverkeeper is a founding member of the Waterkeeper Alliance (www.waterkeeper.org) an international organization that works with over 180 Waterkeepers to protect waterways around the globe.

Riverkeeper is also a founding member of SWIM (Storm Water Infrastructure Matters), a coalition dedicated to ensuring swimmable waters around New York City through natural, sustainable storm water management practices in our neighborhoods. For more information about SWIM, visit www.swimmablenyc.org.

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EXECUTIVE SUMMARY

The federal Clean Water Act of 1972 established one of the clearest benchmarks for achieving and assessing environmental protection: fishable and swimmable waters. But over 35 years later, one of the most basic and frequently asked environmental questions in the Hudson Valley – whether it is safe to swim in the Hudson River – remains unanswered.

Fortunately there is a renewed groundswell to not lose sight of the Clean Water Act's overarching goal. Each year, millions of people spend time in or on the Hudson River and the waters surrounding New York City. As the public returns to the waterfront and reclaims its river, the demand for cleaner water and safer recreational opportunities continues to grow. In 2004, New York State recognized as much and pledged to make the entire Hudson River swimmable, from the Adirondacks to New York City, by 2009.[1]

Sewage From Aging Wastewater Infrastructure

Thanks to advances in pollution control, increased environmental enforcement, and improvements in wastewater treatment infrastructure, water quality in the Hudson River and New York Harbor has improved dramatically. However, these waterways are still impaired from discharges of raw sewage from what have now become failing and outdated wastewater treatment systems. Many of the wastewater facilities constructed in the 1970s or earlier have now reached their expected life span and must be upgraded at significant cost.[2]

Poorly designed municipal systems, such as those with combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs), discharge raw sewage into waterways each time it rains. The result is a river continually plagued by sewage. Pathogens – biological agents that cause illnesses and diseases – put the public at risk and greatly impede the Clean Water's Act mandate of attaining fishable and swimming waters.

Insufficient Monitoring & Notification Protocols

Millions of people are spending time in or on the Hudson River and the waters of New York Harbor, but the monitoring and public notification of water quality conditions, particularly with respect to pathogens, is inconsistent and in some areas non-existent. Current reporting procedures are based largely on reporting average water quality conditions, and not extremes or reasonable worst case scenarios. This approach is problematic because residents and visitors of the Hudson Valley do not always recreate in average conditions. People swim and boat from specific locations at specific times and the conditions that matter most in terms of public safety are the highs and lows, not the geometric means. A change in standards and protocols could be on the horizon, but effective and scientifically sound action is needed immediately.

The availability of water quality data for the average recreational user on the Hudson River Estuary, particularly for sewage-indicating bacteria, is very limited.[3] The great improvement in water quality now marks the need for additional monitoring and a change in the way the public is notified about conditions in the Hudson River Estuary.

The Riverkeeper/Lamont-Doherty Pathogen Sampling Program

In 2006, Riverkeeper and Lamont-Doherty Earth Observatory of Columbia University launched a water quality study aboard the Riverkeeper patrol boat in order to begin addressing the issue of whether it is safe to swim and boat in the Hudson River and New York Harbor.[4] The primary goal of this ongoing project is to characterize the conditions of the Hudson River estuary through the testing of nutrients, total bacterial cell counts, and sewage-indicating microorganisms in order to better understand the factors that control the variability of conditions observed in the Hudson River Estuary. Our findings reveal both reason for optimism and cause for concern.[5]

Summary of Findings: Good News and Bad News

Our initial data shows that overall water quality is highly variable depending on both site location and time sampled. This study is ongoing and as more data is collected, a better picture of problem locations throughout the estuary will emerge. But initial samples indicate that, in general, ambient water quality conditions from southern sections of the estuary (New York City Battery to Yonkers) and more northern portions (Yonkers to Peekskill) are relatively similar. During periods of dry weather, conditions in the mid-channel of the river are generally acceptable from an overall environmental perspective.

However, the initial findings also highlight a number of concerns, including:

- There are times and places, particularly near shorelines after wet weather events, where counts of sewage-indicating bacteria far exceed standards for primary contact recreation;
- 21 percent of samples collected north of New York City in 2007 had counts of sewage-indicating bacteria that exceeded the federal single sample guideline for primary contact;
- In the waterways surrounding New York City, 32 percent of the samples exceeded the federal single sample guidelines for primary contact;
- There are specific locations (i.e. Piermont Pier in Piermont and Newtown Creek in Brooklyn) that have chronically poor water quality conditions;
- Severe wet weather conditions, even if short-term, can render much of the estuary unsafe for activities such as swimming and kayaking.

Implications for Millions of Swimmers, Boaters, and Anglers

The bacteriological data collected during this pilot study suggest certain areas of concern:

(1) Even days after localized storm events, levels of pathogens can remain above the allowable federal guidelines for swimming;
(2) Twenty-one of 27 stations sampled experienced single day measurements that indicate an increased risk of illness from swimming or other direct contact with the river;
(3) Even at sites where conditions were generally acceptable, or that had seasonally acceptable conditions according to a geometric mean, there was still poor water quality on individual days, particularly after rain events; and
(4) There are areas of the estuary that experience chronically poor conditions.

While these initial findings are cause for caution, they also suggest that the problems observed are localized issues. Therefore, targeted investigations and sound management decisions may help to yield large positive impacts in local areas of poor water quality.

In general, Riverkeeper recommends that the average beachgoer, swimmer, boater, and kayaker continue to apply the rule of thumb that has been applied de facto for years: avoid substantial contact with the Hudson River and New York City waterways after heavy rains.

This water quality study – and the data analyzed thus far – does not warrant a movement away from river-based recreation but rather towards action, better pathogen monitoring, and increased environmental and public health protection. People are advised to check the Riverkeeper website and to contact their county Health Departments for more information about specific areas, and to use caution where they note elevated bacteria counts in those areas.

Recommendations To Achieve A Swimmable River

If New York is to fully realize its goal of restoring the Hudson River to a swimmable condition from the Adirondacks to the Battery, there must be a renewed focus on: (1) better water quality policies; (2) better wastewater treatment infrastructure; and (3) better monitoring and public notification of conditions.

Based on this three-prong approach, and on data collected as part of the Riverkeeper/Lamont study, Riverkeeper specifically recommends the following actions on the part of government officials and environmental and public health agencies:

Better Water Quality Policies:

- Renew New York's pledge for a swimmable Hudson River;
- Create a cohesive water quality protection program for the region, including water conservation measures, wetlands protection, green design practices, and enforcement;
- Classify kayaking and personal watercraft usage as primary-contact recreational uses;
- Monitor water quality at all public access points;
- List the entire Hudson River estuary as impaired for pathogens and develop permit guidelines to better control sewage pollution; and
- Focus monitoring and notification procedures on extreme conditions in addition to averages.

Better Infrastructure:

- Establish a Clean Water Trust Fund to ensure the funding of wastewater treatment facilities;
- Mandate use of green infrastructure in wastewater and stormwater management systems; and
- Ensure no net increases in combined sewer overflow discharges (CSOs) from new development projects.

Better Monitoring and Notification:

- Develop a uniform system of pathogen monitoring in the Hudson River estuary;
- Increase wet weather monitoring at problem locations;
- Develop testing protocols that are based on extremes, not merely averages;
- Base estuary-wide notification systems on single sample measurements or other data that can capture short-term or localized problems, not just averages;
- Require municipalities to provide timely and location-specific monitoring results;
- Ensure sampling for relevant pollution parameters and develop better notification systems.

Next Steps for the Riverkeeper/Lamont-Doherty Water Testing Program

Thanks to generous funding from the Wallace Research Foundation, the Riverkeeper/Lamont-Doherty water quality sampling program for 2008 is already underway and we are seeking support to continue the study through 2009. Riverkeeper intends on making its data available to the general public via its website as soon as possible after sampling in an effort to help citizens and public officials better understand the factors controlling water quality in the Hudson River. For more information, and for updates of our water quality sampling data, please visit our website at: www.riverkeeper.org.

The initial findings highlighted in this report demand the need for increased discussion and continued in-depth technical analysis. Achieving the common goal of a swimmable Hudson River is a challenge that will require a renewed emphasis on environmental enforcement, sustainable development, and a sustained commitment on the part of public and private partners to work towards better pathogen monitoring throughout the region. This report is intended to identify pollution sources for management action and to advance the process of contributing a sound scientific foundation for implementing effective and rapid change.

The Hudson River and the vast watersheds that comprise it are the lifeblood of New York State. The vision of a fishable and swimmable Hudson is one that needs to be fully embraced if New York is to truly become an environmental model for the world.

Section I *of this report discusses the risks that pathogens present to the recreational user.*

Section II *analyzes the shortcomings of current monitoring and notification procedures.*

Section III *highlights the key findings of the initial water quality monitoring program.*

Section IV *describes what the initial findings mean for the average recreational user.*

Section V *details a series of recommendations.*

Section VI *discusses the next steps planned for this ongoing study.*

Section VII *concludes the report.*

I. SEWAGE FROM AGING WASTEWATER INFRASTRUCTURE

The great strides in pollution control that have been achieved since the Clean Water Act's passage in 1972 cannot be overlooked. Advances in pollution control, enforcement of environmental laws, and improvements in wastewater treatment infrastructure have all led to a dramatic improvement in water quality conditions in general. Analysis of available historical data demonstrates this change locally.[6]

Conditions in the Hudson River and New York Harbor have improved significantly and waterways that were once considered open sewers are now better protected and substantially less polluted. Yet what were once tremendous improvements to pollution control are now crumbling and outdated wastewater infrastructure systems. Many of the treatment facilities constructed in the 1970s or earlier have now reached their expected life span and the combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) they discharge continue to plague our waterways. Many of the infrastructure facilities constructed in the 1970s or earlier have reached their expected life span.[7] Other systems were poorly designed and overflow large volumes of untreated waste through combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs).

