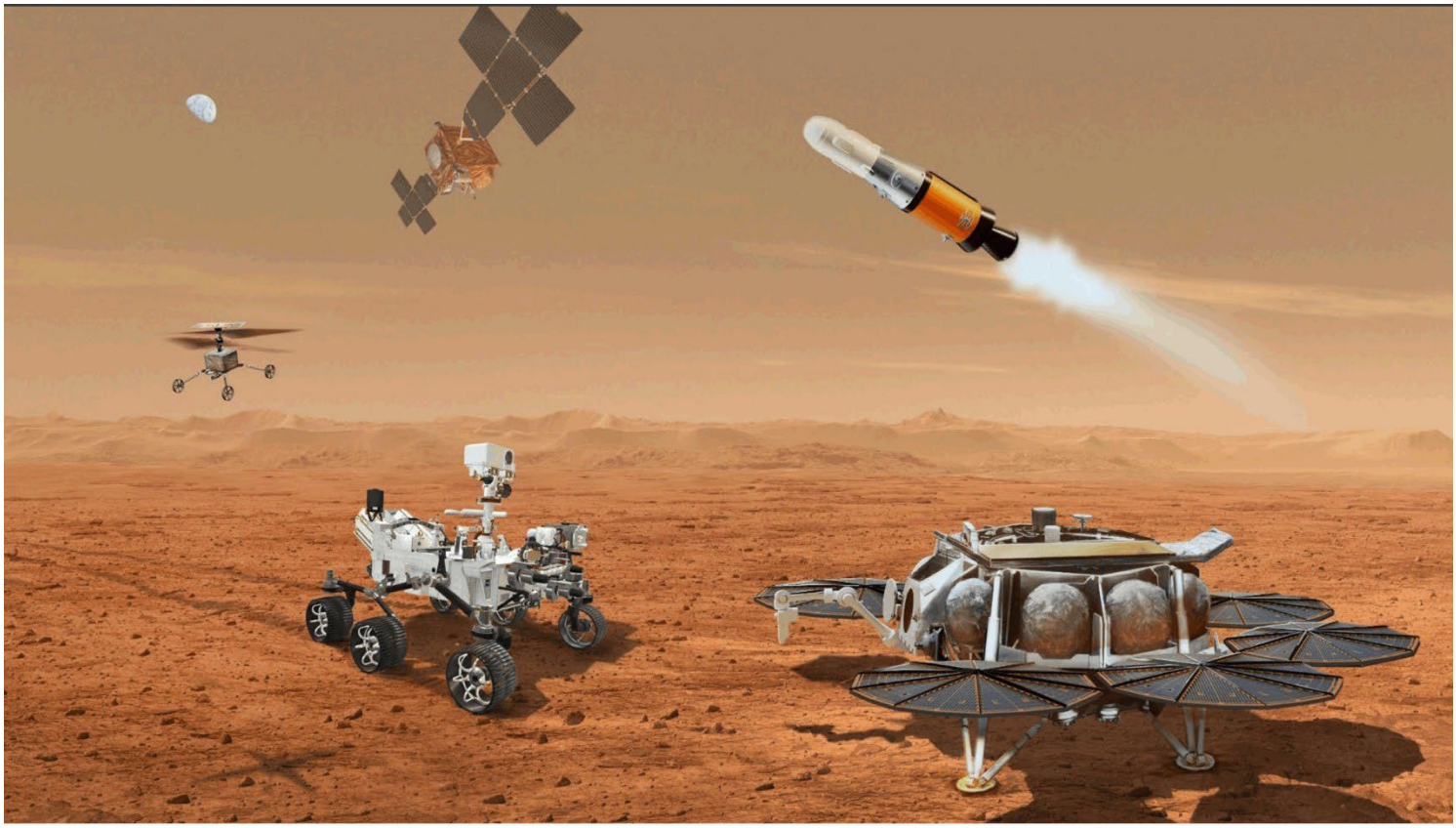
National Aeronautics and Space Administration



