Executive Overview

NRDC's annual analysis of water quality and public notification data at coastal U.S. beaches found that the number of beach closing and advisory days in 2011 reached the third-highest level in the 22-year history of our report, totaling 23,481 days (a 3 percent decrease from 2010). More than two-thirds of closings and advisories were issued because bacteria levels in beachwater exceeded public health standards, potentially indicating the presence of human or animal waste in the water. The portion of all monitoring samples that exceeded national recommended health standards for designated beach areas remained stable at 8 percent in 2011, compared with 8 percent in 2010 and 7 percent for the four previous years. In addition, the number of beaches monitored in 2011 increased slightly (2 percent) from a five-year low in 2010. The largest known source of pollution was stormwater runoff (47 percent, compared with 36 percent last year). The 2011 results confirm that our nation's beaches continue to experience significant water pollution that puts swimmers and local economies at risk.

NRDC continues to push for improvements in beachwater quality standards and test methods. Most recently, the Environmental Protection Agency proposed an action that could leave the public inadequately protected if it is not strengthened—one establishing recommended standards for beach officials to use to keep people from being exposed to unsafe levels of disease-causing bacteria and viruses. While beachwater quality standards are critical, ultimately the most important long-term action is to adopt 21st-century solutions that address the sources of beachwater pollution, particularly stormwater runoff. The most important of these solutions remains incentivizing and implementing green infrastructure in our cities, such as green roofs, porous pavement, and street plantings, which stop rain where it falls. Green infrastructure effectively reduces the amount of runoff that makes its way into beachwater or triggers harmful sewage overflows, transforming potential beach pollution into a tremendous local water supply resource.

POLLUTED BEACHWATER MAKES SWIMMERS SICK AND HURTS COASTAL ECONOMIES

The Environmental Protection Agency (EPA) has estimated that up to 3.5 million people become ill from contact with raw sewage from sanitary sewer overflows each year.[1] Many public health experts believe that the number of illnesses caused by untreated sewage could be much higher than is currently recognized because people who get sick from swimming in polluted recreational waters are not always aware of the cause of their illness and do not report it to doctors or local health officials.

Illnesses associated with polluted beachwater include stomach flu, skin rashes, pinkeye, respiratory infections, meningitis, and hepatitis. Children are especially vulnerable, perhaps because they tend to submerge their heads more often than adults and are more likely to swallow water when swimming. The Centers for Disease Control and Prevention concluded that the incidence of infections associated with recreational water use has steadily increased over the past several decades:[2] one study found that swimmers at polluted beaches in the Great Lakes region were more likely to have gastrointestinal illnesses than nonswimmers;[3] another study found that fecal contamination at Los Angeles and Orange County beaches caused between 627,800 and 1,479,200 excess gastrointestinal illnesses each year.[4]

Our coasts provide more than just local recreation—approximately 85 percent of all U.S. tourism revenue is received in coastal states. According to a 2009 report by the National Ocean Economics Program, the nation's shoreline-adjacent counties contributed an estimated $6 trillion to the nation's gross domestic product and 47 million jobs.[5] With respect to beaches specifically, economists estimate that a typical swimming day is worth approximately $35 to each individual,[6] so depending on the number of potential visitors to a beach, the "consumer surplus" loss on a day that the beach is closed or under advisory for water quality problems can be quite significant. For example, one study estimated that economic losses as a result of closing a Lake Michigan beach due to pollution could be as high as $37,030 per day.[7] Similarly, the Los Angeles/Orange County study mentioned above concluded that the public health cost of the excess gastrointestinal illnesses caused by poor water quality was $21 million to $51 million per year.[8]

