NASA
Office of Inspector General

NASA's Approach to Infrastructure and Operational Resilience

August 4, 2025

IG-25-008

Office of Inspector General

To report fraud, waste, abuse, or mismanagement, contact the NASA OIG Hotline at 800-424-9183 or 800-535-8134 (TDD) or visit https://oig.nasa.gov/hotline.html. You can also write to NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, DC 20026. The identity of each writer and caller can be kept confidential, upon request, to the extent permitted by law.

To suggest ideas or request future audits, contact the Assistant Inspector General for Audits at https://oig.nasa.gov/oig-personnel/.

RESULTS IN BRIEF

NASA's Approach to Infrastructure and Operational Resilience

August 4, 2025 IG-25-008 (A-24-07-00-SARD)

WHY WE PERFORMED THIS AUDIT

NASA mission operations are dependent on unique infrastructure including testing facilities, laboratories, and launch pads—located at Agency centers across the country—that face the constant threat of unexpected and costly extreme weather events. As these weather events increase in frequency and intensity, NASA infrastructure and operations have been directly affected. For example, in 2022, the launch of Artemis I was delayed by over a month due to Hurricane Ian and again by a few days due to Hurricane Nicole. Longer-term trends, such as sea level rise, also impact NASA facilities and require additional expenditures beyond the costs included in the Agency's budget. For instance, in fiscal year 2023, Congress appropriated $103 million in federal funds to replace Wallops Flight Facility's outdated causeway with a new one that will be elevated to compensate for sea level rise and shoreline degradation.

In a rapidly evolving world, resilience has emerged as a crucial capability for both survival and success. Resilience is the capacity to anticipate, prepare for, and adapt to changing conditions, and to withstand, respond to, and recover rapidly from disruptions. At the intersection of many of these disruptions is infrastructure, which provides the necessary framework for day-to-day and mission-focused operations. This includes physical structures such as office buildings, laboratories, and bridges, as well as resource systems such as telecommunications, energy, and sanitation services, and unique infrastructure that drives innovation and economic expansion. NASA's infrastructure—83 percent of which is past its design life—provides the foundational capabilities for the nation's space programs, vital scientific research, and the Agency's partnerships with commercial companies, interagency partners, and international agencies. While NASA's 10 centers are optimally located for mission activities from spacecraft launches, tracking, and recovery to developing and operating sophisticated space telescopes, 5 of the centers are located within 5 to 40 feet of mean sea level.

To ensure the necessary infrastructure is available for the success of NASA's missions, it is imperative that the Agency effectively and efficiently plan for the protection of their assets by actively mitigating near- and long-term weather vulnerabilities. Accordingly, we conducted this audit to assess whether NASA has identified, planned for, and addressed its vulnerabilities and risks associated with near- and long-term weather events and trends. To accomplish this assessment, we interviewed officials from all 10 of NASA's centers and visited 7 of them. We also spoke with Headquarters officials in the Office of Strategic Infrastructure (OSI), Office of Safety and Mission Assurance, and others. We also reviewed documents related to NASA's processes for risk management and addressing infrastructure vulnerabilities, including the NASA Agency Resilience Framework, the Agency Master Plan, and Center Resilience Assessments.

WHAT WE FOUND

While NASA's approach to address weather-related vulnerabilities of its infrastructure integrates resilience activities into existing processes and functions across various Agency programs, it lacks clear communication and sufficient formal guidance from OSI at Headquarters. For example, we found that center officials are not consistently leveraging available resources to identify and address infrastructure vulnerabilities and risks. NASA's Risk Analysis and Solutions Innovators (RASI) workgroup, consisting of NASA scientists and applications developers along with experts from academia, the private sector, and nongovernmental organizations, provides projections for temperature, precipitation, and other variables for each center through the year 2100. RASI provides this information to the centers via calls and workshops. However, many of the officials we spoke to were not aware of the RASI calls or workshops, and at one center, none of the facilities officials were aware of the RASI monthly call focused on their center. Moreover, we interviewed master planners at all 10 NASA centers, and only one was aware of their responsibility to identify and invite relevant staff to RASI monthly calls.

In addition to the RASI monthly calls and workshops, NASA identifies hazards, threats, vulnerabilities, and risks to its infrastructure and operations through Center Resilience Assessments. These assessments help center officials assess baseline conditions, identify and score hazards and vulnerabilities, analyze risks, identify mitigation strategies, develop an action plan for implementation, implement solutions, and inform the prioritization of center goals outlined in the Center Master Plans. However, center officials involved in infrastructure resilience that we spoke with were not aware of the intended purpose of the Center Resilience Assessments. Of the six centers that have completed their assessments, officials at only three centers have or plan to incorporate the results of the Center Resilience Assessments into their Center Master Plans. Even officials at these centers were not aware of the expectation that the results of the assessments should be used to inform the priorities in the Center Master Plans.

We also found that center officials do not consistently enter weather-related risks identified by Center Resilience Assessments into the OSI risk database. Even when centers entered risks like sea level rise into the database, they did not enter risks identified in their Center Resilience Assessments such as the vulnerability of the center's reliance on uninterrupted cooling and dehumidification for mission essential functions due to the increased number of hot and cold days in a year. In addition, centers were inconsistent in identifying risks as weather related in the database. For example, officials at one center identify sea level rise as a weather-related risk but officials at another center identify any weather-related risk as a facility risk—thereby limiting management's ability to thoroughly understand the risk and make informed weather-related mitigation decisions. Center officials told us there was no guidance on whether or when risks identified in the Center Resilience Assessments should be entered into OSI's risk database.

Lastly, NASA is not effectively measuring or assessing the success of its efforts to address weather-related vulnerabilities and increase the resilience of its infrastructure and operations. NASA has not defined or implemented a process to monitor progress toward weather-related infrastructure resilience. In addition to a lack of guidance, inadequate resources create challenges in developing and implementing performance metrics for weather-related infrastructure activities and costs. According to NASA officials, tracking the costs of protecting against weather impacts is particularly difficult. Nonetheless, without systematically monitoring its progress, the Agency has less assurance that taxpayer dollars are being used effectively and efficiently to protect its infrastructure and operations from weather-related risks.

What We Recommended

To increase transparency, accountability, and oversight of NASA's efforts to address weather-related infrastructure vulnerabilities at its centers and facilities, we recommended the Assistant Administrator for Strategic Infrastructure: (1) provide the centers with formal and clear guidance on the roles, responsibilities, expectations, and processes for defining, assessing, addressing, and monitoring weather-related infrastructure resilience; (2) develop a process map (i.e., flow chart) for work being done to assess, address, and mitigate weather-related vulnerabilities; (3) ensure pertinent weather-related risks identified in Center Resilience Assessments are entered into the Agency's OSI risk database; (4) update master planning guidance to include expectations for incorporating Center Resilience Assessments into Center Master Plans; and (5) to the extent practical, develop a process for monitoring and evaluating the costs and performance of post-construction, implemented weather-related resilience activities.

We provided a draft of this report to NASA management who concurred or partially concurred with Recommendations 1, 2, and 4, and we consider comments to those recommendations responsive. Therefore, those recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions. Management did not concur with Recommendations 3 and 5 and those recommendations will remain unresolved pending further discussions with Agency management. We also reject management's assertion that we signaled an intent to increase scope or adjusted criteria during the course of our audit.

For more information on the NASA Office of Inspector General and to view this and other reports visit https://oig.nasa.gov/.

TABLE OF CONTENTS

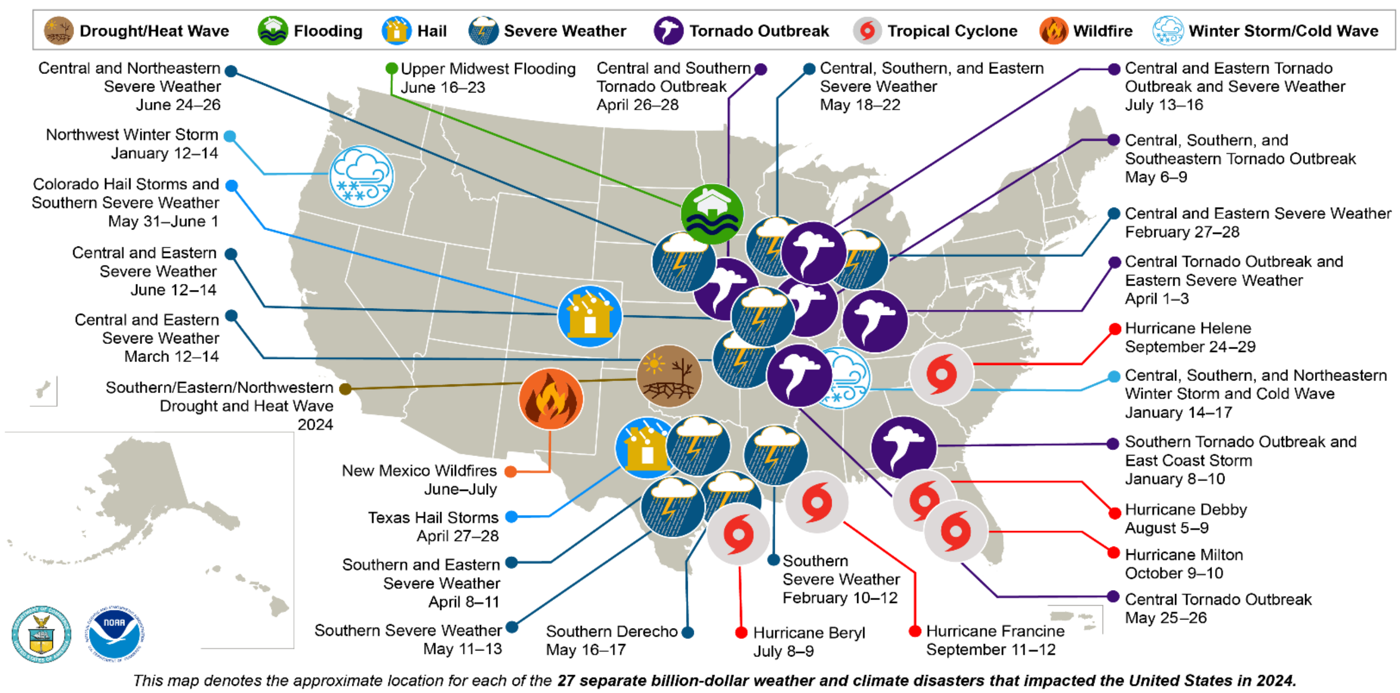
Acronyms

FY	fiscal year
GAO	Government Accountability Office
HVAC	heating, ventilation, and air conditioning
JPL	Jet Propulsion Laboratory
OIG	Office of Inspector General
OSI	Office of Strategic Infrastructure
RASI	Risk Analysis and Solutions Innovators

INTRODUCTION

NASA mission operations are dependent on unique infrastructure including testing facilities, laboratories, and launch pads—located at Agency centers across the country—that face the constant threat of unexpected and costly extreme weather events.[1] As these weather events continue to increase in frequency and intensity, the number of these events causing $1 billion or more in damages has continued to rise as well. There were 10 separate $1 billion-dollar weather disasters across the nation in 2014, 19 in 2017, and 27 in 2024 (see Figure 1).[2]

Figure 1: U.S. 2024 Billion-Dollar Weather-Related Disaster Events



Source: National Oceanic and Atmospheric Administration.

NASA infrastructure and operations have been directly affected by some of these events. For example, in 2022, the launch of Artemis I was delayed by over a month due to Hurricane Ian and again by a few days due to Hurricane Nicole.[3] Longer-term trends, such as sea level rise, also impact NASA facilities and

[1] For the purposes of this report, the terms "weather" or "weather-related" refer to both near- and long-term weather conditions including acute events such as tornadoes, wildfires, and hurricanes, as well as long-term shifts such as sea level and average surface temperature rises.

[2] Inflation impacts our ability to compare costs over time. Adjusting for inflation using the Consumer Price Index allows for easier comparison. Disasters in 2014 may have had less than $1 billion in damages at the time of the event, but after adjusting for inflation using the Consumer Price Index, that amount now exceeds $1 billion in damages.