Record of Decision

Final Programmatic Environmental Impact Statement
Mars Sample Return Campaign – Tier I

October 2023

Science Mission Directorate
National Aeronautics and Space Administration
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Tier I Record of Decision
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INTRODUCTION

The National Aeronautics and Space Administration (NASA), in coordination with the European Space Agency, proposes to conduct a campaign to retrieve samples from Mars and transport them to Earth for scientific analysis and research. The Mars Sample Return (MSR) Campaign involves several flight elements, including launches from Earth to Mars, retrieving the samples on Mars, and delivering them to Earth for study. The sample landing location on Earth is the Department of the Air Force (DAF)-managed Utah Test and Training Range (UTTR), with supporting activities proposed at U.S. Army-managed Dugway Proving Ground (DPG). NASA bases this decision in part on the evaluations presented in the *Mars Sample Return (MSR) Campaign Final Programmatic Environmental Impact Statement (FPEIS).* NASA considered the information, analyses, and public comments received and contained in the FPEIS. Additional Earth-based ground elements associated with sample transportation and sample management/research (otherwise referred to as "curation") involving the development and operation of a Sample Receiving Facility (SRF) are also part of the MSR Campaign architecture. While this Record of Decision applies to the entirety of the MSR Campaign architecture, the specific environmental impacts concerning proposed sample transportation methods and the construction and operation of a SRF will be analyzed in a follow-on tiered NEPA analysis (i.e., Tier II), which will inform future agency decision making concerning these discrete elements of the overall MSR Campaign.

NASA is the lead agency, with the DAF serving as a cooperating agency because the scope of NASA's action involves activities under DAF jurisdiction by law; other agencies are serving as cooperating agencies due to special expertise (i.e., the Department of the Army, U.S. Department of Agriculture, and Centers for Disease Control and Prevention) (*FPEIS, Table 1.1-2*).

This Tier I Record of Decision (ROD) is issued in accordance with the Council on Environmental Quality (CEQ) regulations that implement the National Environmental Policy Act (NEPA) at Title 40 Code of Federal Regulations (CFR) Section 1505.2 (*Record of decision in cases requiring environmental impact statements*). NASA considered all the alternatives, information, and analyses, and concerns submitted by States, Tribal, and local governments, and other public commenters for consideration by NASA in developing the FPEIS.

This ROD documents:

- the decision;
- the alternatives considered;
- the reason (basis) for the selection;
- the environmentally preferable alternative;
- relevant factors and how those factors entered into the decision;
- whether all practicable means to avoid or minimize environmental harm from the selected alternative have been adopted, and if not, why not; and
- mitigations.

NASA DECISION SYNOPSIS

The overall MSR Campaign includes three flight elements and two ground elements. The flight elements consist of the Perseverance rover, a Sample Retrieval Lander, and the Earth Return Orbiter (which includes the Earth Entry System [EES]).

Currently, the Perseverance rover (launch analysis of this aspect was previously addressed in the *Final Supplemental EIS for the Mars 2020 Mission*) is collecting samples and caching them on the surface of Mars. The decision to implement the MSR Campaign within the context of this Tier I ROD involves the following: a) launch of the Sample Retrieval Lander element from Cape Canaveral Space Force Station or Kennedy Space Center (anticipated to launch as early as 2028, with a backup opportunity in 2030) and launch of the Earth Return Orbiter with the EES from French Guiana (covered under Executive Order 12114 - *Environmental Effects Abroad of Major Federal Actions*) within a similar launch timeframe as the Sample Retrieval Lander; b) the landing of the EES (containing the samples) back on Earth (at the UTTR) no earlier than 2033, with a backup opportunity in 2035; and c) the recovery of the EES by NASA [with cooperating agency logistical support (e.g., helicopters, personnel, etc.) as needed] at UTTR and temporary storage at a small DAF-leased location (Detachment-1, or "Det-1") located on DPG while awaiting transfer to an SRF (*FPEIS Section 2.1.3.1 and Figure 2.1-9*). As described in the FPEIS, NASA and DAF will continue to coordinate site preparation activities in advance of the EES' return.

