

The Committee provides \$1,965,000 for the National Space Council. The recommendation is equal to the fiscal year 2021 enacted level and the budget request.

The National Space Council provides advice and assistance to the President on national space policy and strategy. The Council reviews U.S. Government space policy, including long-range goals; develops strategies for national space activities; and develops recommendations for the President on space policy and space-related issues. The National Space Council’s additional roles are to monitor and coordinate implementation of the Nation’s objectives in space by executive departments and agencies; foster close coordination, cooperation, and technology and information exchange among the civil, national security, and commercial space sectors; and facilitate resolution of differences concerning major space and space-related policy issues.

The Committee reiterates its previous direction that the National Space Council provide the Committee with quarterly briefings, beginning with the annual budget submission, that identify current and emerging threats to maintaining U.S. leadership in space-based activities by the Federal Government, industry, and academia and the associated plans and policies to maintain that leadership. The Committee has yet to receive such a briefing in spite of clear direction provided in fiscal year 2021. The Committee expects the National Space Council to provide this briefing prior to November 1, 2021, and quarterly thereafter.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Appropriations, 2021	\$23,271,278,000
Budget estimate, 2022	24,801,500,000
Committee recommendation	24,837,336,000

The Committee’s recommendation provides \$24,837,336,000 for the National Aeronautics and Space Administration [NASA]. The recommendation is \$1,556,058,000 above the fiscal year 2021 enacted level and \$25,836,000 above the budget request.

NASA was established by the National Aeronautics and Space Act of 1958 (Public Law 85–568) to conduct space and aeronautical research and development and to conduct flight activities for peaceful purposes. NASA’s unique mission of exploration, discovery, and innovation is intended to preserve the United States’ role as both a world leader in aviation and as the pre-eminent space-faring nation. It is NASA’s mission to advance human and robotic exploration, use, and development of space; advance and communicate scientific knowledge and understanding of the Earth, the Moon, the solar system, and the universe; and research, develop, verify, and transfer advanced aeronautics and space technologies.

The bill continues investments in human spaceflight that will enable travel to the Moon with NASA-developed crew and launch vehicles; build landers, space suits, and other infrastructure for Moon landings; enable the burgeoning domestic launch industry that is bringing cargo and crew to the International Space Station; and support NASA’s science and technology programs. These elements should be viewed as complementary pieces of a balanced whole.

For Science, the Committee’s recommendation strives to keep NASA’s near-term launches on track to continue progress in explor-

ing our solar system and the universe, understanding the sun, and observing our planet. The Committee expects NASA to continue making progress on the recommendations of the National Academies' decadal surveys, now and in the future.

For Exploration and Space Operations, the Committee's recommendation maintains support for ongoing activities in low Earth orbit, for the production of the vehicles that will take U.S. astronauts to the Moon, and for the continued development of systems that will enable human exploration of space.

NASA is directed to continue providing the Committee with a quarterly launch schedule, by mission, which describes the risks associated with launch delays due to problems with the launch vehicle, impacts of launch delays to other missions in the launch queue, and a budget estimate of the anticipated carrying costs for missed launch windows. Due to disruption of NASA activities and missions, NASA shall also include any adjustments to launch windows for delayed missions.

The Committee expects NASA to maintain focus on improving oversight and accountability throughout the agency. NASA's acquisition management continues to be on the GAO "high risk" list. GAO's most recent assessment of NASA's large-scale projects found that the agency's cost and schedule performance on major projects has deteriorated for the fifth year in a row. GAO noted that "the majority of projects are managing the effects of the pandemic by using cost and schedule reserves. However, the full effects of COVID-19 are not yet known, and these reserves may be insufficient for several projects." NASA's Congressional Budget Justification acknowledges this pressure on reserves. The Committee appreciates that known COVID-related costs have been included in the requested levels for projects and that many costs will remain unknown until normal operations resume. NASA is directed to cooperate fully and to provide timely program analysis, evaluation data, and relevant information to GAO so that GAO can continue to report to Congress shortly after the annual budget submission, and semiannually thereafter, on the status of large-scale NASA programs, projects, and activities.

In addition, NASA is directed to provide the Committee, with its budget justification, the reserves assumed by NASA to be necessary within the amount proposed for each directorate, theme, program, project, and activity; or, if the proposed funding level for a directorate, theme, program, project, or activity is based on confidence level budgeting, the confidence level and reserves assumed in the proposed funding level.

The Committee understands that NASA projects undergo major reviews in addition to regular oversight throughout the year. When one of these reviews results in changing the cost profile of a project in the current or budget request year, the Committee expects to be informed in a timely fashion so that its actions can reflect the most recent NASA analysis and expectation. Keeping the Committee up to date should reduce NASA's propensity to submit spending plans that disregard congressional direction.

The Federal funding priorities for NASA set forth in this bill and explanatory statement should not be interpreted as suggestions from the Committee. Rather they should be interpreted like any

other statutory requirement levied upon NASA. The Committee articulates the funding levels of programs, where appropriate, in the form of tables and, if necessary, supplements with explanatory statement language.

SCIENCE

Appropriations, 2021	\$7,301,000,000
Budget estimate, 2022	7,931,400,000
Committee recommendation	7,901,400,000

The Committee provides \$7,901,400,000 for Science, which is \$600,400,000 above the fiscal year 2021 enacted level and \$30,000,000 below the budget request. The Science account encompasses: Earth Science, Planetary Science, Astrophysics, the James Webb Space Telescope, Heliophysics, and Biological and Physical Science. This funding supports NASA programs that seek to answer fundamental questions concerning the ways in which Earth is changing; the comparison of Earth with other planets in the solar system and around other stars; the connections between the Sun and Earth; and the origin and evolution of planetary systems, the galaxy, and the universe, including the origin and distribution of life in the universe. These objectives are assisted by input from the scientific community through decadal surveys and are achieved through orbital and suborbital experiments, robotic flight missions, ground-based scientific research and data analysis, and the development of new technologies for future missions. NASA shall continue its progress toward implementing the recommendations of decadal surveys in Earth Science, Heliophysics, Planetary Science, Astrophysics, and Biological and Physical Sciences.