CLOSINGS AND ADVISORIES FOR 2011

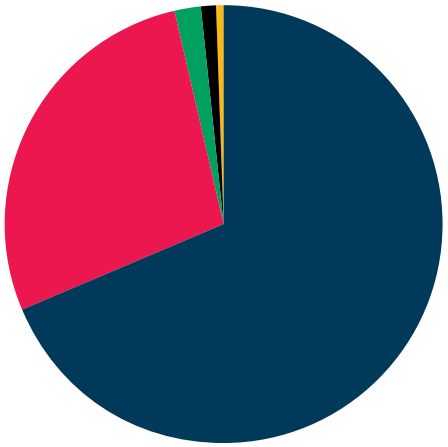
In 2011, the number of closing and advisory days at ocean, bay, and Great Lakes beaches reached its third-highest level since NRDC began tracking these events 22 years ago: 23,481 days nationwide. This is a decrease of 3% (610 days) from the previous year.

In addition, there were 56 closing and advisory events that lasted more than six but not more than 13 consecutive weeks (extended events), and 64 closing and advisory events that lasted more than 13 consecutive weeks (permanent events). Including closing and advisory days that occurred during extended events (3,440 days), the total number of beach closing and advisory days in 2011 comes to 26,921.

The BP oil disaster, which began with the April 20, 2010, explosion on the Deepwater Horizon rig and ended when the well was capped on July 15, 2010, continues to affect beaches along the Gulf of Mexico in Louisiana, Mississippi, Alabama, and Florida. Oil spill inspection and cleanup efforts continued throughout 2011 and into 2012, even at beaches whose oil spill closures, advisories, and notices were lifted. A total of 1,984 closing days at nine Louisiana beach segments and 360 oil spill notice days at two Florida beaches were issued due to the spill in 2011. Four beach segments in Louisiana were closed due to oil for a total of 528 days in the first part of 2012. Over the course of two years, the oil spill resulted in more than 10,000 beach closure, advisory, and notice days at 88 beaches and beach segments in four states. (NRDC includes all oil spill advisory, closure, and notice days at all beaches in its oil spill totals, including days at beaches that were not monitored for bacteria and days that occurred outside of the monitoring season.)

The continued high level of closings and advisories is an indication that serious water pollution persists at our nation's beaches. The most common reason officials cited for closing beaches or issuing advisories in 2011 was testing that revealed bacteria levels that exceeded beachwater quality standards, indicating the potential presence of human or animal waste in the beachwater. Advisories and closings issued as a precaution when poor water quality was suspected were the second-most common type of notification (see Figure EO-1: Reasons Officials Closed Beaches or Issued Advisories in 2011).

Figure EO-1: Reasons Officials Closed Beaches or Issued Advisories in 2011



- 69% (16,240 days)
  Monitoring detected bacteria levels exceeding beachwater quality standards.
- 28% (6,559 days)
  Precautionary actions issued because of excessive rainfall, which, at many beaches, leads to stormwater runoff that carries pollution to swimming waters.
- 2% (582 days)
  Other precautionary actions, predominantly due to algae and storm-related swimmer safety concerns such as riptides and high waves.
- 1% (335 days)
  Known pollution events, such as sewage treatment plant failures or breaks in sewage pipes; in these cases, localities did not wait for monitoring results before deciding to close beaches or issue advisories.
- Less than 1% (34 days)
  Preemptive, due to real-time computer modeling using readily measurable physical parameters, such as wind speed and wave height, to predict indicator bacteria levels.

Totals exceed 100 percent and the number of closing and advisory days discussed in this section because 11 events in New York State were both preemptive (because of rain/poor water clarity) and due to monitoring that revealed high bacteria levels.

POLLUTION SOURCES THAT CAUSED CLOSINGS AND ADVISORIES IN 2011

Most beach closings are issued because beachwater monitoring detects unsafe levels of bacteria. These unsafe levels indicate the presence of pathogens—microscopic organisms from human and animal waste that pose a threat to human health. The key reported contributors of these contaminants are (1) stormwater runoff, (2) sewage overflows and inadequately treated sewage, (3) agricultural runoff, and (4) other sources, such as beachgoers themselves, wildlife, septic systems, and boating waste.