The two ground elements (to be addressed under tiered NEPA analysis and a separate ROD) are transportation of the EES from the DAF-leased Det-1 location on DPG to an SRF, as well as development and operation of an SRF (not currently anticipated to be on UTTR, DPG, or any other Department of Defense-related property). NASA expects to initiate Tier II analysis of the specific ground elements of the MSR Campaign after this ROD has been made available to the public; the Tier II component is anticipated to be completed as early as 2026.

Specific details regarding the above MSR Campaign elements are provided in Section 2.1 et. seq. of the FPEIS.

Relative DAF Decisions

Historically, NASA has utilized the UTTR for the Stardust and Genesis missions, which returned samples of comet dust and the solar wind, respectively. The UTTR is also the planned landing site for the OSIRIS-REx mission, which is returning samples of dust and rocks from the asteroid Bennu in 2023. In cooperation with the DAF, NASA analyzed the environmental impact of these Earth return missions through the NEPA process. The DAF approved the use of the UTTR as the landing site for each of these spacecraft which included coordination on sample recovery procedures. The difference between the aforementioned NASA missions and the MSR Campaign is the payload being returned to Earth and the method of landing; previous missions used a parachute, while the EES is designed and engineered to reenter and land on Earth's surface ballistically (i.e., without a parachute). By taking this approach, the spacecraft's design can be more streamlined and simpler, and it avoids possible complications associated with a parachute failure (e.g., Genesis spacecraft reentry). In brief, the EES is specifically engineered to withstand the impact of landing in the soft soil of the UTTR and maintain containment of the samples without a parachute affecting its descent velocity.

DAF decisions relative to the MSR Campaign within the context of this Tier I ROD are associated with permitting the use of the UTTR for EES landing and recovery operations, and temporary storage of the EES at the DAF-leased Det-1 location on DPG while awaiting transfer to an SRF (it is not anticipated at this time that an SRF would be developed on the UTTR or DPG). Additionally, between the time this ROD is issued and the EES lands at the UTTR, there may be additional testing and training activities at the UTTR to support architecture design refinements and development of more robust reentry modeling and recovery methodologies. NASA will coordinate with the DAF to ensure that these activities are evaluated within the context of the

NEPA process (e.g., 32 CFR Part 989, the DAF's *Environmental Impact Analysis Process*). Should substantial changes relevant to environmental concerns, as described and analyzed in the FPEIS, be proposed for the MSR Campaign architecture or should NASA and/or the DAF become aware of significant new circumstances or information relevant to environmental concerns and bearing on the Proposed Action or its impacts, NASA may prepare a supplemental environmental impact statement or analyze the changes in its Tier II document for ground elements, as appropriate.

ALTERNATIVES CONSIDERED

As more fully described in the FPEIS (*Section 2.3*), NASA identified the UTTR as the only reasonable action alternative for EES landing, based on a rigorous landing location screening process. Therefore, the FPEIS analyzed impacts only associated with the Proposed Action and a No Action Alternative.

Because of the MSR Campaign's large scope and uncertainty regarding future timing, locations, and environmental impacts associated with ground element actions, NASA took a programmatic approach to analyzing the environmental consequences of the MSR Campaign program elements. The FPEIS programmatically addressed the potential impacts associated with all elements of the MSR Campaign and site-specifically addressed potential impacts at the UTTR/DPG associated with flight elements. Due to the programmatic nature of the FPEIS analyses, future tiered NEPA analysis will occur after the ROD is finalized but before additional action is taken to address site-specific environmental impacts related to ground elements (EES transportation, e.g., over the road or via aircraft, from the DAF-leased Det-1 location and DPG complex to an SRF). The type, location, construction, and operation of an SRF would also be analyzed in specific detail after mission requirements are more robustly characterized.

