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**CLEANING UP OUR TOXIC COASTS:
A PRECAUTIONARY AND HUMAN HEALTH-BASED APPROACH TO COASTAL
ADAPTATION**

Robin Kundis Craig*

ABSTRACT

Hurricanes in the United States in 2005, 2012, and 2017 have all revealed an insidious problem for coastal climate change adaptation: toxic contamination in the coastal zone. As sea levels rise and violent coastal storms become increasingly frequent, this legacy of toxic pollution threatens immediate emergency response, longer term human health, and coastal ecosystems' capacity to adapt to changing coastal conditions.

Focusing on Hurricane Harvey's 2017 devastation of Houston, Texas, as its primary example, this Article first discusses the toxic legacy still present in many coastal environments. It then examines the existing laws available to clean up the coastal zone—CERCLA, RCRA, and the Coastal Zone Management Act at the federal level, land use planning, and state tort law—both to identify ways in which states and the federal government could more effectively implement existing law and to suggest improvements to these existing laws to more emphatically prioritize the elimination of toxic coastal legacies. It concludes with three specific recommendations that precautionarily prioritize human health considerations in coastal management as a means of reducing coastal toxicity in the Anthropocene.

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I. INTRODUCTION

When Hurricane Harvey, a Category 4 hurricane, made landfall on the central Texas coast just north of Corpus Christi on August 25, 2017,¹ it demonstrated both the power and the danger of coastal storms in ways that should be relevant for U.S. coastal policy throughout the 21st century. First, Harvey was huge and repeatedly battered the Gulf coast. At its first landfall, the hurricane was 280 miles in diameter and had 130 mile-per-hour winds.² It moved north to Houston the next day and remained there for four days, then made landfall a third time on August 29 at Port Arthur and Beaumont, Texas, near the Louisiana border.³ While Hurricane Harvey concentrated its force on Texas and Louisiana, “[i]t affected 13 million people from Texas through Louisiana, Mississippi, Tennessee, and Kentucky.”⁴ At least 88 people died as a result of the storm,⁵ and thousands more were left homeless.⁶

Second, Hurricane Harvey brought record-breaking rainfall—and subsequent unprecedented flooding—to the Gulf Coast.⁷ As noted, the hurricane stalled out over Houston, dropping two feet of rain in the first 24 hours and 40 inches over 48 hours.⁸

¹ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

² CNN News, “Hurricane Harvey Aftermath: What happened and what’s next,” <https://www.cnn.com/specials/us/hurricane-harvey> (as viewed Feb. 19, 2018); Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

³ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

⁴ *Id.*

⁵ *Id.*

⁶ *Id.*

⁷ For a more comprehensive discussion of Hurricane Harvey’s flooding and its potential implications for reauthorization of the National Flood Insurance Program, see Robin Kundis Craig, *Harvey, Irma, and the NFIP: Did the 2017 Hurricane Season Matter to Flood Insurance Reauthorization?*, 40:3 U. ARK. LITTLE ROCK L. REV. XXX, XXX (forthcoming 2018).

⁸ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018). “In comparison Hurricane Katrina dropped just 5 to 10 inches of rain in 48 hours. Most of its flooding came from storm surges that overwhelmed the levee system.” *Id.*

Two reservoirs overflowed.⁹ When the hurricane made landfall for the third time, “[i]t dumped 26 inches of rain in 24 hours” at the Louisiana border,¹⁰ then rained an additional 10 inches on Nashville, Tennessee, on September 1.¹¹ In an attempt to describe the scale of the rainfall, a *Washington Post* reporter noted that “[a]t least 20 inches of rain fell over an area (nearly 29,000 square miles) larger than 10 states, including West Virginia and Maryland (by a factor of more than two)” and “[a]t least 30 inches of rain fell over an area (more than 11,000 square miles) equivalent to Maryland’s size.”¹² At the storm’s peak on September 1, one-third of Houston was underwater,¹³ and “[t]otal rainfall hit 51.88 inches in Cedar Bayou on the outskirts of Houston. That’s a record for a single storm in the continental United States.”¹⁴

Third, Harvey may be the first hurricane for which scientists agree that climate change made a significant contribution to the storm’s severity.¹⁵ While scientists still will not assert that climate change “causes” any particular coastal storm, in December 2017,

⁹ *Id.*

¹⁰ *Id.*; CNN News, “Hurricane Harvey Aftermath: What happened and what’s next,” <https://www.cnn.com/specials/us/hurricane-harvey> (as viewed Feb. 19, 2018).

¹¹ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

¹² Jason Samenow, “Harvey is a 1000-year flood event unprecedented in scale,” *The Washington Post*, https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/08/31/harvey-is-a-1000-year-flood-event-unprecedented-in-scale/?utm_term=.a36393ce6b2f (Aug. 13, 2017).

¹³ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

¹⁴ *Id.*; CNN News, “Hurricane Harvey Aftermath: What happened and what’s next,” <https://www.cnn.com/specials/us/hurricane-harvey> (as viewed Feb. 19, 2018).

¹⁵ Kimberly Amadeo, “Hurricane Harvey Facts, Damage, and Costs,” *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018); Henry Fountain, “Scientists Link Hurricane Harvey’s Record Rainfall to Climate Change,” *The New York Times*, https://www.nytimes.com/2017/12/13/climate/hurricane-harvey-climate-change.html?_r=0 (Dec. 13, 2017); Mark D. Risser & Michael F. Wehner, *Attributable Human-Induced Changes in the Likelihood and Magnitude of the Observed Extreme Precipitation during Hurricane Harvey*, 44:24 GEOPHYSICAL RESEARCH LETTERS 12,457, 12,457-64 (23 Dec. 2017); Geert Jan van Oldenborgh, Karin van der Wiel, Antonia Sebastian, Roop Singh, Julie Arrighi, Friederike Otto, Karsten Haustein, Sihan Li, Gabriel Vecchi, & Heidi Cullen, *Attribution of extreme rainfall from Hurricane Harvey, August 2017*, 12:12 ENVIRONMENTAL RESEARCH LETTERS 124009, <https://doi.org/10.1088/1748-9326/aa9ef2> (13 Dec. 2017).

two research groups concluded that Harvey's record rainfall "was as much as 38 percent higher than would be expected in a world that was not warming."¹⁶ Warmer-than-normal air and ocean water temperatures, sea levels that are six inches higher than 20 years ago, and climate change-affected weather patterns that promote storm stalling may all have contributed to Harvey's record-breaking precipitation.¹⁷ In addition, both studies "found that climate change roughly tripled the odds of a Harvey-type storm."¹⁸ Thus, as climate scientists have long predicted,¹⁹ it appears that climate change is already increasing the likelihood of increasingly severe hurricanes.

Finally, and of particular relevance to this Article, Hurricane Harvey demonstrated in immediately comprehensible ways the latent toxicity of the United States' coasts. For example, among other issues, "Harvey flooded 800 wastewater treatment facilities and 13 Superfund sites[,] spread[ing] sewage and toxic chemicals into the flooded areas."²⁰ As will be discussed in more detail in Part II, Harvey, and to a lesser extent Hurricane Irma, caused significant toxic pollutant loading in the communities they affected, particularly Houston. Given the prediction of increasing numbers of increasingly severe coastal storms throughout the 21st century,²¹ Harvey and Irma make compelling cases for a more precautionary and health-based approach to coastal management that prioritizes: (1) cleaning up current coastal contamination; (2)

¹⁶ Henry Fountain, "Scientists Link Hurricane Harvey's Record Rainfall to Climate Change," *The New York Times*, https://www.nytimes.com/2017/12/13/climate/hurricane-harvey-climate-change.html?_r=0 (Dec. 13, 2017); Michael Greshko, "Climate Change Likely Supercharged Hurricane Harvey," *National Geographic*, <https://news.nationalgeographic.com/2017/12/climate-change-study-hurricane-harvey-flood/> (Dec. 13, 2017) (reporting the same 38 percent high). *See also* Risser & Wehner, *supra* note 15, at 12,462-63 (reporting 19 percent as most probable); Oldenborgh et al., *supra* note 15, at 1 (reporting 15 percent as most probable).

¹⁷ Kimberly Amadeo, "Hurricane Harvey Facts, Damage, and Costs," *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018); German Lopez, "How global warming likely made Harvey much worse, explained by a climatologist," *Vox*, <https://www.vox.com/science-and-health/2017/8/28/16214268/houston-floods-harvey-global-warming> (Aug. 28, 2017).

¹⁸ Michael Greshko, "Climate Change Likely Supercharged Hurricane Harvey," *National Geographic*, <https://news.nationalgeographic.com/2017/12/climate-change-study-hurricane-harvey-flood/> (Dec. 13, 2017); Oldenborgh et al., *supra* note 15, at 1.

¹⁹ *E.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS Report 53 (2014) [hereinafter 2014 IPCC SYNTHESIS REPORT].

²⁰ Kimberly Amadeo, "Hurricane Harvey Facts, Damage, and Costs," *The Balance*, <https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087> (Feb. 13, 2018).

²¹ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 53.

retrofitting existing coastal facilities that handle hazardous and toxic materials to prevent further coastal contamination; and (3) limiting the siting of additional such facilities in the coastal zone in the future.

This Article explores the toxic risks along the United States' coasts, particularly in light of the increasing threat from coastal storms. It begins in Part II by providing an overview of existing contamination in the United States coastal zones, focusing on the damage that Hurricane Harvey caused in its interactions with Houston's many hazardous waste sites and toxics-handling facilities. Part III then reviews existing legal authorities for dealing with coastal toxicity in both federal and state environmental and tort law. Part IV offers suggestions for a more precautionary and health-based approach to coastal toxicity, emphasizing both cleanup of existing problems and more toxicity-sensitive engagement in coastal land use planning and building codes. The Article concludes that there is much that federal, coastal state, and local governments could do to reduce toxicity exposure along the coasts during coastal storms, emphasizing that these measures also make considerable sense as a climate change adaptation strategy.

II. THE UNITED STATES' TOXIC COASTS

A. An Overview of Coastal Toxicity in the United States

The United States is a coastal nation. As of 2010, over half of the U.S. population (excluding Alaska) lived in one of the nation's 673 coastal counties.²² "Between 1960 and 2008, the national coastline population rose by 84 percent, compared with 64 percent inland, according to the Census Bureau."²³ Moreover, coastal U.S. populations continue to grow at a faster pace than inland populations, despite significant hurricane seasons in 2005 (Katrina), 2012 (Sandy), and 2017 (Harvey, Irma, and Maria).²⁴ Thus, any risks to coastal populations pose a significant *national* problem.

²² National Ocean Service, NOAA, U.S. Dept. of Commerce, *Coastal Hazards: Preparing for the Threats that Face Our Coastal Communities*, <https://oceanservice.noaa.gov/hazards/natural-hazards/> (as viewed July 30, 2018). See also Sarah G. McCarthy, John P. Incardona, & Nathaniel L. Scholtz, *Coastal Storms, Toxic Runoff, and the Sustainable Conservation of Fish and Fisheries*, 64 AMERICAN FISHERIES SOCIETY SYMPOSIUM 2 (Jan. 2008), available at <https://www.coralreef.gov/transportation/stormsfish.pdf> (noting that this land area represents only 17 percent of the United States).

²³ Jeff Donn, "U.S. coastal population continues to grow despite lessons of past storms," *The Denver Post*, <https://www.denverpost.com/2017/09/16/us-coastal-population-growth/> (Sept. 16, 2017).

²⁴ *Id.*

The nation's coasts receive toxic and hazardous pollution and exposure from a number of sources. For example, upstream agricultural and urban runoff carries pesticides, petroleum hydrocarbons, heavy metals, pathogens, and pharmaceuticals downstream to coastal communities and ecosystems;²⁵ mercury has shown up in California coastal fog banks.²⁶ In addition, between 1918 and 1970, the Department of Defense disposed of chemical weapons in the ocean, including sulphur mustard and chemical nerve agents, along all three U.S. coasts,²⁷ although the Department concluded in a 2016 report to Congress that these wastes do not pose a significant threat to human health or the environment and that removal is not warranted.²⁸ Facilities emitting air pollutants, including power plants and waste incinerators, can also be sources of coastal toxic exposure.²⁹

The far more worrisome sources of coastal toxics with respect to hurricanes and sea-level rise, however, are land-based contaminated sites—landfills, illegal hazardous waste disposal sites, and legacy toxic waste dumps—and ongoing facilities that handle toxic and hazardous substances. At the federal level, the U.S. Environmental Protection Agency (EPA) tracks hazardous disposal sites through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, often referred to as Superfund).³⁰ Just a glance at the EPA's map³¹ of sites listed on the National Priorities

²⁵ *Id.* at 2.

²⁶ Alison Hawkes, "Toxic Fog? Mercury Showing Up in Coastal California Fog Banks," *KQED Science*, <https://www.kqed.org/science/419936/toxic-fog-mercury-showing-up-in-coastal-california-fog-banks> (Dec. 18, 2015).

²⁷ David M. Bearden, Congressional Research Service, *U.S. Disposal of Chemical Weapons in the Ocean: Background and Issues for Congress 2* (as updated Jan. 3, 2007), available at <https://fas.org/sgp/crs/natsec/RL33432.pdf>.

²⁸ U.S. Dept. of Defense, *Research Related to Effect of Ocean Disposal of Munitions in U.S. Coastal Waters: A Report to Congress 2* (Nov. 2016), available at <https://www.denix.osd.mil/derp/home/documents/sea-disposal-report-to-congress/>.