[3] Artemis I, launched in November 2022, was an uncrewed test flight for the Space Launch System rocket and Orion crew capsule. Hurricane Ian delayed a launch scheduled for September 27 to November 14, and Hurricane Nicole delayed the rescheduled launch by 2 more days to its actual launch date of November 16, 2022.

require additional expenditures beyond the costs included in the Agency's budget.[4] For instance, NASA manages both the Wallops Flight Facility (Wallops) and Kennedy Space Center (Kennedy) causeways, which are constantly threatened by storms and sea level rise.[5] In fiscal year (FY) 2023, Congress appropriated $103 million in federal funds to replace Wallops' outdated causeway with a new one that will be elevated to compensate for sea level rise and shoreline degradation.[6]

To ensure the necessary infrastructure is available for the success of NASA's missions, it is imperative that the Agency effectively and efficiently plan for the protection of their assets by actively mitigating near- and long-term weather vulnerabilities. Accordingly, we conducted this audit to assess whether NASA has identified, planned for, and addressed its vulnerabilities and risks associated with near- and long-term weather events and trends. See Appendix A for details of the audit's scope and methodology, and Appendix B for a snapshot of weather-related vulnerabilities at each NASA center and select facilities.

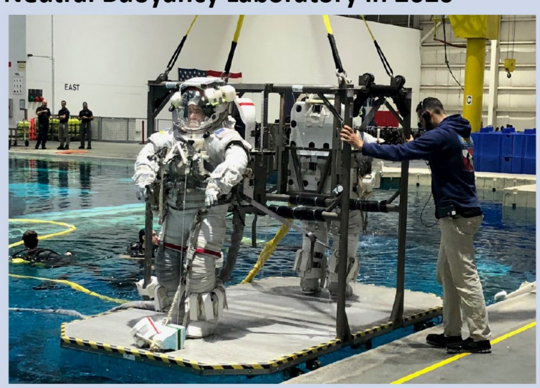
Background

Infrastructure Resilience

In a rapidly evolving world, resilience has emerged as a crucial capability for both survival and success. Resilience is the capacity to anticipate, prepare for, and adapt to changing conditions, and to withstand, respond to, and recover rapidly from disruptions.[7] These disruptions can range from rapid technological advancements to outsider threats to weather events. In particular, the continuous increase in frequency and intensity of near- and long- term weather events have become more disruptive.

At the intersection of many of these disruptions is infrastructure, which provides the necessary framework for day-to-day and mission-focused operations. This includes physical structures such as office buildings, laboratories, and bridges, as well as resource systems such as telecommunications, energy, and sanitation services, and unique infrastructure that drives innovation and economic expansion. For instance, NASA's Neutral Buoyancy Laboratory is one of the world's largest indoor pools that provides a unique training space for internal users like astronauts preparing for operations in space and external users like offshore oil workers attending survival and fire training classes.

Astronaut Jessica Watkins Training at NASA's Neutral Buoyancy Laboratory in 2020



Source: NASA Office of Inspector General (OIG).

[4] According to NASA, sea level rise refers to the increasing average global sea level, primarily caused by the expansion of seawater as it warms and the addition of water from melting ice sheets and glaciers.

[5] A causeway is a raised road or track across low or wet ground. Repairs for the Kennedy Causeway are funded by NASA, the State of Florida, and the U.S. Department of Transportation.

[6] Construction of a replacement causeway at Wallops was funded by the Consolidated Appropriations Act, 2023, Pub. L. No. 117-328 (2022).

[7] National Renewable Energy Laboratory, *Resilience Assessment: NASA Goddard Space Flight Center and Wallops Flight Facility* (July 2022).

To successfully carry out their missions, federal agencies must continually maintain and repair their infrastructure and construct new facilities. The federal government spent $146 billion on infrastructure in FY 2023. The Government Accountability Office (GAO) reported that the federal government's maintenance and repair backlog had more than doubled from $171 billion in FY 2017 to $370 billion in FY 2024.[8] NASA's infrastructure budget in FY 2024 was $660 million—only 2.6 percent of its overall $24.9 billion budget. In a 2024 report, the National Academies of Sciences, Engineering, and Medicine (National Academies) stated that not only has NASA's mission support funding remained relatively flat between 2013 to 2023, but over the same 10-year period, buying power has decreased by 20 percent—effectively, a funding decrease.[9]

Agencies can build and maintain more resilient infrastructure—designed and built to adapt, withstand, and recover from disasters and disruptions—to enable continuity of operations, a faster recovery, and greater cost savings. According to a 2024 U.S. Chamber of Commerce report, every $1 spent on climate resilience and preparedness saves communities $13 in damages, cleanup costs, and economic impact.[10] The Federal Emergency Management Agency committed at least $326.3 million in FY 2023 for impacted communities to repair infrastructure damaged by natural disasters.

Infrastructure Resilience at NASA

At NASA, infrastructure provides the foundational capabilities for the nation's space programs, vital scientific research, and the Agency's partnerships with commercial companies, interagency partners, and international agencies. NASA's unique testing and engineering capabilities are enabled by highly technical facilities, laboratories, and equipment. In its 2024 report, the National Academies recognized that NASA missions are deeply reliant on facilities, 83 percent of which are past their design life.[11] The National Academies also noted the Agency tends to prioritize funding new missions over maintaining and building new infrastructure, which has created infrastructure that would not be acceptable under most industrial standards. As a result, this essential infrastructure—and by extension every NASA mission—is at risk.

Aging infrastructure, rigorous requirements for essential operations, and geographic proximity to high-risk weather areas are major risk factors impacting NASA facilities, assets, and operations. Figure 2 shows the locations of major NASA facilities, including its 10 centers, and the age of their infrastructure. Over half the infrastructure at Ames Research Center (Ames), the Jet Propulsion Laboratory (JPL), Marshall Space Flight Center (Marshall), and Glenn Research Center (Glenn) is 50 years old or older.

---

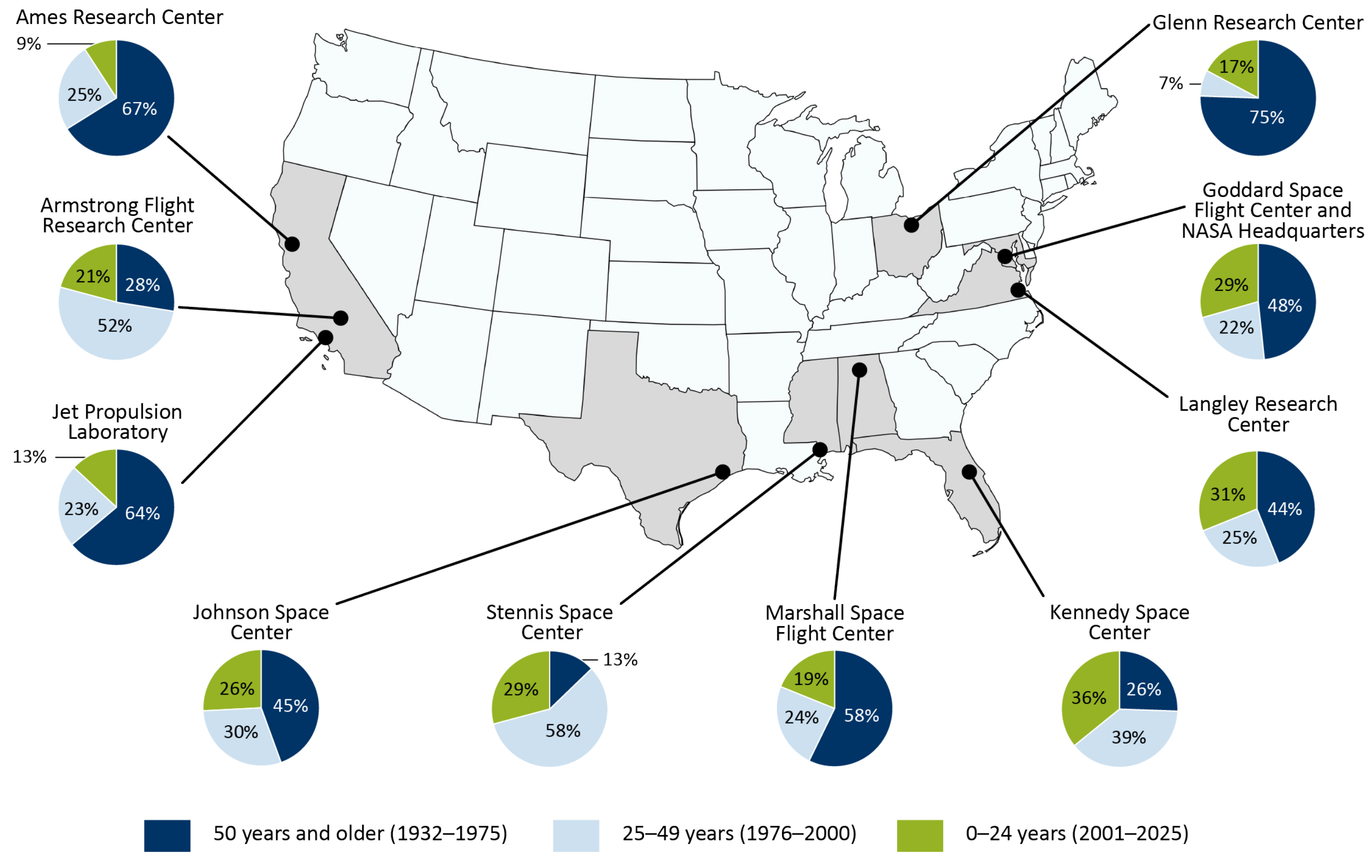
[8] GAO, *HIGH RISK SERIES: Heightened Attention Could Save Billions More and Improve Government Efficiency and Effectiveness* (GAO-25-107743, February 25, 2025).

[9] National Academies, *NASA at a Crossroads: Maintaining Workforce, Infrastructure, and Technology Preeminence in the Coming Decades* (2024). The National Academies are private, nonprofit institutions that provide expert advice to help shape sound policies, inform public opinion, and advance the areas of science, engineering, and medicine. This report can be accessed online at https://www.nationalacademies.org/.

[10] U.S. Chamber of Commerce, Allstate, and the U.S. Chamber of Commerce Foundation, *The Preparedness Payoff: The Economic Benefits of Investing in Climate Resilience* (June 25, 2024).

[11] National Academies, *NASA at a Crossroads*.

Figure 2: NASA's Aging Facilities



Source: NASA OIG analysis of Agency data.

Note: The total percentage for some centers may not equal 100 percent due to rounding.

Older infrastructure is costly to maintain. In NASA's FY 2025 budget request, the Agency requested $100 million for infrastructure maintenance projects at multiple centers that are aimed at upgrading and repairing facilities to reduce operating costs. The Agency carries a deferred maintenance backlog of more than $4.1 billion as of FY 2025, an increase of over 36 percent from the $3 billion backlog in FY 2024.[12] In addition, aging infrastructure is more vulnerable to disasters and disruptions, not only due to natural wear and tear, but also due to less stringent historical construction requirements. Construction requirements have become more rigorous over time, especially for wind, flooding, and fire resistance. For example, between 2001 and 2010, the Florida Building Code raised its window wind resistance standards from 110 miles per hour to 130 miles per hour, and in 2023, expanded areas at risk to include inland regions adjacent to large lakes and inland bays.

[12] NASA Procedural Requirements 8831.2F, *Facilities Maintenance and Operations Management* (October 7, 2015), defines deferred maintenance as the total of essential, but unfunded, facilities maintenance work necessary to bring facilities and collateral equipment to the required acceptable facilities maintenance standards.

NASA's 10 centers are optimally located for mission activities from spacecraft launches, tracking, and recovery to developing and operating sophisticated space telescopes. Of these 10 centers, 5 are located within just 5 to 40 feet of mean sea level.[13] In addition, the Michoud Assembly Facility, located in New Orleans, sits below sea level, and launch infrastructure at Wallops sits just a few hundred feet from the Atlantic Ocean. These necessary coastal locations put NASA facilities at risk for both increasing incidence of extreme weather events such as hurricanes, storm surge, and flooding, but also longer-term environmental shifts such as rising sea levels. Relocating many of NASA's assets is impracticable because of strict launch requirements, including maintaining adequate distance from communities, and other safety measures, which necessitate the use of coastal or other locations facing weather-related impacts.

