United States Government Accountability Office

Report to Congressional Requesters

October 2019

SUPERFUND

EPA Should Take Additional Actions to Manage Risks from Climate Change

GAO-20-73

GAO Highlights

Highlights of GAO-20-73, a report to congressional requesters

October 2019

SUPERFUND

EPA Should Take Additional Actions to Manage Risks from Climate Change

Why GAO Did This Study

Administered by EPA, Superfund is the principal federal program for addressing sites containing hazardous substances. EPA lists some of the most seriously contaminated sites—most of which are nonfederal—on the NPL and has recorded over 500 contaminants, including arsenic and lead, at those sites. Climate change may make some natural disasters more frequent or more intense, which may damage NPL sites and potentially release contaminants, according to the Fourth National Climate Assessment.

GAO was asked to review issues related to the impact of climate change on nonfederal NPL sites. This report examines, among other objectives, (1) what available federal data suggest about the number of nonfederal NPL sites that are located in areas that may be impacted by selected climate change effects and (2) the extent to which EPA has managed risks to human health and the environment from the potential impacts of climate change effects at such sites. GAO analyzed available federal data; reviewed laws, regulations, and documents; interviewed federal officials and stakeholders; visited three nonfederal NPL sites that experienced natural disasters; and compared EPA actions to manage risk to GAO's six essential elements of enterprise risk management.

What GAO Recommends

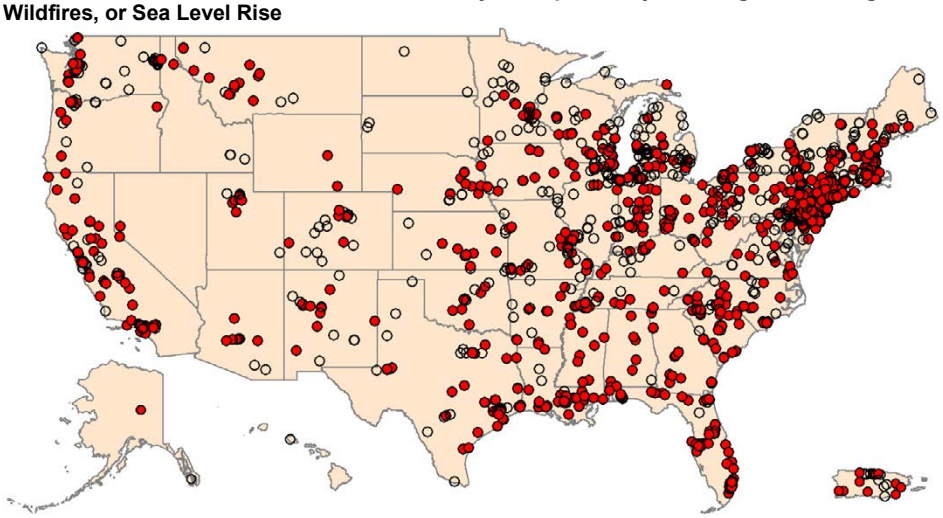
GAO is making four recommendations to EPA, including that it clarify how its actions to manage risks at nonfederal NPL sites from potential impacts of climate change align with current goals and objectives. EPA agreed with one recommendation and disagreed with the other three. GAO continues to believe that all four are warranted.

View GAO-20-73. For more information, contact Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

What GAO Found

Available federal data—from the Environmental Protection Agency (EPA), Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, and U.S. Forest Service—on flooding, storm surge, wildfires, and sea level rise suggest that about 60 percent of all nonfederal National Priorities List (NPL) sites are located in areas that may be impacted by these potential climate change effects. Additional information on these sites can be viewed in an interactive map and downloadable data file, available here (see figure).

Nonfederal NPL Sites Located in Areas that May Be Impacted by Flooding, Storm Surge, Wildfires, or Sea Level Rise



Number of National Priorities List (NPL) sites in potentially impacted areas

● Potentially impacted sites (945) ○ No impact identified (626)

Sources: GAO analysis of Environmental Protection Agency, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, and U.S. Forest Service data; MapInfo (map). | GAO-20-73

Notes: This map does not display all 1,571 active and deleted nonfederal NPL sites GAO analyzed, which also include six sites in American Samoa, the Federated States of Micronesia, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands, though they are included in the counts above. Additional information on all sites GAO analyzed can be viewed at https://www.gao.gov/products/GAO-20-73. Storm surge data are not available for Alaska and Pacific islands other than Hawaii, wildfire data are not available outside the contiguous United States, and sea level rise data are not available for Alaska.

EPA's actions to manage risks to human health and the environment from potential impacts of climate change effects at nonfederal NPL sites align with three of the six essential elements of enterprise risk management GAO previously identified, partially align with two essential elements, and do not align with one essential element. For example, EPA has not taken actions consistent with one essential element because it has not aligned its process for managing risks with agency-wide goals and objectives, which do not mention climate change. Without clarifying this alignment, EPA cannot ensure that senior officials will take an active role in strategic planning and accountability for managing these risks.

Contents

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
National Contingency Plan	National Oil and Hazardous Substances Pollution Contingency Plan
NCA	Fourth National Climate Assessment
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
PRP	potentially responsible party
SLR	sea level rise

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
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October 18, 2019

Congressional Requesters

In 2017, Hurricane Harvey dumped an unprecedented amount of rainfall over the greater Houston area, damaging several Superfund sites that contain hazardous substances.[1] At one site on the San Jacinto River in Texas, floodwater eroded part of the structure containing such substances, including dioxins, which are highly toxic and can cause cancer and liver and nerve damage.[2] That same year, the Fourth National Climate Assessment (NCA) stated that many temperature and precipitation extremes have become more frequent, more intense, or longer in duration.[3] The NCA reported that climate models are consistent with these trends continuing, which may make certain natural disasters more frequent or more intense. Further, the NCA reported that some climate change effects, including sea level rise and increased coastal flooding, could lead to the dispersal of pollutants, which could pose a risk to public health.

The Superfund program—the federal government's principal program to address sites with hazardous substances—was established by the Comprehensive Environmental Response, Compensation, and Liability

[1]The Superfund process begins with the discovery of a potentially hazardous site or notification to the Environmental Protection Agency (EPA) of the possible release of hazardous substances, pollutants, or contaminants that may threaten human health or the environment. EPA's regional offices may discover potentially hazardous waste sites, or such sites may come to EPA's attention through reports from state agencies or citizens.

[2]According to an EPA report on the effects of the 2017 hurricanes on Superfund sites, one of several samples EPA took at the San Jacinto River Waste Pits site after Hurricane Harvey showed high dioxin concentration, above 70,000 nanograms per kilogram, which exceeds the site's risk-based cleanup level of 30 nanograms per kilogram. However, EPA officials told us that they were not able to access the site during the storm because of the severe flooding, so they could not determine whether there was a release of the dioxin-containing waste into the river at that time.

[3]U.S. Global Change Research Program, *Climate Science Special Report, Fourth National Climate Assessment, Volume I* (Washington, D.C.: 2017). Under the Global Change Research Act of 1990, the Committee on Earth and Environmental Sciences of the Federal Coordinating Council on Science, Engineering, and Technology is to periodically prepare a scientific assessment, known as the NCA. Pub. L. No. 101-606, § 106, 104 Stat. 3096, 3101 (1990) (codified at 15 U.S.C. § 2936). The U.S. Global Change Research Program coordinates and integrates the activities of 13 participating federal departments and agencies that carry out research and support the nation's response to global change.

Act of 1980 (CERCLA).[4] EPA is responsible for administering the program. EPA coordinates the cleanup of Superfund sites by identifying sites potentially requiring cleanup action and placing eligible sites on its National Priorities List (NPL), which includes some of the most seriously contaminated sites. As of September 2019, there were 1,336 active sites on the list, and 421 sites that EPA had determined need no further cleanup action (deleted sites). About 90 percent of these active and deleted NPL sites are nonfederal sites, where EPA generally carries out or oversees the cleanup conducted by one or more potentially responsible parties (PRP).[5] The other NPL sites—approximately 10 percent—are located at federal facilities, and the federal agencies that administer those facilities are responsible for their cleanup.[6]

CERCLA authorizes EPA to take various types of cleanup actions to prevent human and environmental exposure to contamination from nonfederal NPL sites, including remedial actions, which are long-term cleanups. As part of the Superfund cleanup process, EPA identifies, analyzes, and selects remedial actions that seek to protect human health and the environment and meet site-specific remediation goals. In September 2015, we found that annual EPA expenditures for remedial actions at nonfederal NPL sites could be considerable—about $400 million for all such sites.[7] EPA is also required to conduct or oversee reviews at least every 5 years at sites where remedial actions are complete but contaminants remain, including at deleted sites, if contaminants remaining on those sites exceed certain levels. Under

[4]Pub. L. No. 96-510, 94 Stat. 2767 (1980) (codified as amended at 42 U.S.C. §§ 9601-9675).

[5]Under CERCLA, PRPs generally include current or former owners or operators of a site and the generators and transporters of the hazardous substances. *See* 42 U.S.C. § 9607(a) (listing the types of parties liable for cleanup costs). In addition to EPA, other entities can be the lead agencies for cleanups under CERCLA, such as state agencies; this report focuses on sites for which EPA is the lead agency.

[6]Federal NPL sites are owned or operated by a department, agency, or instrumentality of the United States, such as the Departments of Defense, Energy, and the Interior. The agencies fund cleanup of federal NPL sites; this funding does not come from EPA's Superfund appropriation. Processes and provisions specific to these federal sites are generally not discussed in this report, although they are subject to the same cleanup requirements in CERCLA.

[7]GAO, *Superfund: Trends in Federal Funding and Cleanup of EPA's Nonfederal National Priorities List Sites*, GAO-15-812 (Washington, D.C.: Sept. 25, 2015). This funding was for remedial cleanup activities, which include remedial investigations, feasibility studies, and remedial action projects (actions taken to clean up a site).

EPA's regulations, the agency may take additional remedial actions to address releases at deleted sites if warranted under future conditions.[8]

Climate change may impact Superfund sites in various ways. For example, extreme precipitation events may impact Superfund sites that have contaminated sediments in aquatic environments. Specifically, in a 2007 report, the National Research Council noted that buried contaminated sediments at Superfund sites may be transported during storms or other high-flow events, becoming a source of future exposure and risk.[9] As a result of the significant risks posed by climate change and the nation's fiscal condition, in February 2013, we added *Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks* to our list of areas at high risk for fraud, waste, abuse, and mismanagement, or most in need of transformation.[10] In March 2019, we reported on progress to address this high-risk area.[11]

You asked us to review issues related to the impact of climate change on nonfederal NPL sites. This report examines (1) what available federal data suggest about the number of nonfederal NPL sites that are located in areas that may be impacted by selected climate change effects; (2) the extent to which EPA has managed risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites; and (3) the challenges, if any, EPA faces in managing these risks.

To determine what available federal data suggest about the number of nonfederal NPL sites that are located in areas that may be impacted by selected climate change effects, we reviewed the NCA and our prior work on the Superfund program, climate change, and federal data on potential

[8]40 C.F.R. § 300.425(e)(3).

[9]National Research Council, *Sediment Dredging at Superfund Megasites: Assessing the Effectiveness* (Washington, D.C.: 2007). The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

[10]GAO, *High-Risk Series: An Update*, GAO-13-283 (Washington, D.C.: Feb. 14, 2013).

[11]GAO, *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas*, GAO-19-157SP (Washington, D.C.: Mar. 6, 2019).

climate change effects.[12] We reviewed agency documents and interviewed officials from agencies including EPA, the Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Forest Service. Based on our review of the NCA, we identified potential climate change effects and, based on our review of EPA documents, determined which of these effects may impact nonfederal NPL sites.[13] For these potential effects, we identified available national-level federal data sets from FEMA, NOAA, and the U.S. Forest Service on flooding, storm surge, and wildfires, respectively, which are based on current or past conditions. The NCA reported that flooding, storm surge, and wildfires will be exacerbated by climate change in some parts of the country, but we did not identify federal data on the extent to which these effects would vary from current or past conditions. We also reviewed NOAA data on sea level rise, which provide information on the geographic extent of inundation from potential sea level rise of up to 10 feet.

In presenting the results of our analysis, we refer to flooding, storm surge, wildfires, and sea level rise as potential climate change effects. To the extent that data were available, we analyzed a range of these potential climate change effects. For example, we used the maximum extent of storm surge from Category 1 hurricanes (the lowest possible category) as well as Category 4 or 5 hurricanes (the highest possible categories), as modeled by NOAA.[14] The full range of our results can be viewed in an interactive graphic, which is available here. We focused on a range

[12]See, for example, *Superfund Sediment Sites: EPA Considers Risk Management Principles but Could Clarify Certain Procedures*, GAO-16-777 (Washington, D.C.: Sept. 22, 2016); *Climate Change: Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance*, GAO-15-28 (Washington, D.C.: Oct. 29, 2014); and *FEMA Flood Maps: Some Standards and Processes in Place to Promote Map Accuracy and Outreach, but Opportunities Exist to Address Implementation Challenges*, GAO-11-17 (Washington, D.C.: Dec. 2, 2010).

[13]These potential climate change effects, which may vary across regions, include sea level rise, which may lead to increased frequency and extent of extreme flooding from coastal storms; greater frequency and magnitude of drought; increased intensity and frequency of heavy precipitation events, which may lead to increased local flooding; increased incidence of large wildfires; and increased intensity of hurricanes.

[14]NOAA rates hurricanes as Categories 1 through 5 on the Saffir-Simpson Hurricane Wind Scale based on a hurricane's sustained wind speed. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 4 hurricanes are those that carry sustained winds of 130–156 miles per hour. Category 5 hurricanes are those with sustained winds exceeding 156 miles per hour.

because, for three of the four effects, we had data on current hazards, which may become more intense and frequent in the future, according to the NCA. Additionally, CERCLA directs EPA to give preference to remedies that would result in the permanent and significant decrease in toxicity, mobility, or volume of the contamination. According to EPA officials, remedies at nonfederal NPL sites may have to be operational indefinitely, during which time the potential effects of climate change may become more extreme.

We obtained data from EPA's Superfund Enterprise Management System—EPA's system of record for the Superfund program—on the location and other characteristics of active and deleted nonfederal NPL sites.[15] We analyzed these data using mapping software to identify nonfederal NPL sites located in areas that may be impacted by selected potential climate change effects. To do so, we determined whether there are areas that may be impacted by flooding, storm surge, wildfires, and sea level rise within a 0.2-mile radius of the primary geographic coordinate of each nonfederal NPL site,[16] which we used to represent the site boundaries.[17] We reviewed this analytical approach with EPA officials. To assess the reliability of all of the data for our analysis, we, among other things, assessed the timeliness and accuracy of the data and related controls and found the data from EPA, FEMA, NOAA, and the U.S. Forest Service to be sufficiently reliable for our purposes. (See app. I for more detail on steps we took to assess the reliability of the data.)

To determine the extent to which EPA has managed risks to human health and the environment from the potential impacts of climate change

[15]According to EPA officials, EPA makes data on the location of nonfederal NPL sites available to the public strictly for informational purposes. Further, according to EPA officials, these data are not intended for use in establishing liability or calculating cost recovery statutes of limitations and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States or third parties. EPA officials told us that EPA reserves the right to change these data at any time without public notice.

[16]According to the *Fiscal Year 2019 Superfund Program Implementation Manual*, NPL sites in the Superfund Enterprise Management System must have one primary coordinate, which indicates the primary latitude and longitude coordinates for the site. This coordinate must be located less than 1,000 meters from the site address.

[17]In a 2018 study, EPA used a 0.2-mile radius to approximate the size of NPL sites. In this study, EPA noted that it used additional information to adjust this radius for some NPL sites. We did not make such adjustments because doing so would have required site-specific analysis, which was outside the scope of our review.

effects at nonfederal NPL sites, we examined relevant provisions in CERCLA, EPA's implementing regulations, executive orders, and EPA documents on the cleanup of nonfederal NPL sites. We also reviewed relevant documents, articles, studies, and other sources that we identified by searching the websites of relevant agencies and organizations and article databases, as well as through recommendations from officials and stakeholders we interviewed. From our prior work, we identified six essential elements of risk management that we reported could help agencies anticipate and manage risk.[18]

We compared EPA's actions to manage risks to human health and the environment from the potential impacts of climate change effects with these essential elements of risk management. We analyzed information on EPA actions by reviewing documents from EPA, the U.S. Global Change Research Program, and the National Research Council and our prior work on the Superfund program and climate change that we identified during our search of documents, articles, and other sources. We interviewed EPA officials at headquarters and all regional offices. We also interviewed four stakeholders and representatives of two associations with knowledge of the nexus between Superfund sites and climate changes effects to obtain their views about the extent to which EPA has managed these risks. We identified these stakeholders, such as a law professor and state environmental officials, from our search of documents, articles, and other sources and through referrals during interviews.

In addition, we selected three nonfederal NPL sites from different EPA regions to illustrate the extent to which EPA is managing these risks: the American Cyanamid site in Bridgewater, New Jersey (Region 2); the Iron Mountain Mine site near Redding, California (Region 9); and the San Jacinto River Waste Pits site in Channelview, Texas (Region 6). We selected these sites based on (1) EPA regional diversity, (2) variety in potential climate change effects, and (3) whether they had been affected by an extreme weather event within the last 10 years. The results from these illustrative examples are not generalizable to nonfederal NPL sites that we did not select. We toured each of these sites, reviewed relevant documents, and interviewed EPA officials and site stakeholders, including

[18]GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risk*, GAO-17-63 (Washington, D.C.: Dec. 1, 2016).

state and local officials, representatives of PRPs, and community organizations.

