Site-Wide Environmental Assessment for Marshall Space Flight Center, Alabama

Draft

February 2024

Prepared for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama

This page is intentionally left blank.

Contents

Appendixes

Tables

Figures

Acronyms and Abbreviations

Acronym	Definition
°C	degree(s) Celsius
ACHP	Advisory Council on Historic Preservation
ADEM	Alabama Department of Environmental Management
amsl	above mean sea level
BMP	best management practice
CAA	Clean Air Act
CASI	Climate Adaption Science Investigators
CatEx	categorical exclusion
CBMPP	construction stormwater best management practices plan
CBS	common booster segment
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH_4	methane
CLD	commercial low Earth orbit destination
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWA	Clean Water Act
dB	decibel(s)
dBA	A-weighted decibel(s)
dBP	decibel(s) of peak pressure
DoD	Department of Defense

Acronym	Definition
DOPAA	description of the proposed action and alternatives
DOT	Department of Transportation
EA	environmental assessment
EEOH	Environmental Engineering and Occupational Health
EIS	environmental impact statement
EJ	environmental justice
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EWS	emergency warning system
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FL	flight level
FONSI	Finding of No Significant Impact
GHG	greenhouse gas
GPS	global positioning system
HAP	hazardous air pollutant
HOSC	Huntsville Operations Support Center
HTPB	hydroxyl-terminated polybutadiene
ICRMP	Integrated Cultural Resources Management Plan
IROD	interim record of decision
LH2	liquid hydrogen
LOX	liquid oxygen
LUC	land use control

Acronym	Definition
MBTA	Migratory Bird Treaty Act
MPR	Marshall Procedural Requirement
MSFC	Marshall Space Flight Center
MWI	Marshall Work Instruction
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NACC	NASA-wide Automated Data Processing Consolidation Center
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act of 1969
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NHL	national historic landmark
NHPA	National Historic Preservation Act of 1966
NIOSH	National Institute for Occupational Safety and Health
NOA	Notice of Availability
NOTAM	notices to airmen
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPR	NASA Procedural Requirement
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
OSHA	Occupational Safety and Health Administration
OU	operable unit
PM	particulate matter

Acronym	Definition
PM_{10}	particulate matter with a 10-micron diameter or less
$PM_{2.5}$	particulate matter with a 2.5-micron diameter or less
RCRA	Resource Conservation and Recovery Act
RDRE	rotating detonation rocket engine
RP	rocket propellant
RP1	Refined Petroleum One
RSA	Redstone Arsenal
RTC	Redstone Test Center
SDZ	surface danger zone
SHPO	state historic preservation officer
SO_2	sulfur dioxide
SOP	standard operating procedure
SPTA	Solid Propulsion Test Area
SUA	special use airspace
SWPPP	stormwater pollution prevention plan
TNT	trinitrotoluene
tpy	ton(s) per year
U.S.	United States
U.S.C.	*United States Code*
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VOC	volatile organic compound
WNWR	Wheeler National Wildlife Refuge

1. Purpose and Need for the Proposed Action

1.1 Introduction

The National Aeronautics and Space Administration (NASA) has prepared this environmental assessment (EA) to analyze the potential environmental impacts of implementing continuing and future mission support activities at the Marshall Space Flight Center (MSFC) in Huntsville, Alabama.

NASA is the lead federal agency for this Proposed Action. This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (*United States Code* [U.S.C.] Title 42, Sections 4321 et seq.); the Council on Environmental Quality (CEQ) regulations for Implementing the Procedural Provisions of NEPA (*Code of Federal Regulations* [CFR] Title 40, Parts 1500 through 1508); NASA's NEPA implementing regulations (14 CFR Part 1216); and NASA Procedural Requirements (NPRs) for NEPA Management, NPR 8580.1.

1.2 Background

MSFC in Huntsville, Alabama (Source: NASA 2023i)

MSFC is in north-central Alabama on approximately 1,841 acres within the U.S. Army's Redstone Arsenal (RSA; refer to Figure 1-1). MSFC is approximately 100 miles north of Birmingham, Alabama; 100 miles south of Nashville, Tennessee; and 180 miles west of Atlanta, Georgia. The irregularly shaped property is roughly 3 miles long on its north-south axis and 2 miles wide on its east-west axis. The property used by MSFC is provided to NASA by the U.S. Army. The U.S. Army granted irrevocable use and occupancy of the lands and facilities known as MSFC to NASA for a term of 99 years beginning on July 1, 1960.

As noted, MSFC is located on RSA, which is roughly 10 miles long on its north-south axis and 6 miles wide on its east-west axis. RSA occupies 38,309 acres in the southwestern portion of Madison County, Alabama. The southern boundary of RSA is formed by the Tennessee River. The City of Huntsville surrounds RSA on the east, north, and most of the west sides. A substantial portion of RSA, including most of the lands to the south and west of MSFC, is a part of the Wheeler National Wildlife Refuge (WNWR). Approximately 180 acres of the WNWR extend onto property controlled by MSFC.

For more than six decades, NASA and the nation have relied on MSFC, to deliver its most vital propulsion systems and hardware, flagship launch vehicles, world-class space systems, state-of-the-art engineering technologies and cutting-edge science and research projects and solutions. From rocket engines to 3-D printing in space, MSFC capabilities and experience are essential to nearly every facet of NASA's mission of exploration and discovery about Earth, the Sun, the solar system and beyond.

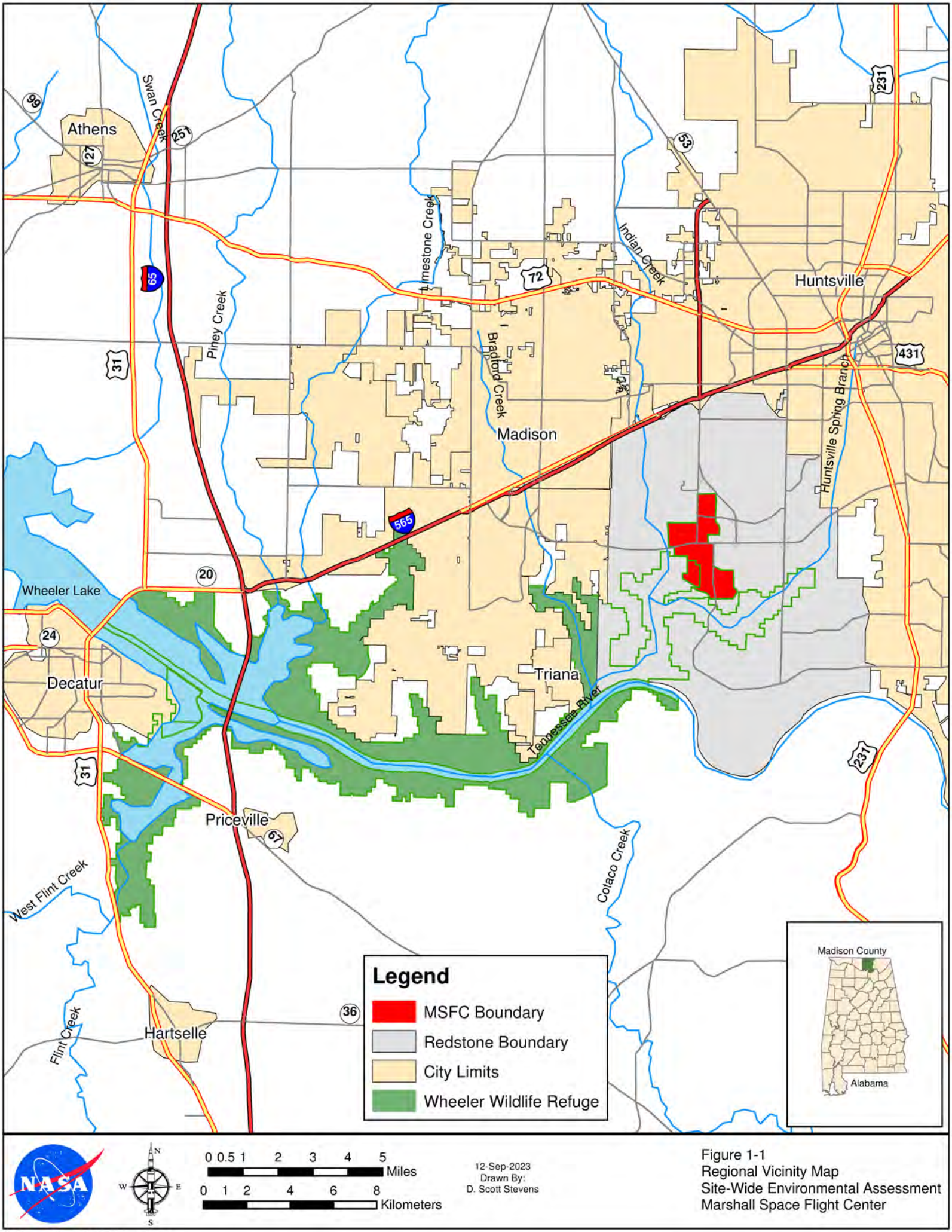


Figure 1-1
Regional Vicinity Map
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\MSFClocationFig.mxd

At the time of publication, the only MSFC tenant is Blue Origin, LLC. In 2019, NASA leased Blue Origin a 33.61-acre tract of land as well as Buildings 4658, 4667, 4667A, 4668, 4669, 4670, 4670A, 4670B, 4671, 4671A, 4671B, 4672, 4674 and 4679. The lease term is 20 years, unless it is extended through a written agreement between NASA and Blue Origin. Blue Origin is performing the following activities:

- Performing space flight hardware testing necessary or desirable to develop and operate a commercial service for delivery of humans, cargo, and payloads to space.
- Testing control and other associated engineering, technical, and administrative support activities associated with the provision of a commercial service for delivery of humans, cargo, and payloads to space.
- Designing and constructing NASA-approved improvements to the premises necessary or desirable to enable, sustain, and perform previous list items.

At MSFC, 15 departments/offices report to the MSFC Office of the Director. The current MSFC organizational chart and descriptions of the responsibilities of each office/directorate at MSFC are included in Appendix A.

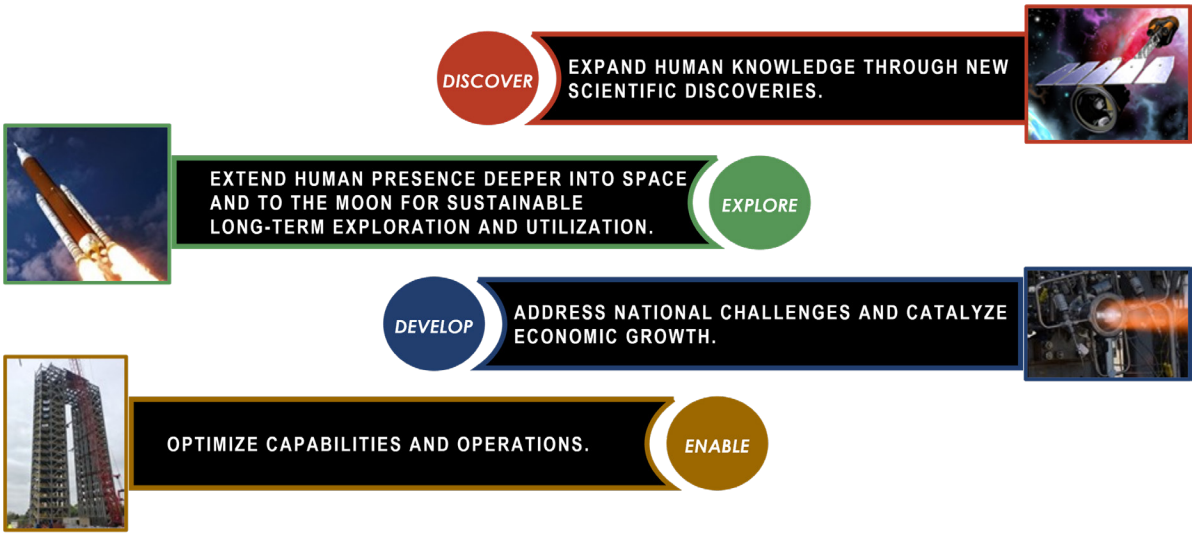
1.3 Purpose and Need for the Proposed Action

The Proposed Action is for MSFC to continue to meet NASA's goals by responding effectively to changes in mission, operations, and activities; and to create a mission-aligned real property portfolio. The purpose of the Proposed Action is to continue to enable MSFC to meet these goals by maintaining and increasing MSFC's ability to support the following core capabilities:

- **Propulsion.** MSFC's expertise in traditional solid and liquid propulsion systems, as well as advanced systems such as solar sails and nuclear propulsion, will enable a diverse array of spacecraft and missions for the future of exploration.
- **Materials and Manufacturing.** MSFC aims to maintain the most exhaustive collection of materials properties data in the world. MSFC will develop new manufacturing technology and techniques applicable to the smallest engine components or the largest cryogenic fuel tanks. MSFC will continue to pioneer work in friction stir welding, ultrasonic welding, and additive manufacturing to help NASA reduce costs, enhance reliability, and expedite development times.
- **Space Transportation Systems.** To enable NASA's human and robotic exploration missions, MSFC must maintain a broad spectrum of design, development, and testing capabilities. For launch vehicles and spacecraft, MSFC must develop and analyze advanced vehicle and systems concepts, design advanced avionics and guidance systems, and provide a full suite of structural testing capabilities.
- **Space Systems.** MSFC will continue to support living and working on the International Space Station, plan future systems for life support and scientific research, study space environment effects, and operate a comprehensive suite of environmental testing facilities to verify hardware prior to flight.
- **Habitation Systems.** MSFC will lead NASA's formulation and development of future exploration habitats, including lunar transit habitats, lunar surface habitats, Mars transit habitats, and Mars surface habitats. These habitation systems will support long-duration stays on the Moon and eventual human missions to Mars.
- **Scientific Research.** MSFC's scientific research must include a broad array of earth science, heliophysics, astrophysics, and planetary science investigations.

The Proposed Action will drive MSFC's programs and objectives which in turn drive its facilities and infrastructure. The Proposed Action is needed is to ensure that MSFC remains critical to the future of NASA and space exploration. In meeting this need, MSFC will remain a mission-focused solutions provider,

establish and increase commercial partnerships to meet NASA's mission needs, and efficiently provide the facilities, tools, and services required to support NASA's Strategic Goals. NASA's Strategic Goals are presented on Figure 1-2 (NASA 2019a).



Source: NASA 2019

Figure 1-2. NASA's Strategic Goals

1.4 Organization of the Environmental Assessment

NASA has prepared this EA to provide an efficient and comprehensive analysis of the potential environmental impacts associated with the implementation of the Proposed Action.

This EA is organized as follows:

- **Section 1**, ***Purpose and Need for the Proposed Action***, provides background information relevant to the Proposed Action, the purpose and need for the Proposed Action, and a brief description of how the document is organized.
- **Section 2**, ***Description of the Proposed Action and Alternatives***, presents detailed descriptions of the Proposed Action and the No Action Alternative.
- **Section 3**, ***Affected Environment and Environmental Consequences***, provides a description of the existing conditions of the environmental resources potentially affected by the Proposed Action and presents an analysis of potential direct, indirect, and cumulative impacts to environmental resources.
- **Section 4**, ***Summary of Impacts***, describes the potential impacts associated with the Proposed Action and the mitigation measures that would be implemented to avoid or minimize those impacts.
- **Section 5**, ***Distribution***, provides a list of agencies and individuals who were contacted for information in the preparation of this document and to whom the EA will be distributed.
- **Section 6**, ***List of Preparers***, provides a list of the names and qualifications of the document preparers.
- **Section 7**, ***References***, lists the references used in preparing this EA.

1.5 Key Documents Section

The following is a list of key documents that this EA will rely on:

- *Agency Master Plan (AMP) Programmatic Environmental Assessment* (NASA 2023i)
- *Natural Resources Management Plan for NASA Marshall Space Flight Center* (NASA 2023c)
- *Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation* (NASA 2023d)
- *George C. Marshall Space Flight Center Environmental Justice and Equity Plan* (NASA 2023b)
- *Marshall Space Flight Center Strategy for the Future* (NASA 2023f)
- *Marshall Space Flight Center 2022 Research and Technology Report* (NASA 2022a)
- *Marshall's Facilities Concept Plan* (NASA 2019a)
- *Marshall Space Flight Center 2017 Environmental Resources Document* (NASA 2017)
- *Integrated Cultural Resources Management Plan for Marshall Space Flight Center 2015-2020* (NASA 2016)
- *Environmental Assessment for Marshall Exchange Retail Development Property Lease at George C. Marshall Space Flight Center* (NASA 2012)
- *Environmental Assessment of Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center* (NASA 2010)
- *Constellation Programmatic Environmental Impact Statement* (NASA 2008)
- *Environmental Assessment for Marshall Space Flight Center Propulsion Research Laboratory* (NASA 2002)
- *Marshall Space Flight Center 20-Year Facilities Master Plan* (NASA 2003)
- *Environmental Impact Statement of Engine Technology Support for NASA's Advanced Space Transportation Program* (NASA 1997)

1.6 Public Outreach and Involvement

The Notice of Availability (NOA) of the Draft EA was advertised in the *Huntsville Times* newspaper on February 4, 2024, as included in Appendix B. The Draft EA and associated NOA are also posted on the NASA NEPA Public Reviews webpage[1] maintained by the NASA Environmental Management Division at NASA Headquarters.[1] Public comments will be accepted through March 5, 2024. NASA will have a limited number of hard copies of the Final EA, which are available upon request by contacting msfc-environmental@mail.nasa.gov. Copies of the Draft EA were provided to the public at the following library locations:

- Huntsville-Madison County Public Library, 915 Monroe Street SW, Huntsville, Alabama 35801
- Madison Public Library, 142 Plaza Boulevard, Madison, Alabama 35758

The comments and responses to the comments on the Draft EA will be provided in Appendix B of the Final EA. When necessary, the Final EA will be updated in response to these comments.

An NOA of the Final EA will also be posted on the NASA NEPA Public Reviews webpage[1] and advertised in the *Huntsville Times*.

[1] https://nasa.gov/news-release/site-wide-environmental-assessment-for-marshall-space-flight-center-alabama/

This page is intentionally left blank.

2. Description of the Proposed Action and Alternatives

2.1 Proposed Action

Activities at MSFC include operational missions and activities, which are program and project driven and can change between years as missions evolve, and routine recurring actions, which support facility operations. The Proposed Action covers MSFC's current and future site-wide operations. Many of the activities have either already been evaluated in previous NEPA analyses or would qualify for a categorical exclusion (CatEx). CatExs are defined in NASA's NEPA implementing regulations (14 CFR Subpart 1216.304) as categories of Agency actions with no individually or cumulatively significant impact on the human environment and for which neither an EA nor an environmental impact statement (EIS) is required. The use of a CatEx is intended to reduce paperwork, improve Government efficiency, and eliminate delays in the initiation and completion of proposed actions having no significant impact. A proposed action may be categorically excluded if the action fits within a category of actions eligible for exclusion, as listed in paragraph D of 14 CFR Subpart 1216.304, and the proposed action does not involve any extraordinary circumstances, as described in paragraph C of 14 CFR Subpart 1216.304.

This EA analyzes the following actions that do not qualify for a CatEx or have previous NEPA coverage:

- Propulsion Testing
- Habitation Systems
- Real Property
  - Construction of Marshall Exploration Facility
  - Construction of Engineering and Sciences Laboratory
  - Construction of Pistol Range Expansion
  - Installation of a Liquid Hydrogen (LH2) Tank

2.1.1 Operational Missions and Activities

Operations at MSFC are program- and project-driven and can change from year to year as missions evolve or change. Anticipated operations at MSFC would include, but not be limited to, Artemis and Mars Forward system developments.

At time of publication, current Operational Missions and Activities that qualify for a CatEx and/or are covered by prior NEPA documents include the following:

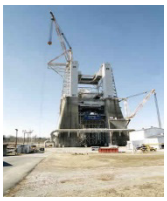
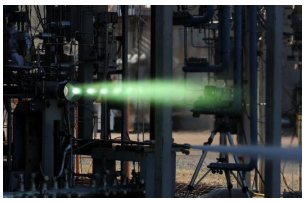
- Advanced Space Transportation Systems
- Lander Systems
- Space Launch Systems
- Surface and Technology Systems
- In-Space and Surface Mission Operations
- Technology
- Science
- Industry and Other Government Organizations

For more information about these covered activities, refer to Appendix C, MSFC Activities Covered by Categorical Exclusions or Previous NEPA Analysis.

2.1.1.1 Advanced Space Transportation Systems – Propulsion Testing

MSFC houses a comprehensive set of testing facilities for propulsion systems as part of the Advanced Space Transportation Systems programs. Table 2-1 describes the locations, engines/components, and propellants associated with propulsion testing that are covered under prior NEPA analyses. Refer to Appendix C, MSFC Activities Covered by Categorical Exclusions or Previous NEPA Analysis, for additional details.

Table 2-1. Propulsion Testing at MSFC with Prior NEPA Coverage

Location/Facility	Maximum Size Engine/Components Housed	Propellants/Pressurants Used
Building 4670, Advanced Engine Test Stand 	75,000-pound thrust class engine or components Blue Engine-4 – 550,000-pound thrust Blue Engine-3 – 125,000-pound thrust Capable of evaluating full-scale and vehicle state systems.	LOX LH2 Liquid methane RP1 Gaseous helium Gaseous hydrogen
Building 4583A, Test Facility 115 	10,000-pound thrust class engine or components 5,000-pound thrust class RDREs Designed for testing small-scale combustion devices including injectors, combustion chambers, and nozzles.	LOX LH2 Liquid methane Gaseous hydrogen RP1
Building 4540, Test Facility 116 	75,000-pound thrust class engine or components 30,000-pound thrust solid rocket motors 30,000-pound thrust class RDRE Designed for testing high-pressure engines/systems, cryogenic propellant systems, combustion devices, and acoustic models.	LOX LH2 Liquid methane Gaseous hydrogen Gaseous nitrogen RP1
Building 4530, Test Facility 300	5-position stand with capability to simulate launch thermal and pressure profiles and high-altitude testing for LOX/LH_2 and LOX/RP1 engines.	LOX LH2 RP1
SPTA	48-inch-diameter, 100,000-pound thrust solid rocket motor Small thrusters or RDRE-type engines or components Designed for testing nozzle insulation, case insulation, fuel cartridge inhibitors, and propellant grains.	RP1 Hydrogen peroxide HTPB
Test cells at Building 4583; SPTA	7,500-pound thrust class solid or hybrid motor 500-pound thrust class RDRE	Gaseous oxygen HTPB

Location/Facility	Maximum Size Engine/Components Housed	Propellants/Pressurants Used
Building 4626, LH2 Cold Flow Facility	Low-pressure flow tests of hydrogen engine and subsystem components	LH2 Liquid Hydrocarbons Gaseous Hydrogen Gaseous Helium Gaseous Nitrogen Gaseous Oxygen Missile Grade Air
Building 4554, Hot Gas Test Facility	Hydrogen/air combustion-driven environmental test facility capable of generating flow speeds up to Mach 4 and high heating rates to test materials and coatings	Gaseous Hydrogen Gaseous Nitrogen Missile Grade Air

Source: NASA 1989, 1997, 2010

HTPB = hydroxyl-terminated polybutadiene

LOX = liquid oxygen

RDRE = rotating detonation rocket engine

RP1 = Refined Petroleum One

SPTA = Solid Propulsion Test Area

Propulsion testing at the SPTA is covered under the *Solid Propulsion Test Bed (SPTB) Environmental Assessment* (NASA 1989) and *Environmental Assessment of Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center* (NASA 2010). The use of Common Booster Segment (CBS) Solid Fuel Propellant, as described in Table 2-2, was not previously analyzed in the 1989 and 2010 EAs (NASA 1989, 2010). Testing at SPTA using CBS Solid Fuel Propellant would occur up to two times per year. CBS Solid Fuel Propellant is proprietary, but it has been determined to be substantially similar to existing solid fuel propellants already in use at MSFC.

Table 2-2. SPTA Solid Fuel Propellant

Location	Propellant	Quantity	Thrust
SPTA	CBS Solid Fuel Propellant, TP-H1271 (Class 1.3C[a])	5,150 pounds	92,000 pounds

[a] Class 1.3 consists of explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard (49 CFR Subpart 173.50).

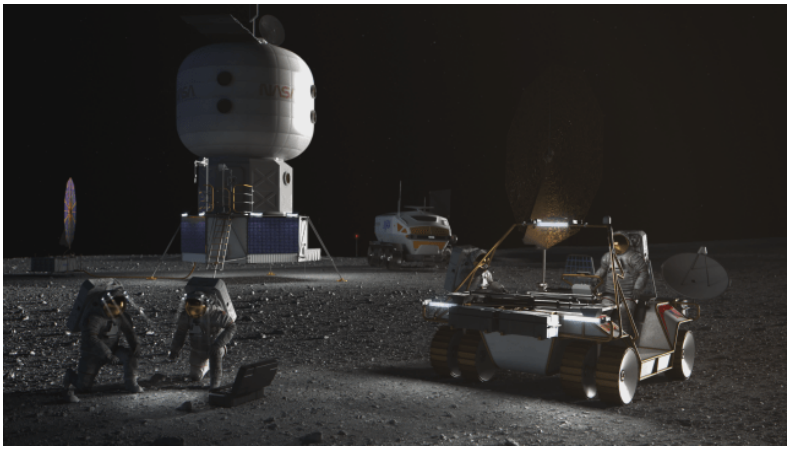
2.1.1.2 Habitation Systems

MSFC leads NASA's formulation and development of future exploration habitats, including lunar transit habitats, lunar surface habitats, Mars transit habitats, and Mars surface habitats. These habitation systems will support long-duration stays on the Moon and eventual human missions to Mars. MSFC personnel perform requirements, development, systems engineering and integration, design integration, launch package integration, acquisition planning and execution, international partner coordination, and Program Planning & Control Functions for the following habitation systems: Commercial Low Earth Orbit Destinations (CLD)/Starlab, CLD/Orbital Reef, Pressurized Rover, Relocatable Surface Habitat, Surface Habitat, Transit Habitat @ Gateway, Constructed Habitat, Transit Habitat @ Mars Transit, Mars Surface Habitat.

NASA and Industry Partners are performing various engineering tests, such as burst and creep-to-burst tests of subscale and full-scale prototypes of inflatable habitat structures that will be sent to space. These tests are designed to intentionally fail the prototype inflatable habitats in a controlled environment to understand the limits of the prototypes and guide better designs for the habitats that will be flown in space. Test engineers plan on using high purity air to inflate the prototypes quickly and at varying pressures to burst in a short time frame (burst test) or at a gradual pace and constant pressure for tens of thousands of hours until it bursts (creep-to-burst test).

The development and testing of habitation systems at MSFC may require construction (less than $1 million) of structures that provide environmental and lighting controls.

Although every effort was made to analyze the habitation system testing at MSFC into the next decade, the reality is that this is an emerging field of research and there may be future designs of habitats that have potential environmental impacts at MSFC that are not addressed in this Site-wide EA. Those that are not covered by this Site-wide EA or a CatEx would go through the NEPA process, which is described in Section C.1 of Appendix C.



Marshall Habitation Systems (Source: NASA 2023l)

2.1.2 Routine/Recurring Actions

Routine site activities at MSFC include recurring actions that are conducted to support facility operations mission-related activities.

Routine/Recurring Actions that qualify for a CatEx include the following:

- Materials and Manufacturing
- Maintenance and Improvements

For more information about Materials and Manufacturing and Maintenance and Improvements activities, refer to Appendix C, MSFC Activities Covered by Categorical Exclusions or Previous NEPA Analysis.

2.1.2.1 Real Property

Real property includes MSFC's buildings, vertical infrastructure, and horizontal infrastructure, such as the following:

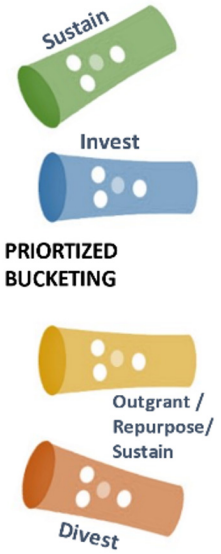
- Administrative facilities
- Engine testing facilities

- Fabrications and assembly facilities
- Ground improvements facilities
- Liquid fuel infrastructure and facilities
- Maintenance facilities
- Operational facilities
- Propellant infrastructure and facilities
- Research, development, and testing facilities
- Storage facilities
- Utilities, infrastructure, and facilities
- Wind tunnel facilities

Prior to a decision on the disposition of any specific real property, the future action must be considered within the context of NEPA to identify and analyze the site-specific environmental effects of proposed infrastructure management projects. Real property decisions would be informed by site-specific environmental effect analysis that considers the unique conditions that exist at each location. This analysis could take the form of a CatEx with Record of Environmental Consideration, an EA–Finding of No Significant Impact (FONSI), or an EIS–Record of Decision. The appropriate level of NEPA would be determined on a case-by-case basis. Section C.1 in Appendix C describes the process for obtaining NEPA coverage at MSFC.

Mission-critical assets were identified by reviewing detailed data behind each asset category. Real property assets at MSFC are inventoried and bucketed as either Sustain, Invest, Divest, or Outgrant, as described in NASA's *Agency Master Plan Programmatic Environmental Assessment* (NASA 2023i), as follows:

- Real Property assets bucketed as "Sustain" have high mission and conditions scores and are to be maintained to their current condition.
- Real Property assets bucketed as "Invest" have a high mission score but a low condition score and should be considered for investments to reduce their DM, improve their FCI to 3.6 or higher, and/or improve their overall affordability.
- Real Property assets initially bucketed as "Outgrant" have a low mission score and a high condition score and need further evaluation/discussion through the adjudication process to determine if they should be outgranted, repurposed, consolidated or sustained.
- Real Property assets bucketed as "Divest" have low mission and condition scores and should be considered for divestment through demolition.



An asset's assignment to one of the four bucket actions was based on its mission relevance score and condition score. Core capabilities determine the bucketing of assets based on future need.

2.1.2.2 Sustainment

Real property assets bucketed as "Sustain" have high mission and conditions scores and are to be maintained in their current condition. Future planning efforts at MSFC may identify sustainment projects and assets. When new sustainment projects come up for evaluation, they will be subject to the NEPA process, as described in Section C.1 of Appendix C. Planned sustainment projects of historic buildings at

MSFC are described in, but not limited to, Table D-1 of Appendix D. Historic building sustainment projects are the sole focus of the analysis in this EA because of their historic status.

2.1.2.3 Investment

Real property assets bucketed as "Invest" have high mission score and should be considered for investments and/or improve their overall affordability. Investment includes repairing degraded assets, renovating to modernize an asset, or creating a new asset via construction. Investment assets at MSFC are described in, but are not limited to, Table D-2 of Appendix D. Planned construction projects of new assets at MSFC are described in Table 2-3. Investment assets and planned construction of new assets are shown on Figures 2-1a, 2-1b, and 2-1c. Future planning efforts at MSFC may identify additional investment projects and assets.

Table 2-3. Planned Construction Projects of New Assets

Project	Description
Construction Site C1 – Marshall Exploration Facility	Construction of a new multi-level, multi-functional building that includes space for training, large auditorium, conferencing space, collaboration/meeting spaces, offices, retail, food service, and be a focal point for visitors. This building would replace Building 4200. The construction site would be up to 8 acres. Groundbreaking is expected December 2024 with construction expected to be completed in summer of 2027.
Construction Site C2 – Administrative Facilities	Construction of new administrative facilities. The construction site would be up to 5 acres.
Construction Site C3 – Propulsion Development Laboratory Expansion	Expansion of the Propulsion Development Lab. The construction site would be up to 4.5 acres.
Construction Site C4 – Engineering and Sciences Laboratory	Construction of a new Engineering and Sciences Laboratory in the 4600 Engineering Directorate complex. The construction site would be up to 3.2 acres.
Construction Site C5 – Firearms Range Expansion	Permit with the Federal Bureau of Investigation (FBI) for expansion of the firearms range.
Construction Site C6 – LH2 Tank Installation	A larger 5,500-gallon LH2 tank would be added adjacent to the current 2,600-gallon tank at Building 4628.

2.1.2.4 Divestment

Real Property assets bucketed as "Divest" have a low mission score and condition scores and should be considered for divestment through demolition or other means. Divestment assets at MSFC are described in, but not limited to, Table D-3 of Appendix D and shown on Figures 2-1a, 2-1b, and 2-1c. Future planning efforts at MSFC may identify additional divestment projects and assets. When new divestment projects come up for evaluation, they will be subject to the NEPA process, as described in Section C.1 of Appendix C.

2.1.2.5 Outgrant

Real Property assets bucketed as "Outgrant" have a low mission score and a high condition score and need further evaluation to determine if they should be outgranted, repurposed, consolidated, or sustained. Outgranting is the non-permanent transfer of rights by NASA or real property to others by means of

lease/permit/easement/right-of-way/license/Space Act Agreement/memorandum of agreement/concessionaire agreement. Outgrant assets at MSFC are described in, but not limited to, Table D-4 of Appendix D and shown on Figures 2-1a, 2-1b, and 2-1c. Future planning efforts at MSFC may identify additional outgrant projects and assets.

2.1.2.6 Development Sites

Sites at MSFC that could be made available for development are described in, but not limited to, Table D-5 of Appendix D and shown on Figures 2-1a, 2-1b, and 2-1c. Future planning efforts at MSFC may identify additional development sites.

2.2 No Action Alternative

The No Action Alternative would maintain existing conditions at MSFC. The activity level of facility support projects and operational missions and activities would remain at present levels and within previously established analyses (NEPA documents, site-wide studies, etc.). Failure to accomplish the Proposed Action would result in the inability to modify operations and real property as new mission needs arise and would also add additional regulatory and financial burden because NASA would need to support additional NEPA analysis. The No Action Alternative would also not be environmentally preferable because it may cause potential damage to the physical environment by allowing real property assets to degrade. The No Action Alternative would not protect, preserve, or enhance MSFC natural resources.

This page is intentionally left blank.

3. Affected Environment and Environmental Consequences

This section provides a description of the affected environment for each of the potentially impacted resources, along with an analysis of the potential environmental consequences associated with the Proposed Action and No Action Alternative.

Affected Environment

The following Affected Environment sections provide an overview of the existing conditions, including trends and planned actions for each resource, within the Proposed Action area. The Proposed Action area is shown on Figure 3.0-1 and Figure 3.0-2. The description of the affected environment focuses on those resources and conditions potentially impacted by the Proposed Action and No Action Alternative.

Environmental Consequences

The purpose of NEPA is to inform decision makers and the public of the likely environmental consequences of the Proposed Action and its alternatives. This section identifies the anticipated effects of the Proposed Action on each resource as distinct from environmental trends and planned actions that could continue under the No Action Alternative. The analysis of resource impacts focuses on environmental issues in proportion to the degree of impact. Impacts described in this EA are evaluated based on level of intensity (no impact, less than significant, or significant). These terms are further defined in Table 3-1.

Table 3-1. Impact Threshold Definitions

Impact Intensity	Intensity Description
No impact	An environmental impact that is so small, it would be difficult to observe, and its effect on human health or the environment would be considered inconsequential. No mitigation is required.
Less than significant	An environmental impact that is not a substantial and adverse change to human health or the environment. This impact level does not require mitigation, even if feasible mitigation measures are available.
Significant	An environmental impact that is observable and could cause a major and lasting impact to human health or the environment. If significant impacts are identified that cannot be mitigated, an EIS would need to be completed prior to implementing the Proposed Action.

If the impact intensities are different among the real property, propulsion testing, and habitation systems testing actions, they are discussed separately by activity. For impact intensities that are similar regardless of the activity, these impacts are grouped together to avoid repetition and the potential cumulative impacts are considered. Cumulative impacts, which are impacts on the environment that result from the combination of impacts of multiple, independent actions over time, are described in Section 3.19.

If future activities could result in significant impacts to any resources analyzed in this EA based on thresholds of significance for each resource, then additional NEPA analysis would be conducted to determine the level of impact and any necessary mitigations. Mitigations are measures implemented to avoid adverse impacts to the environment and/or to reduce them to less than significant.

3.1 Resource Areas Eliminated from Further Analysis

In accordance with the CEQ directives to focus NEPA analyses on environmental resource areas where there is a potential for significant impact and where the analyses are expected to provide useful information to the decision maker (40 CFR Subpart 1502.2), some resource areas have been eliminated from detailed study in this EA. The rationale for their elimination is summarized as follows:

- **Coastal Zones**: The Proposed Action area is not located within a coastal area.
- **Visual Resources**: The Proposed Action would have insignificant impacts on visual resources. The visual appearance of new facilities would be consistent with the industrial character of the area. The Proposed Action would also have a beneficial impact on visual resources because degrading real property assets would be responsibly removed.

3.2 Resources Studied in Detail

Resources analyzed in detail in this EA include the following:

- Air Quality (Section 3.3)
- Climate Change and Greenhouse Gases (Section 3.4)
- Land Use (Section 3.5)
- Water Resources (Section 3.6)
- Biological Resources (Section 3.7)
- Geology and Soils (Section 3.8)
- Noise (Section 3.9)
- Traffic and Transportation (Section 3.10)
- Socioeconomics (Section 3.11)
- Children's Environmental Health and Safety (Section 3.12)
- Environmental Justice and Equity (Section 3.13)
- Hazardous Materials and Wastes, Solid Waste, and Pollution Prevention (Section 3.14)
- Public and Occupational Health and Safety (Section 3.15)
- Utilities and Infrastructure (Section 3.16)
- Cultural Resources (Section 3.17)
- Airspace (Section 3.18)

3.3 Air Quality

3.3.1 Affected Environment

The Alabama Department of Environmental Management (ADEM) is the regulatory authority and administers the various aspects of the Clean Air Act (CAA), including the National Ambient Air Quality Standards (NAAQS), National Emission Standards for Hazardous Air Pollutants (NESHAPS), and Title V air quality regulations.

Under the CAA, the U.S. Environmental Protection Agency (EPA) establishes NAAQS for pollutants that have been determined to affect human health and the environment. The NAAQS represent the maximum allowable concentrations for designated criteria pollutants, including carbon monoxide (CO), nitrogen dioxide, ozone, sulfur dioxide (SO_2), lead, particulate matter with a 2.5-micron diameter or less ($PM_{2.5}$), and particulate matter with a 10-micron diameter or less (PM_{10}). An area with air quality equal to or better than the NAAQS is designated as being in attainment; areas with air quality worse than the NAAQS are classified as non-attainment areas. MSFC is in Madison County, Alabama, which is in attainment for all criteria pollutants (EPA 2023a).

Hazardous air pollutants (HAPs), another group of regulated substances, are pollutants known or suspected to cause health effects. The CAA has defined major sources of HAPs as sources that emit more than 10 tons per year (tpy) of any individual HAPs or 25 tpy of total HAPs.

Title V of the CAA requires states and local agencies to permit the operation of major stationary sources of air pollution. A Title V major stationary source has the potential to emit criteria air pollutants and HAPs at established thresholds. MSFC operates under a Federal CAA Title V Major Source Operating Permit issued by the ADEM (permit number 709-0014) (NASA 2020a). A major source is defined as a facility that emits 100 tpy of a criteria pollutant, 10 tpy of a single HAP, or 25 tpy of a combination of HAPs. Based on the Title V permit, MSFC is classified as a major stationary source of nitrogen oxides (NOx), CO, SO_2, and HAPs.

The following describes each of the MSFC sources that result in air emissions:

- **Propulsion Systems.** MSFC has components for development, testing, and management of propulsion engines and launch vehicle systems. These areas include testing of propellants such as LH_2, LOX, RP1, and solid propellants. The largest quantities of regulated emissions at MSFC are from CO emissions generated by the combustion of RP1 fuel. The test areas qualify MSFC as a major source of air pollutants for CO, NOx, SO_2, volatile organic compounds (VOCs), NOx, particulate matter (PM), and hydrochloric acid.
- **Particulate Blasters.** MSFC has two particulate blasters: a grit blaster with cyclone and a standalone sand blast facility. The particulate blasters are sources of PM.
- **Metal Cleaning and Preparation.** MSFC has components for metal cleaning and preparation of aerospace components, including the one vapor degreaser, one air stripper, cold solvent hand-wipe cleaning, and pipe cleaning. This metal cleaning is performed primarily using degreasers and is a source of VOCs and HAPs.
- **Surface Coating.** MSFC has components for surface coating operations, includes four paint booths and one insulation application booth. Routine maintenance on buildings and equipment and the application of protective coatings accounts for almost all the surface operations at MSFC. The spray-on foam insulation operation applies thermal protection coatings on aerospace vehicles. The surface coating operations are a source of VOCs, HAPs, and PM.
- **Storage Tanks.** MSFC has two gasoline dispensing facilities that include storage tanks with 20,000- and 12,000-gallon capacities, respectively. The storage tanks are a source of VOCs.
- **Boilers**. Boilers are used for heating and operations. There are 30 boilers, including natural gas, propane, and fuel oil boilers. The boilers are sources of PM, SO_2, NOx, CO, and VOCs.
- **Emergency Generators**. MSFC has 45 emergency-use generators that are backups in case of a power failure. The generators are sources of PM, SO_2, NOx, CO, and VOC.

As part of the Title V permit regulations, MSFC conducts an annual air emission inventory. Table 3.3-1 includes the 2022 emissions for all criteria pollutants and carbon dioxide equivalent (CO_2e), which is the most recent data available at this time.

Table 3.3-1. MSFC Facility-Wide Emissions for Criteria Pollutants and CO_2e

Criteria	CO	NOx	PM	SO_2	VOC	HAP	CO_2e
2022 Emissions (tpy)	9.76	9.92	24.66	0.45	5.95	8.06	8,975.88

Source: ADEM 2023

Wind speed and direction are the fundamental parameters for movement and dispersion of pollutants. Within Madison County, the average wind direction is southeast and the average wind speed is 7.3 miles per hour (Huntsville/Madison County Chamber n.d.).

3.3.2 Environmental Consequences

The threshold for significant adverse impacts would be exceeded if the Proposed Action causes or contributes to a violation of any NAAQS or state ambient air quality standard, increase the frequency or severity of a violation of any ambient air quality standard, or delay the attainment of any standard or other milestone contained in the permit limitations.

3.3.2.1 Proposed Action

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant would be used at the SPTA. Emissions from this new solid fuel propellant would be similar to emissions from solid fuel propellants already used during testing at the SPTA and would include NOx, PM_{10}, CO, hydrochloric acid, and carbon dioxide (CO_2). To date, emission concentrations have not exceeded standards (NASA 2010). However, the use of CBS Solid Fuel Propellant would require an update to the Title V permit. Impacts on air quality are expected to be less than significant.

Habitation Systems

Testing of the habitation systems through habitat burst testing would not result in air emissions. Therefore, impacts to air quality would be less than significant.

Real Property

Construction and demolition, including partial and whole implosion, of real property assets would result in fugitive dust (PM) and construction vehicle exhaust emissions, including CO, NOx, PM, and VOCs. However, the level of emissions generated would vary depending on the project and schedule of each constructed element. Fugitive dust would be controlled using best management practices (BMPs) such as watering stockpiled material and phased scheduling for construction. The specific dust control BMPs used during demolition by implosion would be coordinated by the contractor and NASA and would depend on the size and construction of the buildings to be demolished. These BMPs could include scheduling implosion during high humidity and no wind conditions; watering the structure sufficiently prior to demolition; wetting all unpaved areas to saturation prior to implosion; using misting cannons around the building at strategic locations and elevations; applying water to debris immediately following blast and safety clearance; and restricting traffic and operations to paved areas or stabilized surfaces.

Asbestos abatement occurs across MSFC real property assets. The MSFC Asbestos Program (Marshall Procedural Requirement [MPR] 1840.4) protects employees from health hazards related to potential exposure to asbestos in the workplace, including air monitoring associated with the monitoring program. Vehicle emissions would be controlled using BMPs such as limiting the idling of construction vehicles. All applicable laws and regulations would be followed during construction activities. These activities would not collectively represent a new major source of air emissions that would require a modification to the existing Title V air permit under which MSFC operates.

Operation of real property assets, including facilities such as engine testing facilities, fabrications and assembly facilities, propellant infrastructure and facilities, wind tunnel facilities, and other facilities that may have emissions, could result in increased air emissions. However, the level of emissions would vary depending on the project.

Sustainment, investment, and divestment are not expected to result in substantial changes to air emissions. It is possible for outgrant and development sites to result in substantial changes to air emissions, depending

on the operations of the outgrant asset or development site. It is assumed that the developer would be responsible for all air permitting and coordination required for sources of air emissions that are operated on MSFC. The actual sources of air emissions that would be operated on the property, their permitting or coordination requirements and their potential impacts on air quality would be required to be conducted through separate NEPA documentation when information on the actual development planning and design is available. Prior to completion of construction activities, any additional MSFC stationary source operations would need to be reviewed, included in analyses as needed, and managed in accordance with MSFC's air permit. Therefore, impacts on air quality are expected to be less than significant.

3.3.2.2 No Action Alternative

The No Action Alternative would maintain existing conditions at MSFC. The activity level of facility support projects and operational missions and activities would remain at present levels and within the existing Title V permit. As a result, emissions from aging and energy inefficient infrastructure and buildings would continue to be generated at current levels. However, the impacts to regional air quality would remain less than significant under the No Action Alternative.

3.4 Climate Change and Greenhouse Gases

Climate change is caused in part by human-made and naturally occurring emissions of greenhouse gases (GHGs) released and trapped in the Earth's atmosphere. GHGs trap radiant heat reflected from the Earth in the atmosphere, causing the Earth's average surface temperature to rise. The predominant GHGs are CO_2, methane (CH_4), nitrous oxide (N_2O), water vapor, and several fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride. Although GHG levels, surface temperatures, and overall climate conditions have varied for millennia, increases primarily driven by human activity have largely contributed to recent climatic changes. Human-made emissions are primarily from energy use, such as the burning of fossil fuels (EPA 2023b).

To compare GHGs with each other, each GHG quantity is translated into a common unit called the CO_2e. There is no established significance threshold for GHG emissions that relates to impacts to the environment or human health; however, the CEQ suggests that using a relative comparison analysis that relates to impacts to the environment or human health would be considered significant.

In January 2021, President Biden issued Executive Order (EO) 13990, "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis," which directs federal agencies to immediately take action to reduce GHG emissions and bolster resilience to the impacts of climate change. EO 13990 revoked EO 13783, "Promoting Energy Independence and Economic Growth," signed March 28, 2017, by President Trump, which annulled CEQ's final guidance on GHGs and climate change under NEPA, published in August 2016. In January 2023, CEQ issued interim guidance to assist federal agencies in analyzing GHG and climate change effects of an agency's proposed action under NEPA. The guidance provides a multistep process for analyzing a proposed action's climate change effects under NEPA (CEQ 2023).

3.4.1 Affected Environment

3.4.1.1 Greenhouse Gas Emissions

In 2020, Madison County produced an estimated 4 million tons of CO_2e of GHG emissions. Table 3.4-1 shows the CO_2e for the primary GHGs for Madison County in 2020. Transportation (47%) and electric

power (35%) emissions in Madison County constituted nearly all emissions in 2020 (City of Huntsville 2020).

Table 3.4-1. Emissions of Greenhouse Gases in Madison County, Alabama for 2020

Greenhouse Gas	CO_2e
CO_2	3,928,409
CH_4	233,425
N_2O	21,826
Fluorinated compounds	Not applicable
Total	4,138,660

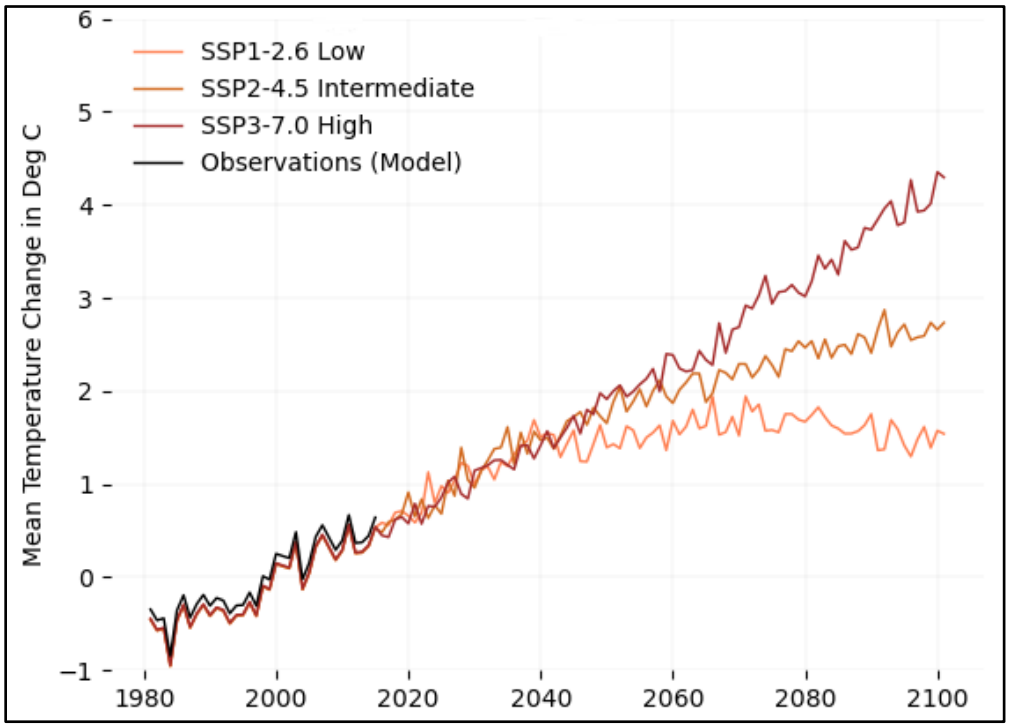
Source: City of Huntsville 2020

Emissions in Madison County decreased 25% between 2000 and 2020. This decrease is attributable to changes in the local power generation mix, most notably including an increased reliance on natural gas and nuclear power and a corresponding reduction in the use of coal in power plants (City of Huntsville 2020).

3.4.1.2 Climate Change

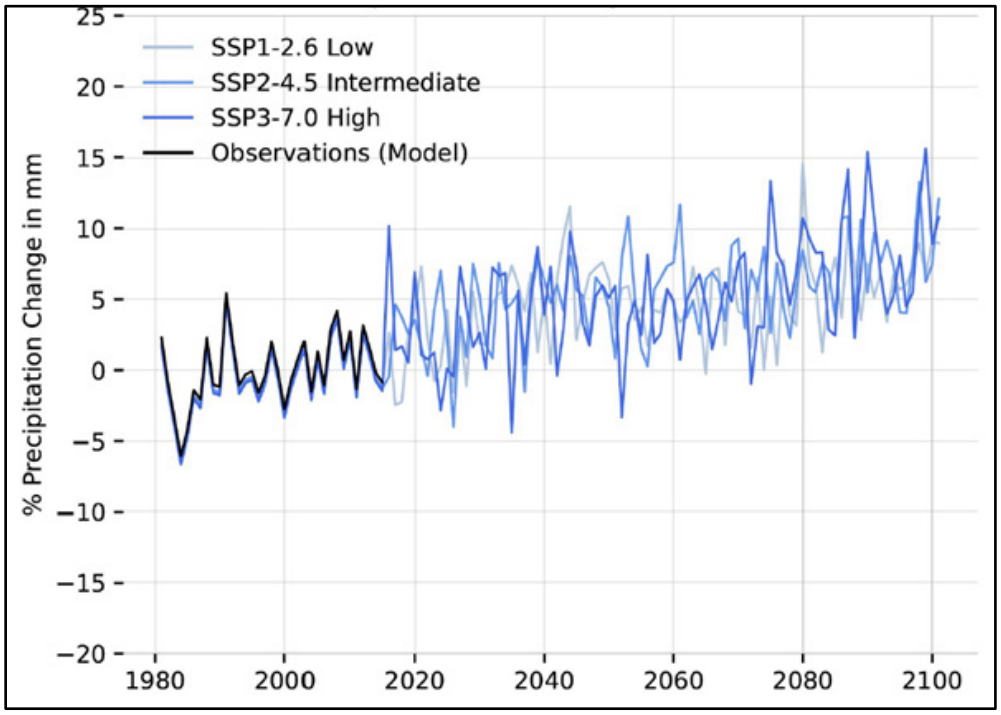
According to the EPA, in the coming decades, Alabama will become warmer and could experience a greater number and increased severity of floods and drought. Unlike most of the nation, Alabama has not become warmer during the last 50 years. However, soils have become drier, annual rainfall has increased in most of the state, more rain arrives in heavy downpours, and sea level is rising about 1 inch every 8 years (EPA 2016).