Beyond the risk of coastal locations, other Agency assets face increasing temperatures as well as variable precipitation intensity and duration. This may impact access to safe working conditions and potable water. Some locations face the combination of increasing temperatures and longer periods of drought, increasing the risk for more frequent, more intense, and larger wildfires. Not only do these acute events endanger Agency assets and delay operations, but the impacts are also felt by individuals. For example, due to the January 2025 California wildfires, more than 1,000 employees at JPL were displaced while more than 200 employees lost their homes. Funded by NASA and operated by the City of Pasadena, a water treatment system facility that provides potable water to the city narrowly avoided destruction when structures all around it burned. The loss of this system would have affected the potability supply of safe drinking water for more than 100,000 people. While no JPL buildings or infrastructure were destroyed, the fires came within 0.6 miles and operations were impacted as the Laboratory closed for 13 days.

NASA-Funded Groundwater Treatment Facility at the Lincoln Avenue Water Company Plant Amid Burned Out Remnants of Neighboring Homes

Source: NASA/Steven Slaten.

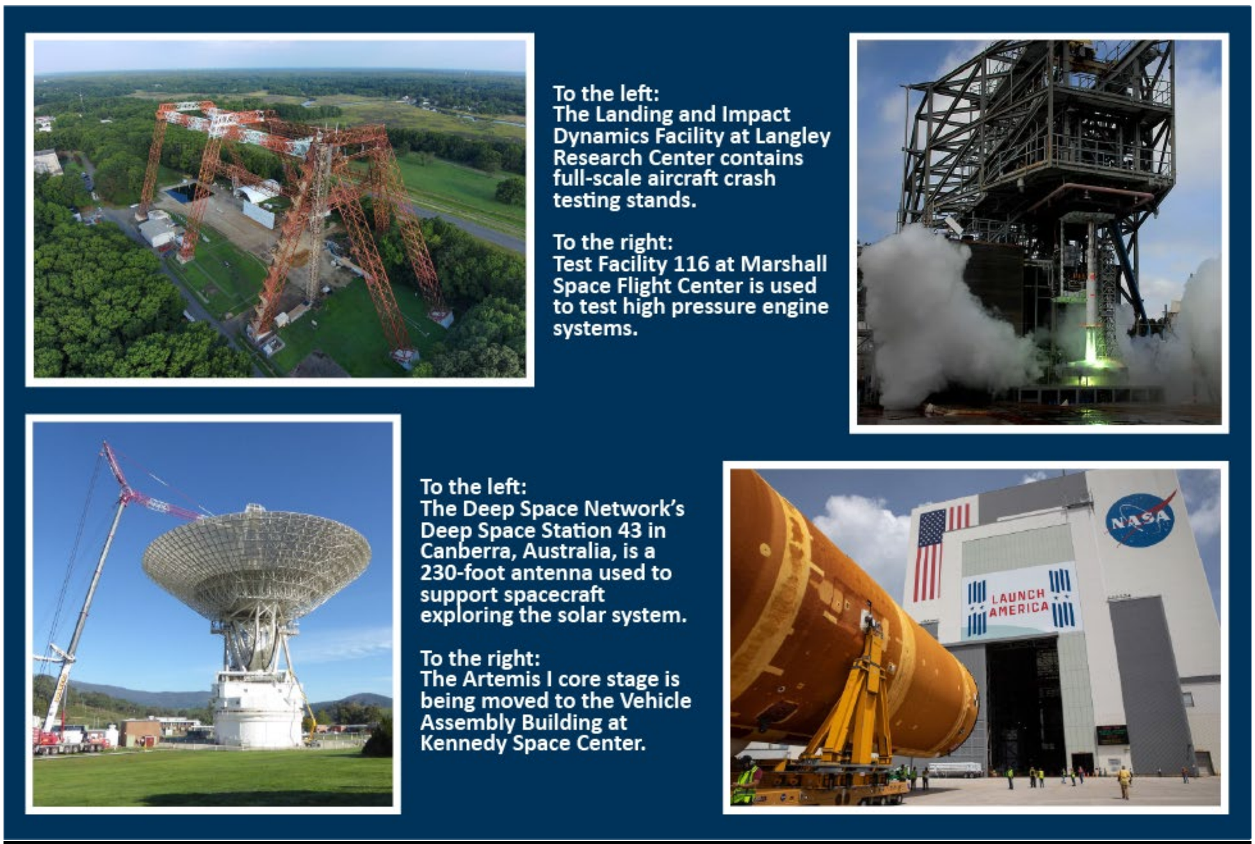
Office of Strategic Infrastructure Enterprise Management Approach

Within NASA's Mission Support Directorate, the Office of Strategic Infrastructure (OSI) is primarily responsible for managing the Agency's assets and capabilities, including resilience preparation of facilities. OSI has four divisions including the Facilities and Real Estate Division, which provides leadership to the Agency in master planning (including related assessments such as the Center Resilience Assessments); facility planning, design, construction, operations, maintenance, and disposal; real estate management and agreements; and energy management and utility management.

[13] The five centers located within 5 to 40 feet of mean sea level are Ames, Johnson Space Center, Kennedy, Langley Research Center, and Stennis Space Center. Mean sea level is the average height for the surface level of a body of water. This is often the midpoint at a given location between mean high tide and mean low tide.

OSI follows an enterprise, or agency-wide, management approach in which capabilities are managed horizontally across the Agency and shared across centers, while realigning structures such as budget authority and lines of reporting. This approach requires more standard systems, practices, and processes across NASA locations. Under enterprise governance, OSI at NASA Headquarters is responsible for approving, prioritizing, and funding center projects related to facilities and environmental issues (excluding those delegated to centers or sponsored by mission directorates in accordance with applicable policy).[14] OSI is also responsible for providing related programmatic guidance for facility and infrastructure activities. For example, center officials are responsible for identifying resilience activities, such as the installation of automatic flood gates to protect critical infrastructure, and submitting funding requests to Headquarters through a standardized process. OSI is responsible for reviewing these requests from NASA centers, selecting projects, and allocating the funds. Figure 3 shows examples of NASA's vast and unique infrastructure.

Figure 3: Examples of NASA Infrastructure



Source: NASA OIG presentation of Agency information.

OSI develops and implements NASA's Agency Master Plan to establish an agency-wide and mission-driven approach that ensures critical assets align with mission requirements and are mission-ready, reliable, and affordable. Based on that alignment and data driven analysis, the plan also identifies assets to sustain, invest, repurpose, consolidate, or divest. Updated every 4 years and most recently published

[14] NASA Procedural Requirements 8820.2I, *Facility Project Requirements* (September 4, 2024).

in April 2024, the Agency Master Plan is the product of multiple datasets, asset prioritization efforts, and prioritization metrics for funding allocation and risk minimization. It also documents the Agency's final recommendations for the treatment of each asset.

In 2022, NASA updated its master planning approach to align with OSI's enterprise management approach by implementing a centralized and standardized Agency master planning process. Previously, the Agency's master planning process was decentralized, so centers developed their own Center Master Plans to manage and develop their own assets—buildings, utilities, and infrastructure—primarily based on center-specific missions, goals, resources, and needs. Now, the Agency Master Plan provides standardized planning guidance for the treatment of infrastructure and assets across all NASA centers and support facilities—based on the Agency's overall mission-critical needs, resource conditions and readiness, risk minimization, and budgetary constraints—for a 20-year period. Centers then develop their Center Master Plans based on the Agency Master Plan. It is through the Agency Master Plan that NASA coordinates and implements efforts to improve its infrastructure resilience and inform center-level planning documents, including Center Master Plans.

Risk Analysis and Solutions Innovators

To help identify risks and vulnerabilities to NASA centers, OSI collaborates with the NASA Risk Analysis and Solutions Innovators (RASI) workgroup. The RASI workgroup consists of NASA scientists and applications developers along with experts from academia, the private sector, and nongovernmental organizations.[15] RASI members are drawn from NASA centers around the country, forming a team that interacts with each other and relevant OSI personnel. They research weather-related vulnerabilities at NASA centers and develop the scientific and technical basis for adaptation and resilience decision-making.

In partnership with OSI, RASI develops scientific and technical tools for use in weather-related risk adaptation and resilience decisions across the Agency. RASI's goal is to provide NASA managers with immediate access to weather science and impacts relevant to their centers and regions that will help them plan for and adapt to increasing weather-related risks in timely and effective ways. For example, RASI provides projections for temperature, precipitation, and other variables for each center through the year 2100. These projections focus on coastal flooding, droughts, heatwaves, heavy downpours, and inland flooding. RASI products and activities also include risk matrices, fact sheets on specific hazards, and weather literacy training.

Center Resilience Assessments

NASA is conducting Center Resilience Assessments at every NASA center. Funded and led by OSI and in collaboration with RASI, the U.S. Department of Energy's National Renewable Energy Laboratory is performing the assessments and preparing reports for each center.[16] These assessments investigate the

---

[15] An application of science is any use of scientific knowledge for a specific purpose that results in practical and societal benefits. For example, application developers can take data collected on evapotranspiration, the process through which water leaves plants, soils, and other surfaces and returns to the atmosphere, and make it available and accessible for use by farmers to plan more efficient and economical crop watering.

[16] The National Renewable Energy Laboratory is the Department of Energy's primary national laboratory for energy systems research and development. The Laboratory partners with federal agencies to provide expertise and support in multiple areas related to resilience including resilient buildings and building energy modeling, as well as resilience assessments, planning, tools, and technoeconomic analyses.

resilience of facilities, infrastructure, and operations at centers by looking at vulnerabilities and threats that could interrupt operations and prevent completion of missions. The National Renewable Energy Laboratory then makes recommendations for risk reduction investments.

Investigating how vulnerabilities can cause problems with power, water, transportation, communications, and other assets or resources allows NASA to better plan and fund resilience efforts. For example, Langley Research Center (Langley) is in the process of relocating its wind tunnel capabilities from its eastern campus along the shoreline to its central campus after RASI data obtained during the Center Resilience Assessment showed that sea level rise was a threat to these facilities. Langley has already demolished its existing 16-inch and 6- by 28-inch Transonic Tunnel and is in the process of constructing a new Flight Dynamic Research Facility as a replacement. The remaining wind tunnel facility, which houses the 12-Foot Low Speed Tunnel and 20-Foot Vertical Spin Tunnel, is slated for demolition in FY 2025. To ensure NASA considers identified vulnerabilities in its plans and priorities, the Agency requires centers to include the results of the Center Resilience Assessments into the Center Master Plans. Table 1 outlines NASA's Center Resilience Assessments schedule.

Table 1: Center Resilience Assessment Schedule

NASA Center or Facility	Date Completed or Date of Planned Completion
Centers with Completed Assessments	
Johnson Space Center	August 2020
Kennedy Space Center	March 2022
Goddard Space Flight Center	July 2022
Langley Research Center	August 2023
Glenn Research Center	January 2025
Marshall Space Flight Center	January 2025
Centers and Facilities with Not Yet Completed Assessments	
Ames Research Center	FY 2025 to FY 2027
Armstrong Flight Research Center	FY 2025 to FY 2027
Jet Propulsion Laboratory	FY 2025 to FY 2027
Michoud Assembly Facility	FY 2025 to FY 2027
Stennis Space Center	FY 2025 to FY 2027
White Sands Test Facility	FY 2025 to FY 2027

Source: NASA OIG presentation of Agency data.

Risk Management

Risk management is a systematic process used to manage all risks, including those associated with weather, that can impact an organization. In NASA's risk management framework, center officials are responsible for assessing their threats, identifying risks, and developing and implementing adaptation strategies endorsed by center and Headquarters leadership.[17] NASA directorates and offices at Headquarters manage their respective Agency-wide overarching risks, build capacity at the centers, and provide guidance and support. In 2023, NASA created an Agency Risk Management Officer position within its Office of Safety and Mission Assurance to improve Agency-wide risk management integration, rigor, and clarity.

In general, NASA attempts to anticipate short-term risks resulting from extreme weather events such as heat waves, precipitation, wind, flooding, and drought, each of which could become more difficult to manage because of an increase in the frequency, intensity, and duration of these events. Over the long-term, NASA anticipates the short-term extreme weather challenges will continue, possibly exacerbated because of longer-term gradual trends including sea level rise and increased average temperatures.

OSI has managed the overarching "natural hazards" risk within the Agency's risk management framework since 2005, aware that shifts in weather could impair its ability to provide important services. In addition, OSI uses the risk management process to identify weather events or circumstances relevant to its objectives, systematically analyze the circumstances in terms of likelihood and magnitude of impact, plan a response strategy, and track progress. OSI then elevates its risks by inputting them into the Mission Support Directorate's risk database per the Agency's risk management framework.

