NASA
Office of Inspector General

NASA's Implementation and Management of Its Planetary Defense Strategy

June 24, 2025

IG-25-006

Office of Inspector General

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RESULTS IN BRIEF

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IG-25-006 (A-24-10-00-SARD)

WHY WE PERFORMED THIS AUDIT

Asteroids and comets that orbit the Sun and come within 30 million miles of the Earth's orbit are known as near-Earth objects (NEO). Every day nearly 50 tons of meteors—small pieces of NEOs up to only a few meters across—fall on the Earth. Although most meteors disintegrate before reaching the planet's surface, objects larger than 10 meters (about 33 feet) in diameter may survive descent, hit the ground, and cause destruction in and around the impact site. For example, on February 15, 2013, an 18-meter-diameter (59 foot) meteor exploded 14.5 miles above the city of Chelyabinsk, Russia, with the force of 30 atomic bombs, blowing out windows, destroying buildings, injuring more than 1,000 people, and raining down fragments along its trajectory.

NASA leads the nation's planetary defense efforts to address the potential hazards of NEOs impacting Earth and improve planetary defense through NEO detection, research, mission planning, emergency preparedness, federal government coordination, and international engagement. In 2016, the Agency established the Planetary Defense Coordination Office (PDCO) to manage its efforts to find, track, and characterize NEOs, and when necessary, mitigate potential impacts to Earth. In doing so, the Agency identified eight internal strategic goals in response to the National Preparedness Strategy and Action Plan for Near-Earth Object Hazards and Planetary Defense issued by the National Science and Technology Council—an entity that advises the President and highest levels of the federal government.

In this audit, we assessed the effectiveness of NASA's implementation and management of its planetary defense strategy. Specifically, we evaluated the Agency's progress in achieving national planetary defense strategic goals and determined whether there were opportunities for NASA to strengthen its ability to meet them. To accomplish our objectives, we reviewed NASA documents, peer-reviewed literature, conference papers, scientific white papers, industry articles, research databases, and technical publications identified by NASA officials, scientists, and other experts. We also interviewed senior leaders in NASA's Science Mission Directorate, PDCO personnel, project managers, and personnel at several ground-based telescope observatories.

WHAT WE FOUND

The Agency has made progress in multiple areas since our last planetary defense audit in 2014, including (1) discovering greater numbers of NEOs, (2) conducting successful space flight missions, (3) developing notification procedures for possible NEO impact events, and (4) collaborating with other federal agencies and international partners. NASA accomplished this progress with limited funding and resources, placing the Agency on a path to accomplish some of the goals outlined in the NASA Planetary Defense Strategy and Action Plan. The Agency has also committed to the NEO Surveyor project—a space-based infrared telescope that aims to complete a congressional mandate to find NEOs 140 meters in diameter and larger within 10 to 12 years of operation. The project continues to operate within its cost and schedule baselines set in November 2022 following a replan due to funding constraints that increased the baseline cost estimate from $1 billion to $1.6 billion and delayed the projected launch date from 2026 to 2028.

Despite the progress NASA has made toward achieving some of its planetary defense strategic goals, there are several challenges the Agency must overcome to effectively achieve all goals outlined in the NASA Planetary Defense Strategy and Action Plan. These challenges include (1) an inadequate management structure and resources, (2) a strategic plan that is missing some key interagency collaboration practices, and (3) friction within NASA between future funding levels for planetary defense activities and the need for detailed plans from PDCO on a sustainable, long-term planetary defense strategy. For example, in 2014, we reported the NEO Observations Program had limited resources and lacked the structure needed to provide efficient and effective program management. We believe this same situation largely remains despite the PDCO's formation with expanded roles and responsibilities. Specifically, a single program executive was responsible for the NEO Program in 2014 and there was still only one full-time civil servant overseeing the PDCO as of May 2025, with assistance provided by one contractor. This situation exacerbates the challenges of a program operating with budget constraints and uncertainty and staffing challenges that inhibit developing concrete, long-range plans that could ultimately hurt the planetary defense mission.

We also found that actions are needed to address the role of ground-based assets in the future of planetary defense. NASA leverages several ground-based observatories, including the Deep Space Network, and the Agency is approaching an era of advanced NEO surveys as new observatory assets come online. While the current network of older ground-based observatories can still play an important role, we spoke with officials from two observatories who noted multiple deferred maintenance issues impacted NEO detection and follow-up capabilities. For example, one observatory has two old cameras that need to be replaced to be more effective. More effective planning is required to ensure these assets are integrated into the work that will be performed by two upcoming observatories—NEO Surveyor and the Vera C. Rubin Observatory. These new observatories are expected to find and track significantly more NEOs than current capabilities, which will likely mean a substantial increase in necessary follow-up observations.

The asteroid Apophis, larger than the size of the Empire State Building, is projected to pass within 20,000 miles from Earth in April 2029—so close that people will be able to see it with the naked eye. Limited-funded plans exist to take advantage of this rare event as time is running out before Apophis approaches Earth. While NASA was considering re-using an existing mission to explore the asteroid, NASA's fiscal year 2026 budget request proposed terminating this mission. Meeting this moment is more than an opportunity to advance planetary defense capabilities and NEO understanding, it could be a goodwill branding benchmark for NASA and the Agency's planetary defense efforts.

What We Recommended

Although there are many unknowns regarding NASA's science budget in the upcoming years, to continue NASA's significant progress in planetary defense, we made six recommendations to the Associate Administrator for Science Mission Directorate and the Director of the Planetary Science Division: (1) commit to providing stable funding levels for the NEO Surveyor mission; (2) develop a plan to assess how current ground-based observatories can prepare for NEO detection, follow-up, and characterization efforts; (3) develop a detailed strategy and long-range roadmap for a sustainable planetary defense program; (4) develop an appropriate governance structure for PDCO within the Planetary Science Division; (5) update NASA's planetary defense strategy to address missing leading collaboration practices; and (6) review Deep Space Network service agreements to ensure they meet NEO Surveyor's telemetry and transmission requirements.

We provided a draft of this report to NASA management who concurred or partially concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

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

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Acronyms

DSN	Deep Space Network
DSS	Deep Space Station
FY	fiscal year
GAO	Government Accountability Office
IAWN	International Asteroid Warning Network
JPL	Jet Propulsion Laboratory
KDP	Key Decision Point
NEO	near-Earth object
NEOWISE	Near-Earth Object Wide-Field Infrared Survey Explorer
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NSF	National Science Foundation
OIG	Office of Inspector General
OSIRIS-APEX	Origins, Spectral Interpretation, Resource Identification and Security – Apophis Explorer
OTPS	Office of Technology, Policy, and Strategy
Pan-STARRS	Panoramic Survey Telescope and Rapid Response System
PDCO	Planetary Defense Coordination Office
PSD	Planetary Science Division
SDL	Space Dynamics Laboratory
SMD	Science Mission Directorate
UFE	unallocated future expenses

INTRODUCTION

Asteroids and comets that orbit the Sun and come within 30 million miles of the Earth's orbit are known as near-Earth objects (NEO).[1] While NASA has been studying these celestial bodies for the past three decades, in 2016, the Agency established the Planetary Defense Coordination Office (PDCO) to manage its efforts to find, track, and characterize asteroids and comets. The PDCO also researches methods to mitigate, when necessary, potential impacts from hazardous NEOs.

NASA leads the nation's planetary defense efforts to address the potential hazards of NEOs impacting Earth and improve planetary defense through NEO detection, research, mission planning, emergency preparedness, federal government coordination, and international engagement. The Agency identified eight internal strategic goals in response to the National Preparedness Strategy and Action Plan for Near-Earth Object Hazards and Planetary Defense (2023 Planetary Defense Strategy) issued by the National Science and Technology Council—an entity that advises the President and highest levels of the federal government.

NASA has made progress toward achieving some of these planetary defense strategic goals since we last reviewed their efforts in 2014.[2] For example, from September 2014 to April 2025, more than 26,000 NEOs have been identified (for a total of more than 38,000); in September 2022, NASA demonstrated the ability to change the orbit of an asteroid; and in November 2022, the Agency confirmed the funding for the final design and fabrication of the NEO Surveyor mission—a space-based infrared telescope that represents the best available technology and fastest way to complete a congressional mandate to find large NEOs. Planetary defense is a growing science discipline that is poised to enter a new era of advanced asteroid surveys and take advantage of fleeting opportunities, such as the 1,100-foot-diameter asteroid, Apophis, that will make a close flyby of Earth in 2029.

In this audit, we assessed the effectiveness of NASA's implementation and management of its planetary defense strategy. Specifically, we evaluated the Agency's progress in achieving national planetary defense strategic goals and determined whether there were opportunities for NASA to strengthen its ability to meet them. See Appendix A for details of the audit's scope and methodology.

Background

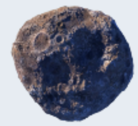
Every day nearly 50 tons of meteors—small pieces of asteroids and comets up to only a few meters across—fall on the Earth. Although most meteors disintegrate before reaching the planet's surface, objects larger than 10 meters (about 33 feet) in diameter may survive descent, hit the ground, and cause destruction in and around the impact site. For example, on February 15, 2013, an 18-meter-diameter (59 foot) meteor exploded 14.5 miles above the city of Chelyabinsk, Russia, with the force of 30 atomic bombs, blowing out windows, destroying buildings, injuring more than 1,000 people, and

[1] An asteroid is primarily a rocky or metallic body that orbits the Sun, with most residing in the main asteroid belt between Mars and Jupiter. A comet is composed of ice and dust that starts to vaporize when it gets close to the Sun and appears fuzzy or with a tail when seen in a telescope.

[2] NASA Office of Inspector General (OIG), *NASA's Efforts to Identify Near-Earth Objects and Mitigate Hazards* (IG-14-030, September 15, 2014).

raining down fragments along its trajectory. While global devastation-sized NEO impacts are rare, modern society may still be vulnerable to smaller impacts. Figure 1 displays NASA's estimate of the NEO population by size.

Figure 1: Near-Earth Object Characteristics by Size

How Big?	10 meters in diameter	50 meters in diameter 	140 meters in diameter 	1,000 meters in diameter 	10,000 meters in diameter 
How Often?	Approximately 1 per decade	Approximately 1 per 1,000 years	Approximately 1 per 20,000 years	Approximately 1 per 700,000 years	Approximately 1 per 100 million years
How Bad?	Very bright fireball, strong sonic boom could break windows if close to habitation	Local devastation, regional effects, may or may not leave an impact crater	1- to 2-kilometer crater in diameter, deadly over metro areas/states, mass casualties	10-kilometer crater in diameter, global devastation, possible collapse of civilization	100-kilometer crater in diameter, global devastation, mass extinctions of terrestrial life
How Many?	Approximately 45 million	Approximately 230,000	Approximately 25,000	Approximately 900	Approximately 4

Source: NASA Office of Inspector General (OIG) presentation of information from the *NASA Planetary Defense Strategy and Action Plan* (April 2023) and Johns Hopkins University/Applied Physics Laboratory.

The threat of NEOs exists because the Earth orbits the Sun amidst millions of asteroids and comets that cross Earth's orbit. Some other recent examples include:

- Asteroid 2019 OK, estimated to be between 60 to 130 meters (195 to 425 feet) in diameter, was discovered in July 2019 on the same day it flew by Earth well inside the orbit of the Moon. It orbits the Sun once every 993 days but will not come this close to Earth again for at least the next 200 years.
- Asteroid 2020 LD, estimated to be between 50 to 200 meters (about 160 to 660 feet) in diameter, passed inside the Moon's orbit in June 2020, which it will not do again for at least the next 170 years. Had this asteroid impacted Earth, the energy would have been equivalent to 200 megatons of TNT, producing a crater 3.5 kilometers (2.2 miles) across and leveling buildings more than 20 kilometers (12.4 miles) from the impact point. It was only discovered after it passed Earth.
- Asteroid 99942 Apophis, larger than the size of the Empire State Building, is projected to pass within 20,000 miles from Earth in April 2029. Apophis is expected to fly past Earth at a distance so close that people will be able to see it with the naked eye.

Artist's Impression of Asteroid 99942 Apophis

Source: European Space Agency and The Planetary Society.

Smaller NEOs also frequently pass relatively close to Earth. NASA's Jet Propulsion Laboratory (JPL) Center for NEO Studies identified 53 NEOs that may pass less than the Moon's distance from Earth in 2025.[3] They range between 1.1 to 290 meters in diameter.

Growing Planetary Defense Awareness and Interest

Planetary defense is a cooperative effort, within the United States and abroad, aimed at protecting all nations against the threats posed by NEOs. Planetary defense encompasses all the capabilities needed to ensure the long-term survival of civilization by protecting Earth against larger and smaller, but still dangerous, impacts.

Since the 1990s, Congress and presidential administrations have directed NASA to take a lead role in planetary defense. Especially noteworthy was the enactment of the George E. Brown, Jr. Near-Earth Object Survey Act (Survey Act) in 2005, which described NEO risks and specific goals for NASA to meet, including providing warning and mitigation of the potential hazard of NEOs to Earth. The Survey Act also added "Warning and Mitigation of Potential Hazards of Near-Earth Objects" to NASA's core policies and purposes as listed in the National Aeronautics and Space Act:

> **Warning and Mitigation of Potential Hazards of Near-Earth Objects.** Congress declares that the general welfare and security of the United States require that the unique competence of [NASA] be directed to detecting, tracking, cataloguing, and characterizing near-Earth asteroids and comets in order to provide warning and mitigation of the potential hazard of such near-Earth objects to the Earth.[4]

Additionally, the Survey Act set a goal for NASA to detect 90 percent of all NEOs 140 meters in diameter or greater by 2020. The Agency missed this deadline, and as of April 2025, NASA estimated it had discovered only half that amount, approximately 45 percent.[5] In response, the NASA Authorization Act of 2022 directed NASA to prioritize its next space-based planetary defense mission—the NEO Surveyor infrared telescope designed to search for NEOs—and added an annual reporting requirement until the 90 percent goal is met.[6]

Along with increased congressional attention, the threat of asteroids has received growing public interest. According to the Pew Research Center, 6 out of 10 Americans say monitoring asteroids that could potentially hit Earth ranks as a top priority for NASA, demonstrating the popularity of planetary defense among the U.S. public.[7]

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[3] JPL is a federally funded research and development center near Pasadena, California, that is operated for NASA by the California Institute of Technology. The JPL Center for NEO Studies computes high-precision orbits for NEOs in support of NASA's PDCO. This data is used to predict NEO close approaches to Earth and produce comprehensive assessments of NEO impact probabilities over the next century. This data can be found at JPL, *Center for Near Earth Object Studies* (accessed June 16, 2025) https://cneos.jpl.nasa.gov/.

[4] The George E. Brown, Jr. Near-Earth Object Survey Act, as enacted by the National Aeronautics and Space Administration Authorization Act of 2005, Pub. L. No. 109-155 (2005). National and Commercial Space Programs, Pub. L. No. 111–314 (2010). Chapter 201 of Title 51 restates the National Aeronautics and Space Act of 1958.

[5] By observing a portion of the sky and counting the actual number of asteroids, NASA makes estimates of the whole population.

[6] The National Aeronautics and Space Administration Authorization Act of 2022, as enacted by the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022, Pub. L. No. 117-167 (2022).

[7] Pew Research Center, *Americans' Views of Space: U.S. Role, NASA Priorities and Impact of Private Companies* (July 20, 2023).