Appropriate transportation, storage, and curation protocols for the Mars samples, including transportation from the Det-1 location on DPG, are currently under investigation, with details incomplete at this time.[1] The FPEIS identifies and evaluates, from a programmatic perspective, the conceptual transportation methods and representative SRF options (i.e., new construction, existing facility, modular, or hybrid) that are most likely applicable to this future recovery and curation action; however, those elements of the Proposed Action cannot be analyzed from a site-specific perspective at this time because the transportation and site alternatives (i.e., mode of transportation and routes, SRF type and location, etc.) are still under consideration. Subsequent Tier II NEPA analyses will address site-specific impacts associated with sample transportation off the DAF-leased Det-1 location and DPG, as well as the type, location, development, and operation of an SRF.

Preferred Alternative (FPEIS, Section 2.1)

Section 2.1 of the FPEIS provides a detailed description of the Proposed Action, which is the Preferred Alternative, and is incorporated by reference. In summary, the Sample Retrieval Lander would be launched by NASA at either Cape Canaveral Space Force Station or Kennedy Space Center. The Orbiter (provided by the European Space Agency and launched from French Guiana) includes the Capture, Containment, and Return System (CCRS) provided by NASA, which would capture and contain the Orbiting Sample container for return to the surface of Earth. The CCRS consists of four components: 1) the Capture Enclosure, 2) the Assembly Enclosure, 3) the Earth

1 40 CFR § 1502.21 requires the identification of incomplete or unavailable information when that information is relevant to reasonably foreseeable significant adverse impacts.

Entry Vehicle, and 4) the Micrometeoroid Protection System. The CCRS captures the Orbiting Sample, ensures the exterior is sterilized and seals it inside a second layer of containment within the Earth Entry Vehicle, creating the EES, which would return to Earth no earlier than 2033, with a backup opportunity in 2035.

The nominal landing target area for the EES consists of an ellipse approximately 379 square kilometers (km^2) (146 square miles [mi^2]) contained within an area of the UTTR (*FPEIS Figures 2.1-3 and 2.1-9*). As identified in the Final PEIS, the nominal landing target area consists of an ellipse that defines the area with a 99.9999 percent probability of landing. The notional area associated with an off-nominal (abnormal or unexpected) landing event is an expanded version of the nominal ellipse; in off-nominal scenarios, it is expected that the landing ellipse may shift further to the northeast but would remain within the UTTR boundary. These landing areas may change slightly as NASA continues to mature the EES design and improve simulation models of the expected flight-environments. As an example, since the publication of the FPEIS, NASA has updated modeling analysis of wind drift effects on landing location. This has refined the probability of landing within the nominal landing target area (as depicted in a FPEIS Figures 2.1-3 and 2.1-9) from 99.9999 percent to 99.87 percent . This change does not constitute either 1) a substantial change to the proposed action that is relevant to environmental concerns or 2) significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (NASA, 2023, Memorandum for the Administrative Record). However, should the landing ellipses change substantively from those analyzed in the FPEIS, based on new information throughout the mission architecture refinement process, NASA may prepare a supplemental environmental impact analysis as appropriate.

The UTTR South Range contains debris such as aerial gunnery tow targets, referred to as “target darts” (*FPEIS Figure 2.1-10*). Within the landing ellipse are many target darts (*FPEIS Figure 2.1-12*), many of which (perhaps up to a few hundred) could require removal (coordinated between NASA and the DAF). Prior to landing, a portion of the landing area would be prepared by removing landing hazards to prevent inadvertent impacts with objects that would adversely affect the integrity of the EES. Currently, the UTTR is testing different methods for object removal, which may include digging below the ground surface (potentially up to 1.2 meters [4 feet]) to remove the large portions of exposed target dart debris or removing the exposed portion of the target dart and leaving the remaining subsurface elements. In either case, debris removal would require ground disturbance in the immediate vicinity of the subject debris, as well as the use of vehicles to transport to the debris removal site and to remove the debris from the landing area. Tracked and/or wheeled vehicles may be utilized. Landing area preparation would be conducted in accordance with the Hill AFB Cultural Resources Programmatic Agreement, as provided in Section B.4.1 of the FPEIS (Table 2.4-1 of the FPEIS provides a summary of site-specific impacts associated with dart removal; detailed analysis is provided throughout Chapter 3 of the FPEIS in each resource area).