Monitoring and Evaluation

Working in tandem, monitoring and evaluation systematically measure performance, progress, and the success of a project or system. Monitoring involves the systematic collection of information on specified metrics. Evaluation is the systematic investigation of the degree to which objectives and goals are achieved. Monitoring and evaluation is an iterative learning process in which information gathered and assessed is used to inform, improve, and adapt the project for greater progress and performance. Ultimately, this bifurcated process allows for actions and decisions to be built on evidence and reflection, rather than speculation.

Within the broader scientific community, including NASA, monitoring and evaluation is standard practice. In 1993, Congress began requiring federal agencies to create strategic plans, annual performance plans, and annual performance reports. These plans and reports included metrics and performance indicators to determine how progress toward program and project goals will be monitored and reported.[18] Since 2000, GAO has identified "monitoring" and "demonstrated progress" as two key elements used to assess progress in mitigating the federal government's high-risk areas, one of which is

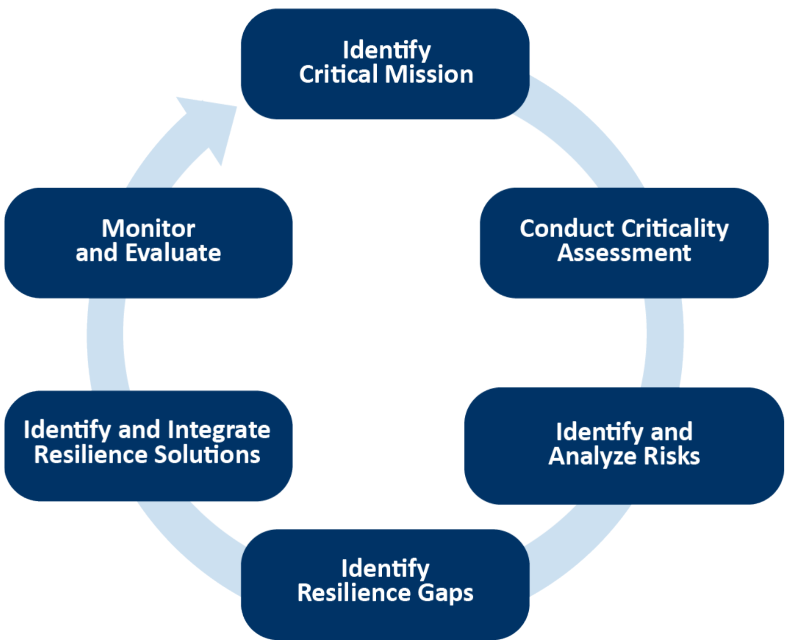
[17] NASA Procedural Requirements 8000.4C, *Agency Risk Management Procedural Requirements* (April 19, 2022), defines risk as "the potential for shortfalls with respect to achieving explicitly established and stated objectives." Office of Management and Budget Memorandum M-16-17, *Circular No. A-123, Management's Responsibility for Enterprise Risk Management and Internal Control* (July 15, 2016), defines management's responsibility for risk management and internal control in federal agencies.

[18] The Government Performance and Results Act of 1993, Pub. L. No. 103-62 (1993), established strategic planning, performance planning, and performance reporting for agencies to communicate progress in achieving their missions. The GPRA Modernization Act of 2010, Pub. L. No. 111-352 (2011), revised the federal government's performance management framework, retaining and amplifying some aspects of the 1993 Act while also addressing some of its weaknesses.

the government's fiscal exposure to climate risk.[19] In addition to its high-risk program, GAO has published multiple reports on the government's approach to addressing climate risks and identifying critical needs and gaps. These reports focused on the lack of or limited national strategy, including the need for adequate monitoring and evaluation of adaptation and resilience.

NASA established the criticality of monitoring and evaluation to mission success in its Governance and Strategic Management Handbook.[20] These foundational principles are routine components in subsequent NASA policies, processes, and frameworks including the Planning, Programming, Budgeting, and Execution process; the risk management framework; and the NASA Agency Resilience Framework.[21] Specifically, Planning, Programming, Budgeting, and Execution requires the establishment of metrics and performance indicators to determine how progress toward program and project goals will be monitored and reported. Under NASA's risk management framework, monitoring and evaluation falls under the fourth step, "Track," which outlines the requirement to acquire, compile, and report observable data to track the progress of the implementation of risk management decisions and their effectiveness once implemented. As depicted in Figure 4, "Monitor and Evaluate" is the final step in the NASA Agency Resilience Framework, which the Agency uses to assess risk mitigation options for mission operations and develop resilience strategies in alignment with Agency Master Plan goals and objectives.

Figure 4: NASA Agency Resilience Framework Steps



Source: NASA OIG presentation of information from the NASA Agency Resilience Framework.

---

19 Since 1990, GAO has published a high-risk report, which focuses attention on government operations with greater vulnerabilities to fraud, waste, abuse, and mismanagement, or that need transformation to address economy, efficiency, or effectiveness challenges. According to GAO, monitoring helps agency leaders track and independently validate effectiveness and sustainability of corrective measures, and demonstrated progress in implementing corrective measures shows the root causes of high-risk areas that have been addressed.

20 NASA Policy Directive 1000.0C, *NASA Governance and Strategic Management Handbook* (January 29, 2020).

21 NASA Police Directive 1000.0C; NASA Procedural Requirements 8000.4C; and NASA, *NASA Agency Resilience Framework* (June 2023).

NASA's Efforts to Protect Infrastructure from Weather-Related Vulnerabilities Are Disjointed

To address the increasing weather-related vulnerabilities of its infrastructure, NASA established a strategic approach that integrates resilience activities into existing processes and functions across various Agency programs. However, the implementation of this approach lacks clear communication and sufficient formal guidance resulting in the inconsistent application of available data. Consequently, NASA is missing valuable opportunities to effectively address its weather-related challenges, increasing the risk that the Agency's infrastructure will not be prepared for future weather events, such as wildfires, flooding, and storms, that could impact mission readiness and success.

Implementation of NASA's Strategic Approach for Addressing Weather-Related Vulnerabilities Lacks Communication and Guidance

NASA's strategic approach to addressing weather-related vulnerabilities is to integrate resiliency activities into existing functions, as opposed to creating dedicated positions or teams. Under this approach, activities are delegated to varying positions under varying programs across NASA centers. For example, depending on the center, work related to implementing recommendations of Center Resilience Assessments may be assigned to a center master planner, sustainability program manager, or energy manager. Additionally, the work is parceled across various programs. For instance, weather-related vulnerabilities are identified by OSI through its partnership with RASI as well as its Center Resilience Assessments; addressed through its master planning process; funded through its Planning, Programming, Budgeting, and Execution process; and monitored under its risk management system.

While we believe this is the most efficient approach to address weather-related vulnerabilities, its implementation has lacked consistent communication and dissemination of guidance from OSI at Headquarters. Specifically, clarity regarding expectations pertaining to the utilization of available resources and identification of weather-related risks to be monitored via the Agency's risk management system is needed for the Agency's approach to address infrastructure vulnerabilities as intended.

Center Officials Are Not Consistently Leveraging Available Resources to Identify and Address Infrastructure Vulnerabilities and Risks

NASA identifies hazards, threats, vulnerabilities, and risks—as defined below—to its infrastructure and operations through RASI and the Center Resilience Assessments:[22]

- **Hazard:** a natural or human-caused source of harm or difficulty.
- **Threat:** a natural or human-made occurrence, individual, entity, or action that has or indicates the potential to harm life, operations, the environment, and property.
- **Vulnerability:** a physical feature or operational attribute that renders an entity open to exploitation or susceptible to a given hazard.
- **Risk:** the potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences.

RASI Center Data. RASI primarily provides information to centers about future weather-related hazards, threats, and vulnerabilities through center-focused calls and workshops.[23] We spoke with officials involved in infrastructure resilience at each of NASA's 10 Centers, including personnel from OSI's Facilities and Real Estate Division. Center officials involved in infrastructure resilience, such as project managers, engineers, architects, and planners, told us they would be interested in the RASI data. We identified several cases where RASI data was used to address weather-related infrastructure decisions. For example, RASI held a call with Glenn officials in November 2023 to share temperature and precipitation projections for the Center. RASI data showed that Glenn would experience steady increases in temperature. At the time, Glenn was in the process of procuring a new heating, ventilation, and air conditioning (HVAC) system and used the temperature projections to determine which system would best meet their needs. Additionally, RASI flood modeling data showed that Langley's 16-inch and 6- by 28-inch Transonic Tunnel was susceptible to storm surge and sea level rise. A NASA official told us this helped the Agency prioritize the demolition of the old tunnel and the building of a new one in a safer location. In another example, Goddard Space Flight Center (Goddard) officials told us they use RASI data to predict monthly utility costs.

Despite the apparent value of the information provided by RASI, many of the officials we spoke to were not aware of the RASI calls or workshops focused on their centers. For example, at one center, none of the facilities officials were aware of the RASI monthly call focused on their center. Facilities staff and other decision-makers from this center did not attend the call or receive information regarding hazards, threats, and vulnerabilities their center will face in the future. One center master planner told us only one person at the center received the call invite with no explanation of who RASI was or any indication of who was required to attend.

RASI officials told us they thought center master planners were responsible for identifying and inviting relevant staff to RASI monthly calls. However, we interviewed master planners at all 10 NASA centers, and only one was aware that this was their role. According to one master planner, siloed information and limited communication are barriers to effectively responding to weather-related impacts. The

[22] NASA, *NASA Agency Resilience Framework.*

[23] Examples of key hazards identified at NASA centers include heatwaves, sea level rise, and wildfires.

official also stated that center master planners are at the bottom of the communication hierarchy and struggle to get the information they need to be most effective. OSI officials acknowledged center master planners have potentially varying authority levels at each center, and in some situations, have difficulty in effective communication across organizations and varying organizational structures. Multiple master planning officials said that additional guidance, such as a handbook or shared information repository with information including best practices, expectations, roles and responsibilities, and points of contact, would be helpful.

Center Resilience Assessments. In addition to the RASI monthly calls and workshops, NASA identifies hazards, threats, vulnerabilities, and risks to its infrastructure and operations through the Center Resilience Assessments that are led by OSI with support from the Department of Energy's National Renewable Energy Laboratory. NASA's Center Resilience Assessments help center officials assess baseline conditions, identify and score hazards and vulnerabilities, analyze risks, identify mitigation strategies, develop an action plan for implementation, and implement solutions. The Center Resilience Assessment process is outlined in Figure 5 below. Adaptation and resilience strategies developed during the Center Resilience Assessments are integrated into findings and recommendations included in the Center Master Plans.

Figure 5: NASA Center Resilience Assessment Methodology

Source: NASA OIG presentation of information from NASA Agency Resilience Framework.

Specifically, the hazards, threats, vulnerabilities, and risks identified in the Center Resilience Assessments should inform the prioritization of center goals outlined in the Center Master Plans. For example, Johnson Space Center's (Johnson) Center Resilience Assessment identified an increased annual average temperature and increased coldest annual temperature as likely threats, and reliance on uninterrupted cooling and dehumidification for mission essential functions as a top vulnerability. In the process of developing its Center Master Plan, Johnson prioritized the repair of facilities that perform unique functions, such as the Mission Control Center, that rely on water cooling and dehumidification.[24]

However, center officials involved in infrastructure resilience that we spoke with were not aware of the intended purpose of the Center Resilience Assessments. Of the six centers that have completed their assessments, only three centers used or planned to use the results of the assessments to inform the priorities in their Center Master Plans. Even officials at those centers were not aware of an expectation or requirement to incorporate the Center Resilience Assessments into their Center Master Plans. Center officials cited several reasons why the assessments may not be used to inform Center Master Plans including the timing of when the assessments and master plans are completed and the lack of guidance from Headquarters. One center completed its master plan prior to the completion of the assessment. Center officials told us they did not have the resources or guidance on how to retroactively incorporate the results of the Center Resilience Assessments into their Center Master Plans. Officials at Headquarters told us they are in the process of updating master planning guidance.