²⁹ See, e.g., Toxics Action Center, *Toxics in Massachusetts: A Town-by-Town Profile 12-16* (April 2010), available at <https://toxicsaction.org/wp-content/uploads/TAC-toxics-in-massachusetts.pdf> (discussing air pollution as a toxicity problem in Massachusetts and providing maps of power plants and waste incineration facilities that show where these sources are located along the coast).

³⁰ 42 U.S.C. §§ 9601-9675 (2012).

³¹ U.S. Env'tl. Protection Agency, *Superfund National Priorities List Map*, <https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=33cebcdfdd1b4c3a8b51d416956c41f1> (as viewed July 30, 2018). See also U.S. Env'tl. Protection Agency, *Cleanups in My Community Map*, https://ofmpub.epa.gov/apex/cimc/f?p=cimc:map:0:::71:P71_WELSEARCH:NULL%7

List (NPL)³² indicates that many coastal cities contain significant concentrations of these highly toxic Superfund sites, especially Seattle, Washington; San Francisco, California; Los Angeles, California; Houston, Texas; Baton Rouge, Louisiana; Pensacola, Florida; Tampa/St. Petersburg, Florida; Jacksonville, Florida; Wilmington, North Carolina; and essentially the entire Atlantic coast from Norfolk, Virginia, north to Portland, Maine.

The EPA regulates ongoing industrial facilities that could pose hazardous or toxic waste problems through the federal Resource Conservation and Recovery Act (RCRA).³³ Releases at hazardous waste treatment, storage, and disposal (TSD) facilities require corrective actions—that is, cleanups.³⁴ While the EPA does not keep cleanup statistics in terms of inland versus coastal communities, its “Cleanups in My Community” map³⁵ indicates that RCRA corrective action sites are approximately as prevalent as NPL sites, roughly doubling the federally-actionable contaminated toxic sites along the U.S. coasts.

State-specific information can also help to flesh out the potential toxicity of the nation’s coasts. In Massachusetts, for example, RCRA large-quantity hazardous waste generators, CERCLA NPL sites, and state-designated Tier 1 hazardous waste sites are concentrated along the coast.³⁶ Together with landfills, power plants, and incinerators, these sites produce a rather pronounced toxic load on the coast, especially around Boston.³⁷ As the Toxics Action Center has summarized,

Massachusetts has thousands of potential and identified hazardous waste sites awaiting cleanup, some of the worst air quality in the nation, and rivers and lakes polluted by industrial contaminants and toxic mercury. Asthma and cancer rates are some of the highest in the country, and both can be linked to environmental causes. Massachusetts is also plagued by economic

CCleanup%7C%7C%7C%7Cfalse%7Ctrue%7Cfalse%7Cfalse%7Cfalse%7Cfalse%7C
%7C%7Csites%7CY (as viewed July 30, 2018).

³² *Id.* § 9605(a); U.S. Env’tl Protection Agency, *Superfund: National Priorities List (NPL)*, <https://www.epa.gov/superfund/superfund-national-priorities-list-npl> (as viewed July 30, 2018).

³³ 42 U.S.C. §§ 6901-69992k (2012).

³⁴ *Id.* at 6924(u), (v).

³⁵ U.S. Env’tl. Protection Agency, *Cleanups in My Community Map*, https://ofmpub.epa.gov/apex/cimc/f?p=cimc:map:0:::71:P71_WELSEARCH:NULL%7Ccleanup%7C%7C%7C%7Cfalse%7Ctrue%7Cfalse%7Cfalse%7Cfalse%7Cfalse%7C%7C%7Csites%7CY (as viewed July 30, 2018).

³⁶ *See* Toxics Action Center, *supra* note 29, at 11, 19, 21 (providing maps).

³⁷ *See id.* at 26 (showing the cumulative concentration of toxic facilities).

disparities. Poor urban areas are often the most overburdened by toxic pollution.³⁸

Although characterization of the toxic burden and risks facing citizens living on the United States' coasts remains incomplete, scientists and federal and state agencies have compiled enough data to suggest that coastal residents should be concerned. For example, between 1991 and 1997, the National Oceanic and Atmospheric Administration (NOAA) analyzed 1543 surface sediment samples from 25 estuaries and marine bays—i.e., the sediments closest to shore—from all three U.S. Coasts (Gulf, Atlantic, and Pacific), concluding that about 6 percent of the coast was toxic; the EPA's parallel study calculated that 7 percent of the coast was toxic.³⁹ However, tests based on sub-lethal effects on marine organisms suggested a much broader problem, with 26 to 39 percent of the U.S. coasts returning toxic results.⁴⁰

Another indicator for concern comes from the EPA's semi-regular National Coastal Condition Reports, which contain summaries of fish tissue contamination by region that provide another indicator of coastal toxic exposure. Specifically, the fish tissue assessment looks at the concentration of various toxics—arsenic, cadmium, mercury, selenium, chlordane, DDT, dieldrin, endosulfan, endrin, heptachlor epoxide, hexachlorobenzene, lindane, mirex, toxaphene, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs)—in fish and assesses coastal condition based on risks to human health through fish consumption.⁴¹ In the latest National Coastal Condition Report from 2012, 13 percent of U.S. coasts overall were in poor condition for fish tissue contamination, but regions ranged from zero percent in poor condition (southeastern Alaska and American Samoa) to 20 percent in poor condition along the northeast coast (although, notably, the calculations did not include the area of the Gulf of Mexico's dead zone).⁴² Another 13 percent of U.S. coasts overall were in fair condition,⁴³ indicating that, in total, over one-quarter of the nation's coasts face some risk from toxicity. The EPA further noted that areas “in poor and fair condition were

³⁸ *Id.* at 4.

³⁹ Edward R. Long, “Spatial Extent of Sediment Toxicity in U.S. Estuaries and Marine Bays,” in SHABEG S. SANDHU, BRIAN D. MELZIAN, EDWARD R. LONG, WALTER G. WHITFORD, & BARBARA T. WALTON, EDs., *MONITORING ECOLOGICAL CONDITION IN THE WESTERN UNITED STATES* 391, 391 (Kluwer Academic 2000).

⁴⁰ *Id.*

⁴¹ U.S. ENVTL. PROTECTION AGENCY, NATIONAL COASTAL CONDITION REPORT IV, at 25 (April 2012), available at https://www.epa.gov/sites/production/files/2014-10/documents/0_nccr_4_report_508_bookmarks.pdf.

⁴² *Id.* at ES-8, tbl. ES-2.

⁴³ *Id.* at 49.

dominated by samples with elevated concentrations of total PCBs, total DDT, total PAHs, and mercury.”⁴⁴

The National Institutes of Health (NIH) has compiled data from the EPA’s Superfund database for CERCLA and Toxic Release Inventory (TRI) database for the federal Emergency Planning and Community Right-to-Know Act (EPCRA),⁴⁵ as well as several other sources of information from both the federal government and Canada,⁴⁶ to create TOXMAP,⁴⁷ a map of releases of specific toxic chemicals across the United States. Designed originally to facilitate emergency response,⁴⁸ EPCRA requires all U.S. facilities releasing listed toxic and hazardous substances at or above reportable thresholds to report those releases,⁴⁹ which are compiled onto the TRI database.⁵⁰ TOXMAP makes clear that larger cities, whether coastal or not, generally endure the greatest concentrations of toxic releases. Nevertheless, as in the EPA’s “Cleanups in My Community” map, many coastal areas light up particularly noticeably on the NIH’s map—Seattle, San Francisco, and Los Angeles on the Pacific; Houston, New Orleans, and Tampa on the Gulf; Milwaukee, Chicago, and Detroit along the Great Lakes; and almost all of Florida’s and the northeastern states’ Atlantic coasts.

Such compilations and characterizations of “standard” toxicity, however, do not paint the full picture of coastal toxic risk. Coastal storms and hurricanes can dramatically increase coastal communities’ acute and even longer-term toxic exposure. Moreover, toxic sites and infrastructure along the coast pose long-term concerns in the face of global sea-level rise. Hurricane Harvey provided a particularly graphic example of how storms can interact with coastal toxicity to pose significant human health concerns.

B. Hurricane Harvey and Houston, August-September 2017

Hurricanes in the United States dramatically illuminate the latent toxicity of coastal zone infrastructure and reveal the fact that invading seawater threatens both unusually high emissions of hazardous air pollutants and a toxic soup of sewage, oil, and hazardous chemicals from coastal businesses (such as dry cleaners and auto repair

⁴⁴ *Id.*

⁴⁵ 42 U.S.C. §§ 11001-11050 (2012).

⁴⁶ National Institutes of Health, U.S. Dept. of Health & Human Services, *TOXMAP Fact Sheet*, <https://toxmap.nlm.nih.gov/toxmap/help/toxmapfs.html> (as viewed July 31, 2018).

⁴⁷ National Institutes of Health, U.S. Dept. of Health & Human Services, *TOXMAP Home Page*, <https://toxmap.nlm.nih.gov/toxmap/app/> (as viewed July 31, 2018).

⁴⁸ 42 U.S.C. §§ 11003-11005 (2012).

⁴⁹ *Id.* §§ 11002, 10023.

⁵⁰ U.S. Env’tl. Protection Agency, *Toxic Release Inventory Program*, <https://www.epa.gov/toxics-release-inventory-tri-program> (as viewed July 31, 2018).

facilities), industrial sites, Superfund sites, and toxic waste facilities.⁵¹ While the full threat of dissolved and mixing toxic chemicals has not yet been fully realized as a result of a major U.S. coastal storm, some have come alarmingly close. For example, after Hurricane Katrina devastated New Orleans in 2005, “hazardous substances such as volatile organic compounds (VOCs), lead, and arsenic were detected in the air, soil, and sediment samples,” and “the potential for a toxic release of hazardous substances after a storm exists.”⁵² Similarly, after Hurricane Sandy hit New York and New Jersey in 2012, officials “had to monitor 247 Superfund sites—one of which, the Gowanus Canal, overflowed into people’s homes.”⁵³

1. Waste-Related Spills During Hurricane Harvey

Hurricane Harvey’s 2017 flooding of the Houston area—the United States’ fourth-largest city—may produce one of the most toxic legacies of U.S. hurricanes. To begin, Harvey inundated 13 of the Houston area’s 41 hazardous waste sites,⁵⁴ and the

⁵¹ Danny D. Reible et al., *Toxic and Contaminant Concerns Generated by Hurricane Katrina*, 36:1 THE BRIDGE, Spring 2006, <http://www.nae.edu/NAE/bridgecom.nsf/weblinks/MKEZ-6MYQQP?OpenDocument>; Kathryn Lane, Kizzy Charles-Guzman, Katherine Wheeler, Zaynah Abid, Nathan Graber, & Thomas Matte, *Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment*, 2013 J. ENVTL. & PUBLIC HEALTH, Article ID 913064, at 2 (21 April 2013), available at <http://dx.doi.org/10.1155/2013/913064>.

⁵² Lane et al., *supra* note 51, at 5. See also Steven M. Presley, Thomas R. Rainwater, Galen P. Austin, Steven G. Platt, John C. Zak, George P. Cobb, Eric J. Marsland, Kang Tian, Baohong Zhang, Todd A. Anderson, Stephen B. Cox, Michael T. Abel, Blair D. Leftwich, Jennifer R. Huddleston, Randall M. Jeter, & Ronald J. Kendall, *Assessment of Pathogens and Toxicants in New Orleans LA Following Hurricane Katrina*, 40:2 ENVTL. SCIENCE & TECHNOLOGY 468, 468 (Dec. 14, 2005) (“Concentrations of aldrin, arsenic, lead, and seven semivolatile organic compounds in sediments/soils exceeded one or more United States Environmental Protection Agency (USEPA) thresholds for human health soil screening levels and high priority bright line screening levels.”).

⁵³ Emily Atkin, *America Has a Toxic Waste Hurricane Problem*, THE NEW REPUBLIC, <https://newrepublic.com/article/144737/america-toxic-waste-hurricane-problem> (Sept. 12, 2017). See also Elizabeth A. Harris, “In Brooklyn, Worrying About Not Only Flooding but What’s In the Water,” *The New York Times*, <http://www.nytimes.com/2012/11/06/nyregion/gowanus-canal-flooding-brings-contamination-concerns.html?mcubz=1> (Nov. 5, 2012) (reporting on the Gowanus Canal Superfund site overflow).

⁵⁴ Emily Atkin, *America Has a Toxic Waste Hurricane Problem*, THE NEW REPUBLIC, <https://newrepublic.com/article/144737/america-toxic-waste-hurricane-problem> (Sept. 12, 2017). *The New York Times* reported that 14 sites had been flooded. Julie Turkewitz,

city contains “several other highly toxic sites managed by the Texas Commission on Environmental Quality.”⁵⁵ (Notably, Hurricane Irma a few weeks later was even worse in terms of threatened superfund sites: 80 such sites stood in Hurricane Irma’s path through Florida.⁵⁶) The *New York Times* described Harvey’s floodwaters as “a stew of toxic chemicals, sewage, debris and waste Runoff from the city’s sprawling petroleum and chemicals complex contains any number of hazardous compounds. Lead, arsenic and other toxic and carcinogenic elements may be leaching from some two dozen Superfund sites in the Houston area.”⁵⁷

The worst of the inundated waste sites was the San Jacinto Waste Pits, a “dioxin-laden federal Superfund site whose protective cap was damaged by the raging San Jacinto River.”⁵⁸ “The San Jacinto Waste Pits are a heavily contaminated area near Houston that is right next to homes and schools, and that has frightened residents for decades.”⁵⁹ The site consists of two waste pits in the middle of the San Jacinto river, where a paper mill dumped its wastes—especially dioxin and furans—during the 1960s.⁶⁰ Paper companies

Henry Fountain, & Hiroko Tabuchi, “New Hazard in Storm Zone: Chemical Blasts and ‘Noxious’ Smoke,” *The New York Times*, <https://www.nytimes.com/2017/08/31/us/texas-chemical-plant-explosion-arkema.html> (Aug. 31, 2017).