Overflow pipes like this one on Newtown Creek discharge raw sewage and dirty stormwater into New York Harbor and the Hudson River. Image: Giles Ashford © 2004.

These overflows, often triggered by wet weather events, send an unsafe amount of pathogens into our waterways. Pathogens – biological agents that cause illnesses and diseases – put the public at risk and greatly impede the Clean Water's Act mandate of attaining fishable and swimmable waters.[8]

Most wastewater treatment systems are able to manage flows of sewage from homes and businesses during dry weather. In fact, the improvement in water quality over the past several decades is due in large part to the investment in more effective treatment technology.[9] But when it rains, many systems are still unable to handle the added flows. Whether through cracks in infrastructure, overflow valves, or failures at treatment facilities, large volumes of sewage and polluted stormwater discharge into nearby waterways. The pathogens, toxins, and other pollutants contained in the sewage severely impair water quality and limit safe recreational uses, hitting recreational users the hardest during extreme conditions.

Upgrades Are Long Overdue

Wastewater treatment infrastructure across New York State is deteriorating. Combined sewage overflows, sanitary sewer overflows, failing wastewater treatment plants, and cracks in pipelines and holding tanks send billions of gallons of untreated sewage and polluted stormwater into the Hudson River and New York Harbor each year. Substantial investments in infrastructure – such as those made shortly after the 1972 Clean Water Act – are once again long overdue.

Aging infrastructure is a problem besetting municipalities across the United States. In fact, a recent study by the American Society of Civil Engineers gave our nation's water infrastructure a grade of "D-."[10] Many of the nation's water systems are over 100 years old and in a state of grave neglect. Between 23,000 and 75,000 combined sewage overflows occur each year as a result of failing infrastructure, spilling out 1.26 trillion gallons of untreated sewage annually and incurring $50.6 billion in cleanup costs. The level of federal funding for clean water infrastructure has drastically dropped from 78 percent in 1978 to 3 percent in 2007. As the federal monies continue to dry up, states and local municipalities are faced with difficult decisions in the allocation of far fewer dollars for far greater needs.

The U.S. Environmental Protection Agency, Government Accountability Office, and Congressional Budget Office each estimate that that our nation will need approximately $300-500 billion over the next 20 years to maintain and upgrade our nation's aging wastewater treatment and drinking water systems. The current national funding gap, approximately $22 billion dollars, leaves essential projects unfunded and communities without clean water.

Meanwhile, federal appropriations for the Clean Water State Revolving Fund and Drinking Water State Revolving Fund programs (which New York State, like all other states, relies on for loan assistance) continue to be severely reduced on a yearly basis. In 2007, New York State identified 148 clean water infrastructure projects in need of a total $3.8 billion but received only $118.1 million for the Clean Water State Revolving Fund. In 2008, New York identified a list of 392 projects in need of a total $3.97 billion.[11] But federal appropriations for the fund were again slashed ($394.7 million below FY 2007 enacted levels) and New York can expect to receive an even lower level of federal loan assistance for water infrastructure projects for 2008 than it received in 2007.

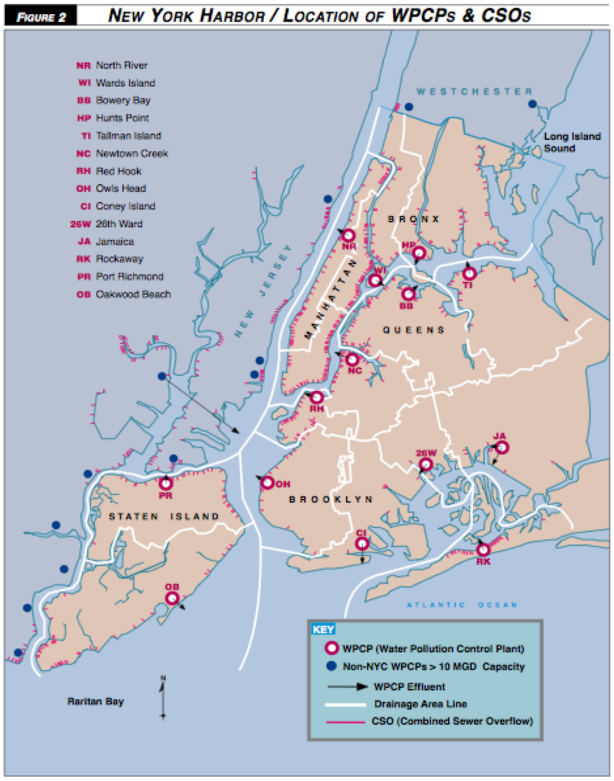
If the Hudson River and New York Harbor are to achieve lasting protection, funding must be made available on a reliable basis and must keep pace with the growing need for infrastructure improvement and clean water.

The Risks From Combined Sewage Overflows (CSOs)

Combined Sewer Overflows (CSOs) impose steep environmental costs on the recreational users of surrounding waterways. Combined sewer systems treat sewage from homes and buildings along with polluted stormwater from streets. As little as one-twentieth of an inch of rain can overload sewage treatment plants and CSOs – a mixture of raw sewage and untreated stormwater discharged directly into waterways – are what result.[12] CSO discharges prevent safe recreation, impair navigation, and damage fish habitat. Unfortunately, the lack of adequate water quality sampling after wet weather events, combined with outmoded sewer system technology, may be drastically understating the need for better forms of public notification about CSOs.

CSOs severely impact water quality and threaten public health. In addition to discharging harmful bacteria and pathogens associated with raw sewage, along with numerous other contaminants and toxins, CSOs invariably inhibit recreational opportunities as beaches must be closed after rains because of health hazards associated with CSOs.[13] In 2006, for instance, Orchard Beach in the Bronx was closed for 3 days and 9 private beaches were closed for a total of 66 days, all because of CSOs.[14] In 2005, CSOs forced the closing of Wolfe Pond in Staten Island for 9 days and two private beaches for 34 days.[15]

FIGURE 2 NEW YORK HARBOR / LOCATION OF WPCPs & CSOs



Source: NYCDEP Harbor Water Quality Report (1997).

New York City has at least 460 CSO outfalls that discharge more than 27 billion gallons of raw sewage and polluted stormwater into the Hudson River and New York Harbor each year. The state of New Jersey adds discharges from at least 60 CSO outfalls into the harbor. The locations of these New York Harbor CSOs is included here:

The Hudson River is on the receiving end of CSO overflows from these municipalities:

- Yonkers: 26 CSO outfalls;
- Newburgh: 12;
- Poughkeepsie: 6;
- Kingston: 7;
- City of Hudson: 10;
- Catskill: 6;
- Waterford: 4;
- Capitol District: approximately 100 CSO outfalls;
- Schenectady (Mohawk River): 4;
- Utica (Mohawk River): 82. [16]

Although water quality has significantly improved over the last few decades, the waterfront and its beaches are still too polluted for safe recreation after it rains. New York City Mayor Michael Bloomberg recognized as much when he announced his goal to make 90 percent of New York Harbor safe enough *for boating* by 2030.[17] However, this goal is not enough to ensure that waters are safe *for swimming* – a goal which Bloomberg originally set forth during his PlaNYC release – nor does it adequately recognize the severity and imminent public health threat that local communities currently face.

While progress on CSO abatement has been building steadily, most municipalities remain far behind what the Clean Water Act requires. For instance, New York City has improved its CSO handling, increasing the wet weather treatment from less than 30 percent in 1989 (when NYC was dumping about 200 million gallons *per day* into the Hudson River) to more than 72 percent today.[18]

But New York City's current administrative consent order still does not mandate compliance with federal water quality standards. For example, Environmental Protection Agency (EPA) policy from 1994 called for 85 percent wet weather capture and yet NYC's administrative consent order guarantees only the implementation of upgrades anticipated to achieve 75.5 percent capture. So PlaNYC's call to improve NYC's CSO capture rate to more than 75 percent is really nothing more than calling for what is already mandated in the consent order (and still below EPA's 1994 policy recommendations). In addition, EPA CSO policy also requires compliance with state water quality standards as a performance measure. Whether NYC's current CSO permit incorporates this criterion is an issue currently pending an administrative appeal to the New York State Department of Environmental Conservation Commissioner. Moreover, this increase would lead to a mere 3 percent improvement over current capture rates. On an aggregate citywide basis, this planned improvement does little more than potentially offset the impacts of projected population growth.[19] CSO impacts present a risk to recreational users, as approximately one-third of waterfront access points in New York City are within three city blocks of a CSO outfall.

Sprawl Impacts

Irresponsible development in the form of both unsustainable urban construction and suburban sprawl only add to these longstanding problems. As wetlands, forested habitat, and other natural areas are replaced by impervious surfaces from buildings, roofs, parking lots, and roadways, key soil functions such as absorption and bank stabilization are damaged.

Additional negative impacts come in the form of increased stormwater that flows off impervious surfaces and either overloads combined sewer systems or discharges directly to nearby waterways via separate stormwater overflows.

The bottom line of irresponsible development is an increase in polluted stormwater and raw sewage. The environmental costs of this pollution are then passed onto local communities. Ultimately, these costs flow downstream.

II. INSUFFICIENT MONITORING AND NOTIFICATION PROCEDURES

Although there are only five officially recognized public beaches in the heart of the estuary (four of which are open), there are at least 50 public and private marine beaches in the waters connected to the Hudson River estuary.[20] There are also well over 100 unofficial access points in the Hudson and New York Harbor from which millions of citizens swim, sail, kayak, and fish.[21] The seven public beaches in New York City alone are now visited by nearly 21 million people a year.[22] Indeed, a 2005 New York State study found that there is a much larger public demand for swimming beaches than can be accommodated by current facilities on the river.[23]

Riverkeeper staff swimming in the Hudson River at Storm King Mtn. (2002).