By not incorporating vulnerabilities identified in the Center Resilience Assessments into the Center Master Plans, the relevant decision-makers at NASA are not receiving all of the information they need to effectively prioritize or address weather-related vulnerabilities. Missing opportunities to address vulnerabilities early can result in increased costs and impacts to missions in the future. For example, every center identified HVAC systems as a major concern. Agency-wide, HVAC systems are taxed by the increasing number of hot and cold days, frequent temperature shifts, and strained maintenance budgets. Without accurate data on projected temperatures and clear guidance regarding when and how to utilize the data, centers may not adequately identify the risk, anticipate the replacement timeline, incorporate new HVAC systems into their Center Master Plans, or set aside sufficient funds.

NASA defines and provides numerous examples of risks, such as cybersecurity and institutional risks, that could impact the Agency's missions and operations in the Agency Risk Management Procedural Requirements.[25] However, there are no NASA procedural requirements, directives, and standard operating procedures that specifically address or mention weather-related vulnerabilities or NASA processes to identify, address, and monitor its weather-related risks and vulnerabilities. Additionally, there are no process flow maps or organizational charts to show who is responsible for carrying out weather-related responsibilities at Headquarters or across the centers. Without this information, weather-related activities—such as RASI monthly calls and Center Resilience Assessments—become siloed, and staff are not able to adequately utilize available resources.

Center Officials Do Not Consistently Enter Weather-Related Risks Identified by Center Resilience Assessments into OSI's Risk Database

OSI uses a risk database to document risk dispositions and risk acceptance decisions and their rationales. The database may include individual risk scenarios and opportunities, leading indicators, performance

[24] Johnson's Mission Control Center is the hub of human space flight. The building is staffed 24/7 with flight controllers who constantly monitor the International Space Station and the humans living onboard. Mission Control is also responsible for overseeing NASA's Artemis missions during journeys to the Moon and back.

[25] NASA Procedural Requirements 8000.4C.

parameters, performance measures, and risk tolerances. However, we found that center officials were not consistently entering risks identified during the Center Resilience Assessments into OSI's risk database. Even when centers entered risks like sea level rise into the database, they did not enter risks identified in their Center Resilience Assessments such as the vulnerability of the center's reliance on uninterrupted cooling and dehumidification for mission essential functions due to the increased number of hot and cold days in a year.

Centers were also inconsistent in identifying risks as weather related in the database. For example, while officials at one center identify sea level rise as a weather-related risk, officials at another center identify any weather-related risk as a facility risk. An inconsistent identification and understanding of weather-related risks that the Agency faces limits management's ability to thoroughly understand the risk and make informed weather-related mitigation decisions. Center officials told us there was no guidance on whether or when risks identified in the Center Resilience Assessments should be entered into OSI's risk database.

Further complicating the matter, existing policy has not been updated to reflect changes in NASA's enterprise approach regarding weather-related vulnerabilities and the associated risks are not included in Agency policy. For example, weather-related risk is not defined or included in the list of institutional risks identified in the Agency Risk Management Procedural Requirements, which makes it difficult for staff to identify and report weather-related risks within the Agency's risk management process.[26] According to a NASA official responsible for managing the risk database, it would be very helpful to have a definition for weather-related risk. Because centers are not uniformly tracking these risks, OSI cannot form a comprehensive picture of these risks and act to address them.

[26] NASA Procedural Requirements 8000.4C.

NASA Is Not Systemically Assessing Progress in Addressing Weather-Related Risks

NASA is not effectively measuring or assessing the success of its efforts to address weather-related vulnerabilities and increase the resilience of its infrastructure and operations. NASA has not defined or implemented a process to monitor progress toward weather-related infrastructure resilience. In addition to a lack of guidance, inadequate resources create challenges in developing and implementing performance metrics for weather-related infrastructure activities and costs. According to NASA officials, tracking the costs of protecting against weather impacts is particularly difficult. Nonetheless, without systematically monitoring its progress, the Agency has less assurance that taxpayer dollars are being used effectively and efficiently to protect its infrastructure and operations from weather-related risks.

NASA Is Not Systematically Monitoring or Evaluating Resilience Activities or Costs

NASA is not systemically monitoring or evaluating weather-related infrastructure resilience activities—including Center Resilience Assessments, the use of RASI data, and resiliency measures—or the costs of these activities across the Agency, despite monitoring and evaluation being a NASA standard and industry requirement.

Resilience Activities Monitoring and Evaluation. In their strategic approach, OSI has outlined tasks such as conducting Center Resilience Assessments and leveraging RASI expertise. However, we found these activities are not tied to specific measurable goals of building resilience. While each Center Resilience Assessment identifies specific weather threats and risks and provides recommendations to address associated vulnerabilities, OSI does not currently have a central repository of this information. OSI is not tracking the implementation or lack thereof of the Center Resilience Assessment recommendations. Similarly, OSI is not tracking the use or assessing the usefulness of RASI data and products. As discussed previously, we found the use of RASI data at centers varied significantly. Officials at three centers indicated positive use of RASI data, officials at two other centers reported limited use, and officials at the five remaining centers said they do not use the RASI data to inform their work at all. Some of these center officials did not receive the data while others reported a preference for local, regional, or other federal resources.

Due to the lack of monitoring and evaluation, NASA did not identify this gap in use of RASI data nor were they able to assess possible solutions. Without adequate metrics and assessments, OSI cannot identify gaps, possible improvements, or best practices. For example, while center applications of and thoughts on RASI data are mixed, officials from several centers identified multiple applications of RASI data and stated the information was useful for planning, utility use prediction, and decision-making. This illustrates not only the missed potential of RASI data—with at least five centers that are not but could be applying the data—but also the missed opportunity to improve data usage and develop best practices.

Furthermore, neither NASA nor the centers are systematically assessing the effectiveness of selected resiliency measures and interventions. For example, Wallops installed breakwaters, an offshore shore-parallel structure that "breaks" waves, reducing coastal erosion. While Wallops is studying the ecological impacts of constructing the breakwaters, the studies do not assess the impact on NASA infrastructure and resilience building. The Agency is not using the data from these studies to assess the effectiveness of the breakwaters on its overall weather-related resilience efforts. An official said they report on the breakwaters from a project management standpoint, focusing on cost and schedule, but do not monitor progress in terms of its effectiveness supporting weather-related resilience.

Wallops Flight Facility on Virginia's Eastern Shore with the Atlantic Ocean to the Right

Source: NASA.

At a different center, an official noted that while their center was tracking progress toward increased adaptation to weather-related impacts, the tracking was conducted by several individuals independently and there was no single collective "written tracking document." Further, the official stated the center had not yet established resilience-related goals. Without comprehensive monitoring and evaluation of resiliency interventions, NASA is unable to pinpoint potential gaps in their strategy, identify acute or crosscutting concerns, determine the effectiveness of its resilience efforts, or ensure efficient use of funds.

Cost Monitoring and Evaluation. Similarly, NASA has not enacted a process to monitor or evaluate costs associated with resilience implementation. As the frequency and intensity of weather events increase, NASA's expenses related to the impacts of weather on its infrastructure are also increasing. However, the Agency only tracks supplemental funding received to address disaster-related expenses. For example, since 2022, NASA has received $556 million in supplemental funding allocated by Congress to repair storm damage following acute disasters—largely, disasters resulting from named storms, such as Hurricanes Ian and Nicole , that provide a clear connection between disaster, damage, and repairs, and the specific funding provided for those repairs.[27] Although the connection between ongoing resilience efforts and repairs is less clear compared to individual disasters, tracking non-supplemental costs related to weather impacts is even more important as NASA's aging infrastructure and growing maintenance backlog increases the Agency's vulnerability to near- and long-term weather events.

Increasing infrastructure resilience often requires more up-front funding than standard construction, however, these efforts are intended to result in substantial cost savings in the future. For example, Wallops and Kennedy installed solar panels using Utility Energy Service Contracts in which a third-party financer pays for the installation of the solar panels and is repaid using the realized savings from utility costs. After the contract is paid off, usually 15 years according to one NASA official, the center receives 100 percent of the realized savings from decreased utility costs. These solar panels cost money to procure and install but could save costs over time. As such, a process to monitor and evaluate costs is critical to determine if specific infrastructure resiliency efforts are achieving their intended cost savings.

[27] Pub L. No 117-328 provided NASA with $556 million to repair damage caused by natural disasters including Hurricanes Ian and Nicole.

Given the limited funding and significant need, it is critical NASA maximize the allocation of funding effectively. According to a NASA official, addressing the threat of sea level rise has diverted funds from infrastructure and facility construction to protection activities. For example, a NASA official said Kennedy has spent $30 million on average every 3 to 5 years since 2012 to restore the dunes that protect mission critical launch facilities. Monitoring and evaluating weather-related spending would enable NASA to assess the cost-effectiveness of its efforts. According to an OSI official, the Agency has responded to broad requests about dollars spent against risks averted. The official suggested some centers may be more closely tracking these costs, but the Agency does not. Currently, OSI does not have a process or tools, such as a database, for tracking or evaluating routine weather-related costs on an enterprise level. Without effectively monitoring its weather-related costs, the Agency has no assurance that it is investing adequately to protect infrastructure and operations from weather-related risks.

NASA Is Providing Insufficient Guidance and Resources on Resilience Monitoring and Evaluation

While NASA has established a strategic approach to integrate resilience efforts into existing processes, the Agency has not applied this same strategic approach to monitoring and evaluation. NASA lacks adequate formal guidance and sufficient resources to develop and implement performance metrics for resilience efforts.

Inadequate Guidance. As NASA officials repeatedly emphasized, resilience is integrated into existing NASA processes including the risk management process and the Agency Master Plan. However, we found that relevant policy directives and handbooks have not been updated to reflect this integration nor are there supplemental directives relevant to resilience. NASA relies primarily on two strategic documents for resilience guidance: the NASA Agency Resilience Framework and NASA's Climate Adaptation Plan.[28] While the NASA Agency Resilience Framework specifically identifies monitoring and evaluation as a primary step, it provides limited detail with no direction or suggestions on methodology, appropriate metrics, or alternative resources. The framework suggests monitoring and evaluation "could" be necessary, but ultimately states, "the center master plans will serve as a baseline for evaluating the effectiveness of any implemented resilience solutions." Current Agency guidance on master planning does not include specific information on resilience. NASA officials indicated they are in the process of updating this guidance to include information on the new enterprise approach.

Similarly, while the Climate Adaptation Plan includes a section on "measuring progress," which identifies key performance indicators, process metrics, and status of the Agency response, it does not provide sufficient detail to determine what NASA is specifically doing beyond task completion and if NASA is evaluating its plan and actions. These measures focus on task completion rather than assessing performance of NASA's strategy. For example, one metric stated in the plan is a list of discrete actions—such as completing recurring RASI meetings and Center Resilience Assessments—that will be taken through 2027 as part of their implementation plan. While these are important tasks, they do not measure the effectiveness or impact of actions on NASA's goal to increase infrastructure resilience. A more effective metric would be to evaluate the impact of each task on its intended purpose to build the Agency's infrastructure resilience. We also found none of the established metrics of the Climate Adaptation Plan focused on monitoring and evaluation of resilience activities or costs.

[28] NASA, *NASA Agency Resilience Framework*, and NASA NP-2024-05-3249-HQ, *NASA's Climate Adaptation Plan* (May 2024).

In addition, NASA does not have official guidance for tracking costs related to weather impacts. Tracking costs related to climate impacts is recommended by GAO and the Office of Management and Budget as well as a practice in other countries. In a 2017 report, GAO recommended the U.S. Department of Defense require overseas installations to systematically track costs related to climate resilience.[29] Although it is not required, Office of Management and Budget Circular A-136 also recommended tracking climate risk costs, which NASA has yet to implement.[30] Further, a report from the World Resources Institute stated that approximately 50 countries have developed a process to assess how funds are spent on climate resilience.[31]

NASA officials emphasized it can be challenging to track weather-related costs with one center official stating, "OSI data calls would need to stretch for years in order to identify costs that can be attributed to climate resiliency." In part, resilience building costs are often comingled with other infrastructure costs. Multiple center officials cited challenges distinguishing weather-related impacts from typical infrastructure wear or tear. For example, as one center official questioned does "an HVAC system need to be replaced due to increased stress from climate . . . or normal wear and tear." Nevertheless, tracking costs is recommended, beneficial, and possible. This was affirmed by a center official who told us that their center does have the capability to track the costs.

