No. 11-460

In The Supreme Court of the United States

LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT,

Petitioner,

v.

NATURAL RESOURCES DEFENSE COUNCIL, INC.
and SANTA MONICA BAYKEEPER,

Respondents.

On Writ Of Certiorari To The United States Court Of Appeals For The Ninth Circuit

BRIEF FOR *AMICUS CURIAE* ALEXANDRIA BOEHM, PH.D., AND MARK GOLD, D.ENV. IN SUPPORT OF RESPONDENTS

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INTEREST OF *AMICI*[1]

Amicus curiae Alexandria Boehm, Ph.D., is a Professor in Stanford University's Department of Civil and Environmental Engineering and an Affiliated Faculty Member of the Woods Institute for the Environment. Dr. Boehm focuses her research on coastal water quality, with an emphasis on understanding the sources, transformation, transport, and ecology of waterborne pathogens, fecal indicator organisms, and phytoplankton. She has published more than 70 articles on water quality issues, many pertaining to Southern California. She holds a Ph.D. and M.S. in environmental engineering from the University of California, Irvine, and a B.S. in Engineering and Applied Science from the California Institute of Technology.

Amicus curiae Mark Gold, D.Env., is the Associate Director of and Adjunct Professor in the University of California, Los Angeles, Institute of the Environment and Sustainability. Dr. Gold has spent more than 20 years dedicated to studying and improving water quality in the greater Los Angeles area, with an emphasis on coastal protection and water pollution. He first devoted himself to the issue

[1] Pursuant to Rule 37.6, counsel for *amici* state that no counsel for a party authored this brief in whole or in part, and that no person other than *amici*, its members, or its counsel made a monetary contribution to the preparation or submission of this brief. Petitioners and respondent have filed a letter of consent with the Clerk of the Court.

as the President of Heal the Bay, and later moved over to his role as a director and professor at the Institute. He holds a B.S. and M.S. in Biology and a Doctorate of Environmental Science and Engineering, all from the University of California, Los Angeles.

SUMMARY OF THE ARGUMENT

Forty years after the enactment of the Clean Water Act, the nation has come a long way in cleaning up its polluted waters. The days of raw sewage and untreated industrial discharges are largely a thing of the past. Gone also are the combustible rivers that prompted the Act's passage in 1972. But a significant and insidious source of water pollution remains – the uncontrolled runoff of contaminated stormwater. Polluted urban runoff, in particular, sickens countless beachgoers each year and threatens the economic and ecological vitality of local communities across the country.

The U.S. Environmental Protection Agency ("EPA") has identified urban stormwater runoff as "a significant threat to water quality across the nation" and "a major cause of water quality impairment." 64 Fed. Reg. 68,722 (Dec. 8, 1999).[2] In promulgating

[2] *See also* U.S. Gov't Accountability Office, GAO-01-679, *Water Quality: Better Data and Evaluation of Urban Runoff Programs Needed to Assess Effectiveness* 37 (2001) [hereinafter "*GAO Report*"].

stormwater regulations in 1999, EPA explained that runoff from land modified by human activities can harm surface water resources by "changing natural hydrologic patterns, accelerating stream flows, destroying aquatic habitat, and elevating pollutant concentration and loadings." *Id.* at 68,723.

As water flows across hardened urban landscapes, it collects and mobilizes myriad contaminants, including disease-inducing bacteria and viruses (pathogens), heavy metals, and other toxins, carrying these pollutants into nearby streams, rivers, lakes, estuaries, wetlands, and oceans. *Id.* at 68,724. Such pollutants "negatively impact receiving waters by changing the physical, biological, and chemical composition of the water, resulting in an unhealthy environment for aquatic organisms, wildlife, and humans." *Id.*

Pathogens, in particular, are a cause of human illnesses associated with urban runoff. Exposure to disease-causing bacteria, viruses, and protozoa in polluted stormwater can cause gastroenteritis and respiratory illness, and in some cases more serious consequences. Although metals and other toxic contaminants carried by stormwater have less immediate impact, they too can be a source of real harm. Ingested by aquatic species or taken up from seafloor sediments, many of these pollutants accumulate in living organisms and work their way up through the food web, where they can adversely affect the health

of ecosystems and pose a threat to fish and seafood consumers.

Nowhere are stormwater pollution concerns more pressing than in Los Angeles County, where a sprawling labyrinth of catchment basins, flood control canals, and storm drains collects urban runoff flowing across more than 3,500 square miles of mostly paved surfaces – roads, driveways, parking lots, rooftops, and the like. Operated by the Los Angeles County Flood Control District (along with the County and eighty-four cities within the County), this storm system is so expansive that a comprehensive map of it does not even exist. Court of Appeals Excerpts of Record ("ER") 312. Throughout California's long dry season and during short winter storm bursts, urban runoff entering the storm system ultimately drains through the San Gabriel and Los Angeles Rivers and through thousands of smaller outfalls to the Pacific Ocean. This drainage system channels untreated pollutants onto public beaches and into the nearshore waters of Santa Monica Bay and Long Beach Harbor, putting millions of recreational users and the coastal ecosystem at risk.