To determine the challenges EPA faces in managing risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites, we reviewed documents from EPA and other relevant entities, including from the National Research Council, which we obtained from EPA officials and stakeholders or identified from our search of documents, articles, and other sources. We also interviewed EPA officials at headquarters and all regional offices and stakeholders. We grouped all challenges we identified into three categories for reporting purposes: institutional, resource, and technical challenges. Appendix I describes our objectives, scope, and methodology in more detail.

We conducted this performance audit from April 2018 to October 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

CERCLA established the Superfund program to clean up contaminated sites to protect human health and the environment from the effects of hazardous substances. CERCLA requires the President to establish procedures and standards for prioritizing and responding to releases of hazardous substances, pollutants, and contaminants into the environment and to incorporate these procedures and substances into the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan).[19]

Under CERCLA, PRPs are liable for conducting or paying for the cleanup of hazardous substances at contaminated sites. EPA and PRPs can undertake two types of cleanup actions: removal actions and remedial actions. Removal actions are usually short-term cleanups for sites that

[19]According to EPA, the National Contingency Plan is the federal government's blueprint for responding to both oil spills and hazardous substance releases. The National Contingency Plan is the result of efforts to develop a national response capability and promote coordination among the hierarchy of responders and contingency plans.

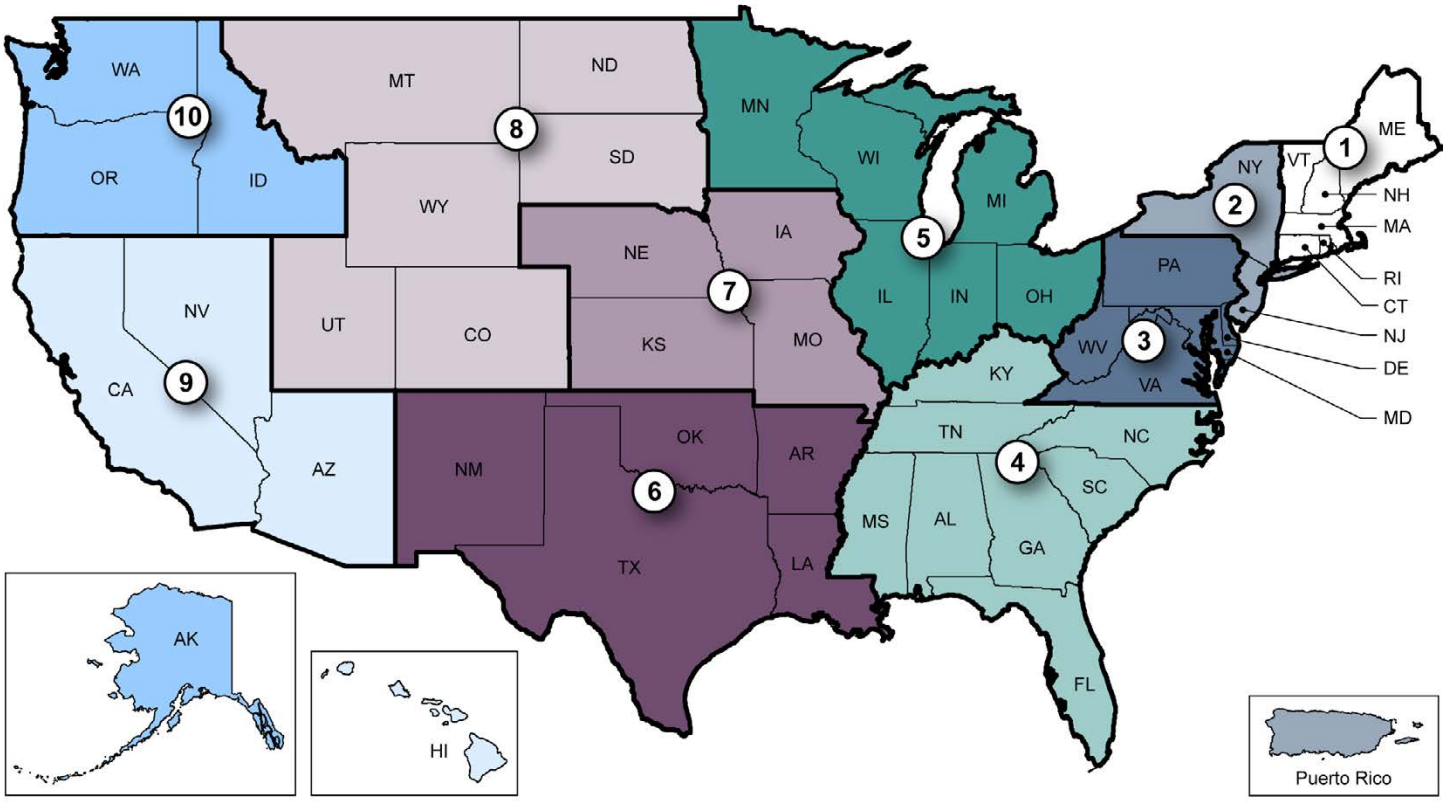
pose immediate threats to human health or the environment. Remedial actions are generally long-term cleanups—consisting of one or more remedial action projects—that aim to permanently and significantly reduce contamination. Remedial actions can take a considerable amount of time and money, depending on the nature of the contamination and other site-specific factors.

EPA's Office of Superfund Remediation and Technology Innovation, which is part of the Office of Land and Emergency Management, oversees remedial actions at NPL sites, including nonfederal NPL sites.[20] At each nonfederal NPL site, the lead official who is responsible for compliance with the National Contingency Plan is the remedial project manager.[21] Management of nonfederal NPL sites is the responsibility of the EPA region in which a site is located. EPA has 10 regional offices, and each one is responsible for executing EPA programs within several states and, in some regions, territories. Figure 1 illustrates EPA's 10 regions.

[20]According to EPA's website, the Office of Land and Emergency Management provides policy, guidance, and direction for the agency's emergency response and waste programs. The Office of Superfund Remediation and Technology Innovation administers the Superfund program and works to ensure that the hazardous waste sites on the NPL are cleaned up to protect human health and the environment. The Office of Land and Emergency Management was previously named the Office of Solid Waste and Emergency Response.

[21]40 C.F.R. § 300.120(f)(1).

Figure 1: EPA's 10 Regions

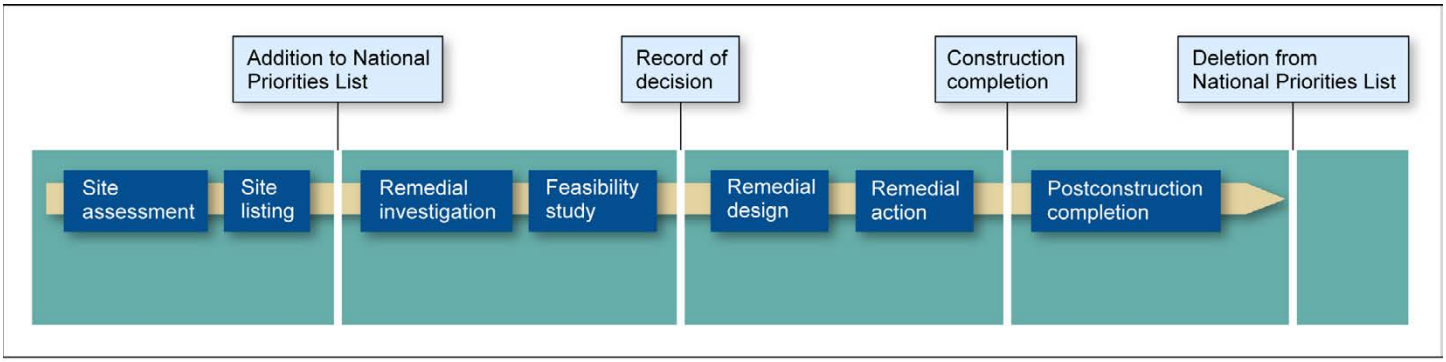


Sources: GAO analysis of Environmental Protection Agency (EPA) information; MapInfo (map). | GAO-20-73

Notes: EPA Region 2 also includes the U.S. Virgin Islands. EPA Region 9 also includes American Samoa, the Federated States of Micronesia, Guam, the Northern Mariana Islands, the Republic of the Marshall Islands, and the Republic of Palau.

The Superfund process begins with the discovery of a potentially hazardous site or notifications to EPA regarding the possible release of hazardous substances that may pose a threat to human health or the environment. EPA's Superfund remedial cleanup process for nonfederal NPL sites includes the actions shown in figure 2.

Figure 2: EPA's Remedial Cleanup Process at Nonfederal National Priorities List Sites



Source: GAO analysis of Environmental Protection Agency (EPA) information. | GAO-20-73

Note: EPA's actions in the remedial cleanup process may overlap, and EPA may undertake multiple actions concurrently at a site.

- **Site assessment.** EPA, states, tribes, or other federal agencies evaluate site conditions to identify appropriate responses to releases of hazardous substances to the environment. During this process, EPA or other entities, such as state or tribal agencies, collect data to identify, evaluate, and rank sites using agency criteria.[22]
- **Site listing.** EPA considers whether to list a site on the NPL based on a variety of factors, including the availability of alternative state or federal programs that may be used to clean up the site. Sites that EPA proposes to list on the NPL are published in the *Federal Register*. After a period of public comment, EPA reviews the comments and makes final decisions on whether to list the sites on the NPL.
- **Remedial investigation and feasibility study.** EPA or the PRP will generally begin the remedial cleanup process for an NPL site by conducting a two-part study of the site. First, EPA or the PRP conducts a remedial investigation to characterize site conditions and assess the risks to human health and the environment, among other

[22]EPA uses the Hazard Ranking System to guide decision-making and, as needed, to numerically assess the site's relative potential to pose a threat to human health or the environment. Sites with a Hazard Ranking System score of 28.50 or greater are eligible for listing on the NPL.

actions.[23] Second, EPA or the PRP conducts a feasibility study to assess various alternatives to address the problems identified through the remedial investigation. Under the National Contingency Plan, EPA considers nine criteria, including long-term effectiveness and permanence, in its assessment of alternative remedial actions.[24]

- **Record of decision.** EPA issues a record of decision that identifies its selected remedy for addressing the contamination at a site. A record of decision typically lays out the planned cleanup activities for each operable unit of the site as well as an estimate of the cost of the cleanup.[25]
- **Remedial design and remedial action.** EPA or the PRP plans to implement the selected remedy during the remedial design phase, and then, in the remedial action phase, EPA or the PRP carries out one or more remedial action projects.[26]
- **Construction completion.** EPA generally considers construction of the remedial action to be complete for a site when all physical construction at a site is complete, including actions to address all immediate threats and to bring all long-term threats under control.
- **Postconstruction completion.** EPA, the state, or the PRP performs operation and maintenance for the remedy, if needed, such as by operating a groundwater extraction and treatment system. EPA generally performs reviews of the remedy at least every 5 years to

[23]As part of the remedial investigation, EPA is to identify applicable or relevant and appropriate requirements for the site. These requirements may include cleanup standards set by federal or state environmental laws that specifically address a contaminant, remedial action, location, or other circumstance at an NPL site.

[24]The nine evaluation criteria are (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance. 40 C.F.R. § 300.430(e)(9)(iii).

[25]An operable unit is a discrete action that comprises an incremental step toward comprehensively addressing site problems. 40 C.F.R. § 300.5. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site.

[26]In some cases, EPA will fund the cleanup, such as when EPA cannot identify a PRP.

evaluate whether it continues to protect human health and the environment.[27]

- **Deletion from the NPL.** EPA may delete a site, or part of a site, from the NPL when the agency and the relevant state authority determine that no further site response is needed.[28]

Contaminants and Remedies at Nonfederal NPL Sites

Nonfederal NPL sites may include a variety of contaminants, and EPA may select different types of remedies to clean up the sites. EPA had recorded more than 500 contaminants at nonfederal NPL sites as of fiscal year 2014, the most recently available data. According to the Agency for Toxic Substances and Disease Registry, the highest-priority contaminants—based on a combination of their prevalence, toxicity, and potential for human exposure—are arsenic, lead, mercury, vinyl chloride, and polychlorinated biphenyls.[29] For example, in 2016, the Agency for Toxic Substances and Disease Registry reported that exposure to arsenic in drinking water is associated with various health effects, such as pulmonary and cardiovascular disease, diabetes, and certain cancers.[30] Contaminants may be found in different media at nonfederal NPL sites. In 2017, EPA reported that groundwater and soil were the most common contaminated media, including at the nonfederal NPL sites it analyzed.[31]

[27]EPA is to review Superfund remedial actions at least every 5 years where hazardous substances, pollutants, or contaminants will remain on-site above levels that allow for unlimited use and unrestricted exposure. EPA is also to report to Congress the list of sites for which these reviews are required, the results of such reviews, and any actions taken as a result of the reviews. 42 U.S.C. § 9621(c).

[28]EPA is to conduct Five-Year Reviews at deleted sites if the level of contamination at the sites exceeds what would permit unlimited use and unrestricted exposure. 40 C.F.R. § 300.430(f)(4)(ii).

[29]Under CERCLA, the Agency for Toxic Substances and Disease Registry and EPA are to prepare, in order of priority, a list of substances that are most commonly found at NPL sites and revise it periodically. The Agency for Toxic Substances and Disease Registry's most recent update to the substance priority list was in 2017. We accessed the list on April 24, 2019, at https://www.atsdr.cdc.gov/spl/.

[30]Agency for Toxic Substances and Disease Registry, *Addendum to the Toxicological Profile for Arsenic* (Atlanta, Ga.: February 2016).

[31]Environmental Protection Agency, Office of Land and Emergency Management, *Superfund Remedy Report*, 15th Edition (July 2017). In this report, EPA analyzed Superfund sites, including 1,508 nonfederal NPL sites, that had signed decision documents—records of decision, amendments to records of decision, and explanations of significant differences. EPA also conducted more detailed analyses of decision documents signed in fiscal year 2012 through fiscal year 2014.

To clean up a nonfederal NPL site, EPA may select various on-site or off-site remedies. For example, EPA may select on-site remedies that include treatment as well as those that do not, such as on-site containment, monitored natural recovery, and institutional controls.[32] In 2017, EPA reported that about a quarter of the decision documents for sites it analyzed included on-site treatment. EPA may also treat or dispose the contamination off-site. Examples of off-site treatment and disposal include incineration and recycling. EPA reported that sites it analyzed may have various combinations of remedies, including treatment, on-site containment, off-site disposal, and institutional controls.

Available Federal Data on Flooding, Storm Surge, Wildfires, and Sea Level Rise

Various federal agencies provide nationwide data on flooding, storm surge from hurricanes, wildfires, and sea level rise. Data on flooding, storm surge, and wildfires are generally based on current or past conditions. NOAA models the extent of inundation for various heights of sea level rise compared to the most recently available data on average high tide.

Flooding

FEMA provides flood hazard and risk information to communities nationwide. Among other information, FEMA provides data on coastal and riverine flooding in the National Flood Hazard Layer,[33] a database that contains the most current flood hazard data.[34] Federal law requires FEMA to assess the need to revise and update the nation's flood maps at least every 5 years.[35] Among other uses, the flood hazard data are used for flood insurance ratings and floodplain management. The National Flood Hazard Layer identifies areas at the highest risk of flooding, which are

[32]Institutional controls include administrative and legal controls that minimize the potential for human exposure, for example, by limiting land use or providing information to guide behavior at the site, such as through zoning restrictions. Institutional controls are a subset of land use control, which can include physical measures such as fencing.

[33]Riverine flooding is flooding related to or caused by a river, stream, or tributary overflowing its banks because of excessive rainfall, snowmelt, or ice.

[34]FEMA provides a tool for viewing, downloading, and printing flood maps for specific locations. We accessed the tool on August 8, 2019, at https://www.fema.gov/national-flood-hazard-layer-nfhl.

[35]42 U.S.C. § 4101(e).

those that have a 1 percent or higher annual chance of flooding.[36] In some locations, the National Flood Hazard Layer also identifies areas with 0.2 percent or higher annual chance of flooding, which FEMA considers to be a moderate flood hazard,[37] as well as other flood hazards. The National Flood Hazard Layer also identifies areas with minimal flood hazard, including those with less than 0.2 percent annual chance of flooding, and unknown flood hazard, including areas FEMA had not assessed for flood hazards.[38] In 2018, the Technical Mapping Advisory Council noted that FEMA has produced modernized data (i.e., digital maps) for areas of the United States where 98 percent of the population resides, but has not determined the flood hazard for 40 percent of streams.[39] In general, flood hazards are based on existing conditions in the watershed and floodplains. However, in certain cases, FEMA may include flood hazard information that is based on future conditions, according to FEMA regulations.[40]

Storm Surge

NOAA provides estimates of hurricane storm surge using a model called Sea, Lake and Overland Surges from Hurricanes.[41] Estimates are

[36]These areas are known as Special Flood Hazard Areas. Under federal law, in communities that participate in the National Flood Insurance Program, homeowners are required to purchase flood insurance for properties located in Special Flood Hazard Areas that are secured by mortgages from federally regulated lenders. 42 U.S.C. § 4012a(b)(1).

[37]According to the NCA, the magnitude and intensity of riverine flooding is projected to increase in the future, so areas with moderate flood hazard may have increased flood hazards in the future.

[38]We also considered areas where flood data are not available in a form compatible with our mapping software, such as those only available in paper maps, as unknown flood hazard. Paper-based maps can provide information on flood hazards to other users, such as communities and owners of Superfund sites, according to FEMA officials.

[39]The Technical Mapping Advisory Council is a federal advisory committee established to review and make recommendations to FEMA on matters related to the national flood mapping program.

[40]Future conditions refer to the flood discharges that would occur if current zoning or comprehensive land use plans were realized. *See* 44 C.F.R. § 59.1. For example, as planned buildings and parking lots are constructed, the amount of impervious land within the watershed increases, which can increase the amount of direct runoff. In our analysis, we categorized these areas as other flood hazards.