National Science and Technology Council

The National Science and Technology Council within the executive branch prepares research and development strategies and coordinates science and technology policymaking across federal agencies to accomplish national goals. After releasing two versions of the national planetary defense strategy and action plan in 2016 and 2018, the council issued the 2023 Planetary Defense Strategy. The updated plan emphasized increasing prioritization of planetary defense by the scientific community and recognized the need to develop new U.S. and global planetary defense capabilities. NASA subsequently developed and released its first NASA Planetary Defense Strategy and Action Plan in April 2023 in support of the council's national strategy.

Federal Government Planetary Defense Activities

While NASA is the lead agency in planetary defense, as shown in Table 1, several federal agencies are identified in the 2023 Planetary Defense Strategy, each helping to achieve the strategy's six core goals:

1. Enhance NEO detection, tracking, and characterization capabilities.
2. Improve NEO modeling, prediction, and information integration.
3. Develop technologies for NEO reconnaissance, deflection, and disruption missions.
4. Increase international cooperation on NEO preparedness.
5. Strengthen and routinely exercise NEO impact emergency procedures and action protocols.
6. Improve U.S. management of planetary defense through enhanced interagency collaboration.

Table 1: Federal Agency Roles in the 2023 Planetary Defense Strategy

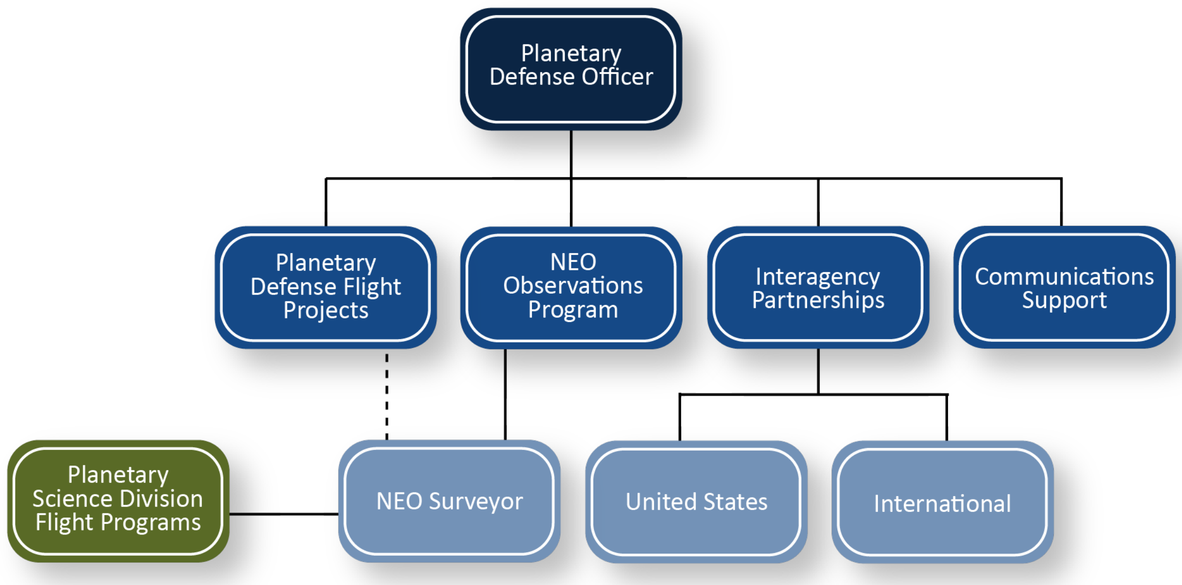
Agency	Goals
Cybersecurity and Infrastructure Security Agency, Department of Homeland Security	2, 5
Department of Commerce	1, 3, 4, 6
Department of Defense	1, 2, 5, 6
Department of Energy	1, 6
Department of Homeland Security	2
Department of State	1, 2, 3, 4, 5, 6
Federal Communications Commission	1
Federal Emergency Management Agency, Department of Homeland Security	2, 4, 5, 6
National Aeronautics and Space Administration	1, 2, 3, 4, 5, 6
National Nuclear Security Administration, Department of Energy	2, 3, 5
National Oceanic and Atmospheric Administration, Department of Commerce	1, 2, 6
National Science Foundation	1, 2, 4, 6
National Security Council	5
Office of Science and Technology Policy	5
United States Geological Survey, Department of the Interior	1, 2, 4, 5, 6
United States Space Command, Department of Defense	6
United States Space Force, Department of Defense	1, 3, 6

Source: NASA OIG analysis of National Science and Technology Council information.

NASA's Planetary Defense Coordination Office

In 2016, NASA formalized its planetary defense efforts by establishing the PDCO within the Planetary Science Division (PSD) under the Agency's Science Mission Directorate (SMD). According to NASA officials, since 2016 the PDCO has averaged about 4.5 full-time equivalent employees collectively spread across seven to eight employees, most working part-time. As of December 2024, the office is managed by an Acting Planetary Defense Officer and an Acting NEO Observations Program Manager. Additionally, the PDCO hired a contractor to assist with grant management and cooperative agreements. See Figure 2 for details of the PDCO organization.

Figure 2: PDCO Organization Chart (as of December 2024)



Source: NASA OIG analysis of PDCO data.

Note: NEO Surveyor has a dotted line up to Planetary Defense Flight Projects because it reports flight project progress to the PDCO but is managed by the PSD Flight Programs Office.

The PDCO oversees and funds ongoing NEO searches and new capabilities and coordinates activities between federal and international government entities. While the PDCO leads the Agency's planetary defense efforts and supports all strategic goals set forth in the NASA Planetary Defense Strategy and Action Plan, other relevant NASA organizations and offices were identified as having recommended roles in leading and supporting NASA's progress toward meeting the goals (see Table 2).

Table 2: Distributed Responsibilities in the NASA Planetary Defense Strategy and Action Plan

NASA Plantary Defense Strategic Goal	PDCO	OIIR	STMD	SMD	PSD	OGC	OTPS[a]	OLIA	OCOMM	OCFO	Admin.
1. Enhance NASA NEO detection, tracking, and characterization capabilities	Lead & Support	Support	Lead & Support	Support							
2. Improve NASA coordination on NEO modeling, prediction, and information integration	Lead										
3. Develop technologies for NEO reconnaissance, deflection, and disruption missions	Lead & Support	Support	Support		Lead	Support					
4. Increase NASA contributions to international cooperation on NEO preparation	Lead & Support	Lead & Support			Lead		Lead & Support				
5. Coordinate with other agencies to strengthen and routinely exercise NEO impact emergency procedures and action protocols	Lead	Support						Support	Support		
6. Improve NASA contributions to ongoing interagency coordination on planetary defense	Lead & Support	Lead & Support					Support			Lead	
7. Improve organization of NASA's planetary defense activities	Lead						Lead				
8. Enhance NASA's strategic communications related to planetary defense	Lead & Support	Support		Support			Support	Support	Support		Lead

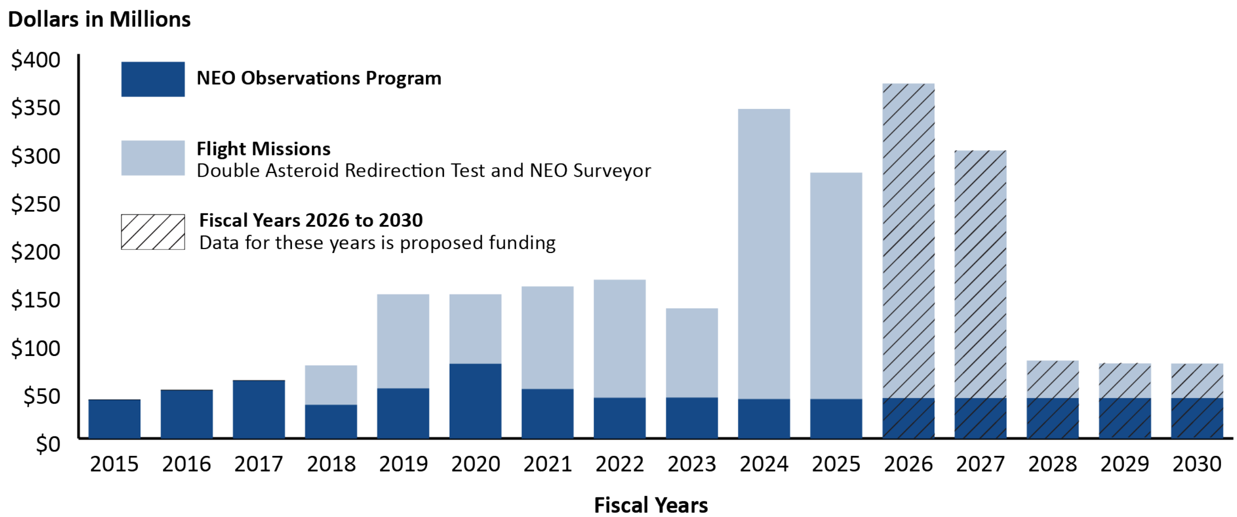
Source: NASA OIG analysis of the NASA Planetary Defense Strategy and Action Plan.

Note: Planetary Defense Coordination Office (PDCO); Office of International and Interagency Relations (OIIR); Space Technology Mission Directorate (STMD); Science Mission Directorate (SMD); Planetary Science Division (PSD); Office of the General Counsel (OGC); Office of Technology, Policy, and Strategy (OTPS); Office of Legislative and Intergovernmental Affairs (OLIA); Office of Communications (OCOMM); Office of the Chief Financial Officer (OCFO); and Office of the Administrator (Admin.).

[a] On March 10, 2025, NASA announced that it was closing OTPS as part of a broader government-wide restructuring effort.

To meet NASA's planetary defense strategic goals, the PDCO funds efforts to search for undiscovered NEOs through its NEO Observations Program. Additionally, the office funds space flight missions such as the Double Asteroid Redirection Test that successfully altered the orbit of an asteroid in 2022. Currently, NASA is funding the development of the space-based NEO Surveyor infrared telescope to search for NEOs, scheduled to launch no later than June 2028. NASA's total planetary defense funding, managed within PDCO's budget, to accomplish these responsibilities is shown in Figure 3.

Figure 3: NASA's PDCO Budget for Planetary Defense Activities Fiscal Years 2015 to 2030 (as of May 2025)



Source: NASA OIG analysis of Agency data.

Near-Earth Object Observations Program

A key element of NASA's planetary defense activities, the PDCO's NEO Observations Program is focused on finding and tracking hazardous NEOs. Comprehensive detection and characterization capabilities, including ground-based telescopes and radars, survey the sky for threatening NEOs and allow for a rapid determination of an object's trajectory. Early detection expands the amount of response options available and increases the likelihood of a successful NEO deflection, if needed. With a $41 million budget for fiscal year (FY) 2025, the program funds efforts to search for undiscovered NEOs using observatories around the world, calculates and refines NEO orbits, determines NEO physical properties and composition, and studies NEO deflection and mitigation technologies. Annually, NASA announces opportunities for research in planetary defense through the competitive Research Opportunities in Space and Earth Sciences process.[8]

The categories discussed below—detection and tracking, data processing and management, follow-up and characterization, mitigation studies, and other research and program support—represent areas of funding and support the NEO Observations Program provides for the Agency's planetary defense activities.

Detection and Tracking. The ability to detect a NEO is dependent on the object's distance from the Earth, its size and location relative to the Sun, and how well light reflects from its surface. It is extremely difficult, if not impossible, to detect a NEO that is near, or as observed from Earth, positioned in front of the Sun. The NEO Observations Program provides funds to survey teams that operate ground-based telescopes to detect and track NEOs. This includes the Catalina Sky Survey telescopes in the Santa Catalina Mountains of Arizona and the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) telescopes on Haleakalā, Maui, in Hawaii.

Data Processing and Management. The NEO Observations Program supports two centers for data processing and management and orbit computation. The International Astronomical Union's Minor Planet Center is the key repository for all NEO observations collected worldwide.[9] The center conducts an initial analysis of observations to identify and confirm NEOs, computes orbits based on these observations, highlights objects of interest, transmits this information to JPL's Center for NEO Studies, and makes this information publicly available. This information is then used by the Center for NEO Studies to calculate high-precision orbits, scan confirmed NEOs for any potential impacts via its Sentry impact monitoring system, and monitor potential newly discovered NEOs via its Scout hazard assessment system.

Follow-up and Characterization. To follow-up on new and known NEOs, NASA funds several projects to provide the additional orbit position measurements required to improve the accuracy of predicted orbit calculations and any impact prediction. The Agency also funds projects that characterize NEOs—measuring shape, size, rotation, and composition—to the extent possible from ground-based telescopes looking through Earth's atmosphere. In addition, NASA funds research on NEO radar observations for precise positions and velocities (i.e., speed) of these objects when they come close enough to be within

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[8] NASA's Research Opportunities in Space and Earth Sciences is an annual omnibus solicitation open to all organizations for proposals of basic and applied research resulting in grants, cooperative agreements, and interagency or intra-agency transfers.

[9] The International Astronomical Union promotes and safeguards astronomy—with a focus on research, communication, education, and development—and collaborates with scientific organizations from all over the world. Its members are professional astronomers from 92 countries.

the radar's range for detection. The NEO Observations Program supports observations using NASA's Deep Space Network (DSN) for ground-based radar, and it funds NASA's Infrared Telescope Facility as well as other science facilities for NEO follow-up and characterization.[10]

Mitigation Studies. Mitigation is the means of defending Earth and its inhabitants from the effects of NEO impacts. Potential actions could include emergency evacuations or efforts to deflect the trajectory of an object through "slow-push" or "slow-pull" techniques, kinetic impact, or nuclear explosions in space.[11] Of these techniques, NASA has only demonstrated kinetic impact—the Double Asteroid Redirection Test—of which the results are still being studied. The NEO Observations Program funds and oversees the Asteroid Threat Assessment Project managed at NASA's Ames Research Center, a team that assesses and models the risk from asteroid impacts. NASA, in collaboration with other federal agencies, uses data produced by the project team for interagency and international asteroid impact exercises, which in turn helps to further advance NEO impact response planning.

Other Research and Program Support. Other research includes the recent collection and analysis of meteorites to better understand the physical properties of near-Earth asteroids. PDCO also supports various interagency and international coordination and communication efforts. For our analysis, we grouped these various other costs and program support into this category.

See Appendix B for more information on a sample of the major NASA-funded organizations and ground-based telescopes.

Prior NASA Office of Inspector General Audits

We previously issued two reports with recommendations relevant to planetary defense activities at NASA.[12] In September 2014, we recommended NASA establish formal, documented partnerships with domestic and international agencies. Since that time, NASA has established official partnerships with four federal agencies for planetary defense. We also recommended the Agency develop a formal NEO Program, which officials used as justification to create the PDCO in January 2016. In September 2020, we recommended NASA coordinate with Congress and request funding to support completion of the Survey Act's requirement to catalog 90 percent of NEOs 140 meters in diameter or greater. NASA agreed with this recommendation and subsequently committed funding to NEO Surveyor in FY 2023.

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[10] The DSN is NASA's international array of giant radio antennas and consists of three deep space communications facilities located approximately 120 degrees apart on the Earth's axis near Goldstone, California; Madrid, Spain; and Canberra, Australia.