ARGUMENT

I. Urban Stormwater Is a Significant Source of Water Pollution Across the Nation.

Urbanization poses a unique set of water quality problems. Urban development radically alters the natural infiltration capacity of the land, as farms, forests, wetlands, and meadows are converted to impermeable surfaces that have "virtually no ability to absorb storm water." 64 Fed. Reg. at 68,725. Rainfall, snowmelt, and other urban runoff then "wash[es] over these impervious areas, picking up pollutants along the way while gaining speed and volume because of their inability to disperse and filter into the ground." *Id.* EPA studies show that "[w]hat results are storm water flows that are higher in volume, pollutants, and temperature than the flows in less impervious areas, which have more natural vegetation and soil to filter the runoff." *Id.* (citing U.S. EPA, *Urbanization and Streams: Studies of Hydrologic Impact* (1997)).

During the wet season, rain falling on concrete and asphalt collects in storm drains, where it is channeled into receiving waters. In natural landscapes, only about 10 percent of rainfall ultimately makes its way to receiving waters; the rest percolates into the ground or evaporates. By contrast, in heavily urbanized hardscapes like Los Angeles County, more than 50 percent of the water deposited during rain events ends up in downstream surface waters, *GAO Report* at 16, carrying with it "high levels of pollutants" such as "heavy metals, toxic substances, oil

and grease, solvents, nutrients, viruses and bacteria into receiving water bodies."[3] Not surprisingly, "[s]tudies reveal that the level of imperviousness in an area strongly correlates with the quality of the nearby receiving water." 64 Fed. Reg. at 68,725.

Even during the dry season, however, urban runoff is a significant concern. Like stormwater, runoff from manmade sources (such as landscape irrigation and the washing of cars, sidewalks, and driveways) flows into storm drain systems, moving along fertilizers, pesticides, petroleum contaminants, and other harmful pollutants as it flows to receiving water bodies. The higher density of urban environments exacerbates the problem, as "[m]ore people in less space results in a greater concentration of pollutants that can be mobilized by, or disposed into . . . storm sewer systems." *Id.* Ubiquitous urban pollutants like car wastes, litter, and household hazardous wastes only add to the problem because they, too, get washed into storm system drains. *Id.*

One of the most problematic of these human sources of urban runoff is contamination leaking from cracked sanitary sewage systems and septic tanks into storm drain channels. Although storm systems like those in Los Angeles County are not designed to accept or handle pollutants from sanitary sewers,

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[3] U.S. EPA, *Report to Congress on the Phase II Storm Water Regulations*, at I-3 (1999), *available at* http://www.epa.gov/npdes/pubs/ReptoCong_ PhII_ SWR.pdf.

septic tanks, commercial car washes and laundries, or similar sources, illicit discharges from such sources regularly reach storm drains, contributing high levels of heavy metals, toxics, solvents, and fecal contamination. *Id.* at 68,728. In its 1983 *Nationwide Urban Runoff Program* study, for instance, EPA found extremely elevated fecal coliform bacteria counts – sometimes at levels hundreds of times higher than water quality standards – where sanitary sewers were leaking into storm drains. The contaminants in these discharges were "high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health." *Id.*[4]

Compounding the situation in coastal communities, stormwater contaminants that enter the marine environment can persist near shore, largely undiluted, for days or even weeks. As channelized freshwater from a storm system flows into the ocean, it creates a contaminated plume that can penetrate many meters deep and extend as far as six miles offshore.[5] Such plumes can exist for weeks after a storm event, sometimes unmixed with the surrounding seawater due to differences in salinity and

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[4] Close inspection of storm and sanitary sewers in urban areas can reveal that cross connections are not uncommon. Bram Sercu et al., *Storm Drains are Sources of Human Fecal Pollution in Three Urban Southern California Watersheds*, 43 Envtl. Sci. Tech. 293 (2009).

[5] Steven Bay et al., *Study of the Impact of Stormwater Discharge on Santa Monica Bay*, at ES-4 (1999).

temperature.[6] The plume water can be highly turbid, carrying large quantities of suspended particulates like soils, street dust, and litter, as well as chemicals that adhere to them, which eventually settle on the seafloor, where they can adversely affect marine life.[7]

Even after the visible particulates settle out, the contaminants in the plume may remain at levels harmful to human health for days or weeks.[8] For instance, in a study of a Santa Monica Bay stormwater plume originating from the adjacent Ballona Creek watershed, plume water samples showed that initial dilution was not sufficient to reduce the concentration of contaminants below harmful levels.[9] Toxic levels of various contaminants were detected in almost every sample from the plume, and the samples remained toxic even after they were diluted tenfold.[10]

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[6] Kristen M. Reifel et al., *Impacts of Stormwater Runoff in the Southern California Bight: Relationships Among Plume Constituents*, 29 Continental Shelf Res. 1821, 1822 (2009).

[7] *See* Kenneth C. Schiff et al., *Characterization of Stormwater Toxicants from an Urban Watershed to Freshwater and Marine Organisms*, 4 Urban Water 215 (2002).

[8] *Id.* In Santa Monica Bay, for example, a small storm with less than an inch of rainfall generated a large plume that persisted for three days. Steven Bay et al., *Study of the Impact of Stormwater Discharge on Santa Monica Bay*, at ES-5 (1999).

[9] Steven Bay et al., *Study of the Impact of Stormwater Discharge on Santa Monica Bay*, at ES-7 (1999).

