DRAFT

FINDING OF NO SIGNIFICANT IMPACT (FONSI)

AND FINDING OF NO PRACTICABLE ALTERNATIVE (FONPA)

ENVIRONMENTAL ASSESSMENT FOR STOKE'S NOVA LAUNCH PROGRAM AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA

Introduction

Pursuant to the provisions of the National Environmental Policy Act (NEPA), as amended (*United States Code* [U.S.C.] Title 42, Sections 4321 through 4347), the Council on Environmental Quality's (CEQ's) implementing regulations (*Code of Federal Regulations* [CFR] Title 40, Parts 1500 through 1508), and the Department of the Air Force's Environmental Impact Analysis Process (EIAP) (32 CFR Part 989), the U.S. Space Force (USSF) has prepared an Environmental Assessment (EA) to identify and evaluate the potential impacts to the natural and human environment associated with the proposed launches and launch pad improvements associated with Stoke Space Technologies, Inc.'s (Stoke's) proposed Nova Launch Program at Space Launch Complex 14 (SLC-14) on Cape Canaveral Space Force Station (CCSFS), Florida. The *Environmental Assessment for Stoke's Nova Launch Program at Cape Canaveral Space Force Station, Florida* is attached and incorporated by reference.

Purpose of and Need for Proposed Action

The purpose of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015 (Public Law 114–90, November 25, 2015), which was developed to promote the growth of a competitive space launch industry. Cost-competitive commercial space launch systems are needed to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology. The Proposed Action is needed to deliver satellites to orbit for government and private sector clients. In so doing, the Proposed Action allows for the continued fulfillment of the National Space Policy (85 *Federal Register* 81755, 2020) to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs. The Proposed Action would contribute to meeting the goals of the National Space Transportation Policy (Executive Office of the President, November 21, 2013) and Department of Defense (DOD) policy pursuant to DOD Directive 3230.3, "DoD Support for Commercial Space Launch Activities" (October 14, 1986).

Description of the Proposed Action and Alternatives

The Proposed Action is to execute a real property agreement and reactivate SLC-14 in support of Stoke's launch program, which includes the demolition of existing structures, the construction of new facilities, and improvements to existing infrastructure, ground support operations, and launch operations (up to 10 launches per year). New ground elements would include a launch mount/pad, propellent tank farm, engineering support facility, launch vehicle/payload processing/maintenance hangar, utilities, and roads and security.

Alternatives Eliminated from Further Consideration

In 2022, Space Launch Delta 45 (SLD 45) developed the Launch Pad Allocation Strategy (LPAS) to ensure the equitable allocation of excess launch property, while protecting and preserving National Security

Space Launch and Major Range and Test Facility Base missions and addressing environmental concerns. The strategy supports the commercial space launch industry as directed by Title 51 U.S.C., National and Commercial Space Programs. Based on the previous criteria and delegated authority from SAF/IE, the SLD 45 Commander allocated SLC-14 to Stoke through LPAS. The allocation of SLC-14 to Stoke was an initial determination arrived at by weighing the previous factors and subject to the completion of, and compliance with, the EIAP. Even though Stoke was allocated SLC-14, Stoke is not precluded from carrying out the Proposed Action at another (unallocated) site at CCSFS or on Kennedy Space Center.

As part of the alternative development process, Stoke evaluated the following launch sites in accordance with EIAP requirements: SLC-13, SLC-15, SLC-19, SLC-20, SLC-46, SLC-50, and SLC-48. The potential reasonable alternatives were evaluated using the following selection standards:

- Uses an SLC on the Eastern Range with Range Safety support capabilities.
- Maximizes the use of existing suitable launch infrastructure by reactivating an SLC.
- Accommodates Stoke's launch vehicle and necessary infrastructure, taking into consideration Stoke's upcoming phased program approach, which involves landing.
- Minimizes conflicts with operational restrictions related to noise, lines of sight, air installation compatible use zones, exclusionary safety zones (that is, blast danger areas, flight hazard areas, flight caution areas, and special clear areas), airfield operation clear zone, accident potential zone, explosive safety quantity distance (ESQD) arcs, and antiterrorism/force protection standards.
- Maximizes physical distances between launch service providers using liquid methane due to the explosive standards, which require greater separation to minimize ESQD arc conflicts and impacts to launch operations.
- Minimizes impacts to undisturbed land and mitigation areas.
- Able to support launches in 2025.

The evaluation determined that only SLC-14 met the operational and technical requirements of the Proposed Action and the definition of a "reasonable" alternative in accordance with 32 CFR Part 989 and 40 CFR 1508.1(z).

Description of the No Action Alternative

CEQ regulation 40 CFR 1502.14(c) requires the inclusion of a No Action Alternative in the NEPA analysis. Under the No Action Alternative, Stoke would not reactivate SLC-14 for the Stoke launch vehicle service and Stoke would not apply for a Federal Aviation Administration license. The No Action Alternative would not allow Stoke to provide a low-cost launch service to meet the goals of the National Space Transportation Policy. Although the No Action Alternative would not allow Stoke to meet the purpose and need, this alternative is carried forward as a baseline condition for comparison in accordance with 40 CFR 1502.14(c).

Summary of Environmental Findings

Environmental analyses focused on the following areas: biological resources, cultural resources, air quality and climate change, noise, hazardous material, solid waste, and hazardous waste, water resources, geology and soils, infrastructure, health and safety, land use, visual, and coastal resources, socioeconomics, environmental justice and children's environmental health and safety risks, airspace and marine transportation management, and cumulative impacts. USSF has concluded that no significant impacts would result to these resources.

Mitigations

SLD 45 shall take steps as appropriate to the action and shall monitor these as necessary to ensure that Stoke implements avoidance, minimization, and/or mitigation measures as set forth in the Final EA under the various impact categories. These avoidance, minimization, and mitigation measures include:

- Avoidance and minimization measures, as well as reporting requirements, identified in Endangered Species Act consultations with National Marine Fisheries Service and the U.S. Fish and Wildlife Service.
- Mitigation of up to approximately 0.5 acre of low-quality wetlands through the purchase of wetland mitigation bank credits.