The Committee notes that the number of commercial providers offering suborbital and orbital platforms for scientific experiments continues to grow, making these platforms affordable and essential for researchers, particularly when missions require tailored launch to mission-dependent orbits, locations, and schedules or frequent iteration and repetition. NASA shall ensure that its merit review systems encourage principal investigators [PIs] to use these platforms. In fiscal year 2022, NASA expects to launch approximately 19 small satellite missions. Due to continued and increasing demand for these services, NASA is directed to implement new competitive processes to ensure they are readily available.

The Committee is encouraged by the Science Mission Directorate’s efforts to promote diversity and inclusion among PIs, including the use of double blind proposal reviews and rolling announcements of opportunity.

SCIENCE

[In thousands of dollars]

	Committee recommendation
Earth Science	2,230,000
Planetary Science	3,161,000
James Webb Space Telescope	175,400
Astrophysics	1,400,200
Heliophysics	825,700
Biological and Physical Science	109,100

SCIENCE—Continued
 [In thousands of dollars]

	Committee recommendation
Total, Science	7,901,400

Earth Science.—Within the amount for Earth Science, the Committee recommendation includes \$119,400,000 for the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission to maintain its target launch date; \$18,500,000 for CLARREO Pathfinder to continue progress on this tier-1 decadal survey recommendation; no less than \$10,000,000 for the Carbon Monitoring System; \$326,900,000 for Earth Venture Class Missions to support missions under development while maintaining the cadence of future missions; and \$1,700,000 for NASA instruments on the Deep Space Climate Observatory. As articulated by the National Academies' Earth Science and Applications from Space Decadal Survey report, the Committee acknowledges the vital role of the Venture Class Missions program in supporting the development of novel remote sensing technologies and sustaining the scientific workforce. The Committee remains supportive of NASA's collaborative research that works to advance our understanding of the behavior of the Earth by engaging academia, particularly students, in studies and investigations, as these partnerships ensure that NASA's data expertise remains up-to-date and increases the research capacities at universities.

The recommendation fully supports, at no less than the request level, Applied Sciences, NASA-ISRO Synthetic Aperture Radar, Geosynchronous Littoral Imaging and Monitoring Radiometer [GLIMR] instrument, and Geostationary Carbon Cycle Observatory [GeoCARB].

Earth System Observatory.—The Committee is pleased to see NASA's announcement and support for the Earth System Observatory to address high priority "designated observables" identified by the decadal survey. In keeping with the report and previous direction from Congress, NASA should plan to competitively select future missions. The Committee believes an increase in competed, PI-led missions will encourage responsible cost and schedule constraints, develop novel remote sensing technologies, and leverage the talents and expertise of scientists at universities and research institutions. The recommendation fully supports Decadal Survey and Future Missions at no less than \$150,000,000.

Use of On-Orbit Assembly Platforms.—The Committee encourages NASA, in partnership with industry, to support the development and demonstration of a prototype on-orbit robotically assembled Earth Science Platform designed to address critical gaps in NASA's climate, weather, and ecosystem monitoring. In partnership with industry, NASA should develop and demonstrate a space-based capability for autonomous and simultaneous operation of multiple modular Earth remote sensing instruments that utilizes robotic assembly and on-orbit structure manufacturing technologies derived from the OSAM-2 SBIR Phase III effort.

Planetary Science.—The Committee recommendation includes \$197,200,000 for planetary defense, of which \$11,100,000 shall be

for the Double Asteroid Redirect Test [DART] and not less than \$186,100,000 shall be for other Near Earth Object Observations missions and data analysis. The Committee recommendation supports the development of the Near Earth Object Surveyor Mission [NEOSM]. NASA shall include in future budget requests the amount required for Planetary Defense to ensure a June 2022 launch of DART and simultaneous development of NEOSM that pursues a launch date in 2025 while maintaining the mission's current instrument architecture, to the extent that it is scientifically justified and cost effective. NASA is directed to provide a report to Congress within 180 days from the enactment of this act on the fulfillment of its mandate to detect 90 percent of objects greater than 140 meters that threaten Earth and development progress of both NEOSM and DART missions. The Committee expects NASA to continue the selection and launch cadence of New Frontiers and Discovery class missions in spite of any cost pressures from planetary flagship missions or the Mars program. In addition, the Committee expects NASA to submit a report with the 2023 budget request to frame how the request fulfills the Planetary Science Decadal Survey. Within New Frontiers, \$201,100,000 is provided for the Dragonfly mission.

The recommendation includes the budget request level for Volatiles Investigating Polar Exploration Rover. The recommendation also includes up to \$497,300,000, for Lunar Discovery and Exploration, including \$22,100,000 to continue the Lunar Reconnaissance Orbiter, and up to the request level for Commercial Lunar Payload Services. The Committee supports NASA's commitment to utilizing public-private partnerships to advance its lunar science and exploration agenda and encourages the agency to leverage the resources and expertise of both private industry and universities in pursuit of these goals. The Committee directs that the Lunar Discovery and Exploration program adhere to the lunar science priorities established by decadal surveys and the National Research Council's consensus report titled "Scientific Context for the Exploration of the Moon." Activities funded within the program should meet both lunar science and human exploration needs.

Mars Sample Return.—The Committee recommendation includes \$653,200,000 for further development of a Mars Sample Return [MSR] mission to be launched in 2026. Given that sample return was the highest priority of the previous planetary science decadal survey, NASA shall provide the Committee with a year-by-year funding profile for a planned 2026 MSR launch.

Astrophysics.—The Committee recommendation for Astrophysics includes no less than \$98,300,000 for the Hubble Space Telescope, \$300,400,000 for Astrophysics Explorers, and \$501,600,000 for the Nancy Grace Roman Wide-Field InfraRed Survey Telescope [Roman]. The Committee is encouraged by NASA's commitment to accelerate the cadence of Astrophysics Explorer missions and to establish a new line of small Pioneer-class missions that leverage advancements in low-cost platforms such as CubeSats and balloons to support groundbreaking science. Such activities can improve scientific understanding while simultaneously developing the scientific workforce through increased research opportunities for students and faculty.