⁵⁵ Darryl Fears & Brady Dennis, “Houston’s polluted Superfund sites threaten to contaminate floodwaters,” *The Washington Post*, https://www.washingtonpost.com/news/energy-environment/wp/2017/08/29/houstons-flood-threatens-to-turn-polluted-superfund-sites-into-a-toxic-gumbo/?utm_term=.44b94aadf1bb (Aug. 29, 2017).

⁵⁶ Emily Atkin, *America Has a Toxic Waste Hurricane Problem*, THE NEW REPUBLIC, <https://newrepublic.com/article/144737/america-toxic-waste-hurricane-problem> (Sept. 12, 2017).

⁵⁷ Hiroko Tabuchi & Sheila Kaplan, “A Sea of Health and Environmental Hazards in Houston’s Floodwaters,” *The New York Times*, <https://www.nytimes.com/2017/08/31/us/houston-contaminated-floodwaters.html?mcubz=1> (Aug. 31, 2017).

⁵⁸ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁵⁹ Rebecca Hersher, “EPA Takes Toxic Site Flooded by Harvey Off Special Cleanup List,” *National Public Radio (NPR)*, <https://www.npr.org/sections/thetwo-way/2018/04/16/601867839/epa-takes-toxic-site-flooded-by-harvey-off-special-cleanup-list> (April 16, 2018).

⁶⁰ *Id.*

used dioxin to bleach paper white, and the compound is toxic at parts per *quadrillion*.⁶¹ Temporary concrete caps installed in 2011 were supposed to keep the pits from further contaminating the river, but Hurricane Harvey caused the river to rip through them,⁶² releasing contamination to the river.

However, smaller waste spills were also noteworthy. For example, W&P Development Corp., owns “an industrial park where about 100,000 gallons of oily wastewater were reported to have spilled into the San Jacinto from Aug. 29 to Aug. 31. The site was formerly Champion Paper Mill and a landfill there received wastes including turpentine- and lead-contaminated soil and mercury until 2008.”⁶³

Wastewaters also proved problematic. “The largest spill, by far, was at ExxonMobil Corp.’s Olefins Plant in Baytown, east of the ship channel. Two days after Harvey hit, some 457 million gallons of stormwater mixed with untreated wastewater, including oil and grease, surged into an adjacent creek.”⁶⁴ Floodwaters also became contaminated with sewage, and testing of floodwater samples revealed *E. coli* bacterial concentrations 10 to 80 times higher than the EPA’s recommendations for recreational water quality (the recommendation for drinking water is zero), although all the tests for heavy metals revealed concentrations below the EPA’s levels of concern.⁶⁵

2. Petroleum-Related Spills in Houston During Hurricane Harvey

However, Houston has more sources of toxicity than just waste sites. “Some 500 chemical plants, 10 refineries and more than 6,670 miles of intertwined oil, gas and chemical pipelines line the nation’s largest energy corridor.”⁶⁶ The city is, of course,

⁶¹ WILLIAM BOYD, *THE SLAIN WOOD: PAPERMAKING AND ITS ENVIRONMENTAL CONSEQUENCES IN THE AMERICAN SOUTH* 198 (2015).

⁶² Rebecca Hersher, “EPA Takes Toxic Site Flooded by Harvey Off Special Cleanup List,” *National Public Radio (NPR)*, <https://www.npr.org/sections/thetwo-way/2018/04/16/601867839/epa-takes-toxic-site-flooded-by-harvey-off-special-cleanup-list> (April 16, 2018).

⁶³ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁶⁴ *Id.*

⁶⁵ Susan Scutti, “Sewage, fecal bacteria in Hurricane Harvey floodwaters,” *CNN News*, <https://www.cnn.com/2017/09/01/health/houston-flood-water-contamination/index.html> (Sept. 15, 2017).

⁶⁶ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

famous for its oil industry, including oil refineries. Needless to say, record flooding and oil refineries don't mix well. For example, "storage tanks holding crude oil, gasoline and toxic contaminants failed when storm water from Harvey caused them to collapse, spilling at least 145,000 gallons of fuel and polluting the air." "High levels of the carcinogen benzene were detected in a Houston neighborhood close to a Valero Energy refinery, . . . heightening concerns over potentially hazardous leaks from oil and gas industry sites damaged by Hurricane Harvey." "Preliminary air sampling in the Manchester district of Houston showed concentrations of up to 324 parts per billion of benzene"—a concentration "above the level at which federal safety officials recommend special breathing equipment for workers." In late August, ExxonMobil acknowledged "that Hurricane Harvey damaged two of its refineries, causing the release of hazardous pollutants"—specifically, high emissions of volatile organic compounds and over 1 million pounds of sulfur dioxide,⁶⁷ both of which are regulated air pollutants under the Clean Air Act. Initial reports from Texas regulators indicate that because of Hurricane Harvey, "the region's massive petrochemical industry released more than 2 million pounds of harmful pollutants into the air as of Aug. 29"—"roughly 40 percent of what the entire Houston released in 2016"⁶⁸ As of October 2017, the EPA was still assessing three reported spills at US Oil Recovery, described by news outlets as "a former petroleum industry waste processing plant contaminated with a dangerous brew of cancer-causing chemicals."⁶⁹

Numerous other petroleum-related spills also occurred. Flooding in Panther Creek, for example, caused several releases, including a "460,000-gallon gasoline spill at a Magellan Midstream Partners tank farm and nearly 52,000 pounds of crude oil from a Seaway Crude Pipeline Inc. tank."⁷⁰ Residents of Galena Park, a mostly Latino

⁶⁷ Steven Mufson, "ExxonMobil Refineries are Damaged in Hurricane Harvey, Releasing Hazardous Pollutants," *Washington Post*, https://www.washingtonpost.com/news/energy-environment/wp/2017/08/29/exxonmobil-refineries-damaged-in-hurricane-harvey-releasing-hazardous-pollutants/?utm_term=.d8ccfb69eaf7 (August 29, 2017).

⁶⁸ Adam Allington, "Flooded Houston Facing Air Threat, Too, With Toxic Gas Releases," in Bloomberg BNA, *Natural Disasters Cast Unexpected Light on Environmental Hazards, Regulatory Gaps* 1, 1 (Oct. 2017) (quoting Elena Craft).

⁶⁹ Michael Biesecker & Frank Bajak, "Hurricane Harvey: Floodwaters 'caused chemical spill' at Houston's dirtiest toxic waste plant," *The Independent*, <http://www.independent.co.uk/news/world/americas/hurricane-harvey-latest-houston-chemical-plant-toxic-spill-floodwater-us-oil-recovery-superfund-epa-a7954586.html> (19 Sept. 2017).

⁷⁰ CBS News, "Hurricane Harvey's toxic impact deeper than public told," <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

neighborhood, were subjected to more than one dozen releases within a two-mile radius as a result of Harvey, including a gasoline spill at the Magellan terminal initially reported at 42,000 gallons but eventually revealed to be ten times bigger.⁷¹ In addition, “[t]he spill ranked as Texas’ largest reported Harvey-related venting of air pollutants, at 1,143 tons.”⁷²

3. Chemical Spills in Houston During Hurricane Harvey

As noted, Houston is also home to, or near, 500 chemical plants, many of which were flooded. As CBS News reported in March 2018, “Nearly half a billion gallons of industrial wastewater mixed with storm water surged out of just one chemical plant in Baytown, east of Houston on the upper shores of Galveston Bay. Benzene, vinyl chloride, butadiene and other known human carcinogens were among the dozens of tons of industrial toxins released into surrounding neighborhoods and waterways following Harvey’s torrential rains.”⁷³

Some of the chemical releases created acutely dangerous conditions. For example, on August 28, “an 18-inch pipeline leak at Williams Midstream Services Inc. unleashed a plume of [hydrogen chloride gas] near the intersection of two major highways in La Porte, southeast of Houston, where the San Jacinto River meets the 50-mile ship channel. It’s the petrochemical corridor’s main artery that empties into Galveston Bay.”⁷⁴ The resulting toxic cloud of hydrochloric acid spread about one-quarter mile through the industrial neighborhood, forcing people to remain inside lest the vaporized acid burn their skin and lungs or suffocate and kill them.⁷⁵ At the Channel Biorefinery & Terminals, “some 80,000 gallons of methanol spilled from a tank rupture into Greens Bayou, which enters the ship channel just downstream of the Magellan terminal. Highly flammable and explosive, methanol can cause brain lesions and other disorders.”⁷⁶

Many other notable chemical releases occurred in and around Houston during Harvey. Royal Dutch Shell PLC’s Deer Park complex on the ship channel’s south bank released more than 3000 pounds of benzene, and the company initially reported a 1000-

⁷¹ *Id.*

⁷² *Id.*

⁷³ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁷⁴ *Id.*

⁷⁵ *Id.*

⁷⁶ *Id.*

pound release of phenol, “which can burn skin and be potentially fatal”⁷⁷ The Chevron Phillips Chemical Company plant in Baytown released “about 34,000 pounds of sodium hydroxide, or lye, which can cause severe chemical burns, and unpermitted airborne emissions, including 28,000 pounds of benzene”⁷⁸

One of the worst hit chemical plants during Hurricane Harvey was the Arkema chemical plant, about 20 miles northeast of Houston,⁷⁹ which is considered one of the most hazardous plants in Texas.⁸⁰ Harvey’s rains inundated the plant, causing it to lose power, which in turn led to a loss of refrigeration.⁸¹ Unfortunately, “The plant manufactures organic peroxides commonly used in everyday products like kitchen countertops, industrial paints, polystyrene cups and plates, and PVC piping. The materials must be kept very cool, otherwise there is ‘the potential for a chemical reaction leading to a fire and/or explosion within the site confines,’ Arkema said.”⁸² Arkema itself reported the sequence of events as follows:

The plant made extensive preparations prior to Hurricane Harvey. We have backup generators at the site solely for the purpose of being a redundant power supply for refrigeration necessary for the safe storage of products. We also brought in diesel powered refrigerated tank trailers and additional fuel as a further redundancy. Employees safely shut down all operations on Friday, August 25, prior to the hurricane’s landfall. We left a small “ride-out” crew on site to address situations that could arise at the site during the storm to protect the safety and security of the community. The site lost primary power early Sunday morning August 27. The additional back-up generators subsequently were inundated by water and failed. On Monday, August 28 temperature sensitive products were transferred into 8 diesel-

⁷⁷ *Id.*

⁷⁸ *Id.*

⁷⁹ Julia Bagg, Alex Johnson, & Jason Cumming, “Crosby, Texas, Chemical Plant Explodes Twice, Arkema Group Says,” *NBC News*, <https://www.nbcnews.com/storyline/hurricane-harvey/harvey-danger-major-chemical-plant-near-houston-likely-explode-facility-n797581> (Aug. 31, 2017).

⁸⁰ Julie Turkewitz, Henry Fountain, & Hiroko Tabuchi, “New Hazard in Storm Zone: Chemical Blasts and ‘Noxious’ Smoke,” *The New York Times*, <https://www.nytimes.com/2017/08/31/us/texas-chemical-plant-explosion-arkema.html> (Aug. 31, 2017).

⁸¹ *Id.*

⁸² Alex Stuckey, “Arkema officials were warned of flood risks a year before Hurricane Harvey,” *The Houston Chronicle*, <https://www.chron.com/news/science-environment/article/Arkema-officials-were-warned-of-flood-risks-a-12937654.php> (May 25, 2018).

powered refrigerated containers where they currently reside. We evacuated the ride-out crew on Tuesday, August 29 for their safety. As of August 30, most of the refrigeration units have failed due to flooding. The site itself is now completely flooded and inaccessible except by boat. In conjunction with the Department of Homeland Security and the State of Texas, Arkema has set up a command post in an off-site location near the plant.⁸³

“With the power out and cooling systems failing, volatile organic peroxides exploded multiple times over the course of a week, producing towering pillars of fire and thick plumes of black smoke.”⁸⁴ In all, “[m]ore than 200 residents had to evacuate because of the chemical fumes and noxious smoke caused by [the fire], and 21 people sought medical attention.”⁸⁵ In particular, “15 public safety officers were treated at a hospital after inhaling smoke from chemical fires that followed the explosions.”⁸⁶ These “sickened first responders” later filed suit, “as have Harris and Liberty counties, which claim the company violated numerous environmental and safety regulations.”⁸⁷

4. Houston’s Post-Harvey Toxic Exposure

Houston residents were aware of at least some of the toxic releases around them during Harvey itself: “From Aug. 24 to Sept. 3, callers made 96 reports of oil, chemical or sewage spills across southeast Texas.”⁸⁸ As of March 2018, however, “reporters

⁸³ Arkema Innovative Chemistry, *Frequently Asked Questions Answered*, <https://www.arkema-america.com/en/social-responsibility/incident-page-2/frequently-asked-questions-answered/> (as viewed July 31, 2018).