Finding of No Significant Impact

Based on my review of the facts and analyses in the attached EA, which is hereby incorporated by reference, conducted under the provisions of NEPA, CEQ's implementing regulations, and the EIAP, I conclude that the Proposed Action would have no significant environmental impact, either by itself or cumulatively with other known projects. Accordingly, an Environmental Impact Statement is not required. This analysis fulfills the requirements of NEPA, the CEQ's implementing regulations, and the EIAP. The signing of this FONSI completes the EIAP.

Finding of No Practicable Alternative

Pursuant to Executive Orders 11988, 11990, and 13690, and considering all supporting information, I find there is no practicable alternative to the Proposed Action, which will impact floodplains and wetlands. As noted in the attached EA, there are no practicable alternatives that would avoid all impacts or further minimize impacts to wetlands based on conceptual sizing requirements and existing environmental constraints. Wetland impacts would be avoided and minimized to the greatest extent practicable during project design and permitting. The proposed improvements would be located within the floodplain as the majority of SLC-14 is located in the 100-year floodplain. The location of existing facilities and utilities, limited developable area outside the floodplain, and the requirement to avoid listed species habitat to the greatest extent possible precludes placing these improvements outside the floodplain. This finding fulfills both the requirements of the referenced Executive Orders and the EIAP regulation, 32 CFR 989.14(g) for a FONPA.

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Paul G. Filcek, Col, USAF   Date
Director, Space Force Mission Sustainment
(Engineering, Logistics, & Force Protection)

Draft

Environmental Assessment for Stoke's Nova Launch Program at Cape Canaveral Space Force Station, Florida

Stoke Space Technologies, Inc.

May 2024

Privacy Advisory

This Draft Environmental Assessment (EA) is provided for public comment in accordance with the National Environmental Policy Act (NEPA), the President's Council on Environmental Quality (CEQ) NEPA regulations (40 *Code of Federal Regulations* [CFR] Parts 1500–1508), and 32 CFR Part 989 Environmental Impact Analysis Process (EIAP).

The EIAP provides an opportunity for the public to comment on Department of the Air Force (DAF) decision-making, allows the public to offer input on alternative ways for the DAF to accomplish what it is proposing, and solicits comment on the DAF's analysis of environmental effects.

Public commenting allows the DAF to make better, informed decisions. Letters or other written or oral comments provided may be published in the EA. As required by law, comments provided will be addressed in the EA and made available to the public. Providing personal information is voluntary. Any personal information provided will be used only to identify your desire to make a statement during the public comment portion of any public meetings or hearings or to fulfill requests for copies of the EA or associated documents. Private addresses will be compiled to develop a mailing list for those requesting copies of the EA; however, only the names of the individuals making comments and their specific comments will be disclosed. Personal home addresses and phone numbers will not be published in the Final EA.

Compliance with Section 508 of the Rehabilitation Act

To the extent possible, this document is compliant with Section 508 of the Rehabilitation Act. This allows assistive technology to be used to obtain the available information from the document. Due to the nature of graphics, figures, tables, and images occurring in the document, accessibility is limited to a descriptive title for each item.

Compliance with Revised CEQ Regulations

This has been verified 75 pages, not including appendices, 40 CFR 1501.5(f). As defined in 40 CFR 1508.1(v) a "page" means 500 words and does not include maps, diagrams, graphs, tables, and other means of graphically displaying quantitative or geospatial information.

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Acronyms and Abbreviations

Acronym	Definition
ACAM	Air Conformity Applicability Model
ACHP	Advisory Council on Historic Preservation
ACM	Asbestos-containing Material
AFB	Air Force Base
AFMAN	Air Force Manual
AHPA	Archaeological and Historic Preservation Act of 1974
AIRFA	American Indian Religious Freedom Act
ALTRV	Altitude Reservation
APE	Area of Potential Effects
BA	Biological Assessment
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practice
BRL	Banana River Lagoon
BRRC	Blue Ridge Research and Consulting, LLC
CAA	Clean Air Act
CCAFS	Cape Canaveral Air Force Station
CCSFS	Cape Canaveral Space Force Station
CD	Consistency Determination
CDNL	C-weighted Day-Night Average Sound Level
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLSP	Commercial Launch Service Provider
CNS	Canaveral National Seashore
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent

Acronym	Definition
CRM	Cultural Resources Manager
CSLA	U.S. Commercial Space Launch Act
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAF	Department of the Air Force
DAFI	Department of the Air Force Instruction
dB	Decibel(s)
dBA	Decibel(s) (A-weighted scale)
DNL	Day-Night Average Sound Level
DOD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
ECS	Environmental Control System
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIAP	Environmental Impact Analysis Process
EJ	Environmental Justice
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERP	Environmental Resource Permit
ESA	Endangered Species Act
ESQD	Explosives Safety Quantity-Distance
F.A.C.	*Florida Administrative Code*
FAA	Federal Aviation Administration
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FFWCC	Florida Fish and Wildlife Conservation Commission
FIRM	Flood Insurance Rate Map

Acronym	Definition
FLAME	Hydrogen and Methane Flame Stack(s)
FLUCCS	Florida Land Use, Cover and Forms Classification System
FONSI	Finding of No Significant Impact
GHG	Greenhouse Gas
HAER	Historic American Engineering Record
ICBM	Intercontinental Ballistic Missile
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
IRL	Indian River Lagoon
IRP	Installation Restoration Program
kg	Kilogram(s)
km	Kilometer(s)
kN	Kilonewton(s)
KSC	Kennedy Space Center
$L_{A,max}$	Maximum A-weighted Sound Level
lb	Pound(s)
lbf	Pound-force
lbm	Pound mass
LBP	Lead-based Paint
LH_2	Liquid Hydrogen
L_{max}	Maximum Unweighted Sound Pressure Level
LN_2	Liquid Nitrogen
LNG	Liquid Natural Gas
LOA	Letter of Agreement
LOX	Liquid Oxygen
LPAS	Launch Pad Allocation Strategy
LPS	Lightning Protection System
LZ	Landing Zone
MBTA	Migratory Bird Treaty Act