[10] *Id.*

The adverse impacts of urbanization on the nation's water quality are real and growing, even as we have significantly reduced pollution from other sources like sewage treatment plants and industrial facilities. Across the country, urbanized land increased by 327 percent between 1945 and 1997, while paved road miles increased by 278 percent. *GAO Report* at 4. In its 1996 *National Water Quality Inventory*, EPA found urban runoff/storm sewers to be a source of pollution in 13 percent of impaired rivers, 21 percent of impaired lakes, ponds, and reservoirs, and 45 percent of impaired estuaries. 64 Fed. Reg. at 68,726; *see also* ER 307 (noting EPA report showing that ocean shoreline impairment due to urban runoff increased from 55 percent in 1996 to 63 percent in 1998). In fact, stormwater runoff now poses the largest single threat to water quality in the United States, acting as "a leading cause of impairment to nearly 40% of the US water bodies that do not meet water quality standards."[11]

II. Stormwater Pollution Poses a Particularly Serious Problem in Los Angeles County.

The stormwater pollution problems associated with urbanization are particularly acute in Southern

[11] Russell D. Arnone & Joyce Perdek Walling, *Waterborne Pathogens in Urban Watersheds*, 5 J. Water & Health 149, 150 (2007).

California, where demographics, climate, and geography interact to put millions of coastal residents and tourists at elevated risk of illness. Rapid urban development coupled with the episodic nature of local storm events cause "turbid pollutant and pathogen-laden stormwater plumes that are clearly visible nearshore" along the Southern California coast after rainstorms.[12] Scientists working on this issue generally agree that "[u]rban stormwater runoff is a major source of contaminants to [S]outhern California's coastal waters,"[13] and that such contaminants "can negatively impact human and ecosystem health and productivity."[14]

Between 1970 and 2000, the population of the four coastal counties of Southern California doubled, with almost 25 percent of all coastal populations in the United States now living in these communities.[15] Los Angeles has become the second largest city in the

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[12] Nikolay P. Nezlin et al., *Stormwater Runoff Plumes Observed by SeaWiFS Radiometer in the Southern California Bight*, 98 Remote Sensing Env't 494 (2005).

[13] *See, e.g.*, Steven Bay et al., *Water Quality Impacts of Stormwater Discharges to Santa Monica Bay*, 56 Marine Envtl. Res. 205, 205 (2003) (showing "four lines of evidence that the discharge of stormwater from Ballona Creek is a source of impairment to water quality in Santa Monica Bay").

[14] Nikolay P. Nezlin et al., *Stormwater Runoff Plumes Observed by SeaWiFS Radiometer in the Southern California Bight*, 98 Remote Sensing Env't 494 (2005) (citing five other studies reaching this conclusion).

[15] Kenneth C. Schiff et al., *Southern California*, 41 Marine Pollution Bull. 76, 78 (2000).

nation and is part of the thirteenth largest urban area on the planet, which now supports 17 million people – and counting.[16] Predictably, the amount of waste and pollution has soared. Every month, residents of Los Angeles County alone throw 915,000 cigarette butts onto the ground, toss litter from a car window 830,000 times, allow paper or trash to blow away 800,000 times, toss something into a gutter 280,000 times, empty their car ashtrays in the street 40,000 times, wash dirt and leaves into the street with a hose 420,000 times, wash off paintbrushes outside 130,000 times, and spray their yards with pesticides 210,000 times.[17]

This rapid population growth also has been accompanied by dramatic changes in the urban landscape and associated urban runoff. Even on bone dry days, roughly 100 million gallons of contaminated water and debris drain to the ocean, enough to fill the Rose Bowl 1.2 times.[18] On wet days, the volume of discharged stormwater can swell to 10 billion gallons per day.[19] Historically, wetlands served as a natural form of flood control by filtering many pollutants from stormwater before they could reach the ocean. But along the Santa Monica Bay coastline, urban

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[16] *Id.*

[17] State Water Res. Control Bd., Cal. Envtl. Prot. Agency, *Erase the Waste: Storm Water Pollution*, http://www.waterboards.ca.gov/water_issues/programs/outreach/erase_waste/swpollution.shtml (last visited Oct. 31, 2012).

[18] *Id.*

[19] *Id.*

development has destroyed approximately 95 percent of these wetlands.[20] In fact, roughly 83 percent of the landscape in the Ballona Creek watershed, which drains directly to the Bay, is now developed.[21] As a result, more water – and more contaminants in the water – now flow to the coastal waters and beaches where tens of millions of people recreate every year.

Much of this contaminated water drains through the Los Angeles County storm sewer system. Composed of roughly 5,000 miles of drains and open channels, this system carries fully half of all rainwater that reaches the ground to the ocean, much of it within hours of a storm event.[22] This stormwater contributes more than 95 percent of the total runoff volume reaching the coastal zone,[23] adding more metals like chromium, copper, lead, and zinc to coastal waters than all other sources combined.[24]

A broad array of harmful constituents are found in Los Angeles County urban runoff, including pesticides; fertilizers; hydrocarbons; oil; grease; heavy

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[20] Kenneth C. Schiff et al., *Southern California*, 41 Marine Pollution Bull. 76, 78 (2000).

[21] M. Dojiri et al., *Changing Anthropogenic Influence on the Santa Monica Bay Watershed*, 56 Marine Envtl. Res. 1, 9 (2003).

[22] *Id.*

[23] Kristen M. Reifel et al., *Impacts of Stormwater Runoff in the Southern California Bight: Relationships Among Plume Constituents*, 29 Continental Shelf Res. 1821, 1822 (2009).