⁸⁴ Alex Stuckey, “Arkema officials were warned of flood risks a year before Hurricane Harvey,” *The Houston Chronicle*, <https://www.chron.com/news/science-environment/article/Arkema-officials-were-warned-of-flood-risks-a-12937654.php> (May 25, 2018).

⁸⁵ Stephanie Ebbs, “Noxious chemical fire during Hurricane Harvey caused by failure of ‘all levels of protection,’ probe reveals,” *ABC News*, <https://abcnews.go.com/Politics/noxious-chemical-fire-hurricane-harvey-caused-failure-layers/story?id=55410407> (May 25, 2018).

⁸⁶ Julie Turkewitz, Henry Fountain, & Hiroko Tabuchi, “New Hazard in Storm Zone: Chemical Blasts and ‘Noxious’ Smoke,” *The New York Times*, <https://www.nytimes.com/2017/08/31/us/texas-chemical-plant-explosion-arkema.html> (Aug. 31, 2017).

⁸⁷ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁸⁸ Julie Turkewitz, Henry Fountain, & Hiroko Tabuchi, “New Hazard in Storm Zone: Chemical Blasts and ‘Noxious’ Smoke,” *The New York Times*,

catalogued more than 100 Harvey-related toxic releases — on land, in water and in the air. Most were never publicized, and in the case of two of the biggest ones, the extent or potential toxicity of the releases was initially understated.”⁸⁹ Notably, many of the companies who owned the sites where spills occurred had violated environmental laws in their management of those sites in the past.⁹⁰

Perhaps most novel were the air pollution problems that Harvey generated: “from Aug. 23 to Aug. 30, 46 facilities in 13 counties reported an estimated 4.6 million pounds of airborne emissions that exceeded state limits, an analysis by the Environmental Defense Fund, Air Alliance Houston and Public Citizen shows.”⁹¹ Air pollution issues continued after the storm as plants that had shut down for the storm released unusual amounts of pollutants in restarting. For example, “A giant plastics plant in Point Comfort, about 100 miles southwest of Houston, released about 1.3 million pounds of excess emissions, including toxic gases like benzene, when it restarted after the storm.”⁹²

Clearly, acute toxic exposures occurred during and immediately after the hurricane. For example, in early September, Houston “a high benzene level of 324 parts per billion—more than three times the level at which federal worker safety guidelines recommend special breathing equipment.”⁹³ Around the San Jacinto Waste Pits, “[p]reliminary data from the EPA indicated that in sediment samples taken around the site, dioxins levels spiked 2,300 times above acceptable levels.”⁹⁴

<https://www.nytimes.com/2017/08/31/us/texas-chemical-plant-explosion-arkema.html> (Aug. 31, 2017).

⁸⁹ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁹⁰ *Id.*

⁹¹ Troy Griggs, Andrew W. Lehren, Nadja Popovich, Anjali Singhvi, & Hiroko Tabuchi, “More Than 40 Sites Released Hazardous Pollutants Because of Hurricane Harvey,” *The New York Times*, <https://www.nytimes.com/interactive/2017/09/08/us/houston-hurricane-harvey-hazardous-chemicals.html> (Sept. 8, 2017).

⁹² CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁹³ *Id.* See also Troy Griggs, Andrew W. Lehren, Nadja Popovich, Anjali Singhvi, & Hiroko Tabuchi, “More Than 40 Sites Released Hazardous Pollutants Because of Hurricane Harvey,” *The New York Times*, <https://www.nytimes.com/interactive/2017/09/08/us/houston-hurricane-harvey-hazardous-chemicals.html> (Sept. 8, 2017) (reporting on the same release).

⁹⁴ Michael D. Regan, “Health concerns swirl in Texas months after floods from Harvey spread toxic waste,” *PBS NewsHour*, <https://www.pbs.org/newshour/nation/health->

However, because investigations remain incomplete, the longer-term toxic legacy that Harvey gifted to Houston residents is less clear. “Texas regulators say they have investigated 89 incidents, but have yet to announce any enforcement actions.”⁹⁵ Nevertheless, government monitoring of residual toxicity in Houston has been limited compared to what occurred after previous hurricanes, such as Ike (2008) and Katrina (2005).⁹⁶ Academic testing and studies, however, suggest that the storm essentially washed out the city’s topsoil, leaving relatively few sites with worrisome levels of petroleum-related toxins.⁹⁷ Nevertheless, while residents were initially told that the releases posed no threat to human health, as of March 2018 the EPA continued to worry about local toxic “hotspots” and the risks that they pose.⁹⁸

C. The Long-Term Threat of Toxic Sea-Level Rise

While hurricanes likely Harvey dramatize coastal toxicity and its public health risks for coastal inhabitants, sea-level rise (and the increased storm surge that comes with it) present coastal planners with a far more insidious toxicity problem.

First, rising seas make coastal storm events worse; indeed, the exacerbation of storm surge is the most immediate and significant consequence of sea-level rise. According to the Intergovernmental Panel on Climate Change (IPCC), “it is likely that extreme sea levels (for example, as experienced in storm surges) have increased since 1970, being mainly the result of mean sea level rise.”⁹⁹

Second, in many parts of the United States—notably the Gulf Coast—sea-level rise will cause the ocean to progressively inundate and saturate existing toxic infrastructure, potentially condemning emerging coastal communities and ecosystems to a toxic existence. According to the IPCC, global mean sea level rose by 0.19 meters over the period 1901 to 2010, and “the rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia.”¹⁰⁰ The IPCC also

concerns-swirl-in-texas-months-after-floods-from-harvey-spread-toxic-waste (Dec. 10, 2017).

⁹⁵ CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018).

⁹⁶ *Id.*

⁹⁷ *Id.*

⁹⁸ *Id.*

⁹⁹ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 53.

¹⁰⁰ *Id.* at 4.

concluded that the mean rate of global average sea level rise for the period from 1993 to 2010 was twice what occurred from 1901 to 2010.¹⁰¹

Sea level rise has two main components: melting land-based ice (glaciers and ice shelves) and expanding volume as the ocean warms.¹⁰² Although the two contributors have been roughly equal until recently, melting ice and disintegrating ice shelves have become significantly more important.¹⁰³ Sea level rise will continue to accelerate through the 21st century and beyond, affecting a projected 95 percent of the ocean area and approximately 70 percent of coastlines worldwide.¹⁰⁴ However, sea level rise will not be uniform across regions. For example, “[s]ince 1993, the regional rates for the Western Pacific are up to three times larger than the global mean, while those for much of the Eastern Pacific are near zero or negative.”¹⁰⁵

The future of the planet’s ice presents a worrisome uncertainty, and the increasing pace of polar ice melt has added significant volatility to the art of sea level rise prediction.¹⁰⁶ Studies repeatedly indicate that the Greenland ice sheet and Antarctic ice are melting faster than expected,¹⁰⁷ and the IPCC noted in 2014 that the Greenland and Antarctic ice sheets were losing mass, likely at an increasing rate, and that glaciers around the world have continued to shrink.¹⁰⁸ It projects that these ice sheets and glaciers will continue to decrease throughout the 21st century, shrinking 15% to 85% by 2100.¹⁰⁹ The IPCC concluded that knowledge concerning “[a]brupt and irreversible ice loss from the Antarctic ice sheet...is insufficient to make a quantitative assessment” of its

¹⁰¹ *Id.* at 42.

¹⁰² *Id.*

¹⁰³ Mark F. Meier *et al.*, *Glaciers Dominate Eustatic Sea-Level Rise in the 21st Century*, 317 *SCIENCE* 1064, 1065 (2007) (arguing that glaciers and ice caps “contribute about 60% of the eustatic, new-water component of sea-level rise”); Antarctic Climate & Ecosystems Cooperative Research Centre, Australia, Report Card: Sea Level Rise 2012, at 4, 10 (2012), *available at* <http://acecrc.org.au/wp-content/uploads/2015/03/2012-ACE-RC-Sea-Level-Rise.pdf> (noting that while “[t]his present sea-level rise is due to a combination of thermal expansion of a warming ocean and the melting of glaciers and ice sheets,” “[o]ver the last decade, the contribution to sea-level rise from melting ice has exceeded that due to thermal expansion of the ocean.”).

¹⁰⁴ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 13.

¹⁰⁵ *Id.* at 42.

¹⁰⁶ Anny Cazenave, *How Fast Are the Ice Sheets Melting?*, 314 *SCIENCE* 1250, 1250-51 (2006).

¹⁰⁷ *Id.* at 1251; J.L. Chen, *et al.*, *Satellite Gravity Measurements Confirm Accelerated Melting of Greenland Ice Sheet*, 313 *SCIENCE* 1958, 1958 (2006).

¹⁰⁸ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 4.

¹⁰⁹ *Id.* at 12.

likelihood.¹¹⁰ However, the West Antarctic Ice Sheet contains enough ice to raise sea level by five to seven meters (17-23 feet).¹¹¹ If all of Antarctica melts, sea level will rise approximately 60 meters, or almost 200 feet.¹¹² If both Greenland and Antarctica melt completely, sea level would rise about 65 meters,¹¹³ or approximately 215 feet.

Regardless of which of these ice-melt calamities occur, and when, sea-level rise will continue throughout the 21st century,¹¹⁴ although its exact impact will vary considerably among coastal regions. For example, the U.S. Global Change Research Program has noted that the southeastern region of the United States, which includes the Gulf Coast, is particularly at risk from sea-level rise, while the Northeast's threats arise more from coastal flooding as a result of increased precipitation and coastal storms.¹¹⁵ In the Southeast,

Global sea level rose about eight inches in the last century and is projected to rise another 1 to 4 feet in this century. Large numbers of southeastern cities, roads, railways, ports, airports, oil and gas facilities, and water supplies are vulnerable to the impacts of sea level rise. Major cities like New Orleans, with roughly half of its population below sea level, Miami, Tampa, Charleston, and Virginia Beach are among those most at risk.

As a result of current sea level rise, the coastline of Puerto Rico around Rincón is being eroded at a rate of 3.3 feet per year. Puerto Rico has one of the highest population densities in the world, with 56% of the population living in coastal municipalities.¹¹⁶

As the Program is quick to point out, the economic consequences of sea-level rise in the Southeast could be considerable. As one example, "Louisiana State Highway 1, heavily used for delivering critical oil and gas resources from Port Fourchon, is sinking, at the

¹¹⁰ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 16.

¹¹¹ *Id.*

¹¹² ANTARCTIC TREATY CONSULTATIVE MEETING XXIX, THE ANTARCTIC AND CLIMATE CHANGE 3 (2006), *available at* <http://www.asoc.org/portals/0/pdfs/Climate%20Change%20IP.pdf>.

¹¹³ Cazenave, *supra* note 106, at 1250.

¹¹⁴ 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 58.

¹¹⁵ U.S. GLOBAL CHANGE RESEARCH PROGRAM, HIGHLIGHTS OF CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 70, 72 (2014), *available at* http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1 [hereinafter 2014 USGCRP CLIMATE CHANGE REPORT].

¹¹⁶ *Id.* at 73.

same time sea level is rising, resulting in more frequent and more severe flooding during high tides and storms. A 90-day shutdown of this road would cost the nation an estimated \$7.8 billion.”¹¹⁷ It does not mention, however, the implications for toxic exposures.

Along the Pacific coast, in California, “Sea level has risen approximately 7 inches from 1900 to 2005, and is expected to rise at growing rates in this century.”¹¹⁸ “Flooding and erosion in coastal areas are already occurring even at existing sea levels and damaging some California coastal areas during storms and extreme high tides. Sea level rise is projected to increase as Earth continues to warm, resulting in major damage as wind-driven waves ride upon higher seas and reach farther inland.”¹¹⁹ In the Pacific Northwest, “the effects of sea level rise, erosion, inundation, threats to infrastructure and habitat, and increasing ocean acidity collectively pose a major threat to the region.”¹²⁰ The damage to critical coastal infrastructure could be considerable:

The region’s populous coastal cities face rising sea levels, extreme high tides, and storm surges, which pose particular risks to highways, bridges, power plants, and sewage treatment plants. Climate-related challenges also increase risks to critical port cities, which handle half of the nation’s incoming shipping containers.¹²¹

Most of this infrastructure, however, is also associated with coastal toxicity and hazardous materials.

Thus, even in government reports that acknowledge climate change and describe its projects impacts on U.S. coastal communities in detail, little attention is paid to the existing and potential risks from toxics in the coastal zone. Dealing with this toxic load, however, should be added to climate change adaptation efforts in this country. As part of that effort, the next Part reviews existing laws particularly relevant to reducing the toxic load along the nation’s coasts.

III. EXISTING FEDERAL AND STATE LAWS RELEVANT TO COASTAL TOXICITY

A. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

¹¹⁷ *Id.*; see also *id.* at 90 (discussing the potential for economic disruption in the nation’s coastal regions).

¹¹⁸ *Id.* at 92.

¹¹⁹ *Id.* at 78.

¹²⁰ *Id.* at 80.

¹²¹ *Id.* at 78.

As noted, Congress enacted CERCLA in 1980 to promote the cleanup of existing toxic sites; in that sense, CERCLA is best characterized as retrospective environmental law (i.e., providing for cleanup liability *after* a hazardous release has already occurred) than proactive or preventive. Nevertheless, CERCLA and its state analogs remain important legal vehicles for promoting the cleanup of existing toxic sites along the coast.