Acronym	Definition
mg/m^3	Milligram(s) per Cubic Meter
mgd	Million Gallon(s) per Day
MINWR	Merritt Island National Wildlife Refuge
MMPA	Marine Mammal Protection Act
MTS	Marine Transportation System
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NO_2	Nitrogen Dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Air Missions
NOTMAR	Notice to Mariners
NOTU	Naval Ordnance Test Unit
NO_X	Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
O_3	Ozone
OFW	Outstanding Florida Water
OSHA	Occupational Safety and Health Administration
OSRO	Oil Spill Removal Organization
Patrick F2F	Patrick Fence to Fence Contractor

Acronym	Definition
Pb	Lead
PCB	Polychlorinated Biphenyl
PM_{10}	Particulate Matter Equal to or less than 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Equal to or less than 2.5 Microns in Diameter
ppb	Part(s) per Billion, by Volume
ppm	Part(s) per Million, by volume
psf	Pound(s) per Square Foot
RCRA	Resource Conservation and Recovery Act
ROI	Region of Interest
RWWTP	Regional Wastewater Treatment Plant
SC-GHG	Social Cost of GHG
SCTPO	Space Coast Transportation Planning Organization
SEL	Sound Exposure Level
SHPO	State Historic Preservation Office
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SLC-14	Space Launch Complex 14
SLD 45	Space Launch Delta 45
SO_2	Sulfur Dioxide
SPCC	Spill Prevention, Control, and Countermeasures
SR	State Route
SSCM	Space Systems Command Manual
Stoke	Stoke Space Technologies, Inc.
SWI	Space Wing Instruction
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
tpy	Ton(s) per Year
U.S.	United States
U.S.C.	*United States Code*

Acronym	Definition
USAF	U.S. Air Force
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USSF	U.S. Space Force
VOC	Volatile Organic Compound
WDR	Wet Dress Rehearsal

1. Purpose and Need for the Proposed Action

1.1 Introduction

The U.S. Space Force (USSF) has prepared this Environmental Assessment (EA) to analyze the environmental impacts of implementing Stoke Space Technologies, Inc.'s (Stoke's) proposed Nova Space Launch Program at an existing launch complex on Cape Canaveral Space Force Station (CCSFS), Florida. Stoke is a space and technology company founded in 2019 and headquartered in Kent, Washington. Stoke's goal is to deliver satellites to orbit for government and private sector clients ultimately using fully reusable rockets designed for rapid reuse. Stoke's program would be developed in two phases. Phase 1 involves the development and operation of expendable launch vehicles. Phase 2 would be informed by Phase 1 and involves the development and operation of a reusable launch vehicle. While Stoke's goal is reusable rockets, reusable rockets are in the developmental phase, and this EA considers the reasonably foreseeable use of expendable use rockets, as there is not enough information or data available at this time to include the Phase 2 proposals. When the technology for reusable rockets is developed into a proposal for agency action, a supplemental National Environmental Policy Act (NEPA) analysis would be performed to assess the environmental effects of Stoke's proposal and a reasonable range of potential landing alternatives, which may include landing pads at Space Launch Complex 14 (SLC-14), landing on a barge at sea, and landing at another offsite location.

USSF is the lead federal agency for this Proposed Action because it is the landowner and would license the CCSFS real property to Stoke. The National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), and the U.S. Coast Guard (USCG) are cooperating agencies.

NASA provides special expertise with respect to environmental issues concerning space launch operations. NASA would rely on the analysis contained in this EA to support its environmental review process as a potential future customer of the Stoke launch vehicle.

The FAA has a role in licensing commercial space launch operations in the United States (U.S.) and approving airspace closures for launch operations. The U.S. Congress, under the U.S. Commercial Space Launch Act (CSLA), *United States Code* (U.S.C.) Title 51, Subtitle V, Chapter 509, Sections 50901–50923, provided the Department of Transportation (DOT) with statutory direction to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] that United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities." Within the DOT, the Secretary of Transportation's authority under the CSLA has been delegated to the FAA Office of Commercial Space Transportation.

The FAA expects to receive one or more Vehicle Operator License applications from Stoke for launch operations at CCSFS. The FAA's federal action would include the following:

- Issuing one or more Vehicle Operator Licenses to Stoke, as well as potential future renewals or modifications to the Vehicle Operator Licenses for operations that are within the scope analyzed in this EA
- Developing Letters of Agreement (LOAs), if needed, with Stoke to outline notification procedures prior to, during, and after an operation, as well as procedures for issuing a Notice to Air Missions (NOTAM)

The FAA intends to adopt this EA to support its environmental review when evaluating Stoke's launch license application(s) for operations at CCSFS and related airspace closures. The FAA will draw its own conclusions from the analysis presented in this EA and assume responsibility for its environmental decision and any related mitigation measures. The successful completion of the environmental review process does not guarantee that the FAA will issue a Vehicle Operator License to Stoke, issue an LOA, or approve related airspace closures.

The USCG has authority over waters subject to jurisdiction of the U.S. pursuant to the Ports and Waterways Safety Act, 46 U.S.C. Section 700; regulatory authority of vessels as outlined in *Code of Federal Regulations* (CFR) Title 33 and Title 46; and responsibility to review and advise USSF on all launch and reentry site evaluation risk assessments regarding navigation safety. The USCG also supports USSF with early warning communication to the maritime community with Notice to Mariners (NOTMAR) as outlined in 33 CFR Part 72. The USCG evaluates every launch and reentry activity for associated risks to the marine transportation system and waterway users.