NASA anticipates up to six recovery operation dress rehearsals during the 24 months prior to EES landing, with a team of up to 12 personnel, depending on required operational parameters. Dress rehearsals would likely involve the use of two to four helicopters. Additionally, NASA anticipates that a team of up to 40 personnel may be staged at the UTTR and/or DPG from 6 to 12 months prior to the EES reentry date for site preparation and recovery operations setup. Support for dress rehearsals and recovery operations setup would likely involve use of equipment (helicopters, wheeled vehicles, etc.), infrastructure (facilities, utilities, etc.), and personnel support supplied by the U.S. Army and the DAF (Table 2.4-1 of the FPEIS provides a summary of site-specific impacts

associated with these activities; detailed analysis is provided throughout Chapter 3 of the FPEIS in each resource area). This support would be coordinated with the respective agencies once requirements have been defined.

Upon landing, the EES would be expected to create an impact crater of approximately 1.2 meters (4 feet) in diameter and 0.5 meter (1.6 feet) in depth, based on soil composition, with soil ejected from the crater to approximately 15 meters (approximately 49 feet) from the EES. The entire area within which this small area impact (i.e., the size of the EES) could be made is approximately 570 km^2 (200 mi^2) (Table 2.4-1 of the FPEIS provides a summary of site-specific impacts associated with EES landing; detailed analysis is provided throughout Chapter 3 of the FPEIS in each resource area).

It is anticipated that tracking capabilities (e.g., radar) provided by Hill Air Force Base (AFB) would provide sufficient resolution of the landing site such that a single recovery team may be utilized; however, studies of the need for multiple teams and the required capabilities are underway. Prior to EES landing, one or more recovery teams would be staged at a strategic location away from the proposed landing site, with the objective to contain and recover the EES. The staging area would include communications equipment and vehicles (land and/or air) and equipment for use in transport to and from the landing site, as well as an environmentally isolated, biocontained, safe and secure mobile enclosure (or "vault"). The exact location of the staging area has not yet been determined; however, the most likely location for a staging area would be the DAF Detachment 1 (Det-1) location adjacent to the Michael Army Field runway located on DPG where the vault would be located for temporary storage of the EES while awaiting transfer to an SRF; the Det-1 location is DAF managed and leased from the U.S. Army. The Det-1 location has ready access to improved roadways and utilities if needed. This would facilitate transportation of the EES to the vault once contained, as well as transportation of the vault off Department of Defense property.

Other staging areas that may be utilized would consist of previously disturbed test site areas near the proposed landing ellipse that are accessible by road or air from DPG. While the EES recovery team would likely access the landing site via helicopter, the use of wheeled vehicles cannot be discounted. Recovery operations specific to the UTTR/DPG are described in the FPEIS (*Section 2.1.3*), with Table 2.4-1 of the FPEIS providing a summary of site-specific impacts associated with EES recovery and use of staging areas and Chapter 3 of the FPEIS providing detailed analysis in each resource area.

It is anticipated that the vault containing the EES would be transported off the UTTR/DPG to an SRF location as soon as possible, barring specific weather and other day-of-landing operational constraints. However, in the event of an off-nominal landing, NASA personnel could remain on site for several weeks or months as part of contingency activities. Specific contingency activities are unknown at this time, as NASA is currently evaluating contingency planning concepts; should contingency activities result in the potential for impacts outside the scope of this Tier I analysis then supplemental NEPA analysis may be required. As mentioned previously, potential site-specific impacts associated with transportation of the EES from the Det-1 location to an SRF, as well as development and operation of an SRF, will be addressed in follow-on Tier II NEPA analysis; Table 2.4-1 of the FPEIS provides a summary of potential impacts associated with these activities from a programmatic perspective; detailed programmatic analysis is provided throughout Chapter 3 of the FPEIS in each resource area.