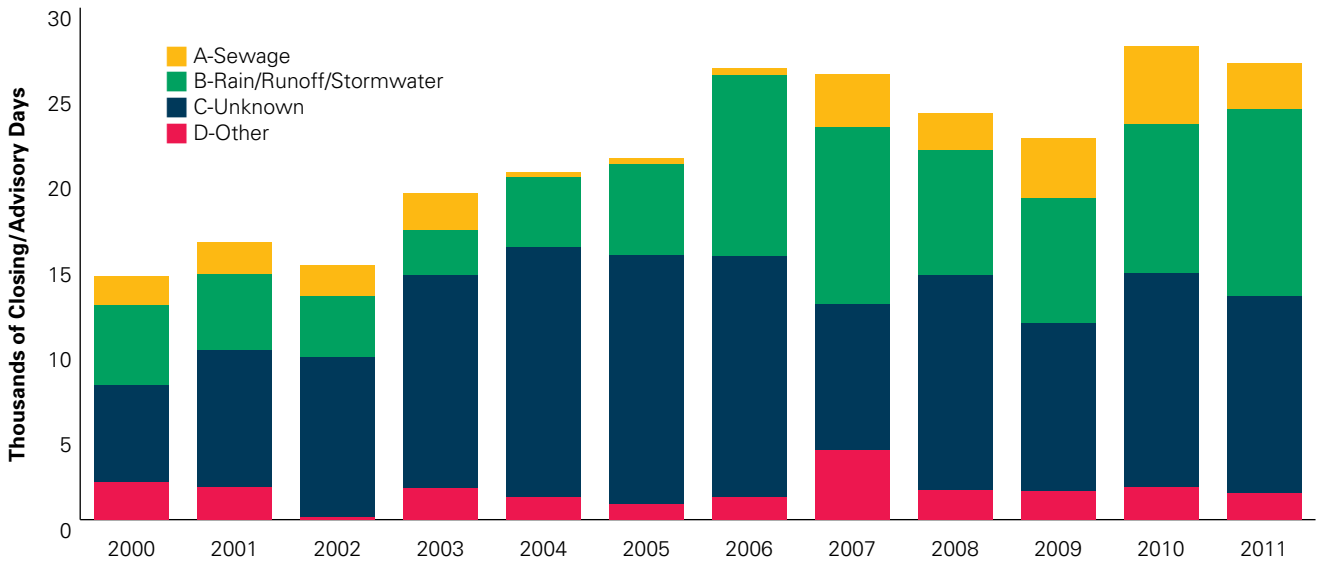
Advisories may also be issued as precautionary measures when a pollution event is expected to occur, for instance during rainstorms. (See also Figure EO-2: Sources of Pollution That Caused Closings/Advisories, 2000–2011.)

For advisory and closing days issued during events that lasted six weeks or less:

- 49 percent (11,588 closing/advisory days) were attributed to unknown sources of pollution.
- 47 percent (10,954 closing/advisory days) were attributed to polluted runoff and stormwater. In 2010, 36 percent of closing advisory/days were attributed to polluted runoff and stormwater.
- 12 percent (2,690 closing/advisory days) were attributed to miscellaneous pollution sources, such as boat discharges. Of those, 1,366 days were attributed to wildlife sources.
- 6 percent (1,541 closing/advisory days) were attributed to sewage spills and overflows. This category includes combined sewer overflows, sanitary sewer overflows, breaks or blockages in sewer lines, and faulty septic systems.

(Totals exceed total closing/advisory days and 100 percent because more than one contamination source was reported for some events.)

Figure EO-2: Sources of Pollution That Caused Closings/Advisories, 2000–2011



Total days shown are greater than annual totals because more than one pollution source may have contributed to each closing/advisory.
Key: (A) Sewage spills and overflows. (B) Polluted runoff, stormwater, or preemptive due to rain. (C) Unknown. (D) Other reasons (including closings/advisories with no source information provided).