[24] Kenneth C. Schiff et al., *Southern California*, 41 Marine Pollution Bull. 76, 80 (2000).

metals such as lead, copper, zinc, nickel, and mercury; human and animal feces and their accompanying bacteria and protozoa; viruses of various kinds; synthetic organic compounds; suspended sediments; garbage; and other intermingled substances.[25] In many places, this runoff flows out of storm drains or urban creeks and directly across Southern California beaches before entering the surf zone.

The climate that draws so many to Southern California exacerbates the magnitude of the region's stormwater pollution problem. Los Angeles has a long dry season punctuated by a shorter period of episodic winter storms. During the dry months, contaminants accumulate on the largely impermeable landscape. With the first rains, these pollutants are flushed into the storm system and concentrated in drainage channels flowing to the ocean. 64 Fed. Reg. at 68,724. Adding to this pollution load are sediments that have accumulated during the dry months in the storm drains themselves, which serve as a repository of bacteria and other organisms,[26] toxic chemicals, and even infectious viruses.[27] As a result, although urban

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[25] Kristen M. Reifel et al., *Impacts of Stormwater Runoff in the Southern California Bight: Relationships Among Plume Constituents*, 29 Continental Shelf Res. 1821, 1822 (2009).

[26] Ryan L. Reeves et al., *Scaling and Management of Fecal Indicator Bacteria in Runoff from a Coastal Urban Watershed in Southern California*, 38 Envtl. Sci. Tech. 2637, 2637 (2004).

[27] Adam W. Olivieri et al., Water Environment Research Foundation, *Development of a Protocol for Risk Assessment of Microorganisms in Separate Stormwater Systems* 3-14 (2007).

runoff poses a year-round concern, it is particularly serious during the winter when intermittent storm events flush pollutants through the system.[28]

For instance, more than 99 percent of fecal indicator bacteria[29] detected in urban runoff ditches along the Los Angeles coast is present during or in the immediate aftermath of storm events.[30] Moreover, the quantity and variety of pathogenic bacteria are higher during the rainy months.[31] Altogether, rainwater runoff causes over half of the water quality violations on beaches along Santa Monica Bay even though it rains fewer than 15 days a year.[32] In one study, for instance, over 90 percent of the sites evaluated adjacent to stormwater drains failed to meet bacterial water quality standards after a rain event.[33]

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[28] Rachel T. Noble et al., *Storm Effects on Regional Beach Water Quality Along the Southern California Shoreline*, 1 J. Water & Health 23, 28 (2003).

[29] Fecal indicator bacteria, such as fecal coliform, occur in feces and correlate to illness in swimmers. They serve as a useful proxy for the presence of pathogenic organisms transmitted via the fecal-oral route.

[30] Ryan L. Reeves et al., *Scaling and Management of Fecal Indicator Bacteria in Runoff from a Coastal Urban Watershed in Southern California*, 38 Envtl. Sci. Tech. 2637, 2637 (2004).

[31] Rachel T. Noble et al., *Storm Effects on Regional Beach Water Quality Along the Southern California Shoreline*, 1 J. Water & Health 23, 28 (2003).

[32] *Id.* at 24.

[33] *Id.* at 30.

In granting the 2001 stormwater permit at issue in this case, the California Regional Water Quality Control Board acknowledged that "monitoring indicates that instream indicators (fecal coliform and streptococcus), heavy metals (such as [lead, copper, and zinc]), and pesticides (such as diazinon) exceed state and federal water quality standards." ER 308 (citing *Los Angeles County 1998-1999 Storm Water Monitoring Report*). Subsequent stormwater monitoring data reported since that permit was issued show continued violations of water quality standards for fecal coliform, cyanide, copper, aluminum, zinc, and other contaminants every single year thereafter. ER 358-64. These exceedances are, in many cases, alarming. For instance, during one storm event in October 2005, fecal coliform was detected in the Los Angeles River at 60,000 times the applicable water quality standard and in the San Gabriel River at 40,000 times the standard. ER 360. Nor were these detections anomalous; similar levels were detected in November 2008, ER 364, and somewhat lower but still significant exceedances were reported many times in between those events. The same monitoring data reveal that water quality standards for various metals and other chemical compounds (for example, copper, aluminum, zinc, cyanide, etc.) are being routinely exceeded by 100, 500, or 1,000 percent and sometimes by more. ER 358-64.

III. Urban Stormwater Runoff Poses Significant Risks to Human Health, Especially in Southern California.

A. Exposure to Pathogens Transported by Stormwater Can Cause Serious Human Illnesses.

Millions of people become ill each year from exposure to stormwater. Waterborne infections can result from ingestion, inhalation, or dermal exposure to disease-causing bacteria, viruses, and protozoa. Thus, swimmers, surfers, and others recreating near stormwater outfalls are at increased risk of contracting serious, even occasionally life-threatening, illnesses.

Some types of microorganisms detected in stormwater can be fatal. *Pseudomonas aeruginosa*, for example, is a common but potentially deadly bacterium that can infect any part of the body, especially in individuals who are already weakened by some other illness. These bacteria most commonly attack the respiratory system, urinary tract, gastric system, or injured bones or joints, although ear and eye infections and skin ulcers also are common symptoms of a *Pseudomonas* infection.[34] Sufferers from cystic fibrosis are at particular risk.[35] Infections can

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[34] Adam W. Olivieri et al., Water Environment Research Foundation, *Development of a Protocol for Risk Assessment of Microorganisms in Separate Stormwater Systems* 2-5 to -6 (2007).