Because the proposed launches are more than five years away, and the landing potentially ten years away, the mission and design requirements are still in development and subject to further

refinement. As a result, the MSR Campaign and its elements were analyzed using the most current planned mission architecture at this time. Should substantial changes relevant to environmental concerns, as described and analyzed in the FPEIS, be proposed for the MSR Campaign architecture or should NASA become aware of significant new circumstances or information relevant to environmental concerns and bearing on the Proposed Action or its impacts, NASA may prepare a supplemental environmental impact analysis as appropriate.

No Action Alternative. The FPEIS also evaluated a No Action Alternative (*FPEIS, Section 2.2*). With the No Action Alternative, NASA would not proceed with the MSR Campaign as currently devised. The affected environment (*FPEIS, Section 3*) for each resource area at the launch site(s) and landing site (UTTR) would be unaffected by MSR Campaign-related actions. Table 2.4-1 of the FPEIS provides a summary of both programmatic and site-specific impacts associated with the No Action Alternative.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

Of the alternatives considered, the environmentally preferred alternative is the No Action Alternative because taking no action would result in no impacts to environmental resources from ground disturbance, such as soil and air resources.

BASIS OF DECISION

The basis of the decision to proceed with the MSR Campaign is to support NASA's goal of collecting samples of Martian rocks, regolith, and atmosphere and delivering those samples to Earth for detailed analysis to enable significant advances in the following:

- the search for evidence of ancient life forms on Mars;
- the understanding of the origin and evolution of Mars as a geological system and how it may relate to the origin and evolution of other terrestrial planets;
- the understanding of the processes and history of climate on Mars; and
- the preparation for human exploration.

By acquiring and delivering to Earth a rigorously documented set of Mars samples for investigation in terrestrial laboratories, scientists would have access to the full breadth and depth of analytical science instruments available across the world. Similar to the lunar samples retrieved by NASA's Apollo missions to the Moon (1969 – 1972), the Mars samples would be studied for many decades and would likely include using future techniques that have not yet been invented.

The FPEIS analyzed the programmatic and site-specific (UTTR/DPG) aspects of the Proposed Action associated with health and safety, cultural resources, hazardous materials and waste, soils and geology, biological resources, water resources, air quality/climate, land use, socioeconomics, environmental justice / protection of children, noise, infrastructure, and cumulative impacts. The FPEIS found that no significant adverse impacts are anticipated from implementing the MSR Campaign Tier I elements. Based on the analysis presented in the FPEIS, NASA has selected the Preferred Alternative (i.e., Proposed Action) to implement the MSR Campaign.

MITIGATIONS

In the absence of any identified significant adverse impacts, no mitigations have been identified. NASA actions associated with launches, landing site preparation, and EES landing and recovery activities are subject to standard management actions and operating permit requirements relative to

the action location (e.g., NASA-related requirements at Kennedy Space Center, DAF-related requirements for hazardous materials handling at Cape Canaveral Space Force Station and the UTTR/Det-1 location). NASA does not consider non-discretionary regulatory compliance requirements or standard operating procedures (e.g., Best Management Practices implemented as part of normal business practices) as mitigations within the context of this NEPA analysis because these would be required to be implemented regardless of the scope of the action (e.g., compliance with Federal and state hazardous waste or stormwater requirements). However, NASA, in coordination with the DAF, will prepare a collaborative mitigation and monitoring plan (MMP) to identify and track any non-discretionary requirements (e.g., permit requirements) and Best Management Practices to ensure all actions to minimize potential environmental impacts are accomplished in a timely fashion. In developing the MMP, NASA and DAF will consider the requirements of NASA policies, similarly situated DAF policies and regulations, and other legal and regulatory requirements. The MMP shall be a living document, subject to change and kept up-to-date resulting from tiered and supplemental analysis and current and future permitting.