Protecting infrastructure and operations from weather-related impacts is a complicated and rapidly growing risk that is consuming more and more of NASA's resources. Understanding how much it costs to mitigate, manage, and adapt can give the Agency perspective on how much this risk needs to be prioritized. It can also provide the Agency a basis for facilitating cost-sharing with commercial partners and other government agencies, as part of its lease agreements, for example. However, tracking weather-related costs, especially across multiple centers and facilities, will require a unified methodology and clear guidance. NASA does not have adequate formal guidance, including a methodology in place to identify weather-related expenditures beyond disaster relief funding. Without an effective cost tracking methodology, NASA is unable to ensure that it is adequately and wisely investing in weather-related resilience for modern infrastructure.

Inadequate Resources. NASA faces challenges developing metrics and a methodology that are applicable to all 10 centers and other facilities spread across the nation with variable hazards, threats, vulnerabilities, and risks. Developing and implementing appropriate monitoring and evaluation for resilience requires resources, including expert staff and specific funding. Establishing benchmarks in a dynamic and interconnected environment is challenging, especially as the evaluation of longer-term weather-related adaptations may not be known for years or even decades. In the interim, initial definitions of success may not be relevant as weather factors, land use change, and other system drivers shift over time. For example, the effectiveness of the dune system Kennedy built to reduce coastal erosion may take years to measure as sea level rise is comparatively slow and conditions could worsen or improve.

---

[29] GAO, *Climate Change Adaptation: DoD Needs to Better Incorporate Adaptation into Planning and Collaboration at Overseas Installations* (GAO-18-206, November 13, 2017).

[30] Office of Management and Budget Circular No. A-136, *Financial Reporting Requirements* (May 19, 2023).

[31] World Resources Institute, *How Much Is Being Spent?* (September 2023). The World Resources Institute is an independent research organization focused on people, nature, and the environment including how food, land, and water is managed; how energy is produced and used; and how cities are designed and managed.

According to a NASA official, the Agency intends to produce annual progress reports on the Center Resilience Assessments and assess “what is working, what has not.” However, during our audit, we found only one person was assigned these tasks. Another NASA senior official stated “there is no plan to monitor progress” regarding NASA’s resilience strategy. As stated previously, much of the work related to weather-related vulnerabilities is assigned as additional duties to various staff at NASA Headquarters and centers. Along with insufficient personnel, NASA continues to face a flat budget with reduced buying power. NASA carries a significant maintenance backlog of more than $4.1 billion, which multiplies the weather-related risk to Agency facilities and operations as it makes NASA more vulnerable, especially during extreme weather events. Many centers leverage supplemental disaster relief funding for repairs, but that funding is limited and requires congressional appropriation. At the time of our audit, Johnson suffered damages from Hurricane Beryl and had not received supplemental funding.

CONCLUSION

As the frequency and intensity of weather-related events increase, so does the risk to NASA's unique infrastructure. According to the National Academies, NASA's physical infrastructure is well beyond its design life and conditions are deteriorating. Continuing along this path with its infrastructure, NASA may undermine its efforts to implement leading-edge advancements in science and technology due to consequential interruptions with its mission operations. The risk to NASA's vulnerable infrastructure is compounded by constrained budgets, its maintenance backlog, rigorous requirements for essential operations, and geographic proximity to areas where intense weather events occur.

Although NASA is addressing these concerns by integrating resilience activities into existing processes and functions across various programs, this strategic approach lacks clear communication and sufficient formal guidance. Additionally, NASA is not effectively tracking resilience activities and measuring the success of its efforts to address weather-related vulnerabilities. The Agency has not defined or implemented a process to monitor progress and is not fully tracking costs associated with protecting against weather-related impacts. Without establishing performance measures that are clear, quantifiable, objective, and provide a baseline measurement of current performance, decision-makers may find it difficult to determine whether investments are achieving intended outcomes. We recognize that NASA is working with limited resources to address these concerns and must prioritize its work accordingly. However, without addressing these issues, the Agency has no assurance that it is adequately protecting its infrastructure and operations from weather-related risks and associated costs.

Recommendations, Management's Response, and Our Evaluation

To increase transparency, accountability, and oversight of NASA's efforts to address weather-related infrastructure vulnerabilities at its centers and facilities, we recommended the Assistant Administrator for Strategic Infrastructure:

1. Provide the centers with formal and clear guidance on the roles, responsibilities, expectations, and processes for defining, assessing, addressing, and monitoring weather-related infrastructure resilience. (Specifically, define "weather-related risks.")
2. Develop a process map (i.e., flow chart) for work being done to assess, address, and mitigate weather-related vulnerabilities.
3. Ensure pertinent weather-related risks identified in Center Resilience Assessments are entered into the Agency's OSI risk database.
4. Update master planning guidance to include expectations for incorporating Center Resilience Assessments into Center Master Plans.
5. To the extent practical, develop a process for monitoring and evaluating the costs and performance of post-construction, implemented weather-related resilience activities.

We provided a draft of this report to NASA management who concurred or partially concurred with Recommendations 1, 2, and 4, and we consider comments to those recommendations responsive. Therefore, those recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

NASA management did not concur with Recommendations 3 and 5 and these recommendations will remain unresolved pending further discussions with management. Regarding Recommendation 3, management stated that it already ensures pertinent resilience-related vulnerabilities identified in Center Resilience Assessments are evaluated for potential integration into the Agency's OSI risk database and centers assess whether such vulnerabilities rise to a level that warrants elevation to the Agency-level database. However, we found inconsistencies in how risks identified in the Center Resilience Assessments are considered and incorporated in the OSI risk database and the process needs to be improved to ensure significant risks are not omitted.

Regarding Recommendation 5, management argued that it is not practical to establish a monitoring and evaluation process in light of staffing levels and funding constraints. While we acknowledge these real challenges, we believe that for those reasons it is even more important to ensure that taxpayer funds are actually achieving what was intended. The Agency Resilience Framework steps conclude with monitoring and evaluation, and we believe management should follow its established process or advocate to change it to a model that can better assure their limited funds are achieving desired and intended outcomes.

In addition, in its formal response, management suggested that we signaled "an intent to broaden the scope beyond climate-specific impacts" and that "the body of the report and its recommendations do not reflect this pivot." We disagree. Our audit work was not expanded beyond our announced objective in April 2024 of evaluating how NASA was protecting its infrastructure from weather-related impacts and any change in scope would have been formally communicated to the appropriate NASA officials. Moreover, management points out the specific climate-related executive orders from previous administrations that were canceled by the current presidential administration. However, our audit work did not rely on the criteria stated in those canceled executive orders, and importantly, in no way did they serve as a basis for our findings and recommendations. Furthermore, NASA did not materially change its policies, plans, and practices relative to our original objectives and audit criteria.

Management's comments are reproduced in Appendix C. Technical comments provided by management and revisions to address them have been incorporated as appropriate.

If you have questions about this report or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or laurence.b.hawkins@nasa.gov.

Digitally signed by Robert Steinau
Date: 2025.08.01 14:02:23 -04'00'

Robert H. Steinau
NASA OIG Senior Official

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from April 2024 through June 2025 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.

We announced this audit with a stated intent to evaluate NASA's efforts to address vulnerabilities to and preparation for climate change impacts to its infrastructure, operations, and mission. Our overall objective was to assess the Agency's vulnerabilities to climate change impacts and any adaptation, mitigation, and preparation efforts to address these vulnerabilities at NASA facilities. In consultation with OSI, we revised language in our draft report following the cancellation of several executive orders that cited "climate change" to better align and support the new administration's priorities. However, our objective remained consistently focused on weather-related impacts and NASA's mitigation efforts relative to infrastructure and operational resiliency. Consequently, the adjusted language in our draft report was not material, and we confirmed with OSI that its processes and procedures regarding its efforts to protect infrastructure and operations from weather-related events and trends were not substantively altered in response to newly introduced administration policies.

To assess NASA's efforts for addressing infrastructure vulnerabilities related to weather impacts, we interviewed NASA officials in OSI, RASI, and risk management at Headquarters and all 10 NASA centers (visiting 7 of them). We also reviewed documents related to NASA's process for addressing vulnerabilities of infrastructure resilience to weather-related impacts, such as the NASA Agency Resilience Framework, Center Resilience Assessments, the Agency Master Plan, the Agency Master Plan Programmatic Environmental Assessment, Center Master Plans, Center Framework Plans, Center Development Plans, the most recent Asset Inventory Assessment, RASI work products, and related NASA policies and requirements. We also reviewed weather-related risks in the Agency's risk database and NASA guidance related to the Agency's risk management process.

To evaluate NASA's efforts with assessing the effectiveness of addressing its weather-related risks and infrastructure, we interviewed officials from OSI, the Office of Safety and Mission Assurance, and the Office of the Chief Scientist as well as officials at all 10 Centers (visiting 7 of them) to gain an understanding of tracking, monitoring, and evaluating resilience activities and costs.[32] We reviewed and analyzed the documents listed in the prior paragraph, and others including the NASA 2014 Climate Risk Management Plan; OSI Planning, Programming, Budgeting, and Execution presentations; and center-specific documentation to determine the importance, expectations, and requirements regarding monitoring and evaluation of resilience efforts and costs.

Finally, we reviewed federal and NASA criteria, policies, procedures, and supporting documentation; prior audit reports; external reviews; and other documents relevant to weather-related infrastructure resilience. The documents we reviewed included:

[32] NASA disbanded the Office of the Chief Scientist in March 2025.

- NASA NP-2024-05-3249-HQ, *NASA's Climate Adaptation Plan* (May 2024)
- NASA, *Agency Master Plan* (April 19, 2024)
- National Academies, *NASA at a Crossroads: Maintaining Workforce, Infrastructure, and Technology Preeminence in the Coming Decades* (2024)
- NASA Procedural Requirements 8000.4C, *Agency Risk Management Procedural Requirements* (April 19, 2022)
- NASA, *NASA Strategic Plan 2022* (March 28, 2022)

Assessment of Data Reliability

The findings and conclusions of this report do not rely on computer-generated data.

Review of Internal Controls

We assessed internal controls associated with how NASA is addressing weather-related infrastructure vulnerabilities at its centers and facilities and how the Agency is assessing the effectiveness of its efforts. We identified that NASA's approach to addressing weather-related infrastructure vulnerabilities lacks clear communication and sufficient formal guidance. We also identified that NASA is not effectively tracking activities and measuring the success of its efforts to address weather-related vulnerabilities for its infrastructure and operations. Control weaknesses are identified and discussed in this report. Our recommendations, if implemented, will improve those identified weaknesses.

Prior Coverage

During the last 5 years, the NASA Office of Inspector General and Government Accountability Office have issued four reports of significant relevance to the subject of this report. Reports can be accessed at https://oig.nasa.gov/audits/ and https://www.gao.gov, respectively.

NASA Office of Inspector General

NASA's Construction of Facilities (IG-21-027, September 8, 2021)

Government Accountability Office

High-Risk Series: Heightened Attention Could Save Billions More and Improve Government Efficiency and Effectiveness (GAO-25-107743, February 25, 2025)

Climate Resilience: Congressional Action Needed to Enhance Climate Economics Information and to Limit Federal Fiscal Exposure (GAO-24-106937, August 14, 2024)

Climate Change: Summary of GAO's Work on Federal Climate Resilience Projects (GAO-23-106362, June 20, 2023)

Appendix B: Weather-Related Vulnerabilities by NASA Center or Facility

This appendix provides center or facility descriptions, examples of identified weather-related vulnerabilities, and notable weather events that occurred at each NASA center or facility we visited or contacted as part of our audit work.[33]

Ames Research Center

Date Facility Opened	Location of Facility	Size of Facility
December 20, 1939	Moffett Field, California	1,900 acres

Ames Research Center, located in Silicon Valley, conducts research and development in aeronautics, exploration technology, and science.

Type of Vulnerability	Description of Vulnerability
Drought 	Drought is defined as an extended period of deficient rainfall relative to the average for a region.
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Wildfires 	Wildland fires—uncontrolled fires that occur in areas of combustible vegetation—are an essential process that connects terrestrial systems to the atmosphere and environment. But their effects can also be disastrous to the communities in their path, in both the short- and long-term.

Notable Events at Ames

- **Northern California Wildfires 2019:** These wildfires impacted Ames' operations primarily through air quality issues affecting employees.
- **California Drought 2020:** Drought conditions led to increased potable water costs for NASA and impacted employees. Drought conditions in 2011 to 2017 drove similar issues.