NASA's Climate Adaption Science Investigators (CASI) Program analyzes observed climate trends and projected climate trends and risk for all NASA Centers. This assessment includes projections for temperature and precipitation (Figures 3.4-1 and 3.4-2, and Table 3.4-2), energy, extreme events, water budget, and sea level rise and coastal flooding for this century. Projections indicate that over the next century (from 1 to 87 years), MSFC could experience increased temperature, precipitation, drought, extreme flood events, water demand, inundation, and energy demand (NASA 2023k).



Source: NASA 2023k

Figure 3.4-1. Mean Temperature Change per Scenario at MSFC



Source: NASA 2023k

Figure 3.4-2. Percent Precipitation Change per Scenario at MSFC

Table 3.4-2. MSFC Temperature and Precipitation Projections

Decade	Low Scenario (SSP1-2.6) Mean Temperature Change (°C) from Baseline[a]	Low Scenario (SSP1-2.6) Precipitation Change (%) from Baseline[b]	Intermediate Scenario (SSP2-4.5) Mean Temperature Change (°C) from Baseline[a]	Intermediate Scenario (SSP2-4.5) Precipitation Change (%) from Baseline[b] (%)	High Scenario (SSP3-7.0) Mean Temperature Change (°C) from Baseline[a]	High Scenario (SSP3-7.0) Precipitation Change (%) from Baseline[b] (%)
2020s	0.92	2.33	0.93	2.62	0.87	2.45
2030s	1.22	3.77	1.31	3.73	2.18	3.02
2040s	1.39	4.4	1.65	4.91	1.69	3.51
2050s	1.50	4.38	1.89	5.13	2.08	3.63
2060s	1.59	4.02	2.12	5.19	2.52	4.20
2070s	1.62	4.71	2.30	5.41	2.99	5.90
2080s	1.55	5.21	2.47	6.41	3.51	6.94
2090s	1.49	5.78	2.64	7.42	4.01	7.95

Source: NASA 2023k

[a]Baseline temperature value is calculated from 1980 through 2020 and is 16.46°C

[b]Baseline precipitation value is calculated from 1980 through 2020 and is 1,484.23 millimeters

°C = degree(s) Celsius

Additionally, the Federal Emergency Management Agency's (FEMA's) National Risk Index indicates that Madison County has a relatively moderate risk index compared to the rest of the nation. The climate hazards include heat waves, cold waves, ice storms, winter weather, strong winds, and tornadoes, which all have varying impacts from climate change. Table 3.4-3 outlines the hazard type and the associated risk index rating and score for Madison County (FEMA 2023a).

Table 3.4-3. Hazard Type Risk Index for Madison County

Hazard Type	Risk Index Rating	Risk Index Score
Lightning	Very high	99
Winter weather	Very high	96.3
Tornado	Relatively high	98.8
Heat wave	Relatively high	97.9
Strong wind	Relatively high	93.4
Cold wave	Relatively high	93.1
Ice storm	Relatively high	88.9
Earthquake	Relatively moderate	94.8
Landslide	Relatively moderate	81.8
Riverine flooding	Relatively low	72.9
Hurricane	Relatively low	68
Hail	Relatively low	68.6
Drought	Relatively low	50.6

Source: FEMA 2023a

Portions of MSFC are within a 100-year floodplain. Considering the increase in precipitation, flooding poses the greatest potential risk to assets at MSFC. That risk may increase over time because of the impacts of climate change.

3.4.2 Environmental Consequences

This section describes the potential impacts from GHG emissions, impacts on climate change, and impacts from climate change from the implementation of the Proposed Action and No Action Alternative.

NASA has not identified specific factors to consider in making a significance determination and has not established a significance threshold for GHGs or climate change. The threshold for significant adverse impacts would be exceeded if the Proposed Action is inconsistent with NASA's Climate Action Plan (NASA 2021).

NASA's Climate Action Plan provides NASA's vision for adapting to climate change effects on its mission, facilities, infrastructure natural lands, and other assets, now and in the future (NASA 2021). NASA's Climate Action Plan identifies five priorities, as follows:

- Priority 1: Ensure access to space by identifying climate change-related vulnerabilities that threaten access to space, perform risk assessments, and develop risk reduction strategies to enable prioritizing adaptations.
- Priority 2: Integrate climate adaption into agency and center master plans.
- Priority 3: Integrate climate risks into agency risk analysis and resilience planning.
- Priority 4: Update climate modeling to enable better understanding of agency threats and vulnerabilities.
- Priority 5: Advance aeronautics research on technologies and processes that reduce contributors to climate change.

3.4.2.1 Proposed Action

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant would be used at the SPTA during propulsion testing. Emissions from this solid fuel propellant would be similar to solid fuel propellant already used during testing at the SPTA. In turn, this would maintain current operational activities and would likely have a minimal effect on current GHG emissions and contributors to climate change. Climatic changes could impact the SPTA infrastructure; however, these impacts are not expected to be significant, as propulsion testing would be consistent with NASA's Climate Action Plan priorities. A significant increase in propulsion testing frequencies beyond the levels of the Proposed Action may increase the quantity of GHG emission, which could require additional air emission analysis. Therefore, impacts from GHG on climate change and climate change impacts on advanced space transportation systems are expected to be less than significant.

Habitation Systems

Testing of the habitation systems through habitat burst testing would not result in air emissions. High purity gaseous nitrogen would be released during habitation systems testing; however, this is not a GHG. No impacts to habitation systems testing infrastructure are expected from the projected climate changes. For example, habitation system activities at MSFC do not occur within floodplains, so impacts from flooding are nonexistent. Additionally, NASA completed a Record of Environmental Consideration in 2023

documenting less than significant impacts (NASA 2023h). Therefore, impacts from GHG on climate change and climate change impacts on the habitation systems would be less than significant.

Real Property

Construction and operations of real property assets would result in GHG emissions, including CO_2, CH_4, N_2O, water vapor, and fluorinated gases. However, the level of GHGs generated would vary depending on the project. Additionally, climatic change events, such as increased temperature and precipitation, may impact real property assets. However, new construction by a lessee would be required to comply with NASA's Climate Action Plan. Therefore, it is expected that impacts from GHG on climate change and climate change impacts on real property would be less than significant.

3.4.2.2 No Action Alternative

The No Action Alternative would maintain existing conditions at MSFC. The activity level of facility support projects and operational missions and activities would remain at present levels. As a result, emissions from aging and energy inefficient infrastructure and buildings would continue to be generated at current levels. Infrastructure and assets could be impacted by projected climate changes; however, these impacts are expected to be unsubstantial in the near term. Therefore, the No Action Alternative would have no impact on GHG or climate change.

3.5 Land Use

Land use describes how land is developed and managed for different uses. Land use planning refers to the planned development of property typically with the goal of achieving compatibility among uses within and adjacent to the property. NASA has a master planning program to ensure that activities are coordinated effectively and without conflict. Land use and zoning at MSFC is governed by the 2003 approved Master Plan.

3.5.1 Affected Environment

MSFC is a tenant of RSA through a 99-year grant from the U.S. Army, dated July 1, 1960. NASA has irrevocable use and occupancy rights to the land and facilities within MSFC; however, the Army retains the right of access to all major utility lines, rail tracks, and main roads for applicable operations and maintenance.

Approximately 45% (829 acres) of MSFC's property consists of buildings, roadways, parking areas, and other development. The remaining 55% (1,012 acres) of the land consists of upland and wetland natural communities.

MSFC's Master Plan divides MSFC into seven definable zones: North Campus, South Campus, Research and Development Support Area, Test Area, North Services Area, South Services Area, and Future Development Zone. The Facilities Planning and Utilization Office at MSFC is responsible for ensuring that development of facilities, utilities, and other infrastructure is in accordance with NASA's mission of achieving land use compatibility and operational functionality at MSFC.

The North Campus includes MSFC's administration and management functions, directorate and program management functions, and some research functions. The majority of the facilities in the North Campus consist of office space. The South Campus includes office and laboratory space for research and technology functions. The Test Area represents a sizable area to the south where the main activity is

component testing, including propulsion and habitation testing. The Research and Development Support Area includes the Flexible Development Area comprising industrial-type buildings. The Flexible Development Area also includes high-bay assembly and manufacturing buildings. This area is available to contractors for activities related to technology development or related assembly operations. The North and South Service Areas include maintenance activities and receiving and supply activities. The Future Development Zone is where NASA can locate functions that are independent of MSFC activities. The site is located on a vacant parcel of land to the extreme north of the MSFC. More recently, MSFC has been using only three functional zones to divide land use at MSFC: Administrative Area (includes North Campus, North Services Area, and Future Development Zone), Research Area (includes Research and Development Support Area, South Services Area, and South Campus), and Test Area (includes Test Area) (Figures 3.5-1a, 3.5-1b, and 3.5-1c). NASA reserves the right to deviate from zoning, as required.

MSFC's buildings, vertical infrastructure, and horizontal infrastructure are considered real property. Real property is categorized into development sites, investment sites, sustainment projects, divestment sites, and outgrant sites. These real property assets may include administrative facilities, engine testing facilities, fabrication and assembly facilities, ground improvement facilities, liquid fuel infrastructure and facilities, maintenance facilities, operational facilities, propellant infrastructure and facilities, research, development, and testing facilities, storage facilities, and utilities.

3.5.1.1 Special Zones and Clearances

The Service Areas and Test Area require stringent zoning requirements because these two activities are not compatible with other land uses and must be located within defined areas. Large-scale testing has diminished at the Test Area, but this area does retain this capability. The majority of testing is related to component and small-scale testing and occurs on a regular basis; however, large-scale testing could also be conducted in the test area. Some testing has high noise levels and explosion risks requiring significant safety precautions, including large buffer zones. For these reasons, testing activities must remain in this area.

3.5.1.2 Land Use Restrictions

Land use restrictions are based on physical limitations and federal policies, including Section 404 permits from the U.S. Army Corps of Engineers (USACE), EO 11988, and the National Historic Preservation Act of 1966 (NHPA).

Wetland and Floodplains

Based on its close proximity to the Tennessee River and Wheeler Reservoir, MSFC is bordered by floodplain areas and several wetland areas. Special consideration is required in these areas before construction, filling, ditching, or other land-disturbing activities can be conducted. Dredging or filling requires a Section 404 permit from the USACE and floodplains are protected under EO 11988. New construction within a floodplain must address the potential effects of existing floodplain benefits. Wetlands are shown on Figures 3.6-1a, 3.6-1b, and 3.6-1c and floodplains are shown on Figures 3.6-2a, 3.6-2b, and 3.6-2c.

Williams Spring Ecologically Sensitive Area

The Williams Spring pool, run, and surrounding wetlands and forest together are designated as the Williams Spring Ecologically Sensitive Area (Figure 3.6-1b). Protection of the Williams Spring Ecologically Sensitive Area is integrated into project planning at MSFC. Restrictions are in place on the type of activities that can be conducted within the Williams Spring Ecologically Sensitive Area, as well as activities that are

distant from Williams Spring but have the potential to impact the water quality of the spring, including sediment, erosion, and stormwater controls during construction and other land-disturbing activities at MSFC (NASA 2023c).

Cultural Resources

Section 106 consultation under the NHPA would be initiated when new construction, demolition, or renovation is planned for historic properties, which are properties (buildings, districts, archaeological sites, and objects) that are listed in, or are eligible for listing in, the National Register of Historic Places (NRHP). Section 106 consultation for specific projects has not been conducted for this EA. Section 106 consultation will be carried out on a case-by-case basis as projects are implemented. Refer to Section 3.17 for more information about cultural resources and the Section 106 consultation process.

Specific Easements and Rights-of-Way

The Right-of-Way Plan indicates and reserves the necessary right-of-way and building setback requirements for each basic type of road facility. The road rights-of-way have been established to provide ample space for future widening without infringing on building setback space. Areas in the Master Plan that also may have land use restrictions include utilities (water supply, sewer, electrical, and telecommunications) and existing vehicular parking and pedestrian walkways, landscape planting and conservation, security, and emergency services.

3.5.2 Environmental Consequences

The threshold level for a significant adverse impact to land use is defined as changes in land use that would conflict with zoning, planning documents, or planning goals.

3.5.2.1 Proposed Action

Under the Proposed Action, the land use classification of the real property sites, habitation simulation location, and SPTA propulsion testing site would not be changed. The Facilities Planning and Utilization Office at MSFC is responsible for ensuring that development of facilities, utilities, and other infrastructure is in accordance with NASA's mission of achieving land use compatibility and operational functionality at MSFC. Therefore, existing buildings, habitation systems, leases, and construction sites are located in the appropriate land use areas already established in the MSFC's Master Plan, as shown on Figures 3.5-1a–c.

For these reasons, the Proposed Action is expected to have no impact on land use based on special land use restrictions. If the need arises to conduct habitation system testing or propulsion testing in other locations in the future, the location would need to be screened for compatibility with its current land use, in conjunction with considerations for other resources such as the distance to sensitive noise receptors. If land use in the new location is not compatible, MSFC master planners would need to revise the facility plans accordingly.

All tenants of MSFC would be obligated to comply with all applicable federal, state, and local environmental laws, statutes, ordinances, regulations, rules, judicial and administrative orders, and decrees issued by governmental agencies (including, but not limited to, EPA, U.S. Department of Transportation [DOT], U.S. Occupational Safety and Health Administration [OSHA], U.S. Nuclear Regulatory Commission [NRC], and ADEM), existing now or adopted later during the period of the lease. The need for preparing Environmental Due Diligence documentation, NEPA documentation, cultural resource documentation, Endangered Species Act (ESA) documentation, or additional environmental documentation would be

defined in the lease agreement with MSFC. Tenants are independent entities solely responsible for their own required environmental permits, licenses, registrations, and approvals for its site activities.

3.5.2.2 No Action Alternative

Under the No Action Alternative, land use classifications would not be changed. Therefore, the No Action Alternative would have no impact on land use.

3.6 Water Resources

The following section describes water resources at MSFC, including surface water, groundwater, wetlands, and floodplains. The region of influence for water resources includes the Huntsville Spring Branch-Indian Creek Watershed (HUC 0603000205), as well as the aquifers beneath the watershed (USGS 2023).

Surface water resources include lakes, rivers, streams, and wetlands. These resources can be important to economic, ecological, recreational, and human health resources. Stormwater flows, defined as runoff from precipitation that are increased by impervious surfaces, may introduce sediments and other contaminants into the water resource environment.

Groundwater includes subsurface hydrologic resources. Groundwater properties are often described in terms of depth to aquifer or water table, water quality, and surrounding geologic composition. Groundwater is an essential resource because it supplies drinking water for a large percentage of the U.S. population. It is also used for irrigation and industrial purposes, and it provides a source of recharge for lakes, rivers, and wetlands. On the federal level, groundwater resources are regulated by the Safe Drinking Water Act. Agencies are required to determine whether an action would have an environmental effect on drinking water that would constitute a significant hazard to a human population.

EPA and the USACE define wetlands as "…areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (EPA 2023c). Jurisdictional Determinations are issued by the USACE and determine whether a water or wetland is subject to regulation under Clean Water Act (CWA) Section 404 or under Section 10 of the Rivers and Harbors Act. NEPA regulations require that impacts on wetlands be assessed and alternatives for protection of these resources be evaluated in accordance with EO 11990, "Protection of Wetlands."

Floodplains are areas of land adjacent to rivers that flood during periods of high-water discharge. Floods are usually seasonal and can be predicted in advance. The risk of flooding typically depends on topography, frequency of precipitation events, and watershed characteristics. Floodplains along a river are important because they temporarily store floodwaters, improve water quality through capture of sedimentation and debris, provide important habitat for river wildlife, and create opportunities for recreation. EO 11988, "Floodplain Management" requires a federal agency to evaluate the potential effects of any actions it may take in a floodplain and to avoid floodplain development wherever there is a practicable alternative.

3.6.1 Affected Environment

3.6.1.1 Surface Water

MSFC is located in the Middle Tennessee-Elk Basin. Indian Creek lies approximately 0.25 mile south of MSFC and the Tennessee River is approximately 3 miles south of MSFC. The average annual precipitation is approximately 54.29 inches (National Weather Service 2023). There are 11 springs located on MSFC, the largest of which discharges approximately 3,800 liters per minute of water into a tributary that leads to Indian Creek. The Williams Spring Ecologically Sensitive Area protects the Williams Spring pool, run, and surrounding wetlands. Surface water includes natural, modified, and constructed water confinement and conveyance features that may or may not have a defined channel and discernable water flows. Surface water includes discussions of runoff, changes to surface drainage, and general surface water quality. Most runoff at MSFC flows through human-made ditches into streams that ultimately end up in Indian Creek or Huntsville Spring Branch (NASA 2023c). Huntsville Spring Branch discharges into Indian Creek in the area of Wheeler Lake and then ultimately discharges into the Tennessee River (distance of approximately 5.5 miles). Indian Creek is listed as an impaired water body for *E. coli* upstream of Martin Road SW to US Highway 27 (distance of approximately 10.4 miles) according to the EPA-approved CWA Section 303(d) list for Alabama (ADEM 2022). The Tennessee River downstream of the confluence with Indian Creek to the confluence of Cotaco Creek (distance of approximately 1.9 miles) is listed as an impaired water body for nutrients and mercury according to the EPA-approved CWA Section 303(d) list (ADEM 2022).

NASA holds National Pollutant Discharge Elimination System (NPDES) Permit AL0000221 for MSFC (ADEM 2020b). The permit specifies discharge limitations and monitoring requirements for 11 outfall points on MSFC. NASA will monitor seven process water outfalls. Discharge limitations and monitoring requirements can be found in the CWA final NPDES permit. The results of these tests are kept on file at the Environmental Engineering and Occupational Health (EEOH) Office and uploaded to ADEM's eDMR website.

Precipitation levels have gradually increased over the last 20 years and are expected to continue to climb in the future (Figure 3.4-2). A discussion of projections for precipitation, droughts, flooding, and water demand is included in Section 3.4.1.2.

3.6.1.2 Groundwater

The Tuscumbia-Fort Payne aquifer (300 to 330 feet thick) is the primary aquifer for water supply in the region. In the area of MSFC, the surficial aquifer (closest to the ground surface) is 10 to 80 feet thick and is recharged through precipitation. Groundwater from the surficial aquifer flows downward through a relatively less permeable layer called the Chattanooga Shale to recharge the underlying Tuscumbia-Fort Payne aquifer at a lower rate. The Tuscumbia-Fort Payne aquifer is a karst aquifer, which means that groundwater occurs within enlarged voids in the formation that may result in greater or irregular groundwater flow rates. Groundwater in the region also flows horizontally, generally south toward the Tennessee River (NASA 2017).

Because of contamination, groundwater under MSFC's 1,841 acres is controlled by the MSFC Land Use Control (LUC) Proposed Plan and Interim Record of Decision (IROD) and should be not encountered or impacted without consultation with the EEOH Office. MSFC's Superfund electronic database identification number is AL7210020742 (NASA 2007). Additional information about groundwater contamination can be found in Section 3.14.1.

3.6.1.3 Wetlands

Wetlands are areas where the frequent and prolonged presence of water at or near the soil surface drives the natural system, including the kinds of soil that form, the plants that grow, and the fish and wildlife communities that use the habitat. Wetland locations for the region of influence were obtained from the National Wetlands Inventory database (USFWS 2023) and MSFC ground-truthed the wetland areas for their internal GIS maps in August 2023, as shown on Figures 3.6-1a, 3.6-1b, and 3.6-1c.

3.6.1.4 Floodplains

FEMA defines geographic areas according to varying levels of flood risk, called flood zones. These zones are depicted on a community's Flood Insurance Rate Map or Flood Hazard Boundary Map and are based on historic events and insurance claims. Each zone reflects the severity or type of flooding in the area. FEMA designates the 100-year floodplain as an area that has a 1% chance in any year of flooding and an area in which construction activities are regulated. Special Flood Hazard Areas are used by the National Flood Insurance Program (NFIP) to determine where the NFIP's floodplain management regulations must be enforced, and flood insurance requirements apply.

Figures 3.6-2a, 3.6-2b, and 3.6-2c display FEMA's 100- and 500-year floodplains (FEMA 2023b).

3.6.2 Environmental Consequences

The threshold for a significant adverse impact would be met if the Proposed Action permanently impacted groundwater, surface water, wetlands, or floodplains without the provision of compensatory mitigation; threatened or damaged hydrologic characteristics; adversely affected water quality or endangered public health by contributing pollutants to groundwater or surface water; and/or violated established laws or regulations that have been adopted to protect or manage water resources of the area.

3.6.2.1 Proposed Action

The greatest potential for adverse impacts to water resources would be from a contaminant spill or leak, filling water features, or indirect filling from uncontrolled surface erosion. Impacts such as contaminated groundwater or surface water or altered streams and wetlands would be short or long term, depending on the type of contaminants involved and the type of construction. NASA has prepared a *Spill Prevention, Control, and Countermeasure Plan* (NASA 2023d), which includes BMPs for preventing spills and operational procedures for responding to and collecting and containing spills to minimize the impacts an accident has on the environment. Additional mitigation measures identified in MSFC's IROD (NASA 2007) and Marshall Work Instruction (MWI) 8550.2 are described in the discussion of impacts for the specific elements of the Proposed Action to which they apply.

The goal of the ongoing remediation of MSFC water resources is to protect human health and the environment and to reduce and/or contain the major source areas of contamination. Current or future use of MSFC's groundwater for potable or non-potable needs creates potential risks from human ingestion or exposure that are unacceptable (NASA 2007).

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant would be used during propulsion testing at the SPTA and can produce explosive hazards, potentially contaminating groundwater. The use of CBS solid fuel propellant up to two times per year would not change the quantity or management of deluge, quench or cooling water that has been

previously analyzed under the *Environmental Assessment of Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center* (NASA 2010). Existing management policies and procedures for propulsion testing using solid propellants would be followed when dealing with CBS Solid Fuel Propellant and adverse impacts to water resources would be less than significant from the use of CBS Solid Fuel Propellant at the SPTA.

Habitation Systems

The development and testing of habitation systems activities at MSFC would not occur within wetlands, waterbodies, or floodplains. Potential groundwater and surface contamination could occur from a spill or leak of hazardous materials or hazardous wastes. It is expected that the environmental enclosures (shed-like enclosure) for the habitation system testing would be torn apart by the pressure released from the test article and debris would temporarily litter the nearby area. All environmental enclosure debris would not be hazardous and would be recovered and properly disposed of to prevent potential impacts to the nearby wetlands and any other surface water features (Figure 3.6-1c). Standard BMPs and procedures would be followed to avoid contamination. The sound and pressure impulse wave would have the potential to knock down loose lead paint chips from the test stands and older buildings. Paint chips result from weathering caused by the elements over time. EEOH and the Test Area Managers would monitor for lead paint chip accumulation and remove the lead paint chips by disposing of them in the proper hazardous waste container. This would prevent unwanted releases of lead into the stormwater conveyances and the soil. Increased habitation system testing could cause new lead paint chip accumulation, but mitigation measures and proper hazardous material handling would prevent impacts to water resources. Therefore, impacts to groundwater or surface water from habitation systems activities at MSFC are expected to be less than significant.

Real Property

Groundwater and Surface Water

Construction and demolition projects would result in less-than-significant adverse impacts to groundwater. Construction and demolition would not use groundwater for any purposes. Instead, potable water needs would be met through the established water distribution systems at MSFC. Based on the presence of contaminated groundwater plumes at MSFC, construction activities at MSFC are not permitted to disturb groundwater. No de-watering activities would be allowed to occur as part of land-disturbing activities in accordance with the IROD Interim Action Project for Operable Unit 3: Groundwater at MSFC (NASA 2007). Any potential groundwater disturbance would be coordinated with MSFC's EEOH Office (NASA 2007).

Construction and demolition projects would result in less-than significant adverse impacts to surface water. Creating infrastructure typically increases impervious area, resulting in increased stormwater runoff. Increased stormwater runoff from the addition of impervious area as well as possible increased precipitation from climate change would require increasing the capacity of the stormwater infrastructure. The need for additions or changes to existing stormwater management would be evaluated as projects are proposed. The main surface water features are Indian Creek and the Tennessee River (0.25 mile and 3 miles from MSFC, respectively). As required by NASA's NPDES Permit AL0000221, sampling at outfalls where stormwater is released from the site is required prior to the runoff reaching these impaired waters downstream of MSFC (NASA 2023c).

Surface water impacts would be minimized through the implementation of a Construction Best Management Practices Plan (CBMPP) that depicts erosion and sediment control measures in accordance with Section 01 06 50 Environmental Compliance of TSRC-2022 MSFC Technical Specifications for

Repairs and Construction (NASA 2022c). Construction disturbances of one acre or greater would require the contractor to obtain a Construction Storm Water Notice of Intent from ADEM to authorize stormwater discharges under general NPDES permit ALR100000 (ADEM n.d.) During construction and demolition, the fugitive dust control BMPs described in Section 3.3.2.1 would protect water resources from being impacted. NASA has developed a Stormwater Pollution Prevention Plan (SWPPP) (NASA 2023g) that would prevent contamination to groundwater and surface water during construction and operational activities.

In accordance with the Record of Environmental Consideration for the LH2 tank installation, impacts to NPDES conveyance and outfall adjacent to Building 4628 would be avoided and stormwater BMPs would be implemented during the LH2 tank installation. The LH2 tank installation would involve less than 1 acre of land disturbance and, therefore, would not require a construction stormwater permit.

Construction and demolition contractors would be responsible for approved disposal of wastewater in accordance with MWI 8550.2, Stormwater and Wastewater Management (NASA 2021).

Wetlands

While construction and demolition are not planned to occur on wetlands, the expansion of the NASA/FBI Pistol Range will occur close to a wetland within the WNWR (Figure 3.6-b). The range design, which is currently in progress, will route runoff drainage to the east of the new range to prevent runoff from reaching the WNWR and mitigate the release of lead into the environment.

Wetland delineations would be conducted as required for projects that could impact wetlands. Construction impacts to wetlands would be mitigated. The Tennessee Valley uses the Tennessee Rapid Assessment Method, which provides a standardized procedure for assessing the ecological values and functions of wetlands and other surface waters. Compensatory mitigation activities would be developed during the Section 404 permitting process. Therefore, construction and demolition projects would have less than significant impacts on wetlands.

Floodplains

Based on FEMA's flood maps, the 100-year and 500-year annual flood hazard contour is within future development and demolition areas (Figures 3.6-2a, 3.6-2b, and 3.6-2c). Construction of new buildings and impervious areas within the floodplain would reduce the existing flood storage capacity of previously undeveloped sites. All new construction would comply with the requirements of the NFIP and obtain the necessary FEMA permits for floodplain development. Future projects at MSFC would be required to confirm floodplain storage and conveyance capabilities would not decrease. Therefore, impacts to floodplains would be less than significant as a result of the construction and demolition projects.

3.6.2.2 No Action Alternative

Under the No Action Alternative, existing conditions at MSFC would continue. No impacts to water resources would be anticipated.

3.7 Biological Resources

Biological resources refer primarily to plants and animals, with focus given to species that are protected under the ESA as endangered or threatened. The ESA, as amended, requires the government to protect threatened and endangered plants and animals (listed species) and the habitats upon which they depend. The ESA requires federal agencies to ensure that any action it authorizes, funds, or conducts does not

adversely impact listed species or "destroy or adversely modify" critical habitat for that species. "Critical habitat" is defined as a specific geographic area that contains features for the conservation of an endangered species and may require special management and protection.

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) and EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds." The MBTA makes it illegal to pursue, hunt, kill, capture, possess, buy, sell, purchase, or barter any migratory bird, including the feathers or other parts, nests, eggs, or migratory bird products, except as allowed by implementing regulations. EO 13186 requires that federal agencies avoid or minimize the impacts of their activities on migratory birds and make efforts to protect birds and their habitat.

The Bald and Golden Eagle Protection Act of 1940, as amended, provides for the protection of the bald eagle and golden eagle by prohibiting, except under certain specified conditions, the taking, possession, and commerce of such birds.

There are no state laws in Alabama equivalent to the ESA. However, some species in Alabama do receive regulatory protection through the Alabama Regulations on Game, Fish, and Fur-Bearing Animals, which include the Nongame Species Regulation (Section 220-2-92) and the Invertebrate Species Regulation (Section 220-2-98). These are the primary regulations affording state protection for some animal species in Alabama, and they are administered by the Alabama Department of Conservation and Natural Resources. Animal species that are protected under these regulations are listed as either State Protected or Partially Protected. In addition to these regulations, the Alabama Cave Protection Law protects the biological life in caves, as well as speleothems (formations). Plants are not protected under any State of Alabama regulations.

3.7.1 Affected Environment

3.7.1.1 Vegetation

MSFC is located in the Tennessee Valley district of the Highland Rim physiographic region. There are eight distinct upland communities at MSFC: mixed forest, mesic mixed forest, pine forest, deciduous forest, planted pine, mowed field, fallow, and xeriscape. Upland communities occupy approximately 879 acres or 48% of MSFC's property and represent approximately 87% of the total natural community area at MSFC (NASA 2020b). The planted pine, mowed field, fallow field, and xeriscape community types are considered natural areas; however, these communities are purposefully maintained in an altered state, making them highly disturbed habitats. The mixed pine and deciduous forest communities have been impacted to varying degrees by fire suppression, hydrological alterations, and development. Most of the upland forests at MSFC have been fragmented by facilities, roadways, and human-made drainage features. Native oak-hickory-eastern red cedar forests that historically existed at MSFC have been largely replaced by pine-dominated forests. Existing upland forests have canopies that are relatively even aged and sub-canopies that are overgrown and dense, primarily because of fire suppression (NASA 2023c). Additional information regarding the upland communities at MSFC is available in Appendix E, Supplemental Environmental Information Used for Analysis.

3.7.1.2 Wildlife

Approximately 55% of the MSFC's property consists of a combination of upland and wetland communities (NASA 2020b). These natural communities provide habitat for numerous wildlife species that are endemic to northern Alabama's Highland Rim, Cumberland Plateau, and Southern Piedmont ecosystems. The remaining 45% of MSFC is developed and consist of buildings, roads, parking lots, and landscaped areas

(NASA 2020b). The landscaped areas, which are areas of mowed grass and sparse landscaping shrubs/trees around buildings, provide small, isolated patches of poor-quality wildlife habitat. These areas may be used by common wildlife species that typically occur in developed settings such as certain songbirds, gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), and mice (*Mus musculus*) (NASA 2023c).

The natural communities at MSFC provide wildlife habitat of variable quality. In general, the wetland and upland forests within the WNWR and the upland forests along the perimeter of MSFC that are contiguous with large forests on RSA property provide the best quality habitat and support the highest diversity of wildlife species (NASA 2023c). Common mammals that occur in the natural communities at MSFC can be found in Appendix E, Supplemental Environmental Information Used for Analysis.

The quality of wildlife habitat provided by the natural communities at MSFC was evaluated during the August 2015 ecological survey. Upland and wetland natural communities were qualitatively rated as providing either good, moderate, or poor quality wildlife habitat based on specific community criteria associated with habitat quality. The community criteria evaluated included vegetation strata (stand age and density); vegetation diversity and abundance; food sources (mast producing species); water sources; parcel size and connectivity to other habitats; habitat buffers; snags and downed wood; ground disturbance; hydrological alterations; invasive exotic species; seasonal disturbances (mowing); and fire regime (NASA 2023c). Additional information describing the quality of upland and wetland communities is found in Appendix E, Supplemental Environmental Information Used for Analysis.

3.7.1.2.1 Wheeler National Wildlife Refuge

A substantial portion of RSA, including much of the installation property immediately south and west of MSFC, is part of the WNWR, which encompasses approximately 34,500 acres. The WNWR extends into the southwestern part of MSFC (approximately 180 acres) and its boundary runs east/west outside the southern and southeastern boundaries of the East Test Area (NASA 2023c).

3.7.1.3 Special-Status Species

Special-status species with potential to occur at MSFC are presented in Appendix E, Supplemental Environmental Information Used for Analysis. An experimental, non-essential population of the endangered whooping crane is known to occur on WNWR, including within the portion of MSFC that is located within WNWR. Because this population occurs on public land, it is treated by regulation as a threatened species. The only other sensitive species that have been observed is the Tuscumbia darter (*Etheostoma tuscumbia*), which is a state protected species and under review for federal listing, and the engraved elimia (*Elimia perstirata*), which is under review for federal listing. The only known location of these species at MSFC is in Williams Spring and its run. Surveys for the Tuscumbia darter in MSFC's Williams Spring have been conducted annually since 2000. There is no U.S. Fish and Wildlife Service (USFWS)-designated critical habitat for any federally-listed species within or near MSFC. However, MSFC has designated Williams Spring as ecologically sensitive.

3.7.2 Environmental Consequences

The threshold level of significant adverse impacts for natural and biological resources is defined by any of the following:

- Potential "take" of a federal or state threatened or endangered species

- Loss or impairment of sensitive or other native habitats or riparian corridors, such that the loss or impairment of habitat negatively affects the population of a species
- Take of birds in violation of the MBTA that could result in an enforcement action against MSFC
- Introduction or spread of invasive or otherwise undesirable non-native species

3.7.2.1 Proposed Action

Vegetation

Most of the Proposed Action is located within developed portions of MSFC. Development sites, investment sites, habitation systems testing, and the SPTA that include new construction would occur within developed areas and areas consisting of upland forest, fallow fields, xeriscape, or mowed grass. Figures 3.7-1a, 3.7-1b, and 3.7-1c show the existing vegetative cover within the Proposed Action area. As shown, four upland forest communities exist in the Proposed Action area: planted pine, mixed forest, pine forest, and deciduous forest. Planted pine is the dominant upland forest community on the property. Given that the vast majority of the total vegetative cover that exists in the Proposed Action area is planted pine, most of the vegetation that would be removed under any reasonable development scenario is expected to be planted pine. Planted pine is considered to be a relatively low-quality vegetative community because it is human-made and undergoes frequent disturbance. Appendix E, Supplemental Environmental Information Used for Analysis, identifies vegetation types that Proposed Action sites and indicates if tree clearing would need to occur.

RSA foresters manage the planted pine parcels at MSFC (NASA 2023c). They plan and conduct forest management in accordance with Alabama's BMPs for forestry to minimize excess sedimentation and hydrological alterations (Alabama Forestry Commission 2007). All forest management activities (i.e., planting, thinning, harvesting, and prescribed fires) proposed within, or in close proximity to, ecologically sensitive habitat at MSFC are coordinated with the MSFC Natural Resources Manager, RSA Installation Ecologist, and RSA Natural Resources staff (NASA 2023c). The landscaping plan that would be developed for each site or group of sites would meet a minimum 3:1 native to non-native planting ratio and would prohibit the planting of any species on the RSA "Do Not Plant" list (NASA 2023c).

Of the 79 sites under the Proposed Action, 19 would involve direct impacts to vegetation. The Proposed Action is expected to have less than significant impacts on vegetation. Future planning efforts at MSFC may identify additional projects within areas not specifically addressed within this EA. It is unknown at this time how much of the existing vegetation at each site would be displaced because no planning or designs for the new construction have been initiated to date. Additional NEPA analysis would be conducted for development sites as their design plans progress to accurately analyze the quantity and quality of vegetation that would be impacted by the project.

Noise has the potential to impact vegetation growth. Research studying noise impacts on plants indicates that noise-exposed plants have stunted growth and increased stress response mechanisms (NPS 2022). Most noise generated during activities at MSFC would be temporary and no increase in chronic noise sources would be anticipated under the Proposed Action. Therefore, impacts to vegetation from noise would be less than significant.

Wildlife

The Proposed Action would result in adverse impacts to wildlife because of disturbances from noise, construction/demolition activities, and heavy equipment use. The potential for incidental animal mortality under the Proposed Action during construction exists, but it is considered to be relatively low and limited

to slow-moving species. Losses of wildlife are not likely to have a significant impact on MSFC and regional wildlife population levels. Temporary disturbances to wildlife may occur during construction and demolition activities. Wildlife responses to noise may include the perception of a threat; sensory degradation or the inability to detect acoustic cues from conspecifics, predators, prey, or the environment; and a reduction in reproductive success (Shannon et al. 2016). There is also evidence that alterations to the sensory environment (i.e., light and noise) can adversely alter the richness and composition of wildlife communities and also alter foraging behavior (Willems et al. 2022) and predator-prey dynamics (NPS 2022). The disturbance caused by noise at the real property sites that require construction and/or demolition activities would be limited to the construction period and is expected to be relatively minor.

Wildlife species that occur on or in the vicinity of MSFC are adapted to human activity as well as noise levels generated by test activities at MSFC, which can exceed those that would be generated during construction activities. While there is no information on wildlife responses to noise from bombs and other explosives detonations, noise can be a direct stressor on wildlife, causing pain or elevated stress hormone levels (Shannon et al. 2016). Impulsive noise thresholds for humans typically are used in impact analyses for wildlife. A peak impulsive sound level of 140 decibels of peak pressure (dBP) is the threshold for physical injury to humans in the form of temporary hearing loss (Jacobs 2023). The 140-dBP to 150-dBP noise contour at the habitation system location is contained in the center and the duration of the noise is instantaneous and temporary (Jacobs 2023). The wildlife habitat quality is poor to moderate within this area. For these reasons, the Proposed Action is expected to have less than significant impacts on wildlife. Additional NEPA analysis would be conducted for development sites as their design plans progress to accurately analyze the quantity and quality of wildlife habitat that would be impacted by the project.

Special-Status Species

The Proposed Action area does not contain the types of habitat that are known to support listed or sensitive plant species or suitable nesting or foraging habitat for any listed or sensitive animal species that occur on RSA or MSFC. If bats are discovered during construction activities, work would stop and the MSFC Natural Resources Manager would be contacted. Therefore, the proposed development of the properties under the Proposed Action is not expected to directly impact listed or sensitive species or their habitat. Noise generated during construction activities is not expected to disturb listed or sensitive species based on the distance of known habitat from the Proposed Action area. Removal of any habitat within the Proposed Action area is expected to have no indirect impact on gray bat migration or foraging. The Proposed Action is also not expected to indirectly impact the groundwater, surface water, or wetlands/springs that occur in the Williams Spring or any other Ecologically Sensitive Area.

The Proposed Action is expected to have no impact on listed and sensitive species. Additional NEPA analysis would be conducted for development sites as their design plans progress to accurately analyze the potential impacts of the project on listed and sensitive species.

3.7.2.2 No Action Alternative

Under the No Action Alternative, the Proposed Action would not be implemented. Therefore, the No Action Alternative would have no impact on vegetation, wildlife, or special-status species.

3.8 Geology and Soils

This section describes soil, underlying geology, and the potential for geologic hazards and erosion within MSFC.

3.8.1 Affected Environment

3.8.1.1 Geology

The geology underlying MSFC is composed of three stratigraphic units, including Tuscumbia Limestone, Fort Payne Chert, and Chattanooga Shale. The Tuscumbia Limestone immediately underlying the surface has an average thickness of approximately 150 feet and is exposed in much of MSFC and RSA. The Fort Payne Chert underlies the Tuscumbia and consists of fossiliferous and dolomitic limestone with some chert that ranges in thickness from 155 to 185 feet. The underlying Chattanooga Shale generally is 10 to 40 feet thick and consists of thinly bedded shale with occasional sandstone at its base. It has high gamma radiation from its relatively high uranium content (GSA 2015). The Tuscumbia Limestone and Chattanooga Shale are both known to have high concentrations of radon. Sinkholes and dropouts or collapses within MSFC have been reported in the vicinity of the following locations (NASA 2017):

- North of 4200 building complex
- Buildings 4205, 4207, 4251, 4316, 4487, 4637, 4663, 4656, 4653, 4656, 4653, 4666, 4679, 4527, 4597, 4764, 4705, and 4707

MSFC, located in the Highland Rim Section of the Interior Low Plateaus, has a gently rolling topography with elevations ranging from 560 to 650 feet above mean sea level (amsl). Slopes range from 1% to 10%. The lower elevations occur near WNWR and the south-bounding Tennessee River (NASA 2023c).

3.8.1.2 Soils

Soils of the Decatur-Cumberland-Abernathy Association cover most of MSFC (NASA 2017). The Decatur series consists of very deep, well drained, moderately permeable soils, on level to strongly sloping uplands in valleys (USDA 2023a). Cumberland Soils are well drained with moderate permeability and medium runoff on level to strongly sloping topography (USDA 2023b). The Abernathy series consists of very deep, well drained, moderately permeable soils, found on uplands, drainageways, and depressions (USDA 2023c). Surface soil groups at MSFC are shown on Figures 3.8-1a, 3.8-1b, and 3.8-1c.

3.8.2 Environmental Consequences

The threshold for a significant impact would be met if the Proposed Action increased the likelihood of, or resulted in exposure to, foundation instability, land subsidence, or other severe geologic hazards; resulted in the loss of soil used for agriculture or habitat, loss of aesthetic value from a unique landform, or loss of mineral resources; and caused severe erosion or sedimentation from site preparation, construction/demolition, or operational activities.

3.8.2.1 Proposed Action

The greatest potential for adverse impacts to geology and soils would be from erosion and disturbance of soils. Impacts would be short or long term, depending on the type of construction activity. NASA has implemented controls to prevent or minimize impacts on soil resources, including the following:

- A *Spill Prevention, Control, and Countermeasure Plan* (NASA 2023d), which includes BMPs for preventing spills and operational procedures for responding to and collection and containment of spills to minimize the impacts an accident has on the environment.
- The EPA's *Best Management Practices for Lead at Outdoor Shooting Ranges* (EPA 2005)

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant would be used during propulsion testing at the SPTA and can produce explosive hazards, potentially contaminating the soil. Existing management policies and procedures for propulsion testing using solid propellants would be used when dealing with CBS Solid Fuel Propellant. Impacts to geology or soils from the use of CBS Solid Fuel Propellant at the SPTA are expected to be less than significant.

Habitation Systems

The development and testing of habitation systems activities at MSFC would have less than significant environmental impacts as stated in NASA's Record of Environmental Consideration (NASA 2023h). The sound and pressure impulse wave would have the potential to knock down loose lead paint chips from the test stands and older buildings. Paint chips are the result of weathering from the elements over time. The EEOH Office and the Test Area Managers would monitor for lead paint chip accumulation and remove the lead paint chips by disposing of them in the proper hazardous waste container. This would prevent unwanted releases of lead into the soil. Increased habitation system testing could cause new lead paint chip accumulation, but mitigation measures and proper hazardous material handling would prevent impacts to soils.

Real Property

Construction and demolition projects would result in less-than-significant adverse impacts to geological resources. Future construction sites would require at least 20.7 acres of land and up to 316.5 acres of land could be made available for development. Increased erosion and sedimentation may be caused by site preparation and construction activities; however, these would be avoided or minimized by incorporating proper construction techniques, erosion-control measures, and structural engineering designs into project development. A construction stormwater permit would be obtained and a CBMPP would be developed prior to construction to provide detailed erosion prevention and control measures to be implemented during site preparation and construction activities. Prior to construction of new facilities, geotechnical investigations would be conducted to ensure the project is not sited over an area likely to be affected by sinkholes. Individual building design and planning would determine the need for radon mitigation systems. No mineral resources or farmland soils are present.

Expansion of the NASA/FBI Pistol Range would result in an increased amount of shooting and potential for lead contamination of soil. The EPA's *Best Management Practices for Lead at Outdoor Shooting Ranges* (EPA 2005) would be implemented at the site. Impacts to soils from the NASA/FBI Pistol Range are expected to be less than significant. Refer to Section 3.14.2.1 for more information on lead mitigation.

3.8.2.2 No Action Alternative

Under the No Action Alternative, existing conditions at MSFC would continue. No new impacts to geology or soils would be anticipated.

3.9 Noise

U.S. Government agencies provide guidelines on permissible noise exposure limits for unprotected human hearing. These guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of noise-induced hearing loss. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 hertz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Even if the sound levels are the same, sounds with

different spectra can be perceived differently by humans. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. The two most common weightings are A-weighting and C-weighting. A-weighting puts emphasis on the 1,000 to 4,000 hertz range to match the reduced sensitivity of human hearing for moderate sound levels. Rocket engine testing produces predominantly low-frequency noise. The human auditory system does not respond to this low-frequency noise as much as to high-frequency noise. It is, however, noticeable in the form of vibration in walls and windows.

A number of federal agencies have set exposure limits on non-impulsive noise levels, including OSHA, National Institute for Occupational Safety and Health (NIOSH), and the U.S. Department of Defense (DoD) Occupational Hearing Conservation Program. The most conservative of these upper noise level limits is the OSHA standard, which specifies that exposure to continuous steady-state noise is limited to a maximum of 115 A-weighted decibels (dBA). At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. The maximum sound level can be used to identify potential locations where hearing protection should be considered.

The NASA Health Standard on Hearing Conservation (NPR 1800.1C) establishes minimum requirements for the NASA Agency-wide Hearing Conservation Program. This standard is applicable to all NASA employees and NASA-controlled, government-owned facilities. Exposure limits outlined by the NASA Hearing Conservation Program vary with the sound pressure level of the noise, as detailed in Table 3.9-1. It is NASA policy to control noise generated by NASA operations and to prevent occupational noise-related hearing loss. In accordance with this policy, maximum exposure limits have been established to provide an environment free from hazardous noise. NASA's noise exposure program is more stringent than OSHA's. Earmuffs or earplugs are to be provided to attenuate employee noise exposure at a level above 85 dBA. A combination of both earmuffs and earplugs are required where noise levels equal or exceed 97 dBA.

Table 3.9-1. NASA Noise Exposure Limits

Exposure level, dBA	Noise duration, hour	Noise duration, minutes
82	16	0
85	8	0
88	4	0
91	2	0
94	1	0
97	0	30
100	0	15
103	0	7.5

Source: NASA 2017

A NASA study (Guest and Slone 1972) concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The study found that the estimated number of damage claims is 1 in 100 households exposed to an average continuous sound level of 120 decibels (dB) (unweighted) and 1 in 1,000 households exposed to 111 dB (unweighted).

The City of Huntsville's noise ordinance (Ordinance 99-766) regulates noise produced by various sources and defines acceptable noise levels for several types of land use. Daytime sound levels in residential, public space, open space, agricultural, or institutional areas are limited to 55 dBA between the hours of 7:00 a.m. and 10:00 p.m. and 50 dBA between the hours of 10:00 p.m. and 7:00 a.m. Sound levels in commercial areas are limited to 62 dBA and the limit is 70 dBA in industrial areas. There are no state or

federal noise standards that specifically address environmental noise from engine testing. City ordinance codes also do not specifically address noise from rocket engine testing.

3.9.1 Affected Environment

MSFC is located in the center of RSA, which provides a buffer zone between noise-producing activities and the nearest civilian population centers. The largest population densities in the vicinity are the City of Huntsville on the north, west, and east boundaries and the City of Madison directly adjacent to the western boundary of RSA. Huntsville International Airport is located approximately 5.5 miles to the west of the MSFC and contributes to the ambient noise in the vicinity of the MSFC.

Sensitive noise receptors on MSFC include the Marshall Child Development Center. Sensitive noise receptors near MSFC include the RSA Mills Road Child Development Center approximately 1 mile east of MSFC and the Ardent Preschool and Daycare–Redstone 1.8 miles north of MSFC. The nearest residences are approximately 2 miles west of MSFC. The nearest schools are over 3 miles from MSFC.

Engine testing is conducted at MSFC as part of the Advanced Space Transportation Systems programs. The U.S. Army has been developing and testing rocket engines at RSA since soon after the end of WWII. Development and testing of space propulsion systems has been the primary mission of MSFC since its establishment in 1960, and significant engine testing has occurred since that time. Table 3.9-2 describes the existing locations and engines associated with the engine testing at MSFC. Engine testing has previously been evaluated in other NEPA analyses; this information is provided in this EA to provide background information on the typical noise environment at MSFC.

Table 3.9-2. Engine Testing at MSFC

Location	Maximum Size Engine/Components Housed
Building 4670, Advanced Engine Test Stand (West Test Area)	75,000-pound thrust class engine or components 550,000-pound thrust Blue Engine-4 125,000-pound thrust Blue Engine-3 Deflector with water cooling capacity of 340,000 gallons per minute
Building 4583A, Test Facility 115 (East Test Area)	10,000-pound thrust class engine or components
Building 4540, Test Facility 116 (East Test Area)	75,000-pound thrust class engine or components 30,000-pound thrust solid rocket motors
Building 4530, Test Facility 300 (East Test Area)	5-position stand with capability to simulate launch thermal and pressure profiles and high-altitude testing for LOX/LH_2 and LOX/RP1 engines
SPTA	48-inch-diameter, 100,000-pound thrust solid rocket motor Small thrusters or rotating detonating rocket engine type engines or components
Test cells at Building 4583; SPTA	7,500-pound thrust class solid or hybrid motor 500-pound thrust class RDRE
Building 4626, LH2 Cold Flow Facility	Low-pressure flow tests of hydrogen engine and subsystem components
Building 4554, Hot Gas Test Facility	Hydrogen/air combustion-driven environmental test facility capable of generating flow speeds up to Mach 4 and high heating rates to test materials and coatings

Source: NASA 1989, 1997, 2010

NASA also is performing burst and creep-to-burst tests of subscale and full-scale prototypes of inflatable habitat structures at MSFC that will be sent to space. Most, if not all, will use missile-grade air to either cause a burst or a creep (creep test is a constant pressure until the article fails). *Memorandum: Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation* (Jacobs 2023), attached in Appendix F, summarizes modeling of impulse noise resulting from the bursting of these structures from intentional pressurization-to-failure testing. The distance-to-effect data from the sound level predictions for the subscale and full-scale tests are provided in Table 3.9-3. The predicted sound level contours for the subscale and full-scale burst tests are shown on Figures 1, 2, 3, and 4 in Appendix F.

Table 3.9-3. Predicted Peak Sound Levels at Radial Distances from Inflatable Habitat Burst Testing Source

Predicted Sound Level (dB)	12-pound TNT Equivalent Subscale Test Distance from Source (feet)	145-pound TNT Equivalent Full-scale Test Distance from Source (feet)
150	555	1,360
145	840	2,050
140	1,260	3,080
135	1,895	4,620
130	2,850	6,950
125	4,300	10,460
120	6,460	15,750
115	9,750	23,800

Source: Jacobs 2023

TNT = trinitrotoluene

3.9.2 Environmental Consequences

The threshold level for a significant adverse noise impact is defined as a permanent increase in noise or prolonged periods of nighttime noise in noise-sensitive areas.