With millions of people recreating on or in the Hudson River and the waters of New York Harbor, the monitoring for sewage-indicating bacteria – and the proper public notification of high levels of such bacteria – is essential.

The Clean Water Act of 1972 provides the backbone for improving water quality conditions by prohibiting the discharge of pollutants into surface waters without a permit and applicable controls.[24] The federal Wet Weather Water Quality Act of 2000 requires all municipalities with combined sewer systems to implement Long Term Control Plans (LTCPs).[25] Unfortunately, many municipalities (including New York City) are behind in the long-term control planning process and implementation of effective pollution control technologies have been lagging. Source control technologies – commonly referred to as Best Management Practices (BMPs) – utilize stormwater as a resource and thereby prevent additions to combined sewer systems, or direct discharges in the case of separate sewer systems.

Federal Monitoring Requirements Under The BEACH Act

The BEACH (Beaches Environmental Assessment and Coastal Health) Act of 2000 requires coastal and Great Lake states to report to EPA on beach monitoring and notification data for coastal recreation waters within the states' jurisdictions. The BEACH Act also requires EPA to maintain an electronic monitoring and notification database of that data.[26] EPA has developed a comprehensive advisory and closing system called BEACON (Beach Advisory and Closing Online Notification). However, as of late July 2008, there is no water quality data posted for the 2008 season, highlighting the lag time between monitoring and public notification.[27] New York State currently monitors and reports to EPA on 353 beaches throughout the state, of which approximately 50 are in Hudson River estuarine waters.[28]

Much of this monitoring is based on testing for fecal coliform, although a growing number of scientists (including those collecting data as part of the Riverkeeper/Lamont-Doherty study) sample for *Enterococcus*. *Enterococcus* counts are useful as a water quality indicator due to their abundance in human sewage, correlation with many human pathogens, and low abundance in sewage free environments.[29]

Federal guidelines outlined in the BEACH Act indicate that a single sample maximum (SSM) value of greater than 104 *Enterococci* colonies per 100ml, or a geometric mean from five or more samples of greater than 35 *Enterococci* colonies per 100ml, be used as a water quality limit to close marine swimming beaches. Slightly more stringent guidelines were suggested for freshwater beaches. These values are based on epidemiological studies relating the abundance of *Enterococcus* to swimming related illness following full body emersion.[30]

In general, municipalities in New York will close a swimming beach when the single sample maximum is reached (i.e. when *Enterococci* counts are above the 104/100ml level). But beaches may also be closed once the 30-day average for *Enterococci* is greater than 35/100ml. This has the potential to lead to odd results. For instance, a beach may be closed once the average level is exceeded, but this could be weeks after the peak levels of pathogens were reached. So a beach might remain open when levels are relatively high (though still less than 104/100ml) and closed on days when it was lower, thereby exposing the public to higher pathogen levels and denying public access when the levels come down and the water is safer.

Thus, the 30-day average is generally a bad metric to use given that water quality is characterized by periodic spikes in pathogens after rainfalls and sampling during wet weather events is infrequent. In fact, even EPA "considers the single sample maximum level to be 'especially important for beaches *and other recreational waters* that are infrequently monitored or prone to short-term spikes in bacteria concentrations, e.g., waters that may be affected by combined sewer overflow outfalls.'"[31]

EPA indicated in the preamble to the 2004 BEACH Act rule that it expected the single sample maximum values would be used for informing beach closure and notification decisions.[32] But this rule left to states' discretion whether to also use the single sample maximum for other purposes under the Clean Water Act, such as making 303(d) impairment determinations or developing water quality-based effluent limitations in National Pollution Discharge Elimination System (NPDES) permits.

Therefore, a striking regulatory gap exists that allows agencies such as New York City Department of Environmental Protection to use the 30-day average and not the single sample level and thus claim that all open waters are in compliance with New York State pathogen standards for "primary contact recreation" even though there are frequent spikes in levels that render those waters above the levels at which they would be required to close a beach.

For instance, pathogen levels in the ambient waters near some CSO outfalls can be high during or after storm events, even though the 30-day geometric mean level in these same waters meets the current state water quality standards for coliforms. Therefore, merely stating that the open waters surrounding New York City are in compliance with pathogen standards does not accurately characterize the daily effects of CSOs on those waters. As EPA recognizes, the use of "appropriate time scales" is important because "CSO loads are typically delivered in short pulses during storm events."[33] Thus, while the current state water quality standards are undoubtedly an important benchmark (and some of those standards are expressed as 30-day averages), proper characterization of CSO effects requires a fuller picture for planning, disclosure, public education, and public notification purposes.

Pathogen monitoring and notification procedures differ substantially on the Hudson. This results in both the scope of sampling and the availability of data being determined by political, as opposed to geographical, boundaries. Because of this, the right type of data is generally not available to the public, and as a result, people are not as informed as they should be about changing river conditions.

New York State Water Quality Monitoring

Each summer, New York monitors bacteriological indicator levels at bathing beaches along Lake Erie, Lake Ontario, Long Island Sound, and the Atlantic Ocean as part of EPA's BEACH Grant Program. This monitoring is undertaken by the New York State Department of Health, which contracts with local health departments, the New York City Department of Health and Mental Hygiene, and the New York State Office of Parks, Recreation, and Historic Preservation in order to provide information regarding beach water quality conditions to the public.[34]

Marine beaches in New York State utilize the *Enterococcus* federal guidelines outlined in the BEACH act of a single sample maximum of 104/100ml or a geometric mean of 35/100ml from five or more samples in a 30-day period. Freshwater beaches may use either *Enterococcus* or total/fecal coliform standards for beach testing. Microbiological testing at permitted swimming beaches as part of New York State's beach monitoring program is overseen by the New York State Department of Health and in New York City testing is conducted by the Department of Health and Mental Hygiene. Current and archived data is available to the public on the web.[35] In contrast to the publicly available data for permitted marine swimming beaches, there is much less information currently available for the heart of the Hudson River Estuary.

New York City Sampling

The New York City Department of Environmental Protection (NYCDEP) conducts extensive water quality surveys for New York Harbor that include bacteriological surveys of fecal coliform (prior to 2004) and *Enterococcus* (post-2004).[36] This data is analyzed and released periodically to the public in a water quality report. This data is collected as part of an historical record reaching back into the early 1900s and provides valuable information on the long-term trends in New York Harbor water quality. The remarkable improvements in seasonal mean fecal coliform levels and dissolved oxygen levels over the last thirty years are well documented thanks to this extensive sampling and reporting. These improvements are attributed primarily to upgrades in the New York City wastewater treatment plants over the last several decades.

The NYCDEP New York Harbor Water Quality Report highlights long-term trends and reports primarily seasonally and spatially averaged data. However, there are limitations to this report, namely the delay in its release (typically more than a one-year lag time) and the lack of raw (or daily count) data to evaluate patterns of smaller spatial and temporal scale variation. This disconnect exists because the data is not intended to inform recreational users of the harbor about the short-term patterns and immediate changes in water conditions.

In addition, the summary of the Harbor Water Quality Report's fecal coliform data is reported in geometric means, leaving out what could be important periods of single sample exceedences (as discussed above). Indeed, the 2006 survey plainly admits that NYCDEP is only "beginning a long-term analysis of a possible linkage between wet weather and…observed water quality measurements…[and that]…several years of correlating weather and sampling will be necessary to determine if there is a direct link."[37] While this implicit recognition of a link between CSO events and changes in water quality is appreciated, it also amplifies the need for a rapid shift in how and where water quality is tested.

In addition to the substantial delay in public dissemination, a major limitation of current monitoring and notification systems is the lack of raw data to evaluate water quality patterns at smaller distances and time scales. This approach fails to document the intensive short-term events that can cause great stress to the ecosystem. In addition, it fails to provide the public and public health officials with information to guide safe recreational use of the natural resource at a time when contact with the water is being encouraged by the extensive development of piers and facilities to support activities such as fishing, swimming and kayaking.

The New York City Department of Health and Mental Hygiene is required to monitor and conduct surveillance of permitted beaches in the City of New York.[38] The department administers the Beach Surveillance and Monitoring Program during the bathing season. This program includes conducting annual compliance inspections of beach facilities and collecting routine beach water quality samples at the seven public and 12 private permitted beaches in the five boroughs.[39] To its credit, the New York City Department of Health monitors and samples each beach on a weekly basis with the exception of the Rockaway beaches, which are sampled biweekly. Additional samples are collected when necessary using the following determining factors: (1) proximity to suspected pollution sources; (2) extent of pollution; (3) beach use; (4) historical water quality data; and (5) other health risk factors.[40]

Upon evaluation and assessment of beach water quality as specified above, when beach status changes occur, the New York City Department of Health notifies the public by on-site postings, website postings, through a non-emergency government service hotline (311), and through press releases. Beach operators are also notified by phone and/or email for on-site postings. These procedures are aimed at (1) providing timely public notification and risk communication that allows the public to find out if a particular beach area is closed or poses a potential health risk and make informed decisions before actually going to the beach; (2) promoting public education and participation in keeping beaches cleaner and improving public health and safety; and (3) serving as a communication link between the public, environmental advocates and related agencies for easy reporting of bathing related illnesses, chemical spills, or incidents.[41]

The downside of this reporting scheme is that, as thorough as it is, it applies only to permitted beaches, leaving out a large number of unofficial, albeit known, access points.