CERCLA is triggered by the release—past or present—of hazardous substances from a facility.¹²² Because CERCLA was one of the last major federal environmental statutes that Congress enacted, it defines “hazardous substances” by referencing earlier legislation—toxic pollutants under the Clean Water Act, hazardous wastes under the Resource Conservation and Recovery Act, hazardous air pollutants under the Clean Air Act, and imminently hazardous chemicals under the Toxic Substance Control Act.¹²³ However, the EPA can also designate additional “hazardous substances” particularly for CERCLA.¹²⁴

The EPA also designates “reportable quantities” of hazardous substances.¹²⁵ In order to facilitate effective responses to new releases of hazardous substances, CERCLA requires “[a]ny person in charge of a vessel or an onshore or offshore facility” to immediately report releases of hazardous substances in excess of the relevant reportable quantities to the National Response Center as soon as that person knows of the release.¹²⁶ CERCLA defines “release” broadly to include “any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment,” except for the many kinds of “releases” that are regulated under other statutes.¹²⁷ Thus, pesticide applications regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and pollutant discharges regulated under the Clean Water Act are exempt from CERCLA’s reporting requirement.¹²⁸ Otherwise, failures to report releases of hazardous substances and false reports are subject to criminal penalties.¹²⁹

Section 104 of CERCLA authorizes the President of the United States—who has since delegated this authority to the EPA—to respond to releases of hazardous substances

¹²² 42 U.S.C. § 9603(a) (2012).

¹²³ *See id.* § 9601(14) (defining “hazardous substance” by cross-referencing these statutes).

¹²⁴ *Id.* §§ 9601(14)(B), 9602(a).

¹²⁵ *Id.* § 9602(a).

¹²⁶ *Id.* § 9603(a).

¹²⁷ *Id.* § 9601(22).

¹²⁸ *Id.* § 9603(e).

¹²⁹ *Id.* § 9603(b).

through removal and remedial actions.¹³⁰ Removal actions are the government's immediate response to a spill or release, designed primarily to contain the hazardous substances and limit the threat to the public.¹³¹ Remedial actions, in contrast, are "actions consistent with permanent remedy"¹³² Both such cleanup actions must be consistent with the National Contingency Plan,¹³³ which establishes "procedures and standards for responding to releases of hazardous substances, pollutants, and contaminants"¹³⁴

Alternatively, the EPA can order abatement actions under section 106 of CERCLA.¹³⁵ As a practical matter, the primary difference between a section 104 cleanup and a section 106 cleanup is that under section 104, governments perform the cleanup and seek reimbursement, while under section 106, potentially responsible parties (PRPs) perform (and generally pay for) the cleanup themselves, subject to federal and/or state supervision.¹³⁶ The EPA must notify the affected state before ordering a section 106 abatement action¹³⁷ and "shall promulgate regulations providing for substantial and meaningful involvement by each State in initiation, development, and selection of remedial actions to be undertaken in that State."¹³⁸ The affected state also has a right to concur (or not) in the federal government's selection of certain remedial actions and a right to intervene in or bring a relevant action if the state objects to the remedy that the federal government chooses.¹³⁹

Section 107 is the heart of CERCLA's liability scheme. First, section 107 identifies four categories of PRPs:

- (1) the owner and operator of a vessel or a facility,
- (2) any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of,

¹³⁰ *Id.* § 9604(a).

¹³¹ *See id.* § 9601(23) (defining "remove" and "removal").

¹³² *Id.* § 9601(24).

¹³³ *Id.* § 9604(a).

¹³⁴ *Id.* § 9605(a).

¹³⁵ *Id.* § 9606(a).

¹³⁶ *Cooper Indus., Inc. v. Aviall Servs., Inc.*, 543 U.S. 157, 161 (2004) (citing *Key Tronic Corp. v. United States*, 511 U.S. 809, 814 (1994)).

¹³⁷ 42 U.S.C. § 9606(a) (2010).

¹³⁸ *Id.* § 9621(f).

¹³⁹ *Id.* § 9621(f)(2).

(3) any person who by contract, agreement, or otherwise arranged for disposal or treatment, or arranged with a transporter for transport for disposal or treatment, of hazardous substances owned or possessed by such person, by any other party or entity, at any facility or incineration vessel owned or operated by another party or entity and containing such hazardous substances, and

(4) any person who accepts or accepted any hazardous substance for transport to disposal or treatment facilities, incineration vessels or sites selected by such person, from which there is a release, or a threatened release which causes the incurrence of response costs¹⁴⁰

These PRPs become liable for four kinds of costs and damages:

(A) all costs of removal or remedial action incurred by the United States Government or a State or an Indian tribe not inconsistent with the national contingency plan [response costs];

(B) any other necessary costs of response incurred by any other person consistent with the national contingency plan;

(C) damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such a release [natural resources damages]; and

(D) the costs of any health assessment or health effects study [required under section 104].¹⁴¹

Finally, Section 107 provides PRPs with only three defenses: (1) if the release and resulting damages were caused solely by “an act of God”; (2) if the release and resulting damages were caused solely by “an act of war”; or (3) if the release and resulting damages were caused solely by “an act or omission of a third party other than an employee or agent” of the PRP, and with no contractual relationship with the PRP, if the PRP exercised “due care” and “took precautions against foreseeable acts or omissions of any such third party and the consequences that could foreseeably result from such acts or

¹⁴⁰ *Id.* § 9607(a).

¹⁴¹ *Id.*

omissions¹⁴² Otherwise, PRPs can pursue a variety of settlement options with the governments¹⁴³ and contribution actions against each other.¹⁴⁴

CERCLA's basic goal is thus to have the people or companies who created a contaminated site pay to clean it up. However, Congress also created a Hazardous Substance Superfund, funded through a tax on chemical and oil companies, to pay for the cleanup of "orphan" sites.¹⁴⁵ This tax "expired in 1995, and [it has] not been reinstated,¹⁴⁶ with the result that Congress has been appropriating money to the Superfund through the normal federal budget process.

While CERCLA remains an important legal aspect of promoting coastal cleanups, contamination removal under its auspices has been notoriously slow in many circumstances, and nothing in the act requires governments to prioritize sites by location (say, in the coastal zone). The San Jacinto Waste Pits flooded during Hurricane Harvey provide an apt example. As noted, the site first became contaminated in the 1960s, and it has long been known for its toxicity. For example, "the Texas Parks and Wildlife Department warns people should not eat fish and crabs from the area because the animals may be contaminated," and the EPA added the site to the CERCLA NPL in 2008.¹⁴⁷ After Harvey, then-EPA Administrator Scott Pruitt put the San Jacinto Waste Pits on a list of special sites deserving of his personal attention, the EPA announced a \$115 million plan to remove contaminated material from the site, and a court approved an agreement whereby two companies would come up with a plan to clean up the site.¹⁴⁸ However, in April 2018, Pruitt removed the San Jacinto Waste Pits from his special list, leaving the

¹⁴² *Id.* § 9607(b).

¹⁴³ *Id.* § 9622

¹⁴⁴ *Id.* § 9613(f).

¹⁴⁵ *Id.* § 9611.

¹⁴⁶ *Id.*

¹⁴⁷ Rebecca Hersher, "EPA Takes Toxic Site Flooded by Harvey Off Special Cleanup List," *National Public Radio (NPR)*, <https://www.npr.org/sections/thetwo-way/2018/04/16/601867839/epa-takes-toxic-site-flooded-by-harvey-off-special-cleanup-list> (April 16, 2018).

¹⁴⁸ *Id.* See also Michael D. Regan, "Health concerns swirl in Texas months after floods from Harvey spread toxic waste," *PBS NewsHour*, <https://www.pbs.org/newshour/nation/health-concerns-swirl-in-texas-months-after-floods-from-harvey-spread-toxic-waste> (Dec. 10, 2017) (reporting the same figures).

companies with 29 months—more than two years—to formulate their cleanup plan.¹⁴⁹ Cleanup at the site, even after Harvey, is expected to take more than four years.¹⁵⁰

B. Resource Conservation and Recovery Act (RCRA)

Congress enacted the Solid Waste Disposal Act (SWDA)¹⁵¹ in 1976, but after the 1980 amendments it is much more commonly known the Resource Conservation and Recovery Act (RCRA). Unlike CERCLA, RCRA is proactive, seeking to prevent new contamination for hazardous waste. Specifically, Congress found that “although land is too valuable a national resource to be needlessly polluted by discarded materials, most solid waste is disposed of on land in open dumps and sanitary landfills” and that “disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment * * *.”¹⁵²

RCRA applies to “solid waste,” which the statute defines as:

any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial sources which are point sources subject to permits under section 1342 of Title 33 [the Clean Water Act], or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended * * *.¹⁵³

From there, RCRA regulation depends on whether solid waste is hazardous or not.

¹⁴⁹ Rebecca Hersher, “EPA Takes Toxic Site Flooded by Harvey Off Special Cleanup List,” *National Public Radio (NPR)*, <https://www.npr.org/sections/thetwo-way/2018/04/16/601867839/epa-takes-toxic-site-flooded-by-harvey-off-special-cleanup-list> (April 16, 2018).

¹⁵⁰ Michael D. Regan, “Health concerns swirl in Texas months after floods from Harvey spread toxic waste,” *PBS NewsHour*, <https://www.pbs.org/newshour/nation/health-concerns-swirl-in-texas-months-after-floods-from-harvey-spread-toxic-waste> (Dec. 10, 2017) (reporting the same figures).

¹⁵¹ 42 U.S.C. §§ 6901–6992k (2012).

¹⁵² *Id.* § 6901(b)(1), (2).

¹⁵³ *Id.* § 6903(27).

Nonhazardous solid waste is subject to RCRA Subtitle D. Under these provisions, states received the primary authority to regulate non-hazardous solid waste. First, they were expected to enact state solid waste management plans.¹⁵⁴ In order to receive federal approval, these state plans had to meet six statutory requirements. Most importantly, states had to forbid new open dumps within their borders and provide for the closing or upgrading of all existing open dumps.¹⁵⁵ As part of these controls, states were expected to implement permit programs for solid waste management facilities to control their intake of hazardous waste.¹⁵⁶ In addition, new disposal could only occur at sanitary landfills.¹⁵⁷ Under Congress's requirements, all new, replacement, and expanded landfills had to be built with at least two liners and leachate collection systems and had to provide for groundwater monitoring.¹⁵⁸

RCRA regulation, however, focuses far more stringently on hazardous waste, which is regulated under Subtitle C. A "hazardous waste" is "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—"

- (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
- (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.¹⁵⁹

The EPA had the responsibility to "develop and promulgate criteria for identifying the characteristics of hazardous waste, and for listing hazardous waste" and to actually list hazardous wastes subject to RCRA's subtitle C requirements, "taking into account toxicity, persistence, and degradability in nature, potential for accumulation in tissue, and other related factors such as flammability, corrosiveness, and other hazardous characteristics."¹⁶⁰ It identified characteristics that made wastes hazardous—

¹⁵⁴ *Id.* § 6943.

¹⁵⁵ *Id.* § 6943(a)(2), (3).

¹⁵⁶ *Id.* § 6945(c)(1).

¹⁵⁷ *Id.* § 6944(b).

¹⁵⁸ *Id.* § 6924(o).

¹⁵⁹ *Id.* § 6903(5).

¹⁶⁰ *Id.* § 6921(a), (b)(1).

ignitability,¹⁶¹ corrosiveness,¹⁶² reactivity,¹⁶³ and toxicity¹⁶⁴—but also listed specific types of hazardous wastes from various types of industries and industrial processes.¹⁶⁵

Subtitle C seeks to regulate hazardous wastes from “cradle to grave”—that is, from initial creation to eventual (safe) disposal. Hazardous waste generation is “the act or process of producing hazardous waste.”¹⁶⁶ Hazardous waste generators must keep records that identifying the hazardous wastes that they generate; label those wastes properly; store the waste in appropriate containers; begin RCRA’s manifest system to track the waste; and provide information and reports about the waste.¹⁶⁷ Hazardous waste transporters, in turn, must keep records about the waste they transport, continue the manifest system, refuse to transport improperly labeled hazardous waste, and deliver the waste only to permitted treatment, storage, and disposal (TSD) facilities.¹⁶⁸ RCRA rigorously regulates these TSD facilities, requiring permitting, financial responsibility, contingency plans, recordkeeping, and strict compliance with storage, handling, and disposal requirements.¹⁶⁹ In addition, as noted above, TSD facilities become liable for corrective actions—that is, for cleanups at and beyond the TSD facility if hazardous wastes escape.¹⁷⁰

Several facilities located in and near Houston during Hurricane Harvey were regulated under Subtitle C. For example, the Arkema Chemical Plant in Crosby, Texas, that caught fire was regulated as a RCRA large quantity hazardous waste generator under the Handler ID TXD043750512.¹⁷¹ Until 2011, the plant shipped all of its wastes off-site, but by 2013 it was generating over 16,000 tons of hazardous waste and handling most of that waste on-site.¹⁷² It produces a variety of hazardous wastes, including toxic metals (arsenic, cadmium, chromium, lead, mercury, selenium, and silver), toxic benzene, and toxic tetrachloroethylene, among several others.¹⁷³ Nevertheless, until Harvey, the

¹⁶¹ 40 C.F.R. § 261.21 (2017).

¹⁶² *Id.* § 261.22.

¹⁶³ *Id.* § 261.23.

¹⁶⁴ *Id.* § 261.24.

¹⁶⁵ *Id.* §§ 261.31-261.33.

¹⁶⁶ 42 U.S.C. § 6903(6) (2012).

¹⁶⁷ *Id.* § 6922(a).

¹⁶⁸ *Id.* § 6923(a).

¹⁶⁹ *Id.* § 6924(a).