Roman Telescope.—The Committee notes this telescope was the highest priority of the 2010 Astrophysics decadal survey to settle fundamental questions about the nature of dark energy. The Committee reiterates the expectation that NASA will use a firm \$3,200,000,000 development cost cap in its future execution of the mission.

Science Mission Directorate [SMD] Education.—The Committee provides no less than \$55,600,000 for education and outreach efforts. The Committee further supports the recommendation that the Astrophysics program continue to administer this SMD-wide education funding. The Committee encourages SMD-funded investigators to be directly involved in outreach and education efforts and support citizen science. NASA should continue to prioritize funding for ongoing education efforts linked directly to its science missions.

Astrophysics Research.—The Committee recognizes the role of the Astrophysics Research program in supporting the development of novel astrophysics observation technologies that lay the foundation for future mission architectures. Additionally, a strong research program maximizes the scientific value of space-based missions by ensuring that the data collected through such observations can continue to provide new insights into the mechanisms behind cosmological phenomena. The Committee also understands that supporting these activities through extramural grant funding contributes to the long-term viability of the U.S. astrophysics community. As such, the Committee recommends \$285,500,000 for Astrophysics Research.

James Webb Space Telescope.—The Committee maintains its strong support of the James Webb Space Telescope [JWST] and provides \$175,400,000 for JWST. The Committee understands that JWST has arrived at the launch site, in anticipation of a launch in calendar year 2021. JWST will be nearly 100 times more powerful than Hubble and will cement continued American leadership in astronomy.

Heliophysics.—The Committee recognizes that a greater understanding of our Sun and the accompanying technologies developed for that purpose will help to mitigate the hazards that solar activity poses to ground- and space-based platforms that strengthen our national security, economic competitiveness, and scientific prowess. The recommendation provides \$825,700,000 for Heliophysics, including \$253,400,000 for Solar Terrestrial Probes to: support continued mission formulation and development of Interstellar Mapping and Acceleration Probe [IMAP]; implement accompanying Missions of Opportunity [MOs]; maintain operations for ongoing missions, including the Magnetospheric Multiscale [MMS] mission; and continue formulation for the Dynamical Neutral Atmosphere-Ionosphere Coupling [DYNAMIC] mission as a PI-led mission. The Committee directs NASA to provide not less than the fiscal year 2021 level for operations and scientific analysis for MMS. Given that MMS's phase two objective of night side reconnection events are yet to be completed due to these phenomenon occurring less frequently than day side reconnection events, NASA should take no steps to reduce MMS operations in future year budgets until this primary mission objective is achieved.

Heliophysics Explorer.—The Committee is encouraged by NASA's commitment to accelerate the cadence of alternating Small Explorer and Mid-sized Explorer missions and enable a regular selection of MOs to allow heliophysics researchers to rapidly respond to and participate in missions both inside and outside of NASA. This commitment follows the recommendations of the National Research Council Decadal Survey and can accelerate scientific understanding while developing the scientific workforce through increased research opportunities for students and faculty. The recommendation provides \$189,200,000 for Heliophysics Explorers, the same amount as the request.

Diversify, Realize, Integrate, Venture, Educate [DRIVE] Initiative.—The Committee supports implementation of the DRIVE initiative, a top priority of the National Research Council Decadal Survey and encourages NASA to implement the goal of increasing the competitive research program to 25 percent of the Heliophysics budget request to enable the development of new technologies, including advanced computational tools, establish competitively-awarded DRIVE Science Centers, support multidisciplinary research collaboration using integrated observatory data, and support early career investigators. In addition, the Committee recognizes that the continued success of DRIVE relies upon a robustly supported research budget, and so provides \$235,500,000 for Heliophysics Research. Within Heliophysics Research, the Committee recommendation supports Research Range at the request level and provides \$77,000,000 for Heliophysics Research and Analysis, an increase of \$25,000,000 above the request.

Heliophysics Technology Program.—The Committee appreciates NASA including Heliophysics Technology as a standalone program line in the budget request and supports the request level for this transformative activity.

Geospace Dynamics Constellation [GDC].—The Committee provides \$119,300,000 for Living with a Star [LWS], which supports a diverse portfolio of activities that contribute to our understanding of the societal impact of the Sun-Earth system. This includes the upcoming Geospace Dynamics Constellation mission, which will meet the recommendations of the Heliophysics decadal survey through improved understanding of the variability of the space weather environment surrounding Earth. The Committee notes LWS supports GDC and other missions alongside a portfolio of applied research activities, such as the Space Weather Science and Applications program, designed to maximize the scientific value of LWS missions and create a pipeline of enabling technologies.

Space Weather Science Applications.—In response to the Space Weather Action Plan and the recommendations of the Decadal Strategy for Solar and Space Physics, the Committee recommendation provides no less than \$25,000,000 for Space Weather Science and Applications to support innovation in observational capabilities and advance research-to-operations, operations-to-research, and computational aspects of space weather mitigation in accordance with the recommendations of the decadal survey and the National Space Weather Strategy and Action Plan. The Committee also notes the relevance of these activities to safeguarding human health against radiation during long-duration deep space explo-

ration activities. NASA should coordinate with NOAA, NSF, and the Department of Defense to ensure that NASA is focused on research and technology that enables other agencies to dramatically improve their operational space weather assets and the forecasts they generate using data from those assets, including current and future ground-based telescopes and instruments, such as the Daniel K. Inouye Solar Telescope.

Within funding for Space Weather Science and Applications, the Committee allocates \$1,000,000 to initiate the implementation of a center-based mechanism to support multidisciplinary space weather research, advance new capabilities, and foster collaboration among university, government, and industry participants aimed at improving research-to-operations and operations-to-research. NASA should coordinate with NOAA to ensure that research pursued through this activity meets NOAA operational needs.

Biological and Physical Science.—The recommendation provides the full requested amount of \$109,100,000 for Biological and Physical Science within Science.

AERONAUTICS

Appropriations, 2021	\$828,700,000
Budget estimate, 2022	914,800,000
Committee recommendation	940,000,000

The Committee provides \$940,000,000 for Aeronautics, which is \$111,300,000 above the fiscal year 2021 enacted level and \$25,200,000 above the budget request. The Aeronautics account funds research in key areas related to the development of advanced aircraft technologies and systems, including those related to aircraft safety, ultra-efficient vehicles and fuel efficiency, hypersonics, and research that supports the Next Generation Air Transportation System in partnership with the Joint Planning and Development Office.