[35] Ctrs. for Disease Control & Prevention, *Multi-level Antimicrobial Susceptibility Testing Resources* (*MASTER*): Pseudomonas aeruginosa *from Cystic Fibrosis Patients*, http://

(Continued on following page)

be quite serious, especially in the lungs or heart, where they often prove fatal.[36] Indeed, *Pseudomonas* infections kill roughly half of all people who contract them.[37]

Several viruses detected in stormwater runoff also are potentially lethal. Numerous forms of Enterovirus, a genus of very serious viruses with the potential to cause a range of illnesses, have been found in stormwater. Some enteroviruses can cause a variety of life-threatening conditions, including aseptic meningitis,[38] paralysis, and myocarditis,[39] while others cause symptoms like gastroenteritis, discussed below.[40] Troublingly, "enteroviruses . . . can spread to various organs and persist in the body for years – potentially causing disease long after the initial infection."[41]

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wwwn.cdc.gov/dls/master/select_documents.aspx?type=1&cat=19 (last visited Oct. 31, 2012).

[36] Adam W. Olivieri et al., Water Environment Research Foundation, *Development of a Protocol for Risk Assessment of Microorganisms in Separate Stormwater Systems* 2-5 to -6 (2007).

[37] *Id.*

[38] Nino Khetsuriani et al., Ctrs. for Disease Control & Prevention, *Enterovirus Surveillance – United States, 1970-2005*, Mortality & Morbidity Weekly Rep., Sept. 15, 2006, at 1, *available at* http://www.cdc.gov/mmwr/preview/mmwrhtml/Ss5508a1.htm.

[39] *Id.*

[40] *Id.*

[41] Enterovirus Foundation, *About EV*, http://www.enterovirus foundation.org/aboutev_mid.shtml (last visited Oct. 31, 2012).

The Hepatitis A virus also can be carried in stormwater. This virus infects the liver, manifesting after a gestation period of several weeks. Symptoms include fever, fatigue, loss of appetite, nausea, vomiting, abdominal pain, dark urine, clay-colored bowel movements, joint pain, and jaundice.[42] The effects linger for months, and while most sufferers eventually make a full recovery, a small percentage suffer liver failure and die.[43]

While the risks of contracting these serious illnesses from stormwater are real, by far the most common symptoms for people exposed to contaminated runoff are gastroenteritis and respiratory illness. When someone contracts gastroenteritis, she will face a number of unpleasant symptoms ranging from vomiting and diarrhea to extreme dehydration. Most people become ill a few days after exposure,[44] although the onset can be several weeks later for those whose symptoms are caused by protozoa like *Giardia lamblia*.[45] Initial symptoms like stomach

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[42] *Id.*

[43] Ctrs. for Disease Control & Prevention, *Hepatitis A Information for the Public*, http://www.cdc.gov/hepatitis/a/afaq.htm (last visited Oct. 31, 2012).

[44] A recent study in Orange County found a "strong peak" in gastroenteritis symptoms manifesting two days after exposure. John M. Colford Jr. et al., *Using Rapid Indicators for Enterococcus to Assess the Risk of Illness After Exposure to Urban Runoff Contaminated Marine Water*, 46 Water Res. 2176, 2183 (2012).

[45] Ctrs. for Disease Control & Prevention, *Parasites* – Giardia, http://www.cdc.gov/parasites/giardia/gen_info/faqs.html (last visited Oct. 31, 2012).

cramping and fever grow into nausea and eventually vomiting and diarrhea. In more intense cases, loss of fluids can lead to dehydration and weight loss, requiring hospitalization.[46]

These symptoms can last for anywhere from several days to several months, depending on the cause of the infection. In *Giardia* infections, for example, symptoms can remain for over six weeks.[47] In some cases, gastrointestinal problems persist long after the parasites have been expurgated from a patient's system.[48] *Cryptosporidium* infections typically run their course in two to four weeks, but sometimes lead to more serious symptoms, like cholecystitis, an inflammation of the gallbladder that if left untreated can cause organ rupture.[49] Other forms of gastroenteritis, such as those caused by rotaviruses and adenoviruses, last for a comparatively brief three to

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[46] *See, e.g.*, *id.*; Ctrs. for Disease Control & Prevention, *National Center for Emerging and Zoonotic Infectious Diseases: Salmonellosis*, http://www.cdc.gov/nczved/divisions/dfbmd/diseases/salmonellosis/ (last visited Oct. 31, 2012).

[47] Ctrs. for Disease Control & Prevention, *Parasites* – Giardia, http://www.cdc.gov/parasites/giardia/gen_info/faqs.html (last visited Oct. 31, 2012).

[48] Mayo Clinic, Giardia *Infection* (*Giardiasis*), http://www.mayoclinic.com/health/giardia-infection/DS00739 (last visited Oct. 31, 2012).

[49] Mayo Clinic, *Cholecystitis*, http://www.mayoclinic.com/health/cholecystitis/DS01153 (last visited Oct. 31, 2012).

nine days.[50] Adenoviruses, however, can come with an array of other symptoms, such as sore throat, bronchitis, pneumonia, pink eye, bladder infection, and neurologic disease.[51] Rotaviruses are the most common cause of severe gastroenteritis in young children,[52] and adenoviruses also target children with weakened immune systems.

