### DA: NASA Tradeoff

#### A: Link Story

#### First, NASA’s budget is tapped out through 2022—Adding new projects will force tradeoffs with other major programs

GAO 19 US Government Accountability Office, Report to Congressional Committees: Assessments of Major Projects at NASA, GAO-19-262SP, Published 30 May 2019, https://www.gao.gov/assets/700/699373.pdf

Affordability of NASA’s Portfolio Will Be Strained as Cost and Schedule Performance Continues to Deteriorate and New Projects Begin The cost and schedule performance of NASA’s portfolio of major projects continues to deteriorate. Since we last reported in May 2018, cost growth has increased to 27.6 percent and the average launch delay is approximately 13 months, the largest schedule delay we have ever reported.14 This deterioration in cost and schedule performance is largely due to the replan of the JWST project as a result of spacecraft integration and test challenges. Cost growth in the past year was further driven by the SLS program, stemming from continued production challenges with the SLS core stage—which functions as the SLS’s fuel tank and structural backbone. In its fiscal year 2019 budget request, NASA did not request funding for two major projects yet were proceeding with planned work on them. If Congress continues to fund these projects along with other ongoing major projects, NASA will have to increase its annual funding request for major projects in future years or make other funding trade-offs as part of its annual budget request. NASA Cost and Schedule Performance Continues to Deteriorate with Further Growth Likely The cost and schedule performance of NASA’s portfolio of major projects continues to deteriorate. Since our last assessment, overall portfolio cost growth was 27.6 percent, up from 18.8 percent.15 At that time, we also found that 18.8 percent may not represent the total cost growth for the portfolio. This was because the Orion program—one of the largest projects in the portfolio—did not have an updated cost estimate and project officials expected cost growth. In June 2018, the Orion program provided an updated cost estimate, which is included in the analysis in this report. The average launch delay increased to approximately 13 months, up from 12 months since we last reported and is the longest launch delay we have reported since our first assessment in 2009 (see figure 3). Cost and schedule performance deteriorated largely due to the most recent replan of the JWST project in response to spacecraft integration and test challenges, among other factors. As we found in March 2019, to develop a new schedule for JWST’s replan, NASA took into account the remaining integration and test work and added time to address other potential threats to the schedule, including about 6 months to address an integration and test anomaly that occurred on the spacecraft in 2018.16 As a result of the replan, the project had a 10-month launch delay beyond the 19-month delay since our last assessment and an $813.8 million cost increase.17 When JWST is excluded from the above analysis, the average schedule delay was approximately 9 months. Cost growth since our last assessment was further driven by the SLS program, stemming from continued production challenges with the SLS core stage—which functions as the SLS’s fuel tank and structural backbone.18 According to program officials, Boeing underestimated both the complexity of engine section assembly and the time and manpower that would be needed to complete the effort, which has contributed to cost growth. In addition to JWST and SLS, four other projects—SGSS, ICON, Mars 2020, and Orion—experienced cost growth since we last reported in May 2018.19 ICON also experienced a schedule delay. The remaining 11 major projects stayed within cost and schedule estimates since we last reported. Of these projects, Parker Solar Probe, which launched in August 2018, completed technology development having spent approximately $40 million less than its cost baseline. Table 2 provides data on the cost and schedule performance of the 17 major projects in development that have cost and schedule baselines since our last assessment.20 Beyond JWST and SLS, reasons projects experienced cost increases or schedule delays include the following: • Mars 2020 experienced cost growth in multiple areas, including new developments such as the Sampling and Caching Subsystem (SCS) that will collect and cache Martian soil and rock samples and the Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC) that will search for organics and minerals that have been altered by watery environments. SHERLOC and SCS faced technical challenges that resulted in increased costs. • ICON experienced schedule delays and associated cost growth due to issues with its Pegasus launch vehicle, not with the observatory portion of the project. The project missed its latest launch date due to anomalous telemetry from the launch vehicle. In November 2018, the project convened a Failure Review Board to investigate the anomaly. Project officials noted that the ICON observatory was completed on schedule and within cost. As of December 2018, the program had not rescheduled the launch date. • The Orion program completed an updated cost estimate, which includes a 5.6 percent development cost increase. Program officials explained that the major drivers of this cost growth were the slip of the EM-1 launch date, which reflected delays in the delivery of the service module; Orion contractor underperformance; and NASA directed scope increases, including purchasing EM-2 avionics. Furthermore, as we found in 2018, NASA officials told us that new hardware and development challenges contributed to increased cost for the program.21 • The SGSS project completed a cost estimate through its final acceptance review. As we