The Committee supports New Aviation Horizons and is encouraged by NASA’s efforts toward developing a Low Boom Flight Demonstrator X-plane, referred to as the Low Boom Flight Demonstrator [LBFD]. Appropriate funds are also included to enable the next X-plane demonstration planned beyond LBFD.

LBFD Over Land Supersonic Testing.—NASA has identified a comprehensive set of atmospheric environments that its low sonic boom aircraft will encounter in flights over land in anticipation of initial test flights of the LBFD experimental aircraft beginning in 2022. As this testing progresses toward potential commercial use, it will be vital that this technology be tested over land in proximity to populations on the ground unaccustomed to supersonic flight testing in order to validate the technologies and sonic impacts to communities associated with over land flights. NASA is directed to include established non-military supersonic test corridors for the LBFD flight tests.

University Leadership Initiative [ULI].—The Committee recognizes that universities are uniquely suited to contribute revolutionary advances in aeronautical technologies through NASA’s ULI program. NASA is encouraged to utilize universities and their capabilities in areas where multidisciplinary convergent research is

needed to address complex technical challenges in early stage aeronautics research and technology development.

Electric Air Flight.—NASA should work to further strengthen collaborations with the Department of Energy to overcome energy storage challenges for novel modes of mobility, including electric air flight. As NASA continues its work on electric powered air flight, NASA is encouraged to advance its work on high power, fast charging batteries to advance work on these next generation vehicles.

Hypersonics Technology.—The Committee notes that opportunities for low-speed hypersonic flight enable development of the next generation of commercial aeronautics travel. The development of new hypersonic capabilities at speeds above Mach five can sustain hypersonic competency for national needs while advancing fundamental hypersonics research. Both require technology development that includes hypersonic propulsion systems, reusable vehicle technologies, high-temperature materials, including carbon fiber components, and systems analysis. The Committee provides \$60,000,000 for hypersonics technology research, which is equal to the fiscal year 2021 level. Within this amount, the Committee provides \$10,000,000 for collaborative work between industry and academia for carbon/carbon material testing and characterization that will benefit the next generation of very high temperature composites for hypersonic vehicles.

High-Rate Composite Aircraft Manufacturing [HiCAM].—The Committee is supportive of NASA's HiCAM project that demonstrates high rate manufacturing at full scale to enable increased rates of composite structures for aircraft. The Committee provides no less than \$32,000,000 to enable HiCAM to select large-scale ground tests of both fuselage and wing to accelerate industry's development of this critical technology to help ensure the global competitiveness of the U.S. aerospace industry. NASA is encouraged to leverage existing academic and industry expertise to help demonstrate efficient design, development, and certification requirements associated with this program and to utilize no less than 75 percent of these funds to support public-private partnerships with at least a 50 percent government cost share.

Advanced Materials Research.—The Committee recognizes the continuing role NASA and university research institutions play in developing advanced materials platforms for next-generation air and space vehicles. NASA is encouraged to partner with academic institutions that have strong capabilities in aviation, aerospace structures, and materials testing and evaluation, and provides \$7,000,000 above the request to advance university-led aeronautics materials research.

Unmanned Traffic Management.—The Committee commends NASA for its work to advance efforts on the unmanned traffic management [UTM] program. NASA is encouraged to continue work with the FAA and other Federal agencies, States, counties, cities, and Tribal jurisdictions on research toward the development of a UTM system, technologies, and applications for enhanced UTM air domain awareness.

Cleaner, Quieter Airplanes.—The Aeronautics Research Mission Directorate continues to make significant strides in demonstrating new technologies, including systems architecture, components, inte-

gration of propulsion systems and airframe structures, and in electric or hybrid-electric aircraft concepts that are capable of reducing both carbon and noise emissions. The Committee supports NASA’s Sustainable Flight National Partnership and other efforts to bring these technologies to market.

Aerosciences Evaluation and Test Capabilities [AETC].—The Committee recommendation provides the requested amount for AETC activities. This funding is intended to provide the necessary support for operations and maintenance so that AETC capabilities are available for use across NASA.

Aviation Supply Chain.—The Committee directs NASA to conduct an assessment of the existing aviation supply chain, including modeling of gaps in the supply chain, from structures manufacturing to material suppliers, in order to enable a proactive and ready industry to support U.S. interests in advanced air mobility. As NASA moves forward with planning future aviation technology and research, it should also identify how existing capabilities will impact the ability of industry to take advantage of NASA’s work. In conducting the assessment, NASA should consult with industry and other relevant Federal agencies.

SPACE TECHNOLOGY

Appropriations, 2021	\$1,100,000,000
Budget estimate, 2022	1,425,000,000
Committee recommendation	1,250,000,000

The Committee provides \$1,250,000,000 for Space Technology, which is \$150,000,000 above the fiscal year 2021 enacted level and \$175,000,000 below the budget request. The Space Technology mission directorate funds basic research that can advance multi-purpose technologies to enable new approaches to all of NASA’s current missions. Space Technology also includes funding for NASA’s Small Business Innovative Research [SBIR] and Small Business Technology Transfer programs.

The Committee is supportive of many of the technologies being developed within Space Technology, which will have wide ranging benefits for NASA missions and throughout the agency. Of particular note are the enabling technologies of Solar Electric Propulsion, Fission Surface Power, OSAM-2, in-space robotic manufacturing, and active debris removal technology development. These key supporting technologies will provide enabling capabilities for multiple robotic and human exploration missions. The Committee is also supportive of the Regional Economic Development Program, including partnering with the NIST Hollings Manufacturing Extension Partnership and its local offices to target technologies of interest to NASA’s overarching mission of exploration, while also driving innovation and economic growth. NASA is encouraged to expand the program to all 50 States.

The recommendation includes \$27,000,000 for the Flight Opportunities Program and \$5,000,000 to advance large scale production and use of innovative nanomaterials, including carbon nanotubes and carbon/carbon composites.