Another shortcoming of this monitoring scheme is that aside from the actual testing under the Beach Surveillance and Monitoring Program, the basis for most of the water quality decision making in New York – including determinations of water quality standard compliance, development of long term control plans to control CSOs, and decisions to limit recreational use of waterways – is computer modeling, not actual sampling.[42]

Most of the approximately 460 CSO outfalls in NYC are not monitored either for volume or pollutants.[43] Also, some beach closures are based on preset standards based on predicted sewage overflows that will result from certain amounts of rain. For instance, if it rains X amount, Y beach will be closed. However, the models are only verified from a small amount of actual sampling and are based on decades-old modeling studies. It is simply not known whether the modeling is properly estimating conditions. As discussed in the Recommendations section of this report, the New York City Department of Environmental Protection, along with other agencies, should ensure that its models are informed by – and represent to the greatest extent practicable – actual data.

Hudson River Counties North of New York City

North of New York Harbor there is very little information that can be used to adequately evaluate water quality and make determinations regarding the safety of recreation at specific times and locations.[44] The waters north of the Bronx Borough line and south of the Bear Mountain Bridge are classified by the New York State Department of Environmental Conservation (NYSDEC) for primary and secondary recreation (including swimming), and fishing (class SB). The waters from the Bear Mountain Bridge north to Houghtaling Island are classified for swimming (class B) and in some cases are also used as a water supply (class A). Between the Bronx county line and Houghtaling Island there are four active public swimming beaches (three in Ulster and one in Westchester County) and NYSDEC surveys have determined that there are more than 100 sites used for "informal" swimming.

Monitoring and notification systems in the 10 Hudson River counties north of New York City are piecemeal at best. In general, the systems employed vary from county to county but the end result is generally the same: there is not sufficient information made available to the public in a timely manner.

Of 10 counties recently surveyed for this report, only four (Westchester, Rockland, Dutchess, and Ulster Counties) reported conducting pathogen testing in the Hudson River. Nine counties have water testing capabilities, but generally limit such testing to freshwater lakes and ponds within their jurisdictions. Counties are only required to test at public swimming locations not operated by the state, unless they have been delegated testing responsibility from the New York State Department of Health. In most counties along the Hudson there are no officially recognized public swimming locations and therefore, there is little to no testing.

Putnam, Orange, Columbia, Albany and Rensselaer Counties all test at public bathing beaches located elsewhere in the counties, while all testing for Greene County is done by the New York State Department of Health.

Westchester County currently tests for fecal and total coliforms weekly during summer months at four locations: Matthiessen Park; Phillips Manor; Croton Point County Park; and Senasqua Park. Of these, only Croton Point County Park is open for public swimming. The Westchester County Department of Health also tests for *Enterococcus*, but only at sites along Long Island Sound.

Rockland County also tests weekly during summer months at four locations: Piermont Pier; Hook Mountain; Bowline Point; and Grassy Point. None of these are open for public swimming. Like Westchester, pathogens being tested are limited to total and fecal coliforms, and no testing is done during or after wet weather events. Rockland also does not publish the test data, but members of the public can contact the Division of Environmental Resources to request the data.

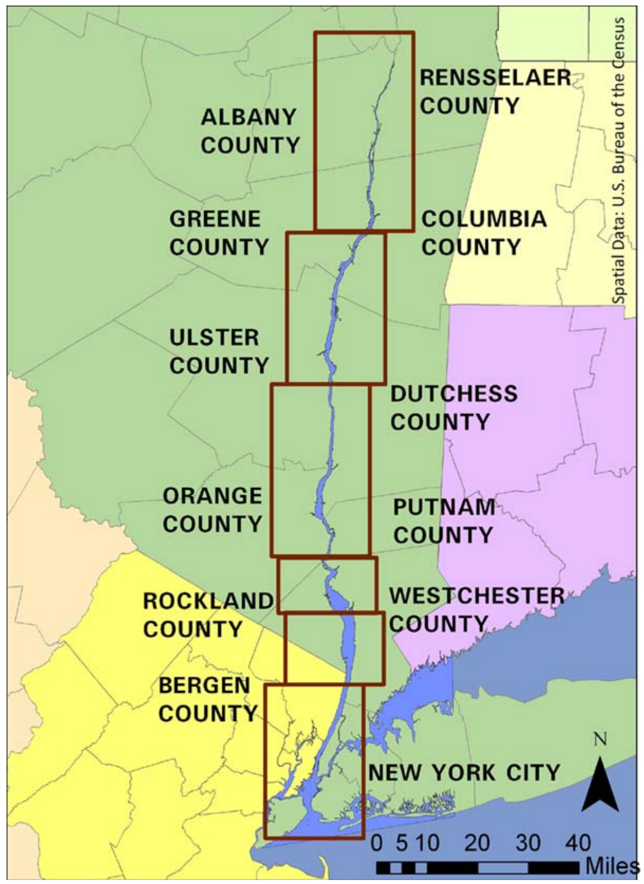
Dutchess County has no public beaches open along the Hudson, but the Department of Health does test weekly at a privately operated Riverpool in Beacon. The County does not publish the data itself, however the Riverpool website includes data that is received from the county. As of the publication of this report, the most recent data available was from the 2007 swimming season.

III. SUMMARY OF FINDINGS

One of the primary goals of the Riverkeeper/Lamont pilot study was to identify the areas most susceptible to extreme variation in water quality and to better understand the environmental factors influencing water quality. This focus will lead to better prediction of when and where problems will occur and assist public officials in remediating pollution problems and informing the public of unsafe conditions. Our results indicate that water quality in the Hudson River and New York Harbor remains highly variable and often exceeds federal guidelines for pathogens, especially after wet weather events. In addition, factors such as temperature, salinity, particle load, oxygen and nutrient concentration all influence water quality and have potential to alter the persistence of pathogens in the environment.

From September 2006 to September 2007, two hundred fifty-two samples were collected monthly from 27 sampling stations from the Battery in New York City to Peekskill in northern Westchester County.[45]

Our initial data shows overall water quality to be highly variable depending on both site location and time sampled. This study is ongoing and as the data increase a better picture of problem locations throughout the estuary will emerge. But initial samples indicate that, in general, ambient water quality conditions in the northern (Peekskill to Yonkers) and southern (Yonkers to New York City Battery) portions of the estuary are relatively similar and during periods of dry weather, mid-channel conditions are generally acceptable from an overall environmental perspective.



The study spans the entire Hudson River Estuary. The data is available in a map-based search engine, as depicted above, on our website at www.riverkeeper.org. Map data: U.S. Bureau of the Census.

However, the initial findings also highlight a number of concerns:

- Conditions in the mid-channel of the Hudson often differ substantially from near-shore conditions;
- There are times and places, particularly near-shore after wet weather events, where counts of sewage-indicating bacteria far exceed federal and state standards for primary contact recreation;

- In 2007, twenty-one percent of samples collected north of New York City had counts of sewage-indicating bacteria that exceeded the federal single sample guideline for primary contact;
- In the waterways surrounding New York City, 32 percent of the samples exceeded the federal single sample guidelines for primary contact;
- There are specific locations (i.e. Piermont Pier and Newtown Creek in Brooklyn) that have chronically poor water quality conditions;
- Severe wet weather conditions, even if short-term, can render much of the estuary unsafe for activities such as swimming and kayaking.

Sampling Methodology

The sampling system employed during the study measured salinity, oxygen, temperature, suspended sediment and chlorophyll and recorded a database of these water quality indicators every three minutes.[46] In order to characterize the level of sewage-related microbial contamination in the Hudson, the study applied U.S. Environmental Protection Agency (EPA) method 1600 to quantify the abundance of *Enterococcus* bacteria, a reliable indicator of sewage contamination.[47] *Enterococcus* counts are useful as a water quality indicator due to their abundance in human sewage, correlation with many human pathogens, and low abundance in sewage free environments.[48]

Enterococcus counts are expressed as a Most Probable Number (MPN) per 100 ml of water and can be analyzed given the following guidelines that currently exist:

- MPN above 104/100ml indicates a single sample exceedance of the suggested federal guideline for water quality at marine swimming beaches.
- MPN between 35/100ml and 104/100ml indicates a level that if sustained would be an exceedance of the suggested federal guideline for water quality at marine swimming beaches.
- MPN below 35/100ml indicates acceptable water quality.

Federal guidelines for *Enterococcus* counts suggest two types of measures to be used in closing down swimming beaches: a single sample over 104/100ml or a geometric mean over 35/100ml calculated from greater than five samples in a month. Since the current data set does not have the required data density to provide a geometric mean from five samples in a month, the geometric mean is used to summarize the seasonal counts.[49]

Findings

Analysis of the 2006-2007 *Enterococcus* data showed a number of trends. Of the 252 samples taken during the pilot study, 26 percent had Most Probable Numbers (MPNs) greater than 104/100ml, indicating that approximately one quarter of the samples were collected from an environment that presented a substantial risk of illness from swimming.[50] These exceedances occurred at 21 of the 27 sampling stations (see Table 1, below). Eleven percent of the samples had values between 35 and 104, suggesting marginal water quality. Only two stations, Croton Point Beach (HD14) and Peekskill Bay (HD19) had all measured values less than 35/100ml. It is worth noting that Peekskill Bay had only four samples collected, compared to the nine samples collected from Croton Point Beach.