¹⁷⁰ *Id.* § 6924(v).

¹⁷¹ Information retrieved from the EPA’s RCRAInfo database on July 31, 2018, https://ofmpub.epa.gov/enviro/rcrainfoquery_3.facility_information?pgm_sys_id=TXD043750512.

¹⁷² *Id.*

¹⁷³ *Id.*

chemical plant was relatively compliant with RCRA: The State of Texas had taken only two informal (letter-based) enforcement actions under RCRA against the plant, although the facility has not been inspected since October 2013.¹⁷⁴

C. Coastal Zone Management Act

The federal Coastal Zone Management Act (CZMA)¹⁷⁵ essentially bribes coastal states with federal consistency requirements, money, and technical assistance into engaging in proactive coastal planning and management.¹⁷⁶ Specifically, the Act encourages states to create Coastal Zone Management Programs that meet 16 detailed requirements,¹⁷⁷ most of which are easily classified as land (and sometimes water) use planning¹⁷⁸ or governmental organization, authority, and procedures.¹⁷⁹ A few requirements are fairly specific; for example, coastal states must address energy facilities in the coastal zone (including their impacts),¹⁸⁰ coastal erosion,¹⁸¹ and nonpoint source pollution.¹⁸²

The delineated components of a Coastal Zone Management Program are certainly broad enough to allow a state to prioritize coastal toxicity.¹⁸³ However, nothing in the Act explicitly mentions toxics, toxicity, or hazardous waste.

Like all coastal states except Alaska, Texas implements an approved Coastal Zone Management Program, which it first adopted in 1997.¹⁸⁴ The state's goals for its program center around Coastal Natural Resource Areas, or CNRAs. Those goals are:

- To protect, preserve, restore, and enhance the diversity, quality, quantity, functions, and values of CNRAs;

¹⁷⁴ Information retrieved from the EPA's Enforcement and Compliance History Online (ECHO) database on July 31, 2018, <https://echo.epa.gov/detailed-facility-report?fid=110000463258>.

¹⁷⁵ 16 U.S.C. §§ 1451-1466 (2012).

¹⁷⁶ *See id.* §§ 1455-1456.

¹⁷⁷ *Id.* § 1455(d).

¹⁷⁸ *Id.* § 1455(d)(2), (9), (11)(B), (12), (13).

¹⁷⁹ *Id.* § 1455(d)(3)-(7), (10), (14)-(16).

¹⁸⁰ *Id.* § 1455(d)(2)(H), (8).

¹⁸¹ *Id.* § 1455(d)(2)(I).

¹⁸² *Id.* §§ 1455(d)(16), 1455b.

¹⁸³ *E.g., id.* § 1456b(a)(2), (4)-(6).

¹⁸⁴ TEXAS COASTAL MANAGEMENT PROGRAM, 2015-2016 BIENNIAL REPORT 1-2 (Dec. 2016), available at <http://www.glo.texas.gov/coast/coastal-management/forms/files/CMP-Biennial-Report-2015-2016.pdf>.

- To ensure sound management of all coastal resources by allowing for compatible economic development and multiple human uses of the coastal zone;
- To minimize loss of human life and property due to the impairment and loss of protective features of CNRAs;
- To ensure and enhance planned public access to and enjoyment of the coastal zone in a manner that is compatible with private property rights and other uses of the coastal zone;
- To balance the benefits from economic development and multiple human uses of the coastal zone, the benefits from protecting, preserving, restoring, and enhancing CNRAs, the benefits from minimizing loss of human life and property, and the benefits from public access to and enjoyment of the coastal zone;
- To coordinate agency and subdivision decision-making affecting CNRAs by establishing clear, objective policies for the management of CNRAs;
- To make agency and subdivision decision-making affecting CNRAs efficient by identifying and addressing duplication and conflicts among local, state, and federal regulatory and other programs for the management of CNRAs;
- To make agency and subdivision decision-making affecting CNRAs more effective by employing the most comprehensive, accurate, and reliable information and scientific data available and by developing, distributing for public comment, and maintaining a coordinated, publicly accessible geographic information system (GIS) of maps of the coastal zone and CNRAs at the earliest possible date;
- To make coastal management processes visible, coherent, accessible, and accountable to the people of Texas by providing for public participation in the ongoing development and implementation of the CMP; and
- To educate the public about the principal coastal problems of state concern and technology available for the protection and improved management of CNRAs.¹⁸⁵

In addition, however, Texas is pursuing a coastal resiliency program, with public meetings focused on “increasing economic and environmental vulnerabilities, resulting from population growth, increased storm intensity, and shoreline erosion” and on “planning for changing conditions and future storm hazards along the coast.”¹⁸⁶ In addition, the Program “is developing the Master Plan, a long-term framework intended to mitigate damage from future coastal natural disasters and preserve and enhance the state’s coastal natural resources and assets.”¹⁸⁷ Nevertheless, although coastal infrastructure is clearly part of these discussions and resiliency planning, none of the identified strategies—“ 1) restoring Texas’s beaches and dunes; 2) bay shoreline stabilization and estuarine wetland restoration (living shorelines); 3) stabilizing the

¹⁸⁵ *Id.* at 3.

¹⁸⁶ *Id.* at 10.

¹⁸⁷ *Id.*

GIWW; 4) freshwater wetland and coastal uplands conservation; 5) delta and lagoon restoration; 6) oyster reef creation and restoration; 7) rookery island creation and restoration; and 8) plans, policies, and programs”¹⁸⁸—acknowledge coastal toxicity as a possible problem.

Toxicity consciousness may emerge in some parts of Texas at a more local level. For example, using grants from the Coastal Zone Management Program, Galveston Bay engaged both in a contaminated seafood warning program to educate subsistence and recreational fishers, especially in low-income and Spanish-speaking immigrant communities, “about the risk of consuming seafood contaminated with toxic substances” and a program to educate boaters about their wastes—most recently, the illegality of sewage discharges but with additional issues slated for future years.¹⁸⁹ These developments thus suggest that Galveston might be one of the Texas coastal municipalities that most open to dealing more proactively with coastal toxicity problems.

D. State and Local Land Use Planning

Unlike environmental and natural resource regulation, land use planning is usually the particular province of municipalities, and this aspect of local law can be critical to dealing with climate change and its impacts. C40, “a network of the world’s megacities committed to addressing climate change,”¹⁹⁰ has underscored the importance of land use planning as follows:

Land use planning provides the strategic framework for the growth of a city, determining the physical uses of space that will influence how people live and move, for generations to come. Cities have significant authority over land use policies and regulations. . . . It is particularly important that cities have a good plan for how they will address growth, because as C40 research has shown, the planning decisions made today will have a major impact on the carbon emissions of tomorrow.¹⁹¹

By this organization’s international count, “79% of cities have the power to set land use policies and regulations and 81% are responsible for carrying out the function of land use planning.”¹⁹²

¹⁸⁸ *Id.*

¹⁸⁹ *Id.* at 16, 18, 22, 26.

¹⁹⁰ C40 Cities, *About C40*, <https://www.c40.org/about> (as viewed July 31, 2018).

¹⁹¹ C40 Cities, *Land Use Planning: Network Overview*, <https://www.c40.org/networks/land-use-planning> (as viewed July 31, 2018).

¹⁹² *Id.*

Land use planning is also relevant to latent and cumulative toxicity concerns. Indeed, “[l]and use data are increasingly understood as important indicators of potential environmental health risk in urban areas where micro-scale or neighborhood level hazard exposure data are not routinely collected.”¹⁹³ In 2003, a National Academy of Public Administration panel reported to the EPA that municipalities could use land use more effectively to reduce residents’ cumulative toxic exposures. Most directly, “local planning and zoning authorities could be used to reduce adverse impacts where industrial and residential areas are located near each other.”¹⁹⁴ Notably, however, the report also advocated greater coordination and interaction between states and local governments to best deploy land use planning tools. For example, it recommended that states take steps to ensure local government participation in environmental permitting decisions (such as RCRA permitting decisions made through delegated federal authority), because “[t]hrough active involvement, local governments can help ensure that proposed environmental permits contain the conditions necessary to protect public health and the environment at the community level.”¹⁹⁵ The report saw great promise for such increased cooperation, concluding that “[i]f state and local officials make creative and aggressive use of existing legal authorities, it may be possible to resolve the environmental and public health concerns of community residents.”¹⁹⁶

Houston is infamous, however, for its *lack* of land use planning: “The city of Houston proper is unique among large US cities in that it has no traditional use-based zoning (ala-Sim City: residential here, commercial there, etc.)”¹⁹⁷ However, that

¹⁹³ Jason Corburn, *Urban land use, air toxics and public health: Assessing hazardous exposures at the neighborhood scale*, 27:2 ENVTL. IMPACT ASSESSMENT REV. 145, 145 (March 2007), available at <https://www.sciencedirect.com/science/article/pii/S0195925506001260>.

¹⁹⁴ PHILIP RUTLEDGE, A. JAMES BARNES, TEODORO BENAVIDES, JONATHAN HOWES, DAVID MORA, JAMES MURLEY, & SYLVESTER MURRAY, NATIONAL ACADEMY OF PUBLIC ADMINISTRATION, ADDRESSING COMMUNITY CONCERNS: HOW ENVIRONMENTAL JUSTICE RELATES TO LAND USE PLANNING AND ZONING 18 (July 2003), available at <https://www.epa.gov/sites/production/files/2015-02/documents/napa-land-use-zoning-63003.pdf>.

¹⁹⁵ *Id.*

¹⁹⁶ *Id.* at 19.

¹⁹⁷ Daniel Herriges, “Houston Isn’t Flooded Because of Its Land Use Planning,” *Strong Towns*, <https://www.strongtowns.org/journal/2017/8/30/houston-hurricane-harvey-land-use> (Aug. 30, 2017). See also Nolan Gray, “How Houston Regulates Land Use,” *Market Urbanism*, <https://marketurbanism.com/2016/09/19/how-houston-regulates-land-use/> (Sept. 19, 2016) (“Unlike every other major U.S. city, Houston doesn’t mandate the separation of residential, commercial, and industrial developments. This means that restaurants, homes, warehouses, and offices are free to mix as the market allows. As many

doesn't mean that development is completely haphazard. The city itself "regulates land use in many other ways, such as minimum-parking requirements. Many neighborhoods have homeowners associations and deed restrictions that limit what can be built. And Houston's suburbs largely do have zoning."¹⁹⁸

Notably, in the immediate wake of Harvey, both local and national pundits debated the contribution of Houston's land use planning to the severity of the flooding, particularly in terms of wetlands destruction and building in floodplains.¹⁹⁹ Less flamboyant were several pre-Harvey examinations of the relationship between Houston area's land use planning and residents' potential toxic exposure. For example, Houston passed a hazardous materials ordinance in 1996 that prevents hazardous facilities from locating in neighborhoods that are more than one-third residential.²⁰⁰ However, like most such laws, this ordinance did not apply to hazardous facilities already in existence, effectively allowing those existing facilities to continue.²⁰¹

A team of economists from the University of Pittsburgh and University of Washington, Bothell, happened to be assessing the long-term effect of zoning in Chicago across Hurricane Harvey's timeframe, drafting their results in 2016 but publishing in May 2018.²⁰² Because of Houston's resistance to traditional zoning, it served as the

have pointed out, however, market-driven separation of incompatible uses—think strip clubs and preschools—is common in Houston.”).

¹⁹⁸ Herriges, *supra* note 197.

¹⁹⁹ *Compare id.*; Emily Hamilton, “What Houston’s Critics Get Wrong: land use regulations weren’t to blame for Hurricane Harvey’s destruction,” *U.S. News & World Report*, <https://www.usnews.com/opinion/economic-intelligence/articles/2017-09-18/land-use-wasnt-to-blame-for-houstons-hurricane-harvey-destruction> (Sept. 18, 2017), with Ana Campoy & David Yanofsky, “Houston’s flooding shows what happens when you ignore science and let developers run rampant,” *Quartz*, <https://qz.com/1064364/hurricane-harvey-houstons-flooding-made-worse-by-unchecked-urban-development-and-wetland-destruction/> (Aug. 29, 2017); Shawn Boburg & Beth Reinhard, “Houston’s ‘Wild West’ growth: How the city’s development may have contributed to devastating flooding,” *The Washington Post*, https://www.washingtonpost.com/graphics/2017/investigations/harvey-urban-planning/?utm_term=.658f694b5b1a (Aug. 29, 2017).

²⁰⁰ Lydia DePillis, “How zoning impacts your proximity to pollution: Sixty-five percent of Houston is within a mile of a toxic emitter,” *The Houston Chronicle*, <https://www.chron.com/business/texanomics/article/How-zoning-impacts-your-proximity-to-pollution-9232526.php> (Sept. 20, 2016).

²⁰¹ *Id.*

²⁰² Allison Shertzer, Tate Twinam, & Randall P. Walsh, *Zoning and the economic geography of cities*, 105 J. URBAN ECON. 20, 20 (May 2018).

researchers' control/counterfactual.²⁰³ Provocatively, 65 percent of Houston lies within one mile of a TRI reporting facility, compared to 30 percent of Austin, 44 percent of Dallas, and 43 percent of San Antonio, "suggest[ing] that land use patterns in relatively un-regulated Houston differ measurably from comparable cities that experienced formal zoning."²⁰⁴ In addition, the researchers' results for Chicago "strongly suggest that over the long-run urban planning has been effective in creating residential neighborhoods that are distant from undesirable manufacturing uses, and that houses in these neighborhoods are more valuable as a result,"²⁰⁵ a result the economists clearly view as desirable.