[33] We did not include all weather-related vulnerabilities impacting each center. This appendix provides a snapshot of each center's weather-related vulnerabilities.

Armstrong Flight Research Center

Date Facility Opened	Location of Facility	Size of Facility
September 30, 1946	Edwards, California	301,000 acres

Armstrong Flight Research Center, located at Edwards Air Force Base, performs flight research and technology integration to advance aviation and aerospace technology, validates space exploration concepts, and conducts airborne remote sensing and science missions.

Type of Vulnerability	Description of Vulnerability
Heavy Precipitation 	Current models indicate that rising temperatures will intensify the Earth's water cycle, increasing evaporation. Increased evaporation leads to more frequent and intense storms. As a result, storm-affected areas are likely to experience increases in precipitation and an increased risk of flooding.
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Wildfires 	Wildland fires—uncontrolled fires that occur in areas of combustible vegetation—are an essential process that connects terrestrial systems to the atmosphere and environment. But their effects can also be disastrous to the communities in their path, in both the short- and long-term.

Notable Events at Armstrong

- **Northern California Wildfires 2019:** These wildfires impacted Armstrong's operations and flight visibility due to smoke and poor air quality.
- **Tropical Storm Hilary 2023:** This storm impacted Armstrong's operations and caused facility-related damages to roofs, electrical vaults, and manholes. Storm-related erosion issues had to be mitigated.

Glenn Research Center

Date Facility Opened	Location of Facility	Size of Facility
May 8, 1942	Cleveland, Ohio	307 acres

Glenn Research Center, located at Lewis Field, develops critical space flight systems and technologies to advance the exploration of our solar system and beyond.

Type of Vulnerability	Description of Vulnerability
Heavy Precipitation 	Current models indicate that rising temperatures will intensify the Earth's water cycle, increasing evaporation. Increased evaporation leads to more frequent and intense storms. As a result, storm-affected areas are likely to experience increases in precipitation and an increased risk of flooding.
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Winter Storms 	A winter storm is a combination of heavy snow, blowing snow, and/or dangerous wind chills. A winter storm can be life-threatening.

Notable Events at Glenn

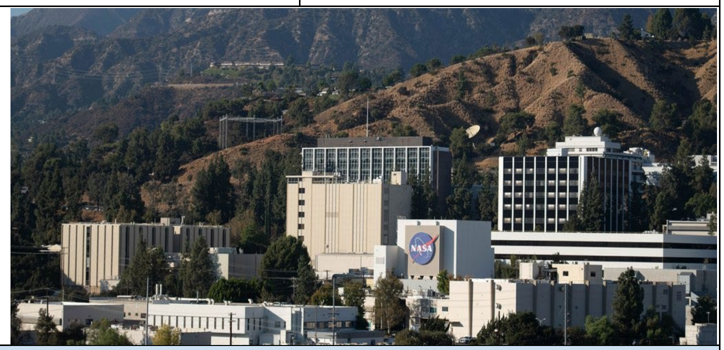
- **Polar Vortex 2014:** This storm caused extremely cold temperatures affecting Cleveland, disrupting daily operations at Glenn.
- **Winter Storms 2018:** A series of significant snowstorms and freezing temperatures affected Glenn's operations. Significant damage to the 10- by 10-Foot Supersonic Wind Tunnel took it offline for several months.

Goddard Space Flight Center		
Date Facility Opened	**Location of Facility**	**Size of Facility**
May 1, 1959	Greenbelt, Maryland	1,270 acres
Goddard Space Flight Center conducts scientific investigations; develops and operates space systems; and advances technologies to expand our knowledge of Earth, the solar system, and the universe through observations from space.		

Type of Vulnerability	Description of Vulnerability
Hurricanes 	Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Winter Storms 	A winter storm is a combination of heavy snow, blowing snow, and/or dangerous wind chills. A winter storm can be life-threatening.

Notable Events at Goddard

- **Hurricane Sandy 2012:** This hurricane caused high winds and heavy rain leading to operational delays and facility closures at Goddard. Primary impacts were to the employees in the surrounding communities.
- **Snow and Nor'easter Season 2018**: A number of major snowstorms impacted Goddard, leading to operational disruptions.

Jet Propulsion Laboratory		
Date Facility Opened	**Location of Facility**	**Size of Facility**
October 31, 1936	Pasadena, California	176 acres
The Jet Propulsion Laboratory develops robotic space missions to explore our own and neighboring planetary systems.		

Type of Vulnerability	Description of Vulnerability
Heavy Precipitation	Current models indicate that rising temperatures will intensify the Earth's water cycle, increasing evaporation. Increased evaporation leads to more frequent and intense storms. As a result, storm-affected areas are likely to experience increases in precipitation and an increased risk of flooding.
Increasing Temperatures	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Wildfires	Wildland fires—uncontrolled fires that occur in areas of combustible vegetation—are an essential process that connects terrestrial systems to the atmosphere and environment. But their effects can also be disastrous to the communities in their path, in both the short- and long-term.

Notable Events at JPL

- **Bridge Fire 2024:** This wildfire destroyed 81 structures, including over 15 homes in the nearby town of Wrightwood, home to several JPL/Table Mountain Facility employees.
- **Eaton Fire 2025:** This wildfire occurred in Los Angeles County, closing JPL for 14 days, displacing 1,000 employees, and causing over 200 employees to lose their homes.

Johnson Space Center		
Date Facility Opened	**Location of Facility**	**Size of Facility**
November 1, 1961	Houston, Texas	1,620 acres

Johnson Space Center strives to advance human capability for exploration and utilization of space by conducting space operations and designing, testing, and developing space flight hardware and systems. The Center also manages International Space Station operations.

Type of Vulnerability	Description of Vulnerability
Hurricanes 	Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.
Sea Level Rise 	Global sea level rose faster than expected in 2024, mostly because of ocean water expanding as it warms. According to a NASA-led analysis, the 2024 rate of rise was 0.23 inches per year, compared to the expected rate of 0.17 inches per year.

Notable Events at Johnson

- **Hurricane Harvey 2017:** This hurricane caused extensive flooding and high winds in Houston, including at Johnson, leading to significant damage and delays.
- **Hurricane Beryl 2024:** This hurricane caused extensive flooding and high winds in Houston, including at Johnson, leading to significant damage and delays. This Category 1 storm recorded a high of 84 mile per hour winds compared to the 50 mile per hour winds during Hurricane Harvey. Ellington Field, Sonny Carter Test Facility, and portions of Johnson's main campus lost power. Employees and their families used the Rest and Recovery Center set up at NASA's Gilruth Center.

<table>
<tr><th colspan="3">Kennedy Space Center</th></tr>
<tr><th>Date Facility Opened</th><th>Location of Facility</th><th>Size of Facility</th></tr>
<tr><td>July 1, 1962</td><td>Cape Canaveral, Florida</td><td>140,000 acres</td></tr>
<tr><td colspan="2">Kennedy Space Center is responsible for the Agency's space launch processing and services, and planning and implementation of ground operations for NASA space flight programs.</td><td></td></tr>
<tr><th>Type of Vulnerability</th><th colspan="2">Description of Vulnerability</th></tr>
<tr><td>Hurricanes
</td><td colspan="2">Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.</td></tr>
<tr><td>Sea Level Rise
</td><td colspan="2">Global sea level rose faster than expected in 2024, mostly because of ocean water expanding as it warms. According to a NASA-led analysis, the 2024 rate of rise was 0.23 inches per year, compared to the expected rate of 0.17 inches per year.</td></tr>
<tr><td>Storm Surge
</td><td colspan="2">Storm surge is the abnormal rise in seawater level during a storm. The surge is caused primarily by a storm's winds pushing water onshore.</td></tr>
<tr><th colspan="3">Notable Events at Kennedy</th></tr>
<tr><td colspan="3">• Hurricane Ian 2022: This hurricane caused extensive flooding and high winds at Kennedy leading to significant damage and delays.
• Hurricane Milton 2024: This hurricane caused only minor damage to some of Kennedy's facilities, but the Center was forced to delay the launch of the Europa Clipper spacecraft by 4 days.</td></tr>
</table>

<table>
<tr><th colspan="3">Langley Research Center</th></tr>
<tr><th>Date Facility Opened</th><th>Location of Facility</th><th>Size of Facility</th></tr>
<tr><td>July 17, 1917</td><td>Hampton, Virginia</td><td>764 acres</td></tr>
<tr><td>Langley Research Center conducts work to improve aviation, expand our understanding of Earth’s atmosphere, and develop technology for space exploration.</td><td colspan="2"></td></tr>
<tr><th>Type of Vulnerability</th><th colspan="2">Description of Vulnerability</th></tr>
<tr><td>Hurricanes
</td><td colspan="2">Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.</td></tr>
<tr><td>Sea Level Rise
</td><td colspan="2">Global sea level rose faster than expected in 2024, mostly because of ocean water expanding as it warms. According to a NASA-led analysis, the 2024 rate of rise was 0.23 inches per year, compared to the expected rate of 0.17 inches per year.</td></tr>
<tr><td>Winter Storms
</td><td colspan="2">A winter storm is a combination of heavy snow, blowing snow, and/or dangerous wind chills. A winter storm can be life-threatening.</td></tr>
<tr><th colspan="3">Notable Events at Langley</th></tr>
<tr><td colspan="3">Snowstorm and Ice Storm 2011: This storm caused closures and delays to Langley’s operations and impacted employees in the area.
Hurricane Florence 2018: This hurricane caused flooding from the heavy and quick intensity rain, which overcame storm drains and sump pump systems. High winds also caused minor damage. Employees were impacted in the surrounding areas.</td></tr>
</table>

Marshall Space Flight Center		
Date Facility Opened	**Location of Facility**	**Size of Facility**
July 1, 1960	Huntsville, Alabama	1,800 acres
Marshall Space Flight Center serves as a systems developer and integrator for exploration and science missions, providing full life-cycle engineering capabilities and developing and integrating human and scientific space flight systems from concept to development to operation.		
Type of Vulnerability	**Description of Vulnerability**	
Heavy Precipitation 	Current models indicate that rising temperatures will intensify the Earth's water cycle, increasing evaporation. Increased evaporation leads to more frequent and intense storms. As a result, storm-affected areas are likely to experience increases in precipitation and an increased risk of flooding.	
Increasing Temperatures 	Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.	
Tornadoes 	Tornadoes are small-scale circulations that are rarely more than a few hundred feet across when they touch the ground. Most tornadoes grow out of severe thunderstorms that develop in the high wind-shear environment of the United States' Central Plains during spring and early summer. Tornado wind speeds may reach 100 to 300 miles per hour and cause havoc on the ground.	
Notable Events at Marshall		
• **Tornado 2011:** This tornado caused Marshall to lose power for 10 days. While the Center's specific utilities or buildings were not impacted, the power outage was at the region's major power plant. The Tennessee Valley Authority has since hardened those distribution systems.		

Michoud Assembly Facility		
Date Facility Opened	**Location of Facility**	**Size of Facility**
September 7, 1961	New Orleans, Louisiana	43 acres

Michoud Assembly Facility, managed by Marshall Space Flight Center, manufactures and assembles large-scale space structures and systems.

Type of Vulnerability	Description of Vulnerability
Hurricanes	Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.
Sea Level Rise	Global sea level rose faster than expected in 2024, mostly because of ocean water expanding as it warms. According to a NASA-led analysis, the 2024 rate of rise was 0.23 inches per year, compared to the expected rate of 0.17 inches per year.
Storm Surge	Storm surge is the abnormal rise in seawater level during a storm. The surge is caused primarily by a storm's winds pushing water onshore.

Notable Events at Michoud

- **Hurricane Zeta 2020:** This hurricane caused operational delays and damage to Michoud including roof damage, puncture issues, and water intrusion into the facility.
- **Hurricane Ida 2021:** Similar to Hurricane Zeta, this hurricane caused operational delays and damange to Michoud including roof damage, puncture issues, and water intrusion into the facility.