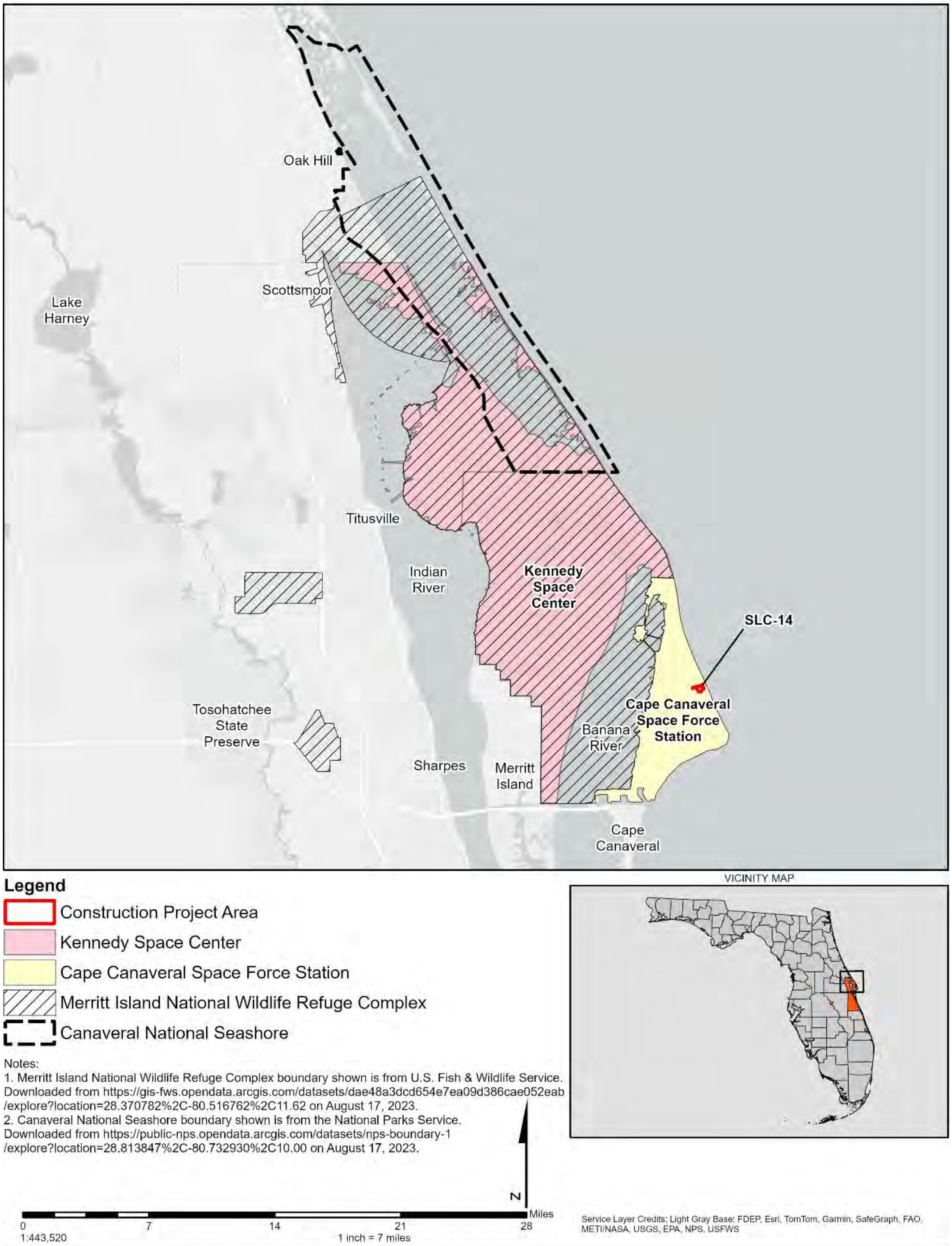
This EA has been prepared in accordance with NEPA, as amended (42 U.S.C. Section 4321, et seq.); the Council on Environmental Quality's (CEQ's) regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500 through1508); the Department of the Air Force's (DAF's) NEPA implementing regulations (32 CFR Part 989) and policy; and FAA Order 1050.1F, Environmental Impacts: Policies and Procedures, and FAA Order 1050.1F Desk Reference so that the FAA can adopt, fully or in part.

1.2 Project Setting

CCSFS occupies approximately 15,800 acres along the Atlantic Coast of Brevard County, Florida, southeast of NASA's Kennedy Space Center (KSC) on adjacent Merritt Island (Figure 1-1). It includes 81 miles of paved roads and a 10,000-foot runway (Skid Strip). Natural areas near CCSFS include the Merritt Island National Wildlife Refuge (MINWR) and the Canaveral National Seashore (CNS). SLC-14 is located on CCSFS, approximately 12,000 feet east of the Banana River and 1,000 feet west of the Atlantic Ocean, as shown on Figure 1-1. The location of SLC-14 relative to the other Space Launch Complexes (SLCs) is shown on Figure 1-2.

CCSFS is managed by Space Launch Delta 45 (SLD 45) as the primary launch site for the Eastern Range. The Eastern and Western Ranges of the National Security Space Launch program are national assets serving two major functions: long-range missile testing and operational space lift (AFSPC 2020). They are part of the Major Range and Test Facility Base construct, which is a set of test installations, facilities, and ranges that support Department of Defense (DOD) Test and Evaluation programs. They are also spaceports, providing passage to and from space and supporting U.S. national security, commercial, and civil space missions (AFSPC 2020).