[11] Slow-push and slow-pull methods use ion beam deflection or gravity tractor technologies that rely on low-thrust, high efficiency propulsion systems to gradually deflect a NEO off course. Ion beam deflection, the slow-push method, uses a spacecraft to spray the NEO surface with ions to push it. Conversely, a gravity tractor, the slow-pull method, uses the gravitational attraction of the spacecraft to pull the NEO. Kinetic impact in planetary defense is when a spacecraft crashes into a NEO to alter the NEO's trajectory.

[12] IG-14-030 and NASA OIG, *NASA's Planetary Science Portfolio* (IG-20-023, September 16, 2020).

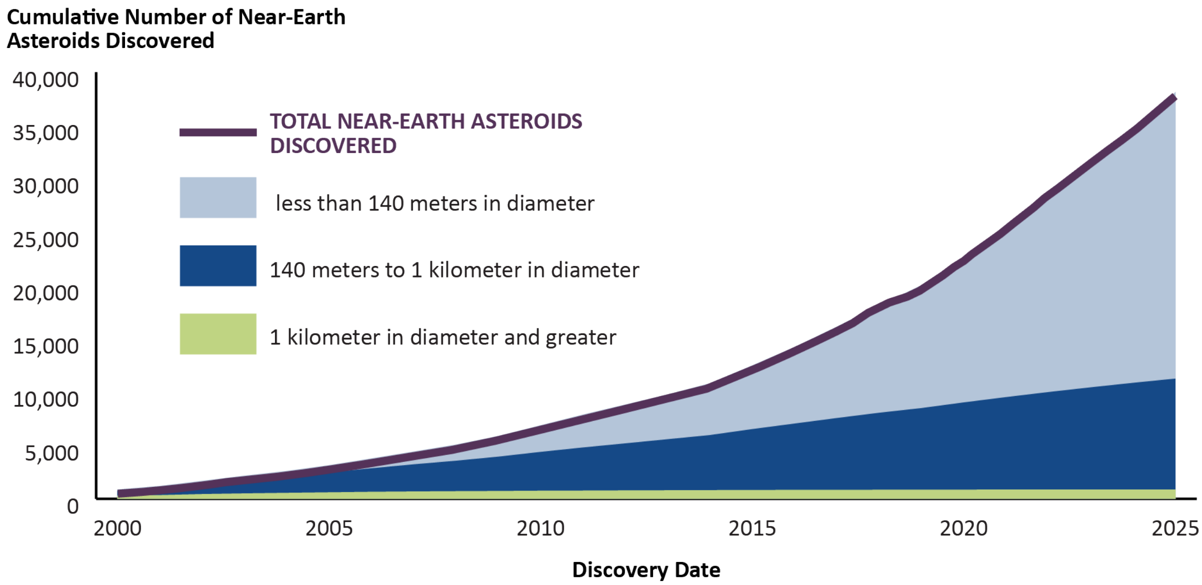
NASA Has Made Significant Progress in Its Planetary Defense Mission

Since our last planetary defense audit in 2014, we found the Agency has made progress in multiple areas, including (1) discovering greater numbers of NEOs, (2) conducting successful space flight missions, (3) developing notification procedures for possible NEO impact events, and (4) collaborating with other federal agencies and international partners. NASA accomplished this progress with limited funding and resources, placing the Agency on a path to accomplish some of the strategic goals outlined in the NASA Planetary Defense Strategy and Action Plan. The Agency continues work on the NEO Surveyor—a space-based infrared telescope that aims to complete a congressional mandate to find large asteroids and comets within 10 to 12 years of operation.

NASA's Planetary Defense Responsibilities and Initiatives Have Grown over the Last Decade

In our September 2014 audit of NASA's efforts to identify NEOs and mitigate hazards, we found a single program executive managing a fragmented, loosely structured organization of research activities. In the decade since, NASA has taken steps to remediate this and integrate planetary defense operations into a single leading organization, the PDCO. This office has, among other things, played a significant role in successfully completing planetary defense space flight missions, funding and coordinating NEO searches, developing procedures for potential NEO impacts, and growing interagency and international partnerships. Largely the result of these actions, 45 percent of the estimated number of NEOs 140 meters in diameter or greater have been discovered as of April 2025, an increase from 24 percent in September 2014, and more than 38,000 near-Earth asteroids of all sizes have been discovered (see Figure 4).

Figure 4: Number of Near-Earth Asteroids Discovered (as of April 2025)



Source: NASA OIG presentation of data from the JPL Center for NEO Studies.

NASA Planetary Defense Space Flight Missions

NASA has demonstrated significant progress in planetary defense by successfully completing two space flight missions, developing the next planetary defense mission, and leveraging another planetary science mission to gain insights during an asteroid's close approach to Earth. Specifically, the Agency completed the repurposed Near-Earth Object Wide-Field Infrared Survey Explorer (NEOWISE) and Double Asteroid Redirection Test missions. NASA is also developing the upcoming NEO Surveyor telescope and planning potential opportunities for the Origins, Spectral Interpretation, Resource Identification and Security – Apophis Explorer (OSIRIS-APEX) mission.

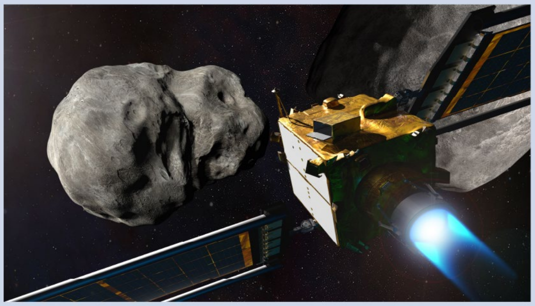
Near-Earth Object Wide-Field Infrared Survey Explorer

Launched in December 2009, NASA's Wide-field Infrared Survey Explorer telescope surveyed the sky in infrared to detect dim stars and faint galaxies in space until its primary mission was completed in February 2011. In late 2013, PSD took the telescope out of hibernation and repurposed it as NEOWISE. Used to complement ground-based telescopes and continue surveying the sky for NEOs and other small celestial objects, NEOWISE discovered 215 NEOs and made infrared measurements of more than 3,000 NEOs before NASA decommissioned the spacecraft in August 2024 because it could no longer maintain an appropriate orbit. In November 2024, the spacecraft reentered Earth's atmosphere and burned up as planned.

Double Asteroid Redirection Test

The Double Asteroid Redirection Test launched in November 2021. NASA navigated the spacecraft to intentionally collide with the asteroid Dimorphos to alter its orbit around the larger asteroid Didymos. This was the world's first planetary defense technology demonstration that validated a technique of asteroid deflection by using a kinetic impactor spacecraft to intentionally collide with an asteroid to change its orbital path.

Artist's Impression of the Double Asteroid Redirection Test



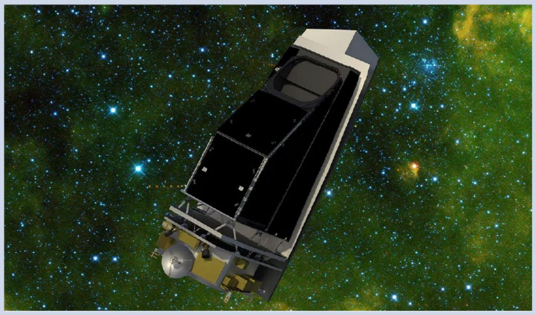
Source: NASA.

NEO Surveyor

NASA is currently developing the space-based NEO Surveyor telescope to search for NEOs using infrared technology.[13] According to the National Academies of Sciences, Engineering, and Medicine (National Academies), space-based telescopes have distinct advantages over their ground-based counterparts in detecting NEOs—uninterrupted operations, a more optimal field of view to see more objects yielding higher detection rates, and the ability to operate at infrared wavelengths blocked by the Earth's atmosphere.[14]

While dark asteroids and comets do not reflect much visible light, NEO Surveyor's infrared detectors will be able to track them since NEOs glow as they are heated by sunlight. NEO Surveyor will also be able to find asteroids that approach Earth from the direction of the Sun and ones that lead and trail Earth's orbit where they are typically obscured by the glare of sunlight. When compared to ground-based telescopes, where asteroids of different sizes can look similar when viewed in visible light, NEOs detected in infrared can be estimated more accurately.

Artist's Impression of the NEO Surveyor Space Telescope



Source: NASA.

As a result, a much more accurate determination of an object's diameter can be made, which is critical for rapid impact hazard assessment. Scheduled to launch no later than June 2028, NEO Surveyor—working in tandem with existing ground-based capabilities—is predicted to drastically accelerate the rate at which NASA can discover the remaining undiscovered NEO population.

[13] Development of the NEO Surveyor is managed by JPL and led by a Survey Director from the University of California, Los Angeles. The Survey Director, similar to a Principal Investigator, is generally given end-to-end mission responsibility and is accountable to NASA for overall mission success including meeting cost and schedule milestones.

[14] National Academies, *Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032* (2023). The National Academies provide independent analysis and advice to inform policy. At NASA's request, the National Academies conducts decadal surveys and respective midterm reviews based on science community consensus and makes recommendations for each of NASA's science divisions.

There are three fundamental goals of the NEO Surveyor mission:

1. Identify impact hazards to Earth posed by NEOs by performing a comprehensive survey of the NEO population and identifying at least two-thirds of potentially hazardous asteroids greater than 140 meters in diameter within 5 years.
2. Obtain detailed physical characterization data for individual objects that are likely to pose an impact hazard.
3. Characterize a significant fraction of the potentially hazardous NEOs to inform potential mitigation strategies by assisting the determination of impact energies through accurate object size determination and physical properties.

The mission is required to achieve more than two-thirds of the survey within 5 years for potentially hazardous asteroids larger than 140 meters in diameter, with a goal of achieving 90 percent survey completeness in 12 years.

Origins, Spectral Interpretation, Resource Identification and Security – Apophis Explorer

OSIRIS-APEX is the repurposed OSIRIS-REx (Regolith Explorer) spacecraft that collected material from the asteroid Bennu in 2021 and returned the samples to Earth in 2023. In June 2029, OSIRIS-APEX could rendezvous with Apophis to study its physical changes after the asteroid's close encounter with Earth in April 2029.[15] While neither mission was funded nor managed by PDCO, some of the missions' science goals help inform planetary defense knowledge and strategies.

NASA Developed Notification Procedures for Possible NEO Impacts

When we conducted our 2014 NEO audit, NASA did not have official notification procedures in place for potential asteroid impacts to Earth. Since that time, the Agency developed, and established within a policy directive, procedures to notify various federal government entities of very close approaches or predicted impacts of NEOs. The NEO Observations Program funds efforts to calculate and refine NEO orbits. If a NEO greater than 10 meters in diameter is found to have a 1 percent or greater chance of impacting Earth, the PDCO is responsible for providing notification messages to NASA officials for them to send to the Executive Office of the President, Congress, and other government departments and agencies.[16]

The NEO warning system was most recently used when the asteroid 2024 YR4 was discovered by the Asteroid Terrestrial-Impact Last Alert System telescope. The Center for NEO Studies' Sentry impact monitoring system identified the possibility that the asteroid might impact Earth on December 22, 2032. The probability gradually increased, and in January 2025, it surpassed 1 percent, which required NASA to notify domestic stakeholders per NASA Policy Directive (NPD) 8740.1 and, as the coordinator of the International Asteroid Warning Network (IAWN), to notify the United Nations Office for Outer Space

[15] On May 30, 2025, NASA released its FY 2026 budget request that proposed canceling the mission to Apophis.

[16] NASA's NEO threat notification process is found in NASA Policy Directive (NPD) 8740.1, *Notification and Communications Regarding Potential Near-Earth Object Threats (Revalidated with Change 1)* (January 27, 2017). The policy establishes the order in which NASA will inform other federal agencies.

Affairs.[17] However, in February 2025, follow-up observations of the asteroid and calculations of its orbit reduced the chance of striking Earth to negligible over the next century.

Interagency and International Planetary Defense Coordination

In 2014, we reported a lack of planning and resources prevented NASA from developing partnerships that could help it achieve Agency and national planetary defense strategic goals. NASA had established two formal partnerships and other informal partnerships at that time, which helped the Agency begin to coordinate planetary defense efforts across the federal government and international community. In the last 10 years, NASA has bolstered its efforts to raise interagency cooperation and international awareness in the planetary defense field. These advancements led to significant developments that include establishing formal agreements with four federal agencies, holding five biennial impact planning exercises, participating in a working group, and creating two United Nations-endorsed groups.

Interagency Work Across the Federal Government

NASA plays a key coordinating role in leading collaboration among various federal departments and agencies with planetary defense expertise and capabilities. To this end, the Agency has signed three memorandums of understanding and one charter with four federal agencies (see Table 3).

[17] IAWN is a global planetary defense collaboration of organizations and individual astronomers who detect, monitor, and characterize potentially hazardous NEOs. The United Nations Office for Outer Space Affairs works to help countries access and leverage the benefits of space to accelerate sustainable development as well as ensure the sustainability of outer space activities. They work with space agencies and leaders to devise solutions to challenges that require an international response such as the threat of NEO impacts.

Table 3: NASA's Interagency Agreements for Planetary Defense

Agency	Areas of Cooperation or Interest	Type of Agreement
United States Space Force, Department of Defense	Use deep space survey and tracking technologies to support extended NEO detection beyond geosynchronous orbit. Detect and collect data on bolides caused by natural objects entering the Earth's atmosphere to provide timely reporting to the public and scientific community.	memorandum of understanding
Department of Energy	Provide space science capabilities, high-end computing capabilities, and data initiatives for planetary defense from NEOs.	memorandum of understanding
National Science Foundation	Respond to potentially dangerous objects from space by expanding toolsets in search and detection, consistent early warning, and timely response.	memorandum of understanding
Federal Emergency Management Agency, Department of Homeland Security	Coordinate responsibilities and resolve preparedness and operational issues relating to interagency response and recovery activities at the national level in preparation for a predicted or actual impact of an asteroid or comet that could affect the United States or its territories.	charter

Source: NASA OIG analysis of Agency information.

These agencies, along with other entities across the federal government, participate in interagency tabletop exercises that provide opportunities for participants to better understand the preparedness and response challenges associated with the threat of an asteroid impact. NASA and the Federal Emergency Management Agency jointly sponsor these planning exercises approximately every 2 years and have held five since April 2013. The participants publish after-action reports following each exercise that discuss important observations, gaps, and recommendations to improve interagency planetary defense operations. These recommendations have led to change and fostered collaboration. For example, the first tabletop exercise recommended officials establish an authoritative NEO working group. The Planetary Defense Interagency Working Group now exists under the National Science and Technology Council's Committee on Homeland and National Security.

International Planetary Defense Collaboration

PDCO has an active role in the international planetary defense community and leads efforts in two international collaborative bodies endorsed by the United Nations' Committee for Peaceful Uses of Outer Space—IAWN and the Space Mission Planning Advisory Group.[18] As of May 2025, IAWN is composed of over 70 signatories and representatives from about 30 countries, including space agencies, universities, private organizations, and independent astronomers, who collectively work to detect,

[18] The Committee on the Peaceful Uses of Outer Space reviews international cooperation in peaceful uses of outer space, studies space-related activities that could be undertaken by the United Nations, encourages space research programs, and studies legal problems arising from the exploration of outer space.

monitor, and characterize potentially hazardous NEOs. If an asteroid threat were ever identified, IAWN would act as a centralized hub for disseminating information to governments worldwide to aid with analysis of impact consequences and planning of mitigation response options. In addition to coordinating efforts of the IAWN, NASA's Planetary Defense Officer has a seat on the IAWN Steering Committee.