[41]According to a NOAA document, storm surge is an abnormal rise of water generated by a storm, over and above the predicted tides. Storm surge is produced by water being pushed toward the shore by the force of the winds. NOAA's storm surge hazard maps, accessed on December 31, 2018, are available at https://www.nhc.noaa.gov/nationalsurge/.

available for eastern U.S. coastal areas from Texas through Maine and other areas affected by storm surge, including Hawaii, Puerto Rico, and the U.S. Virgin Islands. As of June 2019, NOAA had not modeled storm surge for the West Coast of the United States or other Pacific islands. The model takes into account a specific locale's shoreline, incorporating bay and river configurations, water depths, bridges, roads, levees, and other physical features. It estimates the maximum extent of storm surge at high tide by modeling hypothetical hurricanes under different storm conditions, such as landfall location, storm trajectory, and forward speed. NOAA models storm surge from Category 1 through Category 5 hurricanes for the Atlantic coast south of the North Carolina–Virginia border, the Gulf of Mexico, Puerto Rico, and the U.S. Virgin Islands and Category 1 through Category 4 hurricanes for the Atlantic coast north of the North Carolina–Virginia border and Hawaii.[42] According to NOAA's website, the model is to be used for educational purposes and awareness of the storm surge hazard at a city or community level. In accordance with federal law, the model is also used for other purposes, such as hurricane evacuation studies.[43] According to NOAA's website, the agency updates the model for portions of the shoreline each year to account for, among other changes, new data and the addition of flood protection devices, such as levees. The model does not account for future conditions such as erosion, subsidence (i.e., the sinking of an area of land), construction, or sea level rise.

Wildfires

The U.S. Forest Service maps wildfire hazard potential based on landscape conditions and other observations.[44] According to the U.S. Forest Service, the primary intended use of the wildfire hazard potential map is to identify priority areas for hazardous fuels treatments from a broad, national- to regional-scale perspective. The U.S. Forest Service maps an index of wildfire hazard potential for the contiguous United

[42]According to a NOAA official, NOAA does not estimate storm surge for Category 5 hurricanes in areas where such hurricanes have not historically made landfall, such as areas north of the North Carolina–Virginia border.

[43]6 U.S.C. § 721.

[44]According to the U.S. Forest Service, the objective of the wildfire hazard potential map is to depict the relative potential for wildfire that would be difficult for suppression resources to contain. For the 2018 map, the U.S. Forest Service used spatial data sets of wildfire likelihood and intensity from 2016, spatial fuels and vegetation data from 2012, and point locations of past fire occurrence from 1992 to 2013. The U.S. Forest Service's wildfire hazard potential map, accessed on May 3, 2019, is at https://www.firelab.org/project/wildfire-hazard-potential.

States, based on, among other factors, annual burn probabilities and potential intensity of large fires. The U.S. Forest Service categorizes the wildfire hazard potential index into five classes of very low, low, moderate, high, and very high. For example, the U.S. Forest Service designates as "high" those areas with wildfire hazard potential index from the 85th to the 95th percentile, and "very high" above the 95th percentile. The U.S. Forest Service also categorizes areas as nonburnable (including agricultural and developed lands) and water. According to the U.S. Forest Service, areas with higher values of wildfire hazard potential represent vegetation that is more likely to burn with high intensity under certain weather conditions. However, areas with moderate, low, and very low wildfire hazard potential may still experience wildfire, particularly if they are near areas that have higher wildfire hazard potential. Wildfire hazard potential is not a forecast or wildfire outlook for any particular season as it does not include any information on current or forecasted weather or fuel moisture conditions.[45]

Sea Level Rise

NOAA models the extent of inundations from various heights of sea level rise (up to 10 feet above average high tides) for the contiguous United States, Hawaii, the Pacific islands, Puerto Rico, and the U.S. Virgin Islands and provides the results in a web mapping tool called the Sea Level Rise Viewer.[46] NOAA's guidance on the Sea Level Rise Viewer states that data are not available for Alaska. The uses of the sea level rise data include planning and education but not site-specific analysis, according to a NOAA document. NOAA labels areas as not mapped if elevation data of sufficient quality for the areas are not available. NOAA does not model natural processes, such as erosion, subsidence, or future construction, or forecast how much sea level is likely to rise in a given area. Rather, for various heights of local sea level rise, NOAA determines extent of inundation based on the elevation of an area and the potential for water to flow between areas.

Enterprise Risk Management

Enterprise risk management is a tool that allows agencies to assess threats and opportunities that could affect the achievement of their goals. In a December 2016 report, we updated our 2005 risk management

[45]According to a U.S. Forest Service official, the wildfire hazard potential data are not meant to substitute for local data that may more accurately capture the potential for wildfire in particular areas.

[46]NOAA's Sea Level Rise Viewer, accessed on August 7, 2019, is at https://coast.noaa.gov/digitalcoast/tools/slr.html.

framework to reflect changes to the Office of Management and Budget's Circular A-123,[47] which calls for agencies to implement enterprise risk management.[48] We also incorporated recent federal experience and identified essential elements of federal enterprise risk management.[49]

Our December 2016 report states that beyond traditional internal controls, enterprise risk management promotes risk management by considering the effect of risk across the entire organization and how it may interact with other identified risks. Additionally, it addresses other topics, such as strategy determination, governance, communicating with stakeholders, and measuring performance. The principles of enterprise risk management apply at all levels of the organization and across all functions, such as those related to managing risk to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites. The six essential elements of enterprise risk management that we identified in our December 2016 report are as follows:

1. **Align risk management process with goals and objectives.** Ensure that the process maximizes the achievement of agency mission and results. Agency leaders examine strategic objectives by regularly considering how risks could affect the agency's ability to achieve its mission.
2. **Identify risks.** Assemble a comprehensive list of risks—both threats and opportunities—that could affect the agency's ability to achieve its goals and objectives.
3. **Assess risks.** Examine risks, considering both the likelihood of the risk and the impact of the risk to help prioritize risk response.

[47]We developed our 2005 risk management framework in the context of risks associated with homeland security and combating terrorism. However, increased attention to enterprise risk management concepts and their applicability to all federal agencies and missions led us to revise our risk framework to incorporate enterprise risk management concepts. These concepts can help leaders better address uncertainties in the federal environment, including changing and more complex operating environments based on technology changes and other global factors and stakeholders seeking greater transparency and accountability.

[48]Office of Management and Budget, *Management's Responsibility for Enterprise Risk Management and Internal Control*, OMB Circular No. A-123 (July 15, 2016).

[49]GAO-17-63. See also GAO, *Risk Management: Further Refinements Needed to Assess Risks and Prioritize Protective Measures at Ports and Other Critical Infrastructure*, GAO-06-91 (Washington, D.C.: Dec. 15, 2005).

4. **Respond to the risks.** Select risk treatment response (based on risk appetite), including acceptance, avoidance, reduction, sharing, or transfer.
5. **Monitor risks.** Monitor how risks are changing and whether responses are successful.
6. **Communicate and report on risks.** Communicate risks with stakeholders and report on the status of addressing the risks.

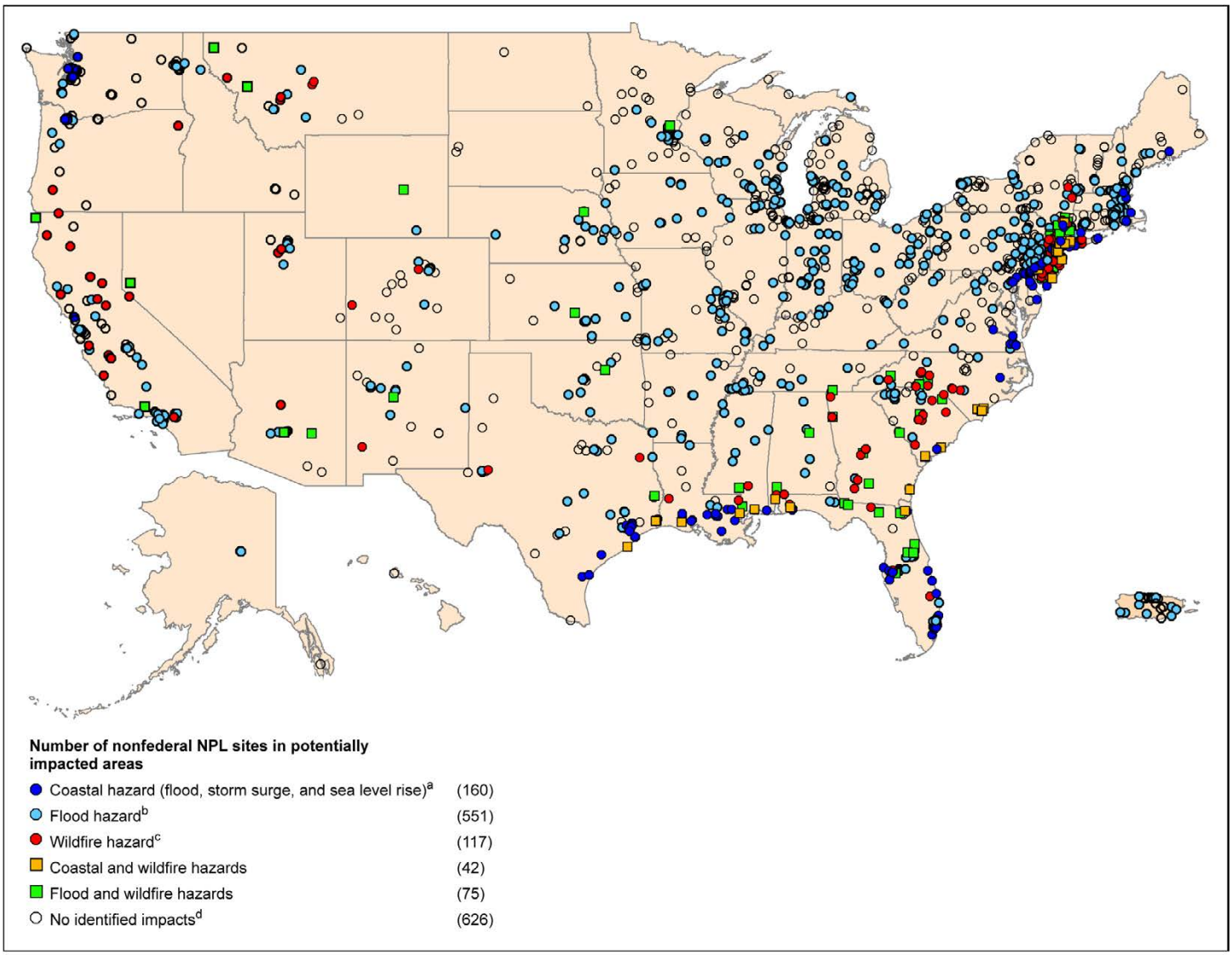
About 60 Percent of Nonfederal NPL Sites Are Located in Areas That May Be Impacted by Selected Climate Change Effects, According to Available Data

Available federal data on flooding, storm surge, wildfires, and sea level rise suggest that about 60 percent (945 of 1,571) of all nonfederal NPL sites are located in areas that may be impacted by one or more of these potential climate change effects. These data, however, may not fully account for the number of nonfederal NPL sites that may be in such areas because (1) federal data are generally based on current or past conditions; (2) data are not available for some areas; and (3) the NCA has reported that climate change may exacerbate flooding, storm surge, and wildfires in certain regions of the United States. In addition, EPA does not have quality information on the boundaries of nonfederal NPL sites, which could affect its ability to identify the number of sites that may be impacted by one or more of these potential climate change effects.

About 60 Percent of Nonfederal NPL Sites Are Located in Areas That May Be Impacted by Selected Climate Change Effects; Additional Sites May Be Impacted in the Future

Available federal data suggest that 945 of 1,571 nonfederal NPL sites, or about 60 percent, are located in areas that may be impacted by selected climate change effects—that is, 0.2 percent or higher annual chance of flooding or other flood hazards, storm surge from Category 4 or 5 hurricanes, high and very high wildfire hazard potential, and sea level rise of up to 3 feet. The locations of these sites are shown in figure 3; the full results of our analysis and additional information on these sites is available in the interactive map and downloadable data file, which can be viewed at https://www.gao.gov/products/GAO-20-73.

Figure 3: EPA's Nonfederal NPL Sites in Areas That May Be Impacted by Flooding, Storm Surge, Wildfire, or Sea Level Rise



Sources: GAO analysis of Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Forest Service data; MapInfo (map). | GAO-20-73

Notes: We represented the boundaries of nonfederal National Priorities List (NPL) sites with a 0.2-mile radius around the primary geographic coordinate of each site. Depending on the actual site boundaries, the results of our analysis may not accurately reflect the number of nonfederal NPL sites located in these areas. This map does not display all 1,571 active and deleted nonfederal NPL sites we analyzed, which also include six sites in American Samoa, the Federated States of Micronesia, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands, although we include them in the counts above. The full results of our analysis, which include additional information about these sites, are available in the interactive map and downloadable data file, which can be viewed at https://www.gao.gov/products/GAO-20-73. This analysis is based on the most recently available data from EPA, FEMA, NOAA, and the U.S. Forest Service as of March 2019.

[a]In our analysis, we use "coastal hazard" to refer to nonfederal NPL sites in areas that may be impacted by storm surge from Category 4 or 5 hurricanes and sea level rise of up to 3 feet. They may also be impacted by 0.2 percent or higher annual chance of flooding or other flood hazards. According to NOAA, storm surge data are not available for the West Coast of the United States, Alaska, and Pacific islands other than Hawaii and sea level rise data are not available for Alaska.

[b]In our analysis, we use "flood hazard" to refer to nonfederal NPL sites in areas that FEMA has determined have a 0.2 percent or higher annual chance of flooding or other flood hazards.

[c]In our analysis, we use "wildfire hazard" to refer to nonfederal NPL sites in areas with high or very high wildfire hazard potential. According to the U.S. Forest Service, wildfire hazard potential data are not available outside the contiguous United States.

[d]In our analysis, we use "no identified impacts" to refer to nonfederal NPL sites in areas with no or unknown hazard levels, including where data were unavailable. For example, FEMA flood data are not available for all locations in a format we could analyze.

Our analysis, however, may not fully account for the number of nonfederal NPL sites that may be impacted by the effects of climate change for various reasons. First, we represented the areas of nonfederal NPL sites based on a 0.2-mile radius around their primary geographic coordinates, which may not accurately reflect their area (i.e., they may be larger or smaller). We did not analyze site-specific information for these nonfederal NPL sites, including the extent of contamination and location of remedies. Such site-specific analyses would be needed to determine whether there is a risk to human health and the environment at nonfederal NPL sites as a result of these potential climate change effects.

Further, according to the NCA, EPA documents, and interviews with EPA officials, there may be other climate change effects that could impact nonfederal NPL sites, such as potential increases in salt water intrusion (the movement of saline water into freshwater aquifers), drought, precipitation, hurricane winds, and average and extreme temperatures; we did not analyze these effects because we did not identify relevant national-level federal data sets.

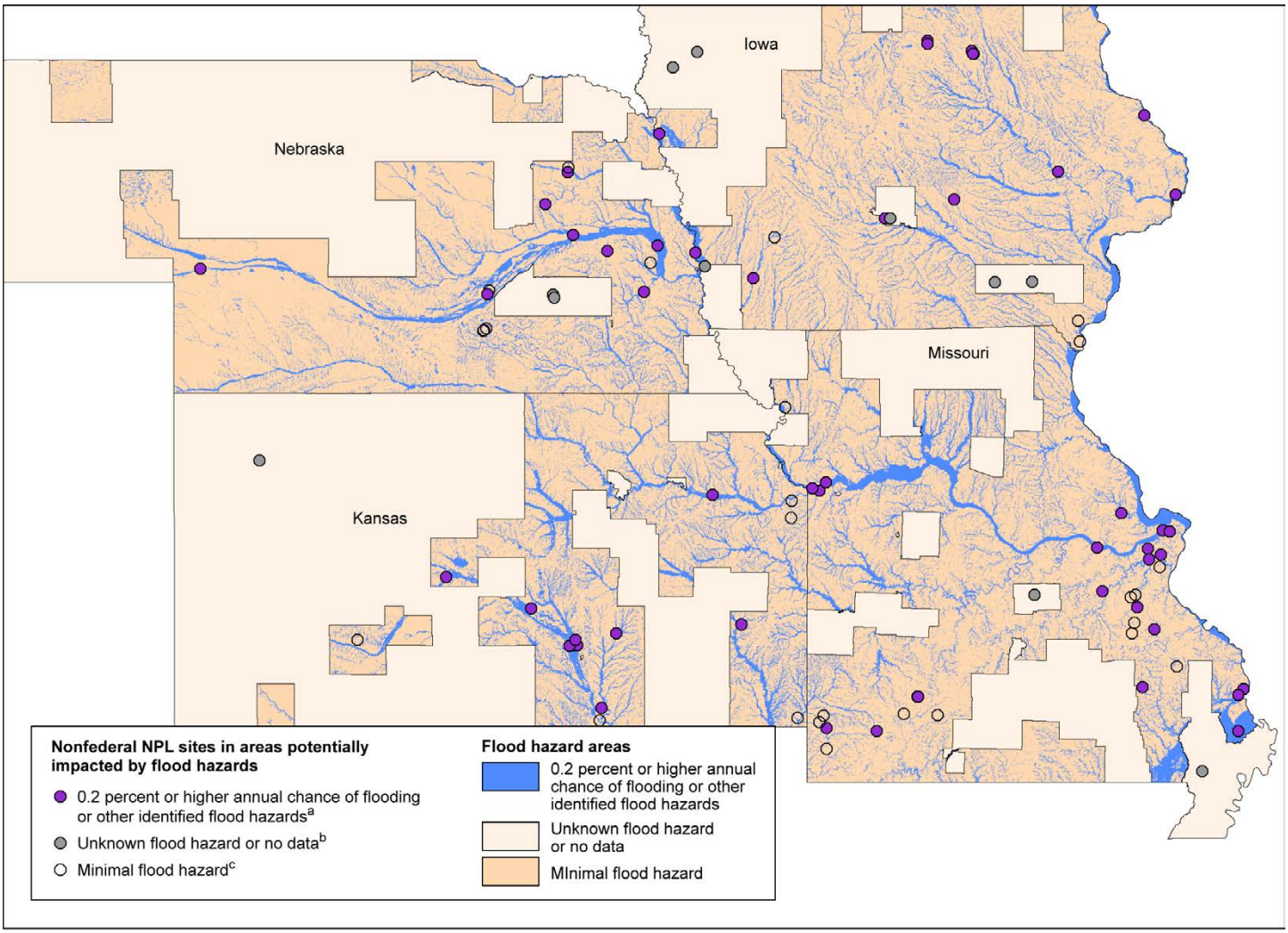
Flooding

We identified 783 nonfederal NPL sites—approximately 50 percent—in areas that FEMA had identified as having 0.2 percent or higher annual chance of flooding, which FEMA considers moderate flood hazard, or other flood hazards, as of October 2018.[50] Of these 783 sites, our analysis shows that 713—approximately 45 percent of all sites—are currently located in areas with 1 percent or higher annual chance of

[50]Other flood hazards include areas with reduced risk because of levees as well as areas with flood hazard based on future conditions, for example, if land use plans were implemented. FEMA considers areas with at least 0.2 percent annual chance of flooding as having moderate flood hazard and those with 1 percent or higher annual chance of flooding to be Special Flood Hazard Areas (i.e., those with the highest chance of flooding).

flooding, FEMA's highest flood hazard category. We provide information on the number of sites in areas with moderate or other flood hazards because, according to the NCA, heavy rainfall is increasing in intensity and frequency across the United States and is expected to continue to increase, which may lead to an increase in flooding in the future. The full results of our analysis—which include information on the sites in areas that may have 1 percent or higher annual chance of flooding, 0.2 percent or higher annual chance of flooding or other identified flood hazards, unknown flood hazard or no data, and minimal flood hazard—are available in our interactive map, which can be viewed here. For example, there are a number of nonfederal NPL sites in EPA Region 7, where states experienced record flooding in early 2019. Specifically, as seen in figure 4, there are 51 sites that are located in areas with 0.2 percent or higher annual chance of flooding or other identified flood hazards, of which 42 are located in areas with 1 percent or higher annual chance of flooding.