However, it should be noted that there is another way of looking at the researchers' results, which is that Houston's approach to land use has more fairly spread the city's overall toxic burden across its citizens. Notably, the researchers found that areas zoned for manufacturing or commercial use in Chicago were statistically more like to contain TRI reporting facilities²⁰⁶—a result that makes inherent intuitive sense. Such concentration of toxics-emitting facilities, however, is also a primary source of environmental justice concerns, as those who cannot afford the more expensive neighborhoods are forced by economics to live with additional toxic exposure and risk.

Regardless of how land use planning distributes toxic exposures, however, such exposures remain public health risks. For better for all concerned to reduce the city's overall toxic burden in the first place. Houston's 1996 hazardous facility ordinance was more akin to Chicago's separation-of-uses approach to land use planning than to a real effort to reduce overall toxicity, but Part IV will discuss alternative approaches that better implement a toxicity reduction goal.

E. Tort Law

Tort is the traditional remedy for preventable damage, and four torts in particular are generally associated with releases of toxic materials. Strict liability arises when a defendant engages in inherently dangerous activities or abnormally dangerous conduct.²⁰⁷ Unlike strict liability, negligence is a fault-based approach to liability that requires a plaintiff to prove that the defendant violated a duty or standard of care, factually and legally causing the plaintiff harm.²⁰⁸ Trespass applies to a defendant's physical invasion of the plaintiff's real property, such as a physical spilling of toxic

²⁰³ *Id.* at 32.

²⁰⁴ *Id.* at 33.

²⁰⁵ *Id.* at 34.

²⁰⁶ *Id.* at 28.

²⁰⁷ ROBIN KUNDIS CRAIG, ENVIRONMENTAL LAW IN CONTEXT: CASES AND MATERIALS 32 (3rd Ed. 2012).

²⁰⁸ *Id.* at 32-33.

materials onto the plaintiff's property.²⁰⁹ Finally, nuisance allows a plaintiff to recover when a defendant unreasonably interferes with the plaintiff's use and enjoyment of real property.²¹⁰ "Public nuisance is an unreasonable interference with rights held by the public in general," while private nuisance "is an unreasonable interference with the rights of a plaintiff who has a possessory interest in the land affected."²¹¹ Like CERCLA, however, tort liability is retrospective and reactive: the damage, in almost all cases, has already occurred.

Hurricane Harvey gave rise to several follow-on lawsuits, many demonstrating how injured plaintiffs can attempt to use tort liability to seek compensation for their exposures to coastal toxicity. The Arkema Chemical Plant in Crosby has become a particularly cogent defendant as a result of the fires and other toxic releases at the plant. In early September 2017, even as Harvey was still winding down, "[s]even police, fire and emergency medical technicians sued Arkema in Harris County District Court for at least \$1 million, alleging negligence by the company and executives led flammable organic peroxides stored at the site to ignite after the plant lost power during the storm."²¹² Their complaint, filed in the Harris County District Court,²¹³ alleges that the plaintiffs suffered vomiting and loss of breath while responding to the Arkema fires and asserts causes of action for negligence, gross negligence, and negligence *per se*.²¹⁴

The next month, residents of Crosby, Texas, filed a class action lawsuit in the U.S. District Court for the Southern District of Texas, Houston Division, against Arkema,²¹⁵ alleging negligence, trespass, nuisance, property damage, personal injury, failure to warn, product liability, ultra-hazardous activity (strict liability), gross negligence, and negligent infliction of emotional distress.²¹⁶ They seek punitive damages and are asking the court to pierce Arkema's corporate veil so that its parent corporations

²⁰⁹ *Id.* at 33.

²¹⁰ *Id.*

²¹¹ *Id.*

²¹² *Reuters*, "First responders file suit against Arkema over 'serious bodily injuries' in Houston chemical plant fire after Hurricane Harvey," *CNBC*, <https://www.cnn.com/2017/09/07/arkema-sued-over-injuries-in-chemical-plant-fire-after-hurricane-harvey.html> (Sept. 7, 2017).

²¹³ The complaint for this case, *Graves v. Arkema*, is available at <http://41af3k34gprx4f6bg12df75i.wpengine.netdna-cdn.com/wp-content/uploads/sites/19/2017/09/Graves-et-al-v-Arkema.pdf>.

²¹⁴ *Id.* at 6, 7-9.

²¹⁵ The complaint for this case, *Wheeler v. Arkema*, is available at https://www.peer.org/assets/docs/csb/12_7_17_Suit_vs_Arkema.pdf.

²¹⁶ *Id.* at 26-29.

may also be held liable.²¹⁷ The plaintiffs base their complaints both on the fires at the plant and on releases from two water tanks. They allege that “an estimated 23,608 pounds of contaminants were released from two [water] tanks including: ethylbenzene, mineral spirits, naphtha, naphthalene, organic peroxides, trimethylbenzene, tert-butyl alcohol, 2,5 dimethyl-2,5 di(t-butylperoxy)hexane and t-amyl alcohol.”²¹⁸ In addition, according to the plaintiffs, the smoke and ash from the fire released PAHs, toxic metals like antimony, volatile organic compounds like acetone, dioxins, furans, and a host of other toxic compounds.²¹⁹

What is striking in both cases is not just the plaintiffs’ assertions of past injuries during the hurricane and its toxic releases, but their fears for unknown future injuries. Thus, the plaintiff first responders seek not only actual damages for pain already suffered and medical care already received, but also “[r]easonable and necessary medical care and expenses which will in all reasonable probability be incurred in the future;” “[p]hysical pain and suffering in the future;” “[p]hysical impairment which, in all reasonable probability, will be suffered in the future;” “[l]oss of earning capacity which will, in all probability, be incurred in the future;” “[d]isfigurement in the future;” “[m]ental anguish in the future;” and “[t]he cost of future medical monitoring.”²²⁰ The Crosby residents, similarly, seek “[a]n Order establishing a Medical Monitoring Program designed to survey as appropriate and to protect the Class Members from latent, dread disease, funded by the Defendants”²²¹ These cases, therefore, frame the Arkema flooding, fire, and releases as the source of true toxic torts, plunging the plaintiffs legally into the uncertain world of “futures” cases.²²²

²¹⁷ *Id.* at 29-31.

²¹⁸ *Id.* at 16 ¶ 46.

²¹⁹ *Id.* at 16-19.

²²⁰ *Graves v. Arkema* Complaint, *supra* note 213, at 13.

²²¹ *Wheeler v. Arkema* Complaint, *supra* note 215, at 32.

²²² One of the classic problems of toxic torts is the sometimes very long latency period between exposure to a toxic agent and manifestation of a disease. “Because of these issues, plaintiffs have increasingly sought recovery after exposure but before the manifestation of disease has taken place. These ‘futures’ cases are among the most hotly debated in toxic tort law.” ROBIN KUNDIS CRAIG, MICHAEL D. GREEN, ANDREW R. KLEIN & JOSEPH SANDERS, *TOXIC AND ENVIRONMENTAL TORTS: CASES AND MATERIALS* 668 (Thompson Reuters 2011). Medical monitoring is the least controversial of the three typical futures remedies, which also include fear of disease and enhanced risk of disease. *Id.* at 668-711.

Studies released in May 2018 suggest that the plaintiffs in these cases may have good grounds for their lawsuits.²²³ The U.S. Chemical Safety and Hazard Investigation Board found that officials at the Arkema chemical plant had been warned over one year before Harvey that that plant was at risk of flooding, and it concluded in its 154-page report that Arkema “was not prepared for the 6 feet of water that wiped out the facility’s power and backup generators.”²²⁴ However, as the claims for medical monitoring and future damages show, the latent toxicity around Houston has morphed, because of Hurricane Harvey, into psychologically real and legally cognizable worries for all of the Arkema-exposed plaintiffs about their future health, with the true future risks that they face from their exposures during Harvey very unclear.

IV. THREE SUGGESTIONS FOR IMPLEMENTING A PRECAUTIONARY, HUMAN HEALTH-BASED APPROACH TO IMPROVING COASTAL ADAPTIVE CAPACITY IN THE ANTHROPOCENE

It can almost always be said, in almost any context, that governments could improve both their enforcement of environmental and public health laws and their disaster preparedness and response. Analyses of Hurricane Harvey in Houston certainly support these common suggestions for improving coastal responses to hurricanes.²²⁵ Nevertheless, environmental enforcement and disaster response are largely reactionary,

²²³ Stephanie Ebbs, “Noxious chemical fire during Hurricane Harvey caused by failure of ‘all levels of protection,’ probe reveals,” *ABC News*, <https://abcnews.go.com/Politics/noxious-chemical-fire-hurricane-harvey-caused-failure-layers/story?id=55410407> (May 25, 2018).

²²⁴ Alex Stuckey, “Arkema officials were warned of flood risks a year before Hurricane Harvey,” *The Houston Chronicle*, <https://www.chron.com/news/science-environment/article/Arkema-officials-were-warned-of-flood-risks-a-12937654.php> (May 25, 2018). The report is available from the Board through <https://www.csb.gov/csb-releases-arkema-final-report/>.

²²⁵ See generally CBS News, “Hurricane Harvey’s toxic impact deeper than public told,” <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018) (noting, for example, that many spills were not reported to emergency responders during Harvey and that many of the facilities involved had track records of environmental violations). Notably, the Texas Legislature had actually hampered environmental enforcement at the municipal level. “Two Texas laws enacted since mid-2015 have weakened counties’ ability to police polluters. The first caps at \$2.15 million what they can collect from polluters in lawsuits. The rest must go to the state. The second law took effect Sept. 1. It obliges counties to give the state right of first refusal on any pollution enforcement cases, which local officials say could mean less punitive action.” *Id.*

rather than precautionary, responses to toxic coasts, effectively focused less on protecting public health than on supporting coastal industry until such industry causes real problems.

Coastal states and municipalities *can* pursue more precautionary, health-based management policies regarding toxics in the coastal zone. Federal law almost always leaves states free to pursue more stringent pollution policies than it requires, and new technologies can help these governments to de-toxify their coastal zones. This Part presents three truly precautionary suggestions that serve to promote coastal public health by reducing the ability of coastal storms and sea-level rise to produce toxic hazards during flooding and inundation.

A. Clean Up Existing Contaminated Sites

While, as Part III discussed, legal authorities exist at both the federal and state levels to clean up existing toxic waste dumps and other hazardous sites, such cleanups have not proceeded as fast as they might, nor has coastal contamination been made a priority. As a result, “[c]ontaminated sites often go for years and sometimes decades without being fully cleaned up.”²²⁶

Finding sufficient money for these often-expensive cleanups is often part of the problem. As noted, the Superfund tax expired in 1995, and Congress has been funding CERCLA cleanups through annual appropriations. In 2015, the U.S. Government Accountability Office (GAO) found that both the funding and the effectiveness of CERCLA were declining, sometimes dramatically.²²⁷ Its more specific findings are worth quoting at length:

Annual federal appropriations to the Environmental Protection Agency’s (EPA) Superfund program generally declined from about \$2 billion to about \$1.1 billion in constant 2013 dollars from fiscal years 1999 through 2013. EPA expenditures—from these federal appropriations—of site-specific cleanup funds on remedial cleanup activities at nonfederal National Priorities List (NPL) sites declined from about \$0.7 billion to about \$0.4 billion during the same time period. . . . EPA spent the largest amount of cleanup funds in Region 2 [comprising New Jersey, New York, Puerto Rico,

²²⁶ Toxics Action Coalition, *supra* note 29, at 6.

²²⁷ U.S. Government Accountability Office, *Trends in Federal Funding and Cleanup of EPA’s Nonfederal National Priorities List Sites* i (Sept. 2015), available at <https://www.gao.gov/assets/680/672734.pdf>. “Nonfederal” sites are sites that are not federal facilities, *id.* at 1—i.e., sites like military bases that are owned by the federal government.

the U.S. Virgin Islands, and eight tribal nations²²⁸], which accounted for about 32 percent of cleanup funds spent at nonfederal NPL sites during this 15-year period. The majority of cleanup funds was spent in seven states, with the most funds spent in New Jersey—over \$2.0 billion in constant 2013 dollars, or more than 25 percent of cleanup funds.

From fiscal years 1999 through 2013, the total number of nonfederal sites on the NPL annually remained relatively constant, while the number of remedial action project completions and construction completions generally declined. . . . The total number of nonfederal sites on the NPL increased from 1,054 in fiscal year 1999 to 1,158 in fiscal year 2013, and averaged about 1,100 annually. The number of remedial action project completions at nonfederal NPL sites generally declined by about 37 percent during the 15-year period. Similarly, the number of construction completions at nonfederal NPL sites generally declined by about 84 percent during the same period.²²⁹

Perhaps surprisingly to many, despite President Trump’s February 2018 overall proposal to slash the EPA’s budget, he proposed to maintain CERCLA cleanup funding at \$1.1 billion for fiscal year 2019 and has proposed other mechanisms for funding cleanups as part of his infrastructure package.²³⁰ Some of these proposals, like giving CERCLA cleanups “access to financing under the Water Infrastructure Finance and Innovation Act (WIFIA) lending program to address contamination to water resources,” might simply shift existing money from other environmental issues to cleanups, both others would expand the grant money available to cleanup both brownfields and NPL sites.²³¹

In March 2018, Congress did appropriate almost \$1.1 billion to the Superfund, although that money can also be transferred to other federal agencies.²³² It also directly provided \$80 million in state and tribal assistance grants under CERCLA,²³³ over \$77 million to the National Institutes of Health for CERCLA-required health studies,²³⁴ and

²²⁸ U.S. Env’tl. Protection Agency, *EPA Region 2*, <https://www.epa.gov/aboutepa/epa-region-2> (as viewed Aug. 1, 2018).