3.9.2.1 Proposed Action

Advanced Space Transportation Systems – Propulsion Testing

Noise levels from propulsion testing using CBS Solid Fuel Propellant would be similar to existing noise impacts associated with solid fuel propulsion testing occurring on MSFC. The testing would be noticeable by people in the community but would cause an insignificant noise impact because of short duration. A significant increase in testing frequencies beyond the levels of the Proposed Action may increase the level of noise perceived in the community and the level of community annoyance in the vicinity of the RSA, which could require additional noise impact analysis. The potential for impacts to people in the community from the Proposed Action with regard to hearing conservation and for impacts to structures outside the MFSC and RSA boundaries is less than significant.

Habitation Systems

According to *Memorandum: Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation* (Jacobs 2023), in monitoring long-range acoustic impacts of detonations for

the DoD, impulse sounds of 115 to 120 dB in daylight hours generally are ignored by the public and complaints generally are not received until sound levels exceed the 125- to 130-dB range. The memorandum is included as Appendix E.

In addition, modeling of the subscale burst (12 pounds TNT equivalent) indicated that peak sound levels would not exceed 115 dB outside the boundaries of the RSA provided adverse atmospheric effects such as inversions or high winds do not direct sounds to farther locations. Modeling of the full-scale burst (145 pounds TNT equivalent) indicated that peak sound levels would not exceed 120 dB outside the boundaries of RSA and would only exceed 115 dB in limited areas outside the boundaries of RSA provided adverse atmospheric effects such as inversions or high winds do not direct sounds to farther locations. The predicted maximum offsite A-weighted sound levels, when adjusted for the reduced sensitivity of human hearing for moderate sound levels, outside the RSA boundary would be lower than predicted unweighted noise.

These results are considered conservative for the following reasons:

- Sound attenuation by trees and other vegetation between the source and receptors is not considered.
- Energy dissipated or sound attenuation by the rupturing of the test structure is not considered.
- Energy dissipated or sound attenuation by the rupturing of the test structure enclosure (building) is not considered.

The following mitigations would be implemented during full-scale and subscale habitat burst tests to minimize loud noise impacts:

- Test Lab will use the best available technology for meteorological prediction for test day selection, lead-up, and GO/NO-GO calls to ensure a test will not be performed when atmospheric conditions are favorable for long-range sound propagation. The Test Lab's use of modeling technology will not cause offsite low-income and minority communities to experience disproportionally high impacts (greater than 125 dB) from noise because of MSFC activities.
- Test Lab will use the AS10 Proposed Risk Acceptance Code Matrix (Table 3.9-4) for testing actions.
- Personnel working or present outdoors in locations closer to the test site than the predicted 130-dB line should wear double hearing protection (earmuffs and ear plugs).
- Scheduled tests will occur at times when a minimum of nonessential personnel are present and after the sensitive noise receptors at the Army and MSFC daycares have gone home. With the use of modeling technology and the Risk Acceptance Code Matrix (Table 3.9-4), an operational window of 6 a.m. to 8 p.m. any weekday is acceptable. Operational windows on the weekend are encouraged. Scheduled events should not be conducted between late evening and early morning because ambient noise levels are typically lower during these times and the thresholds for startle effects are lower.
- No greater than 145-pound TNT equivalence will be creep-tested at MSFC for the safety of onsite personnel and sensitive noise receptors.
- Test Lab shall notify the Redstone Army Garrison's Public Affairs Office to send a "Noise Alert" on the Team Redstone website at least 24 hours prior to a test if the modeling technology shows the predicted sound level offsite to be 125 dB or greater.
- Test Lab will coordinate test schedules between the East and West Test Areas to avoid cumulative impacts of noise to the community.
- If alternative sites for testing on RSA are selected, then the Test Lab would follow Army regulations for noise and environmental considerations.
- Natural resource subject matter expert personnel (AS10) will monitor the known osprey nest at the top of the T-Tower and take action as necessary.

- ET10 will monitor for lead paint chip accumulation in the test area, notify AS10, and respond in accordance with their instructions.

The Test Lab at MSFC is proposing to use the Redstone Test Center's (RTC's) meteorological prediction and probability maps to inform Inflatable Habitat Burst test day selection, lead-up planning actions, and GO/NO-GO calls. The RTC models produce a high-fidelity acoustic model with the following inputs:

- Calculated explosive equivalence (pound TNT)
- Test location
- Height
- Day
- Time
- Local topography
- Predicted weather conditions at a selected time (both empirical data and predictive models)

The acoustic maps produced by the RTC model are good for predictions up to 5 days in advance, but the maps are most accurate within 2 days of running the model. With the predicted sound levels in the acoustic maps, NASA will be able to mitigate potential noise to both onsite workers and the public. Every effort will be made by NASA to ensure that no greater than 130 dB will be heard offsite from the inflatable habitat testing program.

Table 3.9-4. Proposed Risk Acceptance Code Matrix

Predicted Sound Level, dB Peak	Risk of Offsite Complaints	Action
Less than 115	Low	Test Conductor Approval
115 to 125	Moderate	Branch Approval
125 to 130	Medium	Test Lab Approval
Greater than 130[a]	High; possibility of physiological and structural damage	Postpone Activities

Source: NASA 2023j

[a] Personnel working or present outdoors in locations closer to the test site than the predicted 130 dB line should wear double hearing protection (earmuffs and ear plugs)

The testing would be noticeable by the people in the community but would cause an insignificant noise impact because of the short duration of testing. With mitigation measures in place, impacts are expected to be less than significant. If the location of habitation systems testing shifts to other locations within MSFC in the future, screening would need to occur to ensure that OSHA, NIOSH, DoD, and NASA noise standards are not exceeded.

Real Property

Construction and demolition activities, including partial and whole implosion, have the potential to create noise impacts and temporary construction noise, which would result in minor, short-term, direct, adverse impacts. Temporary noise impacts from the operation of construction equipment are usually limited to a distance of 1,000 feet or less. Vehicles associated with construction typically generate between 65 and 100 dBA at a distance of 50 feet. Construction noise would not result in noticeable impacts at offsite properties because of its temporary duration and the lack of sensitive receptors in the immediate vicinity and the buffer provided by RSA between noise-producing activities and the nearest civilian population centers. BMPs and all applicable laws and regulations would be followed during construction. Employee noise exposure limits would be controlled by following all applicable OHSA, DoD, and NASA standards and

by providing appropriate equipment to employees to attenuate noise exposure, including earmuffs or earplugs or a combination of both depending on noise levels.

Development of additional areas for space operations and engine testing activities has the potential to increase noise levels. When information on the actual development planning and design is available, assessment of the Proposed Action's potential impact on noise may differ from this preliminary assessment and additional NEPA and noise impact analysis may be needed.

3.9.2.2 No Action Alternative

Under the No Action Alternative, the activities associated with the Proposed Action would not occur; therefore, no impacts to the noise environment would be expected.

3.10 Traffic and Transportation

This subsection describes the existing traffic and transportation conditions at MSFC and the associated environmental consequences from the Proposed Action and the No Action Alternative. For the purposes of this analysis, transportation and traffic resources include roadways within MSFC, including those on RSA that lead to MSFC, and the regional transportation system within 1-mile of RSA's gates. Transit and nonmotorized transportation modes (pedestrians and bicyclists) would not be affected by the Proposed Action; thus, they are not included in this section.

NASA Transportation and General Traffic Management (NPR 6200.1D) (NASA 2014) sets forth transportation and general traffic management responsibilities and procedures governing the use of commercial and government transportation resources. While not a regulatory standard, it establishes NASA's transportation responsibilities.

3.10.1 Affected Environment

Roadway access from RSA into MSFC is provided via Rideout Road from the north and Martin Road from the east and west. All traffic to and from MSFC and RSA is routed through six gates. The Main Gate (Gate 1) is on Martin Road on the eastern side of RSA. Gate 3 (Redstone Road) is also on the eastern side of RSA. Gate 7 (Martin Road) is on the western side of RSA. Gate 8 (Goss Road), Gate 9 (Rideout Road), and Gate 10 (Patton Road) provide access to RSA and MSFC from the north (NASA 2017). MSFC personnel and visitors traveling from Huntsville, Alabama, or the surrounding area generally access MSFC via Interstate 565 (I-565) to the north, U.S. Route 231 (US 231) to the east, or Zierdt Road to the west. The roadway network is shown on Figures 2-1a, 2-1b, and 2-1c.

The major north-south roads on MSFC are Rideout Road (six lanes), Toftoy Throughway (four lanes), and Dodd Road (three lanes). Major east-west roads are Martin Road (four lanes), Fowler Road (four lanes), and Neal Road (two lanes). The majority of the bridges on MSFC are single lane and two directional, with a 15- to 16-foot clearance and a 36-ton load limit (NASA 2017).

Table 3.10-1 summarizes 2020 average annual daily traffic for the primary roadways within the region of interest.

Table 3.10-1. Average Annual Daily Traffic within the Region of Interest

Roadway	Location	Number of Lanes	Average Annual Daily Traffic
I-565	West of Research Park	6	92,500
I-565	East of Research Park	10	99,800
Martin Road	Between Zierdt Road and RSA Gate 7	2	7,100
Martin Road	Between US 231 and RSA Main Gate	4	10,400
US 231 (Memorial Parkway)	South of Martin Road	6	58,400
US 231 (Memorial Parkway)	North of Martin Road	4	68,300
Rideout Road	North of Gate 9	4	35,200
Rideout Road	South of Gate 9, north of Toftoy Throughway	6	29,837
Rideout Road	Between Toftoy Throughway and Neal Road	6	11,162
Rideout Road	Between Neal Road and Martin Road	6	8,783
Martin Road	West of Rideout Road	4	9,940
Martin Road	Between Rideout Road and Dodd Road	4	9,342
Martin Road	Between Dodd Road and Toftoy Throughway	4	9,601
Fowler Road	Between Rideout Road and Dodd Road	4	3,743
Dodd Road	South of Fowler Road	3	1,320
Dodd Road	At MSFC southern border	3	853
Neal Road	Between Rideout Road and Morris Road	2	2,296
Rideout Road	Between Neal Road and Martin Road	6	8,783

Source: City of Huntsville 2023; Alabama DOT 2023.

Transportation routes for the movement of large vehicles/loads through MSFC include Rideout Road, Martin Road, Gemini Road, and portions of Tiros Street (north of Martin Road), Fowler Road (south of Martin Road), Saturn Road (south of Fowler Road), and Dodd Road (south of Saturn Road) (NASA 2003).

The maintenance of Martin Road, Marshall Road, Neal Road, Morris Road, Fowler Road, Rideout Road, and Dodd Road, gates, and bridges is provided by RSA as part of a support agreement with MSFC. MSFC is responsible for the maintenance of all other roads and paved areas within its boundaries (NASA 2017).

RSA is located adjacent to the Tennessee River and NASA has access to docking facilities on the installation. NASA is responsible for all special water transportation of Space Launch System components

and related cargo between ports for MSFC. The MSFC docks, located at the River Terminal, have a recess for roll-on and roll-off loading and unloading (NASA 2017).

Rail service does not enter MSFC, but a spur rail is available at RSA within a mile of MSFC (NASA 2003). Air transportation is available at RSA Airfield and Huntsville International Airport (NASA 2003).

3.10.2 Environmental Consequences

This subsection provides a description of the potential impacts from implementing the Proposed Action and the No Action Alternative on traffic and transportation. The threshold for a significant adverse impact would be met if the Proposed Action disrupted regional or local (on MSFC) traffic patterns or increased vehicle trips on the roadway network, resulting in severely degraded levels of service.

3.10.2.1 Proposed Action

The Proposed Action would have no impacts on water, rail, or air transportation.

Advanced Space Transportation Systems – Propulsion Testing

Operational missions and activities are not expected to noticeably affect traffic or transportation at MSFC or on regional roadways. Testing at the SPTA would occur up to two times per year, but the associated increase in traffic for testing would be negligible and impacts would be less than significant.

Habitation Systems

Traffic associated with habitation system activities at MSFC would have less than significant impacts associated with testing activities for the prototypes of inflatable habitat structures.

Real Property

The real property actions included in the Proposed Action would affect traffic and transportation at MSFC and the roadways immediately surrounding it. Ongoing maintenance related to sustainment actions would result in maintenance vehicles and personnel accessing properties within MSFC, which would result in a negligible change in traffic volumes and patterns on MSFC roadways and are expected to be less than significant. Effects outside of MSFC and RSA are not expected.

Repair or renovation of existing assets, construction of new assets, or divestment/demolition of assets under the Proposed Action would result in a less than significant temporary increase in construction and/or demolition-related traffic on the roadways at MSFC as well as on the regional roadways surrounding RSA. Construction vehicles, equipment, and personnel would be required to support the investment, divestment, outgranting, and development activities described in Section 2.1.2.1. Exact changes to traffic and transportation are unknown as construction and demolition schedules have not been set and the outcome of the outgranting process has not been identified (lessee and asset use has not been determined). Decisions regarding how projects are phased should include consideration for overall impacts to traffic on the local and regional roadways, and efforts to minimize construction and demolition traffic impacts to roadways should be considered.

Following the completion of the investment, outgrant, and development projects, a permanent change to traffic volumes and traffic patterns would be expected. Impacts to traffic would be less than significant and anticipated traffic volumes would vary by project. For most of the actions, project design and occupancy details are currently unknown. Traffic studies should be conducted and necessary traffic mitigation should

be implemented following the bid process for each project where facilities are expected to generate new traffic. A traffic study is unlikely to be required for investment, outgrant, and development projects where staff or facilities are relocated from another area within MSFC or where operational traffic generation is anticipated to be negligible.

3.10.2.2 No Action Alternative

Under the No Action Alternative, there would be no changes to traffic and transportation resulting from NASA activities. Traffic patterns could continue to change and volumes may continue to increase outside of MSFC. The impacts associated with ongoing traffic growth would be managed by the appropriate agencies (U.S. Army for RSA or state or local agencies for impacts off the installation).

3.11 Socioeconomics

Socioeconomic resources include population and housing, employment, the economy, income, education, and tourism.

3.11.1 Affected Environment

The region of interest for analyzing socioeconomic resources is Madison County, Alabama.

As of 2022, Madison County and the State of Alabama had populations of approximately 403,565 and 5,074,296, respectively (U.S. Census Bureau 2022). From 2017 to 2021, Madison County and the State of Alabama had a median household income (in 2021 dollars) of $71,153 and $54,943, respectively (U.S. Census Bureau 2022).

The aerospace/aviation and defense industry is a large contributor to Alabama's economy by employing more than 61,000 people statewide (Alabama Department of Commerce 2023). Aerospace manufacturing alone accounts for 14,200 jobs in the state. Additionally, Alabama is home to more than 300 aerospace companies from more than 30 different countries. More than $1.7 billion in aerospace equipment and parts were exported from the state in 2022 (Alabama Department of Commerce 2023).

As the third largest employer, MSFC has a significant impact on the Madison County area economy. MSFC has a total workforce of nearly 7,000 employees and an annual budget of $3.6 billion (NASA 2023a). As of 2019, MSFC generates $4.3 billion annually in economic impact for Alabama (NASA 2019b, 2023a) and the MSFC contributions to the local economy account for 7.5% of Madison County's gross product (NASA 2019b).

According to the Huntsville/Madison County Chamber of Commerce, the area economy is dominated by defense, aerospace, and research and technology industries. The leading Huntsville/Madison County employers are U.S. Army/RSA, Huntsville Hospital, NASA/MSFC, The Boeing Company, and Huntsville City Schools. (Huntsville/Madison County Chamber 2022)

3.11.2 Environmental Consequences

The threshold for a significant impact would be met if the Proposed Action were to induce substantial economic growth in an area, either directly or indirectly, disrupt or divide the physical arrangement of an established community, cause extensive relocation when sufficient housing is unavailable, cause extensive relocation of community businesses that would cause severe economic hardship for affected communities, and/or produce a substantial change in the community tax base.

3.11.2.1 Proposed Action

There would not be any substantial changes to the socioeconomic environment within the vicinity of MSFC because of the Proposed Action. Construction activities may have a temporary positive impact due to construction employment and expenditures in local communities. Excluding future proposals for site development projects, the real property actions, propulsion testing using CBS Solid Fuel Propellant, and habitation systems testing included in the Proposed Action are not expected to require a substantially higher number of employees than the current number of employees at MSFC. Any increases in employment levels would be insignificant compared to the population of Madison County, the State of Alabama, and the number of aviation and aerospace industry employees statewide. Therefore, impacts to employment, the local tax base, and the local housing market for activities under the Proposed Action, with the exception of site development projects, would be less than significant.

As details emerge regarding plans for development sites, the development firm(s) would be required to coordinate with NASA to determine what level of additional NEPA may be required to address potential impacts associated with the anticipated increase in employees.

3.11.2.2 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur. Therefore, socioeconomics resources would remain as existing, and no impact would be anticipated.

3.12 Children's Environmental Health and Safety

EO 13045, "Protection of Children from Environmental Health Risks," directs federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. It also ensures that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. Potential risks to health or safety include products or substances that the child is likely to come in contact with or ingest such as air, food, drinking water, and water used for recreational purposes (EPA 2022).

The study area for assessing protection of children is the same as the study area for assessing environmental justice (EJ), described in Section 3.11. It encompasses an area within 5 miles of the boundary of the RSA and is compared to the overall four-county region (Limestone, Madison, Marshall, and Morgan) and the State of Alabama.

3.12.1 Affected Environment

At MSFC, there is one childcare center, the Marshall Child Development Center, which is located in the northern portion of MSFC away from testing activities. The childcare center is for children of government and contractor employees at MFSC or for Redstone families. RSA also has two childcare centers on the installation and there is a private childcare center just outside Gate 9, north of MSFC. In addition, RSA has privatized government housing, which includes general officer quarters and 352 family housing units for officers and enlisted personnel. The housing situation creates a dynamic population of children within the study area.

Table 3.12-1 presents the populations of children under age 5 in the study area, the census tract in which MSFC is located, the surrounding four counties, and the State of Alabama. Within the study area, populations under age 5 in 2022 are 6%, which is consistent with Alabama (6%) (EPA 2023d).

Table 3.12-1. Children Populations in Study Area compared to Surrounding Counties and the State

Children Population Estimates[a]	Study Area (RSA + 5 miles)	Census Tract 111	Limestone County	Madison County	Marshall County	Morgan County	Alabama
Under the Age of 5 Years Old (%)	6	2	5.4	5.5	7.2	5.9	6

[a] Data gathered from EJScreen version 2.2 Community Report (Appendix E) and U.S. Census Bureau Quick Facts

3.12.2 Environmental Consequences

This section evaluates potential impacts resulting from the Proposed Action, including real property actions, propulsion systems, and habitation systems. The anticipated direct and indirect impacts are discussed, considering both short- and long-term project effects.

The threshold for a significant impact to the protection of children would occur if any of the following were to result from the Proposed Action: a higher percentage of children populations are present as compared to the community of comparison; or a significant adverse environmental or health impact occurs such as an environmental hazard exposure of children that would exceed the exposure of the general population or similar comparison groups.

3.12.2.1 Proposed Action

Based on the analysis, there are not higher percentages of children populations in the study area compared to the communities in comparison.

Additionally, the Proposed Action is not anticipated to have significant impacts on children or increase exposure of children to adverse environmental or health impacts. This determination is made because activities under the Proposed Action would occur on MSFC, which is a controlled-access facility that is not publicly accessible and where children are not permitted, except in designated childcare areas. All construction and demolition activities would be conducted by trained personnel in accordance with OSHA regulations. A temporary secure perimeter fence would be installed around each construction and demolition area with a construction access gate. Construction activities could result in temporary impacts to children from increased mobile air sources and noise. It is assumed that impacts from habitation testing and propulsion system activities, such as noise, would be similar to existing noise profiles associated with solid fuel propulsion and habitation testing already occurring on MSFC. Therefore, impacts to protection of children are expected to be less than significant.

3.12.2.2 No Action Alternative

The No Action alternative would have no impact on populations of children. The Proposed Action would not occur, and therefore no impacts beyond the scope or normal conditions would occur. The No Action Alternative would not result in disproportionately high or adverse impacts to children.

3.13 Environmental Justice and Equity

The White House defines EJ as, “the just treatment and meaningful involvement of all people regardless of income, race, color, national origin, or Tribal affiliation, or disability, in agency decision-making and other federal activities that affect human health and the environment.”

EO 12898, "Federal Actions to Address Environmental Justice in Minority and Low-Income Populations," requires federal agencies to identify and address human health or environmental impacts of their actions on minority and low-income populations.

EO 14096, "Revitalizing Our Nation's Commitment to Environmental Justice for All," directs federal agencies to identify, analyze, and address disproportionate and adverse environmental and health impacts on communities with EJ concerns.

MSFC implements an *Environmental Justice and Equity Plan* (NASA 2023b) that builds on previous EJ planning at MSFC and incorporates a renewed emphasis on Title VI of the Civil Rights Act of 1964 and equity to align with the NASA's first *Equity Action Plan* (NASA 2022b).

For the purposes of this analysis, minority populations are defined as Alaska Natives and American Indians, Asians, Blacks or African Americans, Native Hawaiians and Pacific Islanders, or persons of Hispanic origin (of any race); low-income populations include persons living below the poverty threshold as determined by the U.S. Census Bureau.

3.13.1 Affected Environment

The study area for this analysis focused on an area within a 5-mile boundary of the RSA and is compared to the overall four-county region (Limestone, Madison, Marshall, and Morgan) and the State of Alabama. MSFC is within Census Tract 111 and there are 134 census tracts within the entire study area. This study area was chosen to be consistent with the MSFC *Environmental Justice and Equity Plan* (NASA 2023b). The census tracts and the MSFC 5-mile analysis zone are illustrated and labeled on Figure 3.13-1.

This analysis relies on the *Environmental Justice and Equity Plan* (NASA 2023b) because it was conducted recently and represents up-to-date and accurate information on disadvantaged communities surrounding MSFC. For access to the *Environmental Justice and Equity Plan*, which includes a discussion of the methodology used, contact NASA at msfc-environmental@mail.nasa.gov.

This demographic analysis was based on the 2020 U.S. Census data and EJScreen, which relies on 2016 to 2020 American Community Survey data. The demographic analysis includes demographic data for the county where MSFC is located, Madison County, and the three other adjacent counties that fall within a 5-mile buffer area of RSA for comparison (Table 3.13-1).

Table 3.13-1. 2020 Environmental Justice Analysis for Census Tract 111 (RSA/MSFC), Each County, and the Region

Location	% Minority	% Below Poverty Level	Population	Median Household Income
Limestone County	21.10	12.68	103,570	$33,428
Madison County	43.86	14.06	388,153	$40,223
Marshall County	10.14	20.17	97,612	$27,333
Morgan County	20.87	13.38	123,421	$30,412
Four-County Region	25.83	13.31	680,096	
Census Tract 111 (RSA/MSFC)	35.17	7.80	1,308	

Source: NASA 2023b

3.13.2 Environmental Consequences

The threshold for a significant impact would be met if the study area:

- Contains higher percentages of low-income and minority populations as compared to the community of comparison. A census tract is an area of concern when the minority population of the area exceeds 50%. A census tract is an area of concern for poverty if more than 10% of the residents are living below the poverty line.
- Would be adversely affected by the implementation of the Proposed Action.

3.13.2.1 Proposed Action

Census Tract 111, where MSFC is located, is not considered disadvantaged because there are not higher populations of low-income and minority populations as compared to the community of comparison.

Because there are not higher percentages of minority or low-income populations compared to the community in comparison, these populations would not be adversely affected by the implementation of the Proposed Action. Construction and operation activities under the Proposed Action would occur entirely on MSFC. Since there are no residential neighborhoods located on MSFC, there would be no impacts to residential areas, including impacts to minority or low-income populations. Although there is the potential for construction activities to increase traffic and noise levels and impact air quality, these effects would be short term and minor and are not anticipated to impact off-installation populations. Communities surrounding MSFC may benefit from the Proposed Action through increased employment opportunities and positive economic gains in the form of increased wages and spending.

3.13.2.2 No Action Alternative

The No Action alternative would not impact EJ populations. The Proposed Action would not occur, and therefore no impacts beyond the scope of normal conditions would occur. The No Action Alternative would not result in disproportionately high or adverse impacts to minority and/or low-income communities.

3.14 Hazardous Materials and Wastes, Solid Waste, and Pollution Prevention

Hazardous materials have been declared hazardous through federal listings, including Extremely Hazardous Substances listed in Appendix A of 40 CFR Part 355, *Emergency Planning and Notification*; those listed as hazardous if released, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 40 CFR Subpart 302.4, *Designation of Hazardous Substances*; and by definition of hazardous chemicals under OSHA in 29 CFR Subpart 1910.1200, *Hazard Communication*. A toxic substance is a substance that, when ingested or absorbed, is harmful or fatal to living organisms. For purposes of this EA, "hazardous material" refers to any item or agent (biological, chemical, or physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Toxicity is an attribute of some hazardous waste. Through the Toxic Substances Control Act, EPA regulates toxic substances such as asbestos, lead-based paint, polychlorinated biphenyls, and radon.

Hazardous waste is any solid, liquid, or contained gas waste that is dangerous or potentially harmful to human health or the environment. Federal regulations on hazardous waste are contained in 40 CFR

Parts 260 to 279 and are a result of Subtitle C of the Resource Conservation and Recovery Act (RCRA), which requires a program to track hazardous waste from generation to storage to transportation to disposal.

Solid waste is defined by the implementing regulations of the RCRA generally as any discarded material that meets specific regulatory requirements and can include such items as refuse and scrap metal, spent materials, chemical byproducts, and sludge from industrial and municipal wastewater and water treatment plants (40 CFR Subpart 261.2).

The Pollution Prevention Act (42 U.S.C. Sections 13101 through 13109) requires pollution prevention and source reduction control so wastes have less effect on the environment while in use and after disposal. The Pollution Prevention Act describes methods used to avoid, prevent, or reduce pollutant discharges or emissions.

3.14.1 Affected Environment

3.14.1.1 Hazardous Materials Storage and Handling

To support the research mission of MSFC, a variety of hazardous and toxic materials are used. In compliance with the requirements of the Emergency Planning and Community Right-to-Known Act and the Superfund Amendments and Reauthorization Act, an inventory of hazardous substances is maintained. Safety data sheets for all chemicals used on MSFC are maintained within the MSFC Online Master Listing. A Proactive Procurement Request must be submitted and approved before chemicals are brought onto MSFC. The SafeSuite system serves to ensure that all Proactive Procurement System requirements are met (NASA 2017).

In accordance with Sections 311 and 312 of the Emergency Planning and Community Right-to-Know Act, MSFC is required to submit a Tier II report annually for any substance that is present at MSFC in the following quantities:

- Greater than or equal to 10,000 pounds at any one time for a hazardous chemical
- Greater than or equal to 500 pounds or the threshold planning quantity, whichever is less, at any time, for extremely hazardous substances

NASA submitted a Form R for each toxic chemical (found at 40 CFR Subpart 372.65) used at MSFC during previous years (NASA 2017).

3.14.1.2 Hazardous Waste Management

MSFC is classified according to federal and state regulations as a large-quantity hazardous waste generator. MSFC generates more than 1,000 kilograms of hazardous waste each month (NASA 2017). These wastes include cadmium, chromium, lead, and other metals; wastes with characteristics of ignitability, corrosiveness, or reactivity; lab packs of small amounts of hazardous waste; spent solvents; and wastewater treatment sludge (NASA 1997). NASA maintains a comprehensive inventory of all RCRA-defined hazardous wastes and controlled wastes not regulated by RCRA. MSFC has established hazardous and controlled waste accumulation site inspection guidelines that serve to monitor the accumulation activities of each generating activity throughout MSFC. Full drums of wastes are stored temporarily in the Hazardous Waste Storage Facility. MSFC is a 90-day storage facility and must transport waste offsite for disposal within 90 days. All similar waste is combined within a consolidation area in the Hazardous Waste Storage Facility. Hazardous wastes are disposed of offsite at several hazardous waste disposal facilities approved by EPA. Wastes are transported from MSFC by licensed hazardous waste

transporters. Special wastes generated at MSFC include asbestos, industrial waste, petroleum-contaminated soil and water from spill cleanup, and medical waste (NASA 2012, 2017).

Aboveground and Underground Storage Tanks

Aboveground and underground storage tanks include bulk storage containers greater than 55 gallons that are used to store oil. The locations of aboveground and underground storage tanks at MSFC are show on Figures 3.14-1a, 3.14-1b, and 3.14-1c. Currently, there are 68 aboveground storage tanks and 1 underground storage tank in the tank inventory in the *Spill Prevention, Control, and Countermeasure Plan* (NASA 2023d). NASA has containment structures for all of the aboveground storage vessels greater than 55 gallons operating at MSFC. These structures have been designed to contain and prevent discharges caused by equipment or tank failure from entering a navigable watercourse (NASA 2023d).

Radioactive Material and Radiation

NASA uses radioactive materials in a number of test programs. The Compact Fuel Element Environmental Test, which conducts high-temperature, but not high-pressure, testing, is licensed to test with depleted uranium. In all cases, radioactive material is transported, stored, and handled in compliance with NRC and U.S. DOT procedures and MPR 1860.1, *MSFC Radiation Safety Procedural Requirements*. An inventory list of radioisotopes, including their locations, amounts, and custodians, is maintained by the Radiation Safety Officer. All non-exempt radioactive materials currently in use at MSFC are specifically listed in MSFC NRC Materials License 01-06571-10 (NASA 2017).

Radioactive waste materials are disposed of via a licensed radioactive waste broker in compliance with NRC and U.S. DOT regulations. The wastes are shipped to an approved or certified waste disposal site (NASA 2017).

Ionizing radiation sources in use at MSFC include radioisotopes and ionizing radiation-producing devices. Ionizing radiation-producing devices at MSFC include industrial and medical X-ray machines, linear accelerators, particle accelerators, and X-ray diffraction units. Sources of hazardous nonionizing radiation-producing devices at MSFC include class 3B and 4 lasers, radio frequency (including microwave frequency) emitting devices, and lamps that emit ultraviolet and white light (NASA 2017).

Ordnance

Based on its history of military activity, changes in mission, and various tenants, RSA contains areas of ordnance and explosives contamination and potential contamination, including within MSFC. RSA is responsible for the cleanup and disposal of unexploded ordnance (UXO). Figures 3.14-1a, 3.14-1b, and 3.14-1c show the probability of the presence of UXO at MSFC.

The 4200 Building Complex has been categorized as an area with no known ordnance activities. The 4300, 4400, 4500, and portions of the 4600 areas have been designated as potential ordnance areas. The southern portion of MSFC's 4600 area, near Building 4666, has been designated as a known ordnance disposal area. The northern portion of the 4700 area and a small area west of Buildings 4250, 4251, and 4241 have been designated as potential phosphorus areas. In white and plasticized white forms, phosphorus can spontaneously ignite when exposed to air, gases containing oxygen, or oxidizing agents (NASA 2017).

Contaminated Areas

Figures 3.14-1a, 3.14-1b, and 3.14-1c show known areas of contamination at MSFC. MSFC was placed on the National Priorities List in 1994, requiring compliance with CERCLA. Using NASA Construction, Environmental Compliance, and Restoration Account funds, the MSFC Remediation Office is cleaning up contaminated areas within its responsibility. Previous activities at MSFC and RSA have resulted in large areas of contaminated groundwater in both the residuum and bedrock aquifers. Groundwater contamination at MSFC is designated as Operable Unit 3 (OU-3). Contaminated groundwater at MSFC has been divided into five major plumes: Northwest Plume, Northeast Plume, Central Plume, Southwest Plume, and Southeast Plume. The primary contaminants in the rubble zone plumes are the chlorinated VOCs tetrachloroethene, trichloroethene, dichloroethane, vinyl chloride, carbon tetrachloride, chloroform, and 1,1,2,2-tetrachloroethane. Contaminants in the bedrock aquifer appear at significantly lower levels. In addition, a small benzene, toluene, ethylbenzene, and xylene plume is located at the former base refueling area (NASA 2017). NASA has completed a LUC Proposed Plan and an IROD (NASA 2007). The IROD provides restrictions on groundwater beneath MSFC, such as preventing potable use and management control over nonpotable uses of all groundwater beneath the MSFC boundaries. NASA has an approved LUC Remedial Design document for OU-3 at MSFC and is required to submit an annual report documenting the inspection of the OU-3 LUCs and to note the status and updates to the controls that might be warranted (NASA 2017).

Quantity Distance

The quantity distance is the distance that should separate a location where explosive materials/ propellants are stored or used from an inhabited building. Figures 3.14-2a, 3.14-2b, and 3.114-2c show quantity distance zones at MSFC.

3.14.1.3 Solid Waste Management

Refuse and nonhazardous waste are collected by the MSFC Custodial and Refuse Collection Services Contractor and disposed of under the provisions of RSA's Support Agreement. "Acceptable waste" is collected in modular containers and transported to the solid waste disposal authority's mass burn steam plant incinerator. "Unacceptable" nonhazardous waste (construction waste, rubble, vegetation, and asbestos) excluded from the incinerator is disposed of at the Redstone Arsenal Landfill. It is classified as a construction/demolition landfill and receives construction and demolition waste only from RSA tenants (USACE, U.S. Army Aviation and Missile Command, and NASA). The landfill is permitted to accept up to 900 tons of waste per day (NASA 2017). For large demolition projects, solid waste is also taken to approved offsite construction/demolition landfills. NASA contractors are required to dispose of waste in accordance with all federal, state, and local laws and regulations.

3.14.1.4 Pollution Prevention

The *MSFC Spill Prevention, Control, and Countermeasure Plan*, *MSFC Resource Conservation and Recovery Act Contingency Plan*, and MPR 8500.1, *Environmental Engineering and Occupation Health Program*, provide guidance on preventing pollution from contaminating surface waters and groundwater.

MSFC recycles to divert solid waste from the waste stream to a beneficial reuse of the materials. The MSFC recycling program recycles paper, aluminum cans, cardboard, scrap metal, batteries, #1-7 plastics, fluorescent light bulbs, oil, toner and inkjet cartridges, glass, coolant, and other materials. MSFC also reduces, reuses, and recycles hazardous and toxic substances prior to disposal, to the extent feasible (NASA 2017).

MSFC has a green purchasing program for purchasing environmentally friendly products designated by the EPA and U.S. Department of Agriculture (USDA) in accordance with EO 14057, NPR 8530.1, and MPR 8715.1. The purpose of the green purchasing program is to increase and expand markets for recycled and biobased-content materials through greater government preference and use of products made with such materials, consistent with the demands of efficiency and cost-effectiveness.

3.14.2 Environmental Consequences

The threshold for a significant impact would be noncompliance with applicable federal and state regulations as a result of the Proposed Action, disturbance or creation of contaminated sites resulting in adverse effects on human health or the environment, and established management policies, procedures, and handling capacities unable to accommodate the proposed activities.

3.14.2.1 Proposed Action

The greatest potential for adverse impacts to the environment from hazardous materials or hazardous wastes would be from an accident, such as a leak, spill, fire, or explosion, at a storage location, or from an accidental release during normal operating activities. Impacts such as a release of toxic gases, soil contamination, or surface water/groundwater contamination would be short or long term, depending on the type of accident and the hazardous materials and hazardous wastes involved. NASA has implemented controls to prevent or minimize the effects of an accident involving hazardous materials and hazardous wastes, including the following:

- NASA has prepared a *Spill Prevention, Control, and Countermeasure Plan* (NASA 2023d), which includes BMPs for preventing spills and operational procedures for responding to and collection and containment of spills to minimize the impacts an accident has on the environment.
- All NASA personnel and contractor personnel who handle hazardous materials and hazardous wastes receive mandatory training.
- Containers with hazardous materials are inspected for leaks on a scheduled basis.
- All hazardous wastes are stored in closed containers, and accumulation areas have the capability of containing a leak or spill.
- Aboveground and underground storage tanks are inspected monthly and after significant rain events to confirm the tanks, spill prevention controls, and secondary containment are all in good condition and no accumulation of oil is present. Corrosion testing is performed every 3 years on the underground storage tank to check the integrity of the tank.

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant, which can produce explosive hazards, would be used during propulsion testing at the SPTA. Similar to other solid propellants used at MSFC, CBS Solid Fuel Propellant would be kept under carefully controlled storage conditions that would provide protection from mechanical shocks or abrupt temperature changes that may crack the propellant grain and cause unexpected deflagration or detonation. Existing hazardous material and hazardous waste management policies and procedures for propulsion testing using solid propellants would be followed when dealing with CBS Solid Fuel Propellant; therefore, impacts to hazardous materials and wastes from the use of CBS Solid Fuel Propellant at the SPTA are expected to be less than significant.

Habitation Systems

The use of hazardous materials and the generation of hazardous waste is not anticipated during development and testing of habitation systems activities at MSFC. All waste produced is anticipated to be solid waste, which would be transported and disposed of at the landfill in accordance with federal and state regulations. The amount of solid waste disposed of is not expected to exceed landfill capacity and impacts to solid waste from habitation systems would be less than significant.

Real Property

Hazardous Materials and Wastes and Pollution Prevention

Construction and demolition projects would result in less-than-significant adverse impacts resulting from the use of hazardous materials and/or generation of hazardous waste and solid waste. Construction and demolition would require the use of hazardous materials such as gasoline, oils, coolant, and lubricants commonly used by construction equipment, paints, welding gases, solvents, preservatives, and sealants. Equipment servicing and repair activities could temporarily generate oily and hazardous wastes, such as spent solvents, residual fuels, used oils, used batteries, antifreeze, and filters. Contractors would be responsible for the management of hazardous materials, which would be handled in accordance with federal and state regulations and MSFC's *Spill Prevention, Control, and Countermeasure Plan*. Construction and demolition activities would be conducted consistent with hazardous waste and pollution use and storage regulations, with guidelines specified in a SWPPP.

A hazardous materials survey would be conducted before demolition of facilities to identify the types and quantities of hazardous building materials (e.g., asbestos, lead paint, and polychlorinated biphenyls) and to evaluate the history of hazardous wastes stored and/or generated at the facility. Appropriate worker safety measures would be implemented for those workers who could encounter hazardous materials. The construction and/or demolition contract would require the contractor to handle the disposal of all hazardous materials in accordance with applicable federal, state, and local regulations and requirements. Asbestos-containing materials would be handled in accordance with the MSFC Asbestos Program (MPR 1840.4). Within implementation of surveys and regulations and requirements, less-than-significant impacts from the demolition of facilities containing hazardous materials would be expected.

Installation of a new LH_2 tank is proposed adjacent to the current 2,600-gallon tank at Building 4628. The storage tank would have vacuum insulation, which consists of two walls with a layer of high vacuum in between. The double wall would act as containment in the event the inner wall developed a leak, which would prevent a release to the environment. The LH_2 tank would be installed and managed in accordance with federal and state regulations and MSFC's *Spill Prevention, Control, and Countermeasure Plan*. Impacts to hazardous materials and wastes from the installation of an additional LH_2 tank at MSFC are expected to be less than significant.

Expansion of the NASA/FBI Pistol Range would result in an increased amount of shooting and potential for lead contamination of soil and water. The expanded range would be designed to mitigate the release of lead into the environment and the EPA's *Best Management Practices for Lead at Outdoor Shooting Ranges* (EPA 2005) would be implemented at the site. A constructed berm would prevent the lead compound from moving quickly through the subsurface and help minimize migration of lead outside of the range. The number of rounds fired over time at the range would be recorded to help determine when reclamation would be necessary to prevent accumulation of excess amounts of lead, thereby decreasing the potential for the lead to migrate offsite. With design considerations and implementation of BMPs, impacts to human health or the environment from the NASA/FBI Pistol Range are expected to be less than significant.

The construction and operation of new and expanded facilities in the future could increase the use of hazardous materials and generation of hazardous wastes at MSFC. New and expanded facilities and operations would adhere to federal, state, local, and NASA-established procedures for handling, storage, transportation, and disposal of hazardous materials and wastes. With adherence to applicable regulations and requirements, adverse impacts from hazardous materials and wastes from real property projects at MSFC are expected to be less than significant.

If a new facility or operation would require the use and disposal of hazardous materials and hazardous wastes for which NASA does not currently have established management policies, procedures, and/or handling capacities to accommodate, then additional NEPA analysis would be required. Additional NEPA analysis also would be required for any real property project that would disturb an existing contaminated site and have the potential for adverse effects on human health or the environment.

Solid Waste

Construction and demolition projects would result in an increase in construction debris. Solid waste generated would consist of building materials such as solid pieces of concrete, metals, and lumber. Contractors would be required to recycle construction and demolition debris to the extent practicable, thereby diverting it from the landfill. Demolition of older buildings at MSFC could result in the generation of hazardous waste, including lead-contaminated and asbestos-containing building materials and lead-contaminated soil. Asbestos-containing material and materials/soil containing lead-based paint would be handled and disposed of in accordance with federal, state, and local regulations. There would be long-term beneficial impacts from the removal of hazardous building materials at MSFC. Any hazardous materials being stored at facilities to be demolished would be properly relocated and/or disposed of prior to demolition activities.

Ordnance, Quantity Distance, and Contaminated Areas

There is potential to encounter UXO anywhere on MSFC. Portions of development sites L8, L9, and L10 in the southern area of MSFC overlap an inactive old boneyard disposal site and an area that has been deemed to have "occasional" probability of UXO occurrence. These areas are under the responsibility of the U.S. Army. Any digging activity in this area would be coordinated with MSFC's EEOH Office. Prior to ground disturbance in this area, the area would be inspected for subsurface UXO and cleared to the depth of construction. Construction personnel would undergo training, which includes procedures for identifying and responding to UXO if encountered. Should UXO be encountered during construction, work would immediately stop and 911 would be called. No buildings occupied as a habitation for people would be developed within established quantity distance zones at MSFC (Figures 3.14-2a, 3.14-2b, and 3.14-2c).

Five major groundwater plumes of contaminants exist beneath MSFC. The plumes are composed mainly of chlorinated VOCs, with trichloroethene being a significant and common constituent in the plumes. It appears that the plumes emanate from 14 main source areas where former land use activities released contaminants to the environment. A portion of Development Site L10 includes a building restricted site, as shown on Figure 3.14-1c. This restricted area is a groundwater treatment area where NASA has injected zero valent iron. Surface soils are not impacted. Future development activities at Development Site L10 would comply with the IROD (NASA 2007) and be coordinated with ADEM and EPA.

Some development sites and construction sites are located above the contaminated groundwater plume, as shown on Figures 3.14-1b and 3.14-1c. Groundwater disturbance during construction would be avoided to the extent feasible. Any potential groundwater disturbance would be coordinated with MSFC's EEOH Office. If construction would require excavation to the depth of groundwater, the construction contractor's Health and Safety Plan would be required to include OSHA training in handling hazardous materials and

wastes. If groundwater is encountered, it is possible that excavation for site development may require dewatering. If so, any wastewater generated by construction dewatering could contain contaminants, which would be contained, tested, and disposed of appropriately, if required.

With implementation of appropriate coordination, inspections, and safety measures, adverse impacts to human health or the environment from ordnance, quantity distance, and contaminated areas are expected to be less than significant.

3.14.2.2 No Action Alternative

Under the No Action Alternative, existing conditions at MSFC would continue. No new impacts to human health or the environment from the use of hazardous materials or generation of hazardous or solid waste would be anticipated. There would be no beneficial impacts from the divestment/demolition of dated buildings and removal of hazardous building materials from MSFC.

3.15 Public and Occupational Health and Safety

Public and occupational health and safety is the promotion and maintenance of the physical, mental, and social well-being of workers by controlling risk to the highest degree, protecting the safety, health, and welfare of people engaged in work or employment.

3.15.1 Affected Environment

3.15.1.1 Health and Safety Standards

Safety is a major feature of operations at MSFC, with numerous programs and capabilities providing for the safety of workers at MSFC. MSFC is operated in compliance with all applicable federal laws, codes, and regulations and with all applicable laws, ordinances, codes, and regulations of the State of Alabama and Madison County with regard to construction, health, safety, food service, water supply, sanitation, and licenses and permits to do business.

All contractors at MSFC are responsible for following all applicable OSHA regulations and for conducting their work in a manner that does not pose any risk to workers or MSFC personnel. Industrial hygiene responsibilities of contractors as applicable include reviewing potentially hazardous workplaces; monitoring exposure to workplace chemicals (asbestos, lead, hazardous material) and physical (noise propagation) and biological (infectious waste) agents; recommending and evaluating controls (ventilation, respirators) to ensure personnel are properly protected or unexposed; and ensuring a medical surveillance program is in place to perform occupational health physicals for those workers subject to any accidental chemical exposures or engaged in hazardous waste work.

OSHA regulates permissible noise exposures in the workplace without hearing protection. Maximum exposure to impulsive noise should never exceed 140 dB peak sound pressure level (29 CFR Subpart 1910.95). The NASA Health Standard on Hearing Conservation sets permissible exposure limits, which are more conservative than OSHA's permissible levels for continuous noise. Refer to Section 3.9 for additional information.

3.15.1.2 Services

NASA has an established physical security program for MSFC site facilities and operations. Protective security measures at MSFC include the use of physical barriers, electromechanical intrusion detection

systems, protective lighting, warning notification, identification and badge recognition, and automated access control capability. Security officers, under contract to MSFC, patrol the grounds continuously and are in charge of locking and unlocking most MSFC buildings after hours. MSFC is an area of exclusive federal jurisdiction; as a result, state, county, and city police have no jurisdiction within the MSFC and RSA boundaries (NASA 2017).

The Medical Center at MSFC is in Building 4249 and offers out-patient services only and provides therapeutic, preventive, and special medical and health services to MSFC employees and contractor personnel who require specific certifications. Occupational medicine and environmental health services are provided at MSFC under contract. Emergency services are provided to MSFC employees and contractors. Ambulance service is available any time by calling 911. In addition to the services provided at the Medical Center, medical services at MSFC include Employee Assistance Program counseling, respiratory services, and a health and fitness center (NASA 2017).

Twenty-four-hour firefighting services, including hazardous materials response/mitigation and medical first response, are provided to MSFC by five fire stations owned and operated by the U.S. Army under an agreement that reimburses the Army. In the event of a fire at MSFC or RSA, all stations are alerted and respond. In addition, the Army has a mutual aid agreement with the City of Huntsville Fire Department for firefighting and hazardous materials assistance, as well as a working agreement with other local municipalities. All significant MSFC buildings are connected to a central fire alarm and reporting system. Each building has a fire alarm system that includes automatic smoke or heat detectors and manual pull stations (NASA 2017).

The Redstone Fire Department participates with NASA in a Joint 911 Center that is contracted through NASA. Alarm signals report through the Utility Control System and Redstone Fire Department is notified (NASA 2017).

MSFC uses a base-wide warning system to alert personnel of potential danger. The Emergency Warning System (EWS) will alert MSFC personnel and give specific instructions in the case of an emergency. The EWS is delivered using a public address system (NASA 2003). Nixle is a notification tool that sends text and email messages with information specific to MSFC. These messages might include weather alerts, road and gate closure information, and follow-up messages to the EWS announcements.

3.15.2 Environmental Consequences

The threshold for a significant impact would be one that would substantially increase risks associated with the safety of construction personnel, contractors, or the local community; substantially hinder the ability to respond to an emergency; or introduce a new health or safety risk for which the installation is not prepared or does not have adequate management and response plans in place.

3.15.2.1 Proposed Action

Accidents, spills, or leaks associated with various operations at MSFC could impact the health and safety of the public, MSFC personnel and contractors, and the environment. The U.S. Army's Fire Department, MSFC health services staff, and MSFC security forces are available to provide the necessary assistance if such events occur.

The Proposed Action would not result in changes to the availability, capabilities, or capacity of emergency services at MSFC or in neighboring communities.

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant, which can produce explosive hazards, would be used at the SPTA. There are no residents within 4 miles of the SPTA and the nearest MSFC office workers are located one-half mile to the north (NASA 1989). All personnel would be informed of hazardous conditions applicable to the work they perform, regulations applicable to the work environment, and how to control or eliminate the known hazardous conditions or exposure to injury applicable to the work they perform. New worksites would be posted with signage stating the required personal protective equipment to be worn while in the worksite area. Solid propellants are already used during testing at the SPTA and CBS Solid Fuel Propellant would be managed using existing safety protocols and procedures; therefore, there would be no increase in risks to public and occupational health and safety and impacts from the use of CBS Solid Fuel Propellant are expected to be less than significant.

Habitation Systems

Testing of habitation systems in the southern portion of MSFC could have adverse impacts on occupational health and safety from high noise levels. RSA personnel and contractors in the southern test area for UXO remediation and CERCLA cleanup sites could be exposed to noise from habitation systems testing activities. Test areas have restricted access from Dodd Road. Buffer zones would be implemented around testing activities for the safety of personnel and facilities. During a test, access to the area would be limited and roads within a certain distance of the test area would be closed, as necessary. Personnel and contractors working on MSFC would receive prior notification of the testing schedule and public announcements would be made during testing. NASA personnel would be highly encouraged to be indoors during testing and requested to wear double hearing protection outdoors.

Section 3.9 addresses noise impacts from habitation systems testing. Mitigations described in Section 3.9 would be implemented to minimize the onsite and offsite loud noise impacts to personnel from the habitat burst tests. With implementation of mitigations, impacts to public and occupational health and safety are expected to be less than significant.

Real Property

Construction and demolition activities associated with sustainment, investment, divestment, outgrant, and development site projects would have short-term, minor, adverse impacts on worker safety and occupational health. All construction and demolition activities would be conducted by trained personnel in accordance with OSHA regulations. A temporary secure perimeter fence would be installed around each construction and demolition area with a construction access gate. During construction and demolition activities, signs would be placed on roadways to alert drivers to changes in traffic patterns and trucks entering and exiting the road. The demolition implosions of Building 4550 and Building 4572 would be scheduled to occur on the same weekend to minimize impacts to the public and worker safety. The demolition contractor would use drones in support of implosion activities to ensure charges are detonated and the area is safe to occupy by workers post-demolition.

New facilities would be constructed to comply with the Americans with Disabilities Act and fire protection requirements, which would have beneficial impacts to health and safety at MSFC.

Expansion of the NASA/FBI Pistol Range would be designed and constructed with safety considerations for MSFC personnel. Surface danger zones (SDZs), including an impact area, ricochet area, and secondary danger zone, would be established to contain all projectiles and debris caused by firing ammunition. Boundaries of the SDZs would be posted with permanent signs warning of the danger of the live-fire range and prohibiting trespassing. The signs would be posted in a way that would ensure a person could not

enter the SDZ without seeing at least one legible sign (usually 200 yards distant or less). Safety procedures and protocols implemented at the existing NASA/FBI Pistol Range would be implemented at the new, expanded range and impacts to public and occupational health and safety from the range expansion are expected to be less than significant.

A new, 5,500-gallon LH2 tank would be installed adjacent to the current 2,600-gallon tank at Building 4628. Fire and explosion are the primary hazards associated with LH2. The tank would be installed with appropriate setback distances from nearby buildings. The storage site of the new LH2 tank would be fenced to prevent entrance by unauthorized personnel and posted with applicable warning signs, such as "Liquified Flammable Gas – No Smoking – No Open Flames." The tank would be filled by specially trained employees of the LH2 supplier and users of LH2 would follow established NASA safety protocols and procedures. Impacts to public and occupational health and safety from the addition of a new LH2 tank are expected to be less than significant.

3.15.2.2 No Action Alternative

Under the No Action Alternative, existing conditions at MSFC would continue. No new impacts to occupational health and safety would be anticipated.