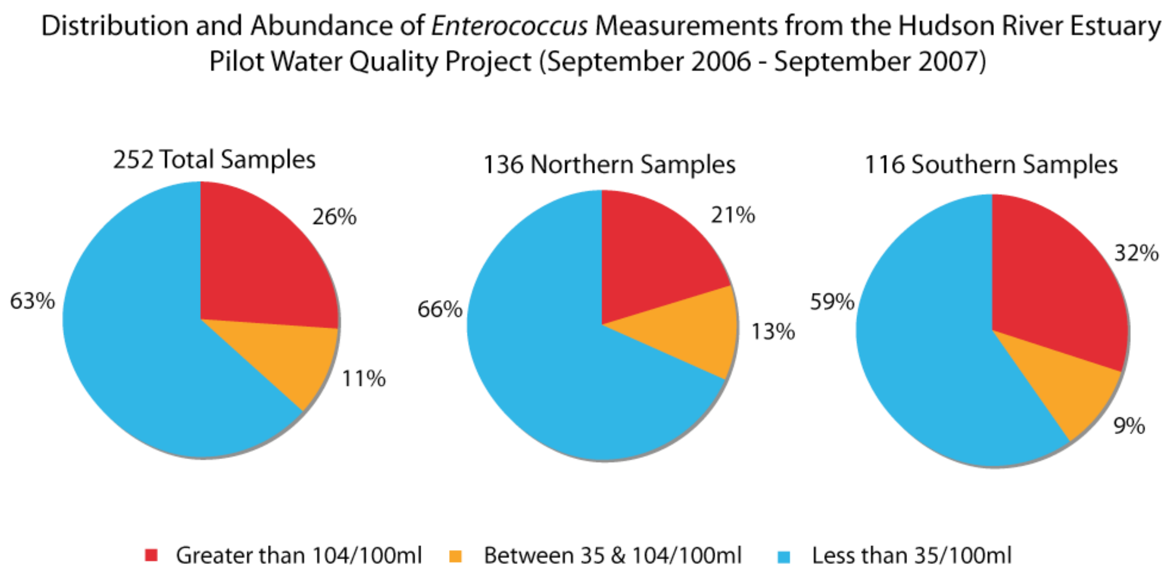
The pilot study revealed extreme variability in water quality, both in location and time. For example, the abundance of *Enterococcus* bacteria not only varied widely by station but also increased dramatically after moderate to heavy rainfall. At some sites, the bacteria were so abundant that levels exceeded federal guidelines for safe swimming many times over. These conditions were observed not only in areas where contamination was expected, but also locations thought to be relatively pristine. Analysis of two higher frequency shore-based sampling locations is reported separately and both stations frequently experienced poor water quality (see Table 2). Although counts at these locations were influenced by wet weather, exceedances were not restricted to wet weather events.

The correlation between sewage indicators and wet weather demonstrates that the Hudson bears significant episodes of localized contamination when stormwater infiltrates or overwhelms the aging and overburdened sewage treatment infrastructure in the river's rapidly urbanizing watershed. However, it is important to note that some locations also experience poor water quality – and thus require immediate monitoring and management attention – even during dry weather conditions.

The study characterized this trend both in the waters surrounding New York City and also in upriver environments that are heavily used for recreation. In fact, 21 of the 27 sampling stations experienced periodic conditions that exceeded the single sample federal guideline for safe swimming conditions. The initial data also suggest significant differences in the response of deep, mid-channel, waters compared to environments at the edge of the river which are more heavily utilized by the public, including significant communities of subsistence fishermen.

Northern vs. Southern Section of the Estuary

The 252 total samples from the pilot study were split between northern (Peekskill to Yonkers) and southern (Yonkers to New York City Battery) stations. Of the 136 samples that were collected from northern stations, 21 percent of these exceeded the 104/100ml guideline. A similar percentage (32 percent) of the 116 southern samples exceeded the guideline. Surprisingly, the distribution of *Enterococcus* counts at northern and southern sites was quite similar. No statistically significant difference was found between northern and southern mid-channel stations. During dry weather conditions the mid-channel of the Hudson generally has acceptably low levels of sewage indicating microbes.



Mid-Channel Overview

Although the mid-channel of the Hudson River estuary often has acceptable conditions, 21 of 27 stations from the sampling program experienced single day measurements that indicate a risk of illness from swimming or direct contact with river water on that day.[51] This demonstrates that even sites with generally acceptable, or seasonally acceptable conditions (according to the geometric mean), can experience poor water quality on individual days. These higher counts are often associated with wet weather. This temporal and spatial variability suggests that more frequent monitoring may be needed in areas used for recreation.

Although no mid-channel sites in the north or the south had a geometric mean above 35/100ml, 27 percent of the mid-channel samples in the south exceeded the daily guideline. Again, this shows that sampling systems based on averages do not adequately reflect the variability in the river system or the safety of recreation on individual days.

Storm Events

There were a number of sampling days that coincided with storm events in the region and which serve to highlight the impact severe weather can have on water conditions in the Hudson River Estuary.

On July 11, 2006, morning sample results from the mid-channel location at the 79th Street site off the west side of Manhattan showed low counts of *Enterococcus*. However, additional samples were collected at the same mid-channel location merely one hour after a major rain event and results showed elevated counts of *Enterococcus* at 1030 colonies/100ml, well over the 104/100ml single sample limit established by EPA. One half-hour later (90 minutes after the rainfall), samples taken under the George Washington Bridge showed *Enteroccocus* counts of

1560/100ml. It should be noted that during dry weather, these stations generally have acceptable low counts and both stations had low geometric means for the study period.

On April 15, 2007, one of the largest rainstorms on record occurred in New York City and the surrounding areas, dropping over 7.57 inches in 24 hrs.[52] Results from sampling conducted on April 18, 2007 (three days after the rain event) and on April 25, 2007 (ten days after the rain event) were elevated in many regions.

This storm delivered enough sewage to the river via tributaries, non-point sources, and CSOs to cause most mid-channel sites of the river to experience high levels of sewage days after the event. Northern samples continued to have elevated mid-channel *Enterococcus* levels 10 days after the April 15th record-setting rainfall, demonstrating the potential impact of a large rainfall event on water quality beyond the commonly quoted "three-day" rule.

Areas of Consistently Poor Conditions

Although the mid-channel of the Hudson generally has acceptable conditions in dry weather, there were near-shore areas where the data suggests chronically poor conditions. For example, in the southern transect, the Harlem River and Newtown Creek were found to often have poor water quality. For our data set, the *Enterococcus* geometric mean from the Gowanus Canal is not greater than 35/100 ml, but other data (including our initial 2008 exploratory sampling) indicates that the water quality of the Gowanus is often poor.[53] In the northern transect, the Saw Mill River, Piermont Pier, Piermont Outfall, and Cedar Pond Brook stations all had geometric means indicating consistently poor water quality.

The data indicate that tributaries can be a large source of sewage contamination in the northern part of the estuary and that tributary waters contaminate the edges of the Hudson where they mix with mid-channel water. It is critical to note that surveys conducted down the middle of the channel may not adequately characterize the spatial variability in water quality of the river.

Equally as important is the fact that all recreation begins ands ends on the shoreline. People are therefore more likely to interact and come into contact with the river on the margins and around tributary inputs rather than in the mid-channel environment. It is therefore important that water quality surveys make an effort to sample in both mid-channel and near-shore environments.

Shore-based sampling also indicated poor water quality conditions at the new site of the 125th St Harlem Pier and in the Sparkill River. The 125th Street Station data is likely impacted by the close proximity of a CSO outfall. However, the source of the sewage indicating microbes at the Sparkill Creek site is unknown and should be the focus of additional study.

For more updated information, and to see recent sampling data from spring/summer 2008, please visit our website at www.riverkeeper.org.

IV. IMPLICATIONS FOR THE RIVER USER

It is important to note that the Riverkeeper/Lamont-Doherty study is ongoing and only the results of the pilot project (2006 – 2007) have been analyzed in detail. Further, neither Riverkeeper nor Lamont-Doherty serves as a public health agency and general guidelines based on data collected by scientists aboard the Riverkeeper patrol boat are not intended to supplant or override guidelines issued by local, county, and state agencies. Rather, these guidelines are based on a limited data set collected over one year, and our suggestions err on the side of protecting public health and the environment based on that limited data. It is also important to note that this water quality data related only to sewage indicating microbes and does not detect chemical pollutants/toxins that may be a source of concern in parts of the estuary.

However, the bacteriological data suggests that there are certain areas of concern. First, the data shows that even days after localized storm events, levels of pathogens can remain above the allowable federal guidelines for swimming. Second, the data shows that 21 of 27 stations sampled experienced single day measurements that indicate an increased risk of illness from swimming or direct contact with the river water on that day. Even at sites where conditions were generally acceptable, or that had seasonally acceptable conditions (according to the geometric mean), there was still poor water quality on individual days, particularly after rain events. Finally, the data shows that there are areas that experience chronically poor conditions, but this data set would suggest that these are localized issues and therefore targeted investigations should be able to identify sources of pollution and lead to management actions that address these local sources of poor water quality. Targeted local actions may therefore yield large positive impacts on local water quality in the areas of concern.

Riverkeeper recommends that the average beachgoer, swimmer, and kayaker continue to apply the rule of thumb that has been applied de facto for years: swimmers should avoid substantial contact with the Hudson River and New York City waterways after rains.

There is not sufficient data to update that recommendation at this time. The recommendation will vary with location and amount of rainfall because there does not appear to be a simple linear relationship between rainfall and *Enterococcus* counts. People are advised to look on our website for information about the areas they are interested in and to use caution where they note elevated bacteria counts in that area.

Riverkeeper does not want to suggest that people stay away from the river or from favorite beaches. In fact, the core of Riverkeeper’s work has always been the belief that every person has an undeniable right to access and enjoy clean water. This water quality monitoring program is not meant to undermine the revival of river-based recreation that has taken place in our region, but rather to inspire discussion and action towards better pathogen monitoring, and thus, increased protection of public health and the environment.

V. RECOMMENDATIONS TOWARDS A SWIMMABLE RIVER

If New York is to fully realize its goal of restoring the Hudson River to a swimmable condition from the Adirondacks to New York City, there must be a renewed focus on: (1) better water quality policies; (2) better wastewater treatment infrastructure; and (3) better monitoring and public notification of conditions. Riverkeeper's Swimmable River Campaign, launched with the release of this report and the Riverkeeper/Lamont-Doherty partnership data, is focused on this three-prong approach.