BEACHWATER MONITORING FOR 2011

In 2011, the portion of all monitoring samples exceeding national recommended health standards for designated beach areas, indicating the potential presence of human or animal waste, remained steady at 8 percent, the same level as in 2010 (7 percent in 2009, 2008, 2007, and 2006). Louisiana, Ohio, Illinois, Indiana, Connecticut, and Wisconsin had the highest percentage of samples exceeding the EPA's recommended single-sample maximum for designated beach areas (see Table EO-1: Rank of States by Percentage of Beachwater Samples Received Exceeding the National Recommended Standard in 2011).[9]

Table EO-1: Rank of States by Percentage of Beachwater Samples Received Exceeding the National Recommended Standard in 2011

Rank	Percent Exceedance	State	2011 Total Samples	Beaches With Reported Monitoring Results
1	1%	Delaware	523	25
2	1%	New Hampshire	1,144	16
3	3%	North Carolina	6,762	240
4	3%	New Jersey	4,187	226
5	3%	Florida	13,288	306
6	4%	Virginia	901	47
7	4%	Hawaii	4,107	158
8	5%	Texas	7,267	66
9	5%	Georgia	1,023	27
10	6%	Washington	1,156	78
11	6%	Maryland	772	70
12	6%	Massachusetts	8,160	597
13	6%	Alabama	991	25
14	6%	Oregon	956	27
15	7%	Pennsylvania	1,005	10
16	7%	Rhode Island	1,752	70
17	8%	South Carolina	2,389	22
18	8%	Michigan	12,474	232
19	8%	Mississippi	1,136	22
20	9%	Maine	1,310	61
21	9%	California	24,659	497
22	9%	Minnesota	1,014	50
23	10%	Alaska	208	12
24	10%	New York	9,133	352
25	11%	Wisconsin	4,428	114
26	11%	Connecticut	2,322	72
27	11%	Indiana	2,976	31
28	12%	Illinois	4,056	51
29	22%	Ohio	2,937	62
30	29%	Louisiana	850	25

The percent exceedances shown in this table are rounded to the nearest whole number, but state ranks are based on percent exceedances to one or two decimal places.

Ways in Which NRDC's Report Differs From the EPA's Beach Report

Most years, the U.S. Environmental Protection Agency (EPA) also issues a beach report summarizing closing/advisory information (see water.epa.gov/type/oceb/beaches/upload/national_facsheet_2011.pdf). NRDC's report is much different from the EPA report.

1. NRDC includes an analysis of monitoring data and compares states and beaches using the available water quality data.
2. NRDC provides state-by-state reporting and analysis of individual beach programs.
3. With respect to closings and advisories, NRDC reports the total number of days and focuses its analysis on events lasting up to six consecutive weeks. Events lasting longer are grouped as either extended or permanent events. EPA reports the number of beaches with closings or advisories and the percentage of total "beach days" that were affected.
4. NRDC analyzes reported contamination sources associated with closings and advisories.
5. NRDC reports closings and advisories beyond monitored beaches. (In 2011, excluding Hawaii, there were 404 closing/advisory days at 19 non-monitored beaches in four states, plus 2 extended and 3 permanent events. Hawaii adds another 3,116 days at 209 beaches.)

Regionally, the Great Lakes had the highest exceedance rate (11 percent) in 2011, followed by western states (8 percent), New England (7 percent), the New York-New Jersey region (6 percent), the Gulf Coast (6 percent), the Delmarva region (4 percent), and the Southeast (3 percent).

For the sixth consecutive year, NRDC determined the number of beaches exceeding the national recommended daily standard more than 25 percent of the time. In 2011, this list included 159 beaches in 22 states, a decrease from 171 beaches in 22 states in 2010. Nineteen beach areas in 7 states (California, Illinois, Louisiana, New Jersey, New York, Ohio, and Wisconsin) made this list in each of the last five years, 2007 through 2011 (see Table EO-2: Repeat Offenders: Beaches With More Than 25 Percent of Samples Received Exceeding the EPA's Applicable Recommended Single-Sample Maximum Bacteria Standards for Designated Beach Areas, Each Year, 2007–2011). Chronically high bacteria counts indicate that the beachwater is probably contaminated with human or animal waste.