3.16 Utilities and Infrastructure

Utilities and Infrastructure include water, sanitary and storm sewer systems, heating and cooling systems, natural and other gases, electric service, and communications service.

3.16.1 Affected Environment

3.16.1.1 Potable and Industrial Water System

Both RSA and the City of Huntsville use the Tennessee River as a source of potable and/or industrial water. RSA operates intakes and two surface water treatment plants along the Tennessee River that supply RSA's and MSFC's potable water. Drinking water for MSFC is obtained from RSA through Huntsville Utilities. Potable and industrial water at RSA is stored in tanks. This equipment is capable of storing 3 million gallons of potable water and 7.5 million gallons of industrial water. Out of 13 storage tanks on RSA, 7 currently are in use. A deionized water tank is on MSFC in the Deionized Water Facility (Building 4700) (NASA 2017).

3.16.1.2 Wastewater System

Sanitary sewage collection at MSFC is handled by the Domestic Treatment and Collection System 3. The current NPDES permit held by RSA allows for effluent discharge into the Tennessee River. Buildings 4541, 4549, 4718-1, and the Skeet Range Trailer (T298) are serviced by a septic tank system (NASA 2017).

3.16.1.3 Stormwater System

RSA owns and operates all stormwater collection systems at MSFC. Stormwater discharge flows into Indian Creek, Huntsville Spring Branch, and an unnamed tributary of Wheeler Lake under the NPDES permit (Permit No. AL0000221) (NASA 2023d).

3.16.1.4 Heating and Cooling Systems

Natural gas and electricity are used to heat the facility buildings at MSFC. A central chiller facility is located in Building 4473. Water is cooled by chillers and cooling towers through evaporation and is replaced with makeup water. The cooling towers have two sources of discharge water (blowdown and side-stream filtration) as well as a third source when maintenance occurs on the sump basin (NASA 2017).

3.16.1.5 Natural Gas, Pressure, and Propellants

RSA receives its natural gas supply from the City of Huntsville. Natural gas is routed through MSFC to serve MSFC buildings. Piping systems and storage vessels for LH_2, LOX, liquid nitrogen, and rocket propellant are also present on MSFC (NASA 2017).

3.16.1.6 Electric Service

Electricity is provided through RSA by the Tennessee Valley Authority Wheeler and Guntersville Dam Stations. A 44-kilovolt subtransmission system connects to 16 distribution substations that convert the 44-kilovolt voltage to a distribution voltage. The system is controlled by U.S. Army Garrison–Redstone. MSFC also has several emergency generators with a total generator capacity of 21,000 kilovolt-amperes (NASA 2017).

3.16.1.7 Communications Service

MSFC provides telecommunication services for its own operations as well as all the communications program support services to NASA Headquarters, field installations, and NASA contractor locations. The primary communication facility is in Building 4207 (NASA 2003).

3.16.2 Environmental Consequences

The threshold for a significant impact would be met if the Proposed Action resulted in a substantial disruption to utilities requiring extensive mitigation to offset adverse impacts, and the success of mitigation could not be guaranteed; and resulted in an exceedance of the existing capacity of the utilities or infrastructure requiring extensive mitigation to offset adverse impacts, and the success of mitigation could not be guaranteed.

3.16.2.1 Proposed Action

Advanced Space Transportation Systems – Propulsion Testing

CBS Solid Fuel Propellant, which can produce explosive hazards, would be used during propulsion testing at the SPTA. Existing management policies and procedures for propulsion testing using solid propellants would be used when dealing with CBS Solid Fuel Propellant, and adverse impacts to utilities or infrastructure from the use of CBS Solid Fuel Propellant at the SPTA are expected to be less than significant. Impacts to utilities and infrastructure from CBS Solid Fuel Propellant would be less than significant.

Habitation Systems

The development and testing of habitation system activities at MSFC would result in a slight increase in utility use at MSFC. Missile-grade air would be provided by trailer and is available and already in use on

MSFC. Therefore, habitation system development and testing would result in less-than-significant adverse impacts to MSFC.

Real Property

Under the Proposed Action, construction and demolition projects would result in both temporary and long-term impacts to utilities and infrastructure. The Proposed Action would include the divestment of at least 43 excess and/or energy-inefficient buildings, investment of at least 17.5 acres of new facilities, development on at least 360.2 acres of land, outgrant assets of 6 buildings, sustainment of 14 buildings, and utility and infrastructure maintenance.

During construction, demolition, investment, outgrant, and sustainment projects, there would be minor, short-term impacts to the water, sanitary and storm sewer systems, heating and cooling systems, chilled water, natural gas lines, and electric service systems. Removal of excess facilities and utility and infrastructure upgrades would create long-term energy and water savings and reduce utility usage at MSFC, causing long-term beneficial impacts to utilities and infrastructure. Construction of new buildings would increase energy and water use and reduce available utility usage at MSFC leading to long-term less-than-significant adverse impacts. The Proposed Action would have less-than-significant adverse impacts to utilities and infrastructure.

3.16.2.2 No Action Alternative

Under the No Action Alternative, existing conditions at MSFC would continue. No new impacts to utilities or infrastructure would be anticipated.

3.17 Cultural Resources

Cultural resources may include archaeological resources (any site that contains material remains of past human life or activities) or other places or items that possess cultural importance to individuals or groups.

This EA evaluates direct and indirect impacts from federal actions on cultural resources under Section 106 of NHPA (54 U.S.C. Sections 300101 et seq.), the principal statute concerning cultural resources.

Section 106 requires federal agencies to take into account the effects of their undertakings on historic properties, defined as “any precontact or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP [National Register of Historic Places], which is maintained by the Secretary of the Interior” (36 CFR Subpart 800.16), and to consult with the Alabama State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer(s), and other parties to develop and evaluate alternatives or modifications to the undertaking where necessary to avoid, minimize, or mitigate adverse effects. The Poarch Creek Indians are the only federally-recognized tribe in Alabama.

Federal agencies must identify historic properties, assess effects, and develop and evaluate alternatives or modifications to the undertaking that could avoid, minimize, or mitigate adverse effects on historic properties. The Advisory Council on Historic Preservation (ACHP) must be afforded a reasonable opportunity to comment on such undertakings subject to Section 106.

Properties listed in the NRHP or eligible for listing in the NRHP are treated the same under Section 106 of NHPA. After cultural resources within the area of potential effects are identified and evaluated, effects evaluations are completed to determine whether the Proposed Action has no effect, no adverse effect, or an adverse effect on historic properties.

3.17.1 Affected Environment

This section details cultural resources at MSFC as described in the *Architectural Survey & NRHP Evaluations of NASA Marshall Space Flight Center at Redstone Army Arsenal, Huntsville, Madison County, Alabama* (Panamerican Consultants, Inc. 2023) A total of 65 historic properties are located at MSFC: 38 buildings and structures, 4 national historic landmarks (NHLs), 15 archaeological sites, and 8 objects.

3.17.1.1 Architectural Resources

In 2020, Panamerican Consultants, Inc, a Commonwealth Heritage Company, Inc. was sub-contracted via the Johnson McAdams Firm for Accura Engineering and Consulting Services, Inc. to complete an architectural survey of all buildings, develop a historic context, and recommend NRHP eligibility for the facilities at MSFC. This exhaustive study provides a detailed historic context for the built environment and presents architectural documents and NRHP evaluations for 349 resources. The assessment concluded that, of the approximately 345 buildings, structures, districts, and objects at MSFC, there are 50 historic properties:

- 4 NHLs
- 38 buildings, structures, and districts
- 8 objects

The 38 eligible or listed architectural resources are shown in Appendix E, Supplemental Environmental Information Used for Analysis. The 50 historic properties (buildings, structures, districts, and objects) are eligible for listing in the NRHP under Criterion A, for association with key missions at MSFC, and, in multiple cases, also under Criterion C, for association with leading aerospace architectural-engineering firms of the early Cold War years. In some cases, research and analysis also will support eligibility under Criterion B, for association with the important contributions of particular German scientists and engineers recruited to the RSA through Project Paperclip and its follow-ons of the early and middle 1950s.

MSFC currently has four designated NHLs:

- Saturn I Propulsion and Structural Test Facility (Building 4572)
- Redstone Rocket Test Stand and Observation Bunker (Building 4665A and 4665B)
- Saturn V Dynamic Test Facility (Building 4550)
- Neutral Buoyancy Simulator Facility (within Building 4705)

The 2023 survey determined the remaining architectural resources at MSFC were not eligible for listing in the NRHP. These resources, which were evaluated under the NRHP criteria and criteria considerations, were recommended ineligible for listing in the NRHP because of lack of integrity, diminished integrity, lack of distinctive historical associations, or lack of architectural distinction under those criteria. Numerous Cold War era properties failed to meet the “outstanding” criteria.

Additionally, an assessment of miscellaneous large equipment stored in several storage yards (referred to as boneyards) in test stand areas and other locations at MSFC was undertaken in 2003 and 2004. As discussed in *Architectural Survey & NRHP Evaluations of NASA Marshall Space Flight Center at Redstone Army Arsenal, Huntsville, Madison County, Alabama* (Panamerican Consultants, Inc. 2023), eight of these items were found to be eligible for listing in the NRHP. These items are listed in Appendix E, Supplemental Environmental Information Used for Analysis.

3.17.1.2 Archaeological Resources

The NASA Office of Archaeological Services maintains archaeological databases for reported archaeological sites and archaeological survey reports. Since 1996, RSA has conducted a series of intensive archaeological surveys to inventory prehistoric and historic archaeological sites in accordance with Section 106 of the NHPA and other federal guidelines.

The entirety of MSFC has been surveyed for archaeological resources. A total of 23 total sites have been recorded at MSFC, 15 of which have been determined eligible or potentially eligible for listing in the NRHP. Appendix E includes a list of the NRHP-eligible or potentially eligible archaeological sites within MSFC and their NRHP eligibility assessment.

There are no maps or graphics showing the locations of the archaeological sites because site locations are sensitive and protected information, according to the Archaeological Resources Protection Act of 1979.

3.17.2 Environmental Consequences

This section identifies potential impacts to cultural resources that may result from implementing the Proposed Actions. Section 106 of the NHPA requires federal agencies to take into account the effects a proposed undertaking may have on historic properties and includes specific criteria for adverse effects. Impacts to significant cultural resources can occur as a result of building or road construction, utility work, demolition, changes to a resource's setting, or use (including both noise and ground disturbing activities). These activities would occur at MSFC as a result of some potential actions.

NASA evaluates direct and indirect impacts from federal actions on historic, architectural, archaeological, and other cultural resources under Section 106 of the NHPA (54 U.S.C. Sections 300101 et seq.). Section 106 requires federal agencies to take into account the effects of their undertakings on historic properties, defined as "any precontact or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP, which is maintained by the Secretary of the Interior" (36 CFR Subpart 800.16), and to consult with the SHPO, Tribal Historic Preservation Officers, and other parties to develop and evaluate alternatives or modifications to the undertaking where necessary to avoid, minimize, or mitigate adverse effects. After cultural resources within the area of potential effects for each project are identified and evaluated, effects evaluations would be completed to determine whether the Proposed Action has no effect, no adverse effect, or an adverse effect on historic properties under Section 106 of the NHPA. An adverse effect under Section 106 is found when an undertaking may alter characteristics of a historic property that qualifies the property for inclusion in the NRHP in a manner that would diminish the integrity of the property. This includes diminishing the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time or be further removed in distance, or effects that may be cumulative.

3.17.2.1 Proposed Action

Advanced Space Transportation Systems – Propulsion Testing

Archaeological Resources

The proposed projects and programs that fall under Operational Missions and Activities have minimal potential to impact archaeological resources, given that many of them happen within existing buildings and labs. However, if any activity were located near a known archaeological site or involved ground

disturbance, MSFC should analyze the potential for adverse effects on identified archaeological properties on a case-by-case basis as the projects included in the Proposed Action are implemented.

MSFC will follow the NHPA Section 106 consultation process, as specified in 36 CFR Part 800, and take into consideration the potential impacts from each project activity to the identified archaeological properties through Section 106 consultation with the Alabama SHPO and identified tribes.

Built Environment – Objects and Structures

The proposed projects and programs that fall under Operational Missions and Activities have minimal potential to impact built environment resources, given that many of these activities happen within existing buildings and labs. However, if any activity were proposed that would involve effects on historically significant buildings, structures, or objects, MSFC should analyze the potential for adverse effects on identified structures on a case-by-case basis as component projects in the updated description of the proposed action and alternatives (DOPAA) are implemented.

MSFC must follow the NHPA Section 106 consultation process, as specified in 36 CFR Part 800, taking into consideration the impacts from each project to built environment and historic properties and carrying out Section 106 consultation with the Alabama SHPO.

Habitation Systems

Impacts to cultural resources associated with the testing of habitation systems would be expected to be the same as those identified for propulsion testing using CBS Solid Fuel Propellant.

Real Property

Real property includes MSFC's buildings, vertical infrastructure, and horizontal infrastructure. Some of these real property assets include administrative facilities; engine testing facilities; fabrications and assembly facilities; ground improvements facilities; liquid fuel infrastructure and facilities; maintenance facilities; operational facilities; propellant infrastructure and facilities; research, development, and testing facilities; storage facilities; utilities, infrastructure, and facilities; and wind tunnel facilities.

Development Site L10 overlaps portions of the boneyard, which contains eight objects that are eligible for listing in the NRHP. The historic properties could be impacted by development in this area. Section 106 consultation would need to be carried out prior to development at Development Site L10.

Archaeological Resources

Construction and demolition projects could potentially affect archaeological resources depending on the location of the project.

Specifically, investment projects C6 and C5 and development sites L4, D8, and L10 have the potential to effect previously identified archaeological sites. MSFC should analyze the potential for adverse effects on identified archaeological properties on a case-by-case basis as component projects in the updated DOPAA are implemented.

For locations where archaeological sites have been previously identified, MSFC will follow the NHPA Section 106 consultation process, as specified in 36 CFR Part 800, and take into consideration the potential impacts from each project to the identified archaeological properties through Section 106 consultation with the Alabama SHPO and identified tribe(s). Currently the Poarch Creek Indians are the only federally recognized tribe in Alabama. Standard Operating Procedure (SOP) 4, Responding to

Inadvertent Discovery of Archaeological Deposits, and SOP 5, Treatment of Human Remains and Funerary/Sacred Objects in the Integrated Cultural Resources Management Plan (ICRMP), address actions to be taken in the event of an inadvertent find of an archaeological resource or human remains. MSFC will follow these procedures in all areas if an inadvertent find of an archaeological resource or human remains are discovered during project activities, particularly the development activities that require tree clearing, excavation, ground clearing, and other ground-disturbing activities.

The LH2 tank would be installed close to a previously identified archaeological site. Work would take place outside the boundaries of the archaeological site. If archaeological resources are discovered during installation, work would stop and the MSFC Cultural Resources Manager would be contacted. Section 106 consultation was completed for the LH2 tank installation in September 2023 and the Alabama SHPO determined that project activities would have no effect on cultural resources listed in, or eligible for listing in, the NRHP, provided that avoidance measures were used.

Building 4643 is slated for demolition and is adjacent to an identified NRHP-eligible archaeological site. Impacts from this demolition are not included in this analysis because the Section 106 consultation process was initiated in 2023 and is ongoing.

Sustainment would not result in any adverse impacts to cultural resources given that the properties are maintained in their current condition.

Built Environment – Objects and Structures

Sustainment would not result in adverse effects to architectural resources given that the historic properties are proposed to be maintained in their current conditions. If any of the historic properties shown in Table 2-1 require repair, roof replacement, window replacement, or other construction that could alter any of their character-defining features, then MSFC must consider the impacts from these repairs under Section 106 and must consult with the Alabama SHPO.

Construction and demolition projects could potentially result in an adverse effect (ranging from negligible to significant impacts) on NHL properties, NRHP-eligible and NRHP-listed historic structures, and NRHP-eligible historic objects present at MSFC (refer to Tables 3.17-1, 3.17-2, and 3.17-3). MSFC will analyze the potential for adverse effects on identified historic properties on a case-by-case basis as component projects are implemented. Development sites would need to include potential visual impacts to adjacent historic properties, if applicable. The cell tower for example, at160 feet tall, could impact the visual setting of historic properties in the vicinity, if any, and may need to be considered.

Building 4550 (Vehicle Static Test Stand) is an NHL and is a building proposed for divestment through demolition or other means. Demolition is an adverse effect that would require Section 106 consultation with the Alabama SHPO, notification to the ACHP regarding the adverse effect, resolution of the adverse effect through mitigation measures, and implementation of the mitigation measures.

The Neutral Buoyancy Simulator located in Building 4705 is an NHL and is proposed for demolition. Demolition of the Neutral Buoyancy Simulator would be an adverse effect that would require Section 106 consultation with the Alabama SHPO, notification to the ACHP regarding the adverse effect, resolution of the adverse effect through mitigation measures, and implementation of the mitigation measures.

Table 3.17-1. Planned Investment Projects that involve Historic Properties

Project	Description	NRHP Eligibility[a]
Building 4663	Huntsville Operations Support Center, International Space Station Flight Payload Operations, and the NASA-wide Automated Data Processing Consolidation Center (HOSC/NACC)	Eligible for the NRHP
Building 4718	X-Ray Calibration Facility	Eligible for the NRHP

[a] Panamerican Consultants, Inc. 2023

Table 3.17-2. Divestment Assets at MSFC that are Eligible for the NRHP

Site	Description	NRHP Eligibility[a]
Buildings 4550, 4551	Vehicle Static Test Stand	NHL
Building 4560	Bunker	Eligible

[a] Panamerican Consultants, Inc. 2023

Table 3.17-3. Development Sites at MSFC that Involve Historic Properties

Development Site	Description	NRHP Eligibility[a]
Buildings 4436, 4476	Exploration Production and Operations Contract Government Furnished Property for use of software development space	Eligible for the NRHP
Building 4705	Neutral Buoyancy Simulator (within building)	Neutral Buoyancy Simulator is a National Historic Landmark
Building 4707	Reimbursable Space Act Agreement for use of high bay space	Eligible for the NRHP

[a] Panamerican Consultants, Inc. 2023

MSFC must follow the NHPA Section 106 consultation process, as specified in 36 CFR Part 800, and take into consideration the impacts from each project on historic properties at MSFC. The Section 106 process would be carried out for individual projects that include historic properties on a case-by-case basis prior to project implementation.

3.17.2.2 No Action Alternative

The No Action Alternative would have no impact on cultural resources, including archaeological or built environment resources.

3.18 Airspace

In the United States, the Federal Aviation Administration (FAA) manages and controls airspace. According to 49 U.S.C. Section 40103, Sovereignty and Use of Airspace, the FAA is responsible for developing plans and policy for the use of airspace as well as for managing airspace in such a manner that it ensures the safety of flight and that all users of the National Airspace System (NAS) can operate in a safe, secure, and efficient manner. The FAA considers multiple and sometimes competing demands for airspace, including

airport operation needs, Air Traffic Service routes, military training airspace, and other special needs to determine how the NAS can best be structured to address all user requirements.

U.S. airspace is classified as controlled, uncontrolled, or special use and is divided into seven categories: Categories A, B, C, D, E and G (available to all users) and special use airspace (SUA). Airspace that falls under Categories A through E is controlled airspace and Category G covers uncontrolled airspace. SUA is restricted airspace, for specific use. The airspace classes dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace.

SUA is designed to ensure the separation of non-participating (nonmilitary) aircraft from potentially hazardous operations or conflict with military operations. SUA typically includes Restricted Airspace, Military Operations Areas, and Air Traffic Control Assigned Airspace. Temporary flight restrictions are a type of Notices to Airmen (NOTAM). A temporary flight restriction defines an area restricted to air travel based on a hazardous condition, a special event, or a general warning for the entire FAA airspace.

In addition, the airspace also includes predefined pathways called airways used for en route navigation. Jet Routes (J-Routes) are designed to serve aircraft operations from 18,000 feet amsl up to and including flight level (FL) 450. Q-routes are available for use by Area Navigation equipped aircraft between 18,000 feet amsl and FL 450 inclusive. T-routes are available for use by global positioning system (GPS)-equipped or GPS/wide area augmentation system-equipped aircraft from 1,200 feet above the surface (or in some instances higher) up to but not including 18,000 feet amsl. V-routes are Very High Frequency Omnirange Station airways designated from 1,200 feet above the surface (or in some instances higher) up to but not including 18,000 feet amsl.

Establishing new SUA or extending SUA normally requires preparation of an Environmental Assessment; unless otherwise explicitly listed as an advisory action in Order 1050.1f, paragraph 2-1.2.b, Advisory Actions, or categorically excluded in Order 1050.1f, paragraph 5-6.

3.18.1 Affected Environment

Redstone Army Airfield is a military airport located at RSA, north of the MSFC boundary. It was originally constructed for munitions testing for the U.S. Army and the U.S. Army Air Forces. It is currently used to support U.S. Army Aviation and Missile Command, NASA, and other U.S. Government aviation and space activities. Table 3.18-1 lists the existing restricted airspace characteristics in the vicinity of the MSFC.

Table 3.18-1. Existing Restricted Airspace Characteristics

Restricted Airspace Name	Designated Altitude	Time of Designation
R-2104A Huntsville, AL	Surface to 12,000 feet amsl	Intermittent, 6:00 a.m. to 8:00 p.m. local time, Monday-Saturday; other times by NOTAM 6 hours in advance
R-2104B Huntsville, AL	Surface to 2,400 feet amsl	Continuous
R-2104C Huntsville, AL	Surface to 12,000 feet amsl	Intermittent, 6:00 a.m. to 8:00 p.m. local time, Monday-Saturday; other times by NOTAM 6 hours in advance
R-2104D Huntsville, AL	12,000 feet amsl to FL 300	By NOTAM 6 hours in advance
R-2104E Huntsville, AL	12,000 feet amsl to FL 300	By NOTAM 6 hours in advance

Huntsville International Airport is located approximately 5.5 miles west of the MSFC; several other public-use airports also are near the MSFC, including Huntsville Executive Airport – Tom Sharp Jr. Field, Pryor Field Regional Airport, Moontown Airport, as well as private-use airports. In addition, there are several airways in the vicinity including J66, J73, Q110, Q139, Q40, Q19, T398, T429, T439, and V321.

3.18.2 Environmental Consequences

The threshold for a significant impact to airspace would be met if proposed airspace changes were to impact the safety of airspace users or cause unacceptable conflicts, congestion, delays, or economic hardship to other airspace users or significantly increase noise due to airspace changes.

3.18.2.1 Proposed Action

No airspace impacts are anticipated from any activities associated with the Proposed Action.

The demolition contractor would use drones in support of implosion activities to ensure charges are detonated and the area is safe to occupy by workers post-demolition. Prior coordination for this action would occur between NASA, other government agencies, and tenants because of proximity to restricted areas. At NASA's request, RSA would activate/deactivate the restricted airspace for pre-and post-implosion demolition activities in the East Test Area. The East Test area is already under RSA's established restricted airspace. RSA would also issue a NOTAM for the period when FAA lighting (the red lights) on top of the two towers goes out prior to demolition activities.

Under a separate proposal, new Restricted Airspace is proposed north of the existing Restricted Airspace to support operational missions and activities. The airspace is proposed adjoining to existing Restricted Airspace R-2104A and R2104-D, as described in Table 3.18-2, and is needed to protect NAS users from hazardous testing operations. The first phase, creating Restricted Airspace Foxtrot from a portion of Restricted Airspaces R-2104A and R-2104D, is approximately 500 acres. The second phase, expanding the newly created Restricted Airspace Foxtrot to include airspace not currently restricted, is approximately 575 acres. The full expansion could take up to 2 years after this EA publication. The FAA is being engaged to create this new Restricted Airspace. The process will be ongoing for several years until full completion. NASA and the tenants will coordinate the test schedules with the Redstone Test Stand and Marshall Operations Control Center to ensure the safety of all airspace users during hazardous testing operations

Table 3.18-2. Future Restricted Airspace Characteristics

Restricted Airspace Name	Designated Altitude	Time of Designation
New Restricted Airspace Foxtrot	To be determined (preliminary information available indicates approximately 4,000 to 5,000 feet amsl)	Intermittent, 6:00 a.m. to 8:00 p.m. local time, Monday to Saturday; other times by NOTAM 6 hours in advance
Expansion to Restricted Airspace Foxtrot	To be determined (preliminary information available indicates approximately 4,000 to 5,000 feet amsl)	Continuous

The creation of additional restricted airspace is needed to ensure the safety of all NAS users. There will be no impact to commercial air traffic. Small civilian aircraft, especially those that fly out of the Redstone Army Airfield, will see a minor impact. However, the restricted airspace will not cause unacceptable impacts as there is ample unrestricted airspace in the vicinity of the Redstone Army Airfield. In addition,

Restricted Airspace Foxtrot will improve safety in the vicinity of the Redstone Army Airfield because it includes areas currently used for hazardous testing operations that could impact low-flying aircraft.

Although some aircraft may have to fly around the area, the detour will be short in both time and distance. It is not anticipated the new Restricted Airspace will impact the airways in the vicinity of the MSFC or the public-use airports. Establishing the new Restricted Airspace would maintain the safety of commercial, civil, and military aviation and would not cause unacceptable conflicts, congestion, delays, or economic hardship for nonparticipating aircraft that would otherwise freely use that airspace.

If future operational missions and activities require additional Restricted Airspace, cumulative impacts on the other NAS users from the combination of the ongoing projects and the expected foreseeable projects should be considered.

3.18.2.1 No Action Alternative

Under the No Action Alternative, proposed changes to airspace would continue to be implemented independent of any activities associated with the Proposed Action. Implementation of the No Action Alternative would not be expected to result in any additional impacts to airspace beyond.

3.19 Cumulative Impacts

Cumulative impacts are defined by the CEQ in 40 CFR Subpart 1508.7 as "impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts must occur to the same resources, in the same geographic area, and within the same period for the Proposed Action and other projects.

The Proposed Action would occur entirely within the boundaries of MSFC and would have little potential to interact with any private-sector actions in the surrounding area. To assess the potential for cumulative impacts on the environment from the Proposed Action, past, present, and future actions at MSFC and RSA were considered.

3.19.1 MSFC Actions

Recent past actions at MSFC that were considered for cumulative impacts include the following:

- Refurbishment of facilities for Blue Origin
- Construction of Building 4221
- Demolition of Building 4200
- Demolition of Building 4201

Most present and future actions at MSFC would be covered under this EA; however, some projects would be analyzed in separate NEPA documentation that may tier off of this site-wide EA. For example, lessees of development sites would be required to complete their own NEPA analysis of their planned construction and operations.

3.19.2 RSA Actions

At RSA, the Technology Park District is being developed over a span of 20 years. Major elements of the development plan include the following:

- Development of an FBI research campus with 2.3 million square feet of research and laboratory space
- Construction of a consolidated test center laboratory complex for the Missile Defense Agency
- Construction of an administration complex consisting of four multistory buildings with a total of more than 1 million square feet of administrative space
- Road improvements
- Large-scale demolition of old industrial facilities

3.19.3 Air Quality

Construction activities and operational activities related to the Proposed Action would cause adverse cumulative impacts on air quality when combined with other past, present, and future projects in the area. These cumulative impacts would not be significant because the Proposed Action would not be expected to increase air pollutants to levels that exceed regulatory thresholds. The Proposed Action would result in short-term cumulative impacts on air quality from the generation of fugitive dust when combined with other planned construction projects at MSFC and RSA. Impacts would not be significant because dust suppression techniques would be used during construction to minimize impacts from dust.

3.19.4 Climate Change and Greenhouse Gases

The Proposed Action would combine with other past, present, and future development projects in the area and contribute to cumulative impacts to GHG emissions. The amount of GHG emissions from the Proposed Action would not be expected to contribute significantly to climate change, but any emission of GHGs represents an incremental increase in global GHG concentrations.

3.19.5 Land Use

No cumulative impacts to land use would occur from implementation of the Proposed Action since proposed development and activities would be consistent with the land use zones for which they are proposed.

3.19.6 Water Resources

An increase of impervious surfaces associated with new developments would contribute to cumulative impacts to water resources; however, BMPs and stormwater controls would be implemented for all projects at MSFC and RSA to reduce impacts to water resources. Appropriate BMPs would be implemented to prevent sedimentation and stormwater runoff. For any impacts to surface waters and wetlands, CWA Section 404 permitting would be obtained, and mitigation completed as required. With implementation of BMPs, stormwater controls, and permits, cumulative impacts to water resources are expected to be less than significant.

3.19.7 Biological Resources

The Proposed Action would contribute to adverse cumulative effects on biological resources from vegetation clearing, habitat loss, disturbances from noise, and incidental wildlife mortalities. Most of the project areas at MSFC contain poor-quality wildlife habitat, have a history of prior disturbance, or are already developed. Cumulative impacts to wildlife from noise disturbances could occur if multiple construction projects or noise-producing operational activities occur at the same time. However, these impacts would be temporary, and geographical separation of projects would lessen noise impacts. Surveys would be conducted prior to tree and vegetation clearing to avoid or minimize impacts to special-status species. Cumulative impacts to biological resources are expected to be less than significant.

3.19.8 Geology and Soils

Actions involving ground-disturbing activities, such as construction and demolition, would have the potential to cumulatively impact soils. Under the Proposed Action, soil disturbance would result from clearing, grading, and excavation activities. Increased erosion following soil disturbance could contribute to cumulative impacts to soils when combined with other past, present, and future projects. With implementation of BMPs and SWPPPs any cumulative impacts to soils would be reduced to less than significant.

3.19.9 Noise

The Proposed Action would combine with other past, present, and future projects at MSFC and RSA and contribute to adverse cumulative effects in the noise environment if the timing of other construction projects in the area overlap with the timing of the construction/demolition projects and/or noise-producing operational activities of the Proposed Action. Multiple concurrent sources of periodic loud noises associated with construction, demolition, and operational activities, such as propulsion and habitation systems testing, could result in increased annoyance and disruptions of outdoor activities compared to single sources. Impacts on the noise environment from these activities would be temporary and intermittent and would occur during daylight hours and primarily on weekdays. Therefore, cumulative noise impacts would not be significant.

3.19.10 Traffic and Transportation

Cumulative impacts to traffic could occur from increased demand on local roadways in the vicinity of MSFC and RSA as a result of the Proposed Action if multiple construction projects were to occur at the same time. However, the cumulative impacts would be temporary and could be minimized by making most or all MSFC access gates and routes available during the work period and through implementation of traffic control procedures. Following the construction of the development projects at MSFC and RSA, a permanent change to traffic volumes and traffic patterns would be expected. With implementation of traffic studies and traffic mitigation, cumulative impacts to traffic and transportation are expected to be less than significant.

3.19.11 Socioeconomics

The Proposed Action would combine with other past, present, and future development projects in the area and result in beneficial cumulative impacts to economic development in the region. Cumulative benefits would derive from the induced construction employment and wages, the increased sales of

construction-related materials, and the employment of new employees for operation of the new proposed facilities.

3.19.12 Children's Environmental Health and Safety

The Proposed Action is not anticipated to impact children or increase exposure of children to adverse environmental or health impacts; therefore, no cumulative impacts to children's environmental health and safety would occur.

3.19.13 Environmental Justice and Equality

Minority and low-income populations would not be affected by the implementation of the Proposed Action; therefore, no cumulative impacts to EJ and equality would occur.

3.19.14 Hazardous Materials and Wastes, Solid Waste, and Pollution Prevention

Construction and demolition projects would combine with other past, present, and future development projects at MSFC and RSA and have the potential for an incremental increase in generation of hazardous wastes. Additionally, operations under the Proposed Action, when combined with existing NASA activities, could result in an increase in the quantity of hazardous waste generated by NASA. With proper handling and disposal of hazardous materials and wastes during construction and operation, cumulative impacts to hazardous materials and pollution prevention would be less than significant.

The demolition of dated facilities at MSFC would have beneficial impacts on hazardous materials from the removal of hazardous building materials, such as asbestos and lead-based paint.

The Proposed Action would contribute to minor, long-term, adverse cumulative impacts on solid waste when added to other construction and demolition projects in the vicinity. However, the construction waste generation would be temporary and would not exceed local capacities of landfills.

3.19.15 Public and Occupational Health and Safety

The Proposed Action, when combined with other past, present, or reasonably foreseeable future projects, would not contribute to short-term cumulative impacts related to construction worker safety and occupational health because the impacts experienced are limited to the individual construction zones. Emergency response times could potentially be impacted if simultaneous projects resulted in multiple lane closures or detours on roadways. Traffic-related cumulative impacts on safety would be minimized through coordination of route closures and proper signage to warn motorists of altered traffic patterns, speed limits, and construction vehicles entering and exiting the road.

The Proposed Action would contribute beneficially to the long-term safety of those at MSFC because replacement facilities would comply with Americans with Disabilities Act and fire protection requirements.

3.19.16 Utilities and Infrastructure

The Proposed Action would interact with other past, present and reasonably foreseeable future projects and increase the demand on local utilities; however, the increased demand would be within the regional capacity and cumulative impacts expected to be less than significant. Removal of inefficient buildings and

construction of modern energy-efficient buildings would result in cumulative improvements to energy use, which would be a benefit to energy consumption in the region.

3.19.17 Cultural Resources

The Proposed Action could contribute to cumulative impacts on cultural resources. If there are impacts on NRHP-eligible or -listed properties, they could together create a cumulative impact to cultural resources. Specific impacts and specific findings of effect under NHPA will be determined on a case-by-case basis as projects are implemented.

Section 106 consultation with the SHPO and tribes would be completed prior to project activities. Adverse effects would be addressed through consultation and mitigation measures would be identified in each case. Inadvertent discoveries of cultural resources would be handled in accordance with the MSFC ICRMP.

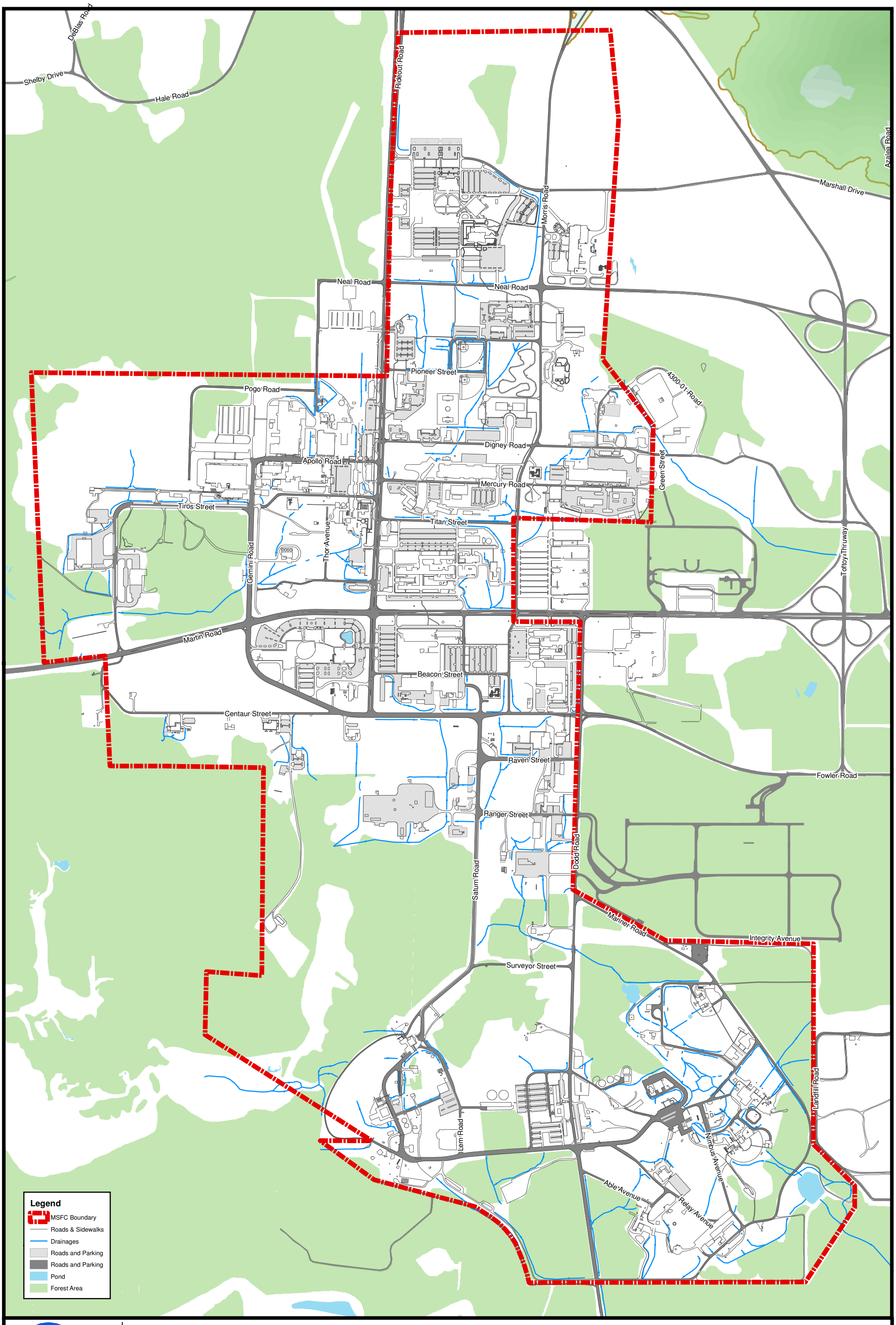
3.19.18 Airspace

The Proposed Action would have no impacts on airspace; therefore, no cumulative impacts to airspace would occur.

3.19.19 Cumulative Impacts Conclusion

The level of cumulative impacts anticipated to occur within these environmental resource categories is not significant based on the types of past, present, and reasonably foreseeable future projects; the extent of the built environment in which they would occur; the lack of certain environmental resources in the area; and the mitigation measures identified for the Proposed Action. Therefore, implementation of the Proposed Action would not result in significant cumulative environmental impacts. When information on the actual development planning and design is available, assessment of the Proposed Action's potential cumulative impacts may differ from this preliminary assessment.

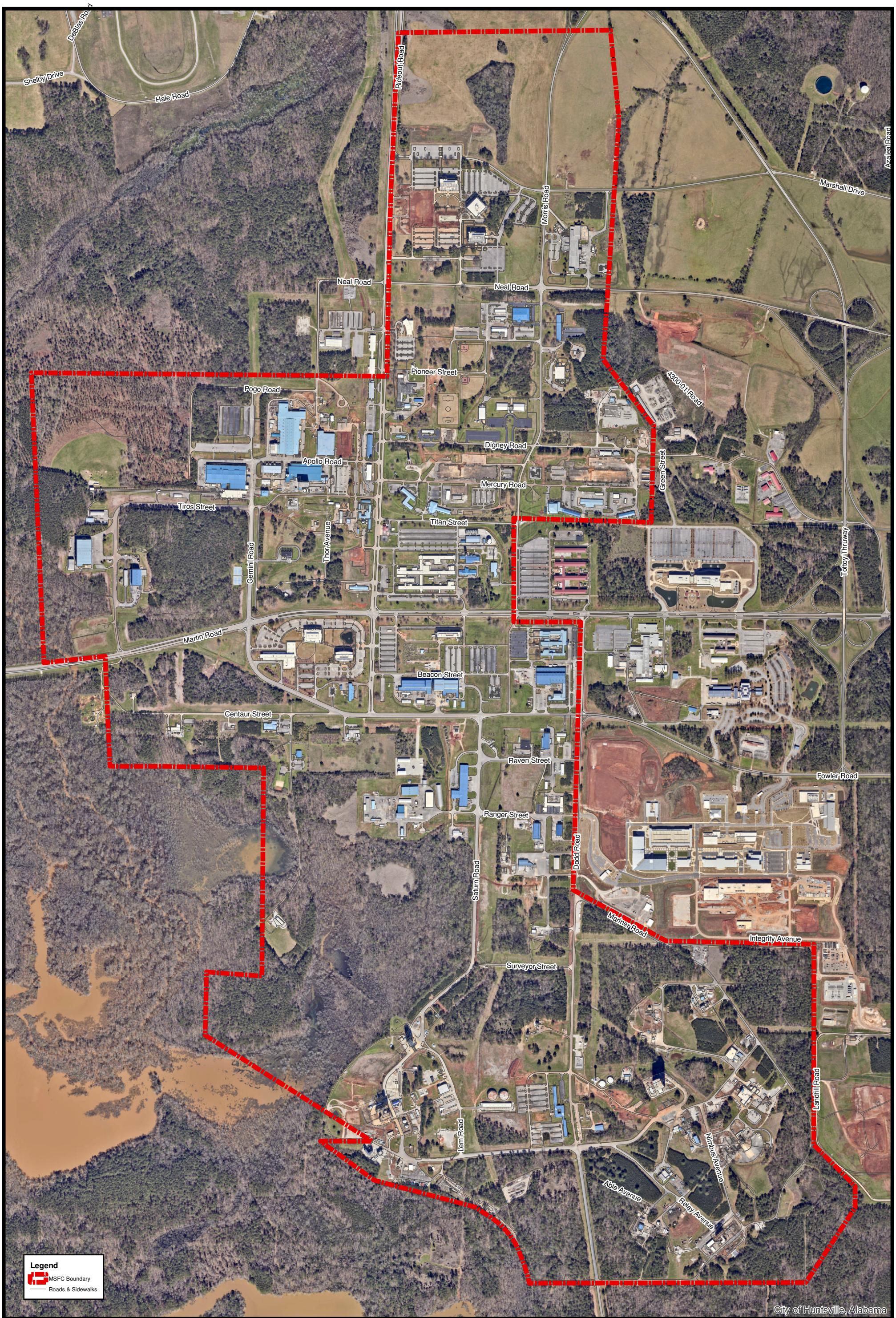
Under the No Action Alternative, the Proposed Action would not be implemented. Therefore, the No Action Alternative would not cause cumulative impacts when considered with other past, present, and reasonably foreseeable future projects at MSFC and RSA.



09-Jan-2024
Drawn By:
Erin Eppling

Figure 3.0-1 Proposed Action Area
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-PropAA.mxd



07-Dec-2023
Drawn By:
Erin Eppling

Figure 3.0-2 Proposed Action Area Aerial Imagery
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-PropAA_Imagery.mxd

4. Summary of Impacts

The potential impacts associated with the Proposed Action and No Action Alternative, the measures that would be implemented to avoid or minimize those impacts, and the threshold for significant adverse impacts for each resource are summarized in Table 4-1.

Table 4-1. Summary of Potential Impacts, Proposed Mitigation Measures, and Impact Thresholds

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Air Quality	Less than significant	Less than significant	It is assumed that NASA will ensure that all air permitting and coordination required for sources of air emissions are conducted for operations on MSFC. Air permitting would be completed before construction is complete. Prior to completion of construction activities, any additional MSFC stationary source operations would need to be reviewed, included in as needed, and managed in accordance with MSFC's air permit. Specific dust control BMPs during demolition by implosion would be coordinated by the contractor and NASA and would depend on the size and construction of the buildings to be demolished. These BMPs could include scheduling implosion during high humidity and no wind conditions; watering the structure sufficiently prior to demolition; wetting all unpaved areas to saturation prior to implosion; using misting cannons around the building at strategic locations and elevations; applying water to debris immediately following blast and safety clearance; and restricting traffic and operations to paved areas or stabilized surfaces. No Action Alternative to remain at present levels and within the existing Title V permit.	▪ Simultaneous construction of multiple projects could exceed allowed fugitive dust (PM) and construction vehicle exhaust emissions ▪ Use of CBS Solid Fuel Propellant would require an update to the Title V permit ▪ Includes new uses that cause or contribute to a violation of any NAAQS or state ambient air quality standard, increase the frequency or severity of a violation of any ambient air quality standard, or delay the attainment of any standard or other milestone contained in the permit limitations

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Climate Change and Greenhouse Gases	Less than significant	No impact	None.	Future projects that increase GHGs that could also increase the risk and severity of flooding *Note: NASA has not identified specific factors to consider in making a significance determination and has not established a significance threshold for GHGs or climate change.*
Land Use	No impact	No impact	The Facilities Planning and Utilization Office at MSFC are responsible for ensuring that development of facilities, utilities and other infrastructure are in accordance with NASA's mission of achieving land use compatibility and operational functionality at the Center.	▪ Change in land use that would conflict with zoning, planning documents, or planning goals ▪ Siting new projects where their use would be incompatible with neighboring land uses
Water Resources	Less than significant	No impact	Any potential groundwater disturbance would be coordinated with MSFC's EEOH Office No de-watering activities would be allowed to occur as part of land-disturbing activities in accordance with the IROD Interim Action Project for Operable Unit 3: Groundwater at MSFC (NASA 2007). Any groundwater that is pumped to the surface would be managed as hazardous waste and must be properly disposed of. NASA would implement a CBMPP. MSFC would follow the NASA-developed SWPPP. NASA would monitor stormwater outfalls in accordance with NPDES Permit AL0000221. Construction and demolition contractors would be responsible for approved disposal of wastewater in accordance with MWI 8550.2. Construction impacts to wetlands would be mitigated	▪ Permanently impacts groundwater, surface water, wetlands, or floodplains without the provision of compensatory mitigation ▪ Threatens or damages hydrologic characteristics ▪ Adversely affects water quality ▪ Endangers public health by contributing pollutants to groundwater or surface water ▪ Violates established laws or regulations that have been adopted to protect or manage water resources of the area ▪ New construction in undeveloped areas could increase the potential and degree of impacts to water resources

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
			through wetland mitigation. Compensatory mitigation activities would be developed during the State 404 permitting process. All new construction would comply with the requirements of the NFIP and obtain the necessary FEMA permits for floodplain development.	
Biological Resources	Less than significant	No impact	The landscaping plan that would be developed for each site or group of sites would meet a minimum 3:1 native to non-native planting ratio and would prohibit the planting of any species on the RSA "Do Not Plant" list. If bats are discovered during construction activities, work would stop and the MSFC Natural Resources Manager would be contacted. Additional NEPA analysis would be conducted for development sites as their design plans progress to accurately analyze habitat disturbance and associated impacts.	▪ Potential "take" of a federal or state threatened or endangered species ▪ Loss or impairment of sensitive or other native habitats or riparian corridors, such that the loss or impairment of habitat negatively affects the population of a species ▪ The take of birds in violation of the MBTA that could result in an enforcement action against MSFC ▪ Introduction or spread of invasive or otherwise undesirable non-native species
Geology and Soils	Less than significant	No impact	For construction projects that would result in 1 or more acres of land disturbance, a construction stormwater permit would be obtained and a CBMPP would be developed prior to construction to provide detailed erosion prevention and control measures to be implemented during site preparation and construction activities. Follow the EPA's *Best Management Practices for Lead at Outdoor Shooting Ranges*	▪ Increases the likelihood of, or result in exposure to, foundation instability, land subsidence, or other severe geologic hazards ▪ Loss of soil used for agriculture or habitat, loss of aesthetic value from a unique landform, or loss of mineral resources ▪ Causes severe erosion or sedimentation from site preparation, construction/ demolition, or operational activities

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Noise	Less than significant	No impact	BMPs and all applicable laws and regulations would be followed during construction. Employee noise exposure limits would be controlled by following all applicable OHSA, DoD and NASA standards and by providing appropriate equipment to employees to attenuate noise exposure, including earmuffs or earplugs or a combination of both depending on noise levels. Implement habitat burst test mitigations in Table 3.9-5.	▪ Permanent increase in noise levels in noise-sensitive areas ▪ Prolonged periods of nighttime noise in noise-sensitive areas ▪ Siting new uses in locations that are incompatible with current noise levels
Traffic and Transportation	Less than significant	No impact	Traffic studies should be conducted and necessary traffic mitigation should be implemented following the bid process for each project where facilities are expected to generate new traffic.	▪ Simultaneous construction of multiple projects could increase traffic to a degree that traffic flow and roadways are degraded ▪ Disrupts regional or local (on MSFC) traffic patterns ▪ Increases vehicle trips on the roadway network ▪ Severely degrades levels of service
Socioeconomics	Less than significant	No impact	As details emerge regarding plans for development sites, the development firm(s) would be required to coordinate with NASA to determine what level of additional NEPA may be required to address impacts associated with the anticipated increase in employees.	▪ Induces substantial economic growth in an area, either directly or indirectly ▪ Disrupts or divides the physical arrangement of an established community ▪ Causes extensive relocation when sufficient housing is unavailable ▪ Causes extensive relocation of community businesses that would cause severe economic hardship for affected communities ▪ Produces a substantial change in the community tax base

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Children's Environmental Health and Safety	Less than significant	No impact	All construction and demolition activities would be conducted by trained personnel in accordance with OSHA regulations. A temporary secure perimeter fence would be installed around each construction and demolition area with a construction access gate	▪ Higher percentage of children populations present compared to the community of comparison ▪ Significant adverse environmental or health impact occurs such as an environmental hazard exposure of children that would exceed the exposure of the general population or similar comparison groups
Environmental Justice and Equity	No impact	No impact	Not applicable	Study area contains higher percentages of low-income and minority populations as compared to the community of comparison
Hazardous Materials and Wastes, Solid Waste, and Pollution Prevention	Less than significant	No impact	Contractors would be responsible for the management of hazardous materials in accordance with construction specification. Implementation of appropriate coordination, inspections, and safety measures Existing management policies and procedures for propulsion testing using solid propellants would be used when dealing with CBS Solid Fuel Propellant. Hazardous wastes would be managed with standard procedures, including proper containment, separation of incompatible and reactive chemicals, worker warning and protection systems, handling procedures to ensure safe operations. Personnel working with hazardous materials would receive appropriate training in advance of any handling/ exposure.	▪ Noncompliance with applicable federal and state regulations as a result of the Proposed Action ▪ Disturbance or creation of contaminated sites resulting in adverse effects on human health or the environment ▪ Established management policies, procedures, and handling capacities unable to accommodate the proposed activities

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Public and Occupational Health and Safety	Less than significant	No impact	All construction and demolition activities would be conducted by trained personnel in accordance with OSHA regulations. A temporary secure perimeter fence would be installed around each construction and demolition area with a construction access gate. During construction and demolition activities, signs would be placed on roadways to alert drivers to changes in traffic patterns and trucks entering and exiting the road. Boundaries of the SDZs would be posted with permanent signs warming person of the danger of the live-fire range and prohibiting trespassing. The storage site of the new LH_2 tank would be fenced to prevent entrance by unauthorized personnel and posted with applicable warning signs, such as "Liquified Flammable Gas – No Smoking – No Open Flames". The tank would be filled by specially trained employees of the LH_2 supplier and users of LH_2 would follow established NASA safety protocols and procedures. All personnel would be informed of hazardous conditions applicable to the work they perform, regulations applicable to the work environment, and how to control or eliminate the known hazardous conditions or exposure to injury applicable to the work they perform.	▪ Substantially increases risks associated with the safety of construction personnel, contractors, or the local community ▪ Substantially hinders the ability to respond to an emergency ▪ Introduces a new health or safety risk for which the installation is not prepared or does not have adequate management and response plans in place

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Utilities and Infrastructure	Less than significant	No impact	None.	▪ Results in a substantial disruption to utilities requiring extensive mitigation to offset adverse impacts, and the success of mitigation could not be guaranteed ▪ Causes an exceedance of the existing capacity of the utilities or infrastructure requiring extensive mitigation to offset adverse impacts, and the success of mitigation could not be guaranteed
Cultural Resources	Less than significant	No impact	MSFC must follow the NHPA Section 106 consultation process, as specified in 36 CFR Part 800, and take into consideration the impacts from each project to historic properties prior to project implementation. Section 106 would require consultation with the Alabama SHPO and tribe(s). Installation of the LH2 tank would be outside the cultural resources site. Demolition of the NHL Neutral Buoyancy Simulator in Building 4705 could be an adverse effect. Development area L10 could impact NRHP-eligible properties within the boneyard. If archaeological resources are discovered during construction activities, then work would stop and the MSFC Cultural Resources Manager would be contacted.	An undertaking may alter characteristics of a historic property that qualifies the property for inclusion in the NRHP in a manner that would diminish the integrity of the property.