A variety of bacteria found in stormwater can also cause gastroenteritis. The best known of these microbial culprits is *Salmonella*, which does not confine itself to poorly-cooked food, as most people imagine. Many of the 1,700 subspecies[53] of *Salmonella* have been found in stormwater, a consequence of dissolved pet feces and leaking sewers that leach into urban runoff. People who contract *Salmonella* poisoning become violently ill, with gastroenteritis so severe that hospitalization is often necessary. Several other species of stormwater bacteria can produce similar symptoms, including *Clostridium perfringens*, which

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[50] Ctrs. for Disease Control & Prevention, *Adenoviruses*, http://www.cdc.gov/adenovirus/about/symptoms.html (last visited Oct. 31, 2012).

[51] *Id.*

[52] Umesh D. Parashar et al., Ctrs. for Disease Control & Prevention, *Prevention of Rotavirus Gastroenteritis Among Infants and Children: Recommendations for the Advisory Committee on Immunization Practices* (*ACIP*), Mortality & Morbidity Weekly Rep., Aug. 11, 2006 at 1, *available at* http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5512a1.htm.

[53] Russell D. Arnone & Joyce Perdek Walling, *Waterborne Pathogens in Urban Watersheds*, 5 J. Water & Health 149, 154 (2007).

can establish colonies in a human intestinal tract, producing a toxin that leads to gastroenteritis,[54] and several subspecies of *Shigella*, which can cause shigellosis, also known as bacillary dysentery, a serious form of gastroenteritis characterized by blood in the stool.[55]

Other kinds of infection are also possible. *Staphylococcus aureus* causes a common bacterial infection, resulting in pus-filled skin abscesses or cellulitis, "an infection of the underlying layers of the skin."[56] Such infections are among the most common in the United States, and they can be extremely painful. In rare cases, moreover, *Staphylococcus* bacteria can lead to serious bloodstream infections, pneumonia, or bone and joint infections.[57]

In short, bacteria, viruses, and protozoa found in stormwater can have potentially debilitating consequences for human health and frequently result in days or weeks of illness and discomfort. Such diseases can exact a substantial economic, as well as human,

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[54] Ill. Dep't of Pub. Health, *Clostridium Perfringens*, http://www.idph.state.il.us/Bioterrorism/factsheets/Clostridium.htm (last visited Oct. 31, 2012).

[55] Russell D. Arnone & Joyce Perdek Walling, *Waterborne Pathogens in Urban Watersheds*, 5 J. Water & Health 149, 154 (2007).

[56] Minn. Dep't of Health, *Causes and Symptoms of* Staphylococcus Aureus, http://health.state.mn.us/divs/idepc/diseases/staph/basics.html (last visited Oct. 31, 2012).

[57] *Id.*

toll, as a result of costly hospital visits and missed work days.

B. Recreational Users Near Stormwater Outfalls in Los Angeles County Are at Significant Risk of Disease.

Every year, tens of millions of Southern California beachgoers unknowingly put themselves at risk for these serious illnesses by playing or swimming near a storm drain outlet, of which there are thousands. A 1999 epidemiologic study conducted by Robert Haile and over a dozen other researchers analyzed the health impacts of swimming at three Santa Monica Bay beaches with stormwater outfalls. The study demonstrated increased risk of disease symptoms for those who swam close to a stormwater outlet, and especially for those who submerged their heads.[58] In particular, the researchers observed "increases in risk for fever, chills, ear discharge, coughing and phlegm, [Highly Credible Gastrointestinal Illness 2], and [Significant Respiratory Disease]," as well as smaller increases in risk for "eye discharge, earache, sore throat, infected cut, and [Highly Credible Gastrointestinal Illness 1]."[59]

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[58] Robert W. Haile et al., *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff*, 10 Epidemiology 355, 355-57 (1999).

[59] *Id.* Highly Credible Gastrointestinal Illness 1 is defined as gastroenteritis in which subjects "experienced at least one of the following: (1) vomiting, (2) diarrhea and fever, or (3) stomach

(Continued on following page)

In the Haile study, people who swam close to a stormwater outlet were far more likely to exhibit symptoms than those who swam at least 400 meters away. Those swimming near the outlet had a 1 in 12 chance of contracting a significant respiratory disease and a 1 in 14 chance of contracting a fever; the risk dropped by 50 percent for those swimming further away.[60] For almost every symptom measured, the probability increased with swimmer proximity to the outfall, dramatically demonstrating the causal link between stormwater exposure and illness.[61]

The Haile study results are consistent with the consensus of other studies analyzing the health impacts of swimming in waters contaminated with bacteria and other pathogens. For example, one very recent study found that "swimmers at Doheny Beach [in Orange County] in the summers of 2007 and 2008 experienced diarrhea at a significantly increased rate compared to non-swimmers," as well as "increased rates of eye infections and earaches

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pain and fever." Highly Credible Gastrointestinal Illness 2 is defined as gastroenteritis evincing vomiting and fever. Significant Respiratory Disease is defined as respiratory disease exhibiting "one of the following: (1) fever and nasal congestion, (2) fever and sore throat, or (3) coughing with phlegm." *Id.*

[60] *Id.*; *GAO Repor*t at 24.