found last year, NASA had only approved the SGSS project’s cost estimate through the initial operational readiness review, currently planned for September 2019.22 As a result, the $167.6 million increase in table 2 represents the additional costs for the SGSS project for the time between the initial operational readiness review to final acceptance review, which is currently scheduled for November 2020. We found three challenges in measuring the cost and schedule performance of the portfolio this year. First, the cost growth and schedule delays are likely an underestimate for the portfolio for two reasons. • The LCRD instrument is a hosted payload on an Air Force Space Test Program mission, and NASA is assessing the impact of continued delays with the spacecraft bus to LCRD’s cost and schedule. According to officials, the contractor—with whom the Air Force holds the contractual relationship—has experienced technical challenges refurbishing the existing spacecraft bus to meet the requirements of one of the other, non-NASA payloads. The full extent of the delay and cost increases will not be known until the Air Force provides the LCRD project with the contractor’s updated schedule and finalizes a new cost-sharing agreement with its mission partners. At that time, the LCRD project will be able to complete a new estimate of its schedule and associated costs. • Although the Orion project provided a revised cost estimate in June 2018, this cost estimate assumes a launch date of September 2022, which is 7 months earlier than the program’s baseline date of April 2023—the commitment date between NASA, Congress and OMB. Subsequently, program officials told us that its cost projections fund one of those seven months. However, the estimate is still not complete as it does not account for all costs that NASA would incur if the program executes to its committed baseline date of April 2023. We continue to follow up with NASA on this through other ongoing work. Second, the human spaceflight programs continue to experience challenges executing to cost and schedule commitments but the extent of those challenges are not yet captured in our assessment. In November 2018—within 1 year of announcing a delay for the first mission—senior NASA officials acknowledged that the revised June 2020 launch date is unlikely. These officials told us that there are 6 to 12 months of risk associated with this date. This means that additional delays beyond the 19 months of delays captured in our analysis for SLS and ground systems are likely. Finally, the SLS and EGS projects are performing development work for missions beyond EM-1 that is not captured in the portfolio analysis because NASA has not established baselines for those efforts. We cannot assess cost and schedule performance as part of our portfolio analysis until NASA establishes baselines for these efforts. To that end, we have made recommendations in the past on the need for NASA to baseline the programs’ costs for capabilities beyond the first mission; however, a significant amount of time has passed without NASA taking steps to fully implement these recommendations. For example, in May 2014, we recommended that because NASA intends to use increased capabilities of the SLS, Orion, and ground support efforts well into the future, that it should establish baselines for those efforts.23 NASA partially agreed with the recommendation but has not taken action. In our February 2019 high-risk report, we reported that the agency has not taken action on several recommendations related to understanding the longterm costs of its human exploration programs.24 Further, we found there was a lack of transparency in major project cost and schedules, especially for the human spaceflight programs. As we noted in the high risk report, without transparency into these estimates, both NASA and Congress have limited data to inform decision making.25 NASA Will Continue to be Challenged to Budget for Planned Major Projects Given Competing Priorities In its fiscal year 2019 budget request, NASA did not request funding for two major projects—WFIRST and PACE—but was proceeding with planned work on these projects while waiting for a final appropriation decision. The two projects together will require almost $3 billion over the next five years, according to NASA documents. Further, in May 2018, NASA reported selecting the Interstellar Mapping and Acceleration Probe project to begin formulation and implementation with a life-cycle cost cap of $565 million, which was not yet categorized as a major project in NASA’s fiscal year 2019 budget request. Continuing these efforts along with other ongoing major projects— including funding for a new Gateway that NASA envisions as a staging point for missions to the Moon and deep space—will result in NASA having to either increase its annual funding request for major projects or continue to make funding trades between projects as part of the annual budget request. For example, in its fiscal year 2020 budget request, NASA again did not request funding for WFIRST and PACE. Agency officials stated that they have difficulty managing the portfolio of major projects—particularly in conducting longer range planning—with continuing funding uncertainties. Further, officials stated that they receive direction from Congress to fund certain projects that may not be in the agency’s longer-range planning. We have previously found that the agency has faced difficulties in executing its plans due to budget uncertainty.26 As seen in figure 4, assuming NASA’s future budget requests align with its budget request for fiscal year 2019, NASA’s potential commitments exceed its topline major-project budget until fiscal year 2022, when a minimal wedge of available funding—approximately $344 million— for new requests begins to open up.