NASA will coordinate with the DAF for planning and site preparation activities necessary for the successful landing and recovery of the EES at the UTTR. This coordination would provide the necessary continuity of operations and management oversight to ensure unity of purpose is achieved and site preparation and recovery procedures are implemented in a timely manner in accordance with NEPA. The framework for this coordination will be developed separately and documented in an Interagency Agreement or other suitable instrument, as agreed to by NASA and the DAF.

While not a mitigation per se, a key component of the Preferred Alternative, in accordance with NASA policy and regulations, is the implementation of design/engineering measures to ensure that the Mars material is fully contained (with redundant layers of containment) within the EES so that it could not be released into Earth's biosphere and impact humans or Earth's environment. The material would remain contained until examined and confirmed safe or sterilized for distribution to terrestrial science laboratories. NASA and its partners would use many of the basic principles consistent with protocols for Biological Select Agents and Toxins (BSAT) (i.e., 7 CFR Part 331, 9 CFR Part 121, and 42 CFR Part 73) that address containment, handling, and study of materials that are known or suspected to be hazardous.

BSAT are specific biological agents that fall under a congressionally mandated level of control. BSAT material requires the use of additional biosafety measures (e.g., a higher level of biocontainment). Biocontainment for BSAT materials is accomplished per the Department of Health and Human Services - Centers for Disease Control and Prevention *Biosafety in Microbiological and Biomedical Laboratories*, and *NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines)*. For highly infectious or unknown materials, the highest level of biosafety and biosecurity measures, in addition to specific measures for transport and inactivation, are utilized for BSAT materials.

Because the samples would be treated as though potentially hazardous until demonstrated otherwise, they would be handled in a manner that leverages the necessary safety principles from the Federal Select Agent Program (*FPEIS Section 2.1.2.2.1*) to provide the highest level of security and containment during the EES landing, recovery, transportation, sample storage, and receiving/curation mission phases in support of planetary protection requirements. The samples would be stored and handled in a manner that is consistent with basic BSAT principles that are required to deem the samples safe for release and/or sterilized.

Regulatory oversight of BSAT material is a joint responsibility of the Centers for Disease Control and Prevention, the U.S. Department of Agriculture, and the Department of Justice. Except for the Department of Justice, each of these Federal departments, or components thereof, is serving as a cooperating agency in the preparation of this FPEIS. In coordination with NASA, the cooperating agencies will provide their unique and substantial experience during the development of appropriate safety assessment protocol(s). The DAF and U.S. Army would have some oversight responsibility for EES transport on the UTTR and DPG, respectively, to ensure regulatory requirements in this regard are being met. Should these protocols result in the potential for environmental impacts outside the scope of those identified in this FPEIS, additional environmental analysis may be required.

DECISION

After considering the potential environmental impacts of the alternatives, as well as comments and concerns of the public, potentially affected native American tribes, and other key stakeholders provided during scoping and on the Draft and FPEIS, NASA will implement the MSR Campaign flight elements, to include the launch of the Sample Retrieval Lander from Cape Canaveral Space Force Station or Kennedy Space Center in Florida and landing, recovery, and temporary storage of the EES at the UTTR/DPG (to include landing site preparation and training activities). As indicated previously, the specific environmental impacts concerning EES transportation methods off the DAF-leased Det-1 location (located on DPG) and the construction and operation of a SRF will be analyzed in a follow-on tiered NEPA analysis (i.e., Tier II). This will inform future agency decision making concerning these discrete elements of the overall MSR Campaign. This decision adopts all practicable means to avoid and minimize the environmental impacts of the Tier I-related decision.

I certify that NASA has considered all the alternatives, information, analyses, and comments submitted by State, Tribal, and local governments and public commenters for consideration by the lead and cooperating agencies in developing the FPEIS for the MSR Campaign and rendering this Tier I-related decision at both a programmatic and site-specific level.

Nicola J. Fox Digitally signed by Nicola J. Fox
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Nicola J. Fox, Ph.D.
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Date