Figure 4: Nonfederal NPL Sites in EPA Region 7 Located in Areas That May Be Impacted by Flooding



Sources: GAO analysis of Environmental Protection Agency (EPA) and Federal Emergency Management Agency (FEMA) data; MapInfo (map). | GAO-20-73

Notes: We represented the boundaries of nonfederal National Priorities List (NPL) sites with a 0.2-mile radius around the primary geographic coordinate of each site. Depending on the actual site boundaries, the results of our analysis may not accurately reflect the number of nonfederal NPL sites located in these areas. This analysis is based on EPA data as of March 2019 and FEMA data as of October 2018.

[a]FEMA considers areas with 0.2 percent or higher annual chance of flooding to have at least moderate flood hazard. Other identified flood hazards include areas with reduced risk because of levees. Of the 51 sites in these areas in EPA Region 7, 42 are located in areas that have 1 percent or higher annual chance of flooding.

[b]Unknown flood hazard or no data include areas that have flood data but that we did not analyze because the data were not available in a digital format.

[c]Minimal flood hazard includes areas with less than 0.2 percent annual probability of flooding.

Nationwide, the number of nonfederal NPL sites in areas that may be impacted by flooding currently may be higher than 783. Specifically, 217 nonfederal NPL sites are located in areas that FEMA has not assessed for flood hazards or that we did not analyze because the data were not available in a form we could use with our mapping software.

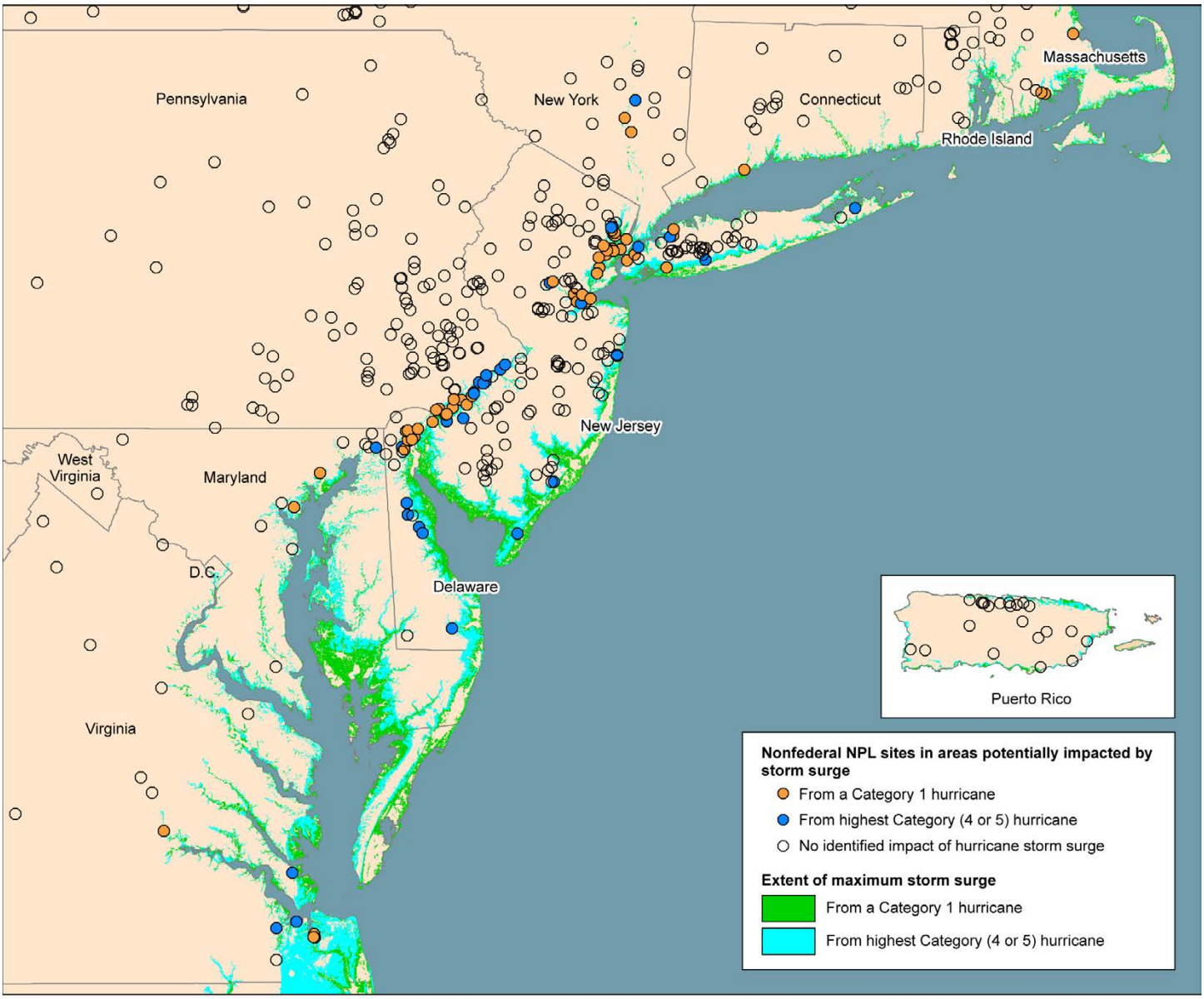
Storm Surge

We identified 187 nonfederal NPL sites—12 percent—in areas that may be inundated by storm surge corresponding to Category 4 or 5 hurricanes, the highest possible category, based on NOAA's storm surge model as of November 2018.[51] Of these sites, 102 are located in areas that may be inundated by a storm surge corresponding to Category 1 hurricanes. We analyzed areas that may be inundated by a storm surge corresponding to the highest possible category because, according to the NCA, a projected increase in the intensity of hurricanes in the North Atlantic could increase the probability of extreme flooding because of storm surge along most of the Atlantic and Gulf Coast states, beyond what would be projected based solely on relative sea level rise. However, the NCA stated that there is uncertainty in the projected increase in frequency or intensity of Atlantic hurricanes, and other factors may affect the potential for flooding because of storm surge, such as changes in overall storm frequency or tracks. The full results of our analysis, which include information on the number of sites in areas that may be inundated by storm surge from Category 1 and from Category 4 or 5 hurricanes, are available in our interactive map, which can be viewed here. In EPA Regions 2 and 3, where states experienced damage from two major hurricanes in 2017, there are 87 nonfederal NPL sites located within areas that may be inundated by storm surge from Category 4 or 5 hurricanes.[52] Figure 5 shows these 87 sites, of which 54 sites may be inundated by storm surge from Category 1 hurricanes.

[51]According to a NOAA website, the model does not account for future conditions, such as erosion, subsidence (i.e., the sinking of an area of land), construction, or sea level rise.

[52]Hurricanes Irma and Maria made landfall in Puerto Rico and the U.S. Virgin Islands in September 2017. These storms are considered among the five costliest hurricanes on record, according to FEMA.

Figure 5: Nonfederal NPL Sites in EPA Regions 2 and 3 Located in Areas That May Be Impacted by Storm Surge



Sources: GAO analysis of Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA) data; MapInfo (map). | GAO-20-73

Notes: We represented the boundaries of nonfederal National Priorities List (NPL) sites with a 0.2-mile radius around the primary geographic coordinate of each site. Depending on the actual site boundaries, the results of our analysis may not accurately reflect the number of nonfederal NPL sites located in these areas. This analysis is based on EPA data as of March 2019 and NOAA data as of November 2018. EPA Region 2 also includes the U.S. Virgin Islands, which we do not depict in this figure.

Nationwide, the number of nonfederal NPL sites in areas that may be impacted by storm surge may be higher than 187 because NOAA has not modeled areas along the West Coast and Pacific islands other than Hawaii.[53] Further, our analysis did not include other potential impacts from hurricanes, such as rainfall. Figure 6 shows an example of the impact of rainfall caused by a hurricane at the American Cyanamid NPL site.

Figure 6: American Cyanamid National Priorities List Site—New Jersey

Overview: The American Cyanamid site is located in Bridgewater Township, New Jersey. Prior owners used the 575-acre site for chemical and pharmaceutical manufacturing operations for more than 90 years, resulting in the contamination of soil and groundwater from 27 unlined chemical waste lagoons and containment areas, or impoundments. Contamination includes volatile and semivolatile organic compounds and metals. EPA listed the site on the National Priorities List in 1983. Wyeth Holdings LLC, a subsidiary of Pfizer Inc., acquired the site in 2009 and assumed responsibility for its cleanup.

Site status in cleanup process: Cleanup of the site is ongoing. According to EPA's website and officials, EPA is treating contaminated soil, is installing caps over three highly contaminated impoundments and all site soils, and has constructed a new water treatment system to treat contaminated groundwater. EPA is in the process of designing the remedy for impoundments 1 and 2, which contain toxic acid tar, a residual by-product of refining coal light oil.

Potential impacts of climate change: According to our analysis, the site is located in an area that has a 1 percent or higher annual chance of flooding and may be impacted by storm surge from highest possible category hurricanes. In 2011, heavy rains from Hurricane Irene flooded the site, leading to, among other impacts, a loss of power and damage to a flood control berm. Impoundments 1 and 2, located about 700 feet from the Raritan River, also flooded, as seen in the picture (below left). After the floodwaters receded, EPA inspected the berm surrounding the impoundments and conducted water sampling. EPA concluded no significant release occurred.

Actions EPA has taken to manage risks to human health and environment from impacts of climate change: Since Hurricane Irene, EPA and the responsible party (i.e., Wyeth Holdings LLC) have taken additional actions to manage risks from flooding at the site, including reinforcing flood control berms, elevating electrical equipment 5 feet higher than flood levels resulting from Hurricane Irene, and, as seen in the picture (right), installing metal pillars to protect the elevated equipment from flood debris. In the 2018 record of decision for impoundments 1 and 2, because of, among other things, risk of future flooding, EPA chose to remove and treat the acid tar off-site.

Sources: GAO analysis of Environmental Protection Agency (EPA) information; EPA (left-hand photo); GAO (right-hand photo). | GAO-20-73

Wildfires

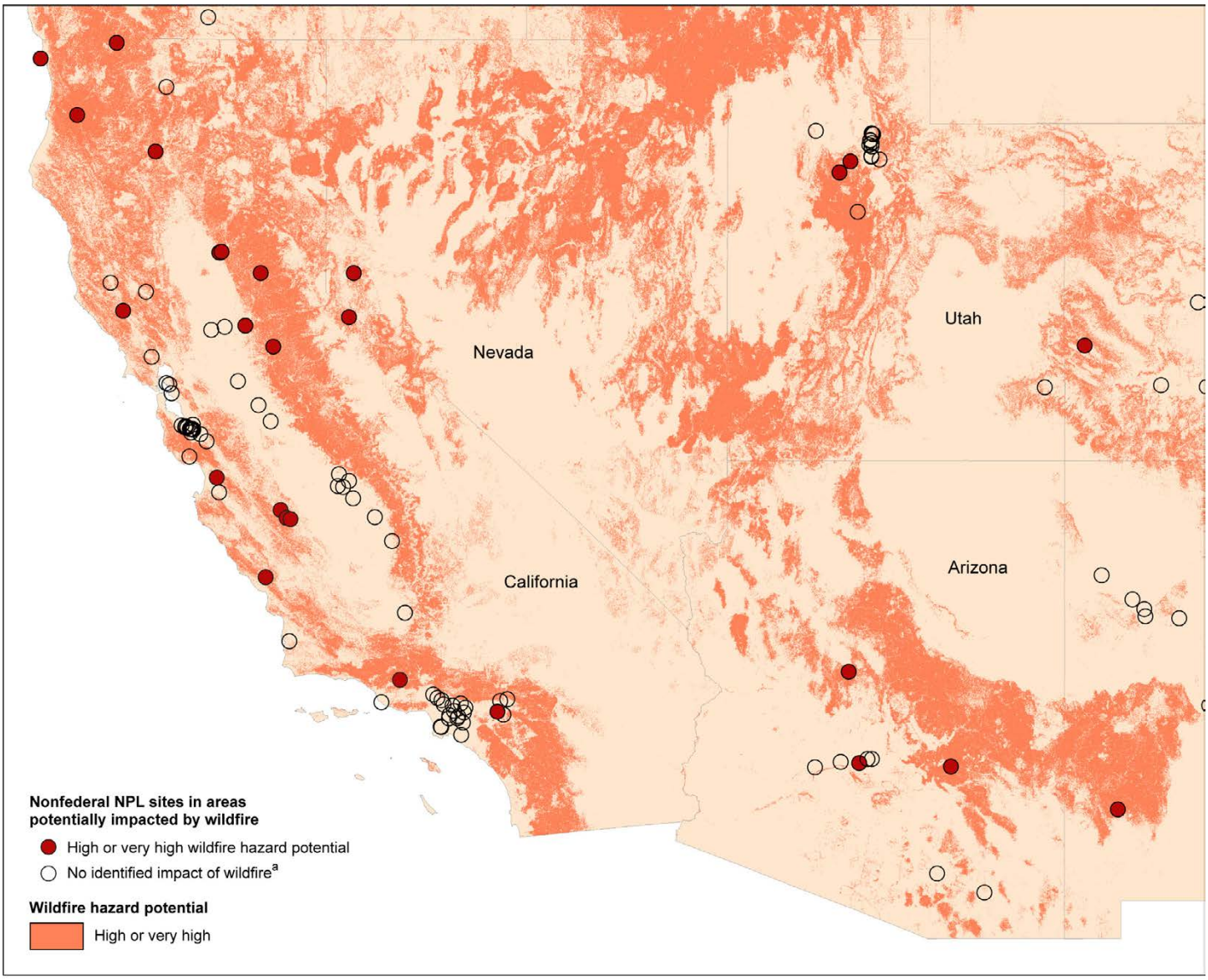
We identified 234 nonfederal NPL sites—15 percent—located in areas that have high or very high wildfire hazard potential—those more likely to burn with a higher intensity, based on a U.S. Forest Service model as of July 2018. For this analysis, we combined the high and very high wildfire hazard potential categories; we did not identify the number of sites in

[53]Our analysis may not accurately account for the impacts of storm surge because we included sites in areas that are protected by levees. NOAA officials told us that storm surge in these areas is difficult to model.

each of these categories separately. We did not analyze areas that currently have moderate or lower wildfire hazard potential because those with moderate or lower wildfire hazard potential are less likely to experience high-intensity wildfire and the extent to which wildfire hazard potential may change in the future is unknown. The full results of our analysis on the number of sites in areas with high or very high wildfire hazard potential are available in our interactive map, which can be viewed here. As seen in figure 7, there are 22 nonfederal NPL sites in areas with high or very high wildfire hazard potential in EPA Region 9, a region that experienced wildfires in 2018, including the highly destructive Carr Fire.[54]

[54]The Carr Fire began on July 23, 2018, within the Whiskeytown National Recreation Area in Northern California, and by the time it was contained on August 30, 2018, it had covered approximately 229,651 acres and destroyed over 1,000 residences.