#### And, NASA outsourcing to private entities saves them money and focus

Miriam Kramer NASA's plans for the future hinge on the success of private companies Axios, Dec 7, 2021 - https://www.axios.com/nasa-private-spaceflight-plans-5a5710e6-5223-4da3-8c5d-5a712e1d862e.html

The private space players who will drive NASA's plans for the coming decade are declaring themselves and defining the stakes. Why it matters: NASA plans to focus on getting people to Mars and the Moon, and its deep space exploration ambitions hinge on the agency being able to successfully hand over major operations in low-Earth orbit to private companies. The space agency hopes companies will build private space stations that its astronauts can use and to continue to buy space on private rockets for launching its satellites and other payloads to orbit and beyond. NASA's "big experiment" right now is to test where these commercial partnerships work, the Planetary Society's Casey Dreier told Axios. What's happening: Last week, NASA announced it would award multimillion-dollar contracts to three teams of commercial space companies to start designing and building privately operated space stations.

#### B. Impact Story

#### NASA earth science programs solve extinction from warming---funding is on the brink, and new spending trades off

Garver, 19 – Chief executive at Earthrise Alliance and was deputy NASA administrator from 2009 to 2013.

Lori Garver, “Forget new crewed missions in space. NASA should focus on saving Earth,” The Washington Post. July 18, 2019. <https://www.washingtonpost.com/opinions/forget-new-manned-missions-in-space-nasa-should-focus-on-saving-earth/2019/07/18/79e55eb8-a995-11e9-9214-246e594de5d5_story.html>

--Climate change is biggest existential threat, not Russia or China

--Causes extinction, war, sv, and disease spread

--Any shift away super risky – we need to fund ALL of it

--NASA can orient towards climate studies – sound data can be communicated to public and create effective solutions

--Squo lacks harmony across countries about how to respond – NASA can standardize data for effective responses

NASA was not created to do something again. It was created to push the limits of human understanding — to help the nation solve big, impossible problems that require advances in science and technology. Fifty years ago, the impossible problem was putting a human on the moon to win the space race, and all of humanity has benefited from the accomplishment.

The impossible problem today is not the moon. And it’s not Mars. It’s our home planet, and NASA can once again be of service for the betterment of all.

Let’s remember our history. We went to the moon 50 years ago in response to the Soviet Union’s perceived domination of spaceflight. The 12 Americans who walked on the moon brought back [842 pounds](https://curator.jsc.nasa.gov/lunar/)of lunar material (rocks and dust), learned about our closest planetary body’s geology and gave us a view of the Earth that changed our perspective. But that’s not what drove [NASA spending](https://www.lpi.usra.edu/exploration/multimedia/NASABudgetHistory.pdf) to 4 percent of the federal budget in 1965. We were willing to stake so much on the moon landing — only because there was so much at stake.

After accomplishing this amazing feat, the aerospace community has again and again sought presidential proclamations to go further. President Trump is the fifth president to [proclaim](https://www.space.com/president-trump-lauds-moon-landing.html) we will send humans to the moon and/or Mars within a specific time frame, a decree without a value proposition that has never inspired broad public support [nor come close to coming true](https://www.washingtonpost.com/news/retropolis/wp/2017/10/10/presidents-love-evoking-jfks-iconic-moon-speech-now-its-the-trump-administrations-turn/?utm_term=.36a7cb94faf7).