On-surface Manufacturing Capabilities.—The agreement provides the budget request of \$8,750,000 for On-Surface Manufacturing and directs NASA, through partnerships with universities, to lever-

age efforts that complement ongoing work on the development of advanced materials with a focus on point-of-need and in-place generated materials, energy capture and power storage, recycling, commercialization, and workforce development.

Satellite Servicing/Restore-L/On-Orbit Servicing, Assembly, and Manufacturing-1 [OSAM-1].—The Committee recommends \$227,000,000 for the Restore-L Project to conduct and demonstrate the capabilities to refuel satellites in low-Earth orbit (LEO) utilizing Landsat-7. As the program progresses from research to implementation, the Committee encourages NASA to work with private sector and university partners to facilitate commercialization of the technologies developed within the program, and directs NASA to submit with its fiscal year 2023 budget request a report on current efforts underway to encourage commercialization of technology within the Restore-L program, with a focus on how IP will be handled. The Committee encourages NASA to make Restore-L's capabilities available to other government agencies that own and operate satellites. NASA is directed to keep the program on track for launch no later than 2025.

Nuclear Propulsion.—NASA is continuing its work to develop the foundational technologies and advance low-enriched uranium nuclear thermal propulsion systems that can provide significantly faster trip times for crewed missions than non-nuclear options. Not less than \$110,000,000 is for the development of nuclear thermal propulsion, of which not less than \$80,000,000 shall be for the design of test articles that will enable a flight demonstration for which a multi-year plan is required. The Committee encourages NASA to coordinate with other relevant Federal departments to maximize the total effort for this propulsion capability. Within 180 days of the enactment of this act, NASA, in conjunction with other relevant Federal departments and agencies, shall submit a multi-year plan that enables technology development leading to an in-space demonstration and describes future missions and propulsion and power systems enabled by this capability. NASA is encouraged to develop innovative nuclear technologies that enable a regular cadence of extended duration robotic missions to the lunar surface and Mars.

Flight Opportunities Program.—The funding provided for this program may be used to support undergraduate and graduate work in developing flight opportunities payloads. NASA should ensure that funds are available for flight opportunities of science, technology demonstration, and educational payloads developed across all NASA Mission Directorates, as well as external flight opportunities, as authorized under section 907 of the NASA Authorization Act of 2010 (Public Law 111–267), including competitively-selected opportunities in support of payload development and flight of K–12 and collegiate educational payloads. NASA is directed to consider how the Flight Opportunities Program may be leveraged to provide expanded opportunities to STEM students and early career researchers, including working directly with the Office of STEM engagement. The recommendation includes \$5,000,000 to support payload development and flight of K–12 and collegiate educational payloads. NASA is encouraged to qualify U.S. suborbital vehicles in order to procure flights for NASA personnel and allow human-tend-

ed payloads through flight opportunities. NASA’s qualification process should prioritize safety and avoid unnecessary duplication of existing licensing procedures.

Small Business Innovation Research.—The Committee recognizes the importance of the SBIR program and its previous success in commercialization of results from federally-funded research and development projects, and includes the requested level for SBIR. The SBIR program encourages domestic small businesses to engage in Federal research and development facilitates job creation. The Committee therefore directs NASA to place an increased focus on awarding SBIR awards to firms with fewer than 50 employees.

EXPLORATION

Appropriations, 2021	\$6,555,400,000
Budget estimate, 2022	6,880,400,000
Committee recommendation	6,960,200,000

The Committee provides \$6,960,200,000 for Exploration, which is \$404,800,000 above the fiscal year 2021 enacted level and \$79,800,000 above the budget request.

In July 2021, NASA proposed a reorganization that divided the Human Exploration and Operations Mission Directorate [HEO] into two separate mission directorates, Exploration and Space Operations. In the course of examining the proposal, NASA identified two elements of the funding provided in fiscal year 2021 and requested in fiscal year 2022 under Exploration that needed to be provided under Space Operations—the funding related to production and operations for the Orion multi-purpose crew vehicle and the Human Research Program. Consequently, the Committee has provided the funding for Orion within Exploration, as discussed below, but has transferred the funding for the Human Research Program to Space Operations.

The Committee appreciates its relationships with the Associate Administrators who have led HEO deftly. Their expertise and straightforwardness about the resources needed to accomplish NASA’s long term goals while balancing current operations has been invaluable to the Committee over the past 10 years.

The Exploration account funds the capabilities required to develop, demonstrate, and deploy the transportation, life support, and surface systems that will enable sustained human presence beyond LEO and throughout the solar system. The Committee believes the Nation deserves a safe and robust human spaceflight program to explore beyond LEO, including establishing a sustainable lunar presence, and ensuring U.S. leadership in space.

EXPLORATION

[In thousands of dollars]

	Committee recommendation
Orion	1,426,700
Space Launch System	2,487,000
Exploration Ground Systems	690,000
Exploration Research and Development	2,356,500
Gateway	785,000
Human Landing System	1,295,000

EXPLORATION—Continued

[In thousands of dollars]

	Committee recommendation
Total Exploration	6,960,200

The Committee supports NASA's goal of returning U.S. astronauts to the surface of the Moon through the Artemis program and provides funding to move its lunar program forward. While the Artemis program is steadily progressing, many challenges remain for the initial crewed landing on the Moon. Many elements are on the cusp of their flight tests, while other critical elements remain in early development and threaten to delay crewed flights to the Moon. NASA also must work on developing the needed systems that will make Artemis a program that will support a sustained lunar presence on and around the Moon. To accomplish this goal, NASA must coordinate and systematically advance the many programs under development through a plan that reflects the complexity of this undertaking. The Committee has provided funds for NASA to advance its human exploration program and expects NASA to provide further definition of the program and a refined cost estimate that reflects NASA's plans.

The Space Launch System [SLS], Orion multi-purpose crew vehicle, and Exploration ground systems are all critical infrastructure for the development and sustainment of the Nation's human exploration goals. These investments will enable the human exploration of space beyond LEO, and provide flexibility for a variety of mission destinations including the Moon and Mars.