It is important to note that while a high percent exceedance rate is a clear indication of contaminated coastal recreational waters, it is not necessarily an indication that the state's beachwater quality monitoring program is deficient or fails to protect public health when beachwater quality is poor. For example, four of the five states with the highest exceedance rates always or almost always close a beach or issue an advisory when a sample exceeds the recommended standard. That is, they do not wait for the results of a resample or check other conditions first, as some other states do.

Table EO-2: Repeat Offenders: Beaches With More Than 25 Percent of Samples Received Exceeding the EPA's Applicable Single-Sample Maximum Bacteria Standards for Designated Beach Areas, Each Year, 2007–2011

State	County	Beach	Tier	Assigned Monitoring Frequency	Potential Pollution Sources (Reported by EPA)
California	Los Angeles	Avalon Beach 100 feet west of the Green Pleasure Pier	1	1/wk	unknown
California	Los Angeles	Avalon Beach 50 feet east of the Green Pleasure Pier	1	1/wk	unknown
California	Los Angeles	Avalon Beach 50 feet west of the Green Pleasure Pier	1	1/wk	unknown
California	Orange	Doheny State Beach, 1000' South Outfall	1	3/wk	unknown
California	Orange	Doheny State Beach, North of San Juan Creek	1	3/wk	unknown
California	Orange	Doheny State Beach, Surfzone at Outfall	1	3/wk	unknown
Illinois	Cook	Winnetka Elder Park Beach	1	Daily	unknown
Illinois	Lake	North Point Marina Beach	1	4/wk	unknown
Louisiana	Cameron	Constance Beach	2	1/wk	unknown
Louisiana	Cameron	Gulf Breeze	2	1/wk	unknown
Louisiana	Cameron	Little Florida	2	1/wk	unknown
Louisiana	Cameron	Long Beach	2	1/wk	unknown
Louisiana	Cameron	Rutherford Beach	2	1/wk	unknown
New Jersey	Ocean	Beachwood Beach West	1	1/wk	Stormwater, Wildlife
New York	Erie	Woodlawn Beach - Woodlawn Beach State Park	1	1/wk	stormwater, combined sewer overflow, sanitary sewer overflow, wastewater treatment plants, other
New York	Monroe	Ontario Beach	1	Daily	stormwater, agriculture, concentrated animal feeding operations, combined sewer overflow, sanitary sewer overflow, wildlife, other
Ohio	Cuyahoga	Euclid State Park	1	Daily	unknown
Ohio	Cuyahoga	Villa Angela State Park	1	Daily	unknown
Wisconsin	Milwaukee	South Shore Beach	1	3/wk	unknown

For 2011, the NRDC data set includes monitoring results for 123,886 samples at 3,325 beaches and beach segments (most state and local officials divide longer beaches into manageable sections for monitoring).[10] Although more beaches were monitored in 2011 than in 2010, fewer samples were collected (131,389 samples were taken at 3,277 beaches and beach segments in 2010).

METHODS BEACH OFFICIALS USE TO SAMPLE, MONITOR, AND/OR PREDICT BEACHWATER QUALITY

Beach officials in all states continue to use traditional methods approved by the EPA that require about 24 hours to quantify bacterial indicator levels in beachwater samples. Because of this, swimmers do not know until the next day if the water they swam in was contaminated. Likewise, beaches may remain closed even after water quality meets standards. There is a great deal of interest in technologies that can provide same-day beachwater quality results. In 2010, pilot studies in Racine, Wisconsin, and in Orange County, California, made the first use of a rapid test method for issuing beachwater quality notifications at coastal beaches in the United States. Additional pilot projects using rapid test methods to issue notifications were conducted in 2011 in Los Angeles County, California; Ocean County, New Jersey; and Racine. All of these pilot studies were demonstrating quantitative polymerase chain reaction (qPCR), an analytical method that quantifies the presence of a targeted genetic sequence. Traditional methods were used to analyze the samples alongside qPCR analysis, and the qPCR results, either alone or in combination with culture method results, were used to determine whether warnings about beachwater quality would be issued and posted. Other states, including Ohio and Michigan, have conducted field research on rapid test methods but have not used them to issue notifications.