Riverkeeper specifically recommends the following actions on the part of government officials and environmental and public health agencies:

Better Policies

Better water quality policies are needed to improve the quality of treatment and overall water management.

(1) *Renew New York's pledge for a Swimmable Hudson River estuary*. In 2004, Governor Pataki publicly called for a commitment by New York State to reach the Clean Water Act's goals of having a swimmable Hudson River by 2009. This pledge should be renewed and pragmatic steps towards achieving this goal should be outlined.

(2) Create cohesive water quality protection policies for the region. New York State should integrate and align water quality protection policies for the entire Hudson River estuarine system – New York Harbor, the Lower Hudson, Long Island Sound, and the New York Bight and its watersheds – with those in other plans developed by New York City and other governmental organizations including: the New York-New Jersey Harbor Estuary Program, the Long Island Sound Study, the Hudson River Estuary Program, and involving those municipalities with approved Waterfront Revitalization Plans.

(3) *Increase protection for key wetlands and buffer zones.* New York State and its municipalities should strengthen classification of and protection for local wetlands and other buffer areas that filter pollution and green our waterfront areas. Currently, New York's Freshwater Wetlands Law only protects freshwater wetlands that are 12.4 acres or larger, or those that have been designated by the New York State Department of Conservation as being of "unusual, local importance." Most wetlands smaller than 12.4 acres used to be protected under federal law, but today, they are no longer guaranteed protections due to recent federal rollbacks to the Clean Water Act.

(4) *Water conservation should be made a key focus of all water supply strategies.* New York State should consider a holistic approach to water conservation in an effort to reduce the amount of wastewater that must be treated.

(5) *Classify kayaking and personal watercraft usage as "primary contact" recreational uses*. These recreational uses bring users into direct contact with water and differ from other waterborne recreational uses, such as sailing and power boating, where users

generally do not come into contact with water. These latter uses are characterized as "secondary contact." Currently, the NYC Department of Environmental Protection and NYS Department of Environmental Conservation deem kayaking and personal watercraft usage as "secondary" contact. An appropriate designation as primary contact recreational use would be consistent with the plain language of NYS regulations, as well as EPA's policy and that of other states.[54] EPA's CSO Control Policy requires that all areas currently used for 'primary contact' recreation be treated as "sensitive areas" in the CSO Long-Term Control Plan process. Such classification would more sensibly guide municipalities towards more stringent water quality goals, consistent with actual uses. Every municipality in the Hudson Valley should hold public hearings to obtain input from a variety of stakeholder groups who recreate on the river and its waterfront areas.

(6) *Increase interagency and intra-agency communication*. Watershed planning decisions should include all relevant local, state, and federal agencies to ensure continuity and a more comprehensive approach. Planning decisions should incorporate officials within agencies that are tasked with protecting waterbodies, managing sewer systems, evaluating development proposals, and making budget recommendations. These agency officials should in turn be in consistent communication with others in their respective departments. Often, agencies in charge of developing Long-Term Control Plans share jurisdiction with other agencies (i.e. those who have budgetary control over given projects) and yet do not coordinate fully with these other agencies. All interested departments and agencies should be included. In New York City, the Best Management Practice ("BMP") Task Force created by PlaNYC is a perfect example of what can be accomplished when information is shared across a wider spectrum.

(7) *Deem all areas where swimming and fishing are occurring as sensitive, whether or not the area is formally designated for those uses.* Waterfront areas that are known or planned to be frequently used for public access should be deemed sensitive areas and given high priority in terms of planning and CSO control, regardless of whether such areas are formally designated as beaches or officially recognized as access points.

(8) *Focus monitoring and notification procedures on extreme conditions in addition to averages*.

Despite reporting guidelines that only require analysis of mean, or average, conditions the public is recreating in a variety of conditions at specific times and locations. Simply stated, the public is not swimming in averages, but in the highs and lows of water quality parameters. Thus, the extremes are most important in terms of protecting public health.

(9) *Establish new public-private partnerships to help create a sound scientific foundation for water quality management decisions.* These partnerships need to be specifically focused on sampling for sewage indication bacteria such as *Enterococcus*, in order to better inform decision making on the part of the public and government agencies responsible for environmental and public health protection.

(10) *Pass the Federal Beach Protection Act.* This Act would reauthorize the federal BEACH Act of 2000 and provide for increased funding of grants aimed at indentifying pollution sources and remediating existing problems.

(11) *Pass the Raw Sewage Overflow Community Right to Know Act.* This Act seeks to amend the Clean Water Act to require operators of sewage treatment plants to develop a notification system to alert local health officials and the public-at-large of sewer overflows within twenty-four hours.

Better Infrastructure

Better wastewater treatment infrastructure is needed to ensure the lasting protection of water quality.

(1) *Establish a Clean Water Trust Fund*. Such a fund would bridge the major gap between needs and availability and ensure that counties and municipalities have a reliable, steady source of funding to address water infrastructure needs. A dedicated Clean Water Trust Fund would establish the equitable distribution of funds across the board, regardless of a community's size or location.[55]

(2) *Pass the Federal Water Quality Financing Act*. The Water Quality Financing Act seeks to amend the Clean Water Act to authorize appropriations for the Clean Water State Revolving Loan Fund program in the total amount of $14 billion over a four-year period. This legislation also requires that a study be conducted into potential funding mechanisms and sources of revenue for a Clean Water Trust Fund. H.R. 720 was passed in the House of Representatives. This legislation does not have a companion bill in the U.S. Senate.

(3) *Pass the Federal Water Quality Investment Act*. The Water Quality Investment Act seeks to amend the Clean Water Act to authorize appropriations for sewer overflow control grants in the amount of $1.7 billion over a five-year period. H.R. 569 passed in the House of Representatives; the Senate has not passed a companion bill.

(4) *Ensure ultraviolet disinfection at wastewater treatment plants*.

(5) *Require all stormwater management systems to incorporate green infrastructure in an effort to reduce flows into treatment systems*. As wet weather events are the primary trigger behind pathogenic overflows into our waterways, there must be a focus on reducing the amount of water that gets into the systems in the first place. This entails capturing stormwater and putting it to use where it falls in such features as street trees, parks, green roofs and the use of porous pavement in area parking lots. These are cost-effective systems that can be used in conjunction with, or sometimes in lieu of, hard infrastructure. An increasing number of municipalities, from New York City to Albany are merging green design into stormwater control and CSO control requirements under federal and state law. All agencies, whether at the municipal, state, or federal levels, should implement a policy of incorporating best management practices into the design of

all public projects with the goal of maximizing the use of on-site retention, detention, and infiltration techniques to reduce stormwater discharges. For more information, see Riverkeeper's "Sustainable Raindrops" report from 2006.[56]

(6) *Prevent Increases in CSO Discharges and Evaluate Potential for Eliminating Existing CSO Discharges to Sensitive Areas.* As required by EPA's CSO Control Policy, municipalities should give highest priority to controlling overflows to sensitive areas by prohibiting increased overflows to these areas (i.e. from new developments) and eliminating or relocating overflows that discharge to these areas.

(7) *Develop and Implement a Stormwater Disposal Rate on Sewer Bills*. A comprehensive state-wide program should restructure sewer rates in order to have two rates: the estimated volume of stormwater discharged into combined sewer systems, and the estimated volume of raw sewage discharged. A more accurate rate than what currently exists would create an incentive to capture water and lead to more equitable accounting.

(8) *Enforce against failing facilities*. The Clean Water Act and other environmental laws that require pollution control should be fully enforced, acting to deter future mismanagement and ensure environmental and public health protection.

(9) *Require implementation of Long-Term Control Plans for all municipalities with CSOs and design infrastructure to accommodate increased amount and intensity of rainfall expected regionally due to the effects of climate change.*

Better Monitoring

Better monitoring of water quality is needed to understand the health of the river, to track down specific causes of exceedences, and to enable regulators to inform the public with more timely and accurate information.

(1) *Develop a uniform system of pathogen monitoring within the Hudson River Estuary that tests water quality based on spatial and geographical, and not political, boundaries.*

(2) *Increase wet weather monitoring at problem locations*.

(3) *Develop testing protocols that are spike-driven and based on extremes, not merely averages.* The EPA single sample maximum of 104cfu/100ml *Enterrococci* used at beaches and other coastal recreation waters should be employed throughout the estuary. EPA considers the single sample maximum level to be "especially important for beaches and other recreation waters that are infrequently monitored or prone to short-term spikes in bacteria concentrations, e.g., water that may be affected by combined sewer overflow outfalls."[57]

(5) *NYSDEC should list the entire Hudson River estuary as impaired for pathogens.* This will lead to the development of Total Maximum Daily Load (TMDL) guidelines which

can then be incorporated into Clean Water Act permits as binding, numeric discharge limits.

Better Notification

Better public notification of water quality exceedences is needed so that the public can make more educated decisions about recreational uses of our waterways.

(1) *Estuary-wide notification systems should be based on single sample measurements, or other data that can capture short-term or localized problems, not just averages*. In terms of public notification of dangerous conditions, closing an access point or an entire waterbody to recreational use based only on average levels may unnecessarily expose the public to pathogens, unnecessarily restrict public access, or do both, if the notice or closure is not coincident with a given pathogen spike.

(2) *All municipalities with CSOs entering the Hudson River estuary should provide timely and location-specific water quality monitoring results for all relevant pollution parameters.*

(3) *The government's computer modeling should be based on actual data collected*. NYCDEP should compare additional data (including the results from this study) to model predictions. Then, the more accurate hour-by-hour modeling predictions should be used to better focus management decisions and public notification.