The Committee provides \$2,487,000,000 for SLS; \$1,426,700,000 for Orion; and \$690,000,000 for Exploration Ground Systems. These funding levels reflect consistent programmatic funding to ensure the earliest possible crewed launch of SLS, as well as prepare for future science and crewed missions.

It is important to note that the funding levels provided by the Committee within Exploration support the development of multiple iterations of launch and crew test articles and flight vehicles that are being developed and produced during fiscal year 2022. Flight hardware that will be used for the initial uncrewed and crewed test launches, as well as the flights that will return astronauts to the lunar surface are included within the funding provided, including funding for procurement of Exploration Upper Stage [EUS] hardware for its initial flight and future missions. As SLS, Orion, EGS and eventually other elements of the Artemis architecture transition from development to production and operations, the long-term cost effectiveness of these capabilities will only be realized with a rebalancing of the workforce. NASA should strive to appropriately align its workforce during this transition to drive affordability and eliminate work products not required for the production and operations phase.

The Committee directs NASA to follow its "Priority of Use" clause for ensuring that its missions are prioritized and that mission related activities and schedules of NASA missions are not impacted by outside activities at its centers. In particular, NASA shall ensure that any non-Federal activities do not interfere with

the progress of, and schedule for, the Artemis missions, and will report to the Committee any conflicting activities and how the conflict was resolved 15 days prior to any activity taking place. Ensuring that NASA's missions and launch schedules are prioritized will become increasingly important as NASA prepares for the test launches associated with returning astronauts to the Moon.

Lunar Cargo.—As NASA further refines its strategy for a sustainable presence and exploration of the lunar surface, the Committee encourages NASA to continue its exploration of a cargo variant of SLS for use in the Artemis program and for other purposes.

Orion Transition to Operations.—The Committee is supportive of transitioning management and funding for programs from Exploration to Space Operations when the programs mature and are in production rather than development. NASA recommended splitting Orion funding between the Exploration and Space Operations accounts with \$799,300,000 for Orion Production and Operations in Space Operations. The bill allows a transfer of up to that amount to Space Operations. However, no fewer than 15 days before exercising any such transfer, the Committee directs NASA to submit a plan for managing Orion that makes clear the roles and responsibilities of each mission directorate and how decision-making that impacts development and operations will occur. Management uncertainty should not interfere with a successful Artemis 1 launch in fiscal year 2022.

Block 1B Development.—The Committee is supportive of fully developing the capabilities of SLS, and directs NASA to continue the simultaneous development of activities authorized under section 302(c)(1)(a) and (b) of Public Law 111–267. Enabling the evolution of SLS from the vehicle to be used in Artemis 1 to the block 1B variant and eventually the 130 metric ton variant requires the continued development of the interim block 1B variation of SLS, including the continued development of EUS. It also requires modifications to SLS, the continued construction of a block 1B compatible mobile launch platform [MLP–2], and any additional processing and launch capabilities. To further enable NASA's goals for the Artemis program, the Committee provides no less than \$579,000,000 for EUS engine development and associated stage adapter work from within the amounts provided for SLS, and no less than \$165,300,000 for MLP–2 from within Exploration Ground Systems.

Exploration Research and Development [ERD].—The Committee provides \$2,356,500,000 for ERD, which is comprised of Gateway, Advanced Exploration Systems, Advanced Cislunar and Surface Capabilities, and the Human Landing System. Funding for the Human Research Program has been transferred to Space Operations at NASA's recommendation. As NASA continues to refine its Artemis program, greater attention must be paid to near term objectives, while still maintaining early work for technologies that will enable a sustainable lunar presence.

Human Landing System.—The Committee notes that in fiscal year 2021, NASA projected that the Human Landing System [HLS] would need \$4,388,100,000 in fiscal year 2022. However, the fiscal year 2022 request before the Committee is \$1,195,000,000. Given that request, NASA's rhetoric of blaming Congress and this Com-

mittee for the lack of resources needed to support two HLS teams rings hollow. The Committee’s—and NASA’s—experience with both Commercial Cargo and Commercial Crew was that even with lofty ambitions, milestones were often not met in the first years of a milestone-based program.

The Committee believed, in providing resources for fiscal year 2021, that the resources would support early work for two teams. The Committee believes having at least two teams providing services using the Gateway should be the end goal of the current development program. To that end, the Committee provides no less than \$1,295,000,000, an increase of \$100,000,000 above the budget request, for HLS. Using this funding, NASA is expected to ensure redundancy and competition, including robust support for research, development, testing, and evaluation for no fewer than two HLS teams. The Committee expects real investments in development rather than additional studies. Within 30 days of enactment of this act, NASA shall deliver a plan to the Committee and post it on its website that explains how NASA will comply with this direction, including the resources needed for fiscal years 2023 through 2026 to execute the plan. NASA is expected to request such resources in future year budgets. In order to support HLS program development, no less than the requested level for the Lunar Lander office is provided.

SPACE OPERATIONS

Appropriations, 2021	\$3,988,200,000
Budget estimate, 2022	4,017,400,000
Committee recommendation	4,128,246,000

The Committee provides \$4,128,246,000 for Space Operations, which is \$140,046,000 above the fiscal year 2021 enacted level and \$110,846,000 above the budget request. The Space Operations account supports the International Space Station [ISS] and the supporting functions required to conduct operations in space at up to the full requested level. The ISS is a complex of research laboratories in LEO in which American, Russian, and international partner astronauts conduct unique scientific and technological investigations in a microgravity environment.

Human Research Program.—At NASA’s request, the Committee recommendation for Space Operations includes \$130,200,000 for the Human Research Program that was requested in Exploration.

Commercial Crew and Cargo.—The Committee recommends up to the requested level of funding for Commercial Crew and Cargo, including the full requested amount to enable cargo flights for all three current providers within the Commercial Crew and Cargo program.