Figure 1-1. Location of SLC-14 at CCSFS



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1 **Figure 1-2. Location of SLC-14 Relative to Other Space Launch Complexes**

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1.3 Purpose and Need of the Action

The purpose of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015 (Public Law 114–90, November 25, 2015), which was developed to promote the growth of a competitive space launch industry. Cost-competitive commercial space launch systems are needed to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology. The Proposed Action is needed to deliver satellites to orbit for government and private sector clients. In so doing, the Proposed Action allows for the continued fulfillment of the National Space Policy (85 *Federal Register* 81755, 2020) to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs. The Proposed Action would contribute to meeting the goals of the National Space Transportation Policy (Executive Office of the President, November 21, 2013) and DOD policy pursuant to DOD Directive 3230.3, "DoD Support for Commercial Space Launch Activities" (October 14, 1986).

USSF's federal action involves the real property agreement at SLC-14 where the Proposed Action would occur, the subsequent approval of site modifications, and the approval of launch operations. If, after the public's review of the EA, the USSF determines that the Proposed Action would not individually or cumulatively result in significant impacts on the human or natural environments, the USSF would issue a Finding of No Significant Impact (FONSI). The FAA expects to receive a Vehicle Operator License application(s) from Stoke for launch operations at SLC-14. The FAA's federal action includes issuing a Vehicle Operator License to Stoke, as well as potential future renewals or modifications to the Vehicle Operator License for operations that are within the scope analyzed in this EA; and developing LOAs with Stoke to outline notification procedures prior to, during, and after an operation, as well as procedures for issuing a NOTAM.

1.4 Agency Coordination and Public Involvement

Implementation of the Proposed Action involves coordination with several agencies. Compliance with Section 7 of the Endangered Species Act (ESA), in accordance with regulations at 50 CFR Part 402, requires consultation with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) in cases where a federal action could affect listed threatened or endangered species, species proposed for listing, or candidates for listing. The NMFS is also responsible for evaluating potential impacts to Essential Fish Habitat (EFH) and enforcing the provisions of the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600.905 et seq.). There is an existing programmatic agreement between USSF, the FAA, NASA, and NMFS regarding launch operations in the Atlantic Ocean; USSF is currently performing a review of this Proposed Action to determine applicability.

In compliance with Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations at 36 CFR Part 800, 40 CFR 1501.2(b)(4)(ii), and Executive Order (EO) 13175, "Consultation and Coordination with Indian Tribal Governments," USSF is consulting with the Florida State Historic Preservation Office (SHPO), Advisory Council on Historic Preservation (ACHP), the National Park Service (NPS), and potentially affected Indian tribes regarding the Proposed Action. Any comments received will be included and addressed in the Final EA.

Pursuant to 40 CFR 1501.5(e), EO 11990, "Protection of Wetlands," EO 11988, "Floodplain Management," and EO 13690 "Establishing a Federal Flood Risk Management Standard," early notices were published in *Florida Today* and *Hometown News Brevard* newspapers from December 17 to 22, 2023. The notices were also published in accordance with Section 106 of the NHPA (54 U.S.C. Section 306108) and its implementing regulations at 36 CFR Part 800 to notify the public that the Proposed Action has the potential to affect historic properties. The 30-day public comment period ended January 21, 2024.

Early notice letters were sent to tribal governments in accordance with 32 CFR Part 989 and Section 306 of the NHPA. The 30-day agency and tribal comment period ended on February 15, 2024, and five comments were received (Appendix A).

The Notice of Availability (NOA) of the Draft EA was advertised in *Florida Today* and *Hometown News Brevard* newspapers on May 24 and 26, 2024. The Draft EA and associated NOA were also posted on the Patrick Space Force Base website (https://www.patrick.spaceforce.mil/Resources/Environmental). Public comments were accepted through June 25, 2024. Copies of the Draft EA were provided to the public at the following library locations:

- Central Brevard Library and Reference Center, 308 Forrest Avenue, Cocoa, FL 32922
- Cocoa Beach Public Library, 550 N Brevard Avenue, Cocoa Beach, FL 32931
- Melbourne Library, 540 E Fee Avenue, Melbourne, FL 32901
- Merritt Island Public Library, 1195 N Courtenay Parkway, Merritt Island, FL 32953
- Port St. John Public Library, 6500 Carole Avenue, Cocoa, FL 32927
- Titusville Public Library, 2121 S Hopkins Avenue, Titusville, FL 32780
- Satellite Beach Public Library, 751 Jamaica Boulevard, Satellite Beach, FL 32937

2. Description of the Proposed Action and No Action Alternative

This section identifies and describes the Proposed Action and the No Action Alternative.

2.1 Proposed Action

The Proposed Action is to execute a real property agreement and reactivate SLC-14 in support of Stoke's launch program, which includes the demolition of existing structures, the construction of new facilities, and improvements to existing infrastructure, ground support operations, and launch operations.

2.1.1 Stoke Launch Vehicle

The Stoke launch vehicle, named Nova and shown on Figure 2-1, would consist of a two-stage liquid-fueled launch vehicle for commercial and government payloads. The medium-class two-stage launch vehicle would be 132 feet tall, with a gross liftoff weight of 500,000 pounds. Stage 1 would have 7 engines, a height of 89 feet, and a diameter of 12 feet; it would be fueled with 315,000 pound mass (lbm) of liquid oxygen (LOX) and 90,000 lbm of liquified natural gas (LNG). Stage 2, including payload fairing, would have 1 engine, a height of 43 feet, and a diameter of 14 feet. It would be fueled with 33,600 lbm of LOX and 6,060 lbm of liquid hydrogen (LH_2). Stage 2 would have a unique actively cooled heat shield for reentry. Stage 1 would have a sea level thrust of 3,110 kilonewton (kN) (700,000 pound-force [lbf]) and Stage 2 would have a vacuum thrust of 111 kN (25,000 lbf). Stage 1 and Stage 2 would break up upon reentry and would be expended into the ocean under the current Proposed Action. The potential reuse of the rocket would be analyzed in a separate NEPA document as the program matures.