Beachwater quality generally depends on many complex factors, but for some beaches, predictions of water quality can be calculated fairly accurately on the basis of measurements of a few physical conditions. Some states have taken advantage of this by creating computer models that rely on data such as rainfall level, wind speed and direction, tides, wave height, and currents. These models rapidly prepare predictions of beachwater quality and allow officials to close beaches or place them under advisory on the day that bacterial levels are expected to be high, rather than 24 hours later. States using computer models to inform closing and advisory decisions for at least some of their beaches in 2011 were California, Illinois, Indiana, New York, Ohio, and Wisconsin. Other states, including Michigan, Minnesota, and Pennsylvania, were building predictive models to use at some of their beaches in the future.

Because the water quality at many beaches is adversely impacted by contaminated stormwater runoff, another means of protecting public health—less sophisticated but often effective—is to preemptively close beaches or issue advisories when indicator bacteria levels are expected to be high after rainfall events. Many states report that they have developed standards for issuing preemptive rainfall advisories based on rainfall intensity or some other rain-related factor for at least some of their beaches. California, Connecticut, Delaware, Florida, Hawaii, Maine, Massachusetts, Michigan, New Jersey, New York, Rhode Island, South Carolina, and Wisconsin all have quantitative rainfall standards at some of their beaches, and New Hampshire is developing them. Ten states reported preemptive rainfall closures or advisories at specific beaches in 2011: California, Connecticut, Hawaii, Illinois, Maine, Massachusetts, Michigan, New Jersey, New York, and Wisconsin.

Some states, including California, Maryland, Minnesota, Mississippi, North Carolina, Rhode Island, South Carolina, and Washington, issue standing advisories warning the public to avoid beachwater contact after heavy rainfall or when storm drains are running. (These standing advisories are not reported in the closing and advisory data that the states send to the EPA.) For example, in North Carolina standing rainfall advisories take the form of permanent signs posted on either side of storm drain outfalls stating that swimming between the signs is not recommended when there is water flowing through the drain.

FACTORS THAT CONFOUND INTERPRETATION OF THE RESULTS

Although it is understandable to expect a correlation between year-to-year changes in water quality and the number of closing/advisory days, there are confounding factors that make such correlations unlikely. While year-to-year change in the percentage of monitoring samples that exceed health standards is an objective assessment of water quality, a year-to-year change in the total number of closing/advisory days is subject to differences in programs and practices. For example, some states or localities:

- **Take multiple samples at each monitoring station.** When making closing/advisory decisions, beach officials might use the average value of all samples taken that day. Using this method, the average value might not exceed the standard even though one (or more) of the multiple samples does. In such a case, the beach would not be closed or put under advisory. Despite this variety of practices, NRDC includes the results of every reported sample when calculating the percent of all samples that exceed the standard in a given year.
- **Resample a beach after an exceedance before issuing a closing or advisory.** In some places, an exceedance triggers a resample, and if the resample does not exceed the standard, the beach is not put under closing or advisory.
- **Preemptively close a beach or issue an advisory without waiting for the results of beachwater monitoring.** In some places, officials may act without current monitoring information if they suspect that pollution has affected beachwater quality or if there are non-pollution reasons to close a beach or issue an advisory. The reasons for these preemptive actions may include heavy rainfall events, known sewage leaks, chemical spills, and high winds and waves.
- **Continue monitoring at beaches that are closed for more than six consecutive weeks during the reporting year.** NRDC does not include extended or permanent beach closings or advisories when comparing closing/advisory days from year to year, but the monitoring data collected at these beaches are included in the percent exceedance analysis.
- **Continue monitoring at beaches that have been closed for reasons other than pollution.** Some places collect monitoring data even at beaches that are closed due to factors such as budget cuts or low attendance. While routine samples continue to be collected and their results reported to the EPA, the beach closing days may not be reported, or they may occur during events that are classified as extended or permanent and excluded from NRDC's analysis.