Figure 7: Nonfederal NPL Sites in EPA Region 9 Located in Areas with High or Very High Wildfire Hazard



Sources: GAO analysis of Environmental Protection Agency (EPA) and U.S. Forest Service data; MapInfo (map). | GAO-20-73

Notes: We represented the boundaries of nonfederal National Priorities List (NPL) sites with a 0.2-mile radius around the primary geographic coordinate of each site. Depending on the actual site boundaries, the results of our analysis may not accurately reflect the number of nonfederal NPL sites located in these areas. This map does not depict nonfederal NPL sites that are located in areas with high or very high wildfire hazard potential in Hawaii and other Pacific islands (which are part of EPA Region 9) because the U.S. Forest Service does not model wildfire hazard potential outside the contiguous United States. This analysis is based on EPA data as of March 2019 and U.S. Forest Service data as of July 2018.

[a]No identified impact of wildfire includes unburnable areas as well as areas with very low to moderate wildfire hazard potential.

Nationwide, the number of nonfederal NPL sites in areas that currently have high wildfire hazard potential may be higher than 234 because wildfire hazard data are only available for the contiguous United States (i.e., there are no data for Alaska, Hawaii and other Pacific islands, Puerto Rico, and the U.S. Virgin Islands). According to the NCA, the incidence of large forest fires in the western United States and Alaska has increased since the early 1980s and is projected to further increase in those regions as the climate changes. However, the NCA noted that analyses regarding the effect of climate change on the incidence of wildfire in other parts of the United States are not readily available, so it is unknown how climate change will affect the number of nonfederal NPL sites in areas rated with high or very high wildfire hazard potential nationwide. As figure 8 shows, wildfires can pose risks at nonfederal NPL sites, such as the Iron Mountain Mine site near Redding, California.

Figure 8: Iron Mountain Mine National Priorities List Site—California

Overview: The 4,400-acre Iron Mountain Mine site near Redding, California, produced iron, silver, gold, copper, zinc, and pyrite through 1963. The underground mine workings and the fractured bedrock allow water and oxygen to react with the ore. The resulting acid mine drainage contains metals such as copper, cadmium, and zinc that are toxic to aquatic life, such as trout and salmon. EPA listed the site on the National Priorities List in 1983. In 2000, federal agencies and California reached a settlement with Aventis, the principal responsible party at the Iron Mountain Mine site. Global Loss Prevention, a wholly owned subsidiary of American International Group, operates the site.

Site status in cleanup process: Cleanup of the site is ongoing. EPA has constructed interim remedies, such as diverting streams to avoid contamination with acid mine drainage, and has begun a remedial investigation and feasibility study. According to EPA's sixth Five-Year Review report, in 2000, the potentially responsible party completed the construction of a water treatment system, seen in the picture, that captures most of the acid mine drainage, neutralizes it, and removes metals prior to discharge. The interim remedies remove 95 percent of the historic quantities of copper, cadmium, and zinc discharged from the Iron Mountain Mine and prevent uncontrolled releases of acid mine drainage into nearby streams and the Sacramento River in all but the most severe storms.

Potential impacts of climate change: According to our analysis, the site is located in an area with high or very high wildfire hazard potential. In July 2018, the Carr Fire burned through the site and almost destroyed the water treatment system. In the days that followed, fire was discovered in the high density polyethylene pipe that conveys acid mine drainage from one of the mines to the water treatment system. Firefighters, using specialized equipment, successfully extinguished the fire before it reached the ore body in the mine, which could have led to an explosion and substantial environmental and health hazards, according to an EPA report. EPA and state officials told us that increasing frequency and intensity of wildfires and landslides and erosion because of storm runoffs are an ongoing concern at the site.

Actions EPA has taken to manage risks to human health and environment from impacts of climate change: Following the fire, the site operator replaced portions of the pipes conveying acid mine drainage with nonflammable stainless steel, as can be seen in the bottom left corner of the picture. EPA officials told us that they plan to develop a model of water quality, including potential changing precipitation patterns because of climate change, in their remedial investigation for one of the operable units at the site.

Sources: GAO analysis of Environmental Protection Agency (EPA) information; GAO (photos). | GAO-20-73

Sea Level Rise

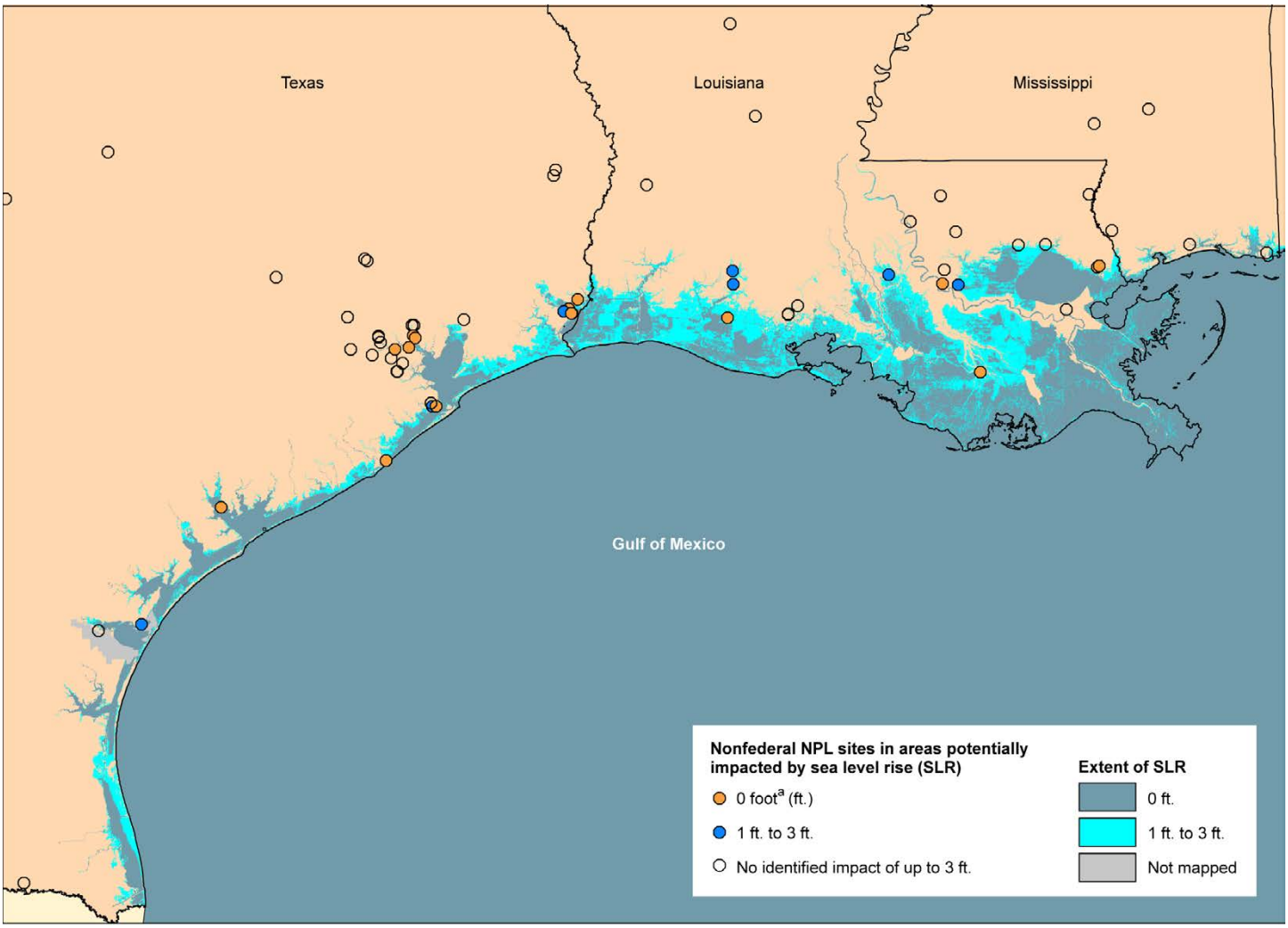
We identified 110 nonfederal NPL sites—7 percent—located in areas that would be inundated by a sea level rise of 3 feet, based on our analysis of EPA and NOAA data as of March 2019 and September 2018, respectively. Our analysis shows that if sea level in these areas rose by 1 foot, 97 sites would be inundated. If sea level in these areas rose by 8 feet, 158 sites would be inundated. We also identified 84 nonfederal NPL sites that are located in areas that may already be inundated at high tide.[55] We provide the number of sites in areas that may be impacted by these sea level rise heights because, according to the NCA, global

[55]These sites are located in areas at 0-foot sea level rise, which according to NOAA data is equivalent to the water level at the average of the highest of the two daily tides from 1983 to 2001.

average sea levels are very likely to continue to rise by at least several inches in the next 15 years and by 1.0 to 4.3 feet by 2100. Further, the NCA states that a rise of as much as 8 feet by 2100 cannot be ruled out. The full results of our analysis, which include information on the number of sites in areas that may already be inundated at high tide and that would be inundated if sea level rose by 1 foot, 3 feet, and 8 feet, are available in our interactive map, which can be viewed here. There are 23 nonfederal NPL sites located within areas that may be impacted if sea level rose by up to 3 feet in EPA Region 6, a region that has experienced land loss because of sea level rise and coastal flooding, according to the NCA.[56] In addition, as seen in figure 9, 16—or 70 percent—of these sites may already be inundated at high tide.

[56]There are 18 nonfederal NPL sites in EPA Region 6 that would be inundated if sea level rose by 1 foot. In addition, 28 nonfederal NPL sites would be inundated if sea level rose by 8 feet in that region.

Figure 9: Nonfederal NPL Sites in EPA Region 6 Located in Areas That Would Be Inundated by Sea Level Rise



Sources: GAO analysis of Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA) data; MapInfo (map). | GAO-20-73

Notes: We represented the boundaries of nonfederal National Priorities List (NPL) sites with a 0.2-mile radius around the primary geographic coordinate of each site. Depending on the actual site boundaries, the results of our analysis may not accurately reflect the number of nonfederal NPL sites located in these areas. SLR is measured relative to the average highest tide from 1983 to 2001. This analysis is based on EPA data as of March 2019 and NOAA data as of September 2018.

[a]A 0 ft. SLR means an area may already be inundated at high tide.

Nationally, the number of nonfederal NPL sites that may be inundated by various heights of sea level rise will vary from the results of our analysis because different parts of the United States may experience higher or lower sea level rise than the global average. For example, the NCA states

that sea level rise will be higher than the global average on the East and Gulf Coasts of the United States and lower than the global average in most of the Pacific Northwest and in Alaska. As can be seen in figure 10, sea level rise and other coastal hazards may impact nonfederal NPL sites, such as the one in the San Jacinto River Waste Pits site in Texas, parts of which are already under water.

Figure 10: San Jacinto River Waste Pits National Priorities List Site—Texas

Overview: The approximately 40-acre San Jacinto River Waste Pits site is located east of Houston, Texas, between two unincorporated areas known as Channelview and Highlands. In the mid-1960s, liquid and solid pulp and paper mill wastes were disposed of at the site in impoundments, or waste disposal areas. The primary hazardous substances at the site, by-products of the pulp bleaching process, are dioxins and furans, exposure to which can cause several health effects, including skin diseases and liver damage. Added to the National Priorities List in 2008, the site consists of impoundments in and adjacent to the San Jacinto River north and south of Interstate 10. As seen in the picture, the San Jacinto River covers part of the northern impoundment, the boundaries of which are marked with buoys. The International Paper Company and McGinnes Industrial Maintenance Corporation are responsible for the cleanup.

Site status in cleanup process: Cleanup of the site is ongoing. In 2010, EPA required the potentially responsible parties to, among other things, install and maintain a temporary armored cap over the waste that could withstand storm events with 1 percent or higher annual chance of occurring. The temporary armored cap includes an impervious geomembrane under the northern impoundment and a cover over the impoundment. The potentially responsible parties also stabilized and solidified part of the paper mill waste. EPA is currently designing the long-term remedy for the site.

Potential impacts of climate change: According to our analysis, the site is located in an area that has a 1 percent or higher annual chance of flooding and that may be impacted by storm surge from Category 1 hurricanes and sea level rise of 0 foot. According to the 2017 record of decision, since the installation of the temporary cap, EPA has observed repeated damage to sections of the cap, including in September 2017 from Hurricane Harvey. Record-breaking rainfall during the hurricane led to flooding, which eroded the cap in some places, exposing some of the contaminated material. EPA detected high levels of dioxins in one area it sampled.

Actions EPA has taken to manage risks to human health and environment from impacts of climate change: According to the operations, monitoring, and maintenance plan of the time-critical removal action for the site, EPA has directed the potentially responsible parties to periodically inspect the cap and conduct repairs as needed after certain flood events. In the 2017 record of decision, EPA required the potentially responsible parties to remove and treat most of the contaminated material off-site, because of, among other things, risk of future flooding from hurricanes and sea level rise.

Sources: GAO analysis of Environmental Protection Agency (EPA) information; GAO (photo). | GAO-20-73

EPA Does Not Have Quality Information on the Boundaries of Nonfederal NPL Sites

EPA does not have quality information on the boundaries of nonfederal NPL sites, which could affect its ability to identify the number of sites that may be impacted by one or more of these potential climate change effects.[57] According to EPA officials, EPA has not validated data on site boundaries and EPA's regional offices do not use a consistent geographic standard,[58] which makes it difficult to produce a national data set. In general, EPA officials told us that information on the boundaries of NPL sites has not been a focus at a national level and is not yet subject to quality standards. For example, EPA officials told us that boundary information for each NPL site represents the remedial project manager's professional judgment and remedial project managers may determine and record the boundaries of sites differently.

EPA has taken some initial actions to improve the quality of information on the boundaries of nonfederal NPL sites. In November 2017, the Office of Superfund Remediation and Technology Innovation issued a directive to all regional Superfund division directors recommending national standards for collecting and maintaining geographic information, including site boundaries.[59] EPA's 2017 directive notes that using national standards to collect geographic information, including site boundaries, promotes EPA's reporting and analytical efforts to support program implementation and evaluation. In addition, in May 2018, EPA's Office of Land and Emergency Management developed technical guidance for all its regions and programs for collecting, documenting, and managing geographic information on Superfund sites, including their boundaries.[60] EPA officials told us that in 2019 and 2020, the agency plans to move

[57]According to 2018 EPA guidance, site boundaries identify the geographic extent of the site as a whole, including areas of contamination, and those boundaries change over time. Environmental Protection Agency, Office of Land and Emergency Management, *Collection and Documentation of General Descriptive Geospatial Site Data*, Version 3.4 (May 2018).

[58]Geographic standards include, for example, using the same geodetic datum, which, according to a NOAA website, uses a reference surface (such as sea level) to provide known locations to begin surveys and create maps. See https://www.ngs.noaa.gov/datums/index.shtml, accessed on July 26, 2019.

[59]Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, *Memo on Geospatial Superfund Site Data Definitions and Recommended Practices*, OLEM Directive 9200.2-191 (Nov. 29, 2017).

[60]Environmental Protection Agency, Office of Land and Emergency Management, *Collection and Documentation of General Descriptive Geospatial Site Data,* Version 3.4 (May 2018).

toward recording site boundaries in a consistent format across regions and instituting procedures to validate and update them at least annually.

However, EPA officials told us that there is no schedule in place for completing this effort and they are uncertain when they will complete it because of competing priorities. By developing a schedule for completing the standardization and improvement of the quality of the information on the boundaries of nonfederal NPL sites, EPA could more reasonably ensure that it would have quality information with which to fully identify nonfederal NPL sites that are located in areas that may be impacted by climate change effects.

EPA Has Taken Some Actions to Manage Risks from the Potential Impacts of Climate Change Effects at Nonfederal NPL Sites

EPA's actions to manage risks from the potential impacts of climate change effects align with three of the six essential elements of enterprise risk management.[61] Specifically, for the six essential elements, EPA's actions do not align with one essential element, aligning its enterprise risk management process with goals and objectives; partially align with two essential elements, assessing risks and responding to risks; and align with three essential elements, identifying risks, monitoring risks, and communicating about and reporting on risks. Table 1 shows the alignment of EPA's actions with the essential elements of enterprise risk management.

Table 1: Extent to Which EPA's Actions to Manage Risks to Human Health and the Environment from the Potential Impacts of Climate Change Effects at Nonfederal National Priorities List Sites Aligned with GAO's Essential Elements of Enterprise Risk Management

Essential elements	Extent to which EPA's actions aligned with essential elements
Aligning enterprise risk management process with goals and objectives	Not aligned
Identifying risks	Aligned
Assessing risks	Partially aligned
Responding to risks	Partially aligned
Monitoring risks	Aligned
Communicating about and reporting on risks	Aligned

Sources: GAO-17-63 and GAO analysis of Environmental Protection Agency (EPA) and stakeholder information. | GAO-20-73

[61]We reported in 2016 that this enterprise risk management framework can help agencies assess threats that could affect the achievement of their goals: see GAO-17-63.

Aligning Risk Management Process with Goals and Objectives

This essential element calls for agencies to align their risk management processes with the goals and objectives of the agency, but EPA has not taken action to clearly align its process for managing risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites with agency-wide goals and objectives. For example, the 2018 to 2022 EPA strategic plan does not include goals and objectives related to climate change or discuss strategies for addressing the impacts of climate change effects.[62] Moreover, neither the fiscal years 2018 to 2019 nor fiscal years 2020 to 2021 national program manager guidance for EPA's Office of Land and Emergency Management mentions climate change among its goals and priorities.[63] In contrast to the current strategic plan, the 2014 to 2018 EPA strategic plan included addressing climate change as one of four strategic goals and specifically discussed climate change as an external factor or emerging issue in the context of planned, current, and completed cleanups, including at nonfederal NPL sites. In addition, the fiscal years 2016 to 2017 national program manager guidance for the office that oversees the Superfund program listed climate change adaptation as one of four national areas of focus for the office.[64]

According to an EPA official, when the 2018 to 2022 strategic plan was drafted, senior agency officials were not aware of the potential risks to the Superfund program mission from the impacts of climate change effects. According to this official, senior EPA officials have expressed support for certain activities related to climate change, such as the work of the Cross-EPA Work Group on Climate Adaptation,[65] but have not issued related

[62]Environmental Protection Agency, *Working Together: FY 2018-2022 EPA Strategic Plan*, EPA-190-R-18-003 (Washington, D.C.: February 2018).