NASA remains one the most revered and valuable brands in the world, and the agency is at its best when given a purpose. But the public doesn’t understand the purpose of spending massive amounts of money to send a few astronauts to the moon or Mars. Are we in another race, and if so, is this the most valuable display of our scientific and technological leadership? If science is the rationale, we can send robots for pennies on the dollar. In a July [Pew Research Center study](https://www.pewresearch.org/fact-tank/2019/07/17/how-americans-see-the-future-of-space-exploration-50-years-after-the-first-moon-landing/), 63 percent of respondents said monitoring key parts of Earth’s climate system should be the highest priority for the United States’ space agency — sending astronauts to the moon was their lowest priority, at 13 percent ; 18 percent favor Mars.

The public is right about this. Climate change — not Russia, much less China — is today’s existential threat. Data from NASA satellites show that future generations here on Earth will suffer from food and water shortages, increased disease and conflict over diminished resources. In 2018, the National Academy of Sciences [released its decadal survey](https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth) for Earth science and declared that NASA should prioritize the study of the global hydrological cycle; distribution and movement of mass between oceans, ice sheets, ground water and atmosphere; and changes in surface biology and geology. Immediately developing these sensors and satellites while extending existing missions would increase the cadence of new, more precise measurements and contribute to critical, higher-fidelity climate models.

NASA could also move beyond measurement and into action — focusing on solutions for communities at the front lines of drought, flooding and heat extremes. It could develop and disseminate standardized applications that provide actionable information to populations that are the most vulnerable. NASA could create a Climate Corps — modeled after the Peace Corps — in which scientists and engineers spend two years in local communities understanding the unique challenges they face, training local populations and connecting them with the data and science needed to support smart, local decision-making.

The fragmented system of roles and responsibilities related to handing the massive amounts of Earth science data is severely hampering global efforts required to make significant progress. The U.S. government role in addressing this challenge is foundering without leadership. Standardizing data collection and coordinating its storage, analysis and distribution require experience working across disciplines, government agencies and universities as well as the private sector and international community. Only NASA has done this sort of thing before; only NASA has the credibility and expertise to do it again.

Assigning NASA this task would require an Apollo-scale change — but could be accomplished within its existing mandate and by shifting funding priorities. [The National Aeronautics and Space Act of 1958](https://history.nasa.gov/spaceact.html) supports expansion of human knowledge of the Earth and phenomena in the atmosphere and directs the agency to develop and carry out a comprehensive program of research, technology and monitoring to understand and maintain the integrity of the Earth’s atmosphere. The act requires NASA to work with other federal agencies, academia and the private sector to make the necessary observations, disseminate their results and enlist the support and cooperation of appropriate scientists and engineers of other countries and international organizations.

Apollo’s legacy should not be more meaningless new goals and arbitrary deadlines. Let’s not repeat the past. Let’s try to save our future. Besides, humanity’s intrinsic need to explore is driven by our need to survive.

### DA

#### Link Story

#### Ownership of Asteroids is necessary to create the incentive for private entities to mine them.

Ross Myers, The Doctrine of Appropriation and Asteroid Mining: Incentivizing the Private Exploration and Development of Outer Space, 2016, Oregon Review of International Law, https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/19850/Meyers.pdf?sequence=1

Despite a decrease in national space program funding, corporate space missions are on the rise. In 2010, President Obama proposed that NASA exit the business of flying astronauts from Earth to low Earth orbit and move it to private companies.52 Several companies have stepped up to bat, and corporate space programs now include space tourism, supply missions, and in one case a one-way colonization mission to Mars.53 Corporate interest in space tourism and development demonstrates a strong private commercial interest in space as an industry, which could serve to finance the exploration of space in a period where national governments do not have an active financial interest in space. However, under current international treaties, the ownership of asteroids is prohibited, preventing corporations willing to invest in asteroid mining from having a secure claim.