[61] Had the study evaluated non-swimmers as a control group, the results may well have been even more dramatic.

among swimmers."[62] Aggregating findings of studies from around the world, Annette Prüss found a "dose-related increase of health risk in swimmers with an increase in the indicator-bacteria count in recreational waters," confirming that people swimming closer to higher concentrations of stormwater pathogens have a higher risk of becoming ill.[63] Of the 22 studies that Prüss analyzed, 19 found a positive correlation between swimming in recreational waters and elevated risk of illness, particularly gastrointestinal illness.[64] Unsurprisingly, studies that assess data by age of subject show that children are the most vulnerable to waterborne illness from swimming.[65]

As one might expect, moreover, the stronger the outflow from a stormwater drain, with its associated pathogens and other pollutants, the greater the probability that swimmers will become ill.[66] The Prüss

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[62] John M. Colford Jr. et al., *Using Rapid Indicators for Enterococcus to Assess the Risk of Illness After Exposure to Urban Runoff Contaminated Marine Water*, 46 Water Res. 2176, 2183 (2012).

[63] Annette Prüss, *Review of Epidemiological Studies on Health Effects from Exposure to Recreational Water*, 27 Int'l J. Epidemiology 1, 1, 3-4 (1998).

[64] *Id.* at 3

[65] *Id.* at 8.

[66] *Id.* at 3; *see also* John M. Colford Jr. et al., *Using Rapid Indicators for Enterococcus to Assess the Risk of Illness After Exposure to Urban Runoff Contaminated Marine Water*, 46 Water Res. 2176, 2183 (2012) (finding "an increasing dose-response relationship" with "the strongest associations . . . seen for those who reported swallowing water, especially on berm-open days").

study found that higher concentrations of bacteria were correlated with higher rates of illness.[67] This means that low-level runoff, which is essentially constant in Los Angeles County, will lead to some sustained increase in illness, while the most severe risk will occur in the days following major rain events.

These studies demonstrate why urban runoff poses such a serious public health problem for Southern California, where residents and visitors alike intensively use beaches and coastal waters throughout the year. People are drawn to the coast for a variety of reasons, including beach recreation, swimming and surfing, pleasure boating and windsailing, commercial and sport fishing, and aesthetic enjoyment, among others. There are between 150 and 400 million distinct beach visits in the state each year,[68] the vast majority of which occur in Southern California. In fact, more than 60 percent of all beach visits in the United States occur on Southern California's 220-mile coastline.[69] Beaches along Santa Monica Bay

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[67] Annette Prüss, *Review of Epidemiological Studies on Health Effects from Exposure to Recreational Water*, 27 Int'l J. Epidemiology 1, 3 (1998).

[68] Linwood Pendleton & Judith Kildow, *The Non-Market Value of California Beaches*, 74 Shore & Beach 34, 34-37 (2006).

[69] Ryan H. Dwight et al., *Influence of Variable Precipitation on Coastal Water Quality in Southern California*, 83 Water Env't Res. 2121, 2121 (2011).

alone experience 50 to 60 million beach visits each year.[70]

And unlike other areas of the country, the mild Southern California winters mean that ocean recreation continues year-round. Hundreds of thousands of people frequent the beaches on the many sunny days that Los Angeles experiences during the winter months, but even on stormy days, surfers flock to the water hoping to catch better waves.[71]

Stormwater-related coastal contamination not only causes human illness in exposed individuals, it also results in lost recreational and economic opportunities among those who do not get sick. In 2000, ocean-dependent activities generated approximately $9 billion for the local economies of coastal communities in Southern California.[72] Yet this economic activity is impacted by coastal pollution because beach closures due to suspected pathogen contamination are routine. In 2004, for example, local health officials in Los Angeles and Orange Counties ordered 2,408 beach closures across the 28 individual beaches

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[70] Robert W. Haile et al., *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff*, 10 Epidemiology 355, 355 (1999).

[71] Jong Ho Ahn et al., *Coastal Water Quality Impact of Stormwater Runoff from an Urban Watershed in Southern California*, 39 Envtl. Sci. & Tech. 5940 (2005).

[72] Steven Bay et al., *Water Quality Impacts of Stormwater Discharges to Santa Monica Bay*, 56 Marine Envtl. Res. 205, 206 (2003).

within their collective jurisdiction.[73] Thus, on average, each beach was closed to visitors for 86 days, or nearly one-quarter of the year. This closure pattern is representative of other years.

Still, these precautions have proved insufficient to protect human health. Studies indicate that each year, people contract between 627,800 and 1,479,200 additional cases of gastrointestinal illness above the societal baseline at beaches in Los Angeles and Orange Counties, resulting in economic costs of between $21 and $51 million (in year 2000 dollars) in medical treatment and lost time on the job.[74]

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[73] Suzan Given, Linwood H. Pendleton & Alexandria B. Boehm, *Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches*, 40 Envtl. Sci. & Tech. 4851, 4851 (2006).

[74] *Id.* In 2012 dollars, this total is actually between $28 and $69 million, although the underlying structural changes to the area – continued urbanization and thus increased levels of stormwater and associated contaminants, as well as higher population to become ill – may only have raised the number further. This total, moreover, measures only the economic costs of increased instances of gastrointestinal illness and does not account for the numerous other diseases that people can contract, or the other economic losses suffered by local businesses or fishermen. Thus, the annual total cost of contaminated coastal waters may actually be far higher.