Resource Category	Proposed Action	No Action Alternative	Measures to Minimize Impact	Significant Adverse Impact Threshold
Airspace	No impact	No impact	NASA and the tenants will coordinate the test schedules with the Redstone Test Stand and Marshall Operations Control Center to ensure the safety of all airspace users during hazardous testing operations. The demolition contractor will use drones in support of implosion activities to ensure charges are detonated and area is safe to occupy by workers post-demolition. Prior coordination for this action will occur between NASA, other government agencies, and tenants due to proximity to restricted areas. At NASA's request, RSA will activate/deactivate the restricted airspace for pre-and post-implosion demolition activities in the East Test Area. RSA will also issue a NOTAM when the FAA lighting (the red lights) on top of the two towers will go out prior to demolition activities.	Proposes airspace changes that impact the safety of airspace users or cause unacceptable conflicts, congestion, delays, or economic hardship to other airspace users.
Cumulative Impacts	Less than significant	No impact	None.	Exceeds thresholds for significant impacts for any resource area when the incremental impact of the Proposed Action is added to other past, present, and reasonably foreseeable future actions.

5. Distribution

The EA was distributed to the following government agencies, stakeholders, and public libraries:

- NASA Headquarters
  - Amy G. Keith (MSFC-LD020) amy.keith@nasa.gov
- NASA MSFC EEOH Office
  - Farley Davis (MSFC-AS10) farley.davis@nasa.gov
  - Malene A. Mcelroy (MSFC-AS10) malene.a.mcelroy@nasa.gov
  - Dan Adams (MSFC-AS10) dan.adams@nasa.gov
  - Brian C. Roberson (MSFC-AS10) brian.roberson@nasa.gov
  - Hannah McCarty (MSFC-AS10) hannah.k.mccarty@nasa.gov
  - Joni M. Melson (MSFC-AS10) joni.m.melson@nasa.gov
  - Andrew L. Watson (MSFC-AS10) andrew.l.watson@nasa.gov
  - Daniel C. Patton (MSFC-AS10) daniel.c.patton@nasa.gov
  - David L. Thaxton (MSFC-AS10) david.l.thaxton@nasa.gov
- NASA MSFC Master Planners
  - Justin J. Taylor (MSFC-AS21) justin.j.taylor@nasa.gov
  - John S. Green (MSFC-AS21) john.s.green@nasa.gov
  - William C. Landers (MSFC-AS21) william.landers@nasa.gov
  - Bryan S. Worley (MSFC-AS21) scott.worley@nasa.gov
- U.S. Army Garrison, RSA
  - Thomas F. Richardson CIV USARMY ID-SUSTAINMENT (USA) thomas.f.richardson16.civ@army.mil
- FBI at RSA
  - Laura Ellen Bradford, lbradford@fbi.gov
  - Brian Mason, BGMASON@fbi.gov
- Blue Origin, LLC
  - Timothy Lyons, II tlyonsii@blueorigin.com
- WNWR
  - Daphne Moland
  - David Young, wheeler@fws.gov
- NASA MSFC Legal
  - Rosalind G. Cylar (MSFC-LS01) rosalind.g.cylar@nasa.gov
- NASA MSFC Public Affairs
  - Molly Porter (MSFC-CS80) molly.a.porter@nasa.gov
- NASA MSFC Disabilities Coordinator
  - Tora R. Henry (MSFC-OS01) tora.r.henry@nasa.gov
  - Carolyn D. Magsby (MSFC-OS01) carolyn.d.magsby@nasa.gov
- NASA MSFC Export Control
  - Elizabeth M. Ewald (MSFC-AS01) [Research Triangle Institute] elizabeth.m.ewald@nasa.gov

This page is intentionally left blank.

6. List of Preparers

The primary persons responsible for preparing and reviewing this report are listed in Table 6-1.

Table 6-1. List of Preparers

Name	Role	Experience
Nicole Bentivegna (Jacobs)	Biological Resources and Land Use	M.S., Environmental Science, 13 years of experience
Edwin Diaz (Jacobs)	Administrative Record	M.S., Planning, 2 years of experience
Laura Dreher (Jacobs)	Traffic and Transportation	B.S., Civil Engineering, 22 years of experience
Bridget Ellis (Jacobs)	Senior Technical Review	Bachelor of Landscape Architecture, 18 years of experience
Jason Glasgow (Jacobs)	Senior Technical Review	M.S., Environmental Engineering, 33 years of experience
Paige Grossman (Jacobs)	Socioeconomics, Children's Environmental Health and Safety, Environmental Justice and Equity	M.S., Resource Management, 4 years of experience
Emily Gulick (Jacobs)	Air Quality, Climate Change, and Greenhouse Gas, Senior Technical Review	B.A., Environmental Studies, 6 years of experience
Sara Jackson, PMP (Jacobs)	Project Manager	B.S., Environmental Studies, 23 years of experience
Sarah Jarzombek (Jacobs)	Water Resources, Geology and Soils, Utilities and Infrastructure	B.S., Wildlife and Fisheries, 2 years of experience
Hannah McCarty (NASA)	Center NEPA Manager	B.S., Geology; B.A., Japanese, 9 years of experience
Christina McDonough (Jacobs)	Senior Technical Review	M.E., Environmental Engineering, 31 years of experience
Tunch Orsoy (Jacobs)	Senior Technical Review	M.S., Marine Science, 30 years of experience
Sara Orton (Jacobs)	Senior Technical Review	M.S., Preservation Studies, 24 years of experience
Julie Philippon (Jacobs)	Airspace and Noise	M.S., Aviation Science, M.S., Aerospace Engineering, 14 years of experience
Michelle Rau, PMP (Jacobs)	NEPA Subject Matter Expert	M.S., Business Administration; B.S., Ecology and Evolutionary Biology; 25 years of experience
Amanda Reese (Jacobs)	Cultural Resources	M.A., Public History, 8 years of experience

Name	Role	Experience
Ursula Rogers (Jacobs)	Description of the Proposed Action and Alternatives, Hazardous Waste, Solid Waste, and Pollution Prevention, Health and Safety, and Cumulative Impacts	B.S., Biology, 15 years of experience
Karen Sanders (Jacobs)	Lead Editor	J.D., Law; B.A., Anthropology; 25 years of experience
Joseph Thacker (Jacobs)	Senior Technical Review	M.S., Geology, 31 years of experience

7. References

Alabama Department of Commerce. 2023. Aerospace and Aviation. https://www.madeinalabama.com/industries/industry/aerospace-aviation/.

Alabama Department of Environmental Management (ADEM). n.d. Construction General Permit. https://adem.alabama.gov/programs/water/constructionstormwater.cnt#:~:text=ALR100000%20for%20discharges%20associated%20with,or%20greater%20than%20one%20acre.

Alabama Department of Environmental Management (ADEM). 2020a. Major Source Operating Permit. Marshall Space Flight Center.

Alabama Department of Environmental Management (ADEM). 2020b. NPDES industrial individual Permit AL0000221. https://adem.alabama.gov/newsEvents/notices/jul20/npdes/7nasa.pdf.

Alabama Department of Environmental Management (ADEM). 2022. 2022 Alabama §303(d) List. April 1. Alabama Final 2022 303(d) List (04-01-2022).xlsx.

Alabama Department of Environmental Management (ADEM). 2023. Title V Operating Permit Fees for 2022 Emissions George C Marshall Space Flight Center Facility Number 709-0014. http://lf.adem.alabama.gov/WebLink/DocView.aspx?id=105214769&dbid=0.

Alabama Department of Transportation (Alabama DOT). 2023. Alabama Traffic Data 2020 Dataset. Accessed October 4, 2023. https://aldotgis.dot.state.al.us/TDMPublic/.

Alabama Forestry Commission. 2007. "Alabama's Best Management Practices for Forestry."

City of Huntsville. 2020. Greenhouse Gas Emission Inventory for the City of Huntsville and Madison County. https://www.huntsvilleal.gov/wp-content/uploads/2022/01/Madison-County-2020-GHG-EI-2.pdf.

City of Huntsville. 2023. City of Huntsville Traffic Count Stations. Accessed October 4, 2023. https://maps.huntsvilleal.gov/trafficcountstations/.

Council on Environmental Quality (CEQ). 2023. National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change. https://www.govinfo.gov/content/pkg/FR-2023-01-09/pdf/2023-00158.pdf.

Federal Emergency Management Agency (FEMA). 2023a. National Risk Index. https://hazards.fema.gov/nri/map.

Federal Emergency Management Agency (FEMA). 2023b. Flood Map Service Center: Madison County. https://msc.fema.gov/portal/search?AddressQuery=marshall%20space%20flight%20center.

Geological Survey of Alabama (GSA). 2015. *Characterization of Hydrogeology and Regional Groundwater Movement in Madison County and Redstone Arsenal, Alabama*. https://www.gsa.state.al.us/downloads/sgap/Redstone/Preliminary%20PDF%27s/Redstone%20GSA%20Hydrogeologic%20Assessment%202015_PreLim.pdf.

Guest, S. H. and R. M. S. Slone Jr. 1972. Structural Damage Claims Resulting from Acoustic Environments Developed During Static Test Firing of Rocket Engines. NASA Marshall Space Flight Center.

Huntsville/Madison County Chamber. 2022. Leading Employers January 2022. https://hsvchamber.org/wp-content/uploads/2022/01/Leading-Employers-January-2022.pdf.

Huntsville/Madison County Chamber. n.d. Climate. https://hsvchamber.org/about-us/hsvmadison-county/climate/.

Jacobs. 2023. *Memorandum: Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation*. August 15.

National Aeronautics and Space Administration (NASA). 1989. *Solid Propulsion Test Bed (SPTB) Environmental Assessment*. March.

National Aeronautics and Space Administration (NASA). 1997. *Environmental Impact Statement of Engine Technology Support for NASA's Advanced Space Transportation Program*. Final. July. https://netspublic.grc.nasa.gov/main/HQ-0027-MSFC-EIS-EngineTechAdvSpaceTrans.pdf.

National Aeronautics and Space Administration (NASA). 2002. *Environmental Assessment for Marshall Space Flight Center Propulsion Research Laboratory*. February 28. https://netspublic.grc.nasa.gov/EA_EIS_Documents.cfm?key=MSFC.

National Aeronautics and Space Administration (NASA). 2003. *Marshall Space Flight Center 20-Year Facilities Master Plan*.

National Aeronautics and Space Administration (NASA). 2007. *Interim Record of Decision, Interim Action Project for Operable Unit 3: Groundwater at Marshall Space Flight Center*. Final. September.

National Aeronautics and Space Administration (NASA). 2008. *Constellation Programmatic Environmental Impact Statement*. Final. January. https://netspublic.grc.nasa.gov/main/207909main_Cx_PEIS_final.pdf.

National Aeronautics and Space Administration (NASA). 2010. *Environmental Assessment of Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center*. Final. September. http://netspublic.grc.nasa.gov/main/SRM%20Final%20EA.pdf.

National Aeronautics and Space Administration (NASA). 2012. *Environmental Assessment for Marshall Exchange Retail Development Property Lease at George C. Marshall Space Flight Center*. Final. http://netspublic.grc.nasa.gov/main/Marshall%20Exchange%20EA_Final%20Feb%202012.pdf.

National Aeronautics and Space Administration (NASA). 2014. NASA Procedural Requirements 6200.1D, NASA Transportation and General Traffic Management. May 1.

National Aeronautics and Space Administration (NASA). 2016. *Integrated Cultural Resources Management Plan for Marshall Space Flight Center, Huntsville, Alabama 2015-2020*.

National Aeronautics and Space Administration (NASA). 2017. *Marshall Flight Center 2017 Environmental Resources Document*. Final. October.

National Aeronautics and Space Administration (NASA). 2019a. *Marshall's Facilities Concept Plan*. May 21.

National Aeronautics and Space Administration (NASA). 2019b. *Marshall Space Flight Center FY19 Economic Impact Report*. Marshall FY19 Economic Impact Report (nasa.gov).

National Aeronautics and Space Administration (NASA). 2020b. *Marshall Space Flight Center Natural Resources Management Plan 2020–2024*. Final. May.

National Aeronautics and Space Administration (NASA). 2021. *Marshall Space Flight Center Propulsion Test Laboratory*. https://www.nasa.gov/wp-content/uploads/2016/01/et10_ptl_3_1_21.pdf.

National Aeronautics and Space Administration (NASA). 2022a. *Marshall Space Flight Center 2022 Research and Technology Report*.

National Aeronautics and Space Administration (NASA). 2022b. *Equity Action Plan.*

National Aeronautics and Space Administration (NASA). 2022c. TSRC-2022 MSFC Technical Specifications for Repairs and Construction. May.

National Aeronautics and Space Administration (NASA). 2023a. About Marshall Space Flight Center. About Marshall Space Flight Center - NASA.

National Aeronautics and Space Administration (NASA). 2023b. *Environmental Justice and Equity Plan*. April.

National Aeronautics and Space Administration (NASA). 2023c. *Interim Natural Resources Management Plan for NASA Marshall Space Flight Center*. Final. November 21.

National Aeronautics and Space Administration (NASA). 2023d. *Spill Prevention, Control, and Countermeasure Plan.* Marshall Space Flight Center (MSFC). June 12.

National Aeronautics and Space Administration (NASA). 2023e. *Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation*. Draft.

National Aeronautics and Space Administration (NASA). 2023f. *Marshall Space Flight Center Strategy for the Future.*

National Aeronautics and Space Administration (NASA). 2023g. *Stormwater Pollution Prevention Plan*.

National Aeronautics and Space Administration (NASA). 2023h. *Record of Environmental Consideration for Habitat Burst Testing*. August.

National Aeronautics and Space Administration (NASA). 2023i. *Agency Master Plan (AMP) Programmatic Environmental Assessment*. December. https://www.nasa.gov/wp-content/uploads/2023/12/nasa-agency-master-plan-programmatic-environmental-assessment.pdf.

National Aeronautics and Space Administration (NASA). 2023j. *George C. Marshall Space Flight Center Record of Environmental Consideration for Habitat Burst Testing*.

National Aeronautics and Space Administration (NASA). 2023k. NASA Climate Adaptation Science Investigators Workgroup CASI2 Monthly Meeting Focus on MSFC/MAF. March 30.

National Aeronautics and Space Administration (NASA). 2023l. Marshall Habitation Systems. July 20. https://www.nasa.gov/reference/marshall-habitation-systems/

National Aeronautics and Space Administration (NASA). n.d. Marshall Work Instruction (MWI) 8550.2, Stormwater and Wastewater Management.

National Aeronautics and Space Administration (NASA). n.d. MSFC Technical Specifications for Repairs and Construction.

National Park Service (NPS). 2022. *Synthesis of Studies on the Effects of Noise*. https://www.nps.gov/articles/effectsofnoise.htm.

National Weather Service. 2023. Huntsville, Alabama Climatology. https://www.weather.gov/hun/huntsvillenormalsandextremesdatabase.

Panamerican Consultants, Inc. 2023. *Architectural Survey & NRHP Evaluations of NASA Marshall Space Flight Center at Redstone Army Arsenal, Huntsville, Madison County, Alabama.* Provided by NASA.

Shannon, G., M. F. McKenna, L. M. Angeloni, K. R. Crooks, K. M. Fristrup, E. Brown, K. A. Warner, M. Nelson, C. White, J. Briggs, S. McFarland, and G. Wittemyer. 2016. *A synthesis of two decades of research documenting the effects of noise on wildlife*. Biol Rev, 91: 982-1005. https://sites.warnercnr.colostate.edu/wp-content/uploads/sites/146/2020/11/biologicalreviews2015.pdf.

U.S. Census Bureau. 2022. Quick Facts. https://www.census.gov/quickfacts/fact/table/madisoncountyalabama,AL,US/PST045222.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2023a. Decatur Series. Accessed October 6, 2023. Official Series Description - DECATUR Series (usda.gov).

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2023b. Cumberland Series. Accessed October 6, 2023. Official Series Description - CUMBERLAND Series (usda.gov).

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2023c. Abernathy Series. Accessed October 6, 2023. Official Series Description - ABERNATHY Series (usda.gov).

U.S. Environmental Protection Agency (EPA). 2005. *Best Management Practices for Lead at Outdoor Shooting Ranges*. June. https://www.epa.gov/sites/default/files/documents/epa_bmp.pdf.

U.S. Environmental Protection Agency (EPA). 2016. What Climate Change Means for Alabama. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-al.pdf.

U.S. Environmental Protection Agency (EPA). 2022. Summary of Executive Order 13045 Protection of Children from Environmental Health Risks and Safety Risks. https://www.epa.gov/laws-regulations/summary-executive-order-13045-protection-children-environmental-health-risks-and#:~:text=Executive%20Order%20(E.O.),economically%20significant%20rules%20under%20E.O.

U.S. Environmental Protection Agency (EPA). 2023a. Nonattainment Areas for Criteria Pollutants (Green Book).

U.S. Environmental Protection Agency (EPA). 2023b. Causes of Climate Change. https://www.epa.gov/climatechange-science/causes-climate-change.

U.S. Environmental Protection Agency (EPA). 2023c. How Wetlands are Defined and Identified under CWA Section 404. Updated April. https://www.epa.gov/cwa-404/how-wetlands-are-defined-and-identified-under-cwa-section-404.

U.S. Environmental Protection Agency (EPA). 2023d. Environmental Justice Screening and Mapping Tool (EJScreen) Version 2.2. https://ejscreen.epa.gov/mapper/.

U.S. Fish and Wildlife Service (USFWS). 2023. National Wetlands Inventory. https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/.

U.S. Geological Survey (USGS). 2023. Science in Your Watershed: Locate Your Stream Site by 10-digit HUC – 0603000205 Huntsville Spring Branch-Indian Creek. Accessed October 3, 2023. https://water.usgs.gov/wsc/a_api/wbd/watershed06/0603000205.html.

Willems, Joshua S., Jennifer N. Phillips, and Clinton D. Francis. 2022. Artificial light at night and anthropogenic noise alter the foraging activity and structure of vertebrate communities. *Science of the Total Environment* 805 (2022) 150223. https://www.sciencedirect.com/science/article/pii/S0048969721053006?via%3Dihub.

This page is intentionally left blank.

Figures

This page is intentionally left blank.

For readability, each resource found throughout Marshall Space Flight Center will be shown on three separate figures, each displaying a different area of the facility. The figure number will include a, b, and c to correspond to the north, middle, and south areas of the facility, as indicated in the figure legend.

This page is intentionally left blank.

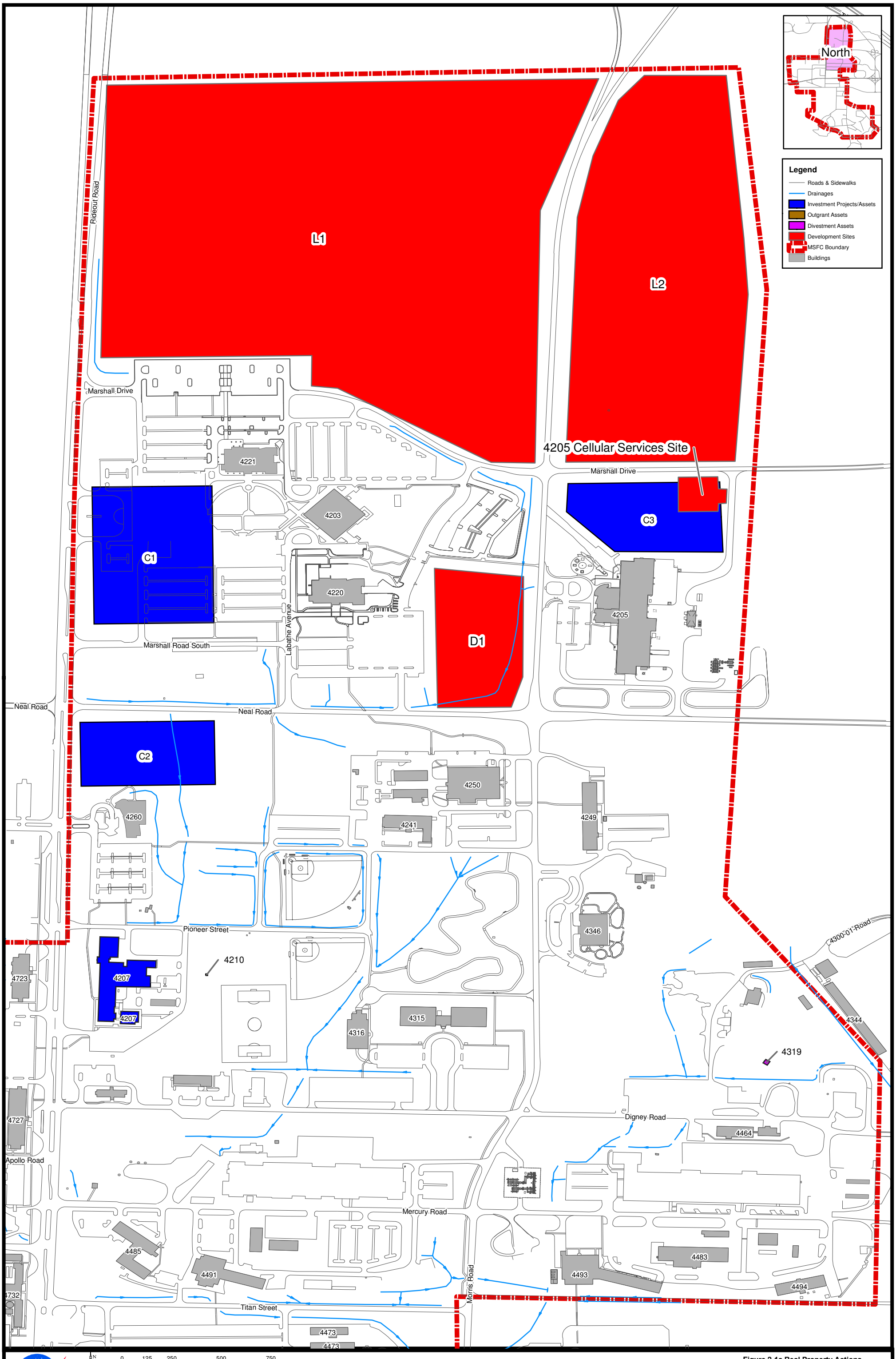
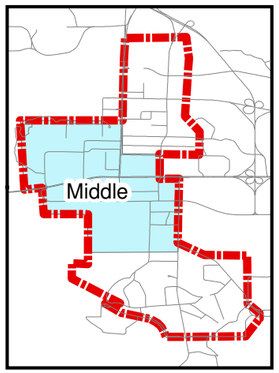
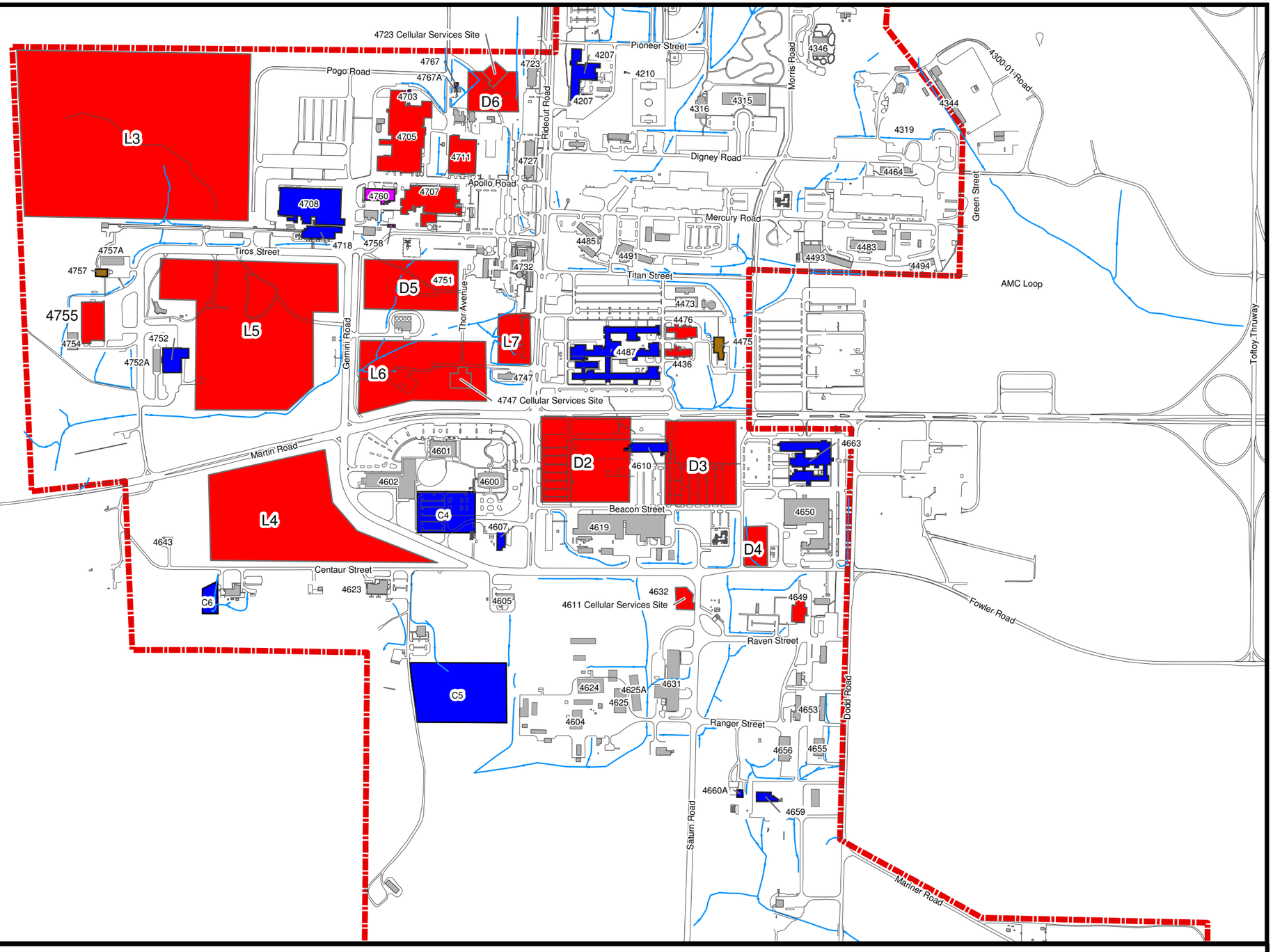


Figure 2-1a Real Property Actions
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesN.mxd





Legend

- Roads & Sidewalks
- Drainages
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

N W E S

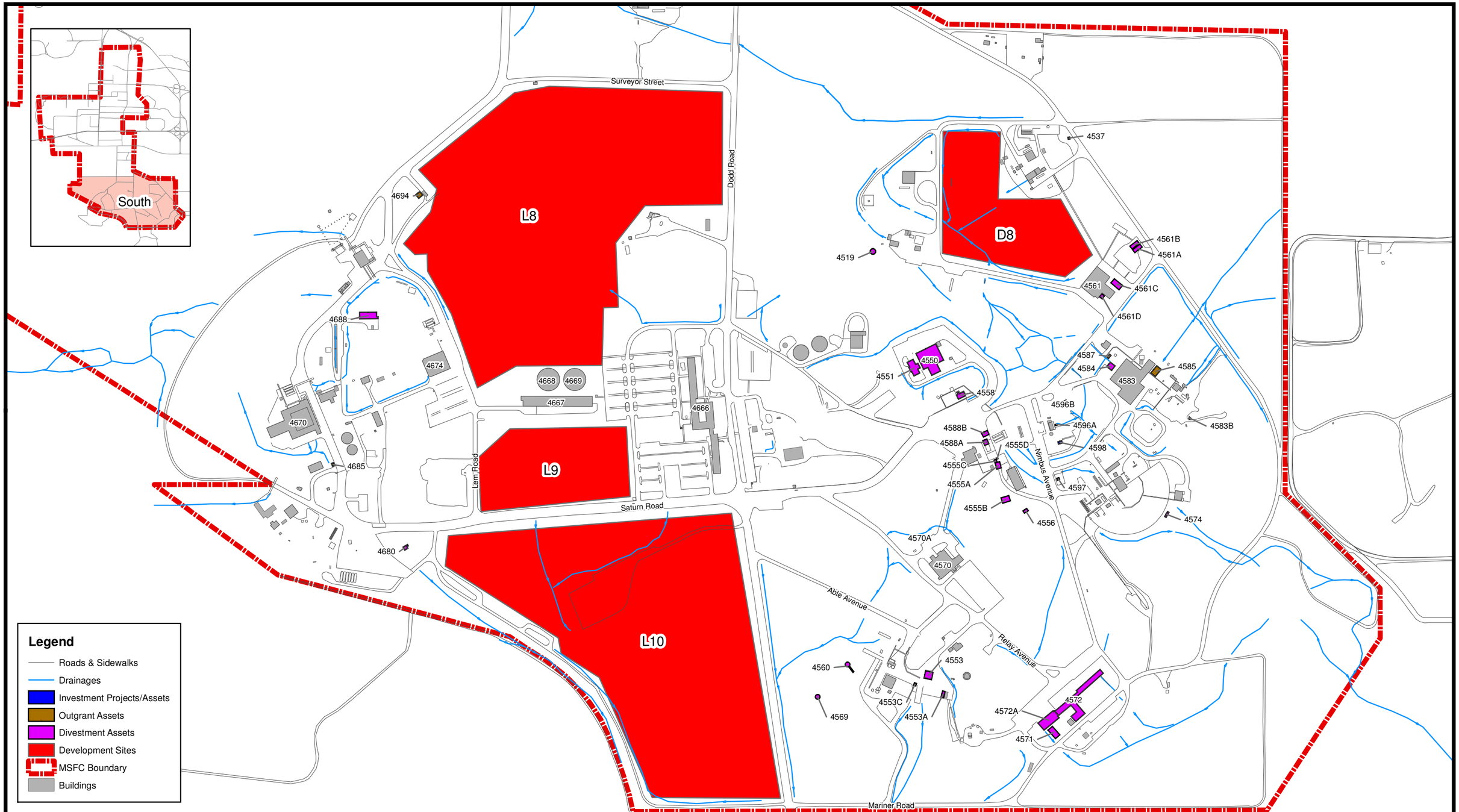
0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

17-Oct-2023
Drawn By:
D. Scott Stevens

Figure 2-1b Real Property Actions
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM.mxd



16-Oct-2023
Drawn By:
D. Scott Stevens

Figure 2-1c Real Property Actions
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS.mxd

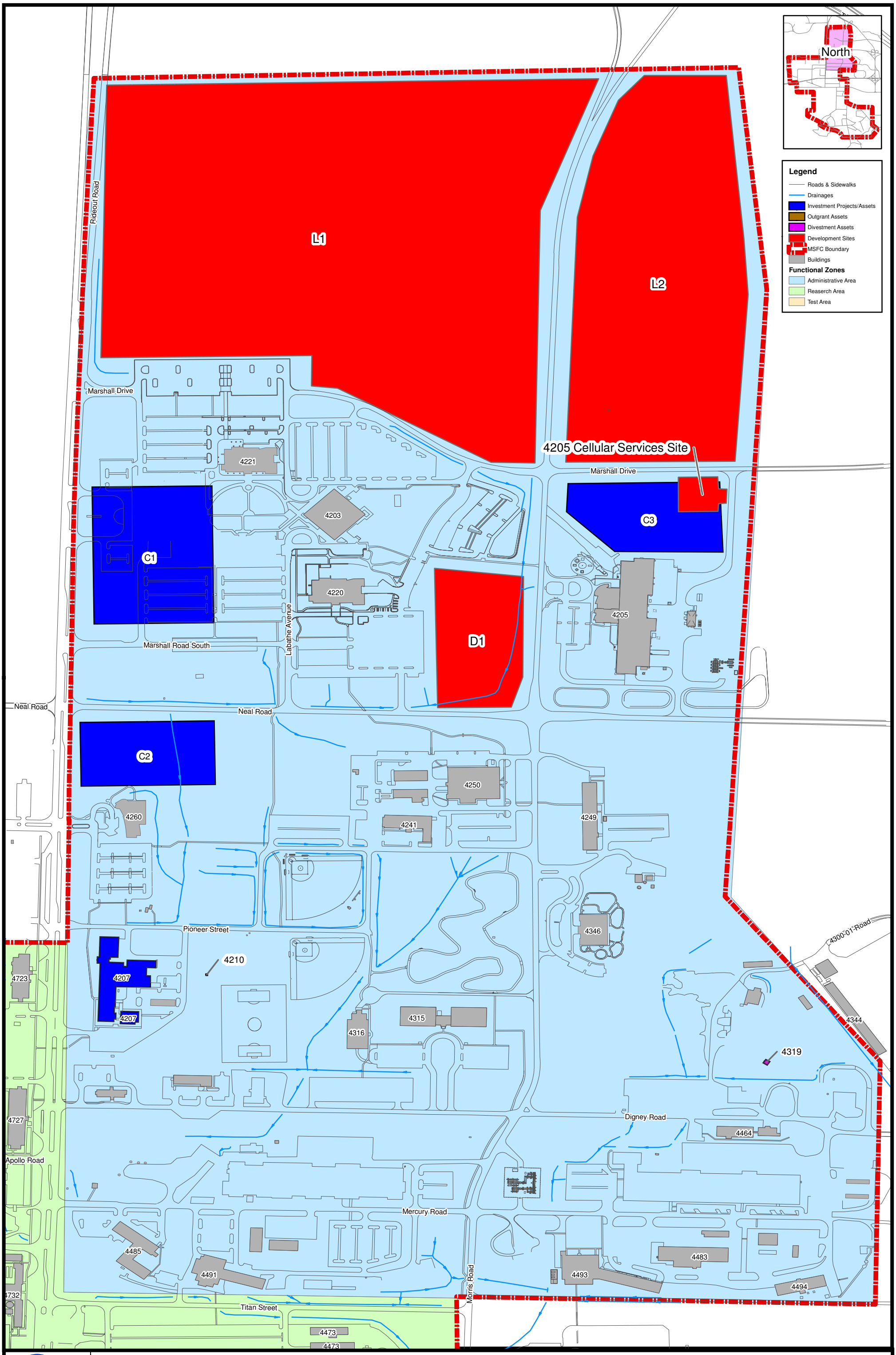
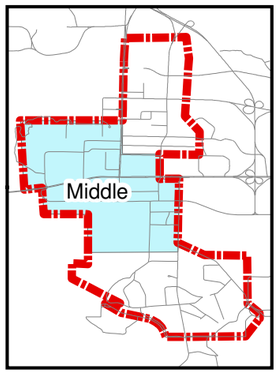
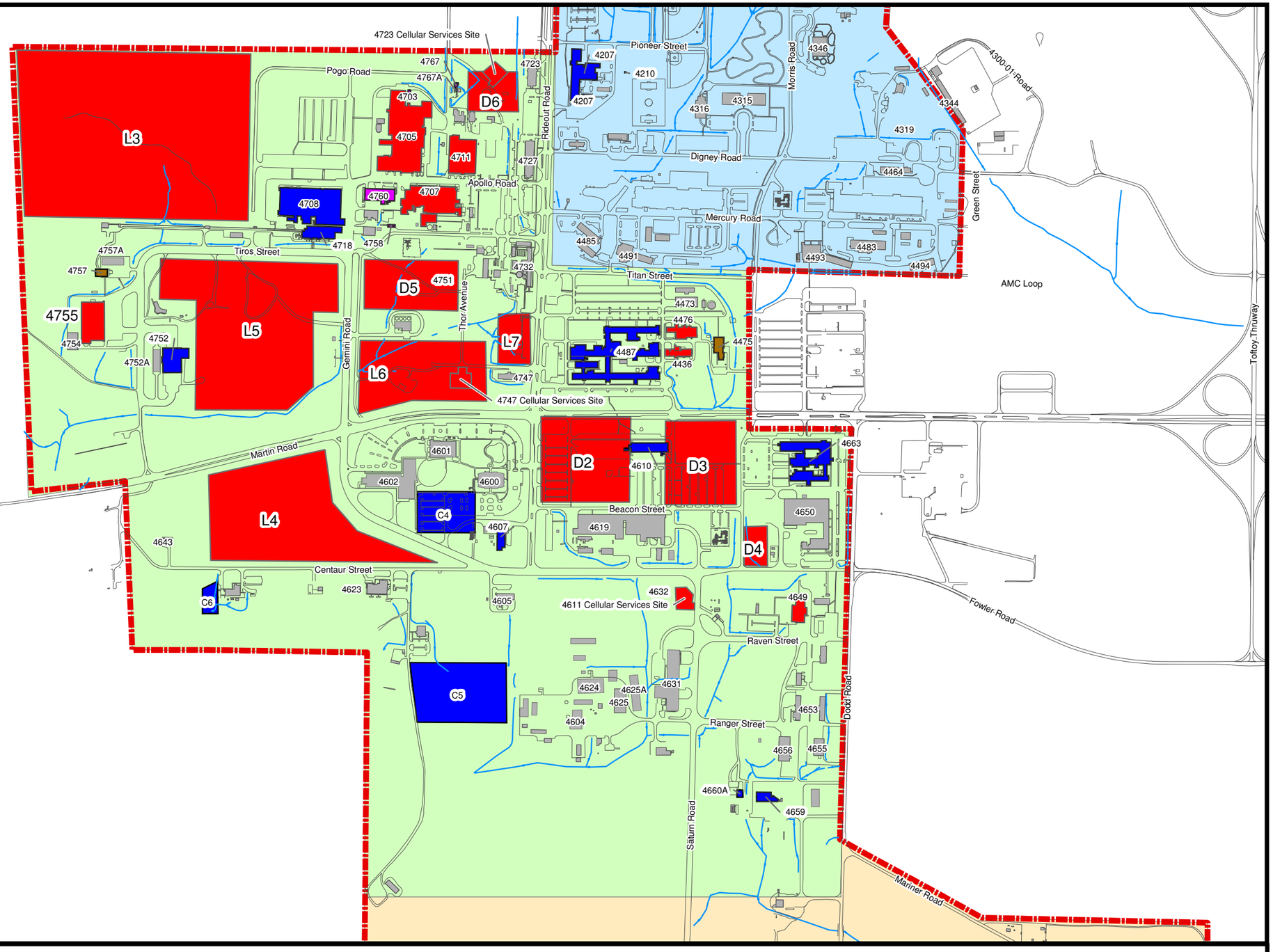


Figure 3.5-1a Functional Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesN-FuncZone.mxd





Legend

- Roads & Sidewalks
- Drainages
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

Functional Zones

- Administrative Area
- Reaserch Area
- Test Area

N
W E
S

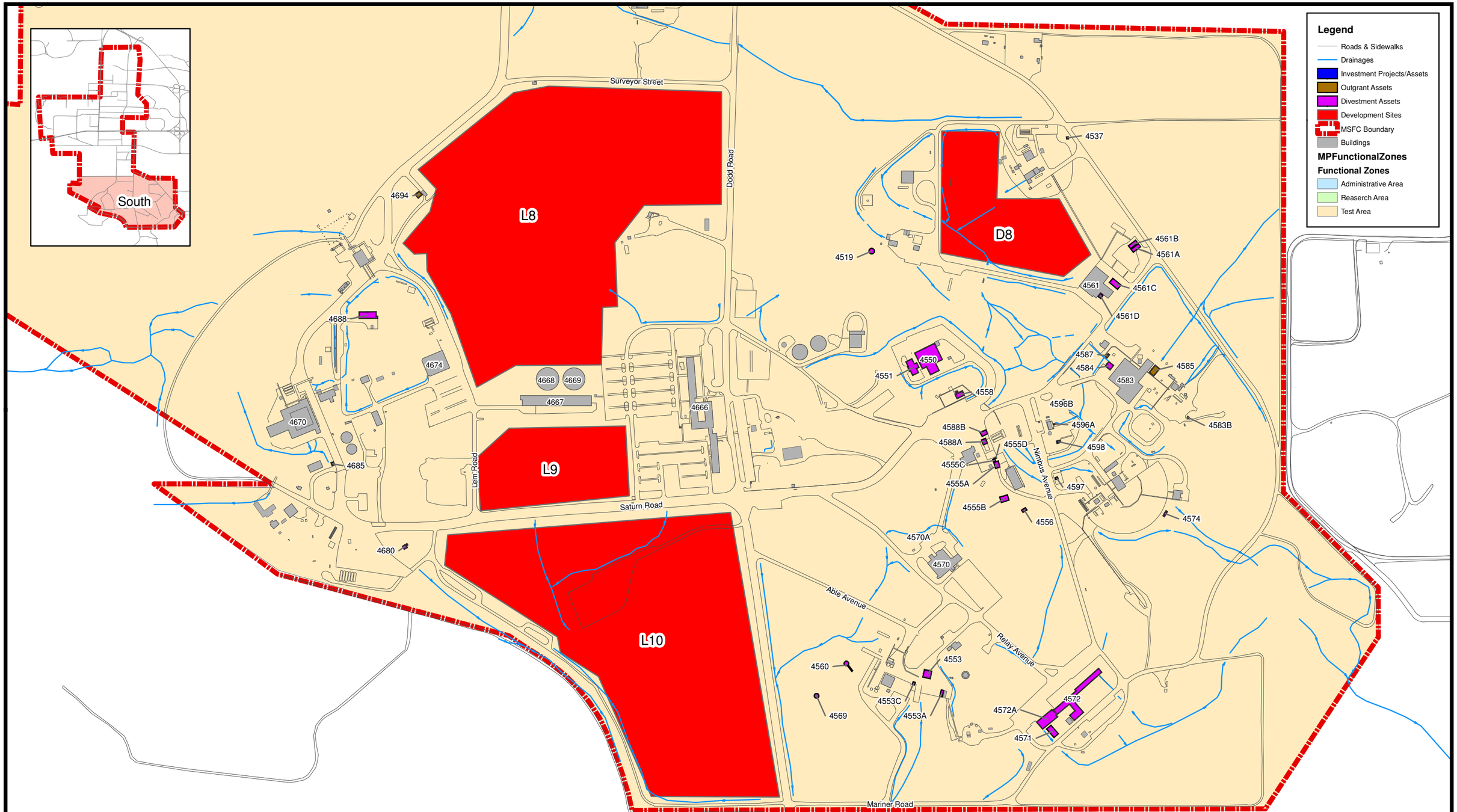
0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

26-Oct-2023
Drawn By:
D. Scott Stevens

Figure 3.5-1b Functional Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM-FuncZone.mxd



26-Oct-2023
Drawn By:
D. Scott Stevens

Figure 3.5-1c Functional Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-FuncZone.mxd

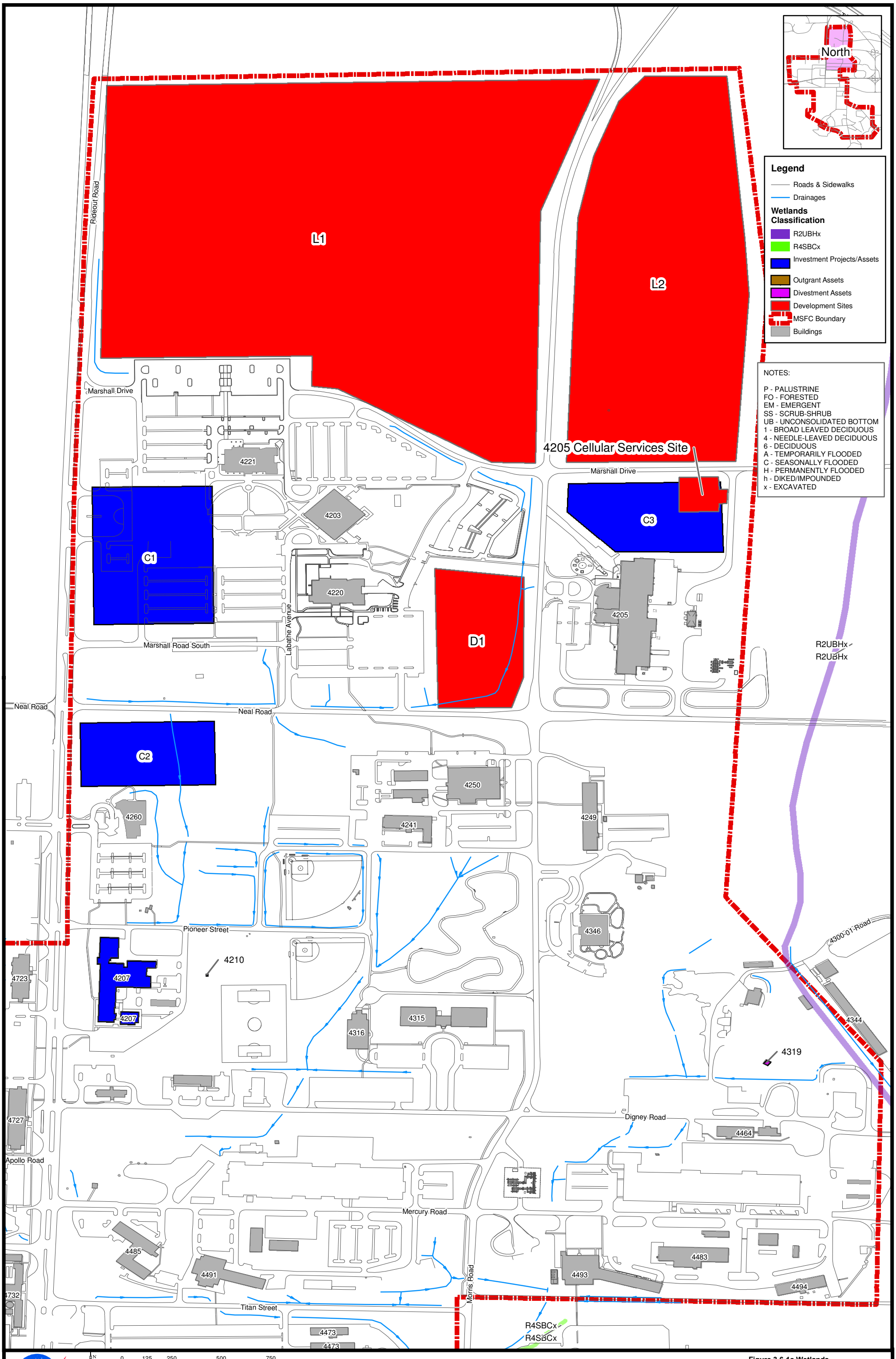


Figure 3.6-1a Wetlands
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesN-WL.mxd

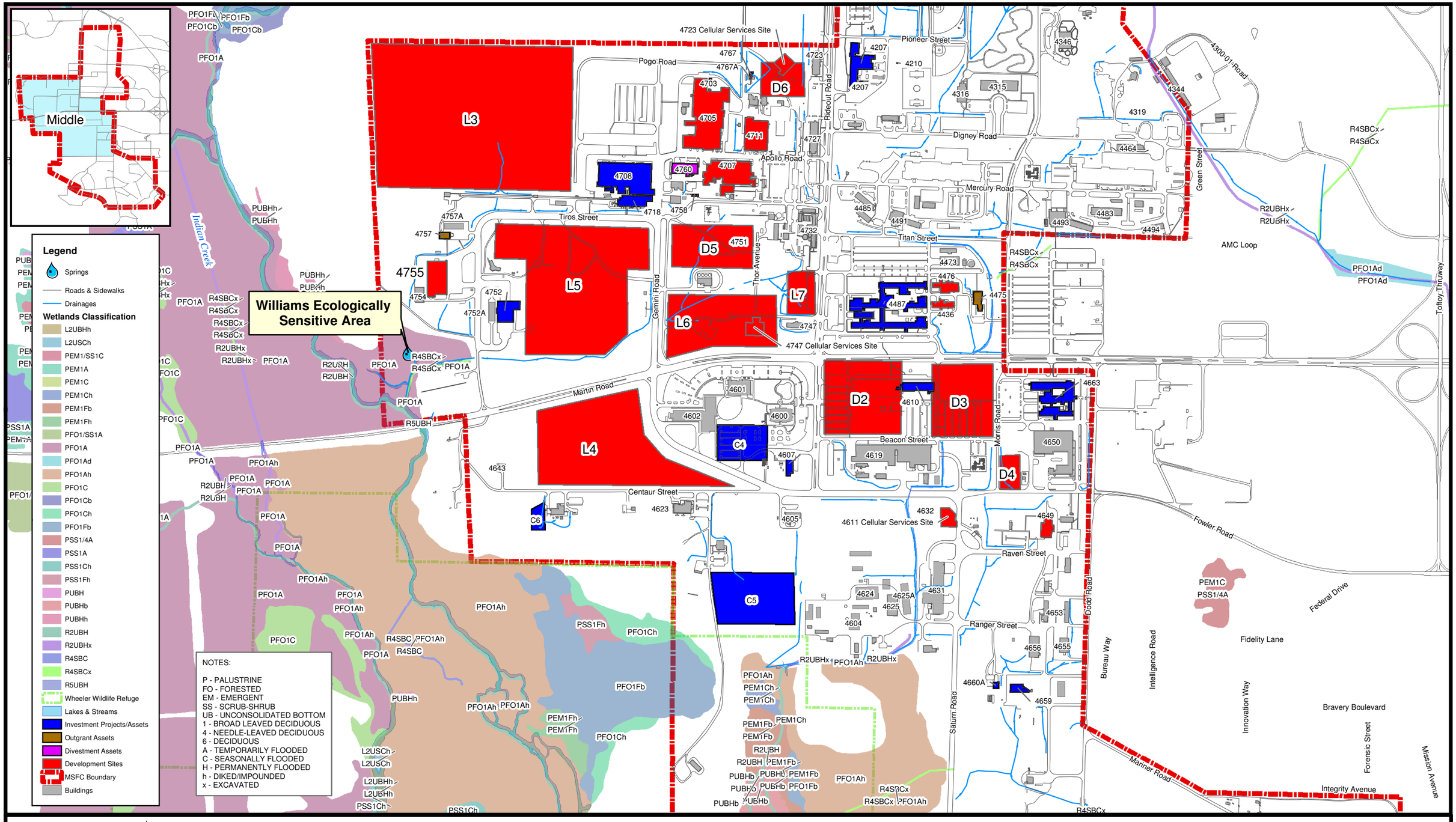
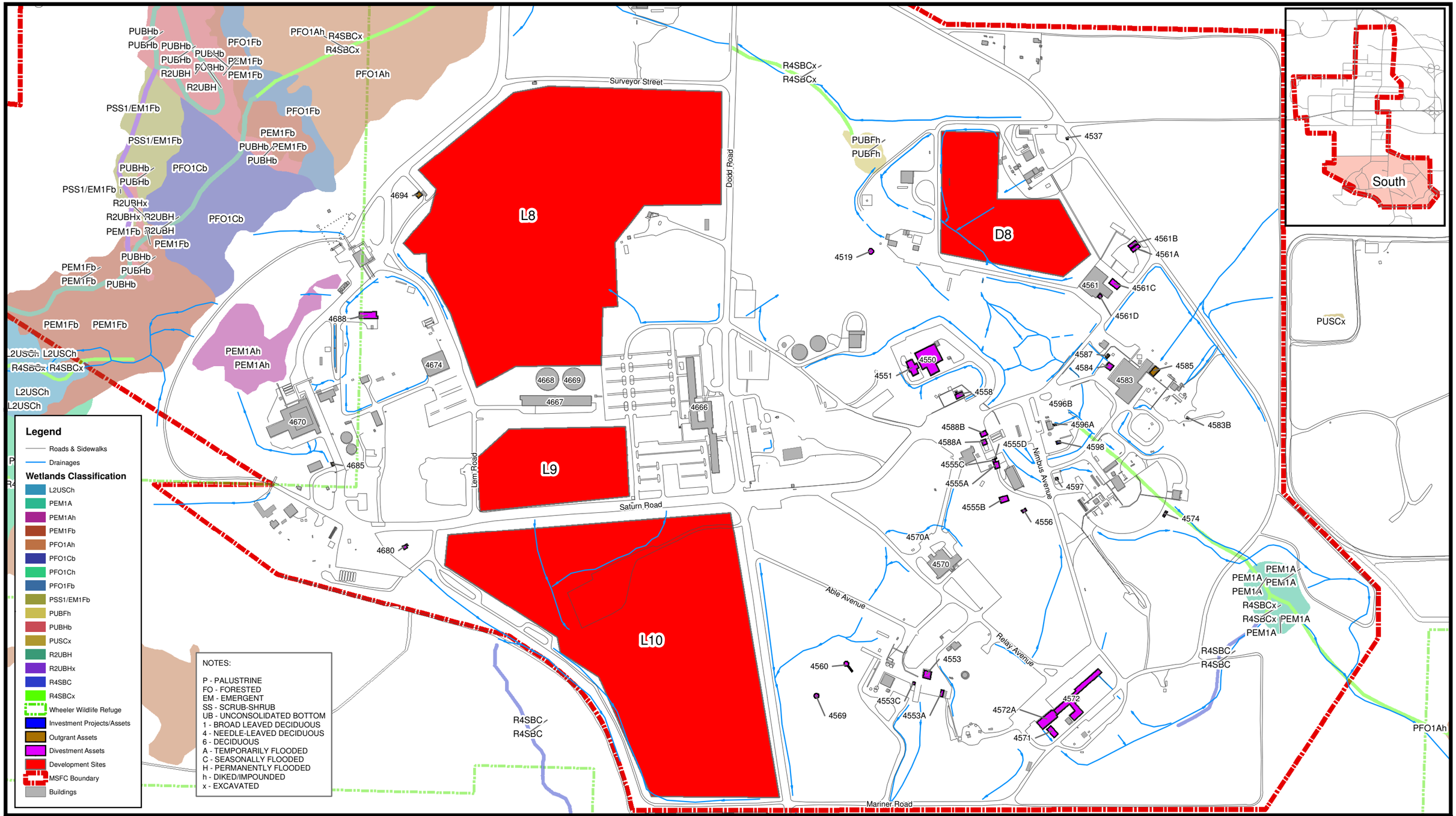