You link –

[1] perceptions

[2] testing

[3] rocket boosters

[4] debris en route and back

#### Impact Story

#### Asteroid mining solves climate change, resource shortages, and environmental degradation – independently its key to space colonization that solves every existential crisis

Tina Hlimi, Canadian lawyer with a Bachelors and Masters Degrees in Environmental Sciences from McGill University, 2014, “THE NEXT FRONTIER: AN OVERVIEW OF THE LEGAL AND ENVIRONMENTAL IMPLICATIONS OF NEAR-EARTH ASTEROID MINING,” ANNALS OF AIR AND SPACE LAW, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2546924]/¶

THE ENVIRONMENTAL BENEFITS OF NEAR EARTH ASTEROID HARVESTING Let us recapitulate what we have already found. Shortage of resources is not a fact; it is an illusion born of ignorance. Scientifically and technically feasible improvements in launch vehicles will make departure from Earth easy and inexpensive. Once we have a foothold in space, the mass of the asteroid belt will be at our disposal, permitting us to provide for the material needs of a million times as many people as Earth can hold. Solar power can provide all the energy needs of this vast civilisation (10,000,000 billion people) from now until the Sun expires. Using less than one percent of the helium-3 energy resources of Uranus and Neptune for fusion propulsion, we could send a billion interstellar arks, each containing a billion people, to the stars. There are about a billion Sun-like stars in our galaxy. We have the resources to colonise the entire Milky Way. 122 In addition to demystifying the legal doctrine governing outer space natural resource appropriation it is also necessary to weigh the benefits and detriments of space-faring activities. Foremost, States around the world are developing at unprecedented rates and the human population is mounting in conjunction with demand for natural resources to sustain the current and newly established western standard of living. One of the fastest growing nations, China, is experiencing unhindered growth facilitated by fossil fuel use from coal and extensive mining. This has caused substantial water, soil and air degradation. In the face of these troubles, NEA mining could be the key to preserving the Earth's bounty and replenishing contaminated water supplies. The influx of natural resources could thwart the burning of dirty coal and fossil fuels, thereby mitigating the effects of climate change, such as, rising sea level, atmospheric pollution, melting of sea ice and rising temperatures. NEA harvesting could also protect the ocean and the fragile and largely unexplored deep seabeds 123 from oil and gas drilling. It could furthermore protect ecosystems from rare-earth mineral mining predominantly used to fuel the electronics sector. 124 NEA mining is especially pertinent as China restricted its global exports of rare-earth minerals in 2009, incongruously citing the need to protect the environment. Unfortunately, the supply cuts have forced dependent States like Japan, the United States and South Korea to heighten rare-Earth mineral exploration. This accordingly led to Japan's 2011 discovery of rare-earth minerals in the ocean-bed deposits of the Pacific Exclusive Economic Zone (PEEZ) thereby necessitating risky, deep-sea mining techniques, which may result in marine pollution if not carefully designed and developed. Other States, which have joined the environmentally destructive rare-earth mineral exploration movement include India, Canada, Tanzania, Australia, Brazil and Vietnam., There is accordingly much competition and exploration for rare-earth minerals which could result in significant exploitation of untouched areas like the PEEZ seabed and Mongolia.125 Other regions which may soon be targeted for mineral and hydrological resources include Antarctica and the Arctic. With the advent of technological advances, environmentally destructive practices such as refining may soon occur in outer space, sparing the Earth of pollution. 126 Accordingly, NEA mining is a viable technology for preserving the Earth's environment by curbing atmospheric and marine pollution, enhancing water supply and quality and mitigating the effects of climate change; all while allowing humankind to maintain and even improve their standard of living through increased technologies, consumption and population growth. B. THE ENVIRONMENTAL CONSEQUENCES OF NEAR EARTH ASTEROID MINING

#### **Expert consensus that warming is *real* and *existential* – it shatters the scales of cost-benefit analysis**

Treich, 15—Christoph Rheinberger (Professor of Health Policy and Management @ Harvard) and Nicolas Treich (Professor at the Toulouse School of Economics). Citing Weitzman (economist @ Harvard) and Bostrom (prof @ Oxford). “On the economics of the end of the world as we know it,” The Economist, http://www.economist.com/blogs/freeexchange/2015/07/climate-change