<table>
<tr><th colspan="3">Stennis Space Center</th></tr>
<tr><th>Date Facility Opened</th><th>Location of Facility</th><th>Size of Facility</th></tr>
<tr><td>October 25, 1961</td><td>Hancock County, Mississippi</td><td>138,000 acres</td></tr>
<tr><td colspan="2">Stennis Space Center manages rocket propulsion testing and serves as the Systems Engineering Center, managing assigned applied sciences program activities.</td><td></td></tr>
<tr><th>Type of Vulnerability</th><th colspan="2">Description of Vulnerability</th></tr>
<tr><td>Hurricanes
</td><td colspan="2">Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.</td></tr>
<tr><td>Increasing Temperatures
</td><td colspan="2">Earth’s average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. The increase in temperatures can lead to an increase in heat waves. A heat wave is a period of abnormally and uncomfortably hot and usually humid weather, lasting several days to several weeks.</td></tr>
<tr><td>Tornadoes
</td><td colspan="2">Tornadoes are small-scale circulations that are rarely more than a few hundred feet across when they touch the ground. Most tornadoes grow out of severe thunderstorms that develop in the high wind-shear environment of the United States’ Central Plains during spring and early summer. Tornado wind speeds may reach 100 to 300 miles per hour and cause havoc on the ground.</td></tr>
<tr><th colspan="3">Notable Events at Stennis</th></tr>
<tr><td colspan="3">• Hurricane Ida 2021: Following Hurricane Zeta 2020, this hurricane caused damage to Stennis facilities.
• Tornadoes 2024: Three tornado events occurred in the spring of 2024. Due to high winds and lightning, there was roof, electrical, and facilities damage across the Center.</td></tr>
</table>

Wallops Flight Facility		
Date Facility Opened	**Location of Facility**	**Size of Facility**
May 7, 1945	Wallops Island, Virginia	6,500 acres

Wallops Flight Facility, managed by Goddard Space Flight Center, provides agile, low-cost flight and launch range services to meet government and commercial sector needs to explore the Earth's surface to the Moon and beyond.

Type of Vulnerability	Description of Vulnerability
Hurricanes 	Hurricanes are rotating, tropical cyclones in the Western Hemisphere with a low pressure center (the eye) and maximum sustained winds of at least 74 miles per hour.
Sea Level Rise 	Global sea level rose faster than expected in 2024, mostly because of ocean water expanding as it warms. According to a NASA-led analysis, the 2024 rate of rise was 0.23 inches per year, compared to the expected rate of 0.17 inches per year.
Storm Surge 	Storm surge is the abnormal rise in seawater level during a storm. The surge is caused primarily by a storm's winds pushing water onshore.

Notable Events at Wallops

- **Hurricane Sandy 2012:** This hurricane wiped out 20 percent of the beach protecting Wallops' launch facilities.
- **Hurricane Nicole 2022:** This hurricane caused damage to Wallops Island Causeway Bridge and major beach and shoreline erosion.

Appendix C: Management's Comments

National Aeronautics and Space Administration

Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001

Reply to Attn of: Office of Strategic Infrastructure

TO: Assistant Inspector General for Audits (Acting)

FROM: Assistant Administrator for Strategic Infrastructure (Acting)

SUBJECT: Agency Response to OIG Draft Report, "NASA's Approach to Infrastructure and Operational Resilience" (A-24-07-00-SARD)

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Approach to Facilities and Operational Resilience" (A-24-07-00-SARD), dated June 12, 2025.

In this draft report, the OIG found that NASA's approach to address weather-related vulnerabilities of its infrastructure lacks clear communication and sufficient formal guidance from the Office of Strategic Infrastructure (OSI) at Headquarters. Additionally, the OIG found that Center officials do not consistently enter weather-related risks identified by Center Resilience Assessments into the OSI risk database and that NASA is not effectively measuring or assessing the success of its efforts to address weather-related vulnerabilities and increase the resilience of its infrastructure and operations.

OIG's effort for this audit began in April 2024 under the title, "NASA's Vulnerabilities to Climate Change Impacts." Following the transition to a new Presidential Administration and the issuance of new executive orders, the OIG revised the title to "NASA's Approach to Infrastructure and Operational Resilience," signaling an intent to broaden the scope beyond climate-specific impacts. However, the body of the report and its recommendations do not fully reflect this pivot.

NASA fully supports the intent behind strengthening infrastructure against risks and disruptions. However, we do not concur with the framing of the recommendations around *weather-related risks*, as broader terminology focused on resilience is a more mission-relevant and sustainable construct. Weather or weather-related risks, as referenced in your report, do not encompass the entirety of NASA's ongoing responsibilities to strengthen its infrastructure against risks and disruptions. NASA's focus is on ensuring resilience to all forms of mission disruption, including but not limited to environmental stressors. This includes physical degradation, utility interdependence, cyber threats, and resource scarcity. These are not neatly categorized under *weather* or *climate*.

On January 20, 2025, Executive Order (EO) 14148, "Initial Rescissions of Harmful Executive Orders and Actions," revoked several significant climate-related executive orders that addressed both climate and weather resilience, including:

- EO 13990, "Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis," dated January 20, 2021.
- EO 14008, "Tackling the Climate Crisis at Home and Abroad," dated January 27, 2021.
- EO 14027, "Establishment of the Climate Change Support Office," dated May 7, 2021.
- EO 14030, "Climate-Related Financial Risk," dated May 20, 2021.

These executive orders explicitly used the term "weather" alongside "climate," underscoring the fact that the two concepts have been closely intertwined in Federal policy. Additionally, the earlier revocation of EO 13653, "Preparing the United States for the Impacts of Climate Change," dated November 1, 2013, under EO 13783, "Promoting Energy Independence and Economic Growth," in 2017, eliminated agency-level requirements for climate and weather resilience planning.

Resilience is the appropriate unifying framework that captures the essence of what the Agency must achieve—the ability of our infrastructure, operations, and mission-critical services to anticipate, absorb, recover from, and adapt to disruptive conditions—regardless of cause.

Focusing on resilience allows NASA to:

- Stay aligned with enterprise-wide strategic risk management goals.
- Avoid politicized terminology that could undermine stakeholder trust or compliance.
- Prioritize investments based on mission impact, not labels.

The OIG makes five recommendations addressed to the Assistant Administrator for Strategic Infrastructure to increase transparency, accountability, and oversight of NASA's efforts to address weather-related infrastructure vulnerabilities at its Centers and facilities.

The OIG recommends the Assistant Administrator for Strategic Infrastructure:

Recommendation 1: Provide the centers with formal and clear guidance on the roles, responsibilities, expectations, and processes for defining, assessing, addressing, and monitoring weather-related infrastructure resilience. (Specifically, define "weather-related risks.")

> **Management's Response:** NASA partially concurs with this recommendation.
>
> NASA is undergoing an Agency-wide reorganization. Before developing new guidance, the Agency needs time to fully assess the impacts, determine the revised organizational structure, and identify available full-time equivalent roles. Once these

elements are understood, NASA expects to issue a Headquarters memorandum to Center leadership that clarifies roles, responsibilities, expectations, and processes for defining, assessing, addressing, and monitoring resilience-related infrastructure needs. To support implementation, NASA will engage relevant Communities of Practice, such as Master Planning, Energy and Water, Construction of Facilities, Maintenance, and Environmental, to help communicate and reinforce the guidance.

Estimated Completion Date: September 30, 2026.

Recommendation 2: Develop a process map (i.e., flow chart) for work being done to assess, address, and mitigate weather-related vulnerabilities.

Management's Response: NASA partially concurs with this recommendation.

A process flow map will accompany the Headquarters memorandum referenced in response to Recommendation 1 to provide additional clarity. It will also be included in communications to relevant Communities of Practice, such as Master Planning, Energy and Water, Construction of Facilities, Maintenance, and Environmental, to support consistent implementation.

Estimated Completion Date: September 30, 2026.

Recommendation 3: Ensure pertinent weather-related risks identified in Center Resilience Assessments are entered into the Agency's OSI risk database.

Management's Response: NASA nonconcurs with this recommendation.

NASA already ensures that pertinent resilience-related vulnerabilities identified in Center Resilience Assessments are evaluated for potential integration into the Agency's OSI risk database, in alignment with NASA's objective-based risk management framework defined in NASA Procedural Requirements (NPR) 8000.4, Agency Risk Management Procedural Requirements. Recognizing that resilience is not a standalone risk mitigation, but rather a component of strategies addressing broader risks (e.g., aging infrastructure), Centers assess whether such vulnerabilities rise to a level that warrants elevation to the Agency-level database, based on their potential impact to safety or mission success.

Estimated Completion Date: N/A.

Recommendation 4: Update master planning guidance to include expectations for incorporating Center Resilience Assessments into Center Master Plans.

Management's Response: NASA concurs with this recommendation.

NASA is in the process of updating policy document NPR 8810.2, Master Planning for Real Property, and will be adding clarity and expectations for resilience assessment use into Center Master Plans. Centers will be expected to cover assessment results under a Resilience Component Plan section of their Center Master Plan. As such, mitigations to risks can be summarized in the component plan section and listed as projects (if warranted) in the Center Master Plan's 20-year project list to inform funding needs and Agency project prioritization.

Estimated Completion Date: September 30, 2026.

Recommendation 5: To the extent practical, develop a process for monitoring and evaluating the costs and performance of post-construction, implemented weather-related resilience activities.

Management's Response: NASA nonconcurs with this recommendation.

While NASA's OSI agrees with the importance of incorporating resilience considerations into facility design and construction, we do not concur with the recommendation to establish a separate process to monitor and evaluate the costs and performance of post-construction resilience activities.

This recommendation introduces administrative and resource burdens that are not practical given current staffing levels, funding constraints, and the broader scope of OSI's mission. NASA's facility investments already follow established engineering and construction standards, including industry best practices for facility hardening, lifecycle renewal, and replacement, that inherently account for resilience and performance in alignment with applicable building codes (e.g., American Society of Civil Engineers, National Fire Protection Association). These standards are updated as the science and engineering guidance evolves, ensuring facilities are appropriately designed to withstand environmental stressors, including those related to climate and weather.

Moreover, the costs associated with post-construction monitoring and evaluation of resilience-specific attributes are difficult to isolate from overall facility performance. For example, a roof replacement or structural upgrade may be resilient to extreme weather, but its performance is assessed as part of standard facility operations and maintenance protocols, not through a distinct resilience-focused mechanism. Creating such a process would likely duplicate existing asset management reviews and facility condition assessments.

Finally, OSI prioritizes efforts that offer the greatest value and impact across the enterprise. Standing up a new monitoring and cost-tracking process for resilience-specific activities, especially when they are embedded within broader infrastructure projects, diverts limited resources from other mission-critical infrastructure and operations initiatives.

NASA remains committed to responsible stewardship of its infrastructure and will continue to integrate resilience best practices within existing planning, design, and maintenance frameworks. However, a new, formalized process for post-construction cost and performance monitoring of resilience-specific activities is not warranted currently.

Estimated Completion Date: N/A.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Glenn Semmel at (321) 289-5232.

Denise Thaller Digitally signed by Denise Thaller
Date: 2025.07.22 14:38:14 -04'00'

Denise Thaller

Appendix D: Report Distribution

National Aeronautics and Space Administration

Acting Administrator
Acting Associate Administrator
Chief of Staff
Associate Administrator for Mission Support Directorate
Acting Assistant Administrator for Strategic Infrastructure
Director, Ames Research Center
Director, Armstrong Flight Research Center
Director, Glenn Research Center
Acting Director, Goddard Space Flight Center
Director, NASA Office of JPL Management and Oversight
Director, Jet Propulsion Laboratory
Acting Director, Johnson Space Center
Director, Kennedy Space Center
Acting Director, Langley Research Center
Director, Marshall Space Flight Center
Director, Michoud Assembly Facility
Director, Stennis Space Center
Director, Wallops Flight Facility

Non-NASA Organizations and Individuals

Office of Management and Budget
    Deputy Associate Director, Energy, Science, and Water Division

Government Accountability Office
    Director, Contracting and National Security Acquisitions

Congressional Committees and Subcommittees, Chair and Ranking Member

Senate Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

Senate Committee on Commerce, Science, and Transportation
    Subcommittee on Aviation, Space, and Innovation
    Subcommittee on Science, Manufacturing, and Competitiveness

Senate Committee on Homeland Security and Governmental Affairs

House Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

House Committee on Oversight and Government Reform
    Subcommittee on Government Operations

House Committee on Science, Space, and Technology
- Subcommittee on Investigations and Oversight
- Subcommittee on Research and Technology
- Subcommittee on Space and Aeronautics

(Assignment No. A-24-07-00-SARD)