Also, year-to-year changes in beach monitoring frequency could impact the total number of closing/advisory days but not the percentage of samples that exceed health standards. For example, increasing routine monitoring from once every two weeks to once a week could decrease the number of closing/advisory days for the same number of events because the duration of many events could go from two weeks to one.

RECOMMENDATIONS FOR IMPROVING BEACHWATER QUALITY

To improve beachwater quality nationwide, our leaders need to adopt policies that clean up the sources of beach pollution. There are numerous things that federal, state, and local officials can do to rein in the sources of beach contamination and to improve beachwater monitoring and public information. For example, the federal government can and should increase its contribution to the Clean Water State Revolving Fund, which provides critical assistance for projects that repair and rebuild failing water and wastewater infrastructure. However, there are two national actions that the Environmental Protection Agency (EPA) is undertaking that would have the most significant impact on efforts to make beaches cleaner and safer for swimming.

EPA is working on a pair of initiatives—one establishing recommended standards for beach officials to use to keep people from being exposed to unsafe levels of disease-causing bacteria and viruses, and one that will curb a principal source of contaminants flowing to the nation's waters and polluting our beaches. The agency will finalize its recreational water safety standards in October and will propose revisions to the national requirements for sources of polluted runoff in the next year.

Cleaning Up Polluted Runoff: Stormwater runoff is the most frequently identified source of beach closings and advisory days, and EPA estimates that more than 10 trillion gallons of untreated stormwater make their way into our surface waters each year.[11]

Often, the best way of avoiding runoff-related pollution is to reduce the volume of stormwater flowing into the storm drains that carry it to nearby water bodies or, in some cases, to sewage treatment plants. Green infrastructure, which restores or mimics natural conditions, allows rainwater to infiltrate into the soil, thereby reducing the volume of runoff. Green infrastructure includes the use of porous pavement, green roofs, parks, roadside plantings, and rain barrels to stop rain where it falls, either storing it or letting it filter into the ground naturally. This keeps stormwater runoff from overloading sewage systems and triggering overflows or from carrying pollutants into natural bodies of water.

These smarter water practices on land not only prevent pollution at the beach but also beautify neighborhoods, cool and cleanse the air, reduce asthma and heat-related illnesses, save on heating and cooling energy costs, boost economies, and support American jobs. Many cities and states have embraced green infrastructure practices.

Consequently, EPA needs to make overdue changes to reform its water pollution regulations for stormwater sources. Strong stormwater retention requirements will help spur widespread implementation of green infrastructure and help keep urban and suburban runoff from reaching beaches. EPA's rules must require new and redeveloped impervious areas—wherever they are located—to infiltrate, evaporate, or reuse the rain that falls on such sites, and must ensure that existing sources of runoff pollution are similarly controlled to meet water quality goals.

Likewise, federal, state, and municipal leaders must use existing authorities—such as Clean Water Act permitting, development of sewage overflow control plans, and local planning responsibilities—to promote green infrastructure and reduce runoff-related contamination problems. NRDC's recent report *Rooftops to Rivers II*[12] spotlights how numerous cities around the country are embracing green infrastructure to address runoff pollution and improve the health of our communities. These leaders have demonstrated the feasibility of green infrastructure solutions and are paving the way for policies that advance green infrastructure nationally.