Figure 2-1. Stoke Launch Vehicle Diagram

2.1.2 SLC-14 Facilities

SLD 45 preliminarily allocated SLC-14 at CCSFS to Stoke in 2023 pending NEPA analysis. SLC-14 was one of four launch complexes built in support of Atlas missile testing in the 1950s and was then modified to support the launch of Atlas-based space launch vehicles. SLC-14 was the launch site of astronaut John Glenn's historic mission to become the first American to orbit the Earth. SLC-14 became inactive in 1966 and was deactivated in 1967. SLC-14 was abandoned in place in 1973, and the northern portion of the launch stand was removed in 1976 because of structural deterioration (Cape Canaveral Space Force Museum 2023a). SLC-14 is one of six launch complexes that contribute to the Cape Canaveral Air Force Station (CCAFS) National Historic Landmark (NHL) district. The six launch complexes include SLC[1]-5/6, SLC-14, SLC-19, SLC-26, SLC-34, and the nonextant SLC-13. The NASA-owned Mission Control located within CCSFS is also a contributing resource to the CCAFS NHL district. The SLC-14 Blockhouse would remain accessible by the federal government while Stoke operates and maintains the launch complex.

The potential site layout of the Proposed Action is shown on Figure 2-2. New ground elements would include a launch mount/pad, propellent tank farm, engineering support facility, launch vehicle/payload processing/maintenance hangar, utilities, and roads and security.

[1] SLC is the abbreviation for Space Launch Complex, which is the current naming convention. Launch Complex is the historic naming convention.

The leased area would be approximately 179 acres and less than approximately 372,000 square feet of new impervious surfaces would be added to the existing impervious area of approximately 412,000 square feet. Construction would begin in 2024 and would be expected to take between 12 to 18 months. During construction, an approximately 36-acre (1,583,000-square-foot) area of non-impervious ground surface would be disturbed.

2.1.2.1 Demolition of Existing Structures

Seven facilities are proposed for demolition inside the complex, in addition to roads, walkways, miscellaneous pipeline stands, and cableway. The nine facilities include the following:

- SLC-14 Launch Pad and Ramp (Facility Number 8605)
- Propellant Conditioning Facility/Propellant Transfer Unit Building (Facility Number 8610)
- SLC-14 JP-4 Facility (Facility Number 1684H)
- SLC-14 LOX Storage Area (Facility Number 1684M)
- SLC-14 Flume and Skimming Basin (Facility Number 1684P)
- Traffic CHK HSE/Sentry House (Facility Number 10908)
- SLC-14 Rails and Service Tower Area (Unnumbered)

The following facilities would remain at SLC-14: the Blockhouse (Facility Number 10905), Communications Cable Building/Subcable Hut and Vault (Facility Number 10907), SLC-14 Thrust Block and Valve Pit (Unnumbered), Septic Tank (Facility Number 10906), Mercury Memorial Monument (Facility Number 8600), and Mercury Memorial (Facility Number 13514). The Mercury Memorial Monument (Facility Number 8600) has been relocated from the launch ramp into temporary storage. The Mercury Memorial (Facility Number 13514) would remain near the SLC-14 entrance on ICBM Road. A Site Kiosk (Facility Number 10901) would remain intact and be relocated for reinstallation by SLD 45.

2.1.2.2 Launch Mount/Pad

The launch mount/pad would include a lightning protection system (LPS) (catenary) on the existing impervious surface. The new ramp grade would support the horizontal transport of the launch vehicle via transporter erector to and from the hangar and launch mount. Cameras would be mounted on the planned infrastructure and would not require additional vegetation clearance. The launch mount would be a structural interface to support the vertical vehicle loads and would be positioned over the flame duct, at the end of the ramp. The launch pad would be made of refractory concrete, which is able to withstand heat exposure.

A transporter erector would transport the integrated vehicle from the launch vehicle processing facility to the launch pad. The launch pad would include an interface that would allow the vehicle to be placed at the same location for each launch. A configuration of hydraulic cylinder and power systems would rotate the vehicle from horizontal to vertical at the launch pad.

The Environmental Control System (ECS) building equipment would supply clean, conditioned air to the vehicle and separately to the payload. Backup vehicle power would be provided at the launch pad to support launch or abort in the event of a loss of range power.

The launch vehicle and payload would maintain connections to the ground at the launch pad through umbilical connections. There would be umbilical connections for ECS, vehicle/payload power, communications, inert gases, and propellants. The umbilical connections would disconnect at lift off.

Under the proposed plan, the Stoke's launch vehicle would require approximately 100,000 gallons of water during a static test fire operation and 100,000 gallons during launches. This water would be sourced from the CCSFS potable water line, utilizing the existing connection along ICBM Road at LC-14. The water would be stored in an elevated above-ground infrastructure, similar to those used at other launch sites along ICBM Road. When needed, the water would be distributed to the launch pad area from the elevated infrastructure through a network of pipes. To fill the elevated water infrastructure, fill pumps would be utilized over a 4-hour period. The water deluge system would be activated by opening large valves in the pipes, allowing gravity to drive the flow of water. Any residual launch deluge water not evaporated would be contained in the impermeable concrete flame trench or connected deluge basin, then sampled, and pumped to a percolation pond, separate from all permitted stormwater management areas, in accordance with a Florida Department of Environmental Protection (FDEP) Industrial Wastewater Discharge Permit. Inadvertent discharge of industrial wastewater (deluge water) into jurisdictional waters of the U.S. due to flame trench proximity to the retention basin would be reviewed during the permitting process and implemented into the launch pad refurbishment design.

Propellant transfer valving would be located close to the vehicle at the launch pad.