Figure 3.6-1b Wetlands
Site-Wide Environmental Assessment
Marshall Space Flight Center

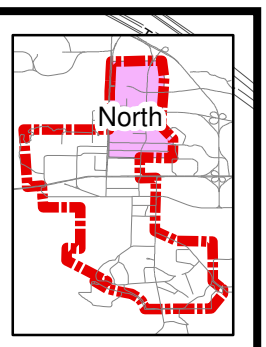
Map Document: G:\maps\EA\EA23\SW-DevSitesM-WL.mxd



30-Oct-2023
Drawn By:
D. Scott Stevens

Figure 3.6-1c Wetlands
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-WL.mxd



Legend

- Roads & Sidewalks
- Drainages
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

Floodplain

- 100 Year
- 500 Year

L1
L2
C1
C2
C3
D1
Rideout Road
Marshall Drive
Marshall Road South
Neal Road
Labathe Avenue
Pioneer Street
Mercury Road
Digney Road
Apollo Road
Titan Street
Morris Road
4300-01 Road
4205 Cellular Services Site
4210
4319
4221
4203
4220
4205
4260
4241
4250
4249
4346
4723
4207
4316
4315
4344
4727
4464
4485
4491
4483
4493
4494
4732
4473

0 125 250 500 750 Feet

0 50 100 200 Meters

26-Oct-2023
Drawn By:
D. Scott Stevens

Figure 3.6-2a Floodplains
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesN-Flood.mxd

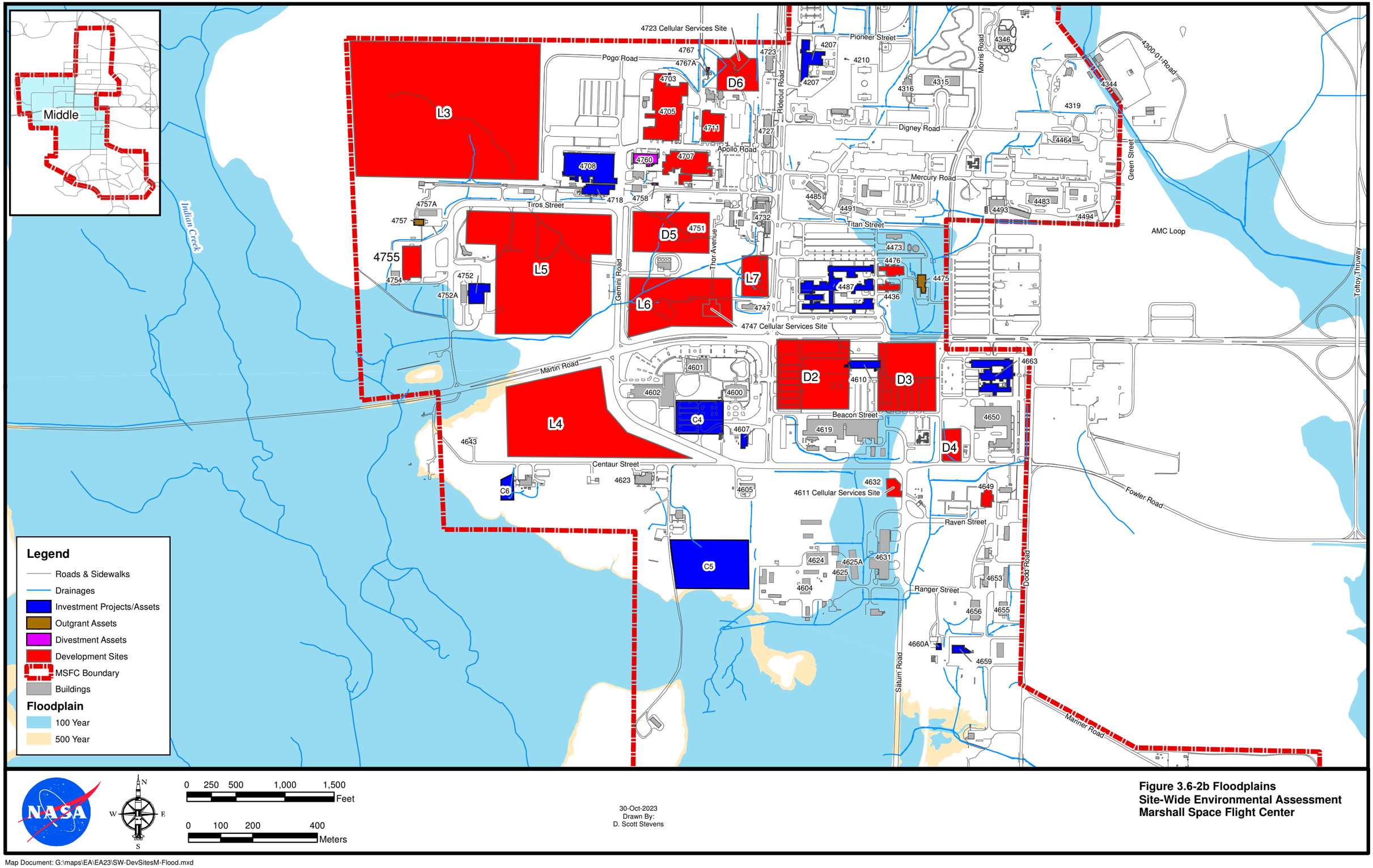


Figure 3.6-2b Floodplains
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM-Flood.mxd

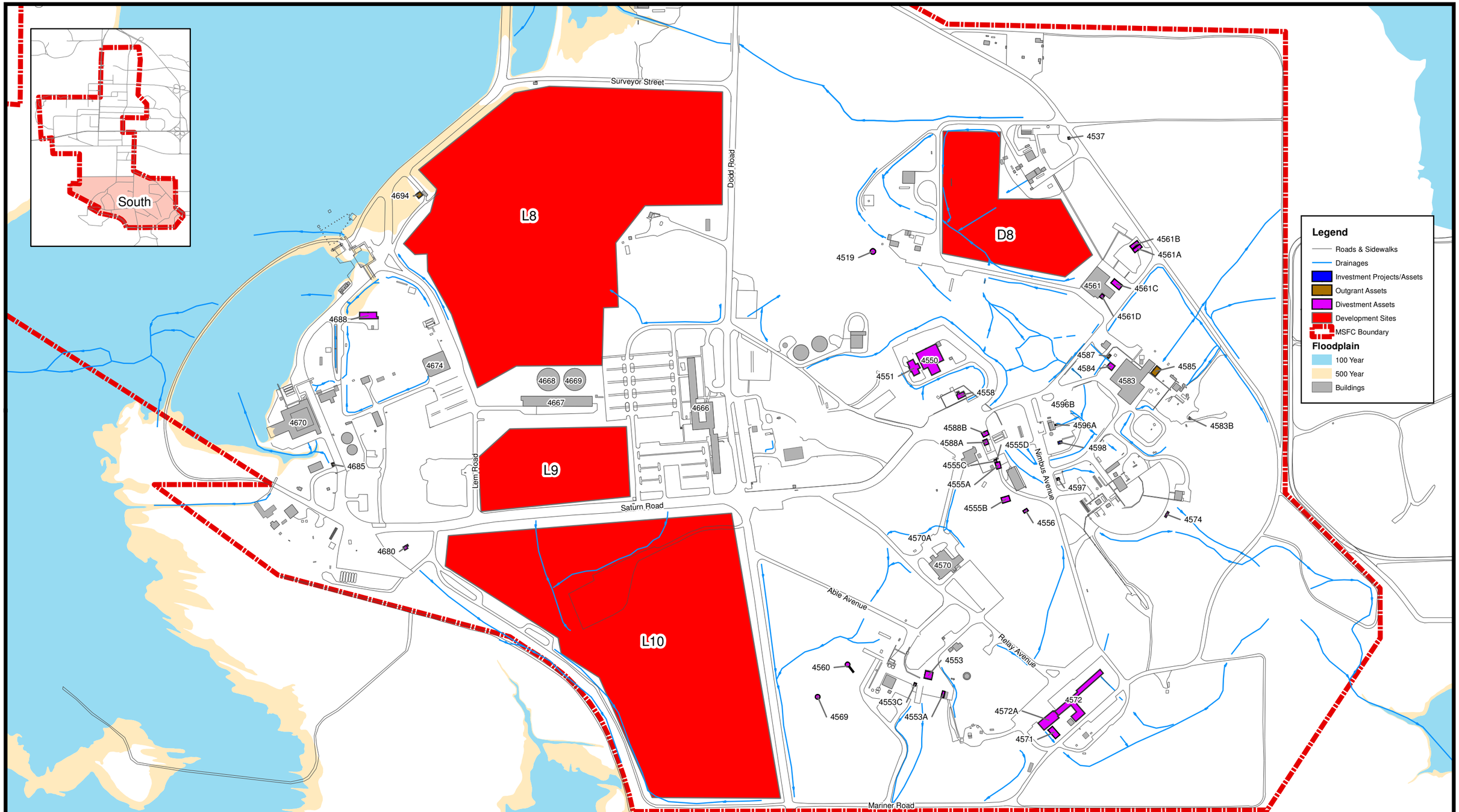


Figure 3.6-2c Floodplains
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-Flood.mxd

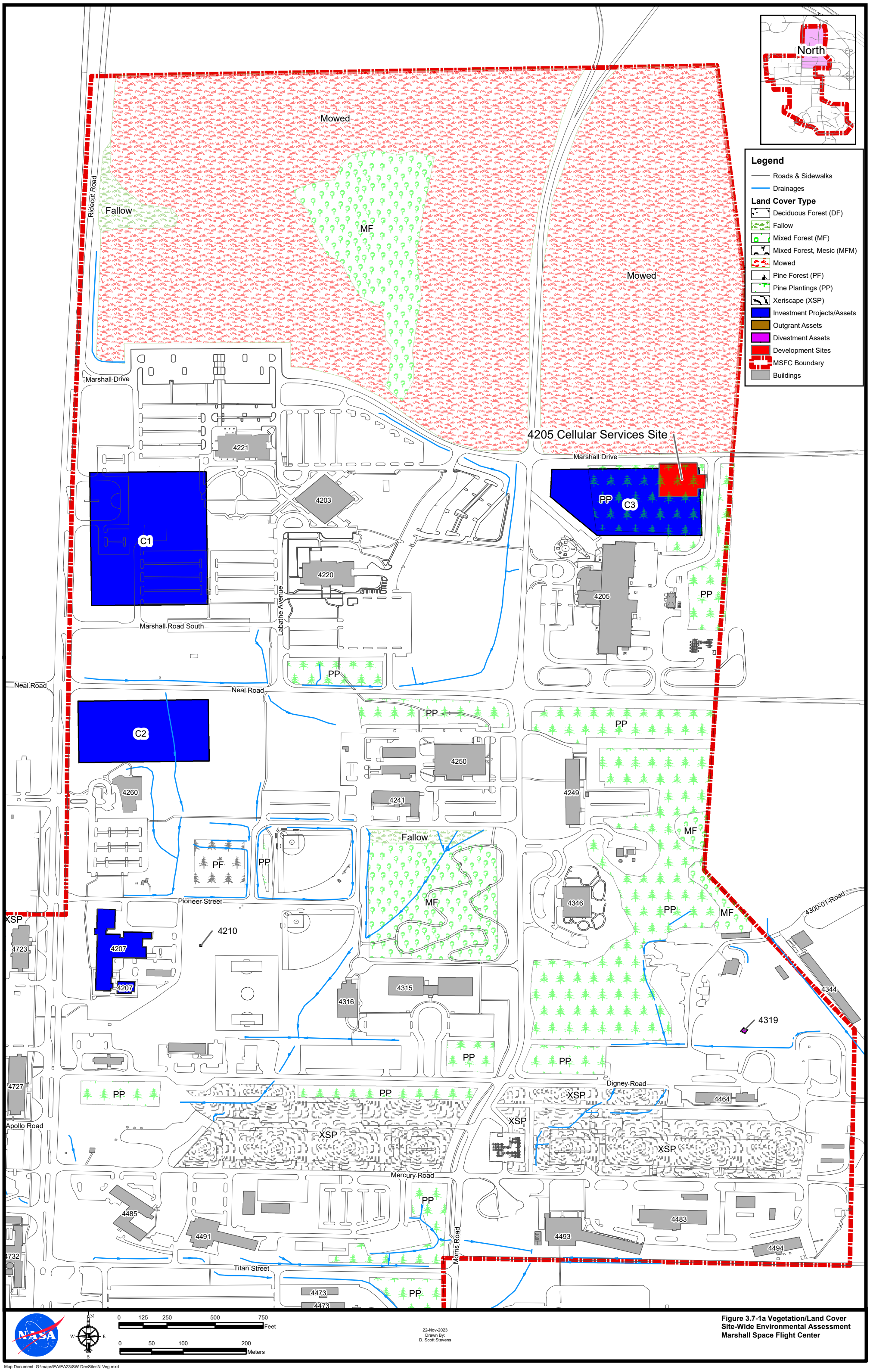
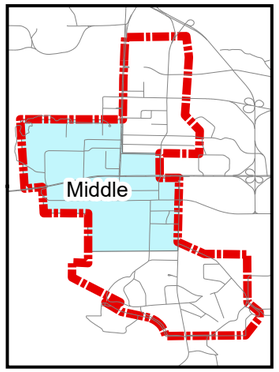
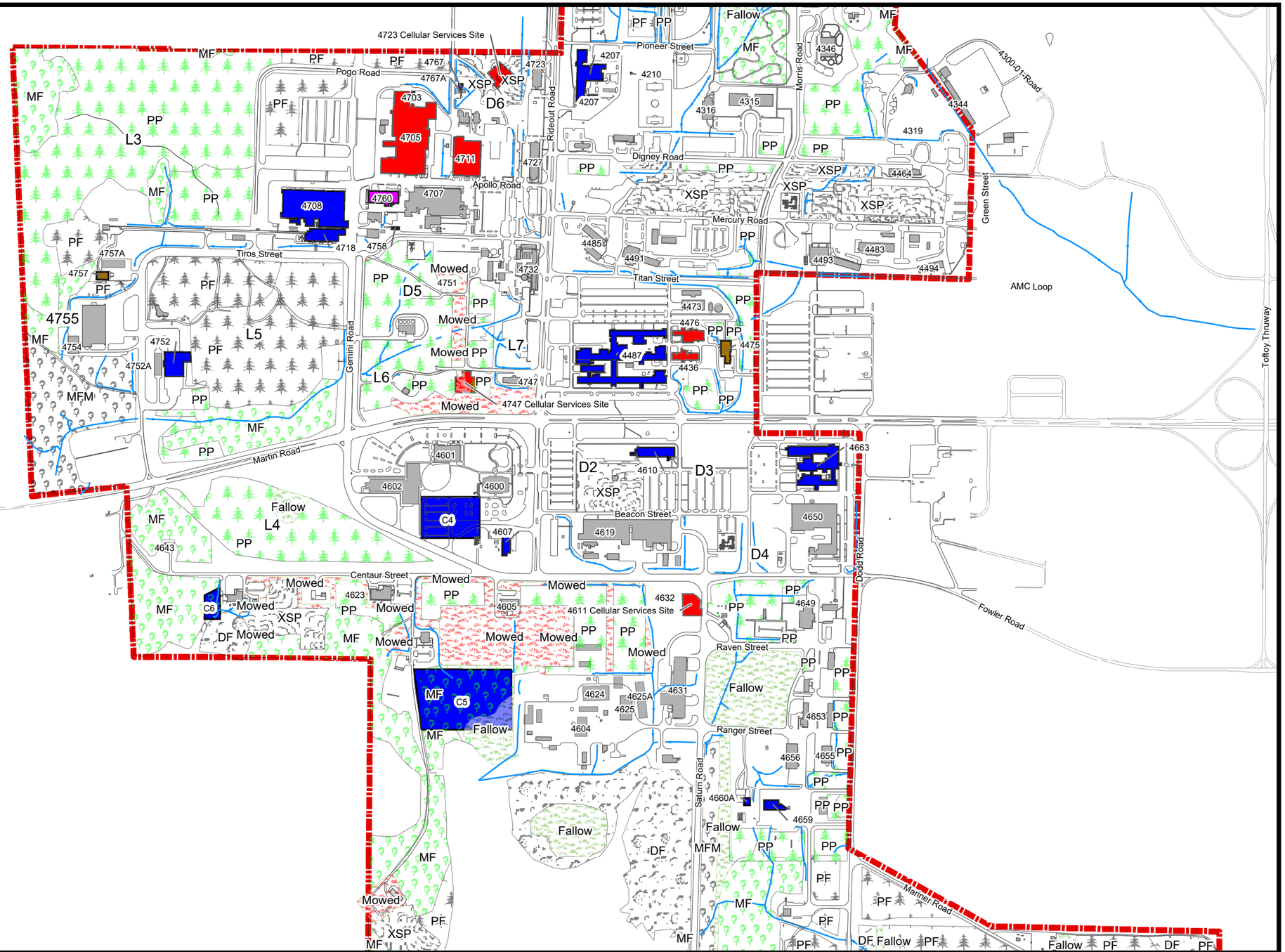


Figure 3.7-1a Vegetation/Land Cover
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesN-Veg.mxd





Legend

- Roads & Sidewalks
- Drainages

Land Cover Type

- Deciduous Forest (DF)
- Fallow
- Mixed Forest (MF)
- Mixed Forest, Mesic (MFM)
- Mowed
- Pine Forest (PF)
- Pine Plantings (PP)
- Xeriscape (XSP)
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

N W E S

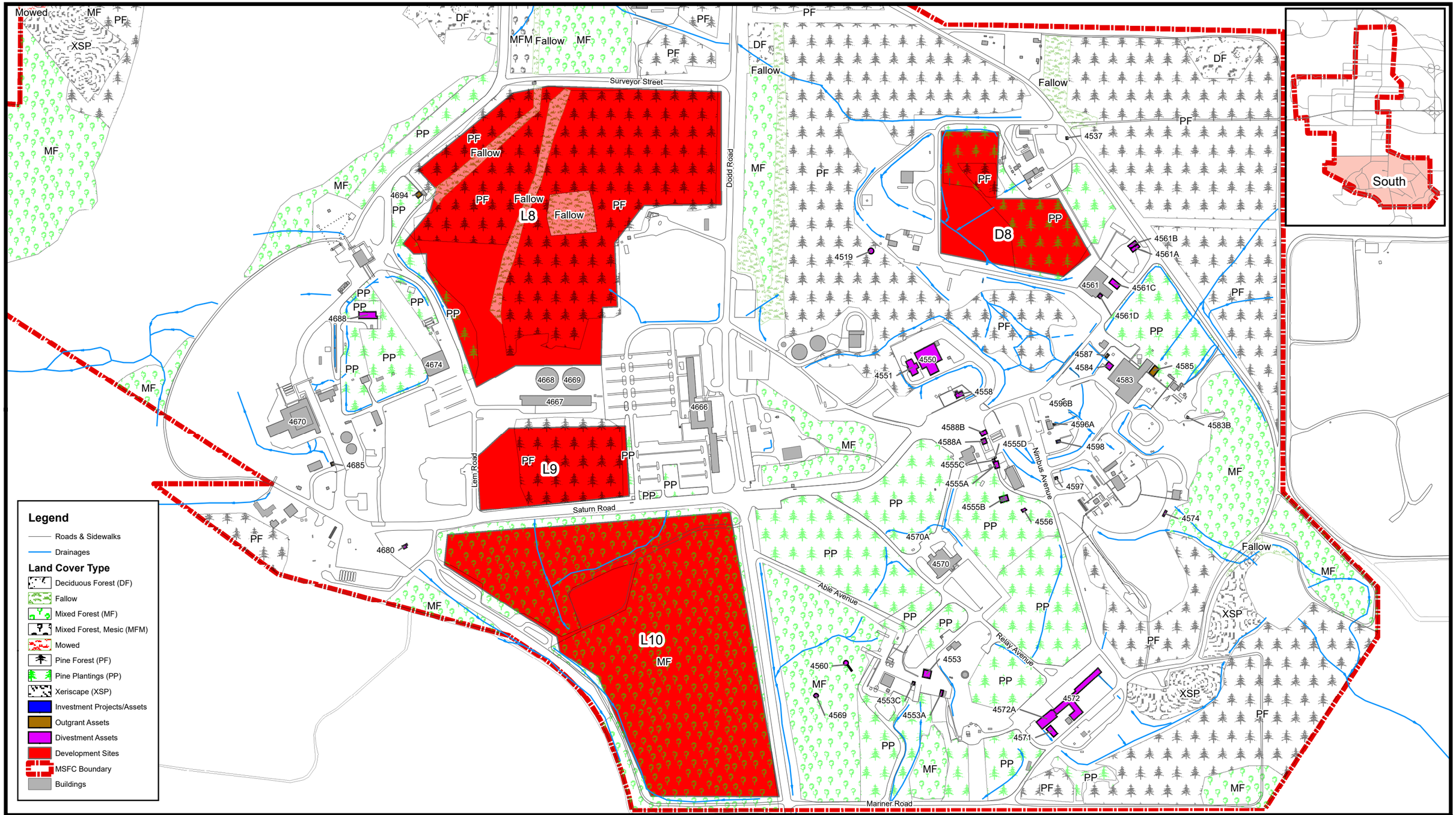
0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

22-Nov-2023
Drawn By:
D. Scott Stevens

Figure 3.7-1b Vegetation/Land Cover Site-Wide Environmental Assessment Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM-Veg.mxd



Legend

- Roads & Sidewalks
- Drainages

Land Cover Type

- Deciduous Forest (DF)
- Fallow
- Mixed Forest (MF)
- Mixed Forest, Mesic (MFM)
- Mowed
- Pine Forest (PF)
- Pine Plantings (PP)
- Xeriscape (XSP)
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

N W E S

0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

22-Nov-2023
Drawn By:
D. Scott Stevens

Figure 3.7-1c Vegetation/Land Cover
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-Veg.mxd

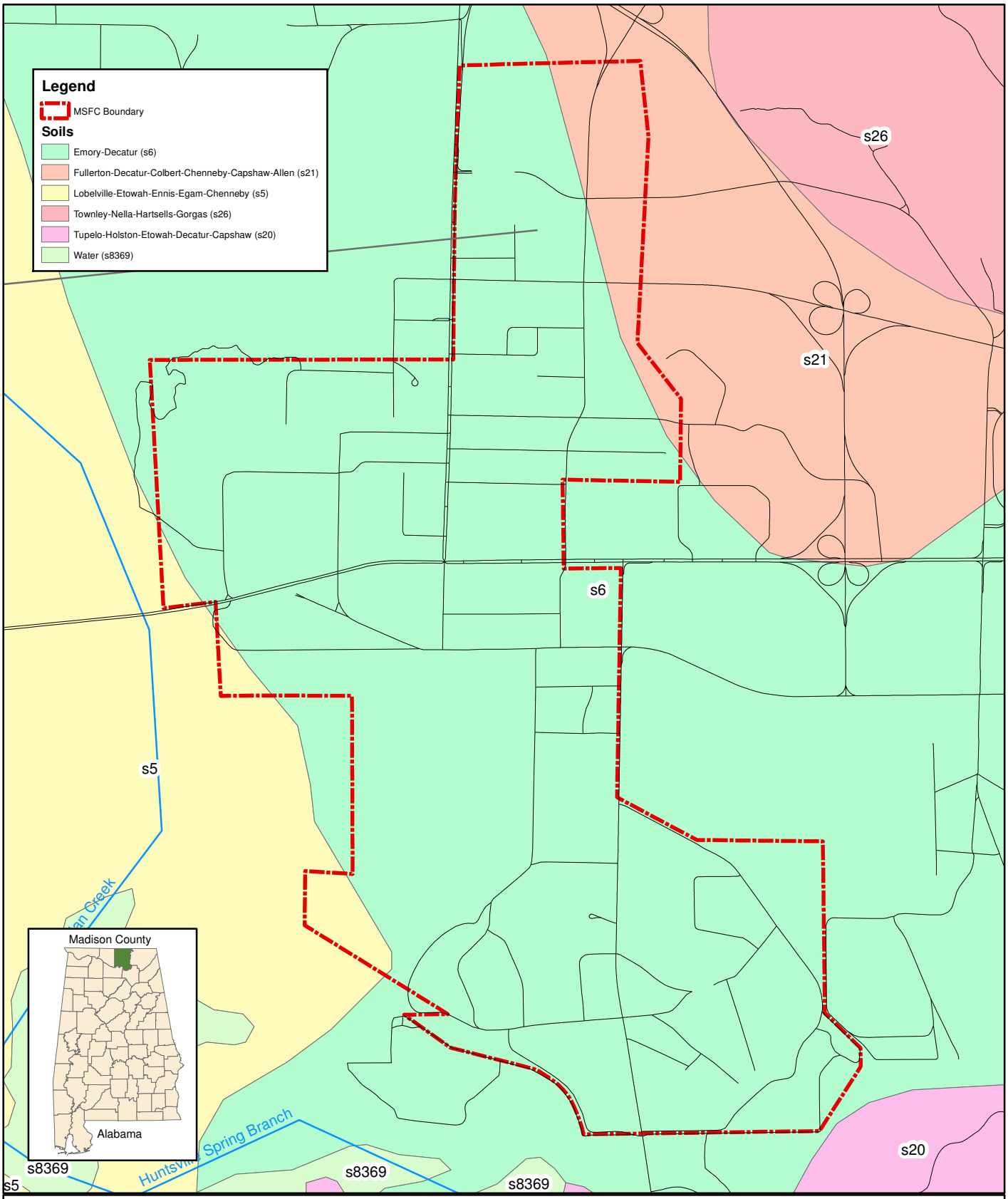
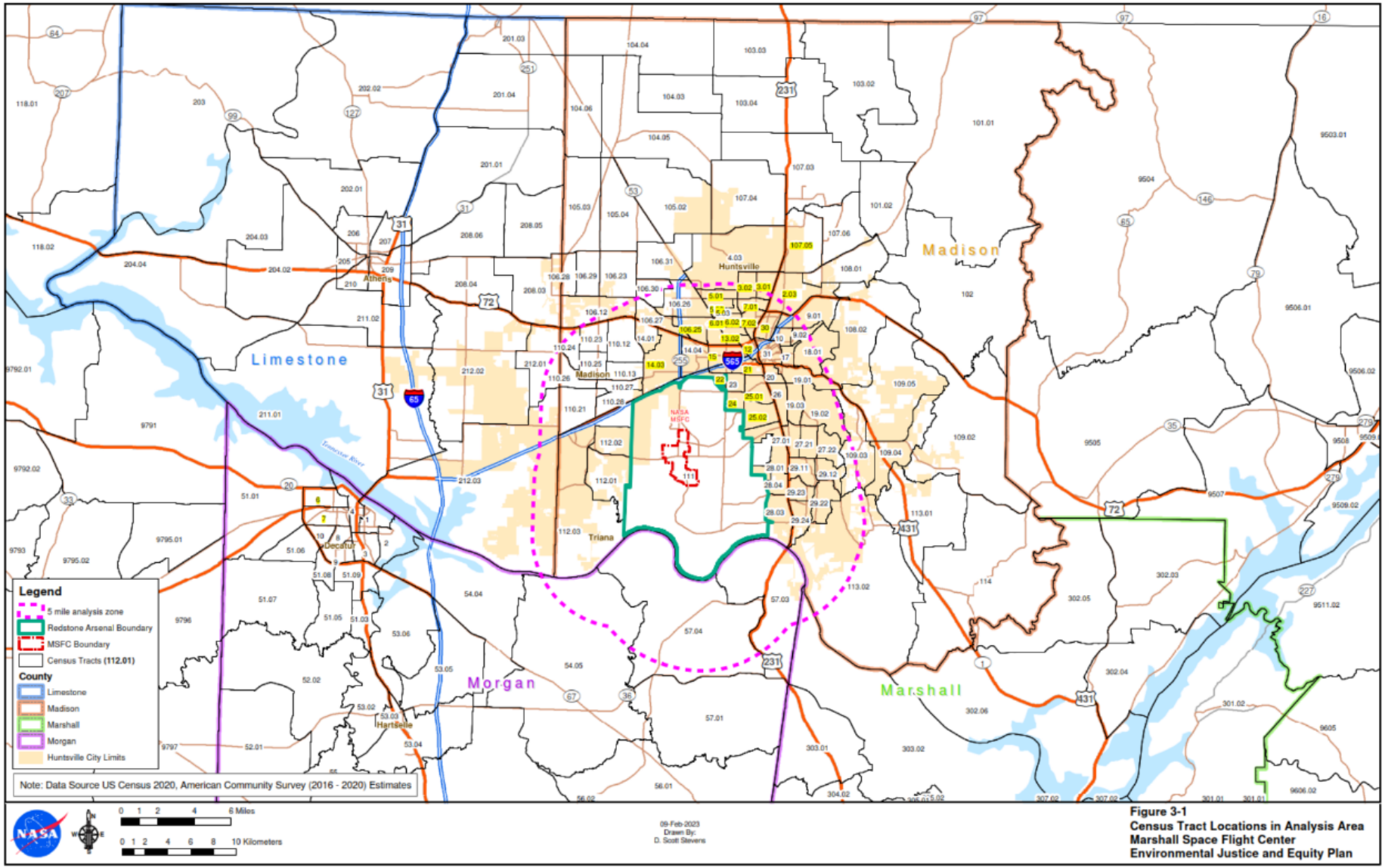


Figure 3.8-1 Surface Soil Groups
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\site-wide\MSFC_Soil.mxd



Source: NASA 2023b

Figure 3.13-1. Census Tract Locations in Analysis Area

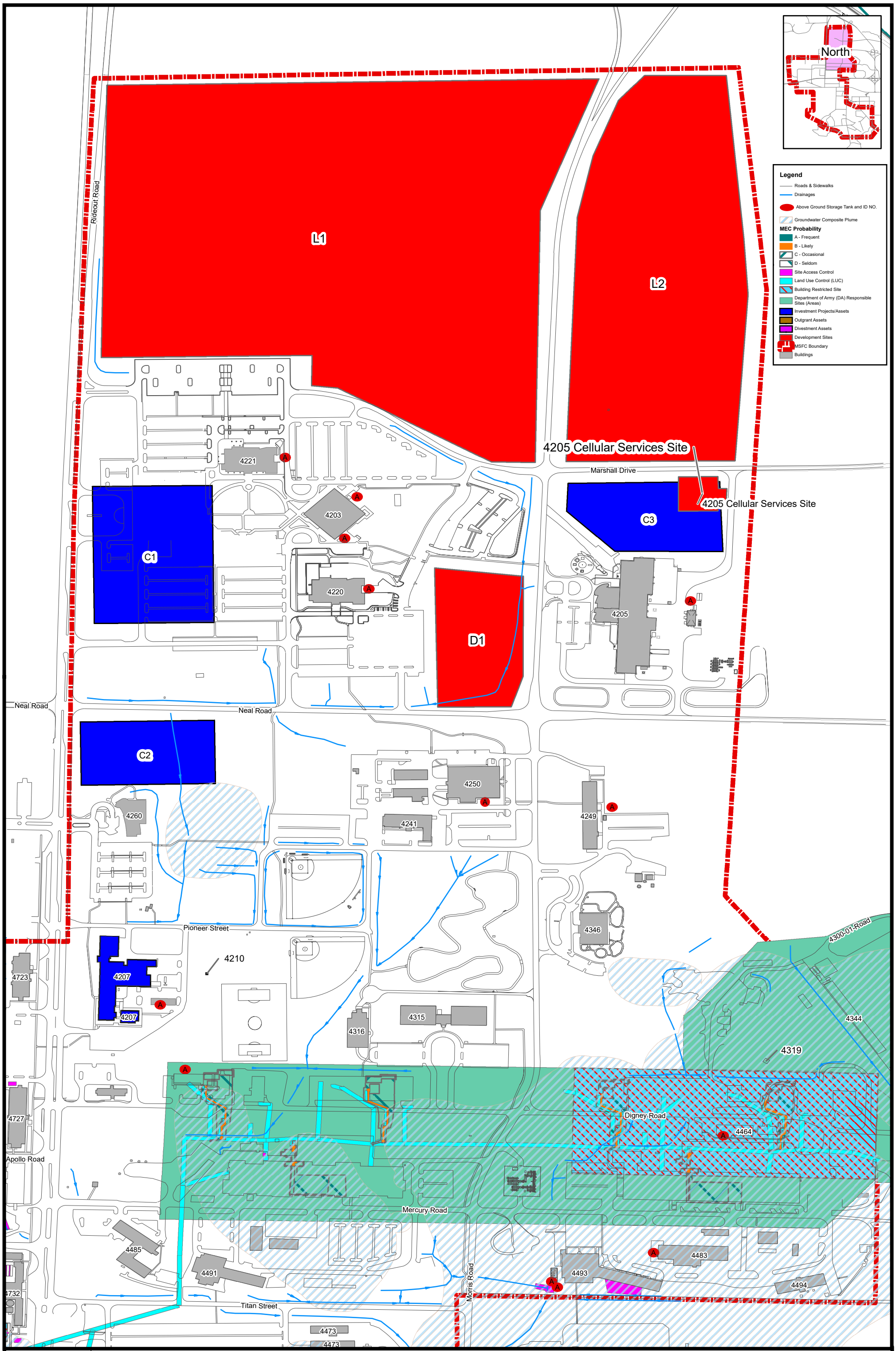
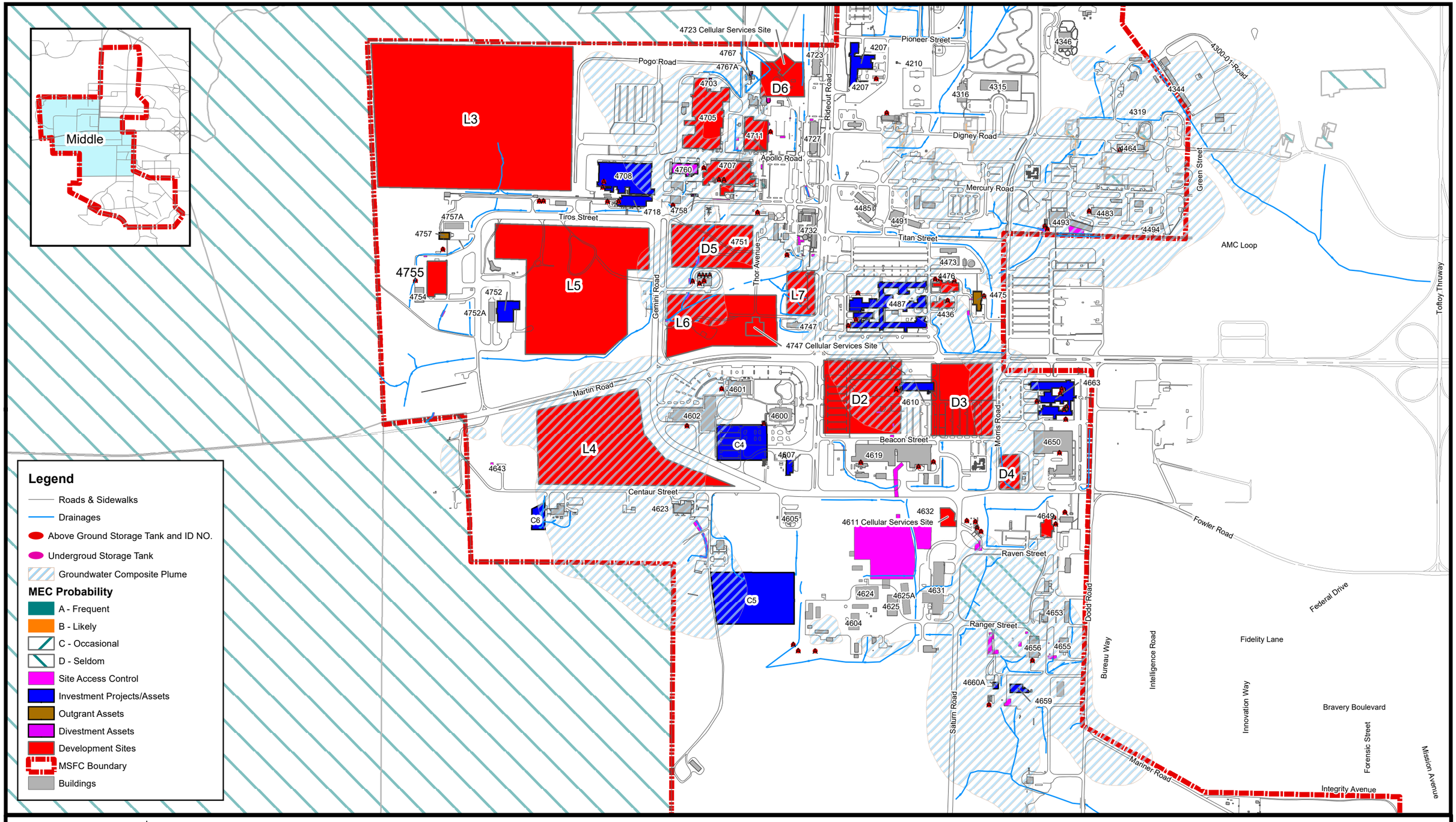


Figure 3.14-1a Hazardous Materials Site-Wide Environmental Assessment Marshall Space Flight Center

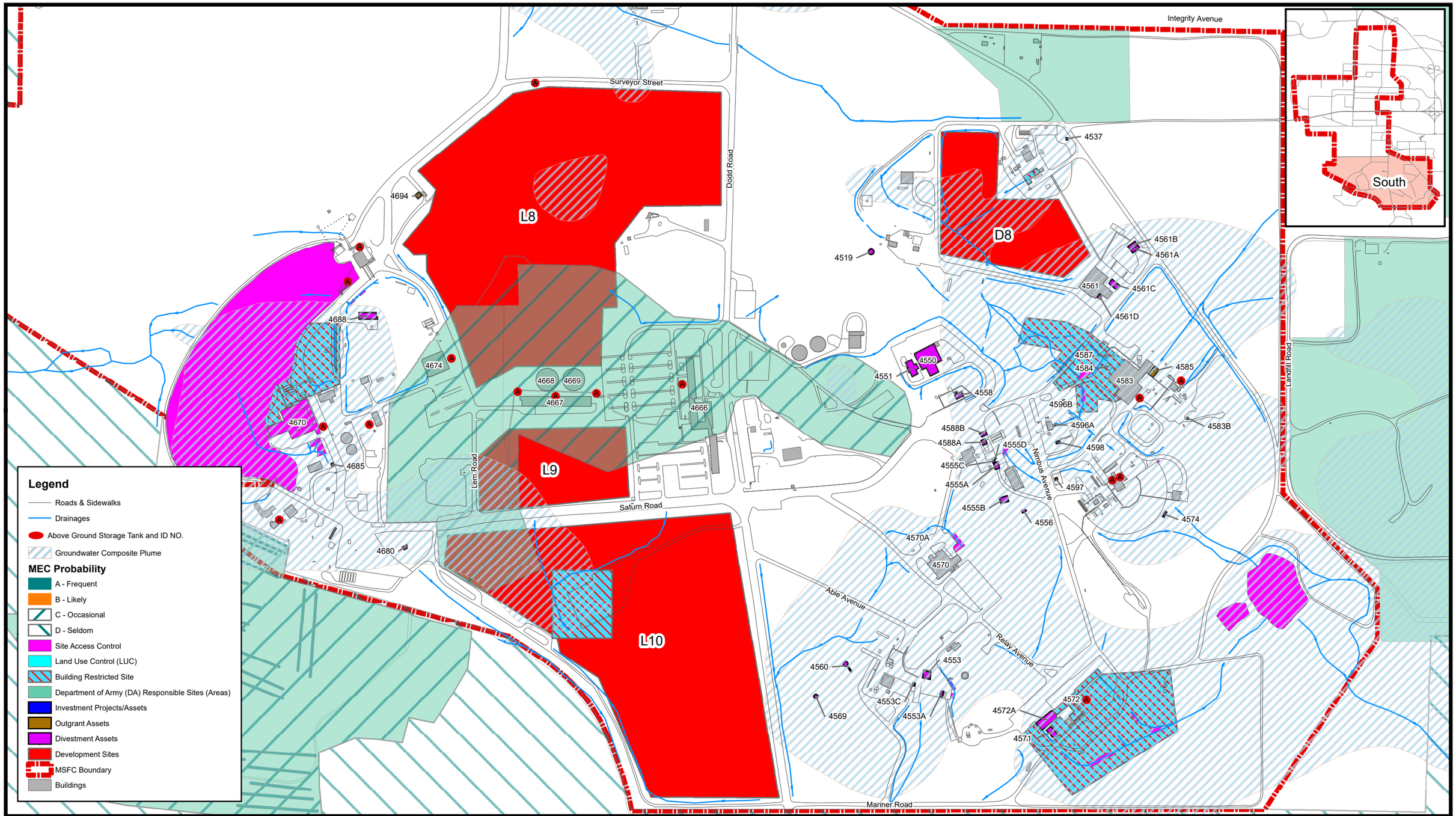
Map Document: G:\maps\EA\EA23\SW-DevSitesN-EnvAccess.mxd



11-Jan-2024
Drawn By:
D. Scott Stevens

Figure 3.14-1b Hazardous Materials Site-Wide Environmental Assessment Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM-EnvAccess.mxd



Legend

- Roads & Sidewalks
- Drainages
- Above Ground Storage Tank and ID NO.
- Groundwater Composite Plume

MEC Probability

- A - Frequent
- B - Likely
- C - Occasional
- D - Seldom
- Site Access Control
- Land Use Control (LUC)
- Building Restricted Site
- Department of Army (DA) Responsible Sites (Areas)
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

N W E S

0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

11-Jan-2024
Drawn By:
D. Scott Stevens

Figure 3.14-1c Hazardous Materials Site-Wide Environmental Assessment Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-EnvAccess.mxd

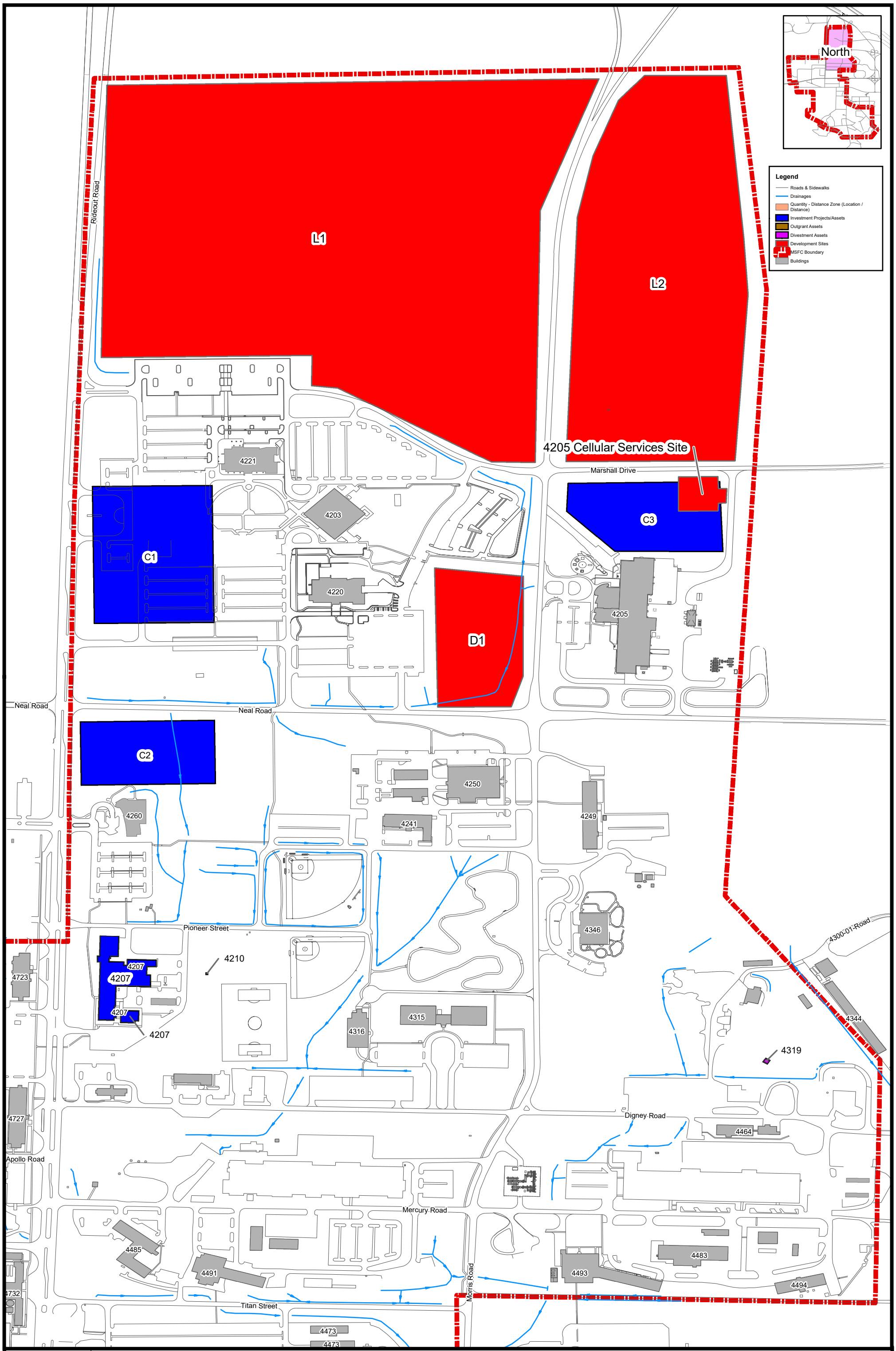
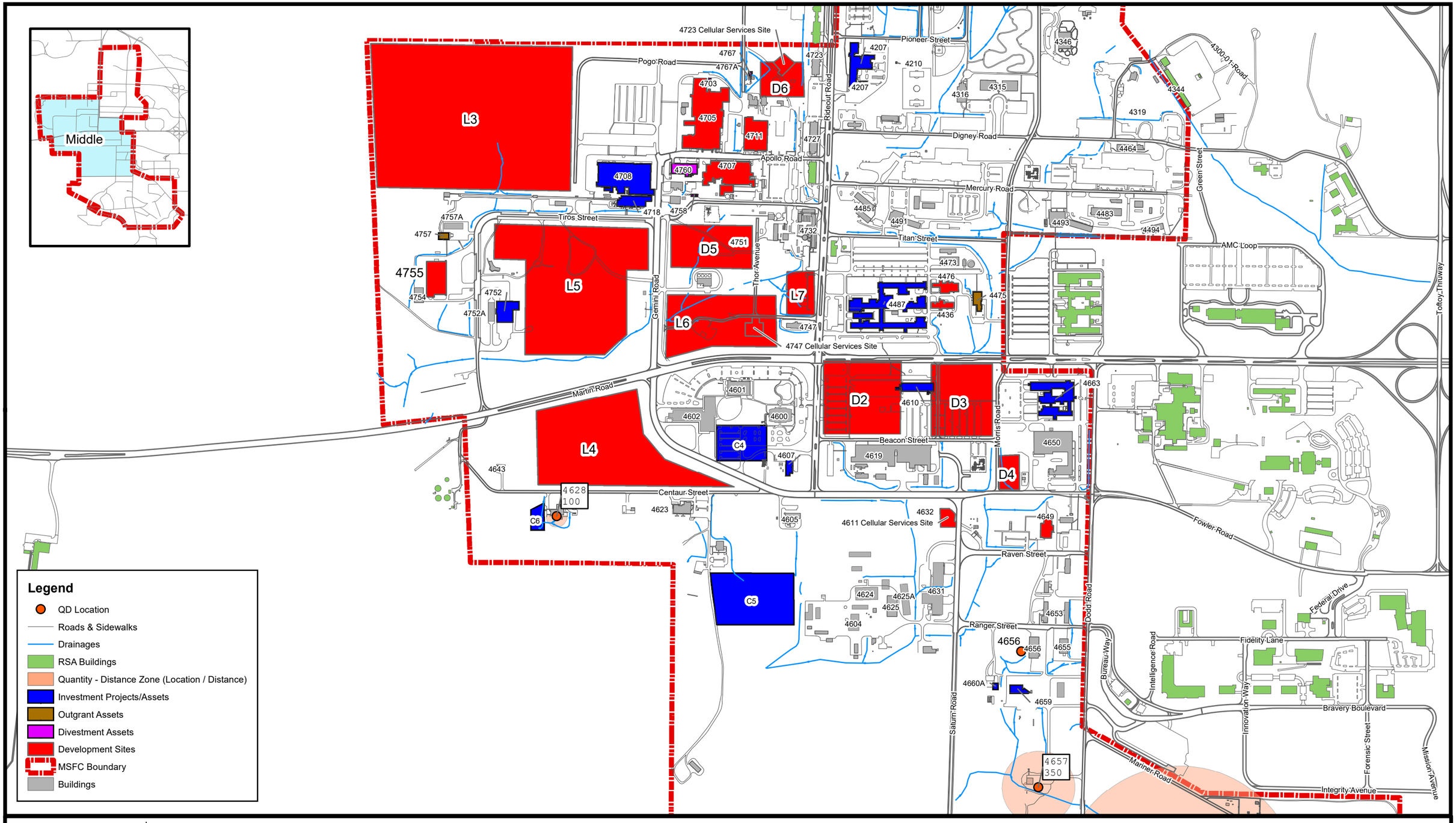


Figure 3.14-2a Quantity Distance Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

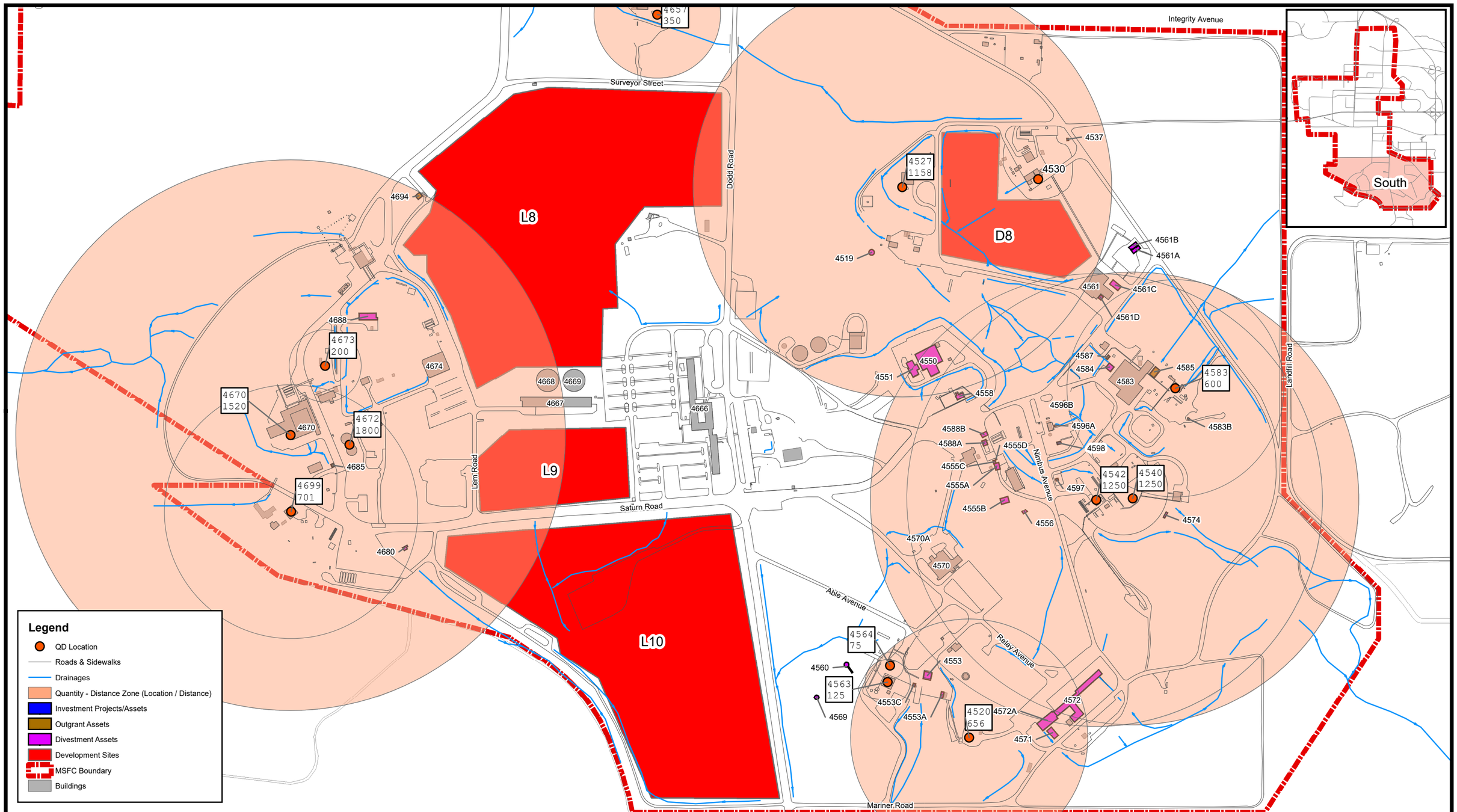
Map Document: G:\maps\EA\EA23\SW-DevSitesN-QD.mxd



20-Dec-2023
Drawn By:
D. Scott Stevens

Figure 3.14-2b Quantity Distance Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesM-QD.mxd



Legend

- QD Location
- Roads & Sidewalks
- Drainages
- Quantity - Distance Zone (Location / Distance)
- Investment Projects/Assets
- Outgrant Assets
- Divestment Assets
- Development Sites
- MSFC Boundary
- Buildings

0 250 500 1,000 1,500 Feet

0 100 200 400 Meters

20-Dec-2023
Drawn By:
D. Scott Stevens

Figure 3.14-2c Quantity Distance Zones
Site-Wide Environmental Assessment
Marshall Space Flight Center

Map Document: G:\maps\EA\EA23\SW-DevSitesS-QD.mxd

This page intentionally left blank.