CLIMATE change puts humanity at risk. The Pope’s celebrated encyclical letter on the subject released last month emphasised this risk “for our common home”, arguing that “doomsday predictions can no longer be met with irony or disdain”. But apocalyptic predictions are often made by religious groups. So, how serious is this claim? Perhaps for the first time in history, there seems to be a broad consensus among scientists. They claim that our planet might face a frightening future if we cannot agree to take decisive actions here and now. Changes to how seawater circulates in the Atlantic, the melting of glaciers on Greenland and in the Antarctic, and rising sea levels might all result from inaction. Accounting for these catastrophic scenarios is a huge challenge for scientists and economists alike. So, what should we do in the face of existential risks? One, perhaps extreme, view is that the mere possibility of massive human extinction should inspire us to do everything we can to avoid it. The counterargument goes that we face several other existential risks and focusing on one may be shortsighted. In his fascinating book “Catastrophe: Risk and Response”, published in 2004, Richard Posner argues that we do not do enough to hedge against catastrophic risks such as climate change, asteroid impacts or bioterrorism. In light of the “competition” of existential risks, how much should humanity invest in the mitigation of climate change? Conventional wisdom holds that we should limit global warming to 2°C. To justify this target, economists seek to compare the cost of reducing current emissions with its benefits. Indeed, there is a trade-off: investing more resources today in climate-change prevention leaves less to combat other immediate risks. Interestingly, the Pope’s letter recognises that “decisions must be made based on a comparison of the risks and benefits foreseen for the various possible alternatives”. However, estimating these benefits means that we need to determine the value of a reduction in preventing a possible future catastrophic risk. This is a thorny task. Martin Weitzman, an economist at Harvard University, argues that the expected loss to society because of catastrophic climate change is so large that it cannot be reliably estimated. A cost-benefit analysis—economists’ standard tool for assessing policies—cannot be applied here as reducing an infinite loss is infinitely profitable. Other economists, including Kenneth Arrow of Stanford University and William Nordhaus of Yale University, have examined the technical limits of Mr Weitzman’s argument. As the interpretation of infinity in economic climate models is essentially a debate about how to deal with the threat of extinction, Mr Weitzman’s argument depends heavily on a judgement about the value of life. Economists estimate this value based on people’s personal choices: we purchase bicycle helmets, pay more for a safer car, and receive compensation for risky occupations. The observed trade-offs between safety and money tell us about society’s willingness to pay for a reduction in mortality risk. Hundreds of studies indicate that people in developed countries are collectively willing to pay a few million dollars to avoid an additional statistical death. For example, America’s Environmental Protection Agency recommends using a value of around $8m per fatality avoided. Similar values are used to evaluate vaccination programmes and prevention of traffic accidents or airborne diseases. Mr Posner multiplies the value of life by an estimate of Earth’s future population and obtains an illustrative figure of $336m billion as the cost of human extinction. Nick Bostrom, a philosopher at Oxford University, argues that this approach ignores the value of life of unborn generations and that the tentative figure should be much larger—perhaps infinitely so. The value of life as a concept is a natural candidate for a tentative estimation of the benefit of reducing extinction risk. Yet the approach seems somewhat awkward in this context. The extinction risk here is completely different from the individual risk we face in our everyday lives. Human extinction is a risk we all share—and it would be an unprecedented event that can happen only once. A lack of reliable data exacerbates the profound methodological and philosophical difficulties faced by climate change economists. Extinction is a threat to future generations, while evaluating and designing prevention policies is an urgent challenge today. The United Nations conference in Paris this December offers a chance to take appropriate steps to protect future generations from this risk. Many economists do not believe in the current pledge-and-review mechanism, and favour the implementation of a generalised carbon-trading system instead. While the Pope dismisses that solution out of hand, his attacks on technological innovation and capitalism, however, may not be very effective in overcoming the current inertia that climate negotiations suffer from.