(4) *New York State and municipalities should develop better public notification systems.* A broadcasted form of public notification, incorporating broadcast meteorologists on TV, radio, and online, public service announcements, 311 interface systems, and/or an email alert system that notifies the public of CSO events, should be developed. Durable and understandable public notification systems should also be installed at the shoreline, especially at outfalls near public access points.

VI. NEXT STEPS FOR THE RIVERKEEPER/LAMONT-DOHERTY STUDY

Thanks to generous funding from the Wallace Research Foundation, the Riverkeeper/Lamont water quality monitoring program for 2008 is already underway and we are seeking support to continue the study through 2009. Riverkeeper intends on making its data available to the general public via its website (www.riverkeeper.org) as soon as possible after sampling.

Through our continued partnership with Lamont-Doherty Earth Observatory of Columbia University, this water quality testing program will help citizens and public officials to understand the factors controlling water quality in the Hudson River and identify pollution sources that require attention. Equally important, this program will provide the public with information about the quality of water in the Hudson as it pertains to the environmental safety of recreational uses.

Once our study is completed, we hope to publish a final analysis of our data in a peer reviewed scientific journal.

For more information, and for updates of our water quality monitoring data, please visit our website at: www.riverkeeper.org.

VII. CONCLUSION

This report is not the final answer on the water quality monitoring systems and pollution control technology that must be employed in order to ensure swimmable waters up and down the Hudson Valley. Rather, the initial findings highlighted in this report demand the need for increased discussion and continued in-depth technical analysis. Achieving the common goal of a swimmable Hudson is a challenge that will require a renewed emphasis on environmental enforcement and a sustained commitment on the part of public and private partners to work towards better pathogen monitoring throughout the region. This report is intended to identify hot spots for management action and to advance the process of contributing a sound scientific foundation for enacting effective and rapid change.

The Hudson River and the vast watersheds that comprise it are the lifeblood of New York State. The vision of having a fishable and swimmable Hudson is one that needs to be fully embraced if we are to truly become an environmental model for the world.

TABLE 1: 2006/2007 Summary of Enterococci Most Probable Number (MPN/100ml), data by sampling site.

Location	Site Name	North or South	Type	MPN Geometric mean	# samples collected	Max. Daily MPN	Min. daily MPN	% daily MPN above 104/100ml	% daily MPN between 35 & 104/100ml	% daily MPN below 35/100ml
GO1	Gowanus Canal	S	Tributary	15.6	6	274	0	**33.3%**	16.75	50.0%
BC	Buttermilk Channel	S	Mid-Channel	1.6	6	210	0	**16.7%**	0.0%	83.3%
ER1	East River 1	S	Mid-Channel	8.7	7	376	1	**28.6%**	0.0%	71.4%
NT1	Newtown Creek 1	S	Tributary	26.0	11	1500	0	**45.5%**	0.0%	54.5%
NT2	Newtown Creek 2	S	Tributary	**144.0**	11	1500	5	**63.6%**	9.1%	27.3%
ER2	East River 2	S	Mid-Channel	10.4	10	344	1	**30.0%**	0.0%	70.0%
HA1	Harlem River 1	S	Tributary	30.4	9	356	3	**33.3%**	0.0%	66.7%
HA2	Harlem River 2	S	Tributary	**47.4**	10	1467	11	**20.0%**	40.0%	40.0%
HD1	Hudson Battery	S	Mid-Channel	2.5	9	274	0	**33.3%**	0.0%	66.7%
HD2	Linc Tunnel- Pier 76	S	User Area	7.8	9	246	0	**22.2%**	11.1%	66.7%
HD3	79th Street	S	Mid-Channel	10.5	9	1032	0	**33.3%**	0.0%	66.7%
HD4	125th St Outfall	S	Outfall	9.8	9	236	0	**22.2%**	22.2%	55.6%
HD5	GW Bridge	S	Mid-Channel	21.2	10	1500	1	**20.0%**	20.0%	60.0%
HD6	Yonkers Outfall	N	Outfall	6.2	10	103	0	**0.0%**	20.0%	80.0%
HD7	Sawmill Crk - Hudson	N	Tributary	**134.6**	9	1500	11	**55.6%**	0.0%	44.4%
HD8	Yonkers	N	Mid-Channel	5.0	11	112	0	**18.2%**	18.2%	63.6%
HD9	Piermont Outfall	N	Outfall	**58.1**	17	1500	1	**52.9%**	0.0%	47.1%
HD10	Piermont Pier	N	User Area	**56.6**	14	1275	0	**42.9%**	21.4%	35.7%
HD11	Tappan Zee	N	Mid-Channel	2.5	15	252	0	**13.3%**	6.7%	80.0%
HD12	Off Petersons	N	Mid-Channel	6.7	4	77	0	**0.0%**	50.0%	50.0%
HD13	Ossining-launch	N	User Area	8.8	9	69	0	**0.0%**	33.3%	66.7%
HD14	Croton Point Beach	N	User Area	2.2	9	17	0	**0.0%**	0.0%	100.0%
HD15	North River	N	Mid-Channel	4.1	10	164	0	**10.0%**	20.0%	70.0%
HD16	Furnace Brk- Hudson	N	Tributary	17.6	10	50	6	**0.0%**	10.0%	90.0%
HD17	Stony Point	N	Mid-Channel	5.3	5	196	1	**20.05**	0.0%	80.0%
HD18	Cedar Brook-Hudson	N	Tributary	**48.7**	9	283	28	**33.3%**	11.1%	55.6%
HD19	Peekskill Bay launch	N	User Area	5.4	4	28	2	**0.0%**	0.0%	100.0%

TABLE 2: 2006/2007 Summary of *Enterococci* MPN data from higher frequency shore sampling sites.

Location	Site	North or South	Type	MPN Geometric mean	# samples	Max.	Min.	MPN above 104/100ml	MPN between 35 & 104/100ml	MPN below 35/100ml
125th St	Harlem Pier	S	Shore line	139	31	1500	8	51.6%	29.0%	19.4%
Sparkill	Sparkill Creek	N	Tributary	610	28	1500	134	**100%**	0%	0%

ENDNOTES

[1] New York State Department of Environmental Conservation, *Swimming in the Hudson River Estuary Feasibility Report on Potential Sites* (2005) at ES-1, available at: http://www.dec.ny.gov/lands/5452.html.

[2] *See*, *e.g.*, Interstate Environmental Commission, 2007 Annual Report, available at: http://www.iec-nynjct.org/reports.htm.

[3] Swimming in the Hudson (*supra* note 1) at 8, available at: http://www.dec.ny.gov/lands/5452.html. Since 2005, additional water quality monitoring partnerships have been established, including, for instance the Hudson River Environmental Conditions Observing System (HRECOS), for which information is available at: http://www.dec.ny.gov/docs/remediation_hudson_pdf/hrecos08.pdf.

[4] Riverkeeper maintains a thirty-six foot patrol and research vessel, the R. Ian Fletcher, which operates 10 months per year, logging approximately 6,000 miles between Waterford, New York (just north of the Federal Lock at Troy) and New York Harbor. Our full-time presence on the Hudson River enables us to respond to and investigate pollution complaints, facilitate scientific research, provide access to the river, and connect with local communities up and down the Hudson Valley.

[5] The data collected for the ongoing study described in this report does not include analysis of water or soil contamination that may result from polychlorinated biphenyls (PCBs), radioactivity, mercury, heavy metals, or other industrial contaminants. For a comprehensive analysis of contamination in New York Harbor, *see*, *e.g.*, Steinberg, N. D.J. Suszkowski, L. Clark and J. Way, *Health of the Harbor: The First Comprehensive Look at the State of the NY/NJ Harbor Estuary*, A Report to the NY/NJ Estuary Program (Hudson River Foundation 2004), available at: http://www.hudsonriver.org/docs/harborhealth.pdf.

[6] *See*, *e.g.*, New York City Department of Environmental Protection, *2006 New York Harbor Water Quality Report*, available at: http://nyc.gov/html/dep/pdf/hwqs2006.pdf.

[7] New York State Department of Environmental Conservation, *Clean Water Act Section 305(b) Report* (2006) at A-120, ("Rapid population growth in the Lower Hudson has also caused many wastewater treatment plants to reach their design capacities sooner than originally expected."), available at: http://www.dec.ny.gov/docs/water_pdf/305bappa4.pdf

[8] For a comprehensive discussion of the public health risks associated with recreating in waters polluted by raw sewage, *see* Dorfman, M., *Swimming in Sewage: The Growing Problem of Sewage Pollution and How the Bush Administration is Putting Our Health and Environment at Risk* (Natural Resources Defense Council and Environmental Integrity Project 2004), available at: http://www.nrdc.org/water/pollution/sewage/sewage.pdf.

[9] *See*, *e.g.*, Interstate Environmental Commission, 2007 Annual Report (*supra* note 2).

[10] American Society of Civil Engineers, *2005 Report Card for America's Infrastructure*, available at: http://www.asce.org/reportcard/2005/page.cfm?id=35.

[11] See New York State Department of Environmental Conservation, *Wastewater Infrastructure Needs of New York State* (2008), available at: http://www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf.

[12] For more information on CSOs, source control methods, and green infrastructure, *see* Seggos, B and M. Plumb, *Sustainable Raindrops: Cleaning New York Harbor by Greening The Urban Landscape* (Riverkeeper 2006), available at www.riverkeeper.org.

[13] *See id*. (citing New York City Department of Health and Mental Hygiene, Office of Public Health Engineering, *Beach Surveillance and Monitoring Program Summary)*. The 2007 Beach Surveillance and Monitoring Program Summary is available at: http://www.nyc.gov/html/doh/downloads/pdf/beach/beach-report-2007.pdf.

[14] *Id*.

[15] *Id*.