[63]Environmental Protection Agency, *Final FY 2018-2019 Office of Land and Emergency Management National Program Manager Guidance*, 540B17001 (Sept. 29, 2017), and *Final FY 2019-2020 Office of Land and Emergency Management National Program Manager Guidance,* 500B19002 (June 7, 2019). The national program manager guidance communicates operational planning priorities, strategies, and key activities for advancing the agency's strategic plan.

[64]Environmental Protection Agency, *Fiscal Year 2014-2018 EPA Strategic Plan*, EPA-190-R14-006 (Washington, D.C.: Apr. 10, 2014), and *Office of Solid Waste and Emergency Response FY 2016-2017 National Program Manager Guidance*, 530R15001 (Apr. 28, 2015).

[65]The Cross-EPA Work Group on Climate Adaptation shares information among regional and program offices to support the integration of climate adaptation planning into EPA's programs and operations, including cleanup at nonfederal NPL sites.

documents or policy statements.[66] Without clarifying how the agency's ongoing actions to manage these risks at nonfederal NPL sites align with current agency goals and objectives, EPA will not have reasonable assurance that senior officials will take an active role in supporting these actions, which would help EPA achieve its mission of protecting human health and the environment.

Identifying Risks

EPA's actions to identify risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites align with this essential element of enterprise risk management. Specifically, EPA identified climate change effects that may impact nonfederal NPL sites—and pose risks to human health and the environment—in studies and climate change adaptation and implementation plans. For example, in a 2012 study of adaptation of Superfund remediation to climate change, EPA identified eight climate change effects that may impact certain NPL site remedies: flooding, sea level rise, extreme storms, large snowfall, wildfires, drought, extreme heat, and landslides.[67] In 2014, EPA issued an agency-wide climate change adaptation plan, which identified climate change effects that may impact NPL sites.[68] The same year, EPA issued a climate change adaptation implementation plan for the office that oversees the Superfund program that identified nine climate change effects that may impact NPL sites.[69]

Each of the 10 EPA regional offices identified relevant regional climate change effects in their 2014 climate change adaptation implementation

[66]In 2011 and 2014, EPA administrators issued policy statements indicating that EPA would take actions to address the impacts of climate change effects. The two most recent EPA administrators have not made policy statements about climate change, according to an EPA official.

[67]Environmental Protection Agency, *Adaptation of Superfund Remediation to Climate Change* (Washington, D.C.: February 2012). According to an EPA headquarters official, the agency does not plan to update this 2012 study, because the data upon which its conclusions are based remain valid.

[68]Environmental Protection Agency, *U.S. Environmental Protection Agency Climate Change Adaptation Plan*, EPA 100-K-14-001 (June 2014).

[69]Environmental Protection Agency, *Office of Solid Waste and Emergency Response Climate Change Adaptation Implementation Plan* (June 2014).

plans.[70] For example, the Region 3 plan states that increased flooding and sea level rise may increase risks of releases of contaminants, salt water intrusion may impact the performance of remedies, and increased temperatures may impact vegetation that prevents erosion. Additionally, five regional offices have conducted or are conducting additional screening-level studies to identify which climate change effects, if any, may impact each of the NPL sites in these regions.[71] For example, Region 10 conducted a study in 2015 that identified, among other effects, sea level rise and wildfires as potential climate change effects that may impact NPL sites in the region.

Assessing Risks

EPA's actions to assess risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites partially align with this essential element. In a 2012 study of adaptation of Superfund remediation to climate change, EPA assessed the impacts of eight climate change effects on certain remedies to determine the risk they presented to the agency's mission to protect human health and the environment.[72] EPA issued climate change adaptation implementation plans for the office that oversees the Superfund program and all regions, as described above, which assessed potential impacts of climate change effects. In addition, five EPA regional offices assessed or are assessing potential impacts of climate change effects on NPL sites in their regions as a whole, and one of these regions assessed both the impacts and likelihood of climate change effects, consistent with this essential element. Specifically, Region 4 identified the sites most likely to face major climate change risks and then examined these sites in greater

[70]In 2014, EPA developed an agency-wide climate change adaptation plan and climate change adaptation implementation plans for each EPA program office and the 10 EPA regions in response to Executive Order 13653, issued in 2013, which directed each federal agency to evaluate climate change risks and vulnerabilities to the agency's mission and operations in both the short and long term. Exec. Order No. 13653, 78 Fed. Reg. 66819 (Nov. 6, 2013). The adaptation plan stated that EPA will take the actions necessary to ensure that it continues to fulfill its mission of protecting human health and the environment even as the climate changes. Executive Order 13653 was revoked in 2017 by Executive Order 13783. Exec. Order No. 13783, 82 Fed. Reg. 16093 (Mar. 31, 2017).

[71]These are regions 1, 3, 4, 6, and 10.

[72]Environmental Protection Agency, *Adaptation of Superfund Remediation to Climate Change* (Washington, D.C.: February 2012).

detail.[73] Additionally, Region 3 has developed a mapping tool on climate change vulnerability that provides site-level assessments of sea level rise, among other potential impacts.

EPA provides training and direction to remedial project managers—the lead EPA officials at nonfederal NPL sites—on conducting site-level risk assessments that incorporate information on potential impacts of climate change effects. Since 2014, EPA has offered optional training to remedial project managers and others on integrating climate change into the Superfund cleanup process. From 2013 through 2015, EPA issued fact sheets as guidance for assessing the potential impacts of climate change effects for three types of remedies.[74] According to EPA officials, these fact sheets constitute the direction that EPA provides to remedial project managers on assessing risks from climate change effects. EPA plans to update these fact sheets in 2019 and is also in the process of developing a compilation of resources for assessing potential flood risks in coastal areas to inform cleanup and reuse decision-making, according to an EPA official. In addition, EPA provides resources on climate change on the Superfund program website, such as links to tools and data on drought and coastal flooding.[75] EPA also offers technical assistance on incorporating climate change information into risk assessments to remedial project managers through groups such as the Contaminated

[73]Environmental Protection Agency and Industrial Economics, Inc., *Methodology for Ranking the Climate Change Vulnerability of NPL Sites* (Mar. 19, 2015).

[74]Environmental Protection Agency, *Climate Change Adaptation Technical Fact Sheet: Groundwater Remediation Systems*, EPA 542-F-13-004 (December 2013); *Climate Change Adaptation Technical Fact Sheet: Landfills and Containment as an Element of Site Remediation*, EPA 524-F-14-001 (May 2014); and *Climate Change Adaptation Technical Fact Sheet: Contaminated Sediment Remedies*, EPA 542-F-15-009 (April 2015).

[75]Environmental Protection Agency, *Superfund Climate Resilience: Vulnerability Assessment*, accessed June 27, 2019, https://www.epa.gov/superfund/superfund-climate-resilience-vulnerability-assessment. In addition, EPA has compiled a more general collection of resources about climate change adaptation for local government officials on the Climate Change Adaptation Resource Center (ARC-X) website, including tools, case studies, and training materials. As of July 2019, the site included one case study on climate change adaptation at a nonfederal NPL site. According to an EPA official, the agency is working to develop additional Superfund case studies. Also, in June 2019, Region 10 launched a Climate Adaptation Action Forum that will share information on climate change issues and is open to all EPA staff, according to an EPA official.

Sediments Technical Advisory Group and the Cross-EPA Work Group on Climate Adaptation.[76]

EPA officials in four regions provided us with site-specific examples of how they used climate change information to assess risks from the potential impacts of climate change effects, but officials from other regions stated that they have not always integrated climate change information into their risk assessments. For example, according to a record of decision for the site, EPA Region 2 incorporated the potential for increased storm flow intensities into the model of the Passaic River used in the remedial investigation and feasibility study at the Diamond Alkali site in Newark, New Jersey.[77] Conversely, officials in six regions told us that they have not used climate change projections for flooding or rainfall in site-level risk assessments. In addition, officials in Region 6 told us that they do not incorporate potential impacts of climate change effects or changes in the frequency of natural disasters into their assessments.

EPA officials have not consistently incorporated climate change information into their assessment of site-level risks because they do not always have the climate data they need to do so, according to our review of EPA documents and interviews with EPA officials and stakeholders. For example, officials in three regions told us that they have not used rainfall or flood projections because the data are not available or they were unsure which data to use. In addition, in the record of decision for the Diamond Alkali site in New Jersey, Region 2 officials stated that they did not integrate sea level rise information into their storm flow modeling for the Passaic River at the site because of the uncertainty in expected future sea level rise values, especially at the regional and local levels. We reported on similar challenges with climate data in our 2015 report on climate information, which found that existing federal efforts do not fully meet the climate information needs of federal, state, local, and private

[76]The Contaminated Sediments Technical Advisory Group reviews cleanup decisions at certain sediment sites and has recommended that EPA remedial project managers require the use of the most recent climate information in characterization data and models, according to an EPA official.

[77]The soil, groundwater, and sediment in rivers and bays at the Diamond Alkali Superfund site are contaminated with dioxins, pesticides, polychlorinated biphenyls, and other hazardous substances from past manufacturing activities.

sector decision makers, and we made a related recommendation in that report.[78]

Further, current EPA practice for assessing risks at NPL sites does not always include consideration of climate change, according to agency documents we reviewed and officials from three regions and a stakeholder we interviewed. EPA's climate change adaptation plan noted that EPA and its partners will need to alter their standard practices—such as their standard methods for estimating the frequency of floods or runoff of pollutants into rivers—to account for a continuously changing climate. The Region 4 climate change adaptation implementation plan, for instance, noted that preliminary assessments and site investigations are typically based on historic information, not future projections and therefore may not fully address risks. Officials in two regions told us that they do not have direction on how to alter their practices to account for climate change. For example, officials in Region 2 said they do not have instructions that identify a particular set of expectations, data, or maps that they should use when considering future risks from flooding. Officials in Region 5 told us that they do not have any formal direction on how to address risks from climate change and are waiting for EPA headquarters to provide information on how to do so.

According to EPA documents and a headquarters official, EPA believes that its existing direction, including general guidance on conducting risk assessments and the fact sheets for assessing potential impacts of climate change effects for three types of remedies, discussed above, provide a robust structure for considering such impacts. However, without providing direction to remedial project managers on how to integrate information on the potential impacts of climate change effects into site-level risk assessments at nonfederal NPL sites across all regions and types of remedies, EPA cannot ensure that remedies will protect human health and the environment in the long term.

[78]GAO, *Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information*, GAO-16-37 (Washington, D.C.: Nov. 23, 2015). In that report, we recommended that the Executive Office of the President designate a federal entity to develop and periodically update a set of authoritative climate change observations and projections for use in federal decision-making and create a national climate information system with defined roles for federal agencies and nonfederal entities. The Executive Office of the President did not respond to our recommendations, and as of March 2019, has not implemented the recommendations. See GAO-19-157SP.

Responding to Risks

EPA's actions to respond to risks that potential impacts of climate change effects may pose to human health and the environment at nonfederal NPL sites partially align with this essential element. In two national studies EPA conducted in 2012 and 2017, EPA examined potential impacts of some climate change effects on selected remedies at NPL sites, including nonfederal NPL sites, and generally found that it has taken actions to respond to risks through its existing cleanup processes. In 2012, as noted above, EPA studied the vulnerability of selected remedies to some climate change effects and found that existing processes—such as EPA's Five-Year Review and operation and maintenance—could adequately address the potential impacts of climate change effects. In addition, EPA studied the impacts of three hurricanes in 2017 on sites with selected remedies in place, including nonfederal NPL sites, and found that the agency has generally taken resiliency measures to respond to risks at these sites.[79]

EPA also provided guidance and training to remedial project managers on responding to risks to human health and the environment from the potential impacts of climate change effects and recently added requirements for certain potential site contractors to describe their capacity to respond to such risks. EPA provided guidance in its fact sheets on integrating climate change information into risk response decisions at nonfederal NPL sites and optional training on integrating climate change into the Superfund cleanup process. In addition, EPA provided relevant information and resources for EPA officials on resiliency measures on the agency website. In 2016, EPA issued performance work statements to potential contractors for environmental services and operations and for remediation environmental services that required contractors to describe their ability to conduct climate change vulnerability analyses and adaptation, as needed, to ensure the resiliency of remedies to climate change impacts.[80] According to an EPA headquarters official, EPA is currently working on developing technical guidance on how remedial project managers can integrate requests for climate change–related analysis into their task orders for contractors.

[79]Environmental Protection Agency, *Evaluation of Remedy Resilience at Superfund NPL and SAA Sites* (August 2018).

[80]Environmental Protection Agency, *Remediation Environmental Services Contract Performance Work Statement*, SOL-HQ-14-00023, Attachment 1 (Sept. 16, 2016) and *Environmental Services and Operations Performance Work Statement*, SOL-R1-14-00003, Attachment 1 (Feb. 26, 2016).

With respect to site-level responses, EPA officials from three regions provided us with examples of site decision documents that described how climate change information will be incorporated into remedy selection and design. For example, the record of decision for the Portland Harbor site in Oregon states that a containment cap will be constructed to withstand more frequent floods with higher peak flows more common with climate change. Officials from Region 3 told us that they take into account a number of factors, including climate change impacts, if any, when they design and select site remedies.

However, according to our interviews with regional officials, they have not consistently integrated climate change information into remedy selection and design. For example, officials from two regions stated that they are not aware of any remedial project managers in their regions who are taking action at nonfederal NPL sites to respond to climate change or consider future conditions. EPA officials have not consistently taken the potential impacts of climate change effects into account in site-level risk response decision making because they do not always have sufficient direction to do so, according to our interviews with EPA officials. EPA officials from three regions told us that they are unsure how to translate data on potential impacts of climate change effects into the design of remedies. For example, officials from Region 10 told us that EPA does not have direction for remedial project managers on how to integrate response to climate change impacts into remedial design. These officials noted that it is up to remedial project managers to be aware of this issue and it is done on an ad hoc basis. Further, EPA headquarters officials who review proposed remedies told us that additional guidance from EPA on managing the risks from potential impacts of climate change effects would be useful.

According to EPA documents and another EPA headquarters official, EPA has determined that existing direction—guidance and processes—for risk response provide a robust structure to integrate climate change information into remedy selection and design. However, without providing direction for remedial project managers on how to integrate information on potential impacts of climate change effects into site-level risk response decision making at nonfederal NPL sites, EPA cannot ensure that remedies will protect human health and the environment in the long term.

Monitoring Risks

EPA's actions to monitor risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites through its Five-Year Review process align with this essential element. In

2016, EPA introduced a new recommended template for the Five-Year Review that includes a section for officials to document their consideration of whether any newly available information related to climate change may call into question a remedy's protectiveness.[81]

Officials in three regions told us they use the Five-Year Review process to identify and evaluate newly available information on climate change effects that may impact nonfederal NPL sites. For example, in the 2014 Five-Year Review report for the Publicker Industries site in Pennsylvania, Region 3 considered newly available information on projected sea level rise in the region to determine if those projections called into question the protectiveness of the existing remedies at the site. Officials in that region told us that they rely on their biological and technical assistance group to identify any new relevant climate change data to incorporate into their Five-Year Reviews. Region 7 officials also told us that they assess any potential changes in future conditions, especially flooding, during the Five-Year Review process. Officials from two other regions told us that they monitor changes in site conditions that may be related to climate change during the Five-Year Review process. For example, Region 2 officials developed additional guidance to help remedial project managers and site project teams consider changes in site conditions related to climate change in the Five-Year Review process. Region 6 officials told us that during the Five-Year Review process, they take into account any current flood hazard information from FEMA as well as current sea levels, but they do not monitor projections about sea level rise.

Communicating and Reporting on Risks

EPA's actions to communicate about and report on risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites align with this essential element. For example, as described above, EPA reported on the potential impacts of climate change effects—which may pose risks to human health and the environment—on NPL sites in its 2014 national climate change adaptation plan and the climate change adaptation implementation plans for the office that oversees the Superfund program and all regions. In addition, publicly available site-level documents, such as the records of

[81]Environmental Protection Agency, *Five-Year Review Recommended Template*, OLEM 9200.0-89 (Washington, D.C.: Jan. 20, 2016). According to an EPA memorandum, the template provides officials with an approach for preparing the Five-Year Review reports in a manner intended to promote national consistency, to reduce nonessential information, and to decrease repetitiveness in the reports.

decision described above, may include information on risks from climate change and EPA's actions to manage these risks. EPA officials may also communicate this information in response to questions from the public. EPA officials from four regions told us that they have not received many direct questions on risks from climate change from the public. However, members of the public can comment on climate change risks through EPA's existing public engagement mechanisms,[82] and some have done so. For example, EPA officials in Region 7 received questions on the draft record of decision for the West Lake Landfill site in Missouri during the public comment period and responded to those questions in the final version of the document, describing how they addressed risks of increased flooding from climate change in the remedy selection processes.

EPA has also communicated with stakeholders and the public on risks to human health and the environment from the potential impacts of climate change effects in other ways. For example, officials from Region 10 convened a workshop in 2017 to discuss climate change impacts on sediment cleanup and upland source control for the Lower Duwamish Waterway site in Washington with other federal agencies, state and local officials, universities, companies, and community groups. In addition, EPA provides an online mapping tool that can help members of the public identify sites located in areas that would be impacted by up to 6 feet of sea level rise or in flood hazard areas as determined by FEMA.[83]

[82]According to EPA, EPA's Superfund Community Involvement Program is to provide individuals affected by hazardous waste sites with information and opportunities to participate in the decisions that affect the Superfund sites in their communities. Further, the program seeks to ensure that each community has a voice during all phases of the Superfund cleanup process.