NASA also participates in the Space Mission Planning Advisory Group, a forum of international space agencies that analyzes and prepares recommendations for an in-space response to a detected threat of a NEO impact. Advisory Group members regularly exchange information of ongoing and planned activities related to planetary defense. For example, Advisory Group members prepared recommendations for an in-space response to a simulated asteroid impact threat scenario at the May 2025 International Academy of Astronautics Planetary Defense Conference. At this conference, scientists, engineers, global thought leaders, policymakers, government officials, and other planetary defense experts discussed what their respective nations and stakeholders were doing to better understand how the international community might respond to a possible NEO impact.

NEO Surveyor on Track to Meet Cost and Schedule Estimates

As of March 2025, NEO Surveyor was on track to launch no later than June 2028 despite two major contract renegotiation delays and limited cost reserves (known as unallocated future expenses or UFE) in FYs 2024 and 2025.[19] The NEO Surveyor project remains on its current schedule following a replan in 2022. The replan was necessary due to funding constraints that increased the baseline cost estimate from $1 billion to $1.6 billion and delayed the projected launch date from 2026 to 2028.

Current Project Status of NEO Surveyor

Cost and Schedule

The NEO Surveyor project continues to operate within its cost and schedule baselines set at Key Decision Point C (KDP-C) in November 2022, including an Agency Baseline Commitment of $1.6 billion and a projected launch date of no later than June 2028.[20] The NEO Surveyor project passed its Critical Design Review in February 2025.[21] As part of that process, the project's Standing Review Board determined the

[19] UFE are costs expected to be incurred but cannot yet be allocated to a specific sub-element of a program's or project's plan. Management at and above the level of the project (i.e., Agency, mission directorate, or program) control some portion of the UFE, such as project-held or headquarters-held. UFE ensures that NASA has sufficient resources to handle unexpected issues that may arise during a project.

[20] The Agency Baseline Commitment contains the cost and schedule parameters NASA submits to Congress and the Office of Management and Budget. A KDP is when the Decision Authority—the responsible official who provides approval—decides on the readiness of the program or project to progress to the next life-cycle phase. KDP-C includes a final assessment of the preliminary design, a determination of whether the program or project is sufficiently mature, and the establishment of cost and schedule baselines.

[21] Critical Design Review demonstrates the program's or project's design is sufficiently mature to proceed to full-scale fabrication, assembly, integration, and testing, and that the technical effort is on track to meet performance requirements within identified cost and schedule constraints.

mission meets all technical performance measures and requirements.[22] The project was then able to move forward to the next phases of assembly and testing. As of March 2025, the project was continuing instrument hardware integration and testing.[23]

This includes testing for a major component of NEO Surveyor, the instrument enclosure, designed to protect the spacecraft's infrared telescope while also dissipating heat during operations. After assembly at JPL's Spacecraft Assembly Facility, the enclosure was moved to Johnson Space Center for testing that replicates the frigid, airless conditions the spacecraft will experience when in deep space. The project's telescope is also undergoing final testing at JPL. The instrument enclosure and telescope are both scheduled to be shipped to a mission contractor, Space Dynamics Laboratory (SDL), in Logan, Utah, in the spring of 2025 where the rest of NEO Surveyor's subsystems will be integrated and tested. In addition, NASA awarded a contract worth about $100 million to SpaceX to provide launch and other mission-related services.

Reserves

As of March 2025, the project's reserve resources faced significant challenges from limited UFE that began in FY 2023. The project currently has a negative UFE balance after all known risks are accounted for. Without additional UFE from NASA management, it will be difficult for the project to address any unforeseen technical issues which may ultimately result in increased costs and schedule delays. In May 2025, NASA said it plans to rephase project UFE from future years to mitigate the limited FY 2025 project UFE.

The Fiscal Responsibility Act of 2023 is compounding these reserve challenges by imposing caps on most discretionary funding for FYs 2024 and 2025.[24] Consequently, NASA did not allocate cost reserves to the project until FY 2025, which resulted in NEO Surveyor having less funding flexibility than originally planned. Project officials took several actions to mitigate the lack of headquarters-held reserves and the low project-held reserves over those 2 years. For example, in FY 2023, the project continued to focus on higher-risk instrument work and deferred work on the spacecraft, which resulted in JPL renegotiating subcontracts with SDL and BAE Systems. SDL provides instrument subsystems and NEO Surveyor's instrument integration, test, and calibration for the telescope assembly. BAE Systems is responsible for design, construction, testing, integration, and delivery of the NEO Surveyor spacecraft. JPL reissued a request for proposals and activities for Phase C—system final design and fabrication—and Phase D—system assembly, integration, test, launch, and check out—after the replan created delays. As a result, the launch readiness date was pushed back 1.5 years and the renegotiated work for Phases C and D increased contract costs by $136 million.[25]

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[22] The Standing Review Board is an independent advisory board chartered to assess programs and projects at specific points in their life cycle. It provides the program or project, Decision Authority, and other senior managers a credible, objective assessment of how the program or project is progressing against Agency criteria and expectations.

[23] Several JPL team members were adversely impacted by the January 2025 Eaton wildfires in southern California. Consequently, the telescope team is currently behind in their schedule.

[24] Fiscal Responsibility Act of 2023, Pub. L. No. 118-5 (2023).

[25] Phase C and D are two phases in the Implementation Phase of NASA's project life cycle where mission development and operation project plans are executed, and control systems are used to ensure they align with NASA's strategic goals.

In accordance with NASA Procedural Requirements (NPR) 7120.5F, the project has used the Earned Value Management tool to track its cost and schedule performance since April 2023.[26] The earned value tool is reporting worse than planned performance, mainly due to the increase of the SDL and BAE Systems subcontract costs as well as schedule delays with longer lead times for parts. Although the trend will continue to pressure cost reserves, our calculations suggest that the Estimate at Completion—the project's estimated final cost including costs to date and estimated costs for authorized remaining work—does not yet exceed the project's Agency Baseline Commitment.

Unstable Funding Drove Significant NEO Surveyor Cost Growth and Schedule Delays

NEO Surveyor has a history of funding constraints and delays that stretched project timelines and increased overall costs. These delays postponed NASA's completion of the 2005 Survey Act requirements and further delays could increase the time needed to find undiscovered large NEOs.

The genesis of the NEO Surveyor project can be traced to an August 2016 concept study report for a space-based infrared camera called the Near-Earth Object Camera. That project had its initial formulation review in 2018, and then in 2020, it was reformulated to the NEO Surveyor configuration. In FY 2021, NASA did not provide the project's requested funding, extending the project's preliminary schedule estimate determined at the Preliminary Design Review.[27] Likewise, although NASA projected needing $174.2 million for FY 2023, the project only received $90 million resulting in another replan with reduced funding before entering the Implementation Phase.[28] In November 2022, NEO Surveyor successfully passed KDP-C, entered the Implementation Phase, and established cost and schedule baselines of $1.6 billion and a projected launch date of no later than June 2028, respectively.

Table 4 summarizes NEO Surveyor's changing cost estimates and planned launch readiness dates.

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[26] NPR 7120.5F, *NASA Space Flight Program and Project Management Requirements w/Change 4* (August 3, 2021). Earned Value Management is a project management tool designed to objectively measure and assess a project's performance and progress by comparing the estimated value of a completed task at a specific point in time in the project's schedule with the actual cost.

[27] Preliminary Design Review evaluates the completeness and consistency of the planning, technical, cost, and schedule baselines developed during the Formulation Phase (Phases A and B); assesses compliance of the preliminary design with applicable requirements; and determines if the project is sufficiently mature to begin Phase C of the Implementation Phase.

[28] The Implementation Phase consists of program and project final design and fabrication; system assembly, integration, and test; launch and checkout; operations and sustainment; and closeout.

Table 4: Changes to NEO Surveyor's Estimated Cost and Launch Readiness Dates

Milestone Event and Date	Phases B/C/D (millions)	Life Cycle (millions)	Launch Readiness Date
NEO Surveyor KDP-B (May 2021)[a]	$639.7	$896.0 to $991.0	February to June 2026
NEO Surveyor KDP-C (November 2022)[b]	$1,361.5	$1,595.1	No later than June 2028

Source: NASA OIG analysis of Agency data.

[a] KDP-B is when the proposed mission and system architecture is credible and responsive to program and project requirements and constraints, including resources, and the mission and system definition and associated plans are sufficient to begin Phase B (preliminary design and technology completion).
[b] KDP-C is when the program's or project's planning, technical, cost, and schedule baselines are complete and consistent, the preliminary design complies with its requirements, and the program or project is sufficiently mature to begin Phase C (final design and fabrication).

Further funding shortfalls, especially given the current limited UFE, would likely result in increased overall costs and a delayed project timeline. As noted by the National Academies, significant cost increases and schedule delays have adversely impacted the cadence of launches to advance key planetary defense technologies.[29]

[29] National Academies, *Decadal Strategy for Planetary Science and Astrobiology 2023-2032*.

Challenges Hinder NASA's Ability to Fully Execute Its Planetary Defense Strategy and Action Plan

While NASA has made progress toward achieving some of its planetary defense strategic goals, there are several challenges the Agency must overcome to effectively achieve all goals outlined in the NASA Planetary Defense Strategy and Action Plan. These challenges include (1) an inadequate management structure and resources, (2) a strategic plan that is missing some key interagency collaboration practices, and (3) friction within NASA between future funding levels for planetary defense activities and the need for detailed plans from PDCO on a sustainable, long-term planetary defense strategy.

Planetary Defense Lacks the Governance Structure Required to Effectively Oversee Responsibilities

In 2014, we reported the NEO Observations Program had limited resources and lacked the structure needed to provide efficient and effective program management. In our assessment, we believe this same situation largely remains despite the PDCO's formation with expanded roles and responsibilities. For example, a single program executive was responsible for the NEO Program in 2014. There was still only one full-time civil servant overseeing the PDCO as of May 2025, with assistance provided by one contractor. In addition to these management challenges, we identified three areas further exacerbating planetary defense issues within NASA: (1) planetary defense is an applied science field, which has caused it to be treated differently than exploratory science; (2) two internal Agency assessments conducted to remediate program management issues have failed to result in changes; and (3) the PDCO is a hybrid organization that is not structured around traditional NASA programmatic policy unlike other programs under PSD. Table 5 compares the PDCO against the three other offices within SMD's PSD where it shows unique structure, leadership, size, and type of science produced.

Table 5: Comparison of the Planetary Science Division's Four Offices

Planetary Science Division Office	Funding[a] (millions)	Structure	Number of Missions[b]	SES Leadership[c]	Output Type
PSD Flight Programs	$1,062.5	Program	12	Yes	Exploratory Science
Planetary Research Program	$310.6	Program	0	No	Exploratory Science
Mars Exploration Program	$248.1	Program	9	No[c]	Exploratory Science
Planetary Defense Coordination Office	$135.5	Hybrid	1	No	Applied Science

Source: NASA OIG analysis of Agency budgets, organization charts, and plans.

[a] Funding amounts as revised in NASA's FY 2023 final Operating Plan in the FY 2025 President's budget request.
[b] Each total includes both current and future missions within the respective program or office.
[c] Senior Executive Service (SES). The Mars Exploration Program Director is an SES position, but as of March 2025, it was not held by an SES.

Planetary Defense Is an Applied Science and Operational Mission Within NASA

Planetary defense is classified as an applied planetary science, meaning it attains a practical goal or benefit for society. This contrasts with the more traditional category of exploratory planetary science within SMD that is driven by scientific curiosity and exploration rather than primarily providing information and support for a public good or addressing congressional policy goals. From NASA's perspective, the output from planetary defense missions is similar to other applied science-based operational programs like the Space Weather and Earth Science Disasters Programs, as opposed to exploratory-based missions, such as astrophysics and planetary science, that are more typical for the Agency.[30] This has resulted in tension arising from the PDCO—a largely applied science and operations-driven organization—existing within SMD, a largely exploratory science-driven organization.

Evidence from the National Academies, the Small Bodies Assessment Group, internal and external NASA documents, and the scientific community suggest planetary defense as an applied science has been disadvantaged due to its distinction from traditional planetary science that is focused on understanding the planets and small bodies of our solar system.[31] This has historically affected planetary defense priorities across mission selection, program funding, and research within the Agency. For example, the National Academies in 2019 noted operational planetary defense activities compete against traditional exploratory science missions for funding, which places them at a competitive disadvantage given their

[30] The Space Weather Program studies the conditions of the space environment driven by the Sun and its impacts on objects in the solar system to enable successful prediction and applications. The Earth Science Disasters Program uses space- and ground-based observations to provide disaster-related data and information products to partners and stakeholders (for more information, see NASA OIG, *NASA's Management of the Earth Science Disasters Program* (IG-22-013, June 14, 2022).

[31] The Small Bodies Assessment Group is NASA's community-based form to provide science input for planning and prioritizing the exploration of small bodies—asteroids, comets, interplanetary dust, small satellites, and Trans-Neptunian Objects—throughout the solar system for the next several decades. It also provides input on how small bodies can be utilized in support of human space exploration.

fundamental differences in objectives.[32] Similarly, the Small Bodies Assessment Group discussed NEO Surveyor's difficulties in being selected as a mission by the Agency because of applied science and planetary defense efforts not being viewed by the scientific community as valuable.[33] Other scientific white papers discuss an institutional bias that prefers exploratory science research over research and development for applied science priorities and that scarce funding should go to non-applied scientific research instead.

While these applied science challenges have affected planetary defense at NASA in the past, there is a shift occurring where missions are increasingly asked to provide social and economic returns to support applications of science research. Planetary defense has also gained prominence after being included in the National Academies' most recent planetary science and astrophysics decadal survey for the first time.[34] Decadal surveys are valued for their consensus-building process that determines research priorities. As a result, this inclusion in the decadal survey was an important step for the planetary defense community. The increasing prioritization of planetary defense as an applied planetary science discipline was also one reason among others that the National Science and Technology Council updated the 2018 National Near-Earth Object Preparedness Strategy and Action Plan to the 2023 Planetary Defense Strategy.

In our assessment, planetary defense funding and support within NASA was not prioritized over the last decade, as discussed by the scientific community above. But this perspective and the prioritization of planetary defense is improving. Funding from the limited resources in SMD's highly competitive portfolio is not likely to change in the future. However, the planetary defense mission has become more formal as evident with NEO Surveyor, which could help improve staffing and support for follow-on missions.

Prior Planetary Defense Reform Assessments at NASA Have Not Led to Changes

Two organizations within NASA assessed the PDCO's structure to examine if it is sufficient to effectively implement the NASA Planetary Defense Strategy and Action Plan. First, the former Office of Technology, Policy, and Strategy (OTPS) drafted a report on NASA's planetary defense activities in July 2023.[35] Second, the PDCO drafted a new planetary defense organizational structure plan and provided it to SMD leadership in September 2023. Both assessments identified the challenges we discussed above. However, officials told us neither assessment has led to any changes to funding, staffing, or elevation of positional authority that could remediate challenges in the PDCO.

OTPS Assessment and Findings

The NASA Planetary Defense Strategy and Action Plan states OTPS will complete "an independent assessment of the organization of planetary defense activities at NASA" and provide leadership with the results of the study to "guide organization, reporting structure or other modifications." Although OTPS drafted this study in July 2023, it was never released because of anticipated pushback from SMD and

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[32] National Academies, *Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes* (2019).