[16] United States Environmental Protection Agency, *Report to Congress: Impacts and Control of CSOs and SSOs* (2004), EPA 833-R-04-001, Appendix D: List of Active CSO Permits, available at: http://www.epa.gov/npdes/pubs/csossoRTC2004_AppendixD.pdf.

[17] Mayor Bloomberg Delivers Sustainability Challenges and Goals for New York City Through 2030, Press Release 432-06, available at: http://www.nyc.gov/portal/site/nycgov/menuitem.c0935b9a57bb4ef3daf2f1c701c789a0/index.jsp?pageID=mayor_press_release&catID=1194&doc_name=http%3A%2F%2Fwww.nyc.gov%2Fhtml%2Fom%2Fhtml%2F2006b%2Fpr432-06.html&cc=unused1978&rc=1194&ndi=1.

[18] Lenzer, A. and Murphy, J., *Water Pressure: Facing the Challenge of New York's Endless Sewage Spill*, City Limits Investigates (2007) at 19.

[19] Personal communication with Lawrence Levine, Staff Attorney, Natural Resources Defense Council, July 2008.

[20]*See* Dorfman, M. and Nancy Stoner, *Testing the Waters: A Guide to Water Quality at Vacation Beaches* (NRDC, 2007), at NY 3-11, available at: http://www.nrdc.org/water/oceans/ttw/ttw2007.pdf.

[21] *See* Swimming in the Hudson River Estuary (*supra* note 1) at 2.2.

[22] *See* New Yorkers For Parks, *Raising the Tide: Strategies for New York Beaches* (2007) at 1, available at: http://www.ny4p.org/index.php?option=com_content&task=view&id=426&Itemid=76.

[23] *See* Swimming in the Hudson River Estuary (*supra* note 3). The 2005 report notes that over five million people live in the counties along the Hudson River and demand for swimming in almost all counties is far greater than can be accommodated by existing facilities.

[24] 33 U.S.C. §1251 et seq. (2006).

[25] 33 U.S.C. §1342 (q)(1) (2006).

[26] *See* United States Environmental Protection Agency, BEACH Report: 2007 Swimming Season (2008), available at: http://www.epa.gov/waterscience/beaches/seasons/2007/pdf/2007fs.pdf

[27] *See* United States Environmental Protection Agency Beach Advisory and Closing On-Line Notification (BEACON), New York Counties with Beach Data, available at: http://oaspub.epa.gov/beacon/beacon_state_page.main?p_state_fips=36. Site last visited July 22, 2008.

[28] *See* Testing the Waters (*supra* note 21).

[29] *Enterococcus* is a genus of Gram positive, facultative anaerobic, lactic acid bacteria that is commonly used as an indicator of water quality and sewage contamination. For additional information *see* Jin, G., A. Englande, H. Bradford, H. Jeng, *Comparison of E. Coli, Enterococci, and Fecal Coliform as Indicators for Brackish Water Quality Assessment*, Water Environment Research 76(3):245-255 (Water Environment Federation 2004), available at: http://www.ingentaconnect.com/content/wef/wer/2004/00000076/00000003/art00008.

[30] *See* United States Environmental Protection Agency, Implementation Guidance for Ambient Water Quality Criteria for Bacteria (2002 Draft), EPA-823-B-02-003, available at: http://www.regulations.gov/fdmspublic/component/main?main=DocumentDetail&o=09000064800c1737.

The above guidelines for marine waters (single count 104/100ml; geometric mean of 35/10ml) relate to the risk of illness, specifically with rates of 19 illnesses per 1000 swimmers. There are multiple factors that determine public health risk to swimmers and exposure to sewage and pathogens is only one aspect of this risk. For example, although *Enterococcus* may be a useful indicator of sewage pollution it may not be an indicator of other biological or chemical contaminants in the River.

[31] U.S. EPA, Water Quality Standards for Coastal Recreation Waters: Using Single Sample Maximum Values in State Water Quality Standards, Office of Water, EPA-823-F-06-013 (2006) at 2 (emphasis added), available at: http://www.epa.gov/waterscience/beaches/rules/singe-sample-maximum-factsheet.htm.

[32] *Id*.

[33] U.S. EPA, Combined Sewer Overflow, Guidance for Long-Term Control Plan, EPA 832-B-95-002 (1995), at 2-57, available at: http://yosemite.epa.gov/water/owrccatalog.nsf/e673c95b11602f2385256ae1007279fe/ed5ffbc2f0fe1ce185256b06007232bf!OpenDocument.

[34] *See* Testing the Waters (*supra* note 21).

[35] For more information on New York marine swimming beach monitoring see: http://home2.nyc.gov/html/doh/html/beach/beach-bmsp.shtml and www.surfrider.org/stateofthebeach/home.asp.

[36] *See* New York Harbor Water Quality Report (*supra* note 6).

[37] *Id*.

[38] *See* Article 167 of the New York City Health Code*,* Tit. 24 RCNY § 167 (2004). *See also* Subpart 6-2 of the New York State Sanitary Code, 10 NYCRR § 6-2.15.

[39] See 2007 NYC Beach Surveillance and Monitoring Program Summary, Department of Health and Mental Hygiene, Office of Public Health Engineering, October 2007, available at: http://www.nyc.gov/html/doh/downloads/pdf/beach/beach-report-2007.pdf

[40] *See id* for additional information on sample collection and inspection protocols.

[41] *See id* for specific notification procedures and requirements.

[42] Personal communication with Reed W. Super, March 31, 2008.

[43] NYCDEP's consultant, Hydroqual, uses two models for projecting and measuring CSO outfalls. Infoworks predicts how much sewage will overflow based on landside rainfall. The System-Wide Eutrophication Model (SWEM) predicts the water quality in New York Harbor that will result from the predicted amount of sewage overflow in the Infoworks model plus additional inputs.

[44] *See*, *e.g.*, recent water quality data for Rockland County, available at: http://www.dec.ny.gov/docs/remediation_hudson_pdf/appendix3ef.pdf . *See also* recent Westchester County water quality, available at**:** http://www.dec.ny.gov/docs/remediation_hudson_pdf/appendix3gh.pdf.

[45] For further updates throughout 2008-2009, *see* www.riverkeeper.org. Beginning in May 2008, the Riverkeeper/Lamont-Doherty sampling program has been expanded to include seasonal sampling further upriver between Peekskill and Waterford, New York.

[46] The sampling program was scheduled based on boat availability and can therefore be considered a random sampling of tidal state and weather patterns. During water quality surveys, many basic physical, chemical and biological properties of the Hudson River's surface water are measured continuously while the Riverkeeper patrol

boat is in motion. Water from approximately 30 cm below the surface is continuously pumped over the side and then past an array of sensors on a Hydrolab DS5 data sonde. As the water flows past the sensors, the Hydrolab records temperature, salinity, and turbidity, as well as the oxygen and chlorophyll concentrations. The Hydrolab is interfaced with a GPS unit so that the time and location of each measurement (in latitude and longitude) are also recorded. Using sensors for oxygen, temperature, salinity, turbidity and chlorophyll, measurements are recorded from a collection depth of approximately 20 cm below surface. Beginning in May 2008, sensor data from the 63 discrete sampling locations will be made publicly available at www.riverkeeper.org.

[47] During the 2006-2007 sampling season Riverkeeper and Lamont-Doherty utilized a membrane filtration, plate count methodology (EPA Method 1600; EPA 821-R-02-022) and during the 2008 sampling season we have begun to use a commercially available Enterolert Most Probable Number (MPN) methodology (www.idexx.com/water/enterolert/). For additional information on U.S. EPA's implementation guidelines for ambient water quality criteria for bacteria, *see* EPA-823-B-02-003 (note 31). For recent discussion of *Enterococcus* sampling in New York and New Jersey, see Ferretti, J et al., Comparison of *Enterococcus* Measurements in Marine Beach and Bay Samples by Quantitative (real-time) Polymerase Chain Reaction, Membrane Filtration and Enterolert (US EPA, NJDEP, MCHD, OCHD 2008).

[48] *See* note 30.

[49] The 2006-2007 data is reported together with precipitation data for Central Park, NY. Precipitation data was obtained from www.wunderground.com for the sampling day and five days prior. This data was used to calculate the 1-, 2-, 3-, 5- day cumulative rainfall prior to sample collection. Water samples were collected on 24 days between September 2006 and September 2007. Twenty-seven stations were sampled approximately once per month.

[50] For a detailed discussion of the health risks of swimming in bacteria-laden waters, *see* Swimming in Sewage (*supra* note 9).

[51] *Id.*

[52] *See* www.weatherunderground.com.

[53] Data from 2008 is available at www.riverkeeper.org.

[54] Tit. 6 NYCRR § 700.1(35) defines "primary contact recreation" as "recreational activities where the human body may come in direct contact with raw water to the point of complete body submergence…include[ing], but…not limited to, swimming, diving, water skiing, skin diving, and surfing." Kayaking fits this definition more closely than it fits the regulatory definition of "secondary contact recreation" which are "recreational activities where contact with the water is minimal and where ingestion of the water is not probable…include[ing], but…not limited to, fishing and boating. 6 NYCRR § 700.1(40).

In its October 2006 Report to Congress, Implementing the BEACH Act of 2000, EPA stated: "the terms swimming and bathing are used in this report to encompass recreational activities (such as swimming, bathing, waterskiing, surfing, and kayaking) where ingestion of, or immersion in, the water is likely. States and territories typically identify these uses in their water quality standards as "primary contact recreation." U.S. EPA, Implementing the BEACH Act of 2000, Report to Congress at 2-4 (2006), available at: http://www.epa.gov/waterscience/beaches/report.

[55] *See* Food and Water Watch, The Case for a Clean Water Trust Fund (2007) available at: http://www.foodandwaterwatch.org/water/pubs/reports/clean-water-trust-fund.