[83]The Cleanups in My Community online tool maps and lists hazardous waste cleanup locations and grant areas, such as nonfederal NPL sites. EPA also integrates other federal data into the tool, including sea level rise scenarios and FEMA flood hazard areas. Accessed April 8, 2019, at https://www.epa.gov/cleanups/cleanups-my-community.

EPA Recognizes Various Challenges in Managing Risks from the Potential Impacts of Climate Change Effects at Nonfederal NPL Sites

EPA recognizes institutional, resource, and technical challenges in managing risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites, according to agency and other documents that we reviewed and EPA officials and stakeholders we interviewed.

Institutional Challenges

According to agency and other documents we reviewed and officials and stakeholders that we interviewed, EPA faces institutional challenges in managing risks to human health and the environment from the potential impacts of climate change effects. As discussed above, officials from three regions told us that they do not have the direction they need to manage these risks. For example, EPA officials in Region 2 told us that during Five-Year Reviews, engineers may analyze several different maps on flooding potential and must use their professional judgment to determine how resilient to design the remedy, because there is no standard guidance on how to do so. Further, EPA officials in two regions and stakeholders we interviewed stated that it may not be clear whether EPA could require PRPs to consider climate change impacts in the cleanup process. However, according to EPA headquarters officials, considering climate change is consistent with the National Contingency Plan and the CERCLA criterion that requires officials to consider the long-term effectiveness of remedies when evaluating cleanup alternatives.

Another institutional challenge that EPA faces is that its ability to manage these risks may depend on actions of other entities that are outside of EPA's control, according to EPA documents we reviewed and EPA officials we interviewed. For example, EPA officials from Region 1 told us that they are not certain whether a hurricane barrier built by the U.S. Army Corps of Engineers that protects the New Bedford Harbor site in Massachusetts is designed to withstand future storms. Managing risks may also require internal coordination within EPA, which presents another challenge. For example, an EPA headquarters official told us that it can be challenging for regional Superfund program staff to connect with EPA experts on climate change, who may be in different program offices. In April 2019, EPA restructured its regional offices, consolidating cross-cutting issue areas in the immediate office of each Regional Administrator

and Deputy Regional Administrator. Although it is too early to evaluate the effect of this restructuring, EPA headquarters officials told us that the restructuring may help address this challenge. Furthermore, EPA officials from three regions told us that they face challenges related to the sensitive nature of climate change. For example, officials in Region 6 told us that when they engaged with the local community during the decision making process for the San Jacinto River Waste Pits site in Texas, they avoided using the term climate change because of concerns that the charged term would alienate some community members.

Resource Challenges

Documents from four EPA regions and headquarters officials and officials from three regions we interviewed stated that insufficient or changing resources—specifically funding and staffing—makes managing risks to human health and the environment from the potential impacts of climate change effects challenging for EPA. For example, according to two regional climate change adaptation implementation plans and EPA officials, assessing these risks may require more resources than assessing risks based on current or past conditions. In addition, designing or modifying existing remedies to respond to these risks could increase costs, according to EPA documents we reviewed and EPA officials we interviewed.

EPA officials from three regions told us that staffing constraints can make it difficult to manage risks. For example, EPA officials from Region 9 told us that the need for remedial project managers to respond to other emergencies, such as overseeing hazardous materials removal after fires, means that they have less time to oversee cleanup of nonfederal NPL sites.[84] Officials from Region 10 told us that they had a climate change advisor who helped integrate climate change into all aspects of the region's work, but that person retired, and the region was unable to fill the position because of resource constraints. As noted above, according to an EPA headquarters official, EPA's recent restructuring of its regional offices may help address this challenge.

[84]EPA's 2019 guidance on planning for natural disaster debris reported that the amount of debris generated by natural disasters will likely increase in the future as a result of climate change. The document also notes that disaster debris–related consequences of major natural disasters may include a greater risk of releases from Superfund sites and that local decision makers should plan accordingly. Environmental Protection Agency, *Planning for Natural Disaster Debris*, EPA 530-F-19-003 (April 2019).

Technical Challenges

EPA faces technical challenges in managing risks to human health and the environment from the potential impacts of climate change effects in terms of available expertise and data, according to documents we reviewed and EPA regional officials we interviewed. In its 2014 agency-wide climate change adaptation plan, EPA reported that site vulnerabilities may be difficult to assess because of limited scientific understanding. EPA officials told us that they need additional expertise and training to better manage risks. For example, an EPA official in Region 2 told us that it would be useful to have training on assessing risks for projects located in floodplains. As noted above, EPA has developed training for officials on managing risks from climate change, such as a course on building resilient Superfund remedies that EPA offered at the annual National Association of Remedial Project Managers meeting in August 2019. The course's focus is to help remedial project managers incorporate consideration of adaptation and build resilience into Superfund remedies at extreme weather event–impacted sites, according to the course agenda.

According to EPA documents and EPA officials from two regions, appropriate climate change data may not be available to inform assessments that help manage risk. For example, the Region 4 study of the vulnerability of NPL sites stated that climate model projections of temperature and precipitation patterns are not available at a spatial resolution that is useful for assessing vulnerabilities at the site level. In Region 6, officials told us that when the U.S. Army Corps of Engineers modeled flooding for the San Jacinto River Waste Pits site in Texas, it had to rely on past flooding data because the only information available was on historical storms.[85] In addition, the level of uncertainty inherent in climate change data may make it challenging for EPA to incorporate that information into risk management processes, according to agency documents we reviewed and some agency officials we interviewed. As noted above, we made recommendations to address similar challenges with climate data in a prior report.[86]

[85]U.S. Army Corps of Engineers, Engineer Research and Development Center, *Modeling the Impact of Hurricane Ike and the October 1994 San Jacinto River Flood on the San Jacinto Waste Pits Cap* (September 2017).

[86]See GAO-16-37.

Conclusions

Climate change may result in more frequent or intense extreme events, such as flooding, storm surge, and wildfires, among other effects, which could damage remedies at nonfederal NPL sites and lead to releases of contaminants that could pose risks to human health and the environment. Our analysis of EPA, FEMA, NOAA, and U.S. Forest Service data has shown that more than half of nonfederal NPL sites—based on a point coordinate with a 0.2-mile radius as a proxy for the site boundaries—are located in areas that may be impacted by selected climate change effects. To help ensure the long-term protectiveness of remedies, it is important for EPA to understand how climate change effects may impact nonfederal NPL sites, and the agency has taken steps to do this. However, EPA does not have quality information on the precise boundaries of nonfederal NPL sites, which could make it difficult to determine the nonfederal sites located in areas that may be impacted by climate change effects. The agency has taken initial steps to develop this information but does not have a schedule in place for completing this effort.

EPA has taken actions to manage risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites. These actions align with three of the six essential elements of enterprise risk management. However, EPA has not clarified how its actions to manage risks from these effects at nonfederal NPL sites align with current agency goals and objectives, which could limit its senior officials' ability to manage these risks. Further, EPA officials do not always have direction to ensure that they consistently integrate climate change information into site-level risk assessments and risk response decisions, according to EPA documents and officials. Without providing such direction for remedial project managers, EPA cannot ensure that remedies at nonfederal NPL sites will protect human health and the environment in the long term.

Recommendations for Executive Action

We are making the following four recommendations to EPA:

- The Director of the Office of Superfund Remediation and Technology Innovation should establish a schedule for standardizing and improving information on the boundaries of nonfederal NPL sites. (Recommendation 1)
- The Administrator of EPA should clarify how EPA's actions to manage risks to human health and the environment from the potential impacts

of climate change effects at nonfederal NPL sites align with the agency's current goals and objectives. (Recommendation 2)

- The Director of the Office of Superfund Remediation and Technology Innovation should provide direction on how to integrate information on the potential impacts of climate change effects into risk assessments at nonfederal NPL sites. (Recommendation 3)
- The Director of the Office of Superfund Remediation and Technology Innovation should provide direction on how to integrate information on the potential impacts of climate change effects into risk response decisions at nonfederal NPL sites. (Recommendation 4)

Agency Comments and Our Evaluation

We provided a draft of this report to EPA for its review and comments. In its comments, reproduced in appendix II, EPA stated that it recognizes the importance of ensuring Superfund sites cleanups are resilient in the face of existing risks and extreme weather events. EPA added that it has taken actions to include vulnerability analyses and adaptation planning in its Superfund activities. We acknowledge that EPA has taken some action to manage risks. However, EPA has not clarified how its risk-related actions align with agency goals and objectives. Further, it has not provided direction to ensure that officials consistently integrate climate change information into site-level risk assessments and risk response decisions.

Regarding our recommendations, EPA agreed with one and disagreed with the other three. We continue to believe that all recommendations are warranted.

In response to our recommendation that the Director of the Office of Superfund Remediation and Technology Innovation establish a schedule for standardizing and improving information on the boundaries of nonfederal NPL sites, EPA noted that it agrees with our finding and acknowledges a lack of consistent standards to identify site boundaries at the national level. According to EPA, it has taken initial steps to develop an approach to standardize and improve information on nonfederal NPL site boundaries. EPA stated that it expects to establish a schedule for this effort by the second quarter of fiscal year 2020, with the aim to have collected an initial set of site boundaries for all NPL sites by the fourth quarter of fiscal year 2021.

In response to our recommendation that EPA clarify how its actions to manage risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites align with the

agency's current goals and objectives, EPA said that it believes managing risks from exposure to contaminants in the environment is integral to EPA's current strategic goal 1.3, Revitalize Land and Prevent Contamination. We agree that protectiveness is a key part of strategic objective 1.3. However, this strategic objective does not include any measures related to climate change or discuss strategies for addressing the impacts of climate change effects. An essential element of enterprise risk management is to align risk management processes with goals and objectives. Consequently, we believe that our recommendation is still warranted.

In response to our recommendations that the Director of the Office of Superfund Remediation and Technology Innovation provide direction on how to integrate information on the potential impacts of climate change effects into risk assessments and risk response decisions at nonfederal NPL sites, EPA said that it strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events are woven into risk assessments and risk response decisions at nonfederal NPL sites. However, as we noted in our report, EPA's current direction does not address all types of cleanup actions or climate change effects. Further, EPA officials from some regions told us that current EPA practice for assessing risks at NPL sites does not always include consideration of climate change and that they have not consistently integrated climate change information into site-specific remedy selection and design. EPA noted that it may issue a memorandum to reinforce the tools and resources available to NPL site teams and would determine whether to issue this memorandum by the end of January 2020.

EPA also provided technical comments, which we incorporated as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Administrator of the Environmental Protection Agency, and other interested parties. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last

page of this report. GAO staff who made key contributions to this report are listed in appendix III.

J. Alfredo Gómez
Director, Natural Resources and Environment

List of Requesters

The Honorable Thomas R. Carper
Ranking Member
Committee on Environment and Public Works
United States Senate

The Honorable Sheldon Whitehouse
Ranking Member
Subcommittee on Clean Air and Nuclear Safety
Committee on Environment and Public Works
United States Senate

The Honorable Tammy Duckworth
Ranking Member
Subcommittee on Fisheries, Water, and Wildlife
Committee on Environment and Public Works
United States Senate

The Honorable Cory Booker
Ranking Member
Subcommittee on Superfund, Waste Management, and Regulatory Oversight
Committee on Environment and Public Works
United States Senate

The Honorable Benjamin L. Cardin
Ranking Member
Subcommittee on Transportation and Infrastructure
Committee on Environment and Public Works
United States Senate

The Honorable Betty McCollum
Chair
Subcommittee on Interior, Environment, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Kirsten E. Gillibrand
United States Senate

The Honorable Kamala Harris
United States Senate

The Honorable Edward J. Markey
United States Senate

The Honorable Jeffrey A. Merkley
United States Senate

The Honorable Bernard Sanders
United States Senate

Appendix I: Objectives, Scope, and Methodology

This report examines (1) what available federal data suggest about the number of nonfederal National Priorities List (NPL) sites that are located in areas that may be impacted by selected climate change effects; (2) the extent to which the Environmental Protection Agency (EPA) has managed risks to human health and the environment from the potential impacts of climate change effects at nonfederal NPL sites; and (3) the challenges, if any, EPA faces in managing these risks.

To determine what available federal data suggest about the number of nonfederal NPL sites that are located in areas that may be impacted by selected climate change effects, we reviewed the Fourth National Climate Assessment (NCA) to identify potential climate change effects.[1] Based on our review of the NCA, we identified the following potential climate change effects: sea level rise, which may lead to increased frequency and extent of extreme flooding from coastal storms; greater frequency and magnitude of drought; increased intensity and frequency of heavy precipitation events, which may lead to increased local flooding; salt water intrusion; increased incidence of large wildfires; increased frequency and intensity of extreme high temperatures and sustained increases in average temperatures; decreased permafrost; and increased intensity—including higher wind speeds and precipitation rates—and frequency of very intense hurricanes and typhoons. We reviewed EPA documents (such as EPA's climate change adaptation implementation plans) to identify potential climate change effects that may impact nonfederal NPL sites and interviewed EPA officials.

Through a review of federal agencies' documents and databases and interviews with officials about their data and research on these effects, we identified available national federal data sets on three current hazards: flooding, storm surge, and wildfires—which the NCA reports will be exacerbated by climate change—from the Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Forest Service.[2] We also identified data on sea level rise from NOAA.

[1]U.S. Global Change Research Program, *Climate Science Special Report: Fourth National Climate Assessment, Volume I* (Washington, D.C.: 2017) and *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (Washington, D.C.: 2018).

[2]We did not include forward-looking data or projections in our analysis on flooding, storm surge, and wildfire because these data are not available at a national level.

In this report, we refer to (1) flooding, (2) storm surge, (3) wildfires, and (4) sea level rise as potential climate change effects. We used the most recently available data for each of these climate change effects; these data do not provide estimates of the projected changes in the future. To the extent that data were available, we analyzed a range of these potential climate change effects. For example, we used the maximum extent of storm surge from Category 1 hurricanes as well as Category 4 or 5 hurricanes, the highest possible categories, as modeled by NOAA. We focused on a range because, for three of the four effects, we had data on current hazards, which may become more intense and frequent in the future, according to the NCA. Additionally, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) directs EPA to give preference to remedies that would result in the permanent and significant decrease in toxicity, mobility, or volume of the contamination. According to EPA officials, remedies at nonfederal NPL sites may have to be operational indefinitely, during which time the potential effects of climate change may become more extreme.

The range of estimates we provide in our report is as follows:

- For flooding, we used data from FEMA's National Flood Hazard Layer as of October 2018. FEMA identifies a variety of flood hazards, and for reporting purposes, we grouped flood hazard zones into four categories: (1) 1 percent or higher annual chance of flooding,[3] (2) 0.2 percent or higher annual chance of flooding or other flood hazards,[4] (3) unknown flood hazards,[5] and (4) minimal flood hazard.
- For storm surge, we used data from NOAA's model on Sea, Lake and Overland Surges from Hurricanes as of November 2018 for Category 1 and Category 4 or 5 hurricanes.
- For wildfire, we used data from the U.S. Forest Service's 2018 wildfire hazard potential map, which the U.S. Forest Service released in July 2018. We used areas with high or very high wildfire hazard potential in our analysis. The U.S. Forest Service based the 2018 map on wildfire

[3]This includes zones A, A99, AE, AH, AO, V, VE, and Open Water.

[4]This category includes hazards FEMA categorizes in zone X (excluding minimal flood hazard).

[5]Unknown includes zones D, NP, missing values, area not included, and no data. In addition, we considered data that we could not analyze using our mapping software, such as those available in paper-based maps, as "unknown flood hazard."

likelihood and intensity data from 2016, spatial fuels and vegetation data from 2012, and point locations of past fire occurrence from 1992 to 2013.

- For sea level rise, we used NOAA data, last updated in September 2018. We downloaded inundation data on 0, 1, 3, and 8 feet of sea level rise and "not mapped" areas.

We obtained data from EPA's Superfund Enterprise Management System on the location and other characteristics of active and deleted nonfederal NPL sites. In our analysis, we used a 0.2-mile radius around the primary geographic coordinate point of each nonfederal NPL site, which may not accurately represent their actual areas because the sites vary in size and shape.[6] The EPA data we used in our analysis on the location of nonfederal NPL sites are current as of March 2019. We also obtained EPA data on contaminants and types of remedies that are current as of fiscal year 2014 to determine the number of contaminants EPA has identified in nonfederal NPL sites. We did not conduct further site-specific analyses, such as those related to the extent of contamination and location of remedies. We reviewed documents from the Agency for Toxic Substances and Disease Registry on the health effects of hazardous substances in nonfederal NPL sites and interviewed officials from that agency.

To analyze whether nonfederal NPL sites are located in areas that may be impacted by flooding, we used ArcGIS mapping software to intersect the area of a 0.2-mile radius around the primary coordinate of the sites with the categories we defined from the National Flood Hazard Layer. If a site overlapped with areas in more than one of the four reporting groups, we categorized the site in the group representing the highest flood hazard. For the purposes of our report, we considered the highest flood hazard to be, in descending order, 1 percent or higher annual chance of flooding, other flood hazards (including 0.2 percent or higher annual chance of flooding), unknown flood hazard or no data, and minimal flood hazard. To analyze whether nonfederal NPL sites are located in areas that may be impacted by storm surge, wildfires, and sea level rise, we used MapInfo mapping software to intersect the area of a 0.2-mile radius

[6]In a 2018 study, EPA used a 0.2-mile radius to approximate the size of NPL sites. In this study, EPA noted that it used additional information to adjust this radius for some NPL sites. We did not make such adjustments because it would have required site-specific analysis, which was outside the scope of our review. See Environmental Protection Agency, *Evaluation of Remedy Resilience at Superfund NPL and SAA Sites* (August 2018).

around the primary coordinates of sites with each of these layers. Overlap indicates that a site is potentially in an area that may be impacted.