[33] Small Bodies Assessment Group, *Goals and Objectives for the Exploration and Investigation of the Solar System's Small Bodies Version 3.1* (August 2024).

[34] National Academies, *Decadal Strategy for Planetary Science and Astrobiology 2023-2032*.

[35] On March 10, 2025, NASA announced that it was closing OTPS as part of a broader government-wide restructuring effort.

Agency leadership. Nonetheless, the draft report discusses the causes behind the PDCO's history of staffing, budget, and other organizational issues:

- **Priority.** Planetary defense was not highly prioritized in National Academies planetary science decadal surveys until the most recent planetary science and astrobiology survey for 2023 to 2032, indicating it was not a high scientific community priority before then.
- **Competition.** Planetary defense missions compete for funding against, and have been disadvantaged by, high-profile programs within SMD and PSD, such as Mars Sample Return and the Perseverance rover.[36]
- **Staffing.** The PDCO has historically had inadequate staffing to fulfill its mission and there was only one full-time permanent Headquarters civil servant working in the office as of May 2025. Various staff support the PDCO part-time, which combined equals approximately three full-time employees.
- **Culture.** Traditional SMD programs and missions generate data for the scientific community and answer key research questions. Conversely, NASA approaches planetary defense as an operational program, supporting the public with applications based on research.
- **Structure.** The PDCO is a hybrid organization, overseeing flight missions and managing the NEO Observations Program. However, it is not an official program office as defined in *NASA Space Flight Program and Project Management Requirements*.[37]

PDCO Assessment and Findings

The PDCO's September 2023 internal report discussed challenges facing the office consistent with the OTPS report. Specifically, the report states the PDCO's organization structure is not adequate for addressing the office's various responsibilities, with success being achieved by stretching personnel across many tasks. The report outlines changes that could be made within the PDCO to adequately cover the office's responsibilities, including

- elevating the Planetary Defense Officer position to the Senior Level;[38]
- creating two new positions for a Deputy Planetary Defense Officer and an Executive Officer;
- sharing workloads for communications, administrative, procurement, and contractor support across more personnel; and
- splitting interagency and international planetary defense portfolios across two positions.

PDCO officials discussed this assessment with SMD and PSD leadership in March 2024, but no actions had been taken on it as of January 2025. According to one PSD official, the division wants to upgrade the Planetary Defense Officer position to Senior Level and said the position's responsibilities are equivalent to this increased authority. However, this official stated that positions waiting to be elevated elsewhere in SMD take precedence. NASA's PSD leadership team has shifted in the past year and officials stated

[36] Mars Sample Return aims to return Martian geological samples to Earth for scientific study. The first part of that mission is the Perseverance rover, which is currently operating on Mars and collecting samples on the planet's surface.

[37] NPR 7120.5F.

[38] The executives who serve in NASA's Senior Level positions are critical technical leaders, like Center and Program Chief Engineers, and Launch Directors.

they are working on a plan to get the division through new administration priorities against the backdrop of an overall executive branch hiring freeze.

The OTPS and PDCO assessments attempted to help reform NASA's planetary defense activities to meet demands from the PDCO's growing responsibilities. We found evidence of similar findings across our review of conference papers, scientific white papers, Agency documents, industry articles, and peer-reviewed literature. For example, the Government Accountability Office's (GAO) *Standards for Internal Control in the Federal Government* states management should use quality information to make informed decisions and evaluate an entity's performance in achieving key objectives and addressing risks.[39] These standards also note that management should communicate quality information down and across reporting lines to enable personnel to perform key roles in achieving objectives. SMD could use draft conclusions of the OTPS assessment until it, or another independent assessment, is finalized and released. With independent insight, NASA officials that have an ability to make organizational changes will be more informed as to the risks facing the PDCO and mitigate the challenges to meeting its planetary defense strategic goals.

Planetary Defense at NASA Could Benefit from Program Structure Elements

Within SMD, the PDCO has a hybrid, or unconventional, structure as compared to other programs that manage flight projects, according to NASA management. The PDCO operates with a small flexible team without some of the typical policy and procedure requirements placed on more standard program offices. However, the PDCO is also disadvantaged by residing outside of some of the established processes found in NASA policy documents for program and project management.[40] It is these processes that could help the PDCO to communicate with decision-makers on how it can best accomplish mission objectives.

For example, we found that many program management aspects as described by Agency policy directives and procedural requirements are already found in various PDCO budgetary and strategic planning documents. These procedural requirements are an established process by which NASA formulates and implements programs and projects consistent with the governance model described in NPD 1000.0C and NPD 7120.4E and provide a standard of uniformity in managing programs and projects at NASA. These principles state that programs are best managed based on a phased life cycle with key decision points, supported by management and independent reviews, all of which is documented in evolving principal documents.

Further, formulating a program plan document such as the one described in NPR 7120.8A could help to capture PDCO practices. That program plan includes goals, objectives, and metrics; stakeholders and external partners; management structures; program requirements, schedules, milestones, resources, costs, and reviews; and budget and acquisition strategy. Moreover, it would be a helpful tool to communicate PDCO plans, risks, grantee requirements, and other critical information with stakeholders and independent reviewers. The PDCO has requested periodic independent reviews, including as part of the NASA Planetary Defense Strategy and Action Plan, and moreover is a policy for NASA programs.

[39] GAO, *Standards for Internal Control in the Federal Government* (GAO-14-704G, September 10, 2014).

[40] NPD 1000.0C, *NASA Governance and Strategic Management Handbook* (January 29, 2020); NPD 7120.4E, *NASA Engineering and Program/Project Management Policy* (June 26, 2017); NPR 7120.5F; and NPR 7120.8A, *NASA Research and Technology Program and Project Management Requirements (Revalidated w/change 5)* (September 14, 2018).

In our judgement, without a PDCO organizational structure commensurate with the mission's expanded responsibilities, it is more challenging for NASA to have the effective and efficient planetary defense operation needed to achieve its planetary defense strategic goals.

NASA's Planetary Defense Strategy and Action Plan Does Not Fully Address Leading Interagency Collaboration Practices

The NASA Planetary Defense Strategy and Action Plan was created in response to the 2023 Planetary Defense Strategy. We compared the NASA Planetary Defense Strategy and Action Plan to GAO's leading collaboration practices in achieving important interagency outcomes.[41] The leading practices are (1) define common outcomes, (2) clarify roles and responsibilities, (3) identify and sustain leadership, (4) develop and update written guidance and agreements, (5) bridge organizational cultures, (6) leverage resources and information, and (7) ensure accountability (see Table 6 for a description of the implementation steps). While our assessment indicated the NASA Planetary Defense Strategy and Action Plan largely met many of the leading collaboration practices, some strategic goals within that plan could be improved by fully implementing these practices.

[41] GAO, *Government Performance Management: Leading Practices to Enhance Interagency Collaboration and Address Crosscutting Challenges* (GAO-23-105520, May 24, 2023). These leading practices are also related to provisions of the GPRA Modernization Act of 2010, Pub. L. No. 111-352 (2011).

Table 6: Leading Practices to Enhance Interagency Collaboration and Address Crosscutting Challenges

Leading Collaboration Practices	Implementation Steps
1. Define common outcomes	• Crosscutting challenges or opportunities are identified • Short- and long-term outcomes are clearly defined
2. Clarify roles and responsibilities	• Roles and responsibilities of each participant are clarified • Relevant participants are included with the knowledge, skills, and abilities to contribute • Process for making decisions has been agreed upon
3. Identify and sustain leadership	• Lead agencies or individuals have been identified • If leadership will be shared between one or more agencies and offices, roles and responsibilities between them are clearly identified and agreed upon • Sustained leadership over the long term has been decided
4. Develop and update written guidance and agreements	• Agreements regarding the collaboration are documented, if appropriate • Ways to continually update, reassess, or monitor guidance and written agreements have been developed
5. Bridge organizational cultures	• Strategies to build trust among participants have been developed • Participating agencies and offices have established compatible policies, procedures, and other means to operate across agency and office boundaries • Participating agencies have agreed on common terminology and definitions
6. Leverage resources and information	• Determination made for how the collaboration will be resourced through staffing and funding • Methods, tools, or technologies to share relevant data and information are being used to measure or assess progress toward each goal
7. Ensure accountability	• Ways to monitor, assess, and communicate progress toward short- and long-term outcomes exist • Collaboration-related competencies or performance standards have been established against which performance can be evaluated

Source: NASA OIG analysis of GAO's leading collaboration practices.

There are two planetary defense strategic goals outlined in the NASA Planetary Defense Strategy and Action Plan that applied the leading collaboration practices less effectively than the others (see Table 7). Specifically, improving organization of NASA's planetary defense activities and enhancing strategic communications related to planetary defense lack ways to bridge cultures, leverage resources and information, and ensure accountability. Ensuring that all of NASA's planetary defense strategic goals are consistent with the leading practices would help the Agency increase participation, articulate the staffing and funding resources needed, and set measurable goals to assess progress toward both NASA and national planetary defense strategic goals. Moreover, we found some leading practices could use more consistent application to all of NASA's planetary defense strategic goals.

Table 7: Application of Leading Collaboration Practices to NASA's Planetary Defense Strategic Goals

NASA Plantary Defense Strategic Goal	Practice 1: Define Common Outcomes	Practice 2: Clarify Roles & Responsibilities	Practice 3: Identify & Sustain Leadership	Practice 4: Develop & Update Written Guidance & Agreements	Practice 5: Bridge Organizational Cultures	Practice 6: Leverage Resources & Information	Practice 7: Ensure Accountability
1. Enhance NEO detection, tracking, and characterization	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Partially Meets
2. Improve NEO modeling, predicting, and information	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets
3. Develop NEO reconnaissance, deflection, and mitigation technologies	Fully Meets	Fully Meets	Fully Meets	Partially Meets	Partially Meets	Partially Meets	Partially Meets
4. Increase NASA contributions to international cooperation	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets
5. Coordinate and strengthen emergency procedures and protocols	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets	Fully Meets
6. Improve NASA contributions to interagency coordination	Fully Meets	Fully Meets	Partially Meets	Fully Meets	Partially Meets	Partially Meets	Fully Meets
7. Improve organization of NASA's planetary defense activities	Fully Meets	Fully Meets	Fully Meets	Partially Meets	Partially Meets	Does Not Meet	Does Not Meet
8. Enhance planetary defense communications	Fully Meets	Fully Meets	Partially Meets	Fully Meets	Partially Meets	Fully Meets	Does Not Meet

Source: NASA OIG analysis of Agency data.

Our analysis found gaps within NASA's Planetary Defense Strategy and Action Plan for the following leading collaboration practices:

Identify and Sustain Leadership (Practice 3). NASA assigned primary and secondary roles to offices within the Agency to lead or support specific NASA planetary defense strategic goals (as noted previously in Table 2). However, officials from two offices identified in the NASA Planetary Defense Strategy and Action Plan told us lead and support roles should be modified or switched. We also found in these discussions, and in a review of documents, that while NASA identified lead and supporting offices to meet the goals, there was not always an assignment to specific officials responsible within each office. Some offices were unaware of their roles in meeting the goals or did not know who in the office was responsible for achieving the goals themselves.

Develop and Update Written Guidance and Agreements (Practice 4). PDCO, in cooperation with NASA's Office of International and Interagency Relations, developed interagency and international cooperation activities for planetary defense. However, these arrangements can be informal and slow to develop. NASA has memorandums of understanding with the Department of Energy, National Science Foundation (NSF), and the United States Space Force for planetary defense activities that are non-binding agreements.[42] The National Aeronautics and Space Act provides NASA the authority to enter into interagency agreements—more detailed agreements with federal (also state and local) agencies where funds, or no funds, are exchanged between the parties.[43] These agreements constitute a formal statement of understanding between NASA and the other agency requiring a commitment of NASA resources (including funds, goods, services, facilities, or equipment) to accomplish stated objectives.

Bridge Organizational Cultures (Practice 5). We found NASA did not sufficiently build trust among all participants or establish procedures that cross boundaries. Specifically, OTPS never released their independent assessment of the PDCO that aimed to improve the organization of planetary defense

[42] A non-binding agreement is a formally documented understanding between two or more parties which may describe or anticipate the provision of goods and services, but which is not legally binding and has no legal effect.

[43] Enactment of Title 51—National and Commercial Space Programs, Pub. L. No. 111-314 (2010).

activities. In another example, NASA officials told us no metrics exist to track progress made toward their office's NASA Planetary Defense Strategy and Action Plan responsibilities and that some should be developed. Officials in another office told us they were unaware of who—in their office or at the PDCO—is responsible for their tasked goals and tracking them. More needs to be done to increase transparency and build trust by ensuring offices in the strategy and action plan follow through on their responsibilities to provide all decision-makers with relevant information.

Ensure Accountability (Practice 7). The leading collaboration practices state goals should be in quantifiable and measurable formats, with a mechanism to routinely assess the progress made toward achieving the goal over time. Specific to planetary defense at NASA, an example of an effective goal under this leading practice using a measure, target, and time frame is to "find 90 percent of NEOs 140 meters in diameter or larger by 2020." However, a less effective example lacking these characteristics is to "increase NASA contributions to international cooperation on NEO preparation." The latter goal provides no mechanisms to measure progress against a target or within a time frame.

We found little to no mechanisms exist for NASA officials to monitor, assess, or communicate progress with four of the NASA Planetary Defense Strategy and Action Plan strategic goals: enhance NEO detection, tracking, and characterization capabilities (Goal 1); develop technologies for NEO reconnaissance, deflection, and disruption missions (Goal 3); improve organization of NASA's planetary defense activities (Goal 7); and enhance NASA's strategic communications related to planetary defense (Goal 8). When we discussed these goals with Agency officials, they agreed that many were ambiguous, and they were unsure how the goals could be measured or tracked. Ultimately, the PDCO may have difficulty assessing and evaluating goals without mechanisms that quantify and measure progress made toward their completion.

NASA's strategy and action plan lists several tasks the PDCO already accomplishes as part of its routine activities. This was especially true for goals with action items listed under them that begin with "continue to." As discussed earlier, we found that descriptions of routine activities correspond with many aspects of NASA's program management as described by policy directive documents. Routine activities do not meet accountability criteria of being a measurable goal with which to assess progress.

We believe NASA would be challenged to apply all the leading collaboration practices to the planetary defense strategic goals because of PDCO's governance structure. Specifically, the PDCO does not have the necessary staffing and capacity to oversee all technical, administrative, oversight, networking, coordinating, and progress tracking for the 42 action items described within the 8 planetary defense strategic goals (see Appendix C for a complete list of the 42 action items and the offices with lead and support roles in the NASA Planetary Defense Strategy and Action Plan). Moreover, as we noted earlier, the PDCO does not follow some essential NASA processes for effective program management. There is a risk that the lack of communication from the PDCO about the goals will result in reduced investments from stakeholders to complete the goals or that goals could be overlooked entirely and not achieved.

Funding Concerns and Lack of Detailed Plans Affect Long-Range Planetary Defense Strategic Goals

Over the course of our review, we received conflicting information from NASA officials as to whether there was a cohesive and long-term strategy with sufficient details to allow for the planning, funding, and development of future planetary defense missions. The PDCO is challenged to provide a viable strategy without clarity on what SMD's future funding levels will look like. Conversely, it is challenging for SMD management to describe future funding levels in the current fiscal environment without supporting details from the PDCO on what a long-term strategy would entail. Ultimately, current budget projections show a potential drop in total planetary defense funding after the projected launch of NEO Surveyor in 2028. It may be harder for NASA to garner support for future planetary defense missions without all levels of management in SMD and PSD agreeing upon a long-range, detailed, and sustainable strategy.