IV. Heavy Metals and Other Contaminants Found in Stormwater May Have Long-Term Ecological Impacts.

Beyond the pathogens that can immediately sicken exposed beachgoers, stormwater routinely contains other contaminants that may pose long term risks to human health and the environment. Through processes known as bioaccumulation and biomagnification, heavy metals and other toxic substances[75] ingested by fish, mollusks, crustaceans, and other organisms can be converted to a chemical state that is easier for humans to absorb; in this state, contaminants can become concentrated in the higher trophic level species that humans are more likely to consume. Many fish species that bioaccumulate metals, like the California Halibut, are among the most popular species for fishermen to catch.[76]

Most troubling from an ecological perspective, heavy metals and excess sediment carried with stormwater plumes can adversely alter the marine environment. As a stormwater plume dissipates, contaminants not taken up by marine organisms in the

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[75] While legacy contaminants such as the pesticide DDT and polychlorinated biphenyls (organochlorine chemicals once used in the production of electrical equipment) may also accumulate in marine organisms, today they generally are not a significant component of stormwater discharge in highly urbanized areas.

[76] Santa Monica Bay Restoration Comm'n, *State of the Bay: Analysis of the Environmental Conditions of Santa Monica Bay* 22 (2010).

water column can settle on the seafloor. Contaminated seafloor sediments can then become an ongoing source of toxicity if they are stirred up in the water column, redistributed across the seafloor, or ingested by marine organisms and enter the food chain.[77]

Organisms lower on the food chain are most susceptible to contamination by toxic metals because they tend to be smaller and less complex. Plankton, for example, are unable to avoid a stormwater plume (because they move with the currents) and are more sensitive than other marine species to pollutants, making them vulnerable to adverse effects from contaminated runoff.[78] Given the fundamental role of plankton at the base of the food chain – they are essential to the survival of various fish, sea urchin, clam and shrimp species – changes in plankton populations due to stormwater toxicity can diminish the viability of other marine species, as pollution effects ripple through the ecosystem.[79]

Although studies of urban runoff impacts on aquatic species are rare, there is good reason to believe that species other than plankton also are adversely affected by the deposition of stormwater

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[77] *See* Steven Bay et al., *Study of the Impact of Stormwater Discharge on Santa Monica Bay*, at ES-22 (1999); Kenneth C. Schiff et al., *Southern California*, 41 Marine Pollution Bull. 76, 80 (2000).

[78] Steven Bay et al., *Study of the Impact of Stormwater Discharge on Santa Monica Bay*, at ES-6 (1999).

[79] *Id.*

pollutants in freshwater or marine sediments. Bottom-dwelling (or benthic) organisms are often largely immobile and rely on the sediment as both a home and food source. Accumulated toxins that precipitate out of urban runoff over the course of several storms, or even several seasons, may bioaccumulate in the flesh of benthic invertebrates and flatfish. Scientists have found, for example, that sea urchins are particularly susceptible to adverse reproductive effects from exposure to metals in stormwater, and other freshwater organisms exhibit sensitivity to contaminants such as organophosphate pesticides.[80]

Stormwater runoff from urban areas is one of the most significant sources of metals in Southern California coastal water, including chromium, copper, nickel, lead, and zinc. This runoff contributes approximately 520 metric tons of metals to Southern California's mainland coastal shelf each year.[81] Sediments tested near stormwater outfalls in Santa Monica Bay discharge points were twice as contaminated with chromium, copper, and lead as sediments from areas that did not receive large amounts of runoff and were

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[80] Kenneth C. Schiff et al., *Characterization of Stormwater Toxicants from an Urban Watershed to Freshwater and Marine Organisms*, 4 Urban Water 215, 215 (2002).

[81] Kenneth C. Schiff, *Sediment Chemistry on the Mainland Shelf of the Southern California Bight*, 40 Marine Pollution Bull. 268, 275 (2000).

50 percent finer than sediments outside of these discharge areas.[82]

The toxic sediments carried to the ocean with stormwater can also significantly alter nearshore habitat, to the detriment of native species. Substantial deposits of fine-grained toxic sediments can cause environmental damage in a variety of ways, including smothering bottom-dwelling organisms, causing irritations of fish gills, reducing the visual clarity of the water, warming the water with consequent decreases in oxygen levels, and reducing the amount of light available for photosynthesis.[83]

While more work needs to be done to fully understand the impacts of polluted stormwater on marine and freshwater ecosystems, the influx of contaminants and the levels of discharge strongly suggest that urban runoff has detrimental effects on the aquatic environment as well as public health.

CONCLUSION

Urban stormwater runoff is the source of significant human illness, particularly along the Southern California coastline, where millions of people live,

[82] *Id.* at 274.

[83] Kristen M. Reifel et al., *Impacts of Stormwater Runoff in the Southern California Bight: Relationships Among Plume Constituents*, 29 Continental Shelf Res. 1821, 1822 (2009).

work, and play. With vast reductions in water pollution loading from traditional sources (like sewage treatment plants and industrial operations) during the past two decades, contaminated stormwater remains the last and most significant uncontrolled source of water quality impairment in populated urban areas. In Los Angeles County, where high levels of pathogens, heavy metals, pesticides, and other chemical compounds are flushed through the storm drain system, untreated discharges to Pacific Ocean beaches and coastal waters adversely affect human, economic, and ecological health. These effects are likely to grow worse as urbanization and the local population continue to grow. Accordingly, the Court should affirm the decision below and allow Respondents to enforce the terms of the stormwater permit at issue in this case.

Respectfully submitted,

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