To assess the reliability of FEMA's National Flood Hazard Layer, we reviewed FEMA's methodology, guidelines, and standards; interviewed FEMA officials to assess the timeliness and accuracy of the data as well as any limitations of the data; conducted data testing to check for missing data and inconsistencies; and reviewed internal controls. We also reviewed a prior GAO report on the methodology FEMA uses to map flood hazards.[7] To assess the reliability of NOAA's data on Sea, Lake and Overland Surges from Hurricanes, we reviewed NOAA's methodology for developing the model, interviewed NOAA officials to assess the timeliness and accuracy of the data as well as any limitations of the data, and reviewed internal controls. To assess the reliability of the U.S. Forest Service's wildfire hazard potential data, we reviewed the agency's documentation of the methodology, interviewed U.S. Forest Service officials to assess the timeliness and accuracy of the data as well as any limitations of the data, and reviewed internal controls. We also reviewed our past reports that cited the 2014 versions of these data.[8] To assess the reliability of NOAA's data on sea level rise, we reviewed the methodology NOAA used for developing the model, interviewed NOAA officials to assess the timeliness and accuracy of the data as well as any limitations of the data, and reviewed internal controls.

To assess the reliability of EPA's data, we reviewed agency manuals and data dictionaries to understand data elements, interviewed EPA officials to assess the timeliness and accuracy of the data and related internal controls, conducted data testing, discussed inaccuracies with EPA officials; and obtained corrected data. For example, we compared the zip code of each nonfederal NPL site to its coordinate to check the accuracy of site locations. We shared potential errors with EPA officials, who corrected the coordinates of six sites. As a result of the steps described

[7]GAO, *FEMA Flood Maps: Some Standards and Processes in Place to Promote Map Accuracy and Outreach, but Opportunities Exist to Address Implementation Challenges*, GAO-11-17 (Washington, D.C.: Dec. 2, 2010).

[8]GAO, *Wildland Fire Management: Agencies Have Made Several Key Changes but Could Benefit from More Information about Effectiveness*, GAO-15-772 (Washington, D.C.: Sept. 16, 2015) and *Wildland Fire Risk Reduction: Multiple Factors Affect Federal-Nonfederal Collaboration, but Action Could Be Taken to Better Measure Progress*, GAO-17-357 (Washington, D.C.: May 10, 2017).

above, we found data from EPA, FEMA, NOAA, and the U.S. Forest Service to be sufficiently reliable for our purposes.

To determine the extent to which EPA has managed risks to human health and the environment from the potential impacts of climate change effects on nonfederal NPL sites, we examined relevant provisions in CERCLA, EPA's implementing regulations, and executive orders. We also reviewed EPA documents, including climate change adaptation and implementation plans; vulnerability studies; training materials; and site-specific documents, our prior work, and relevant documents from other organizations, such as the National Research Council. We identified these documents by conducting a search of (1) websites of relevant agencies and organizations and (2) article databases. We also reviewed documents provided to us by agency officials and stakeholders that we identified as described below. We interviewed EPA officials at headquarters and all regional offices to identify information on agency actions for managing risks. In addition, to obtain their views of EPA's actions, we interviewed former EPA officials, representatives of two associations representing state officials (the Environmental Council of States and the Association of State and Territorial Solid Waste Management Officials), a professor of environmental law, and a private consultant who has worked on Superfund issues, which we identified in the search described above and recommendations from other interviewees. We generally contacted all stakeholders that we identified who appeared to be currently working on issues related to Superfund and climate change and who agreed to speak with us. We also interviewed stakeholders at the three sites we selected as illustrative examples in order to obtain their views of EPA's actions.

We selected three nonfederal NPL sites as illustrative examples of how EPA has managed risks to human health and the environment from potential impacts of climate change effects and challenges EPA may face in managing these risks. The three sites we selected are the (1) American Cyanamid site in Bridgewater, New Jersey; (2) Iron Mountain Mine site near Redding, California; and (3) San Jacinto River Waste Pits site in Channelview, Texas. To select these sites, we initially identified 43 sites based on information in EPA documents, news articles, and interviews with EPA officials and other stakeholders as described above. We selected relevant sites in three different EPA regions that illustrate a variety of potential climate change effects and that had experienced an extreme weather event in the past 10 years. To gather more in-depth information about these sites, we reviewed EPA and other documents; toured the sites; and interviewed EPA officials and relevant stakeholders

at these sites, including state and local officials, representatives of potentially responsible parties, and community organizations. The results from these illustrative examples are not generalizable to nonfederal NPL sites that we did not select.

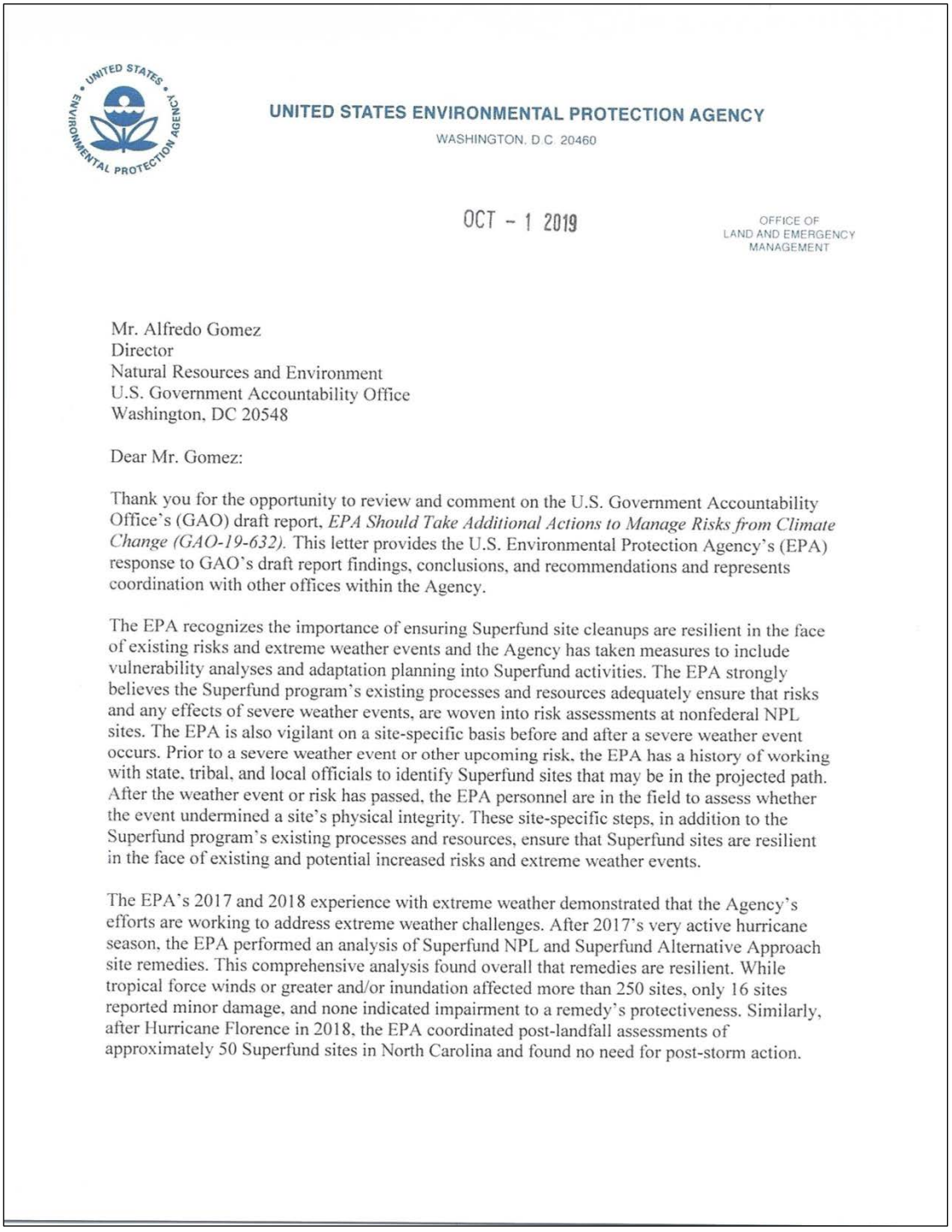
We compared EPA's actions to manage risks to human health and the environment from the potential impacts of climate change effects with essential elements for managing risk as identified in our prior work on enterprise risk management.[9] These essential elements are as follows: (1) align the risk management process with goals and objectives, (2) identify risks, (3) assess risks, (4) respond to the risks, (5) monitor the risks, and (6) communicate and report on the risks. We assessed information on EPA's actions to determine the extent to which the agency's actions aligned with these elements. In assessing EPA's actions against these essential elements, we used "aligned," "partially aligned," or "not aligned" to reflect the extent to which EPA took actions aligned with each essential element. If EPA provided evidence that it had taken major actions in alignment with that essential element, we determined the actions were aligned. If EPA provided evidence that it had taken some actions in alignment with that essential element, we determined the actions were partially aligned. If EPA took only a few or no actions in alignment with that essential element, we determined the actions were not aligned. Two GAO analysts independently reviewed the information on EPA's actions and then reached consensus on the extent to which EPA's actions were aligned with each element.

To identify the challenges EPA faces in managing these risks, we reviewed EPA documents; our prior work; and relevant documents from other organizations, including the National Research Council, that we obtained as described above. We interviewed EPA officials at headquarters and all regional offices and stakeholders in order to obtain their views on the challenges EPA faces. The views of stakeholders we interviewed are illustrative and not generalizable to all stakeholders. We reviewed the challenges that we identified in these documents and interviews and grouped all the challenges into three categories for reporting purposes: institutional, resource, and technical. Two GAO analysts independently reviewed the information and then reached consensus on the challenges and their grouping in the three categories.

[9]GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risk*, GAO-17-63 (Washington, D.C.: Dec. 1, 2016).

We conducted this performance audit from April 2018 to October 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT - 1 2019

OFFICE OF
LAND AND EMERGENCY
MANAGEMENT

Mr. Alfredo Gomez
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Gomez:

Thank you for the opportunity to review and comment on the U.S. Government Accountability Office's (GAO) draft report, *EPA Should Take Additional Actions to Manage Risks from Climate Change (GAO-19-632).* This letter provides the U.S. Environmental Protection Agency's (EPA) response to GAO's draft report findings, conclusions, and recommendations and represents coordination with other offices within the Agency.

The EPA recognizes the importance of ensuring Superfund site cleanups are resilient in the face of existing risks and extreme weather events and the Agency has taken measures to include vulnerability analyses and adaptation planning into Superfund activities. The EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, are woven into risk assessments at nonfederal NPL sites. The EPA is also vigilant on a site-specific basis before and after a severe weather event occurs. Prior to a severe weather event or other upcoming risk, the EPA has a history of working with state, tribal, and local officials to identify Superfund sites that may be in the projected path. After the weather event or risk has passed, the EPA personnel are in the field to assess whether the event undermined a site's physical integrity. These site-specific steps, in addition to the Superfund program's existing processes and resources, ensure that Superfund sites are resilient in the face of existing and potential increased risks and extreme weather events.

The EPA's 2017 and 2018 experience with extreme weather demonstrated that the Agency's efforts are working to address extreme weather challenges. After 2017's very active hurricane season, the EPA performed an analysis of Superfund NPL and Superfund Alternative Approach site remedies. This comprehensive analysis found overall that remedies are resilient. While tropical force winds or greater and/or inundation affected more than 250 sites, only 16 sites reported minor damage, and none indicated impairment to a remedy's protectiveness. Similarly, after Hurricane Florence in 2018, the EPA coordinated post-landfall assessments of approximately 50 Superfund sites in North Carolina and found no need for post-storm action.

The Agency appreciates GAO's review and updates to EPA's 2012 analysis evaluating NPL site remedy vulnerabilities (the 2012 report was the basis for the Superfund Climate Resilience Action Plan, which is in the implementation phase). Both the 2012 EPA report and the 2019 GAO report recognize that a significant percentage (60 percent) of nonfederal NPL sites are in locations that may be affected by risks and severe weather events, that may increase in intensity, duration, or frequency. However, again, the EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, that may increase in intensity, duration, or frequency, are woven into risk assessments at nonfederal NPL sites.

Below are the EPA's comments on the GAO recommendations.

GAO Recommendation 1
The Director of OSRTI should establish a schedule for completing the standardization and improvement of information on the boundaries of nonfederal NPL sites.

EPA Response
The EPA agrees with this finding and has already taken the initial steps prior to this GAO review to develop an approach to improve and standardize Superfund nonfederal NPL site boundaries. The approach will be a substantial and resource-intensive effort requiring input from every NPL or Superfund Alternative Approach site remedial project manager and potentially may require current and former contractors' input. The Agency anticipates completing the analysis to set milestones by fiscal year 2020, Quarter 2 with the aim to have collected an initial set of site boundaries for all NPL sites by fiscal year 2021, Quarter 4. While the EPA acknowledges the lack of consistent standards to identify site boundaries exists on the national level, current efforts on a regional and site-specific basis take into account measures that allows the Agency to assess the risks and identify site boundaries. Additionally, the method of determining site boundaries is only one aspect that can affect the Agency's capacity to address site risks, and the EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, that may increase in intensity, duration, or frequency, are woven into risk assessments at nonfederal NPL sites. These site-specific steps, in addition to the Superfund program's existing processes and resources, ensure that Superfund sites are resilient in the face of existing and potential increased risks and extreme weather events.

GAO Recommendation 2
The EPA Administrator should clarify how Agency actions to manage risks to human health and the environment from the potential impacts of climate change effects at non-federal NPL sites align with the Agency's current goals and objectives.

EPA Response
The EPA understands this recommendation's intent, but the Agency has previously acknowledged its commitment to aligning its risk process with the mission of the Agency and its goals and objectives. The EPA believes that managing risks from exposure to contaminants in the environment is integral to the EPA's current Strategic Goal 1.3, Revitalize Land and Prevent Contamination. The Agency has taken measures to include vulnerability analyses and adaptation planning into the Superfund program and activities, taking the steps to ensure Superfund sites are

resilient and allowing the EPA to effectively manage risks to human health and the environment, consistent with the Agency's mission. Additionally, as we have previously detailed to GAO, the EPA is currently implementing an approach by the Agency to build and strengthen the adaptive capacity of its partners in states, tribes, and local communities through multiple facets—training to increase awareness of the risks posed by climate change to EPA's programs (including OLEM and the Superfund program); tools to provide necessary data, information, and tools, including tools to empower clean-up mangers to assess the risks posed by climate change to Superfund sites; and financial incentives to support climate-resilient investments in communities across the nation. The EPA believes existing processes, resources, and commitments adequately ensure that the Agency's risk management process aligns with current goals and objectives—fulfilling the GAO's identified essential element of enterprise risk management—while also providing a basis for the Agency's view that the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, that may increase in intensity, duration, or frequency, are woven into risk assessments at nonfederal NPL sites. These additional measures, in addition to the Superfund program's existing processes and resources, ensure that Superfund sites are resilient in the face of existing and potential increased risks and extreme weather events.

The EPA strongly believes that we have reasonable assurance throughout the Agency that the current ongoing actions to manage these risks at nonfederal NPL sites align with current Agency goals and objectives, including throughout senior officials and leadership who take an active role in supporting these actions and help the EPA achieve its mission of protecting human health and the environment.

GAO Recommendation 3
The Director of OSRTI should provide direction on how to integrate information on the potential impacts of climate change effects into risk assessments at nonfederal NPL sites.

EPA Response
The EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, that may increase in intensity, duration, or frequency, are woven into risk assessments at nonfederal NPL sites. While the EPA believes that current Agency efforts fulfill the basis for the recommendation, to buttress awareness, the OSRTI office director may issue a memorandum to reinforce for site teams the array of tools and resources available to them. A determination to this effect will be made by January 30, 2020. This additional reinforcement would supplement the Superfund program's existing processes and resources that already ensure that Superfund sites are resilient in the face of existing and potential increased risks and extreme weather events.

GAO Recommendation 4
The Director of OSRTI should provide direction on how to integrate information on the potential impacts of climate change effects into risk response decisions at nonfederal NPL sites.

EPA Response
The EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, that may increase in intensity,

duration, or frequency, are woven into risk response decisions at nonfederal NPL sites. The OSRTI office director may reiterate existing authorities and tools for considering extreme weather effects through the memorandum described in the response to Recommendation 3. This additional reinforcement would supplement the Superfund program's existing processes and resources that already ensure that Superfund sites are resilient in the face of existing and potential increased risks and extreme weather events.

Thank you for the opportunity to review the draft report. We believe the report contains information that will strengthen the EPA's continued efforts to build resilience into Superfund sites. In addition to our comments found in this letter, we have also enclosed technical comments on the draft report. If you have any questions or need additional information, for the Office of Land and Emergency Management, please contact Kecia Thornton at (202) 566-1913 and for the Office of the Administrator, Michael Benton at (202) 564-2860.

Sincerely,

Peter C. Wright
Assistant Administrator

Enclosure

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4

Appendix III: GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

In addition to the contact named above, Barbara Patterson (Assistant Director), Ruth Solomon (Analyst in Charge), Breanne Cave, Charles Culverwell, Cindy Gilbert, Richard Johnson, Gwen Kirby, Krista Mantsch, Patricia Moye, Eleni Orphanides, Ernest Powell Jr., Dan Royer, and Kiki Theodoropoulos made key contributions to this report.

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