2.1.2.3 Propellent Tank Farm

The propellent tank farm would consist of the following estimated amounts; however, final tank configurations are dependent on the explosive site plan:

- 60,000 gallons of LNG with the LNG flare. An LNG impoundment basin would be constructed to contain 110% of the volume in the event of a leak or spill.
- 107,000 gallons of LOX and 1,300 gallons of gaseous oxygen (generated on site from LOX).
- 151,000 gallons of LH_2 and 31,000 gallons of gaseous hydrogen (generated on site from LH_2) surrounded on three sides by a berm/barricade.
- 35,000 gallons of cold liquid nitrogen (LN_2) and tank(s) for gaseous nitrogen (generated on site from LN_2).
- 2,100 gallons of gaseous helium.
- Hydrogen and methane flame stack(s) (FLAME).

2.1.2.4 Engineering Support Facility

An engineering support building would be constructed on the existing impervious surface near the existing Blockhouse. Launch control would be located within an existing facility at CCSFS or nearby facility offsite.

2.1.2.5 Launch Vehicle Processing/Maintenance Hangar

The launch vehicle processing/maintenance hangar would include an adjacent payload integration facility, as well as an overflow storage building and new parking areas. The hangar would house three 30-ton cranes, one 10-ton crane, Stoke engineering/payload processing support space, restrooms, necessary vehicle/payload processing storage space, a dedicated machine shop, and an avionics and electrical rework space.

2.1.2.6 Utilities

Utilities would include the following:

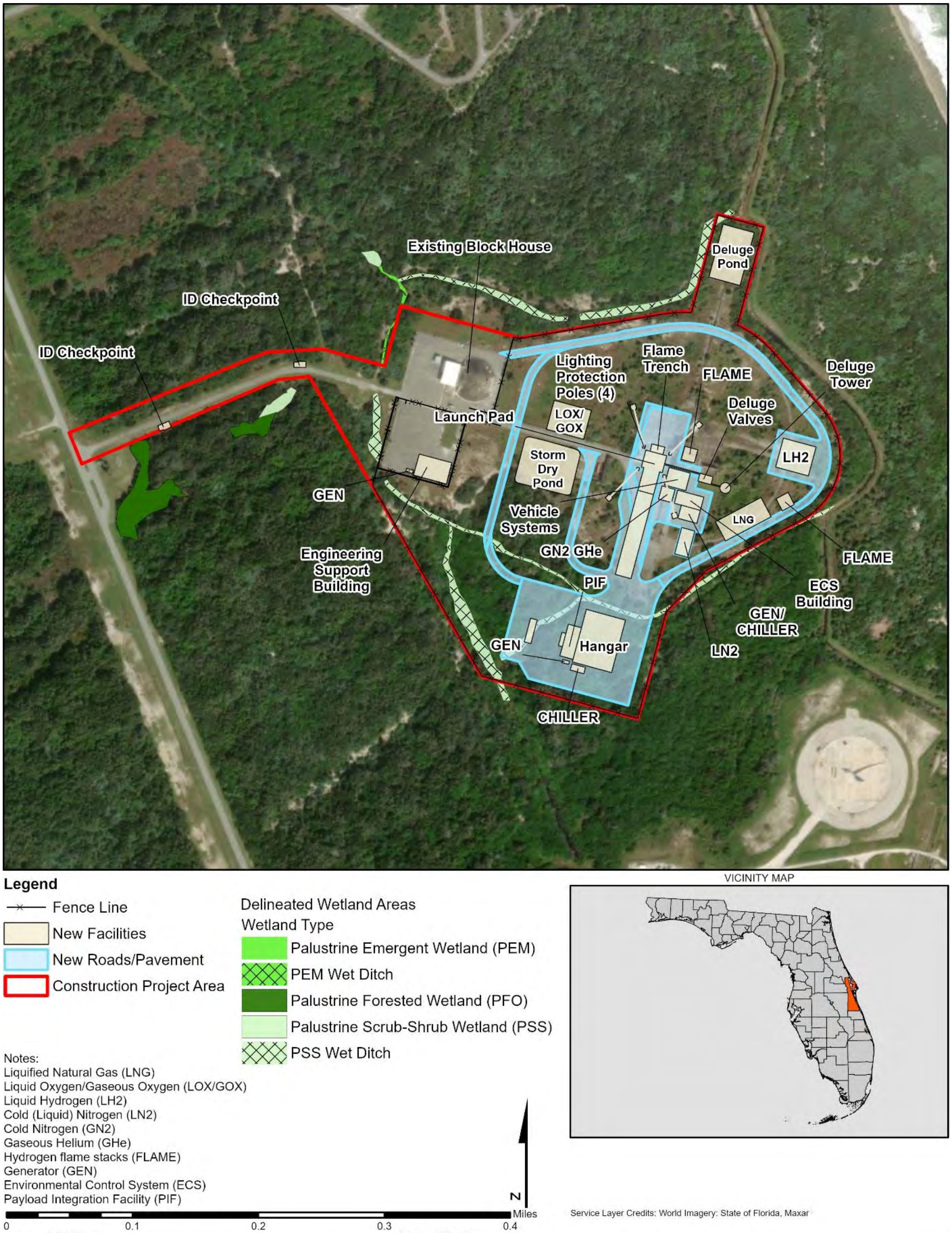
- Deluge system, including valves and a water storage tower, on the existing impervious area.
- Electrical system with 480-volt, 3-phase power at the launch site.

- Potable water, fire hydrants, and sewer at the launch site.
- Pumphouse connection for fire suppression is not available. Fire suppression would be provided by a connection to the potable water and necessary changes to water pressure would be provided at the launch pad.

2.1.2.7 Roads and Security

The existing access road would be improved to maintain access to the existing Blockhouse during Stoke's nonhazardous operations such as vehicle integration, vehicle transportation, and system checkouts. Security would be provided by a new guard house and an estimated 6-foot-tall, 6,000-foot-long perimeter fence with an access gate. Additional 12-foot-wide roads would be added within the site, as shown on Figure 2-2, to connect operational areas.

Figure 2-2. Notional SLC-14 Site Layout



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2.1.3 Ground Support and Launch Operations

A typical mission sequence would include the following steps:

1. Engine and initial stage acceptance testing would be performed and planned at the test site operated by Stoke in Washington state.