Commercial LEO Development.—The Committee supports maintaining the ISS as long as it can be safely operated. However, it is anticipated that current efforts to develop viable alternatives will eventually allow NASA to achieve its objectives in LEO. The Committee supports public-private partnerships to advance commercial capabilities in LEO, particularly those involving in-kind contributions by NASA, such as making a docking node on the ISS available for partnership opportunities. After several years, NASA has finally provided the Committee with a rationale for this funding

and a roadmap that seeks to ensure continued NASA access to LEO on new, commercial, free-flying platforms. The recommendation provides the full budget request of \$101,100,000 for Commercial LEO activities to allow for continued opportunities for LEO commercialization that are not primarily dependent on NASA funding. This funding should be primarily focused on solving supply rather than demand problems and growing promising research across all industries and not one-time novelty events, which are not indicators of future sustainable expansion of commercial activity in LEO.

Within 30 days of enactment of this act, NASA shall provide the Committee with updated criteria used by NASA and any other U.S. based entity allowed to facilitate selection of commercial projects to be flown to the ISS, a list of the projects selected, the total costs incurred by NASA for delivery and execution of each project, and the amount NASA will be reimbursed for transportation, personnel, and facility use to conduct the selected activity. NASA shall not use funds provided in this or any other act to subsidize the cost of any project that is primarily intended for marketing, advertising, or entertainment.

Rocket Propulsion Test Program and Testing Infrastructure.—The Committee recommends the fiscal year 2022 requested amount for the NASA Rocket Propulsion Test program to ensure that test infrastructure remains adequate to support the SLS and other propulsion development programs. In managing the program and its infrastructure, NASA should prioritize facility and fixed infrastructure improvements specific to infrastructure that is shared among users of the facility in a continued effort to attract and facilitate commercial partnerships at NASA’s test centers. Not later than 180 days after the enactment of this act, NASA shall provide a report to the Committee on historical use of Rocket Propulsion Test Program funds, including allocation of resources to specific field centers.

Space Communications.—The Committee recognizes and appreciates the complexities involved in sustaining NASA’s Near Space and Deep Space communications networks and infrastructure, which support NASA’s scientific and exploration activities. With the proliferation of commercial satellites capable of providing communications for NASA’s needs, this program represents a significant opportunity to deliver more economical and efficient services. The Committee supports NASA’s goal to commercialize its Direct-To-Earth communications services. However, much work remains to demonstrate that services tailored to non-space users are capable of meeting NASA mission needs when NASA’s Tracking and Data Relay Satellites reach the end of their service lives in the 2030s. If commercialization plans cannot meet NASA’s needs, the agency will need to plan and budget for replacement of essential services.

The Committee notes that funding for the 18-meter class antenna subnet, lunar communications relay, and long-term upgrades to the Deep Space Network are not built into the out-year funding projected in the fiscal year 2022 request. As NASA’s Congressional Budget Justification states, “Without services to move data and commands between spacecraft and Earth, space assets worth tens

of billions of dollars would be little more than orbital debris.” The Committee directs NASA to provide a timeline for sustainment of the existing network and infrastructure upgrades in the fiscal year 2023 budget request. NASA is also directed to identify adequate resources and provide a plan to address any upgrades identified in its Deep Space Network “Road to Green” study. NASA is directed to brief the Committee on these plans within 30 days after the date of the submission of the fiscal year 2023 budget request. The recommendation supports the full request for the Communications Services Program.

21st Century Launch Complex.—The Committee notes that maintaining multiple launch sites contributes to assured access to the ISS for NASA, researchers, and industry. The recommendation includes \$15,000,000 for NASA-owned launch facilities, of which \$10,000,000 shall be used to fill critical maintenance, capacity, and range safety gaps at the Wallops Flight Facility launch complex. The Committee further directs NASA to take into consideration the full potential of all NASA-owned launch complexes in awarding the balance of funds made available by this program and in planning for future funding requests for this critical space infrastructure program.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS
ENGAGEMENT

Appropriations, 2021	\$127,000,000
Budget estimate, 2022	147,000,000
Committee recommendation	147,000,000

The Science, Technology, Engineering, and Mathematics Engagement account funds STEM education activities to educate and inspire our next generation of explorers and innovators. The Committee provides \$147,000,000 for STEM Engagement, which is \$20,000,000 above the fiscal year 2021 enacted level and equal to the budget request. As part of this activity, NASA is directed to continue progress toward the shared goal of both the Committee and NASA of capping administrative costs at no more than 5 percent.

STEM ENGAGEMENT
[In thousands of dollars]

	Committee recommendation
NASA Space Grant	57,000
Established Program to Stimulate Competitive Research [EPSCOR]	26,000
Minority University Research and Education Project	48,000
STEM Education and Accountability Projects	16,000
TOTAL	147,000

Space Grant.—The Committee provides \$57,000,000 for Space Grant and directs that all 52 participating jurisdictions be supported at no less than \$850,000. NASA shall limit administrative costs to the fiscal year 2021 level and shall continue to have a goal of reducing administrative costs to no higher than 5 percent. The Committee encourages NASA to continue using funds to evaluate

program performance, augment base grants, and competitively respond to local, regional, and national needs.

Competitive Program.—The Committee provides no less than \$5,000,000 for the Competitive Program for Science, Museums, Planetariums, and NASA Visitors Centers within the STEM Education and Accountability Projects, also known as “Teams Engaging Affiliate Museums and Informal Institutions [TEAM II] program.” This competitive grant program supports interactive exhibits, professional development activities, and community-based programs to engage students, teachers, and the public in STEM.

Connecting Science, Indigenous Culture, and Community.—The Committee continues to encourage NASA’s Minority University Research and Education Project to support programs that connect science, indigenous culture, and community at minority-serving higher education institutions, including Alaska Native and Native Hawaiian-Serving Institutions and American Indian Tribal Colleges and Universities. These programs should integrate indigenous practices in science through educational programs for K–12 and college students and the general public. The academic institution or institutions should be located in a State or States where the need for such indigenous-academic collaboration is present.

SAFETY, SECURITY, AND MISSION SERVICES

Appropriations, 2021	\$2,936,500,000
Budget estimate, 2022	3,049,200,000
Committee recommendation	3,064,200,000

The Committee provides \$3,064,200,000 for Safety, Security, and Mission Services, which is \$127,700,000 above the fiscal year 2021 enacted level and \$15,000,000 above the budget request. The Safety, Security, and Mission Services account funds agency management, including NASA headquarters and each of the nine NASA field centers, as well as the design and execution of non-programmatic Construction of Facilities and Environmental Compliance and Restoration activities.