Standards to Protect Beachgoers: EPA is responsible for ensuring that recreational waters are safe for people. One element of this responsibility is establishing criteria—recommended standards—for contaminants in the water, which are supposed to be set at a level sufficient to protect public health. Unfortunately, EPA is proposing new allowable bacteria levels in recreational waters that miss a critical opportunity to better protect the public from the dangers of swimming in polluted water. In fact, in some respects the draft criteria are even less protective than the 25-year-old criteria they would replace. Sound science and good public policy demand better recreational water quality criteria than what EPA is proposing to finalize before October 15, 2012.

Most egregiously, the draft criteria are based on what EPA has determined is an acceptable gastrointestinal illness risk of 3.6 percent. That is, EPA believes it is acceptable for 1 in 28 swimmers to become ill with gastroenteritis from swimming in water that just meets its proposed water quality criteria. This risk is unacceptably high and is not protective of public health. Additionally, EPA does not adequately consider the risks of other health effects such as rashes and ear, eye, and sinus infections, all of which are commonly experienced by swimmers at U.S. beaches. EPA also fails to base the draft criteria on the most recent and best available science.

To address these flaws, EPA must revise the level of acceptable risk so that it is protective of public health. To do so, the latest and best scientific evidence needs to be utilized to determine appropriate water contamination "cut points," above which the public is subject to unacceptable additional health risks on the order of 1 in 100 instead of 1 in 28. The criteria also must adequately address non-gastrointestinal illnesses, such as rash and ear infections. Other needed improvements are discussed in this report's policy recommendations section.

Notes

1 U.S. Environmental Protection Agency (EPA), "Notice of Proposed Rulemaking, NPDES Permit Requirements for Municipal Sanitary Sewer Collection Systems, Municipal Satellite Collection Systems, and Sanitary Sewer Overflows," January 4, 2001; withdrawn January 20, 2001.

2 Yoder, J.S., et al., "Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water Use and Other Aquatic Facility–Associated Health Events—United States, 2005–2006," Centers for Disease Control and Prevention, September 12, 2008/57(SS09) pp. 1-29, available at www.cdc.gov/mmwr/pdf/ss/ss5709.pdf.

3 Wade, T.J., et al., "Rapidly Measured Indicators of Recreational Water Quality Are Predictive of Swimming-Associated Gastrointestinal Illness," *Environmental Health Perspectives*, Vol. 114, No. 1, January 2006, pp. 24-28.

4 Given, S., et al., "Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches," *Environmental Science and Technology*, 40, 2006, p. 4,851.

5 National Ocean Economic Program, Market Data, Coastal Economy Data, Shore Adjacent Coastal Zone Counties, http://noep.mbari.org/Market/coastal/coastalEcon.asp.

6 Rabinovici, S.J., et al., "Economic and Health Risk Trade-Offs of Swim Closures at a Lake Michigan Beach," *Environmental Science and Technology*, Vol. 38, No. 10, 2004, pp. 2,742.

7 Id.

8 Given et al.

9 For the seventh consecutive year, NRDC used the BEACH Act's single-sample maximum standards for designated beach areas to compare water quality at U.S. beaches. For marine waters, the standard for enterococcus density is 104 cfu per 100 milliliters; for freshwater, the standard is 235 cfu *E. coli* per 100 milliliters.

10 For this year's report, NRDC began to count each managed beach segment of longer beaches in California as individual beaches themselves. This was prompted by California's update of the beach identification system it uses to report beach monitoring and notification data to EPA. For purposes of comparison with previous years, however, NRDC used the older beach identification/counting system.

11 EPA, "Report to Congress: Impacts and Control of CSOs and SSOs," April 26, 2004, EPA 833-R-04-001, pp. 4-29, available at cfpub.epa.gov/npdes/cso/cpolicy_report2004.cfm.

12 Natural Resources Defense Council, *Rooftops to Rivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows* (November 2011), available at www.nrdc.org/water/pollution/rooftopsII/default.asp.