Lack of Funding and Detailed Plans Impact Development of Sustainable Planetary Defense Strategy

One of the strategic goals in the NASA Planetary Defense Strategy and Action Plan is to improve organization of NASA's planetary defense activities. The plan states that for NASA to effectively implement its planetary defense strategy, the Agency should formulate a stable "program of record" that features continued support for existing and planned survey and mitigation efforts to enable the long-term development of planetary defense capabilities. Toward this end, we found PDCO officials drafted plans in September 2023 to better posture the office financially for success in meeting the planetary defense strategics goals over the next decade. Officials also developed their annual budget funding plans in May 2024 that showed how to achieve the goals through FY 2030. While both documents provided preliminary funding recommendations to support the strategy, their approval hinges upon PSD budgetary constraints and the ability to gain support from key stakeholders internal and external to SMD. Furthermore, these preliminary plans lack the detail needed to move them forward.

According to a recent National Academies report, a roadmap should represent a flexible, evolving plan that describes what NASA seeks to achieve under strategic objectives stated in a strategic plan over a 20-year or longer time frame.[44] Plans lacking these characteristics may make it more difficult for NASA officials to justify a sustainable planetary defense program and gain funding for a cadence of planetary defense missions following NEO Surveyor. It may also affect the Agency's ability to fund the PDCO at adequate levels to conduct a robust planetary defense program and maintain programmatic balance, as recommended by both the 2023 decadal survey and the Small Bodies Assessment Group.[45] Similarly, Congress has emphasized the importance of prioritizing resources effectively and encouraged NASA to explore funding mechanisms that balance scientific exploration with budgetary constraints.

National Academies Roadmap Definition

A flexible, evolving plan sufficiently detailed to

- define time-based milestones for each objective;
- forecast activities and new technologies needed to meet these milestones; and
- identify mission directorates and centers that oversee, manage, and execute the activities needed to meet those milestones.

Ultimately, budget constraints and uncertainty and staffing challenges inhibit developing concrete, long-range plans and hurt the planetary defense mission. At the same time, we recognize limited funding within a competitive SMD portfolio, that is likely going to be more competitive and challenging in future years, affects PDCO officials' ability to create sustainable plans. Combined with the staffing and organizational challenges previously described, PDCO officials are challenged to develop the concrete

[44] National Academies, *NASA at a Crossroads: Maintaining Workforce, Infrastructure, and Technology Preeminence in the Coming Decades* (2024).

[45] National Academies, *Decadal Strategy for Planetary Science and Astrobiology 2023-2032*, and Small Bodies Assessment Group, *Goals and Objectives for the Solar System's Small Bodies*.

details SMD leadership is looking for. Without support from management, funding cannot be given for new planetary defense missions. Likewise, it is harder for leadership to prioritize and justify greater funding levels without a roadmap to base their decisions.

NASA Faces Potential Planetary Defense Funding Shortfall After NEO Surveyor's Launch

NASA's NEO survey efforts were not adequately funded to ensure 2005 Survey Act requirements—identification of 90 percent of NEOs 140 meters in diameter or greater—would be achieved by 2020. The Agency missed the deadline despite public support for planetary defense, congressional direction, multiple National Academies studies, and a national plan for a planetary defense strategy across the federal government. NASA is currently supporting NEO Surveyor and committed to funding the project in November 2022. However, the Agency's inability to build a sustainable program of record affects the ability to fund planetary defense missions after NEO Surveyor is launched in 2028. Specifically, current budget projections depict a significant drop in planetary defense funding after FY 2027.

NASA risks not launching any new planetary defense space flight missions after NEO Surveyor given current budgetary projections. This is despite the scientific community urging the Agency to conduct a rapid-response, flyby reconnaissance mission targeted to a NEO with the highest probability of a destructive Earth impact.[46] Other mission opportunities include preparing orbital deflection demonstrations and launching a cadence of missions every 2 years to achieve both planetary defense and NEO science objectives. Without any new missions, planetary defense funding would remain flat beginning in FY 2028 with only the funds needed to support the NEO Observations Program and NEO Surveyor's continued operation (see Figure 3).

[46] National Academies, *Decadal Strategy for Planetary Science and Astrobiology 2023-2032*.

ACTIONS NEEDED TO ADDRESS ROLE OF GROUND-BASED ASSETS IN THE FUTURE OF ADVANCED SURVEYS

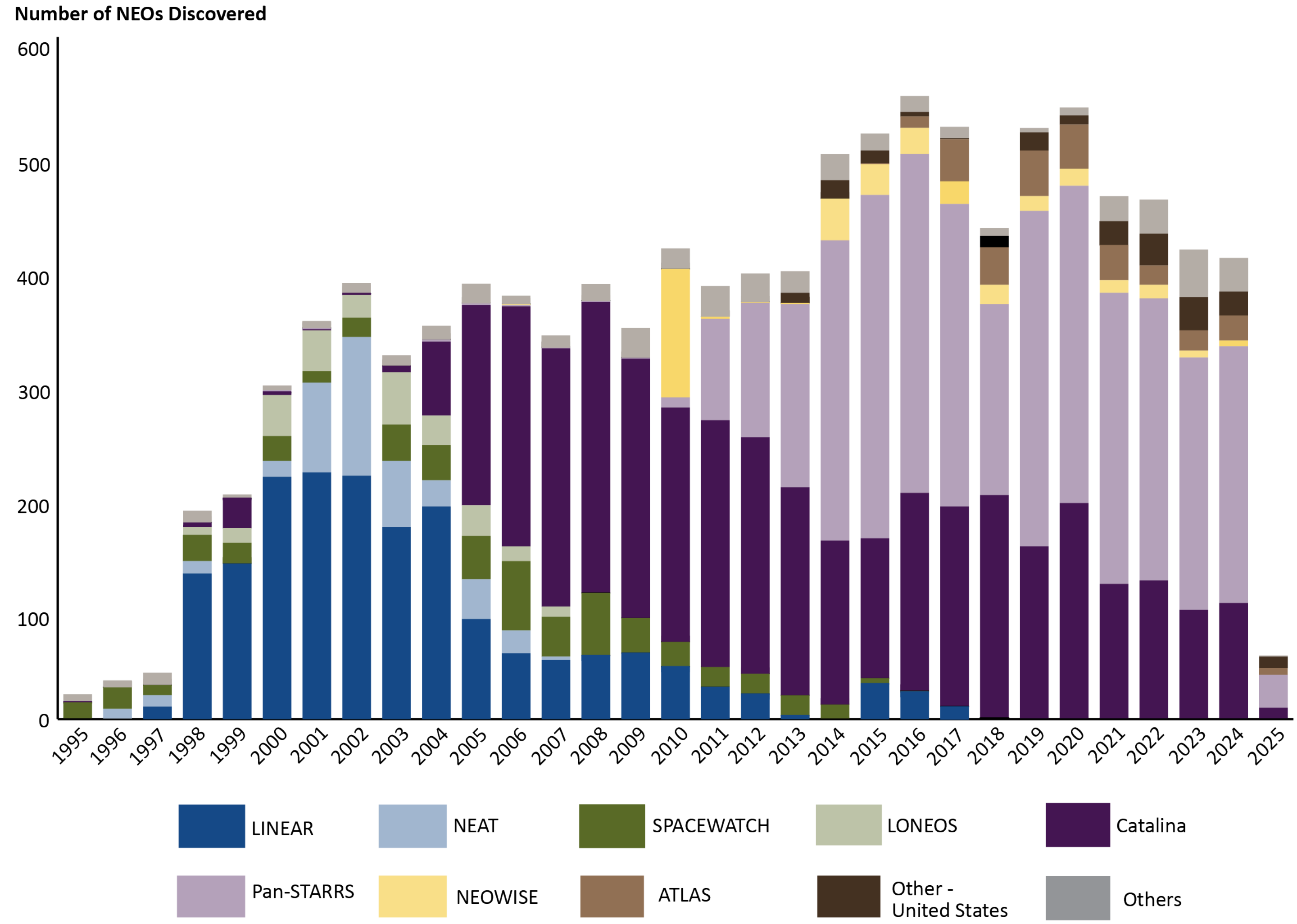
NASA leverages several ground-based observatories to meet its planetary defense mission. The Agency is approaching an era of advanced NEO surveys as new observatory assets come online. The current network of older ground-based observatories can still play an important role, and planning is required to ensure they are integrated into the work that will be performed by two upcoming observatories—NEO Surveyor and the Vera C. Rubin Observatory.[47] These two observatories are expected to find and track a lot more NEOs than current capabilities, which will likely mean a substantial increase in necessary characterizations and follow-up observations. Moreover, ongoing Deep Space Network (DSN) oversubscription concerns, deferred maintenance, and deep space radar capability needs pose additional threats.

Inadequate Infrastructure Planning May Create Detection Challenges

Ground-based telescopes, such as the Catalina Sky Survey and Pan-STARRS observatories, discovered 97 percent of the total detected NEOs 140 meters in diameter or greater. However, Center for NEO Studies data shows detection rates for new NEOs have slightly declined—from finding nearly 500 in 2014 to about 400 in 2024 (see Figure 5). Observatory officials told us the number of new discoveries at any time varies depending on factors such as facility age, weather, maintenance issues at the observatories, and their capability to detect some portions of the population of NEOs during their orbits.

[47] The Vera C. Rubin Observatory, or Rubin Observatory, is a new astronomical observatory on top of the Cerro Pachón ridge in Chile that will survey the Southern Hemisphere sky for 10 years. NSF and the Department of Energy, Office of Science jointly fund the Rubin Observatory—forecast to begin operations in 2025.

Figure 5: Number of NEOs 140 Meters in Diameter and Greater Discovered by Survey 1995 to 2025 (as of April 2025)



Source: NASA OIG presentation of data from JPL's Center for NEO Studies.

Note: Lincoln Near-Earth Asteroid Research (LINEAR), Near-Earth Asteroid Tracking (NEAT), Lowell Observatory Near-Earth Object Search (LONEOS), Catalina Sky Survey (Catalina), Panoramic Survey Telescope and Rapid Response System (Pan-STARRS), Near-Earth Object Wide-Field Infrared Survey Explorer (NEOWISE), and Asteroid Terrestrial-Impact Last Alert System (ATLAS).

Aging Observations Infrastructure Creates Detection Challenges

The average age of assets NASA uses for NEO surveys is over 21 years old. For example, Catalina Sky Survey dates their first of several telescopes in Arizona's Catalina Mountains to 1962, which was upgraded to search for NEOs in 1999, and became the most productive NEO survey in the world by 2005. However, at least two of the observatories have experienced, or need, instrument repairs and updates to maintain their current NEO detection rates.

We spoke with six officials from two observatories who noted multiple deferred maintenance issues that impacted NEO detection and follow-up capabilities. For example, Pan-STARRS has two old cameras that need to be replaced to be more effective. Additionally, some highly specific spare parts are no longer available or supported by manufacturers, which makes it difficult to maintain an observatory with infrastructure that is over 15 years old. These telescopes are also affected by an aging workforce where it is challenging to recruit and replace the unique skill sets required to perform the observations and the advanced technical maintenance of the observatories. For example, Catalina Sky Survey officials said many staff in their small workforce may retire soon and that grant funding is not structured to provide on-the-job training for future employees.

Limited Interagency Progress Made Toward Enhancing Planetary Defense Capabilities

The Small Bodies Assessment Group found that shared-use research facilities provide significant benefits to the planetary defense community. However, the coordination required by multiple federal agencies to use these facilities poses a challenge to planetary defense both in terms of development and maintenance. The National Academies found that while NSF supports ground-based observing infrastructure, NASA is responsible for leading key planetary defense objectives.[48] We are concerned that NASA and NSF have not sufficiently planned and coordinated on continued maintenance and workforce risks to ensure ground-based observatories, that are important capabilities for planetary defense, will be available in the future.

Additionally, it is unclear what role the current network of ground-based observatories will play after NEO Surveyor and the Rubin Observatory enter operation. Current ground-based observatory officials and a planetary defense expert described uncertain plans for integrating these observatories into an operating environment that will include NEO Surveyor and the Rubin Observatory. Nevertheless, coordination will be necessary to ensure efficient and effective integration of existing observation capabilities.

Observatory officials have an idea of how ground-based observatories could complement these future telescopes and have taken some steps to prepare, but it remains to be seen how they will be funded and what role they should expect to perform. For example, the role of existing observatories could include an additional focus on their current ability to do rapid follow-up observations to refine orbits of new NEO discoveries from NEO Surveyor and the Rubin Observatory. The importance of refining orbits was shown in the recent potential threat from the asteroid 2024 YR4. As we noted earlier, follow-up observations of the asteroid, including calculations of its orbit, were conducted. Although the asteroid is rapidly moving away from Earth, larger ground-based observatories were able to see it for several months following the initial observation.

Future NEO Characterization Plans Needed to Meet Planetary Defense Strategic Goals

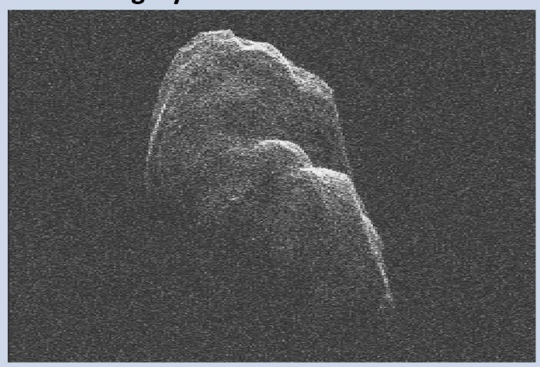
Characterization—determining the physical properties of NEOs—is critical to fully understanding impact hazards. After asteroids are detected, their orbits and physical properties need to be determined and

[48] National Academies, *Decadal Strategy for Planetary Science and Astrobiology 2023-2032*.

the objects monitored to the extent possible. When a NEO is discovered, the initial observations can typically be used to derive an approximate orbit. However, follow-up observations are required to refine the orbit and more accurately predict the NEO's position in the future.

After the initial survey and discovery of a NEO, dedicated follow-up observations are crucial to improving data on the objects' orbits and providing information on their physical properties. After NEO Surveyor and the Rubin Observatory both enter service, additional NEO characterization efforts will be needed to meet the expected ten-fold increase in the number of NEOs detected. Radar observations help provide scientists with data about an asteroid's shape, size, spin, and surface composition. Data obtained through NEO radar observations routinely reduces the orbital uncertainties after only a few minutes of observation, preventing the loss of newly discovered objects and the need for their subsequent rediscovery. This precision also enables radar to accurately predict NEO to Earth encounters up to 400 years into the future.

Radar Imagery of Asteroid Toutatis



Data from the Goldstone Solar System Radar created this image of asteroid Toutatis in 2012.

Source: NASA/JPL-Caltech.

The Goldstone Solar System Radar (Goldstone) is a key facility for ground-based planetary radar observations. Goldstone operates the DSN's 70-meter Deep Space Station 14 (DSS-14) and 34-meter DSS-13 antennas, which are fully steerable and can transmit signals. The DSS-14 is the primary radar used for asteroid and lunar studies, while DSS-13 can be used as a less capable backup. Goldstone is currently the primary facility for NEO radar observations and other planetary bodies after the NSF's Arecibo Observatory's 305-meter telescope collapsed in December 2020 from a lack of maintenance, inspection, and repair.[49] Ground-based radar observations such as those from Goldstone can create images of asteroids. However, oversubscription of the DSN—meaning more time is requested by missions than the network's current capacity can provide—and required maintenance of the DSS-14 antenna may impact future NEO observations and characterization.