Independent Verification and Validation [IV&V] Program.—Within the amounts provided for Safety, Security, and Mission Services, the Committee recommends \$39,100,000 for NASA’s IV&V Program. If necessary, NASA shall fund additional IV&V activities from within the mission directorates that make use of IV&V services.

Cybersecurity.—The Committee’s recommendation includes the full request for Agency Information Technology Services to support shifting NASA’s IT model to one that enhances cybersecurity with strong governance and information security practices.

High Performance Computing.—NASA’s High Performance Computing has historically been budgeted in the Earth Sciences Division, even though it is an agency-wide resource. All other NASA agency wide Information Technology and Mission Enabling Services are budgeted annually in the Mission Services and Capabilities program within Safety, Security, and Mission Services. As NASA embarks on a significant major restructuring of its High Performance Computing program based on the recently published Needs Assessment, NASA should consider taking the complimentary step of separately identifying, budgeting, and managing its High Per-

formance Computing Program as a distinct budget element within Mission Services and Capabilities in future budget years.

Annual Financial Audit.—Over the past 10 fiscal years, NASA has received clean financial audit opinions. The Committee expects that NASA will take every action necessary to achieve clean financial audits this year and in the future. In order to maintain a stable financial base for executing NASA’s mission, no funds are provided to implement, alter, or configure changes to its financial system to accommodate Category B apportionments for amounts below NASA appropriation account levels.

NASA Special Projects.—Within the appropriation for Safety, Security and Mission Services, the Committee recommendation also provides \$19,455,000 for the following Special Projects:

NASA SPECIAL PROJECTS

Recipient	Project Purpose	Recommended (\$)
Atchison Amelia Earhart Foundation	Development of New Programs at the Amelia Earhart Hangar Museum and Memorial.	1,000,000
Bowie State University	Hydroponics Research Laboratory Initiative	1,000,000
Boys & Girls Club of Hawaii	STEM Education Initiative Expansion	80,000
Educate Maine	Satellite Chipset Computer Science Learning Module	400,000
Lincoln University	Food for Human Spaceflight Sustainability	160,000
Louisiana State University National Center for Advanced Manufacturing.	Equipment and Training for Activities at the National Center for Advanced Manufacturing.	5,000,000
McAuliffe-Shepard Discovery Center	McAuliffe-Shepard Discovery Center Planetarium Enhancements.	348,000
Montgomery County Community College	STEM Learning Center Installation	70,000
Norwich University	NASA Research and Technology Development for Cyber Architecture.	250,000
Ohio Aerospace Institute	Research Center Partnership Initiative	1,500,000
Rush University Medical Center	REACH for Information Technology Training	696,000
Springfield Museums Corporation	Springfield Science Museum Upgrades	750,000
University of Connecticut	University of Connecticut Ecological Modeling Institute	2,000,000
University of Delaware/Delaware State University.	The Delaware Space Observation Center Enhancement	900,000
University of Hawaii	'Imiloa Astronomy Center Expansion and Upgrades	1,000,000
University of New Hampshire	University of New Hampshire Magnetometer Research and Education Facility.	501,000
West Virginia University	Spacecraft Development Facility	800,000
Wheeling University Challenger Learning Center.	Update Technology at the Challenger Learning Center and Support Seasonal Educational Programming.	3,000,000

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

Appropriations, 2021	\$390,278,000
Budget estimate, 2022	390,300,000
Committee recommendation	390,300,000

The Committee provides \$390,300,000 for Construction and Environmental Compliance and Restoration, which is \$22,000 above the fiscal year 2021 enacted level and equal to the budget request. The Construction and Environmental Compliance and Restoration account provides for design and execution of programmatic, discrete and minor revitalization, construction of facilities projects, facility demolition projects, and environmental compliance and restoration activities. The Committee recommendation includes the full request for Exploration and Space Operations Construction of Facilities [CofF].

Unmet Construction Needs.—The Committee is disappointed at the gulf between the amount NASA requested for this account and the cost of the projects identified as shovel ready and needed. The Inspector General issued a report titled “NASA’s Construction of Facilities” on September 8, 2021, that recommended NASA “develop and institute an Agency-wide process to prioritize and fund institutional and programmatic CoF projects that align with Agency-level missions and require business case analyses to be completed and considered as part of the process prior to the projects’ approval.” NASA is directed to brief the Committee within 180 days of the date of enactment of this act on implementation of the recommendations in that report. NASA is further directed to include no fewer than the top 10 construction projects that are needed but unfunded in its fiscal year 2023 budget request, along with any unmet repairs that result from damage from wildfires, hurricanes, or other natural disasters.

OFFICE OF INSPECTOR GENERAL

Appropriations, 2021	\$44,200,000
Budget estimate, 2022	46,000,000
Committee recommendation	46,000,000

The Committee’s recommendation provides \$46,000,000 for the Office of Inspector General, which is \$1,800,000 above the fiscal year 2021 enacted level and the equal to the budget request. The Office is responsible for promoting efficiency and preventing and detecting crime, fraud, waste, and mismanagement.administrative provisions

ADMINISTRATIVE PROVISIONS

(INCLUDING TRANSFER OF FUNDS)

The Committee includes bill language regarding the availability of funds for certain prizes. NASA is reminded that under the authority provided in section 20144 of title 52, United States Code, no prize may be announced until the funds needed to pay it have been appropriated or committed to in writing by a private source. NASA is directed to provide any written notification under subsection (h)(4) of that section to the Committee.

The Committee also includes bill language regarding transfers of funds between accounts and the NASA spending plan for fiscal year 2022.

NATIONAL SCIENCE FOUNDATION

Appropriations, 2021	\$8,486,759,000
Budget estimate, 2022	10,169,300,000
Committee recommendation	9,486,759,000

The Committee’s recommendation provides \$9,486,759,000 for the National Science Foundation [NSF]. The recommendation is \$1,000,000,000 above the fiscal year 2021 enacted level and \$682,541,000 below the budget request.

NSF was established as an independent agency by the National Science Foundation Act of 1950 (Public Law 81–507) and is authorized to support research and education programs that promote the progress of science and engineering in the United States. The