Appendix A
MSFC Offices/Directorates and Responsibilities

This page is intentionally left blank.

Appendix A. MSFC Offices/Directorates and Responsibilities

Figure A.1. MSFC Organizational Chart

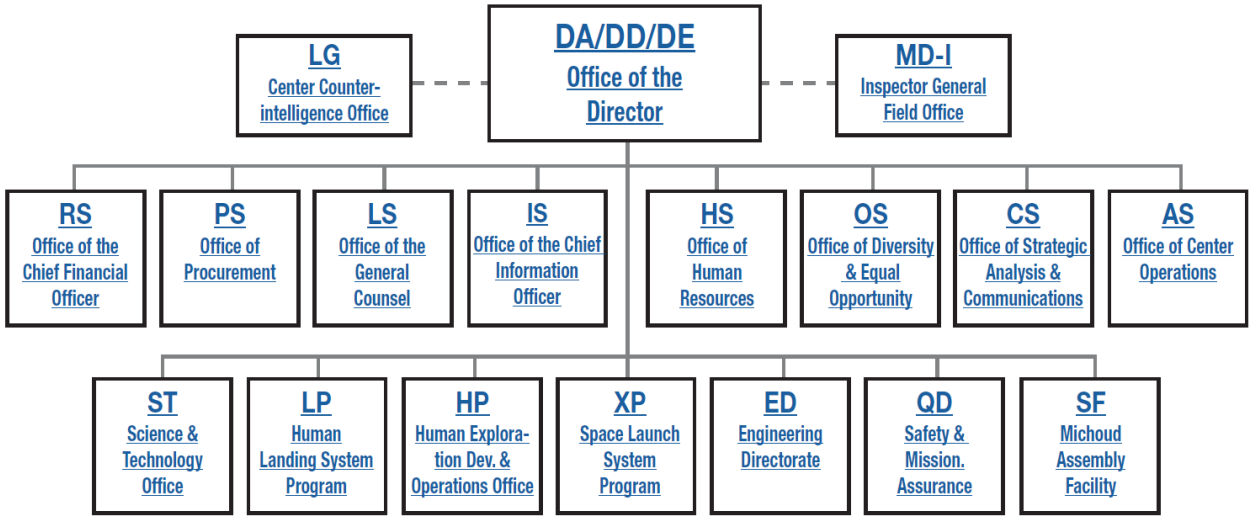


Table A.1 describes the general responsibilities of the offices/directorates currently established at MSFC.

Table A.1. Responsibilities of Offices/Directorates at MSFC

Office/Directorate	General Responsibilities
AS - Office of Center Operations	Design, operation, and maintenance of the total facility; environmental management and occupational health; occupational medicine; food services; acquisition, operation, and maintenance of both institutional and program support equipment; the full range of logistics support services; industrial labor relations; Marshall Space Flight Center (MSFC)-wide service agreements; protective services for personnel, property, and programs; and the Export Control Program for MSFC.
CS – Office of Strategic Analysis and Communications	Provides the integrated planning, analysis, and communications capability that enables MSFC to make sound decisions and better inform NASA stakeholders.
ED – Engineering Directorate	Establishes and directs MSFC's research and development capability for accomplishing engineering functions associated with the design, development, testing, evaluation, and sustaining engineering of assigned projects. The Engineering Directorate provides integrated, quality products and engineering services to NASA, other government agencies, and the commercial space development community.

Table A.1. Responsibilities of Offices/Directorates at MSFC

Office/Directorate	General Responsibilities
HP – Human Exploration Development and Operations Office	Manages and performs human-rated space projects and tasks, conducts mission and payload operations, and manages the Huntsville Operations Support Center primarily for NASA's Human Exploration and Operations Mission Directorate.
HS – Office of Human Resources	Develops and implements human capital strategies that will equip the MSFC with the capabilities for current and future success.
IS – Office of the Chief Information Officer	Technical leadership through the overall design, development, integration, and operation of MSFC and Agency IT systems/services; portfolio management, implementation, enhancement, and maintenance of Agency applications through the Agency Applications Office; IT security, planning, policy development, architecture, and governance; and compliance with MSFC, Agency, and federal policies and directives.
LP – Human Landing System Program Office	Development, technical integrity, cost and schedule performance, and safety and mission success of the Human Landing System
LS – Office of the General Counsel	Provide legal counsel and representation to all elements of MSFC, assuring that MSFC activities conform to applicable legal and policy requirements; and to administer the NASA Patent Program at MSFC.
OS – Office of Diversity and Equal Opportunity	Develop and administer a comprehensive program to ensure equal opportunity based on merit and fitness and with discrimination in the conduct of all operations at MSFC.
PS – Office of Procurement	Plan and administer for MSFC, a complete range of procurement from small purchases and small and minority business programs to major system contracts encompassing proposal solicitation and evaluation, negotiations, awards, administration, contract property management, and contract management in support of the procurement effort at MSFC, associated contractor plants, and other locations as designated.
QD – Safety and Mission Assurance Directorate	Plans, establishes, implements, and directs all safety and mission assurance programs for MSFC in-house and contracted activities to ensure compliance with program/project requirements and controls.
RS – Office of the Chief Financial Officer	Provide financial integrity of NASA MSFC programs, projects, and institutional resources by developing, implementing, and monitoring OCFO policies, processes, and systems that ensure sound planning and execution, program analysis and evaluation, accounting, and internal controls.
SF – Michoud Assembly Facility	The Directorate plans establishes, implements, and directs all utilization, operations, and maintenance of the Michoud Assembly Facility in New Orleans, Louisiana.

Table A.1. Responsibilities of Offices/Directorates at MSFC

Office/Directorate	General Responsibilities
ST – Science and Technology Office	Leads, manages, and performs science and technology investigations, programs, projects, and activities in support of NASA's scientific, technology, and exploration goals.
XP – Space Launch System Program Office	Activities associated with launch system hardware development and integration, including: propulsion systems, to include Core Stage and Upper Stage Engines, Boosters, and Stages (Core Stage and Upper Stage, their associated main propulsion systems, and vehicle avionics and control systems); the Interim Cryogenic Propulsion Stage; and spacecraft and payload integration, to include fairing development, payload adapter development, and the integration of the Multi-Purpose Crew Vehicle, as well as any other payloads; and identifying and prioritizing upgrades to evolve the launch vehicle as required by future exploration missions.

1

This page is intentionally left blank.

Appendix B
Public Engagement

[Note: Any responses received during the 30-day public comment period will be included once received.]

This page is intentionally left blank.

Appendix C
MSFC Activities Covered by Categorical Exclusions or Previous NEPA Analysis

This page is intentionally left blank.

Appendix C. MSFC Actions Covered by CatEx or Prior NEPA Documents

C.1 Obtaining NEPA Coverage at MSFC

National Aeronautics and Space Administration (NASA) Procedural Requirement (NPR) 8580.1, NASA National Environmental Policy Act Management Requirements, and Executive Order (EO) 12114, "Environmental Effects Abroad of Major Federal Actions" require the Program or Project to ensure that the National Environmental Policy Act of 1969 (NEPA) process is integrated into their organization's planning activities at the earliest practicable time. Program, Project, and Facility Managers should contact the Environmental Engineering Office to start the implementation of the NEPA process. The scope of the proposed action or activity and the context and intensity of any environmental effects expected to result from the proposed action or activity will determine the level of NEPA documentation required. Marshall Space Flight Center's (MSFC's) NEPA Preliminary Evaluation Checklist is provided at the end of Section C.1. There are three documentation options for the NEPA process: Categorical Exclusion (CatEx), Environmental Assessment (EA), and Environmental Impact Statement (EIS).

In accordance with the Council on Environmental Quality regulations (*Code of Federal Regulations* [CFR] Title 40, Parts 1500 et seq.), NASA has created criteria defining categories of actions that have been found not to produce significant environmental effects. These actions are "categorically excluded" from requirements to prepare an EA or EIS. The use of a CatEx is intended to reduce paperwork, improve government efficiency, and eliminate delays in the initiation and completion of proposed actions having no significant impact. A proposed action may be categorically excluded if the action fits within a category of actions eligible for exclusion, as listed in paragraph D of 14 CFR Subpart 1216.304, and the proposed action does not involve any extraordinary circumstances, as described in paragraph C of 14 CFR Subpart 1216.304. Note that the CatEx citations included in this appendix are current as of the time of publication of this EA; however, these may change with future updates to 14 CFR Subpart 1216.304. Please consult the MSFC NEPA Program Manager to ensure the current and appropriate CatEx is applied.

Agency and Center activities that have been determined not to affect the human environment, or are categorically excluded, will be documented in a Record of Environmental Consideration (REC) (AS10-OI-010 Record of Environmental Consideration and Design Reviews). The primary purpose of an EA is to evaluate the environmental effects of a proposed action or activity and to determine whether an EIS must be prepared. If the analyses in the EA support the conclusion that no significant impacts would occur, a Finding of No Significant Impact (FONSI) is documented. If significant impacts could occur as a result of implementing the action, a Notice of Intent (NOI) to prepare an EIS is issued and preparation of the EIS begins. The final document for the EIS process is a Record of Decision (ROD).

If an action or activity will result in the release, or potential release, of large quantities of pollutants such as rocket exhaust gases, exotic materials, or radioactive substances, an EIS will be prepared and the EA process is unnecessary. The environmental analyses should be focused on the preparation of the EIS. Relevant project documentation should recognize the applicability of this requirement from the earliest planning, an NOI to prepare an EIS should be published, and the remainder of the EIS process should be initiated as soon as possible.

Even though an action might be categorically excluded from the need for a formal EA or EIS, it is not excluded from the requirement for an environmental analysis conducted during the earliest planning phases. NPR 8820.2G, Facility Project Requirements (FPR), requires an Environmental Analysis (EVAL) to determine if circumstances exist in which a normally excluded action might have an effect on the

environment. If no significant effects are identified, then the environmental review process is complete and a REC is prepared. However, if the analysis shows that the action deviates from the criteria for exclusion, an EA must be initiated. On the basis of that assessment, a determination must then be made as to whether to prepare an EIS. The environmental review process for proposed NASA actions is complete when:

- A REC is completed that demonstrates that no significant effects will occur and the project, action, or activity meets the criteria for a CatEx;
- A FONSI is issued based on an adequate and accurate EA indicating that no significant effect on the human environment will occur; or
- A ROD has been issued based on the EIS.

Specific guidelines and documentation of CatExs, evaluation of project effects, and procedures for preparing EAs and EISs are included in NPR 8580.1A. In addition, NASA policies regarding overall environmental management are outlined in NASA Policy Directive (NPD) 8500.1C, NASA Environmental Management. This directive states that NASA will comply with all regulatory requirements and EOs in the operation and management of MSFC.

NEPA Preliminary Evaluation Checklist

Project Name: _____

Project Type: ☐ **Facilities Construction** ☐ **Facilities Modification** ☐ **Program/Project** ☐ **Program/Project Modification**

Project Contact(s): _____

Project Description:

Originator Signature: _____ **Phase Starts in FY:** _____

Construction Phase	Yes	No	Maybe	Comments
a) Potential to impact site infrastructure	☐	☐	☐	
b) Requires use or storage of toxic or hazardous materials	☐	☐	☐	
c) Will generate hazardous, toxic or radiological wastes	☐	☐	☐	
d) Generate significant solid waste	☐	☐	☐	
e) Potential air impacts	☐	☐	☐	
Causes air pollution or have discharges to air	☐	☐	☐	
Uses Class I ozone-depleting substances	☐	☐	☐	
Causes greenhouse gas emissions	☐	☐	☐	
Climate change	☐	☐	☐	
f) Potential to impact biological	☐	☐	☐	
Vegetation	☐	☐	☐	
Wetlands	☐	☐	☐	
Floodplains	☐	☐	☐	
Wildlife	☐	☐	☐	
Threatened and Endangered Species	☐	☐	☐	
g) Potential to Impact Cultural or Historic Resources	☐	☐	☐	
h) Potential Water Impacts	☐	☐	☐	
Requires New Clean Water Act Permit or Modification	☐	☐	☐	
Causes water pollution or have water discharges	☐	☐	☐	
Potential to impact quality of groundwater	☐	☐	☐	
i) Potential impact to geology and soils	☐	☐	☐	
Potential to impact geology	☐	☐	☐	
Potential to cause soil contamination	☐	☐	☐	

NEPA Preliminary Evaluation Checklist

Construction Phase	Yes	No	Maybe	Comments
Impacts a CERCLA restricted site	☐	☐	☐	
j) Potential to violate safety, health or noise standards	☐	☐	☐	
k) Requires the use of radiation (ionizing or non-ionizing)	☐	☐	☐	
l) Requires the use of pesticides, herbicides, fungicides, etc.	☐	☐	☐	
m) Potential exposure to asbestos or lead containing materials	☐	☐	☐	
n) Potential to have transportation impacts (new roads, traffic, parking)	☐	☐	☐	
o) Significant increase in labor force	☐	☐	☐	
Operational Phase	**Yes**	**No**	**Maybe**	**Comments**
a) Requires use or storage of toxic or hazardous materials (including propellants and explosives)	☐	☐	☐	
b) Will generate hazardous, toxic or radiological wastes	☐	☐	☐	
c) Generate significant solid waste	☐	☐	☐	
d) Potential air impacts	☐	☐	☐	
Causes air pollution or have discharges to air	☐	☐	☐	
Requires New Air Permit or Title V Modification	☐	☐	☐	
Uses Class I ozone-depleting substances	☐	☐	☐	
Causes greenhouse gas emissions	☐	☐	☐	
Climate Change	☐	☐	☐	
e) Potential to impact biological resources	☐	☐	☐	
Vegetation	☐	☐	☐	
Wetlands	☐	☐	☐	
Floodplains	☐	☐	☐	
Wildlife or Marine Species	☐	☐	☐	
Threatened and Endangered Species	☐	☐	☐	
Critical Habitat	☐	☐	☐	
f) Potential to Impact Cultural or Historic Resources	☐	☐	☐	
g) Potential Water Impacts	☐	☐	☐	
Requires New Clean Water Act Permit or Modification	☐	☐	☐	
Causes water pollution or has water discharges	☐	☐	☐	
Significant increases in use of potable water	☐	☐	☐	
Potential to impact quality of groundwater	☐	☐	☐	

NEPA Preliminary Evaluation Checklist

Operational Phase	Yes	No	Maybe	Comments
Requires use of groundwater	☐	☐	☐	
h) Potential impact to geology and soils	☐	☐	☐	
Potential to cause soil contamination	☐	☐	☐	
Impacts a CERCLA restricted site	☐	☐	☐	
i) Potential to violate safety, health or noise standards	☐	☐	☐	
j) Requires the use of radiation (ionizing or non-ionizing)	☐	☐	☐	
k) Requires the use of pesticides, herbicides, fungicides, etc.	☐	☐	☐	
l) Potential exposure to asbestos or lead containing materials	☐	☐	☐	
m) Significant increases in energy consumption	☐	☐	☐	
n) Potential to have transportation impacts (new roads, traffic, parking)	☐	☐	☐	
o) Potential to impact air space or air traffic	☐	☐	☐	
p) Significant increase in labor force	☐	☐	☐	
q) Impacts community socioeconomics	☐	☐	☐	
r) Potential to disproportionately impact low income or minority populations	☐	☐	☐	

C.2 MSFC Actions Covered by CatEx or Prior NEPA Documents

Many of the actions described under the Proposed Action would qualify for a CatEx. Additionally, some actions described under the Proposed Action have already been evaluated under previous NEPA analyses and would not require a separate evaluation.

C.2.1 Operational Missions and Activities

Operations at MSFC are program- and project-driven and can change from year to year as missions evolve or change. Anticipated operations at MSFC would include, but not be limited to, the following Artemis and Mars Forward system developments. More information on MSFC missions is on the NASA Marshall Missions webpage (https://www.nasa.gov/marshall-space-flight-missions/). A timeline of human space exploration activities at MSFC in shown on Figure C-1.

C.2.1.1 Advanced Space Transportation Systems

Advanced Space Transportation Systems activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3).

Under the Artemis program, MSFC is collaborating with commercial and international partners to establish the first long-term presence on the Moon with the Artemis Base Camp on the lunar surface, and the Gateway in lunar orbit. MSFC personnel provide systems engineering, research, and subject matter expertise; and are responsible for developing, testing, and delivering human-rated landers for the Artemis Program which will ferry astronauts to the Lunar surface. Advanced space transportation systems that MSFC is currently leading include the following: Sustaining Lunar Development (SLD) Appendix P to NASA's Next Space Technologies for Exploration Partnerships Un-crewed, Human Lander System (HLS) Option A Crewed, SLD Option B Crewed, SLD Appendix P Crewed, Sustaining Lunar Transport (SLT) Crewed/Cargo, SLT Crewed/Large Cargo Medium Sized Lander, Cryogenic Tug/Depot, Chemical Propulsion Stage, Mars Transit Vehicle, and Mars Lander Cargo/Human.

MSFC houses a comprehensive set of testing facilities for propulsion systems as part of the Advanced Space Transportation Systems programs. All test facilities are located in the southern portion of MSFC. Operation of the Propulsion Research Laboratory at MSFC is covered under the *Environmental Assessment for Marshall Space Flight Center Propulsion Research Laboratory* (NASA 2002). Table C-1 describes the locations, engines/components, and propellants associated with propulsion testing that are covered under prior NEPA analyses. The environmental impacts of propulsion testing described in Table C-1 were analyzed in the *Solid Propulsion Test Bed (SPTB) Environmental Assessment* (NASA 1989), the *Final Environmental Impact Statement of Engine Technology Support for NASA's Advanced Space Transportation Program* (NASA 1997), and the *Environmental Assessment of Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center* (NASA 2010). These EAs and EIS can be found in NASA's NEPA Library (https://www.nasa.gov/emd/nepa-library/). Therefore, propulsion testing described in Table C-1 is not analyzed in this EA since the analysis in the aforementioned NEPA documents remains valid.

Table C-1. Propulsion Testing at MSFC with Prior NEPA Coverage

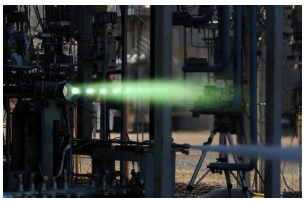
Location	Maximum Size Engine/Components Housed	Propellants/Pressurants Used
Building 4670 Advanced Engine Test Stand 	75,000-pound thrust class engine or components Blue Engine-4 – 55,000-pound thrust Blue Engine -3 – 125,000-pound thrust Capable of evaluating full-scale and vehicle state systems.	LOX LH2 Liquid methane RP1 Gaseous helium Gaseous hydrogen
Building 4583A, Test Facility 115 	10,000-pound thrust class engine or components Designed for testing small-scale combustion devices including injectors, combustion chambers, and nozzles.	LOX LH2 Liquid methane Gaseous hydrogen RP1
Building 4540, Test Facility 116 	75,000-pound thrust class engine or components 30,000-pound thrust solid rocket motors Designed for testing high-pressure engines/systems, cryogenic propellant systems, combustion devices, and acoustic models.	LOX LH2 Liquid methane Gaseous hydrogen Gaseous nitrogen RP1
Building 4530, Test Facility 300	5-position stand with capability to simulate launch thermal and pressure profiles and high-altitude testing for LOX/LH_2 and LOX/RP1 engines.	LOX LH2 RP1
Solid Propulsion Test Area (SPTA)	48-inch-diameter, 100,000-pound thrust solid rocket motor Small thrusters or RDRE-type engines or components Designed for testing nozzle insulation, case insulation, fuel cartridge inhibitors, and propellant grains.	RP1 Hydrogen peroxide HTPB
Test cells at Building 4583; SPTA	7,500-pound thrust class solid or hybrid motor	Gaseous oxygen HTPB
Building 4626, LH2 Cold Flow Facility	Low-pressure flow tests of hydrogen engine and subsystem components	LH2 Liquid Hydrocarbons Gaseous Hydrogen Gaseous Helium Gaseous Nitrogen Gaseous oxygen Missile Grade Air

Table C-1. Propulsion Testing at MSFC with Prior NEPA Coverage

Location	Maximum Size Engine/Components Housed	Propellants/Pressurants Used
Building 4554, Hot Gas Test Facility	Hydrogen/air combustion-driven environmental test facility capable of generating flow speeds up to Mach 4 and high heating rates to test materials and coatings.	Gaseous Hydrogen Gaseous Nitrogen Missile Grade Air

Source: NASA 1989, 1997, 2010
HTPB = hydroxyl-terminated polybutadiene
LH2 = liquid hydrogen
LOX = liquid oxygen
RDRE = rotating detonation rocket engine
RP1 = Refined Petroleum One
SPTA = Solid Propulsion Test Area

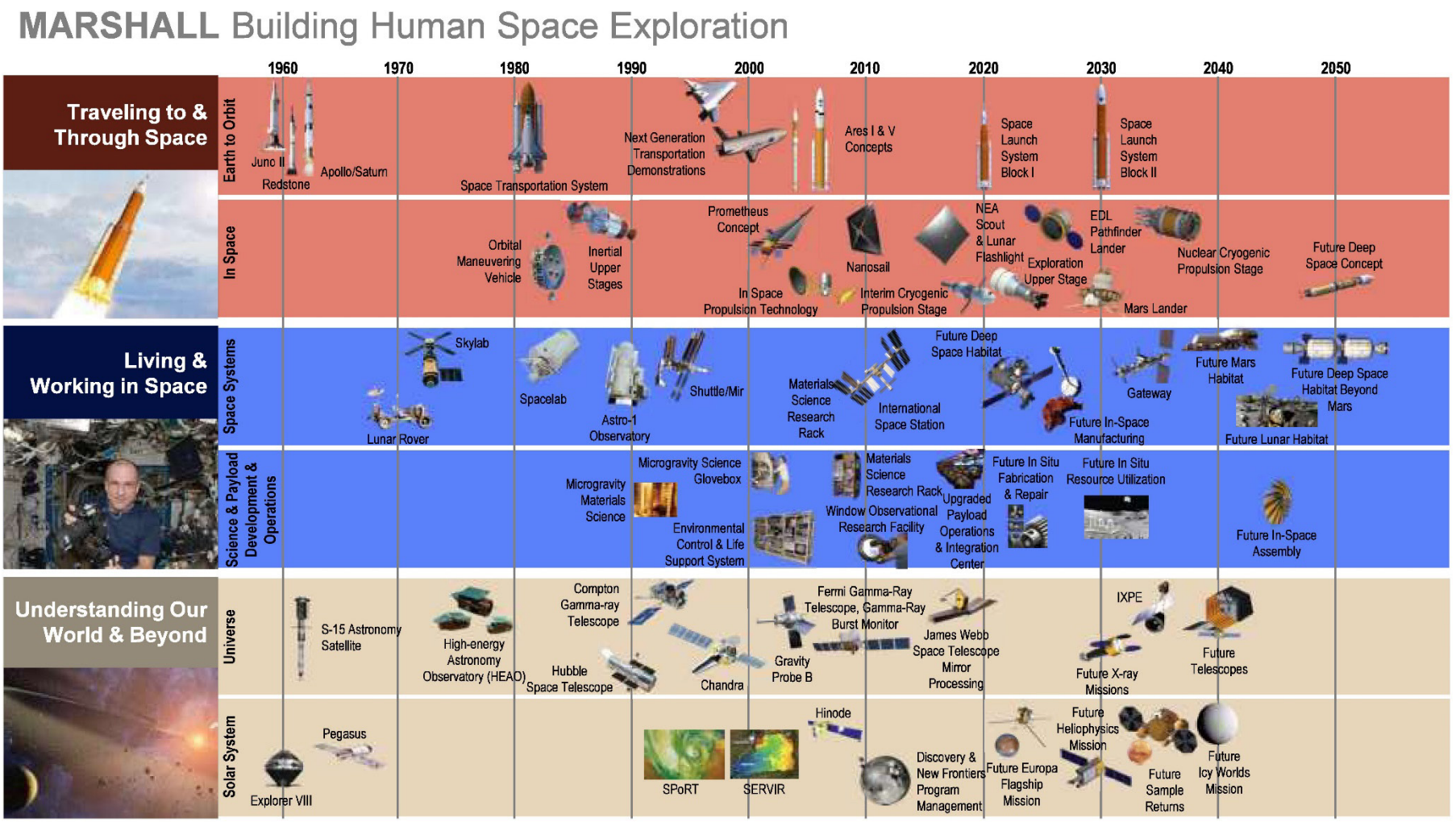


Figure C-1. Timeline of Human Space Exploration Activities at MSFC

The Cryostructural Test Facility is ideal for evaluating the structural integrity of tanks and other propulsion components under a variety of conditions using compression, sheer, and tension loads (NASA 2021).

The Hydrogen Cold Flow Facility is designed for low pressure (≤ 50 pounds per square inch gauge) flow tests of hydrogen engine and subsystem components (NASA 2021).

The Solar-Thermal Test Facility is capable providing 1-megawatt-per-square-meter solar power in a high vacuum environment. The Environmental Test Facility, TS300, is capable of simulating ascent launch profiles and deep space vacuum for cryogenic fluid management. Testing includes loading cryofuels and managing in space full-scale propulsion systems, cryogenic subsystems, and super-insulated LH_2 tanks (NASA 2021).

The Hot Gas Facility provides thermal wind tunnel test capability for thermal protection systems. Various cryogenic fluid management tests are conducted at Test Stand 300, typically with liquid nitrogen. The West Test Area is being used for cryo-structural testing for SLS and has also been used in the recent past for flight research of the small "Mighty Eagle" lander (NASA 2017).

C.2.1.2 Lander Systems

Lander Systems activities at MSFC (https://www.nasa.gov/reference/marshall-lander-systems/) would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3).

MSFC responsibilities involve oversight activities associated with human landing systems hardware development, integration, and flight demonstration, performing risk reduction activities, and identifying and prioritizing upgrades to evolve the human landing systems to support sustainable future exploration missions. Working closely with engineering directorates across the Agency, MSFC personnel are responsible for the integrated lander configuration, integrated lander requirements, verification, validation, interfaces, and flight readiness certification. The lander systems that MSFC is currently leading are Lunar Landers (Crew and Cargo), Mars Cargo Landers, and Mars Human Landers.

C.2.1.3 Space Launch Systems

Space Launch Systems activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(2) or 14 CFR Subpart 1216.304(d)(3).

MSFC oversees the SLS rocket which is the rocket on which the Orion spacecraft will take payloads and astronauts to the Moon for the Artemis program. MSFC was responsible for the design, development, testing, and manufacturing of the rocket, which is designed to send more payload to the Moon than any existing rocket to help NASA establish a long-term presence to prepare for human missions to Mars. SLS rockets for future Artemis missions are currently being manufactured at NASA's Michoud Assembly Facility in New Orleans, which MSFC manages. Actions at NASA's Michoud Assembly Facility will be analyzed in a separate site-wide EA for the Michoud Assembly Facility. MSFC personnel are responsible for leading and performing ground support of flight operations for payloads and missions, including concept development; analysis and development of operations requirements for ground systems; planning and preparing operations; implementing mission support systems; and conducting ground operations. MSFC's SLS Program Office is responsible for SLS hardware and future capabilities. The Space Launch Systems that MSFC is currently leading are SLS Block 1 Crew, SLS Block 1B Crew/Orion, SLS Block 2 Crew, SLS Block 2 Cargo. MSFC will utilize SLS Block 2 Crew/Orion and Block 2 Cargo to expand Lunar/Martian architecture concepts to reduce cost, increase cadence, and broaden utilization. Potential advanced cargo versions of SLS will carry more than double the volume of any contemporary heavy lift vehicle, enabling large habitats, telescopes, and more.

NASA's Constellation Program, which is a coordinated effort to provide the necessary flight systems and Earth-based ground infrastructure required to enable continued access to space and enable future crewed missions to the ISS, the Moon, Mars, and beyond, has NEPA coverage under the *Final Constellation Programmatic Environmental Impact Statement* (NASA 2008).

C.2.1.4 Surface and Technology Systems

Surface and Technology Systems activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3).

MSFC's Surface Technologies and Systems Business Unit was built to align with NASA's Space Technology Mission Directorate and the lunar surface innovation initiatives for development efforts of Artemis and Mars Forward. MSFC is building foundational technology solutions, skills, and capabilities for a sustained lunar presence that feeds to Mars through technology development demonstrations, risk reduction, and mission infusion. High-priority technology areas of interest centers around dust mitigation, extreme environments/survive the night, autonomy and mobility support, In-Situ Resource Utilization (ISRU) for propellant, manufacturing, and construction, and in-space/surface manufacturing and construction.

C.2.1.5 In-Space and Surface Mission Operations

In-Space and Surface Mission Operations activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(1) or 14 CFR Subpart 1216.304(d)(2).

Since the Apollo missions, MSFC has led NASA's In-space and Surface Mission Operations and will serve as the main point of contact for all future low-Earth orbit and cis-lunar payload missions. MSFC is maintaining and developing skills/capabilities in the operations area to direct the infusion of integrated robotic and human operations for science for the Artemis program and Mars Forward. MSFC currently supports the ISS 24 hours a day, 365 days a year, through its Payload Operations Integration Center. MSFC coordinates and integrates all ISS science, commercial experiments, and Earth-to-station science communications. The payload operations team partners with control centers and science partners worldwide to plan and monitor science activities, downlink data, and manage the use of in-orbit resources. NASA-funded missions, Other Government Agency payloads, and commercial partnerships of In-Space and Surface Mission Operations that MSFC is leading include the following: ISS Payload Operations Integration Center, GW I-Habitat, CLD/Orbital Reef, CLD/Starlab, CLD/Northrup Grumman, Relocatable Surface Habitat, Pressurized Rover, CubeSpark, MoonBEAM, Lunar/Surface Habitat, Lunar constructed Habitat, Transit Habitat @ GW, Integrated Mars Transit, Mars Relocatable Surface Habitat, Mars Surface Habitat.

The Payload Operations Integration Center at MSFC (Source: NASA 2016)

C.2.1.6 Technology

Technology activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3).

MSFC's Science and Technology office leads, manages, and performs science and technology investigations, programs, projects, and activities in support of NASA's scientific, technological, and exploration goals. MSFC employees and external partners identify novel solutions to evolving NASA challenges such as lunar thermal design challenges with surviving the lunar night; navigation on the Moon without the use of a Global Positioning System (GPS); and fundamental materials advancement for mechanisms in the lunar environment. The Technology development at MSFC has also led to achieving the most significant breakthroughs in chemical propulsion in decades, the development of the rotating detonation rocket engine. Technology that MSFC is poised to lead includes the following: Propulsion Systems (Nuclear Thermal Propulsion, Advanced Propulsion Technology Development, Liquid Propulsion Technology and Development, Propulsion Industrial Base Sustainment, Propulsion Testing, Solid Propulsion Technology and Development, etc.); Power and Energy Storage; Robotic Systems; Human Health, Life support, and Habitation Systems; Entry, Descent, and Landing; Software, Modeling, Simulation, Information Technology; Ground Test and Surface Systems; Thermal Management Systems (NASA 2022).

C.2.1.7 Science

Science activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3).

MSFC scientists conduct a wide spectrum of space science research seeking to better understand the universe and to unlock scientific mysteries that will improve and protect life on Earth and keep space crews safe as they travel in space, explore the Moon, and journey deeper into the solar system. MSFC scientists support SERVIR, the Earth Science Office, the Astrophysics Office, the Heliophysics and Planetary Science Office, and NASA Short-term Prediction Research and Transition Center. MSFC also continues to support the Chandra X-Ray Observatory, the world's most powerful X-ray telescope. MSFC's Science development for Artemis and Mars Forward is motivated by bidding on and winning proposal solicitations. Development areas and missions where MSFC continues to invest in science discoveries include High Energy Astrophysics, Lightning, Science Management, Lunar Surface Processes, Lunar Interior, Data Science, Solar Coronal Heating, Space Weather, and Neutron Detectors. The following opportunities will be a focus of the Science Business Unit at MSFC: Astrophysics Probes Announcement of Opportunity (AO), Astrophysics Small Mission Explorer AO, Astro Pioneer AO, Commercial Lunar Payload Services AO, Heliophysics Small Mission Explorer AO, Earth Venture AO, New Frontiers AO.

C.2.1.8 Industry and Other Government Organizations

Industry and Other Government Organization activities at MSFC may qualify for a CatEx under 14 CFR Subpart 1216.304(d)(1)(vi), 14 CFR Subpart 1216.304(d)(1)(vii), or 14 CFR Subpart 1216.304(d)(2)(iii). Industry partners and other governmental organizations would be required to coordinate with MSFC environmental staff to ensure they have coverage under NEPA before proceeding with any activities.

C.2.2 Routine/Recurring Actions

C.2.2.1 Materials and Manufacturing

Materials and manufacturing activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(3)(i).

Materials and manufacturing activities at MSFC includes large-scale manufacturing, additive manufacturing, materials diagnostics and fracture/failure analysis, and materials technology and development.

Large-scale manufacturing: Marshall researches, designs, develops, tests and evaluates new processes to be implemented by our contractor partners during production, using both cutting-edge hardware and digital design optimization solutions.

Additive manufacturing: Marshall is advancing cutting-edge commercial capabilities in additive and digital manufacturing and applying them to aerospace challenges. Propulsion system development requires new, more affordable manufacturing techniques and technologies in a constrained budget environment, while future in-space applications will require in-space manufacturing and assembly of parts and systems. The Center is developing the standards by which new manufacturing processes and parts will be tested and qualified. Marshall houses a complete suite of digital manufacturing and support capabilities, including Structured Light Scanning, Non-Destructive Evaluation, Manufacturing Simulation, Manufacturing Planning and Execution, and inspection and machining technologies. The expertise and software available at Marshall can provide virtual fit checks, predict the buildup of material on a surface, reverse engineering, kinematic analysis, and much more.

Materials diagnostics and fracture/failure analysis: Marshall's materials diagnostics, damage tolerance, and failure analysis capabilities ensure crew safety and mission success throughout the service life of spaceflight vehicles, habitation modules, and propulsion systems. This extends down to the component and subcomponent level, including core materials, coatings, and hardware, as well as the manufacturing processes to deliver them. Marshall has unique expertise and in-house knowledge to correlate advanced fracture analysis with hardware tests, as well as a full complement of non-destructive evaluation (NDE) techniques, technologies, and test facilities. Marshall has extensive experience in conducting damage tolerance testing (fatigue and fracture testing) of critical NASA and industry hardware and processes, proving hardware and materials for space shuttle and supporting development of the latest next-generation vehicles and space systems. The Center frequently is called upon by Agency and industry partners to perform custom NDE inspections of hardware and vehicles, including test articles and elements for Space Launch System (SLS), next-generation Cryogenic Propellant Storage and Transfer, and ISS hardware. Marshall also partners with industry, supporting NDE evaluations for ATK, Aerojet Rocketdyne, Blue Origin, Boeing, Dynetics, Lockheed Martin, and other industry partners.

Materials technology and development: In order to ensure the affordability, reliability and strength and minimize the mass of space launch and space system elements, designers must identify and qualify the optimal materials for use, as well as the processes to be applied during manufacturing. Marshall is home

to a full-service materials research, development and manufacturing laboratory, including more than a dozen critical test facilities and a complementary suite of tools to evaluate chemical and microstructural characteristics, mechanical and fatigue properties, tribological and corrosion effects, and the influence of extreme temperature and pressure environments. Marshall offers a comprehensive program for replacement of thermal protection system materials that have become obsolete due to loss of suppliers, environmental regulations or changes in the manufacturing process. The program analyzes the impact of a change in materials, develops programs to demonstrate equivalence to prior materials and evaluates the capability and performance of newly developed materials.

C.2.2.2 Maintenance and Improvements

Maintenance and improvement activities at MSFC would qualify for a CatEx under 14 CFR Subpart 1216.304(d)(2)(i); therefore, these activities were not carried forward for analysis in Section 3 of the EA.

Maintenance and improvement projects would include continuing routine repairs and maintenance of all MSFC facilities and equipment. Activities would include, but not be limited to, the following:

- Operations and maintenance of all MSFC facilities
- Building Automation Systems
- Repair/Replacement-in-Kind Indefinite Delivery Indefinite Quantity (IDIQ) – IDIQ is a federal contract type that provides for an indefinite quantity of supplies or services during a fixed period.
- Wastewater Treatment Facility Operations
- De-ionized Water Operations
- Overhead Crane Operations
- Heavy Equipment Operations
- Repairs
- Project Management of Facility Work Requests for Modifications/Alterations (< $1 million)
- Budgeting
- Installation
- Maintenance and Repair Inspection Services
- Asbestos Abatement (operations and maintenance related only)
- Contracting Officer Representative (custodial services, Utility Control Systems Operations and Pressurants and Propellants Distribution, etc.)
- Facility Condition Assessment Program Management
- Backlog of Maintenance and Repair Program Management – Internal deferred maintenance (e.g., roof and window replacements, elevator repair, etc.) that is completed as funding becomes available.

Appendix D
MSFC Real Property Assets and Projects

This page is intentionally left blank.

Appendix D. MSFC Real Property Assets and Projects

Table D-1. Planned Sustainment Projects of Historic Buildings at MSFC

Project	Description	NRHP Eligibility[a]
Buildings 4718-1, 4718-2, 4718-3	X-Ray and Cryogenic Support Facility.	Eligible
Building 4540	Test Facility 116 (TF116) (Acoustics Position)	Eligible as a contributor to the Test Stand District
Building 4347	Automated Lunar and Meteor Observatory. Has also historically been called Solar Magnetograph Facility	Not eligible
Building 4554	Hot Gas Test Facility	Eligible as a contributor to the Test Area Historic District
Building 4436	Hardware Simulation Laboratory. Has also historically been called SSME [Space Shuttle Main Engine] – HSL [Hardware Simulation Laboratory] Block II Facility	Eligible
Building 4619	Structures, Dynamics & Thermal Vacuum Laboratory	Eligible
Building 4705	Multi-Purpose High Bay Facility	Eligible – Neutral Buoyance Simulator in Building 4705
Building 4707	National Center for Advanced Manufacturing	Eligible
Building 4476	Marshall Avionics Systems Testbed. Has also historically been called Optical Vertical Test Facility	Eligible
Building 4665B	Historic Redstone Test Site Bunker	Eligible
Building 4665	Historic Redstone Test Site. Has also historically been called Redstone Rocket Test Stand	National Historic Landmark
Building 4666	Office Building. Has also historically been called Test Division Engineering Building. The Southern Wing (first floor and the southern wing of the second floor) has been leased to Blue Origin for 20-years as of September 2023. NASA retains ownership and occupancy of the rest of the Office Building	Eligible
Building 4775	High Reynolds Number Facility	Not eligible

[a] Panamerican Consultants, Inc., 2023

Table D-2. Investment Assets at MSFC

Project	Description	NRHP Eligibility[a]
Building 4487	Laboratory and Office building	Not eligible
Building 4708	Engineering and Development Laboratory	Not eligible
Building 4663	Huntsville Operations Support Center (HOSC), International Space Station Flight Payload Operations, and the NASA-wide Automated Data Processing Consolidation Center (NACC)	Eligible

Project	Description	NRHP Eligibility[a]
Building 4610	Office and Engineering Building. This building serves the HOSC/NACC	Not eligible
Gaseous Nitrogen System	High Pressure Gaseous Nitrogen Facility (Building 4659), Nitrogen Gas Storage Facility/Nitrogen Gas Ready Storage Battery (Building 4598), Ambient Air Vaporizers (Building 4660A)	Not eligible
Building 4718	X-Ray Calibration Facility	Eligible
High Pressure Air System	High Pressure Air Storage (Building 4751), Central Air Station (Building 4607), Bottle Battery (Building 4632), High Pressure Air Piping (Buildings 9921 and 9993), High Pressure Air Storage Near 4752 (Building 9923)	Not eligible
Building 4210	Antenna Support Facility	Not eligible
Building 4207	Communications Facility	Not eligible

[a] Panamerican Consultants, Inc. 2023

Table D-3. Divestment Assets at MSFC

Site	Description	NRHP Eligibility[a]
Building 4761	Wastewater Treatment Facility	Not eligible
Buildings 4553A, 4561C, 4555D, 4555C, 4555B, 4555A, 4596B, 4553C, 4596A,	Shed	Not eligible
Buildings 4561A, 4561B, 4561D	Shed	Not eligible
Buildings 4588B	Shed	Not eligible
Building 4739	Shop	Not eligible
Building 4572A	Structural Strength Test & Staging Facility	Not eligible
Buildings 4537, 4553, 4558, 4584	Test Support Building	Not eligible
Buildings 4583B, 4680, 4588A	Test Support Building	Not eligible
Buildings 4758, 4319	Storage Building	Not eligible
Building 4643	Propellants & Reactive Fluids Compatibility Test Facility	Not eligible
Buildings 4569, 4519, 4556, 4574, 4560	Bunker	Eligible for the NRHP as a contributor to the Observation Bunker Historic District
Building 4597	Fuel Ready Storage	Not eligible
Building 4779	Oil-Water Separator	Not eligible

Site	Description	NRHP Eligibility[a]
Building 4570A	Mechanical Equipment Building	Not eligible
Building 4767A	Pump Shelter	Not eligible
Building 4550	Vehicle Static Test Stand – Full implosion-style demolition of the dynamic test stand with some removal of metal prior that could pose a danger/risk.	National Historic Landmark and as a contributor to the Test Stand District
Building 4551	Vehicle Static Test Stand	Eligible for the NRHP as a contributor to the Test Stand District
Building 4572	Vehicle Static Test Stand - Demolition by partial implosion at the T-Tower. Prior to implosion, all the metal that could pose a danger/risk, tanks, utilities, insulation, etc. to the concrete basis of the structure would be removed. The remaining metal and concrete would be imploded to finish the demolition.	National Historic Landmark and eligible as a contributor to a proposed historic district.
Building 4571	Impact Test Facility	Not eligible
Buildings 4703, 4688	General Warehouse	Not eligible
Buildings 4760, 4767	Materials Research and Development Test Building Building 4670 is heavily contaminated and demolition of this facility would include the following environmental cleanup actions: ▪ Small tanks in the building would be cleaned well enough to go to a recycler. ▪ Large tanks would have the liners removed. ▪ All piping in the plating and surface treatment areas would be disposed of as hazardous waste. ▪ Underneath the plating and surface tanks, the floors/trenches would have all debris removed and disposed of as hazardous waste. ▪ Tank ventilation tunnels under the basement floor would be broken up as part of the demolition. ▪ Ventilation stacks on the outside for the plating and surface treatment areas would be removed. ▪ Ventilation stacks on the paint booth side would be removed. ▪ Soil around the slab would be removed to a depth of 10 feet. Groundwater in the area is 35 to 40 feet deep and would not be impacted or encountered. ▪ The abandoned cyanide tank (filled with sand) would be removed and properly disposed of. ▪ Overhead industrial sewer lines would be demolished all the way to the manhole in the southwestern corner of Building 4760. Maintenance hole would be cut down 1 foot and filled with flowable fill and then covered with soil.	Not eligible

[a] Panamerican Consultants, Inc. 2023

Table D-4. Outgrant Assets at MSFC

Site	Description
Building 4475	Power Systems Laboratory
Building 4757	Storage Facility
Building 4694	Storage Building
Buildings 4585, 4685	Test Support Building
Building 4587	Vacuum Pump Station

Table D-5. Development Sites at MSFC

Development Site	Description
D1	Up to 4 acres.
D2	Up to 11 acres suitable for administrative activities.
D3	Up to 8 acres suitable for space operations activities.
D4	Up to 1.2 acres suitable for integration or storage activities.
D5	Up to 7.5 acres suitable for administrative activities.
D6	Up to 3 acres and suitable for manufacturing or integration activities
D8	Up to 9 acres suitable for non-hazardous testing and small-scale hazardous testing activities.
L1	Up to 65 acres of land suitable for administrative activities. Estimated buildout would be 600,000 square feet of administrative space. New facilities would require extension of utilities. Estimated occupancy is 2,600 persons. For Development Sites L1 and L2, site work would include 12 acres of tree clearing and 85 acres of strip/stockpile topsoil and rough grading.
L2	Up to 30 acres of land suitable for administrative activities. New facilities would require extension of utilities. Estimated occupancy is 950 persons. For Development Sites L1 and L2, site work would include 12 acres of tree clearing and 85 acres of strip/stockpile topsoil and rough grading.
L3	Up to 58 acres of land suitable for manufacturing and integration activities. Maximum buildout would be 750,000 square feet of integration/manufacturing space. New facilities would require extension of utilities. Remediation of the skeet/trap range would be required. Site work would include 40 acres of tree clearing and 50 acres of strip/stockpile topsoil and rough grading.
L4	Up to 26 acres of land suitable for administrative, integration, or retail activities. Maximum buildout would be 100,000 square feet. New facilities would require extension of utilities.
L5	Up to 35 acres suitable for manufacturing or integration activities. Estimated buildout would be 391,000 square feet. New facilities would require extension of utilities. Site work would include 35 acres of tree clearing and 35 acres of strip/stockpile topsoil and rough grading.

Table D-5. Development Sites at MSFC

Development Site	Description
L6	Up to 12 acres suitable for administrative or integration activities. Estimated buildout would be 77,000 square feet. Site work would include 1.5 acres of tree clearing and 12 acres of strip/stockpile topsoil and rough grading.
L7	Up to 2 acres suitable for administrative or parts manufacturing activities. Estimated buildout would be 72,000 square feet. Site work would include 1.2 acres of tree clearing and 2 acres of strip/stockpile topsoil and rough grading.
L8	Up to 41 acres suitable for administrative or integration activities. New facilities would require extension of utilities.
L9	Up to 10 acres suitable for storage activities.
L10	Up to 37 acres suitable for non-hazardous testing, small-scale hazardous testing, and storage activities. New facilities would require extension of utilities.
Cell Tower Sites	The 0.5-acre sites would include a 160-foot-tall tower, 100 square foot communications hut, and a natural gas or diesel generator. Utilities, including communications, would need to be extended to the site. The perimeter of the site would be fenced.
Buildings 4705	Human Lander Systems Appendix P Lunar Orbit Insertion for use of high bay space and admin space.
Building 4711	Human Lander Systems Appendix P Lunar Orbit Insertion for use of space.
Building 4752	Human Lander Systems Appendix P Lunar Orbit Insertion for use of high bay space and admin space.
Buildings 4649, 4707, 4755	Reimbursable Space Act Agreement for use of high bay space.
Buildings 4436, 4476,	Exploration Production and Operations Contract Government Furnished Property for use of software development space.
Building 4205	Exploration Production and Operations Contract Government Furnished Property for use of Systems Integration Laboratory/Systems Integration Test Facilities.