DSN's primary mission is spacecraft communication rather than radar observations of solar system objects. It is the only asset that can currently provide communications with spacecraft in deep space, such as NASA's Lucy and Psyche missions.[50] Therefore, the DSN is only available to characterize about 40 to 60 NEOs per year as planetary defense missions compete with other missions for time. Access to the DSN for radar observations may be further limited by growing demands and potential overburdening from future spacecraft missions, including Artemis.[51] Exacerbating the situation is that DSS-14's planned

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[49] The Arecibo Observatory in Puerto Rico had the world's second-largest single-aperture radar telescope at 1,000 feet (305 meters) in size until its sudden collapse on December 1, 2020. The NSF facility was completed in 1963 and used mainly for research in space sciences, atmospheric sciences, and radio and radar astronomy.

[50] Launched in October 2021, Lucy will flyby three asteroids in the solar system's main asteroid belt and by eight Trojan asteroids that share an orbit around the Sun with Jupiter. Launched in October 2023, Psyche will study a metal-rich asteroid located in the main asteroid belt between Mars and Jupiter.

[51] NASA's Artemis campaign will establish a robust human-robotic presence on and around the Moon. Artemis I, launched in November 2022, was an uncrewed test flight for the Space Launch System rocket and Orion Multi-Purpose Crew Vehicle. Future flights include Artemis II, which will fly four astronauts to the Moon's orbit and back while Artemis III will dock with the prepositioned Human Landing System Starship that two astronauts will use to travel to the lunar surface.

2-year maintenance window is from 2026 through 2028. During this time, the antenna will have no observation capability, which will impact NASA's ability to characterize NEOs. DSS-13 also has maintenance and other risks that may impact its planetary defense capability in the near future.

In 2023, NASA funded a study conducted by the Aerospace Corporation to explore NASA's, NSF's, and potentially other government organizations' needs for a future deep space radar facility.[52] This study concluded that a national deep space radar facility composed of a large array of transmitters and receivers could help meet multiple stakeholders' needs and planetary defense objectives. However, barriers exist to implement this solution, including each agency's competing priorities, processes, and future budget uncertainties. Furthermore, NASA does not develop ground-based facilities and NSF does not develop facilities for planetary defense. This new radar facility would require close interagency coordination for sharing responsibilities, costs, priorities, and schedules. While there are areas of significant overlapping needs between many missions and stakeholders, no actions have been taken for a new radar facility since the 2023 study was released.

Deep Space Network Data Loss Risks Could Harm Future Planetary Defense Efforts

The DSN will allow NEO Surveyor's Mission Operations System at JPL to receive telemetry data and send uplink commands to the NEO Surveyor spacecraft.[53] Compressed, encoded survey and engineering data will be downlinked (transmitted) from NEO Surveyor to a DSN 34-meter antenna. It will take on average 120 minutes to transmit the data from NEO Surveyor to the antenna, which will occur on average every 20 to 24 hours.

DSN oversubscription and utilization was a concern during the NEO Surveyor project's Preliminary Design Review. The Standing Review Board voiced concern that higher priority missions may result in the DSN being oversubscribed, which could lead to a loss of data if NEO Surveyor is unable to transmit data to the DSN and there is insufficient data storage onboard the spacecraft. Although DSN officials told us there are no concerns about transmitting NEO Surveyor's data back to Earth, NEO Surveyor project officials remain concerned about data transmission.

Although NEO Surveyor's solid-state drive—where data is stored until it can be downlinked—can hold approximately 4 days of survey data, project officials stated DSN availability will be a concern, especially when future Artemis crewed missions launch. One of the project's DSN oversubscription risk mitigation strategies include the prospective addition of NASA Lunar Exploration Ground Sites—consisting of a series of antennas located at three sites around Earth—that are planned to be in service in 2026. However, in 2024, we reported that upgrades to the Near Space Network antenna at the White Sands Complex in Las Cruces, New Mexico (the first Lunar Exploration Ground Site), were over budget and behind schedule.[54]

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[52] The Aerospace Corporation, *Cross-Disciplinary Deep Space Radar Needs Study* (July 17, 2023). The Aerospace Corporation is an independent, nonprofit corporation that performs objective technical analyses and assessments for government, civil, and commercial customers.

[53] Telemetry data is information transmitted to Earth via radio signals from spacecraft. The DSN acquires, processes, decodes, and distributes this data.

[54] NASA OIG, *Audit of the Nancy Grace Roman Space Telescope Project* (IG-24-014, July 31, 2024). The Near Space Network provides missions within one million miles of Earth with communication services using government and commercial assets.

We also reported in 2023 that the DSN is operating at capacity, with demand sometimes exceeding supply by as much as 40 percent.[55] This amount is expected to grow as more NASA missions come online with more data to transmit. As demands for DSN support increase dramatically in the coming decade, future unmet demand could result in very large data volume shortfalls. NEO Surveyor's project management team is operating under the assumption that existing DSN service agreements represent a commitment of DSN resources. Based on our reporting, this may be an underestimation of the risk.

[55] NASA OIG, *Audit of NASA's Deep Space Network* (IG-23-016, July 12, 2023).

Apophis Is an Important Opportunity for NASA to Increase Support for Planetary Defense

The close approach of the asteroid Apophis in April 2029 is an exceedingly rare event in terms of asteroid size and Earth proximity, occurring roughly once every 7,500 years. It will pass within Earth's belt of geosynchronous satellites (less than 20,000 miles above Earth) and is 370 meters (405 yards) wide. Although Apophis was identified as one of the most hazardous asteroids that could impact Earth, astronomers have since ruled out an impact for the next 100 years. It has the potential destructive power to take out a metropolitan area. At closest approach, Apophis will be visible with the naked eye or binoculars over Europe, Africa, and Western Asia. While NASA is exploring preliminary missions to the asteroid, limited-funded plans exist to take advantage of this rare event as time is running out before Apophis approaches Earth.

As of May 2025, NASA planned to visit Apophis by reusing the Origins, Spectral Interpretation, Resource Identification and Security – Regolith Explorer, which returned to Earth its primary mission payload—a capsule with material from the asteroid Bennu—in September 2023. Renamed Origins, Spectral Interpretation, Resource Identification and Security – Apophis Explorer (OSIRIS-APEX), it is not a PDCO mission, but planetary defense knowledge could be gained from the mission's science objectives. This spacecraft is expected to rendezvous with Apophis in June 2029—3 months after the asteroid passes Earth. The mission is facing programmatic challenges, including descoped operations and insufficient funding for FYs 2026 through 2028. Budget cuts as proposed in the FY 2026 budget request, could affect NASA's ability to achieve this mission's science objectives to examine the properties of a potentially hazardous asteroid that could help inform planetary defense strategies and knowledge.

Artist's Impression of OSIRIS-APEX Studying the Surface of Apophis

Source: NASA Goddard Space Flight Center Conceptual Image Lab.

While OSIRIS-APEX is scheduled to rendezvous with Apophis *after* its close encounter with Earth, planetary research scientists have stated there are benefits to studying the asteroid *before* it flies by Earth. As such, the European Space Agency has begun planning for a spacecraft reconnaissance mission to rendezvous with Apophis as it approaches Earth to study the asteroid's composition. Observations of Apophis leading up to and through its 2029 close approach to Earth offer a unique opportunity for multiple observatories to coordinate simultaneous pre- and post-encounter observations to better understand potential changes in its surface and spin state.

NASA is exploring other innovative, low-cost, and rapidly developed mission options for Apophis that have not yet materialized. Budget concerns and the short time frame for a mission prevent a traditional NASA mission from occurring. Moreover, the United Nations declared 2029 as the International Year of

Asteroid Awareness and Planetary Defense. This could help inspire international partnerships and coordination efforts. Much like the success of the Double Asteroid Redirection Test, an Apophis mission could increase popularity and coverage for planetary defense. Meeting or missing this moment is more than an opportunity to advance planetary defense capabilities and NEO understanding, it could be a goodwill branding benchmark for NASA and the Agency’s planetary defense efforts.

CONCLUSION

The public, both in the United States and abroad, rely on NASA's vast planetary defense mission to protect against potentially devastating asteroid and comet impacts. The Agency has taken important steps in recent years toward this end, such as committing funding to NEO Surveyor and issuing NASA's first Planetary Defense Strategy and Action Plan.

However, issues exist that could impact the Agency's ability to achieve the planetary defense strategic goals outlined in its plan. These challenges include navigating an uncertain budget and funding, competing planetary science missions and goals, an inadequate management structure and resources, not fully addressing leading interagency collaboration practices, and a lack of detailed long-range plans for planetary defense. Additionally, NASA must address issues related to the integration of existing ground-based observatories into the work that will be performed by upcoming advanced NEO surveys, like the NEO Surveyor, as well as DSN oversubscription concerns and deep space radar capability needs. Ultimately, planetary defense has reached a point of significant change and opportunity, with Apophis and the era of advanced asteroid surveys approaching. NASA could do more to ensure the Agency positions itself to take advantage of these critical moments.

Recommendations, Management's Response, and Our Evaluation

Although there are many unknowns regarding NASA's science budget in the upcoming years, to continue NASA's significant progress in planetary defense, we recommended the Associate Administrator for Science Mission Directorate:

1. Commit to providing stable funding levels for the NEO Surveyor mission to reduce the risk of further launch delays, as required by the National Aeronautics and Space Administration Authorization Act of 2022. Conversely, if NASA must prioritize other missions, the Agency should promptly inform Congress, to include the congressionally mandated annual reporting requirement for the PDCO.
2. Work within the construct of NASA and NSF's memorandum of understanding to develop a plan, and an interagency agreement if needed, to assess how current ground-based observatories can prepare for NEO detection, follow-up, and characterization efforts when future advanced survey assets are in operation.
3. Develop a detailed strategy and long-range roadmap for a sustainable planetary defense program.

To ensure planetary defense strategic goals are met, we recommended the Director of the Planetary Science Division:

4. Leverage the draft OTPS report and completed PDCO assessment, as well as lessons from the applied science programs, to develop an appropriate governance structure for PDCO within PSD using the principles of NPD 7120.4E and NPRs 7120.5F or 7120.8A as guidance.
5. Update NASA's planetary defense strategy to address missing leading collaboration practices including processes to identify and assign metrics, track progress, and forecast sufficient resources to meet time-based milestones and monitor the collaboration.
6. Review DSN service agreements to ensure they meet NEO Surveyor's telemetry and transmission requirements and adjust as needed.

We provided a draft of this report to NASA management who concurred or partially concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

Management's comments are reproduced in Appendix D. 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.

Robert Steinau

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Date: 2025.06.23 13:50:33 -04'00'

Robert H. Steinau
NASA OIG Senior Official

Appendix A: Scope and Methodology

We performed this audit from June 2024 through May 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.

The scope of this audit included assessing NASA's implementation and management of the Agency's planetary defense strategy. Specifically, we determined the state of planetary defense at NASA and what progress the PDCO made toward achieving NASA's planetary defense strategic goals since 2016. We also assessed the extent to which NASA is managing the goals and challenges of finding, tracking, and characterizing NEOs; modeling and predicting potential threats; mitigating impact hazards by deflection or other means; and coordinating scientific and operational readiness of planetary defense globally.

We evaluated the extent to which NASA faces additional opportunities and challenges in meeting its planetary defense strategic goals. To help us assess the progress made in meeting these goals, we used our professional judgement to apply collaboration criteria. We found GAO's *Leading Practices to Enhance Interagency Collaboration and Address Crosscutting Challenges* provided valuable insight and guidance on how agencies, or components in the same agency, could improve collaboration.[56]

We interviewed NASA officials at NASA Headquarters and JPL, including from SMD, PDCO, OTPS, the Office of International and Interagency Relations, the Office of the General Counsel, the Office of Legislative and Intergovernmental Affairs, the Office of Communications, and the Office of the Chief Financial Officer. We also met with a representative from the Federal Emergency Management Agency and interviewed officials from the Minor Planet Center, JPL's Center for NEO Studies, Pan-STARRS, and the Catalina Sky Survey. We reviewed NASA documents, peer-reviewed literature, conference papers, scientific white papers, industry articles, research databases, and technical publications identified by NASA officials, scientists, and other experts to increase our understanding of planetary defense and identify individuals or groups to interview.

To evaluate the NEO Surveyor project's management of its goals and objectives, we reviewed the Project Plan and KDP-C Decision Memorandum that set the Management Agreement and Agency Baseline Commitment budgets and launch readiness milestones for the project's life cycle. To assess the project's progress in managing technical, schedule, and cost risks, we interviewed project personnel and reviewed other relevant documents such as discussions provided in project monthly status reports and independent assessments. We also reviewed project earned value reports and instrument and subsystem development and delivery status to determine whether the project is on track to meeting its projected milestones.

[56] GAO-23-105520.

We reviewed the NEO Surveyor Standing Review Board's concern related to DSN use during the project's Preliminary Design Review and followed up on the project's actions to address this concern. We further reviewed the project's agreement with the DSN and interviewed project officials to understand their concerns.

Finally, we reviewed federal and NASA criteria, policies, procedures, and supporting documentation; prior audit reports; external reviews; and other documents related to planetary defense. The documents we reviewed included, but were not limited to, the following:

- NPD 1000.0C, *NASA Governance and Strategic Management Handbook* (January 29, 2020)
- NPD 7120.4E, *NASA Engineering and Program/Project Management Policy* (June 26, 2017)
- NPR 7120.5F, *NASA Space Flight Program and Project Management Requirements w/Change 4* (August 3, 2021)
- NPR 7120.8A, *NASA Research and Technology Program and Project Management Requirements (Revalidated w/change 5)* (September 14, 2018)
- George E. Brown, Jr. Near-Earth Object Survey Act, as enacted by the National Aeronautics and Space Administration Authorization Act of 2005, Pub. L. No. 109-155 (2005)
- National and Commercial Space Programs, Pub. L. No. 111–314 (2010); Chapter 201 of Title 51 restates the National Aeronautics and Space Act of 1958
- The National Aeronautics and Space Administration Authorization Act of 2022, as enacted by the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022, Pub. L. No. 117-167 (2022)

Assessment of Data Reliability

We used computer-processed data to perform this audit, and that data was used to materially support our findings and recommendations. We relied on data from NASA's Earned Value Management System to track the NEO Surveyor's project progress. We performed additional data quality checks on the earned value data to support our conclusions.

Review of Internal Controls

We assessed internal controls and compliance with laws and regulations necessary to satisfy the audit's objectives per GAO's *Standards for Internal Control in the Federal Government*.[57] Specifically, we assessed internal controls associated with the effectiveness of NASA's implementation and management of the planetary defense strategy. We found Risk Assessment, Control Activities, and Monitoring internal controls components as the most relevant to our assessment.

However, because our audit was limited to the scope to meet our objectives, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit. Internal control weaknesses were identified and discussed in this report. Our recommendations, if implemented, will improve those identified weaknesses.

[57] GAO-14-704G.

Prior Coverage

During the last 11 years, the NASA Office of Inspector General and GAO issued eight reports of significant relevance to the subject of this report. Reports can be accessed at https://oig.nasa.gov and https://www.gao.gov, respectively.