²²⁹ U.S. Government Accountability Office, *supra* note 227, at i.

²³⁰ Sylvia Carignan, “Trump Proposes New Funding Options for Superfund, Brownfields,” *BNA News*, <https://www.bna.com/trump-proposes-new-n57982088681/> (Feb. 13, 2018).

²³¹ *Id.*

²³² PUB. L. NO. 115-141, 132 Stat. 348, 664 (March 23, 2018).

²³³ *Id.* at 665.

²³⁴ *Id.* at 680.

over \$74 million to the Agency for Toxic Substances and Disease Registry for health risk assessments under CERCLA.²³⁵ In addition, under the heading of “Infrastructure,” Congress added another \$63 million for the EPA’s CERCLA activities, \$650 million for the state and tribal grants program, and \$53 million to the EPA’s Water Infrastructure Finance and Innovation Program Account for loans.²³⁶ Finally, Congress also enacted through the budget bill the Brownfields Utilization, Investment, and Local Development (BUILD) Act of 2018, which, *inter alia*, increases the availability of grants and loans for brownfield sites—but not those on the NPL.²³⁷

However, this is not enough money. Thus, there continue to be calls to reinstate the Superfund tax,²³⁸ and there are also calls to increase the EPA’s CERCLA enforcement financing, providing the agency the ability to force the liable parties to pay for cleanups.²³⁹

Direct citizen actions offer an alternative approach. The ultimate “fix” to coastal cleanups is altered public priorities that can put sufficient pressure on politicians at all levels of government to provide the funding and personnel necessary to expedite detoxifying actions. In the meantime, citizen lawsuits can sometimes provide a second-best jump-start. Unlike most federal environmental laws, however, CERCLA’s citizen suit provision²⁴⁰ is of limited use to plaintiffs who are not themselves liable under the Act to try to force actual cleanups, because many of the damages that plaintiffs would seek are not “response costs” recoverable under CERCLA,²⁴¹ because individuals, NGOs, and cities cannot seek natural resources damages,²⁴² and because CERCLA includes a fairly stringent bar to any citizen suit that challenges an ongoing cleanup, including suits

²³⁵ *Id.*

²³⁶ PUB. L. NO. 115-141, § 430, 132 Stat. at 694.

²³⁷ *Id.* tit. VII, Div. N, 132 Stat. at 1052-59.

²³⁸ Bryan Anderson, “Taxpayer dollars fund most oversight and cleanup costs at Superfund sites,” *The Washington Post*, https://www.washingtonpost.com/national/taxpayer-dollars-fund-most-oversight-and-cleanup-costs-at-superfund-sites/2017/09/20/aedcd426-8209-11e7-902a-2a9f2d808496_story.html?utm_term=.efca57c3398e (Sept. 20, 2017) (quoting Christina Todd Whitman).

²³⁹ Elliott Gilberg, “Funding the Superfund,” *The Washington Post*, https://www.washingtonpost.com/opinions/funding-the-superfund/2017/09/25/6662a9e8-9fbc-11e7-b2a7-bc70b6f98089_story.html?utm_term=.fc702f93771e (Sept. 25, 2017).

²⁴⁰ 42 U.S.C. § 9659 (2012).

²⁴¹ *E.g.*, *Lutz v. Chromatex, Inc.*, 718 F. Supp. 413, 417-18 (M.D. Penn. 1989).

²⁴² *Id.* at 718-19; *City of Toledo v. Beazer Materials & Services, Inc.*, 833 F. Supp. 646, 650-52 (N.D. Ohio 1993).

seeking to strengthen that effort.²⁴³ RCRA's citizen suit provision, however, can often (but not always) fill in, because it allows plaintiffs to bring suit "against any person who has contributed or is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an imminent and substantial endangerment to health or the environment"²⁴⁴ While litigation also requires money, RCRA allows courts to award costs and attorney fees to successful plaintiffs,²⁴⁵ and, like most federal environmental citizen suit provisions, it preserves plaintiffs' tort remedies.²⁴⁶

However, cities can also act to effectuate coastal cleanups. As one example, the City of Emeryville, California, located between Berkeley and Oakland on San Francisco Bay, was essentially one large brownfield site.²⁴⁷ Specifically, "As large industries began to contract and relocate to other cities in the 1970s, they left behind properties with toxins that had to be cleaned up before other businesses could use them."²⁴⁸ To address these sites, the City assembled state and federal grants both to clean up properties that it owns and to make loans to private property owners for private remediation.²⁴⁹ One of the city's current projects will become a greenway; another will be turned into affordable housing.²⁵⁰

B. Implement Toxic-Aware Land Use and Waste Management Planning Along the Coast

While cleaning up legacy toxicity remains a significant political challenge, coastal municipalities and states can take a number of other measures to reduce the toxic load on the nation's coasts moving forward. One avenue is to revamp land use planning to more directly address toxicity issues. The National Academy of Public Administration panel, for example, made several recommendations relevant to municipalities seeking to avoid concentrations of toxic and hazardous facilities in particular areas. First, such municipalities should "take steps to eliminate existing nonconforming uses that present public health and environmental hazards."²⁵¹ Second, they should adopt more flexible zoning techniques, such as:"

²⁴³ 42 U.S.C. § 9613(h) (2012).

²⁴⁴ 42 U.S.C. § 6972(a)(1)(B) (2012).

²⁴⁵ *Id.* § 6972(e).

²⁴⁶ *Id.* § 6972(f).

²⁴⁷ Emeryville, California, *Brownfield Program*, <https://www.ci.emeryville.ca.us/221/Brownfield-Program> (as viewed Aug. 1, 2018).

²⁴⁸ *Id.*

²⁴⁹ *Id.*

²⁵⁰ *Id.*

²⁵¹ RUTLEDGE ET AL., *supra* note 194, at 19.

- Setting up conditional uses that impose restrictions on certain uses that may affect environmental justice issues;
- Establishing overlay zones that impose additional requirements to provide for additional environmental protections;
- Using performance zoning to regulate the adverse impacts of nuisance-like activities, such as noise and odor; and
- Establishing buffer zones in transitional areas between incompatible land uses, especially for industrial uses adjacent to residential areas.²⁵²

Overall, the panel concluded, “[l]ocal governments can play a primary role in identifying neighborhoods where residents face multiple environmental and public health risks. However, they need help from the other levels of government to develop and implement strategies for reducing risks, taking advantage of each level’s unique authorities and expertise.”²⁵³

The Toxics Action Center has also recommended toxicity-reducing actions that states and municipalities can take. First, states and municipalities can act to reduce or eliminate persistent toxic chemicals in the coastal zone.²⁵⁴ Persistent toxic chemicals are slow to break down and lose their toxicity, and “[t]hese contaminants can cause cancer, birth defects and other reproductive problems, immune system challenges and damage to the nervous and respiratory systems.”²⁵⁵ Massachusetts, for example, “passed the Toxics Use Reduction Act (TURA), creating a highly successful system to assist industrial users of large quantities of toxic chemicals to reduce their toxics use. This program has been good for public health and also resulted in significant cost savings for many participating businesses.”²⁵⁶ Indeed, reports indicate that between 1990 and 1999, businesses in Massachusetts reduced their chemical wastes by 57 percent, reduced their use of toxic chemicals by 40 percent, reduced their chemical emissions by 80 percent—and save \$15 million in the process.²⁵⁷ Other examples of such state statutes exist, including Oregon’s 1989 Toxics Use and Hazardous Waste Reduction Act,²⁵⁸ which requires any large toxics

²⁵² *Id.*

²⁵³ *Id.* at 21.

²⁵⁴ Toxics Action Coalition, *supra* note 29, at 5.

²⁵⁵ *Id.*

²⁵⁶ *Id.*

²⁵⁷ Oregon Center for Environmental Health, Oregon Toxics, & Multnomah County Sustainability Program, *Sustainability Through Toxics Reduction in Local Government* 12, <http://www.orcities.org/Portals/17/a-z/toxicsreductionpp.pdf> (Sept. 2007).

²⁵⁸ OR. REV. STAT. §§ 465.003-465.037 (2017).

user in the state to complete a toxics use reduction and hazardous waste reduction plan that identifies alternatives to its current practices.²⁵⁹

Second, relatedly, states and municipalities can work to reduce specific uses of toxic materials, and hence residents' direct exposures. For example, in 2001 Massachusetts enacted the Children and Families Protection Act²⁶⁰ "to reduce children's exposure to harmful pesticides by restricting pesticide use in private and public schools and daycare centers and increasing right-to-know. Unfortunately, the law has been implemented unevenly across the state."²⁶¹

Third, coastal municipalities can work to reduce their overall waste streams, working toward a goal of zero waste. For example, Nantucket, Massachusetts, "diverts more than 92% of waste from landfills through aggressive recycling and waste reduction practices and has extended the life of the landfill for decades."²⁶²

C. Enact Building Codes that Minimize the Potential for Further Toxic Releases

Many industrial facilities in Houston essentially threw up their hands in trying to prevent releases during Hurricane Harvey. The on-site manager of Gulf Coast Energy, for example, declared his facility's release of methanol "'impossible to contain'" in light of the 20-foot floodwaters.²⁶³ Similarly, Arkema Chemicals resists arguments that it failed to prepare its Crosby, Texas, chemical plant adequately, emphasizing that the flooding during Harvey was "unprecedented."²⁶⁴

While lawyers, politicians, scientists, economists, and public health officials can (and do) debate how much preparation is "too much" in light of increasing risks to coastal communities from climate change, coastal storms, sea-level rise, and storm surge, it is worth noting that architects and building engineers having been putting considerable effort into designing "storm-proof" homes and businesses that could greatly reduce toxic

²⁵⁹ *Id.* § 465.015.

²⁶⁰ MASS. GEN. L. ANN. 132B § 6C (2017).

²⁶¹ Toxics Action Coalition, *supra* note 29, at 7.

²⁶² *Id.* at 6.

²⁶³ CBS News, "Hurricane Harvey's toxic impact deeper than public told," <https://www.cbsnews.com/news/hurricane-harveys-toxic-impact-deeper-than-public-told/> (March 22, 2018) (quoting Dennis Frost).

²⁶⁴ Stephanie Ebbs, "Noxious chemical fire during Hurricane Harvey caused by failure of 'all levels of protection,' probe reveals," *ABC News*, <https://abcnews.go.com/Politics/noxious-chemical-fire-hurricane-harvey-caused-failure-layers/story?id=55410407> (May 25, 2018).

contamination from flooding. These efforts range from developing better building materials, such as bendable glass and ultra-high performance concrete,²⁶⁵ to architectural designs intended to deflect wave and wind energy rather than merely withstand them.²⁶⁶ Some of these are futuristic and rounded; others—like many of those designed for Brad Pitt’s Make It Right Foundation to benefit victims of Hurricane Katrina—simply modify traditional building shapes and incorporate better materials.²⁶⁷

How exactly buildings are constructed is often dictated by building codes. Indeed, as one commentator noted, building codes have already been important in reducing hurricane destruction:

Building codes are the baseline defense against hurricane damage. Improved building codes in Florida (the most stringent in the nation) after 1992’s Hurricane Andrew required installing impact windows, using stronger ties between roofs and walls, and securing roof shingles with nails instead of staples, according to the Wall Street Journal. And indeed, newer buildings built to code fared better during Hurricane Irma.²⁶⁸

Coastal states and municipalities should consider the new hurricane-proof designs when updating coastal building codes.

V. CONCLUSION

Public health considerations are an important part of climate change adaptation strategies. As the U.S. Global Change Research Program recognized in 2014, “Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited.”²⁶⁹

²⁶⁵ Zach Mortice, “Hurricane-Proof Construction Methods Can Prevent the Destruction of Communities,” *Redshift*, <https://www.autodesk.com/redshift/hurricane-proof-construction-methods-can-save-buildings-communities/> (Nov. 9, 2017).

²⁶⁶ See Amy Schellenbaum, “19 Examples of Stunning Hurricane-Resistant Architecture,” *Curbed*, <https://www.curbed.com/2012/10/30/10312068/19-examples-of-stunning-hurricane-resistant-architecture> (Oct. 30, 2012).

²⁶⁷ See *id.*

²⁶⁸ Zach Mortice, “Hurricane-Proof Construction Methods Can Prevent the Destruction of Communities,” *Redshift*, <https://www.autodesk.com/redshift/hurricane-proof-construction-methods-can-save-buildings-communities/> (Nov. 9, 2017).

²⁶⁹ 2014 USGCRP CLIMATE CHANGE REPORT, *supra* note 115, at 34.

Coastal adaptation is a complex subject, but discussions about retreat, armoring, and coastal water supplies often ignore or sideline the ever-present issue of coastal toxicity. Coastal storms like Hurricane Harvey, however, make this toxic potential obvious, underscoring its status as both a continuing present threat to public health and a future burden on changing coastlines, migrating coastal communities, and evolving coastal ecosystems. Therefore, a precautionary and health-based approach to coastal climate change adaptation—at all of the federal, state, and local levels—should explicitly and directly address the reduction of coastal toxicity, better employing environmental law, land use planning, toxicity prevention statutes and ordinances, and even building codes to achieve this goal.