1

This page is intentionally left blank.

Appendix E
Supplemental Environmental Information Used for Analysis

This page is intentionally left blank.

Appendix E. Supplemental Environmental Information Used for Analysis

E.1 Vegetation

Mixed Forest: Mixed forest occurs on slight to moderate topographic slopes and hilltops. Mixed forests are widely distributed throughout MSFC, with the largest parcels being in the Test Area and along the southwestern boundary of the MSFC. Mixed forests at MSFC have canopies that are dominated by southern red oak (*Quercus falcata*), northern red oak (*Quercus rubra*), eastern black oak (*Quercus velutina*), eastern white oak (*Quercus alba*), mockernut hickory (*Carya tomentosa*), pignut hickory (*Carya glabra*), black cherry (*Prunus serotina*), loblolly pine (*Pinus taeda*), eastern red cedar (*Juniperus virginiana*), sweetgum (*Liquidambar styraciflua*), and southern hackberry (*Celtis laevigata*). Common sub canopy species in mixed forests include red bud (*Cercis canadensis*), eastern hophornbeam (*Ostrya virginiana*), sassafras (*Sassafras albidum*), and persimmon (*Diospyros virginiana*). Common shrub species include Carolina buckthorn (*Rhamnus caroliniana*), common pawpaw (*Asimina triloba*), winged sumac (*Rhus copallina*), and smooth sumac (*Rhus glabra*).

Mesic Mixed Forest: This community type occurs on slight topographic slopes and within the transition zones between mixed forests and bottomland hardwood wetlands. The coverage of mesic mixed forests at MSFC is limited to a few parcels in the west central and southern parts. Mesic mixed forests at MSFC have canopies that are dominated by eastern sycamore (*Plantanus occidentalis*), sweetgum, red maple (*Acer rubrum*), box elder (*Acer negund*o), southern hackberry, and American elm (*Ulmus americana*). Common sub-canopy species in mesic mixed forests include red maple (*Acer rubrum*), sweetgum, eastern hophornbeam, ironwood *(Carpinus caroliniana*), and water oak (*Quercus nigra*). Common shrub species include spicebush (*Lindera benzoin*) and common pawpaw.

Pine Forest: This community type occurs on slight to moderate topographic slopes and hilltops. Pine forests and mixed forests occur at similar elevations and have similar soil profiles. The largest parcels of pine forest exist in the East Test Area and the west central portion of the MSFC. Most of the pine forests at MSFC have canopies that are dominated by loblolly pine. A few parcels have canopies that are dominated by shortleaf pine (*Pinus echinata*); however, these parcels represent a very small percentage of the total pine forest coverage at MSFC. Common sub-canopy species in pine forests include sweetgum, water oak, southern red oak, northern red oak, black cherry, eastern red cedar, common persimmon, and red bud. Common shrub species include sassafras, Carolina buckthorn, and winged sumac. The pine forests at MSFC have canopies that are relatively sparse and even aged, which is typical of forests that have been previously cleared.

Deciduous Forest: This community occurs on a range of topographic slopes where soil moisture ranges from mesic to semi-xeric. The coverage of deciduous forests is limited to parcels adjacent to and within the WNWR and to a parcel in the west central portion of the MSFC. Deciduous forests at MSFC are relatively diverse in species composition, with many species codominating the canopy and sub-canopy layers. Common canopy and sub-canopy species in deciduous forests at MSFC include tulip poplar (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), eastern cottonwood *(Populus deltoides*), black walnut (*Juglans nigra*), American basswood (*Tilia americana*), eastern white oak, basket oak (*Quercus michauxii*), willow oak (*Quercus phellos*), northern red oak, southern hackberry, red bud, and flowering dogwood (*Cornus florida*). Common shrub species include red buckeye (*Aesculus pavia*), Carolina buckthorn, and possumhaw holly (*Ilex decidua*). The deciduous forests at MSFC are minimally disturbed.

Planted Pine: Areas of planted pine at MSFC have been created on relatively low topographic slopes where soil moisture ranges from mesic to semi-xeric. The larger tracts of planted pine at MSFC exist in the west central portion. Loblolly pine is the only pine species that is planted at MSFC. Planted areas consist of densely planted rows of even-aged trees. The abundance and diversity of other plant species within most of the planted pine areas is low because of the low light levels under the canopy. Species that typically occur as the understory of planted pine areas include sweetgum, black cherry, blackjack oak (*Quercus marilandica*), common persimmon, and red maple. Several vine species are also common, including poison ivy (*Toxicodendron radicans*), muscadine (*Vitis rotundifolia*), and greenbriars (*Smilax* spp.). Planted pine parcels are human made and undergo regular disturbance; therefore, their overall habitat quality is lower than that of the other forest communities at MSFC.

Mowed Field: Mowed fields are used for hay production; there also are fields that are mowed less than twice a year. Mowed fields do not include areas of planted grass that are maintained around buildings, parking lots, and other developed areas at MSFC. Much of the northernmost portion of MSFC consists of mowed fields that are used for hay production; parcels of mowed field also exist in the west central portion of the MSFC. Mowed fields at MSFC consist primarily of grasses and forbs that include fescue (*Festuca* sp.), goldenrods (*Solidago* spp.), foxtail (*Setaria* sp.), and fingergrass (*Digitaria* sp.). Some portions of the mowed fields contain high densities of invasive exotic species such as Johnsongrass (*Sorghum halepense*). Mowed fields undergo regular disturbance through hay production or mowing. Their overall habitat quality is relatively low and the habitat they provide is temporary as it is subject to the cycle of hay harvest or mowing.

Fallow: Fallow areas are previously cleared or undeveloped areas that are not maintained on a regular basis. These areas have been allowed to revegetate naturally and they consist primarily of invasive species such as kudzu (*Pueraria montana*), shrubby lespedeza (*Lespedeza bicolor*), Chinese lespedeza (*Lespedeza cuneata*), and Johnsongrass mixed with native grasses, forbs, vines, and some shrubs. The coverage of fallow areas at MSFC consists of relatively small parcels dispersed throughout the MSFC. Although fallow areas do not undergo regular disturbance as mowed fields do, their habitat quality is still considered to be relatively low because they contain significant amounts of invasive exotic plant species.

Xeriscape: Xeriscape areas at MSFC are parcels that were formerly mowed fields and are no longer maintained by mowing to reduce costs. These parcels have been allowed to naturally revegetate since 2012. The xeriscape parcels consist primarily of planted grasses and a mix of native and exotic species that are becoming increasing more established. Vegetative cover includes grasses and forbs such as fescue, goldenrods, dog fennel (*Eupatorium capillifolium*), foxtail, fingergrass, lespedeza, and Johnsongrass.

Table E.1-1. Acreages and Percent Cover of Upland Communities at MSFC

Communities	Total Area (acres)	Total Percent Cover	Percent of Total Natural Community Area
Mixed Forest	204	11%	20%
Mesic Mixed Forest	22	1%	2%
Pine Forest	191	10%	19%
Deciduous Forest	30	2%	3%
Planted Pine	231	13%	23%
Mowed Field	127	7%	12%
Fallow	34	2%	3%
Xeriscape	44	2%	4%
Total	**879**	**48%**	**87%**

Source: NASA 2017

E.2 Wildlife

Common mammals that occur in the natural communities at MSFC include white-tailed deer (*Odocoileus virginianus*), gray squirrel, cottontail rabbit (*Sylvilagus floridanus*), raccoon, coyote (*Canis latrans*), and opossum (*Didelphis marsupialis*). Common reptiles and amphibians include eastern box turtle (*Terrapene carolina Carolina*), green tree frog (*Hyla cinerea*), southern leopard frog (*Lithobates sphenocephalus*), skinks (*Scincidae*), black racer snake (*Coluber constrictor*), and garter snake (*Thamnophis sirtalis*). Common bird species at MSFC include northern cardinal (*Cardinalis cardinalis*), rock pigeon (*Columba livia*), black vulture (*Coragyps atratus*), American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), woodpecker (*Picidae*), wild turkey (*Meleagris gallopavo*), northern mockingbird (*Mimus polyglottos*), Carolina chickadee (*Poecile carolinensis*), common grackle (*Quiscalus quiscula*), and eastern bluebird (*Sialia sialis*). Habitat for fish species at MSFC is largely limited to the backwater areas of Wheeler Reservoir within the WNWR and the springs at the MSFC. Common fish species include largemouth bass (*Micropterus salmoides*), sunfish (*Centrarchidae* spp.), chain pickerel (*Esox niger*), bluegill (*Lepomis macrochirus*), and darters (*Etheosomatinae* spp.).

E.3 Special-Status Species

Special-status species with potential to occur at MSFC are presented in Table E.3-1.

Table E.3-1. Special-status Species with Potential to Occur at MSFC

Species Type	Scientific Name	Common Name	Federal Status	State Status	Habitat	Occurrence Potential at MSFC
Plants	*Apios priceana*	Princes' potato bean	T	–	Open, wooded areas and mesic areas near streams/rivers.	Low probability. Occurs on RSA.
Plants	*Panax quinquefolius*	American ginseng	–	R	Shaded areas in broadleaf deciduous forests.	High probability.
Plants	*Trillium pusillum var. alabamicum*	Alabama least trillium			Seasonally flooded, saturated forested wetlands.	High probability. Occurs on RSA. MSFC bottomland hardwood forests near WNWR are suitable habitat.
Invertebrates	*Campeloma decampi*	Slender campeloma	E	SP	Soft sediments or detritus in running waters.	TBD.
Invertebrates	*Cumberlandia monodonta*	Spectaclecase mussel	E	SP	Large rivers, in firm mud and sheltered area (between boulders).	Potential to occur in dock port on Tennessee River.
Invertebrates	*Danaous plexippus*	Monarch butterfly	C	–	Sunny open fields.	High probability.
Invertebrates	*Elimia perstriata*	Engraved elimia	–	SP	Areas of flowing water in small to medium springs.	Occurs in Williams Spring.

Species Type	Scientific Name	Common Name	Federal Status	State Status	Habitat	Occurrence Potential at MSFC
Invertebrates	*Epioblasma triquetra*	Snuffbox mussel	E	SP	Gravel/sand/cobble in swift small to medium rivers.	Potential to occur in dock port on Tennessee River.
Invertebrates	*Lampilis abrupta*	Pink mucket (pearly mussel)	E	SP	Gravel/sand/cobble in good flows of small streams.	Potential to occur in streams.
Invertebrates	*Palaemonias alabamae*	Alabaman cave shrimp	E	SP	Flooded underground pools and caverns in limestone caves in Madison County, Alabama.	In 1992, cave shrimp discovered during well drilling at MSFC. Because of underlying karst, other cave shrimp habitat is likely.
Invertebrates	*Plethobasus cyphyus*	Sheepnose mussel	E	SP	Typically in shallow sand/gravel areas with moderate to swift currents; larger rivers and streams.	Potential to occur in dock port on Tennessee River.
Invertebrates	*Plurobema plenum*	Rough pigtoe	E	SP	Sand/gravel in medium to large rivers.	Potential to occur in streams and dock port on Tennessee River.
Fish	*Etheostoma tuscumbia*	Tuscumbia darter	–	SP	Freshwater streams, valley-floor limestone springs, spring runs of aquatic vegetation.	Occurs in Williams Spring and its run.
Amphibians	*Aneides aeneus*	Green salamander	–	SP	Damp environments such as tree or rock crevices.	Low probability.
Birds	*Grus americana*	Whooping crane	T	SP	Shallow marshes and adjacent open grasslands.	Observed in the part of MSFC that is within WNWR. Winter.
Birds	*Haliaeetus leucocephalus*	Bald eagle	BGEPA	–	Open water with large mature trees nearby.	High probability.
Mammals	*Myotis grisescens*	Gray bat	E	SP	Limestone caves with running water; forages over water; roosts exclusively in caves year-round.	Suitable foraging and summer habitats exist on MSFC.

Species Type	Scientific Name	Common Name	Federal Status	State Status	Habitat	Occurrence Potential at MSFC
Mammals	*Myotis septentrionalis*	Northern long-eared bat	E	SP	During summer and part of spring and fall: roosts in live and dead trees, forages in dense forested areas.	Suitable foraging and summer roosting habitats exist on MSFC.
Mammals	*Myotis sodalis*	Indiana bat	E	SP	Winter in caves; maternity colonies under tree bark near streams and rivers.	Suitable foraging and summer roosting habitats exist on MSFC.
Mammals	*Perimyotis subflavus*	Tricolored bat	PE	SP	Winter in caves; summer roosts likely in tree foliage, forages in forested wetlands/ riparian areas.	Suitable foraging and summer roosting habitats exist on MSFC.

1 Source: NASA 2023c

2 Key: C = Candidate; BGEPA = Bald and Golden Eagle Protection Act; E = endangered; PE = proposed endangered;
3 R = regulated by permit; SP = state protected; T = threatened

4 **Table E.3-2. Vegetation Types at Proposed Action Sites**

Asset Type	Site	Site Acreage	Vegetation	Tree Clearing Required	Strip/Stockpile Topsoil
Development Sites	D2	11	Developed Xeriscape	No	No
Development Sites	D5	7.5	Mowed Planted Pine	Yes	Yes
Development Sites	D6	3	Developed Xeriscape	No	No
Development Sites	D8	9	Developed Pine Forest Planted Pine	Yes	Yes
Development Sites	L1	65	Fallow Mixed Forest Mowed	Yes	Yes
Development Sites	L2	30	Mowed	No	No
Development Sites	L3	58	Developed Mixed Forest Pine Forest Planted Pine	Yes	Yes
Development Sites	L4	26	Developed Fallow Planted Pine	Yes	Yes

Asset Type	Site	Site Acreage	Vegetation	Tree Clearing Required	Strip/Stockpile Topsoil
Development Sites	L5	35	Mixed Forest Pine Forest Planted Pine	Yes	Yes
Development Sites	L6	12	Developed Planted Pine Mowed	Yes	Yes
Development Sites	L8	41	Developed Fallow Pine Forest Planted Pine	Yes	Yes
Development Sites	L9	10	Developed Pine Forest Planted Pine	Yes	Yes
Development Sites	L10	37	Developed Mixed Forest	Yes	Yes
Development Sites	Cell Tower Sites	1	Planted Pine Xeriscape	Yes	Yes
Investment	Construction Site C3 – Propulsion Development Laboratory Expansion	4.5	Developed Planted Pine	Yes	Yes
Investment	Construction Site C5 – Firearms Range Expansion	8.5	Fallow Mixed Forest	Yes	Yes
Investment	Construction Site C6 – Liquid Hydrogen Tank Installation	1	Deciduous Forest Mixed Forest	Yes	Yes
Advanced Space Transportation Systems	Solid Propulsion Test Area	Unknown	Planted Pine	Yes	Not Available
Habitation Systems	Habitation System Location	Unknown	Xeriscape	No	Not Available

1

2

E.4 Wildlife

Table E.4-1 presents the estimated wildlife habitat quality at the Proposed Action sites.

Table E.4-1. Wildlife Habitat Quality at Proposed Action Sites

Asset Type	Site	Habitat Quality
Development Sites	D1	None
Development Sites	D2	None
Development Sites	D3	None
Development Sites	D4	Poor
Development Sites	D5	Poor
Development Sites	D6	Poor
Development Sites	D8	Moderate, Poor
Development Sites	L1	Moderate, Poor
Development Sites	L2	Moderate, Poor
Development Sites	L3	Good, Moderate, Poor
Development Sites	L4	Poor
Development Sites	L5	Moderate, Poor
Development Sites	L6	Poor
Development Sites	L7	None
Development Sites	L8	Poor
Development Sites	L9	Poor
Development Sites	L10	Moderate
Development Sites	Cell Tower Site Development Sites	Poor
Investment	Construction Site C1	None
Investment	Construction Site C2	None
Investment	Construction Site C3	Poor
Investment	Construction Site C4	None
Investment	Construction Site C5	Poor
Investment	Construction Site C6	Good, Moderate
Advanced Space Transportation Systems	TP-H1271	Poor
Habitation Systems	Location	Poor

As indicated in Table E-4.1, most of the sites provide poor-quality wildlife habitat. All of the planted pine, mowed fields, fallow areas, and xeriscape areas at MSFC provide poor-quality wildlife habitat. Most of the surface water systems and many parcels of mixed and pine forest also provide poor-quality habitat. These communities rate low on many of the criteria used to evaluate wildlife habitat quality. Planted pine account for the greatest amount of poor-quality wildlife habitat at the Center.

Planted pine parcels provide poor-quality wildlife habitat because they are heavily disturbed by planting, thinning, and harvesting, which impacts their soil, vegetation, and hydrology. Planted pine parcels have dense monotypic canopies and lack diverse understories. Mowed fields and fallow areas provide poor-quality wildlife habitat because they are disturbed communities that contain significant amounts of

invasive exotic plant species. Mowed fields are planted and they undergo regular disturbance through hay production or mowing. Xeriscape areas currently provide poor-quality wildlife habitat because they were recently created from mowed fields and are in early successional stages of regeneration. They provide little food sources for wildlife and will likely contain invasive exotic species without sufficient controls.

Mixed forests account for the greatest amount of moderate-quality wildlife habitat at MSFC. Most of the parcels of mixed and pine forest at MSFC provide moderate-quality wildlife habitat. These parcels are less fire suppressed and have fewer or less severe physical and hydrological impacts than the poor-quality parcels. The moderate-quality parcels also have more mast producing trees (oaks) than the poor-quality parcels. Five development sites and two investment sites are rated as moderate-quality wildlife habitat.

Most of the deciduous, mesic mixed, and bottomland hardwood forests, and some parcels of mixed and pine forests provide good-quality wildlife habitat. These communities rate highly on many of the criteria used to evaluate wildlife habitat quality. A small portion of the northwestern corner of L3 is mixed forest and rated as good-quality wildlife habitat. The western portion of C6 is also rated as good-quality wildlife habitat and consists of deciduous forest.

E.5 Cultural Resources

Table E.5-1. Identified Historic Properties - Architectural Resources

Real Property Number	Current Name	Historic Name(s)	Design Date	NRHP Status
4436	Hardware Simulation Laboratory; SSME-HSL Block II Facility	Vehicle and GSE Systems Automation Checkout Building SSME-HSL Block II Facility	1962	Eligible for the NRHP
4476	Optical Vertical Test Facility	Hardware Simulator Laboratory (1987) Servo-Actuator Seal Test Facility (1974) Astrionics Laboratory (1967, 1971) Marshall Avionics System Test (MAST) Beds Facility / FSL Simulation Facility (1965) Saturn V Instrument Test Facility (1964) Acceleration, Test and Calibration Facility (1964) Acceleration and Environmental Test Facility (1963)	1963-1987	Eligible for the NRHP.
4519	Observation Bunker	Observation Bunker associated with Test Stand TS 500 (demolished)	1986	Eligible as a contributor to Observation Bunker District
4530	Test Facility 300 (TF-300)	Saturn Components Testing Facilities	1964	Eligible as a contributor to Test Stand District
4531	Test Stand Support Building	Saturn Components Testing Facilities Preparation Shop	1964 1989	Eligible as a contributor to Test Stand District

Table E.5-1. Identified Historic Properties - Architectural Resources

Real Property Number	Current Name	Historic Name(s)	Design Date	NRHP Status
4540	Acoustic Model Engine Test Facility and concrete test apron	TF 116	1964	Eligible as a contributor to Test Stand District
4541	Test Stand Control Building	Control Building Control Blockhouse	1964 1967	Eligible as a contributor to Test Stand District
4550	Microgravity Drop Tower (Heritage)	Zero Gravity Drop Tower (1981) Space Shuttle Mated Ground Vibration Test Facility (1975) Advanced Saturn Dynamic Test Stand (1966) Advanced Saturn Dynamic Test Facility (1963)	1963-1981	National Historic Landmark, eligible as a contributor to Test Stand District
4551	Microgravity Drop Support Building	Terminal Building for the Advanced Saturn Dynamic Test Facility/Stand	1963	Eligible for the NRHP NHL
4554	Hot Gas Facility (HGF)	Support Building for Cold Calibration and Dynamic Test Facility (Building 4588)	1966	Eligible as a contributor to Test Stand District
4560	Propulsion System Test Observation Bunker	Observation Bunker	1958	Eligible as a contributor to the Observation Bunker District.
4561	Test Control and Service Building	Support Services Building (1966) Saturn Testing Components Saturn Facilities (1964) Testing Components Blockhouse (1964) Propellant Shop Support (1960) Support Service Building and Hardstand (1958)	1958-1966	Eligible as a contributor to Test Stand District
4569	Observation Bunker	Observation Bunker	1965	Eligible as a contributor to Observation Bunker District
4570	Advanced Propulsion Research Facility	Blockhouse and Cable Tunnel (1957, 1959, 1966) East Area Blockhouse (1964) Guided Missile Test Facility Blockhouse (1953)	1953-1964	Eligible as a contributor to Test Stand District
4572	Propulsion and Structural Test Facility (Heritage)	Static Test Tower (STT)	1953-1962	NHL

Table E.5-1. Identified Historic Properties - Architectural Resources

Real Property Number	Current Name	Historic Name(s)	Design Date	NRHP Status
4574	Observation Bunker	Observation Bunker	1957	Eligible as a contributor to Observation Bunker District
4583	Test and Data Recording Facility (TS-115)	Test Stand 115 (1965) Components Test Laboratory (1957, 1959, 1966) Guided Missile Components Test Laboratory (1954)	1954-1965	Eligible as a contributor to Test Stand District
4583A	Test Stand 115	TS 115	1957	Eligible as a contributor to Test Stand District
4594	Observation Bunker	Observation Bunker	1952	Eligible as a contributor to Observation Bunker District
4619	Structures, Dynamics and Thermal Vacuum Laboratory	Structures and Mechanics Laboratory (1966) Propulsion and Vehicle Engineering Laboratory (1965) Test Unit (1960) Structures and Mechanics Unit (1957, 1959) Structures and Mechanics Building /Vacuum and Compressor Building (1956)	1959	Eligible for the NRHP
4663	Huntsville Operations Support Center (HOSC)/NASA Data Center (NDC)	Huntsville Operations Support Center (HOSC)/NASA Data Center (NDC) (1996) Launch Information Exchange Facility (1964); Computer Facility (1959)	1959	Eligible for the NRHP
4665	Historic Redstone Test Site	Interim Test Stand (1957, 1959, 1966) Static Test Stand (1952)	1957-1966 1952	NHL & Alabama Historic Civil Engineering Landmark
4665A and 4665B	Jupiter “Hop” Test Stand at Redstone Rocket Test Stand Site and Observation Bunker		1953	NHL
4666	Office Building	Test Laboratory Test Division Engineering Building	1965 1961-1966	Eligible for the NRHP

Table E.5-1. Identified Historic Properties - Architectural Resources

Real Property Number	Current Name	Historic Name(s)	Design Date	NRHP Status
4670	Advanced Engine Test Facility	S-1 C Static Test Complex (1966) Saturn V S-1C Static Test Stand (1965) Saturn V Booster Test Stand (1965) Saturn Static Test Stand (1961, 1966)	1961-1966	Eligible for the NRHP
4670A	Observation Bunker	Observation Bunker	1965	Eligible as a contributor to Test Stand District
4674	Control Facility	Control Center Building Saturn Static Test Facility Control Center	1966 1961	Eligible as a contributor to Test Stand District
4696-1	Observation Bunker	Observation Bunker associated with F-1 Engine Test Stand (1965: Marshall Star, 1966) F-1 Test Facility (1962)	1962-1966	Eligible as a contributor to Observation Bunker District
4699	Cryogenic Structural Test Facility	Structural-Thermal Test Facility S-II Aft Section Assembly Test (1967)	1971 1967	Eligible as a contributor to Test Stand District
4705	Shop and Neutral Buoyancy Simulator (Heritage)	Missile Assembly Shop and Hangar Building (1966), Manufacturing Engineering Division/Laboratory [area] (1962, 1963), Missile Assembly Shop (1952, 1957, 1959). Neutral Buoyancy Simulator Complex (1981),	1952-1981	Building 4705 is not eligible for the NRHP. Neutral Buoyancy Simulator Complex within 4705 is a National Historic Landmark
4707	Productivity Enhancement Complex	Missile Components Hangar (1966) Manufacturing Engineering Division/ Laboratory (1962, 1963) Hydrostatic Test Facility {Added} (1962) Missile Components Hangar (1954, 1957, 1959) Structural Fabrication Building (1956)	1956–1966	Eligible for the NRHP
4718	X-Ray Calibration Facility	X-Ray Calibration Facility	1975–1989	Eligible for the NRHP
4718-1	X-Ray Calibration Support Facility	X-Ray Calibration Support Facility	1970, 1991	Eligible for the NRHP
4718-2	X-Ray Calibration Support Facility	X-Ray Calibration Support Facility	1970, 1991	Eligible for the NRHP
4718-3	X-Ray Calibration Support Facility	X-Ray Calibration Support Facility	1970, 1991	Eligible for the NRHP

Table E.5-1. Identified Historic Properties - Architectural Resources

Real Property Number	Current Name	Historic Name(s)	Design Date	NRHP Status
4732	Office and Wind Tunnel Facility	Trisonic Wind Tunnel	1955	Eligible for the NRHP

Source: Panamerican Consultants, Inc. 2023.

Table E.5-2. Boneyard Equipment with NRHP Eligibility

Name/Equipment	Design and Fabrication Dates	NRHP Status
Orbiter Boat tail (Aft Fuselage) of the Main Propulsion Test Article (MPTA) - 098	1972–1977	Eligible for the NRHP
F-1 Engines and Original Related Equipment	Developed 1955–1963, Manufactured 1964–1966	Eligible for the NRHP
Space Shuttle Main Engine	1986	Eligible for the NRHP
Spacelab Mission I Mockup	1975	Eligible for the NRHP
Hydrogen-Alpha-1 (H-Alpha-1) Telescope[a]	1971	Eligible for the NRHP
RL A-1 Engine	1959-1960	Eligible for the NRHP
Saturn I, Block I Mockup	1960, modifications through 1964	Eligible for the NRHP
14-Inch Trisonic Wind Tunnel	1954–1957	Eligible for the NRHP

Source: Panamerican Consultants, Inc. 2023.

[a] Relocated to University of Alabama, Huntsville

Table E.5-3. Archeological Resources and Treatment Recommendations

Site	Site Type	NRHP Assessment	Recommendation
1MA104	Prehistoric and Historic	Eligible for the NRHP	Avoidance
1MA1095	Historic	Eligible for the NRHP	Avoidance
1MA1096	Historic	Eligible for the NRHP	Avoidance
1MA1097	Historic	Eligible for the NRHP	Avoidance
1MA1098	Historic	Eligible for the NRHP	No further testing
1MA1099	Historic	Eligible for the NRHP	No further testing
1MA1167	Prehistoric and Historic	Eligible for the NRHP	Avoidance
1MA1353	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.
1MA1354	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.
1MA1355	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.
1MA1356	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.
1MA1358	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.

Table E.5-3. Archeological Resources and Treatment Recommendations

Site	Site Type	NRHP Assessment	Recommendation
1MA1390	Prehistoric	Eligible for the NRHP	Avoidance
1MA1391	Historic	NRHP eligibility is undetermined	Further testing may be required to determine eligibility if ground disturbance is planned.
1MA1392	Prehistoric	Eligible for the NRHP	Avoidance

Source: NASA 2003

This page is intentionally left blank.

Appendix F
Summary of Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation Memorandum

This page is intentionally left blank.

Jacobs

Memorandum

4121 Carmichael Road, Suite 400
Montgomery, Alabama 36106
United States
T +1.334.271.1444

Subject	**Summary of NASA Inflatable Habitat Testing Noise Impacts Modeling and Recommended Mitigation**
Project Name	Evaluation of Potential Noise Impacts George C. Marshall Space Flight Center, Huntsville, Alabama
Attention	Farley Davis/NASA MSFC
From	Mitch Lindsay, P. E./Jacobs Robbie Gray, P.E., CHMM/Jacobs
Date	August 15, 2023

1. Background

The mission of the National Aeronautics and Space Administration's (NASA's) Marshall Space Flight Center (MSFC) in Huntsville, Alabama is the research, development, and testing of advanced propulsion systems, integrated space systems, landers, and excursion vehicles. In support of this mission, NASA is performing burst and creep-to-burst tests of sub-scale and full-scale prototypes of inflatable habitat structures at MSFC, which is within US Army Garrison-Redstone Arsenal (USAG-Redstone). NASA requested that CH2M HILL, Inc., a wholly owned subsidiary of Jacobs, perform modeling of impulse noise resulting from the bursting of these structures due to intentional pressurization to failure testing.

2. Acoustic Impulse Modeling

The impulse noise from the structures bursting was calculated following the methodology for an airblast detonation of a hemispherical charge of TNT explosive using relationships originally developed by Kingery et. al. and simplified by Swisdak (NSWC-IH). This approach initially calculates the scaled distance λ using radial distance (r) in feet and TNT equivalent mass (w) in pounds:

$$\text{Scaled distance } \lambda = r / w^{(1/3)}$$

The peak impulse sound level at each scaled distance (for corresponding radial distance) is calculated as follows:

$$\text{Peak (dB)} = 20\log_{10}(226.61762\ \lambda^{-1.4065913}) + dB_{cs}$$

Where dB_{cs} is the initial source peak pressure level in dB (flat weighted). NASA provided TNT equivalency values of 12 lbs TNT for the sub-scale habitat tests and 145 lbs TNT for the full-scale habitat tests based on energy release from pneumatic pressure vessel ruptures. Initial values for dB_{cs} were 170.00 dB for the 12 lbs of TNT (small charge) and 170.75 dB for the 145 lbs of TNT (large charge).

This relationship does not consider atmospheric effects such as focusing from reflective layers, directionality due to winds, or ducting between the surface and low reflective layers. Likewise, near source effects such as baffling and directionality are not included. Frequencies of impulse sound are not considered.

While Swisdak initially proposed these relationships to be valid for scaled distance (λ) between 60 and 500 feet (ft), the impacts have been extrapolated to λ >500 ft for MSFC based on unpublished US Navy data for large surface detonations with scaled distances over 25,000 ft.

3. Modeling Results

The distance-to-effect data from the sound level predictions for the subscale and full-scale tests are provided below:

Predicted Peak Sound Levels (dB) at Radial Distances from Source*
Inflatable Habitat Burst Testing
NASA MSFC, Huntsville, AL

Predicted Sound Level (dB)	12 lbs TNT Equivalent Subscale Test	145 lbs TNT Equivalent Full-scale test
	Distance from Source (ft)	Distance from Source (ft)
150	555	1,360
145	840	2,050
140	1,260	3,080
135	1,895	4,620
130	2,850	6,950
125	4,300	10,460
120	6,460	15,750
115	9,750	23,800

* The source location does not alter the sound level distances predicted by the mathematical model.

In monitoring of long-range acoustic impacts of detonations for the DoD, Jacobs has found that impulse sounds of 115-120 dB in daylight hours are generally ignored by the public and complaints are generally not received until sound levels exceed the 125-130 dB range.

Modeling of the subscale burst (12 lbs TNT equivalent) indicated that peak sound levels would not exceed 115 dB outside the boundaries of USAG-Redstone provided adverse atmospheric effects such as inversions or high winds do not direct sounds to farther locations. The predicted sound level contours for the subscale burst tests at the three proposed test locations are shown in Figures 1, 2, and 3.

Modeling of the full-scale burst (145 lbs TNT equivalent) indicated that peak sound levels would not exceed 120 dB outside the boundaries of USAG-Redstone and would only exceed 115 dB in limited areas outside the boundaries of USAG-Redstone provided adverse atmospheric effects such as inversions or high winds do not direct sounds to farther locations. The predicted sound level contours for the full-scale burst tests are shown in Figure 4.

These results are considered conservative for several reasons:

- Sound attenuation by trees and other vegetation between the source and receptors is not considered.
- Energy dissipated or sound attenuation by the rupturing of the test structure is not considered.
- Energy dissipated or sound attenuation by the rupturing of the test structure enclosure (building) is not considered.

4. Recommended Mitigations

Jacobs recommends the following mitigations to minimize the on-site and off-site impacts to personnel from the full-scale and sub-scale habitat burst tests, subject to review by NASA Occupational Health staff to confirm if the on-site mitigations are sufficient to protect employees within MSFC.

It should be noted that the OSHA threshold for hearing damage from a single impulse event causing hearing damage in humans is 140 dB. Startle effects can occur at much lower levels.

On-site Mitigations:

- Personnel working or present outdoors in locations closer to the test site than the predicted 130 dB line should wear hearing protection. The hearing protection sound attenuation levels (Noise Reduction Ratings; (NRR)) should be of sufficient attenuation to lower the received impulse sound to below 130 dB. For personnel in close proximity to the test site, it may be necessary to use both ear plugs and earmuffs to achieve sufficient protection. 'Ear buds' or other in-ear audio devices and 'noise cancelling' devices for continuous noise are NOT appropriate hearing protection.
- Fully enclosed buildings are estimated to attenuate sound by ~10dB, but no analysis of individual buildings was performed. Portions of buildings such as roofs, sheet metal walls, roll-up doors, and large windows can respond to the impulse sound and 're-broadcast' the impulse sound inside of the building with little attenuation.
- Coordination with operations and activities located closer than the predicted 125 dB line should occur well prior to test events.
- Scheduled tests should occur at times when a minimum of non-essential personnel are present and located closer to the test site than the 130 dB line. Off-site mitigations regarding recommended test timing are described below.

Off-site Mitigations:

- Scheduled tests should only be performed when atmospheric conditions are not favorable for long-range sound propagation. Long-range sound propagation can occur from 'atmospheric focusing' and low level 'ducting' under certain meteorological conditions.
- Scheduled full-scale events should not be conducted if sustained surface winds in excess of 20 miles per hour are blowing towards populated off-site areas.
- Scheduled full-scale events should not be conducted if the Jet Stream (~250 mb pressure altitude) is located close to test site and has wind speeds in excess of 80 knots blowing towards off-site populated areas. High velocity Jet Stream winds can cause atmospheric focusing of impulse sounds in excess of 30 miles from the source.
- Scheduled full-scale events should not be conducted when inversions are present. Weak to moderate inversions are typically indicated by mixing heights less than 6,000' above ground level. Predicted mixing height information is available from the National Weather Service at weather.gov in hourly forecasts.
- Scheduled sub-scale events should not be conducted when strong inversions are present. Strong inversions are typically indicated by mixing heights less than 3,000' above ground level. Predicted mixing height information is available from the National Weather Service at weather.gov in hourly forecasts.
- Scheduled event should not be conducted between late evening and early morning since ambient noise levels ate typically lower during these times and the thresholds for startle effects are lower.

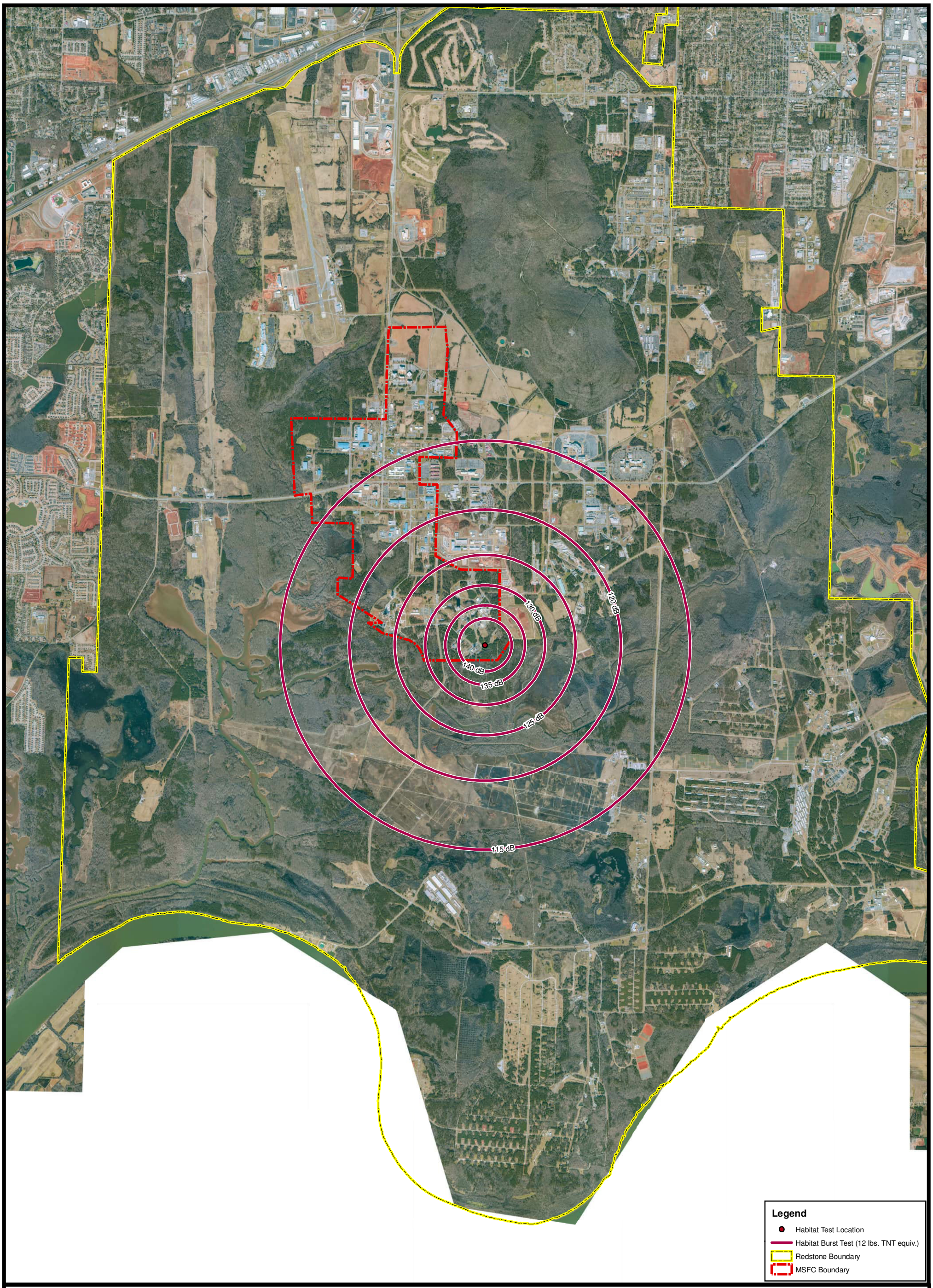
Additionally, inversions occur more commonly during night-time and early morning hours when surface temperatures are lower.

- Public notifications of scheduled events should be performed.
- For creep tests it will not be possible to schedule the burst day and time; it may be beneficial to have a web page providing notice that a creep test is ongoing and if/when a burst occurs. Since a creep test may result in a burst under unfavorable weather conditions or during 'quiet' night-time conditions, off-site impacts to populated areas may be more pronounced.

In addition, it is recommended that MSFC establish a noise monitoring program to evaluate actual noise levels during scheduled events, and to establish the validity of the conservative noise modeling performed to date.

Figures

This page is intentionally left blank.



N
W E
S

0 1,500 3,000 6,000 Feet

0 500 1,000 2,000 Meters

14-Aug-2023
Drawn By:
Scott Stevens

Figure 1
Predicted Sound Levels from 12 lbs. TNT Equivalent Test at IHTP1
NASA Marshall Space Flight Center

Map Document: G:\maps\Safety\InfalatableHabitatIHTP1.mxd

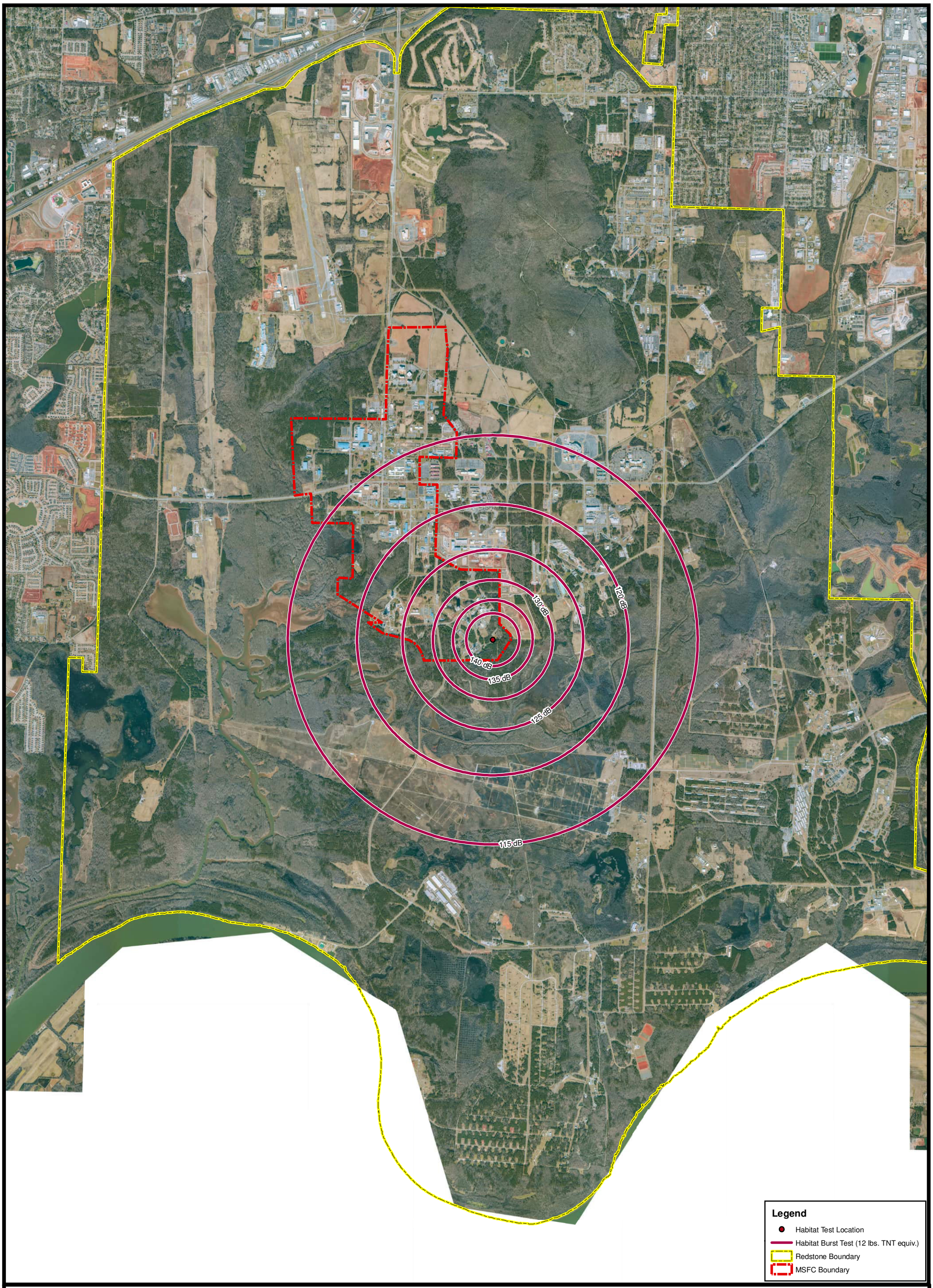


Figure 2
Predicted Sound Levels from 12 lbs. TNT Equivalent Test at IHTP2
NASA Marshall Space Flight Center

Map Document: G:\maps\Safety\InfalatableHabitatIHTP2.mxd

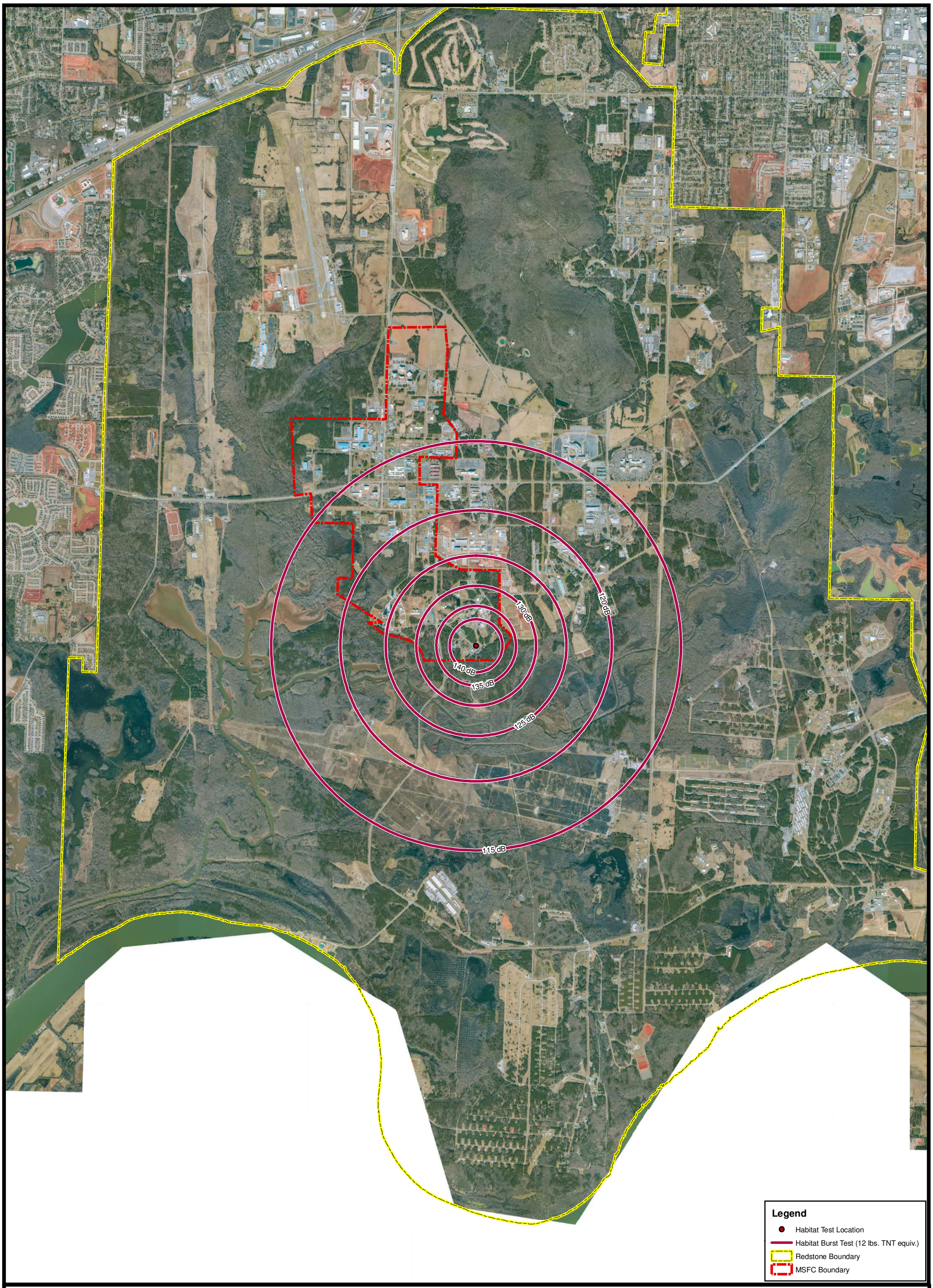
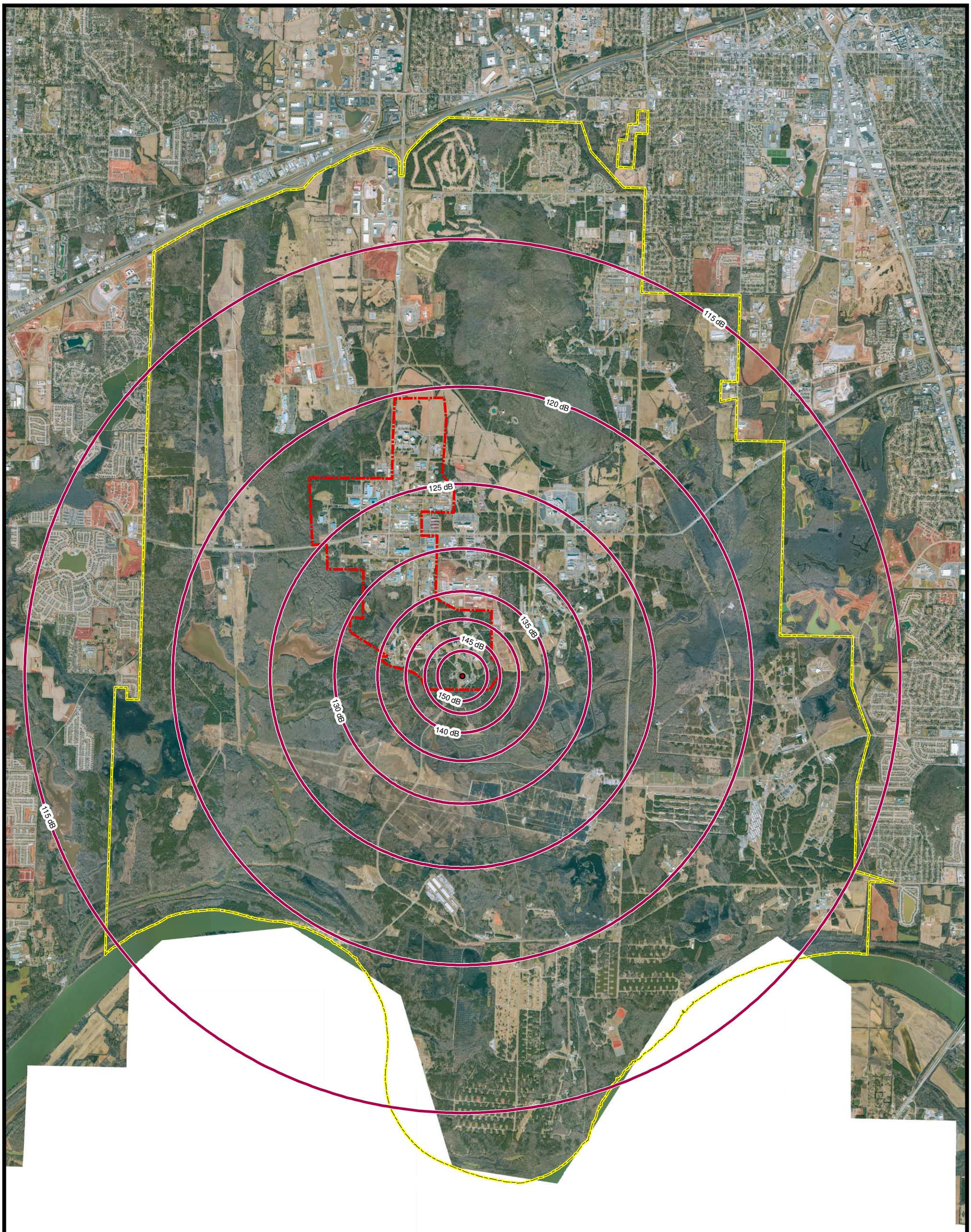


Figure 3
Predicted Sound Levels from 12 lbs. TNT Equivalent Test at T-Tower Trench
NASA Marshall Space Flight Center

Map Document: G:\maps\Safety\InfalatableHabitatT-Tower_Trench.mxd



14-Aug-2023
Drawn By:
Scott Stevens

Figure 4
Predicted Sound Levels from 145 lbs. TNT Equivalent Test
NASA Marshall Space Flight Center

Map Document: G:\maps\Safety\InfalatableHabitat145TNT.mxd