NASA Office of Inspector General

Audit of Nancy Grace Roman Space Telescope Project (IG-24-014, July 31, 2024)

Audit of NASA's Deep Space Network (IG-23-016, July 12, 2023)

NASA's Planetary Science Portfolio (IG-20-023, September 16, 2020)

NASA's Efforts to Identify Near-Earth Objects and Mitigate Hazards (IG-14-030, September 15, 2014)

Government Accountability Office

NASA: Assessments of Major Projects (GAO-24-106767, June 20, 2024)

NASA: Assessments of Major Projects (GAO-23-106021, May 31, 2023)

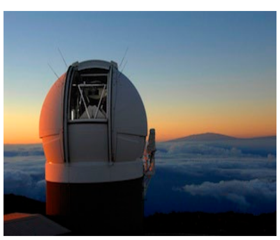
Government Performance Management: Leading Practices to Enhance Interagency Collaboration and Address Crosscutting Challenges (GAO-23-105520, May 24, 2023)

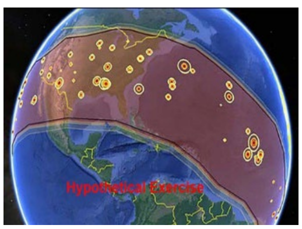
NASA: Assessments of Major Projects (GAO-22-105212, June 23, 2022)

Appendix B: Sample of NASA-Funded Support Organizations and Ground-Based Telescopes

As part of its planetary defense activities, NASA provides funding to multiple organizations and observatories for data and ground-based telescope services. See Table 8 for more information on some of the major organizations, ground-based telescopes, and the roles and responsibilities of each.

Table 8: NASA-Funded Support Organizations and Ground-Based Telescopes

NASA-Funded Organizations and Ground-Based Telescopes		Roles and Responsibilities
Minor Planet Center		The Minor Planet Center designates all minor bodies discovered in the solar system (e.g., comets, asteroids, and natural satellites) and collects, computes, and disseminates astronomical data concerning the positions of these bodies to the worldwide planetary astronomy community. It is fully funded by NASA and hosted by the Smithsonian Astrophysical Observatory in Boston, Massachusetts.
Center for NEO Studies		The Center for NEO Studies is hosted by NASA's JPL and uses data collected on NEOs at the Minor Planet Center for its analyses. It is responsible for computing high-precision asteroid and comet orbits and their potential for impacting Earth to support NASA's PDCO.
Catalina Sky Survey		The Catalina Sky Survey is a NASA-funded NEO discovery project based out of the University of Arizona's Lunar and Planetary Laboratory. Its primary assets consist of two wide-sky-field survey telescopes and one telescope for astrometric follow-up in the Catalina Mountains of Arizona.
Panoramic Survey Telescope and Rapid Response System		Pan-STARRS is a two-telescope system for wide-field astronomical imaging developed and operated by the University of Hawai'i. Located on Haleakala, Maui, NASA provides funds to Pan-STARRS for NEO search and discovery operations.
Asteroid Terrestrial-Impact Last Alert System		The Asteroid Terrestrial-Impact Last Alert System is an asteroid impact early warning system developed by the University of Hawai'i and funded by NASA. It consists of four telescopes (two in Hawaii, one in Chile, and one in South Africa), which automatically scan the entire dark sky every 24 hours for NEOs that could pose a future impact hazard to Earth.

NASA-Funded Organizations and Ground-Based Telescopes		Roles and Responsibilities
Goldstone Solar System Radar		The Goldstone Solar System Radar originated in 1958. It features radar integration and a fully steerable 70-meter dish for high-resolution ranging and imaging of planetary and small body targets, supporting both science objectives and planetary defense. Goldstone is located in Barstow, California, and operated by JPL through NASA DSN funding.
Infrared Telescope Facility		The Infrared Telescope Facility is a 3.2-meter telescope optimized for infrared observations. The observatory is operated and managed for NASA by the University of Hawai'i Institute for Astronomy, located in Honolulu. NASA provides the costs of operation and NSF provides funding for new focal plane instrumentation through the peer review process. Observing time is open to the entire astronomical community, and 50 percent of the facility's observing time is reserved for studies of solar system objects.
Asteroid Threat Assessment Project		The Asteroid Threat Assessment Project, under the NASA Advanced Supercomputing Division at Ames Research Center, leads efforts to model the potential damage and devastation that could occur from a NEO impact. The project's Probabilistic Asteroid Impact Risk model can assess the potential for any given asteroid impact scenario to survive passage through the Earth's atmosphere and produce destructive effects at any selected point on the Earth's surface within a range of possible outcomes driven by the uncertainties in initial conditions.

Source: NASA OIG analysis and presentation of Agency information.

Appendix C: Lead and Support Roles in the NASA Planetary Defense Strategy and Action Plan

The NASA Planetary Defense Strategy and Action Plan includes 8 planetary defense strategic goals and 42 action items to achieve them. Table 9 lists these 8 goals, the actions NASA identified to achieve them, and the relevant NASA organization or office that was identified as recommended to be the lead or support role to meet each action item.

Table 9: Lead and Support Roles in the NASA Planetary Defense Strategy and Action Plan

1. Enhance NEO Detection, Tracking, and Characterization	PDCO	OIIR	STMD	SMD	PSD	OGC	OTPS[a]	OLIA	OCOMM	OCFO	Admin.
1.1 Improve NEO detection by enhancing current data streams	Lead										
1.2 Identify capabilities and opportunities in telescope programs	Lead	Support									
1.3 Enhance multi-agency efforts to detect small and large objects	Lead	Support									
1.4 Identify cislunar space domain awareness capabilities	Lead	Support									
1.5 Support interagency assessment of deep space radar facilities	Lead	Support	Support								
1.6 Inform investments in space domain awareness programs	Lead										
1.7 Advance concepts for rapid characterization of a NEO	Lead										
1.8 Support challenges in NEO survey and characterization	Lead			Support							
1.9 Seek to apply commercial capabilities to planetary defense	Support		Lead								
1.10 Consider strengthening planetary radar partnerships	Lead										
1.11 Consider design for a bolide detector tech demonstration	Lead		Support								
2. Improve NEO Modeling, Prediction, and Information	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
2.1 Support an interagency working group for NEO threat analysis	Lead										
2.2 Ascertain what organizations require for threat analysis	Lead										
2.3 Develop and validate computer simulation tools for NEOs	Lead										
2.4 Improve computer simulation tools for impact scenarios	Lead										
2.5 Develop an impact risk data pipeline to inform decision-makers	Lead										
2.6 Assess validity of modeling and analysis of impact effects	Lead										
3. Develop NEO Reconnaissance, Deflection, and Mitigation Technologies	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
3.1 Collaborate with partners for rapid response technologies	Lead		Support								
3.2 Create plans for NEO reconnaissance mission systems	Support		Support		Lead						
3.3 Develop mission designs for future NEO mission campaigns	Lead		Support								
3.4 Study use of nuclear explosive devices to mitigate NEOs	Lead	Support	Support			Support					
3.5 Continue flights to demonstrate NEO system concepts	Support				Lead						
4. Increase NASA Contributions to International Cooperation	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
4.1 Engage and inform governments to prepare for a NEO event	Support	Lead									
4.2 Demonstrate U.S. leadership in major international bodies	Lead	Support					Support				
4.3 Improve international observation infrastructure and data sharing	Support	Support			Lead						
4.4 Support a plan to improve NEO monitoring	Lead	Support									
4.5 Encourage countries to develop telescopes through IAWN	Lead	Support									
4.6 Support strengthening IAWN and SMPAG	Lead	Support									
4.7 Support and encourage tabletop exercise participation	Lead	Support									
4.8 Explore discussions with international partners for missions	Support	Support			Lead						
4.9 Develop long-term principles for planetary defense	Support	Support					Lead				

5. Coordinate and Strengthen Emergency Procedures and Protocols	PDCO	OIIR	STMD	SMD	PSD	OGC	OTPS[a]	OLIA	OCOMM	OCFO	Admin.
5.1 Support maturation of real-world planning scenarios	**Lead**	**Support**									
5.2 Improve NEO impact notification protocols	**Lead**	**Support**						**Support**			
5.3 Develop and share informational material on planetary defense	**Lead**								**Support**		
5.4 Improve procedures and timeline for a NEO mitigation mission	**Lead**										
6. Improve NASA Contributions to Interagency Coordination	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
6.1 Convene an ongoing interagency group	**Lead**	**Support**									
6.2 Identify offices and points of contact in the National Plan	**Support**	**Lead**									
6.3 Establish study effort to explore authority and legislation	**Support**						**Support**			**Lead**	
7. Improve Organization of NASA's Planetary Defense Activities	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
7.1 Conduct independent assessment of NASA							**Lead**				
7.2 Formulate long-term budget and organizational plan	**Lead**										
8. Enhance Planetary Defense Communications	**PDCO**	**OIIR**	**STMD**	**SMD**	**PSD**	**OGC**	**OTPS[a]**	**OLIA**	**OCOMM**	**OCFO**	**Admin.**
8.1 Prepare strategic communication plan	**Lead**								**Support**		
8.2 Enhance leadership messaging	**Support**	**Support**		**Support**			**Support**	**Support**	**Support**		**Lead**

Source: NASA OIG analysis of the NASA Planetary Defense Strategy and Action Plan (2023).

Note: Planetary Defense Coordination Office (PDCO); Office of International and Interagency Relations (OIIR); Space Technology Mission Directorate (STMD); Science Mission Directorate (SMD); Planetary Science Division (PSD); Office of the General Counsel (OGC); Office of Technology, Policy, and Strategy (OTPS); Office of Legislative and Intergovernmental Affairs (OLIA); Office of Communications (OCOMM); Office of the Chief Financial Officer (OCFO); and Office of the Administrator (Admin.).

[a] On March 10, 2025, NASA announced that it was closing OTPS as part of a broader government-wide restructuring effort.

Appendix D: Management's Comments

National Aeronautics and Space Administration

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

Reply to Attn of: Science Mission Directorate

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Science Mission Directorate

SUBJECT: Agency Response to OIG Draft Report, "NASA's Implementation and Management of Its Planetary Defense Strategy" (A-24-10-00-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 Implementation and Management of Its Planetary Defense Strategy" (A-24-10-00-SARD), dated May 14, 2025.

In this draft report, the OIG evaluated the Agency's progress in achieving national planetary defense strategic goals and determined whether there were opportunities for NASA to strengthen its ability to meet them. The OIG found NASA has made progress in multiple areas on planetary defense since its prior audit in 2014, including (1) discovering greater numbers of near-Earth objects (NEOs), (2) conducting successful space flight missions, (3) developing notification procedures for possible NEO impact events, and (4) collaborating with other Federal agencies and international partners. However, OIG also identified several challenges to achieving all the goals in the NASA Planetary Defense Strategy and Action Plan, as well as identifying actions needed to address the role of ground-based assets in the future of planetary defense.

The OIG makes six recommendations, three addressed to the Associate Administrator (AA) for the Science Mission Directorate (SMD) to continue NASA's significant progress in planetary defense, and three addressed to the Director of the Planetary Science Division (PSD) to ensure planetary defense strategic goals are met.

Specifically, the OIG recommends the AA for SMD:

Recommendation 1: Commit to providing stable funding levels for the NEO Surveyor mission to reduce the risk of further launch delays, as required by the NASA Authorization Act of 2022. Conversely, if NASA must prioritize other missions, the Agency should promptly inform Congress, to include the congressionally mandated annual reporting requirement for the Planetary Defense Coordination Office (PDCO).

Management's Response: NASA concurs with this recommendation. SMD will continue to support NEO Surveyor funding levels that reduce the risk of launch delays, consistent with Congressional direction and Agency requirements to maintain a balanced science portfolio. NASA will also continue to abide by its mandated Congressional reporting requirements.

Estimated Completion Date: November 30, 2026.

Recommendation 2: Work within the construct of NASA and the National Science Foundation's (NSF's) memorandum of understanding to develop a plan, and interagency agreement if needed, to assess how current ground-based observatories can prepare for NEO detection, follow-up, and characterization efforts when future advanced survey assets are in operation.

Management's Response: NASA concurs with this recommendation. Subject to the availability of appropriations and within the construct of its existing memorandum of understanding, NASA will coordinate to the extent practical with NSF to explore options to assess the utility of current ground-based observatories for NEO detection, follow-up, and characterization efforts.

Estimated Completion Date: November 30, 2026.

Recommendation 3: Develop a detailed strategy and long-range roadmap for a sustainable planetary defense program.

Management's Response: NASA concurs with this recommendation. The PDCO will develop an internal long-range roadmap for the Planetary Defense program in SMD and will provide its contributions to Agency-wide strategic planning efforts, drawing from the 2023 NASA Planetary Defense Strategy and Action Plan.

Estimated Completion Date: March 31, 2027.

In addition, the OIG recommends that NASA's Director of the PSD:

Recommendation 4: Leverage the draft Office of Technology, Policy, and Strategy (OTPS) report and completed PDCO assessments, as well as lessons from the applied science programs, to develop an appropriate governance structure for PDCO within PSD using the principles of NASA Policy Directive (NPD) 7120.4E and NASA Procedural Requirements (NPRs) 7120.5F or 7120.8A as guidance.

Management's Response: NASA concurs with this recommendation. PSD will work to define an appropriate governance structure for PDCO, leveraging the draft OTPS report, PDCO assessments, and appropriate NPD and NPRs.

Estimated Completion Date: March 31, 2026.

Recommendation 5: Update NASA's planetary defense strategy to address missing leading collaboration practices including processes to identify and assign metrics, track progress, and forecast sufficient resources to meet time-based milestones and monitor the collaboration.

> **Management's Response:** NASA concurs with this recommendation. Once an appropriate governance structure for PDCO is established, SMD will identify and implement coordination and collaboration practices across the Agency. SMD will provide input to support Agency-level strategic planning processes and clarify Agency-wide organizational roles and responsibilities.
>
> **Estimated Completion Date:** March 31, 2026.

Recommendation 6: Review Deep Space Network (DSN) service agreements to ensure they meet NEO Surveyor's telemetry and transmission requirements and adjust as needed.

> **Management's Response:** NASA partially concurs with this recommendation. SMD will review its existing DSN service agreements and compare them against NEO Surveyor's telemetry and transmission requirements. However, SMD notes that adjudication of DSN transmission time among competing Agency priorities is expected, but contingencies to ensure mission continuity are built into existing mission risk management approaches. This may or may not necessitate adjustments to the service agreements language.
>
> **Estimated Completion Date:** March 31, 2026.

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 Luc Riesbeck at (202) 957-9022 or luc.h.riesbeck@nasa.gov.

Mark Clampin

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Date: 2025.06.18 15:44:56 -04'00'

Nicola J. Fox, Ph.D.

cc:
Director, Planetary Science Division/Dr. Louise Prockter

APPENDIX E: REPORT DISTRIBUTION

National Aeronautics and Space Administration

Acting Administrator
Acting Associate Administrator
Chief of Staff
Associate Administrator for Science Mission Directorate
Director, Planetary Science Division
Planetary Defense Officer
Survey Director, NEO Surveyor
Project Manager, NEO Surveyor
Director, Jet Propulsion Laboratory

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

BAE Systems, Inc.

Utah State University Space Dynamics Laboratory

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-24-10-00-SARD)