2. The new launch vehicle would be delivered from Washington to the hangar at CCSFS SLC-14. Individual launch components would be transported via DOT over-size load truck ground options. Air option exist, if necessary, for contingency. Air options would use existing airports depending on availability and then transport via DOT over-size load truck ground options. All applicable transportation regulations would be followed, and the transportation of the vehicle would be in keeping with existing transportation systems.

3. The launch vehicle would exit the hanger horizontally on a transporter and then be erected vertically on the launch pad.

4. Checkouts would be completed at the launch pad, including propellant system leak checks, valve checkouts, and Stage 1 hold down and release system checkouts.

5. Applicable review would be conducted for the operation, whether it would be wet dress rehearsal (WDR) (on/off load propellants), static fire of Stage 1 (on/off load propellants and ignite engines no longer than 150 seconds), or orbital launch attempt. Stoke anticipates one static fire with nominal results for new boosters and one integrated (Stage 1 and Stage 2) WDR upon pad activation. WDRs are currently not planned for every mission, but when accomplished, the fully integrated vehicle may remain on the pad until the launch attempt (and would likely roll back), barring any operational need to bring the vehicle horizontal and roll it back to the hangar. When Stage 1 static fires are accomplished, the booster would go horizontal and be rolled back to the hangar for final mission integration.

6. The launch vehicle would enter the automated countdown operations on the launch pad for WDR and/or integrated static fire prior to launch. Static fire tests would be limited to daytime hours and/or range availability.

7. Upon successful completion of Stage 1 static fire and/or WDR, the launch attempt would be scheduled and proceed into terminal count. The launch vehicle would lift off upon confirmation that safety criteria for launch have been met.

8. Stage separation would occur, and Stage 1 would return to Earth. Stage 1 would break up upon reentry and the inert debris would land within the Atlantic Ocean Action Area, shown on Figure 2-3. Stage 1 would perform a passivation maneuver[2] to vent residual propellant and tank pressures during coast between stage separation and Stage 1 reentry to ensure Stage 1 breaks up upon reentry.

9. Stage 2 would complete orbital insertion burns. Payload fairing doors (halves) would open, jettison from Stage 2, and the payload would separate. Payload fairing doors would burn up during reentry.

10. Stage 2 would initiate a de-orbit/disposal burn to begin Earth reentry.

11. Stage 2 would perform a passivation maneuver after the de-orbit/disposal burn, which would vent all remaining propellant. There would be no residual liquid propellant onboard at the time of reentry, and

[2] Passivation maneuver refers to the process of removing stored energy from a space vehicle to reduce the risk of high-energy releases.

the residual ullage[3] gas would be very low. This mitigates the risk of distant over-pressure occurring upon impact due to lack of propellants available to mix for detonation in the remote chance the stage remained intact during reentry.

12. Stage 2 would break up upon reentry and any remaining inert debris would land within the Atlantic Ocean Action Area as shown on Figure 2-3 and would be expected to rapidly sink.

For both stages, the vehicle would be expected to break up due to aerodynamic and aerothermal loading during reentry. While the vehicles are designed to reenter Earth's atmosphere intact for long-term reusable mission scenarios, doing so would require active cooling (for Stage 2) or active engine operation (for Stage 1), which would not occur during early phase expendable missions. Additionally, the tank pressure would be reduced during reentry, which further reduces the vehicle's structural capability. This would result in external loads exceeding the vehicle's capability during reentry and result in breakup. The propellant onboard Stage 1 would disperse while still high up in the atmosphere. Stage 1 would have a nominal flight performance reserve of 1% of the full propellant load, or 1,802 kilograms (kg) of propellant, with a maximum residual propellant of 2% of the nominal propellant load or 3,604 kg. The predicted point of maximum aerothermal heating on Stage 1 during reentry would occur at approximately 25 to 35-kilometers (km) altitude, and on Stage 2 the point of maximum aerothermal heating would occur at approximately 60 to 70-km altitude. Rocket material would be mostly stainless steel and other dense metallic materials; therefore, any debris that survived reentry and impact with the ocean would sink. In the unlikely case that debris create a maritime hazard, Stoke would work with the USCG and employ an Oil Spill Removal Organization (OSRO) contractor to remove and/or dispose of the hazard. Stoke would visually confirm that debris are clear with no hazards to navigation remaining.

The heat plume generated from Stoke's launches would travel away from the launch pad at the diverter and concrete flume. Because of the diverter and concrete flume's angle, the heat plume would extend above the tree line. As a result, it is anticipated that the heat plume would have minimal impacts at ground level. The heat plume and increased temperatures in this area would be temporary in nature and would occur only during engine ignition and dissipate rapidly. In the unlikely event of a launch anomaly, Stoke is the responsible party and would work within the National Response Framework and with local law enforcement and regulatory agencies, as applicable, to secure the hazards as quickly as possible to mitigate risk to the public and hazards to various commerce. As a launch service provider on a federal range, a contingency procedure would be developed. As the responsible party in case of a mishap, Stoke would bring the necessary resources for contingency and recovery actions to restore the area to normal operations as soon as possible after the anomalous event. Anomalies are not part of nominal operations and, therefore, would not be a part of the Proposed Action subject to review in this NEPA document.

2.1.3.1 Airspace Protocols

All launch and reentry operations would comply with the necessary notification requirements, including issuance of NOTAMs, as defined in LOAs required for a launch license issued by the FAA. A NOTAM provides notice of unanticipated or temporary closures to components of, or hazards in, the National Airspace System (NAS) (FAA Order 7930.2S, NOTAM). The FAA issues a NOTAM from 24 to 72 hours prior to a launch or reentry activity in the airspace to notify pilots and other interested parties of temporary conditions. Advance notice via NOTAMs and the identification of aircraft hazard areas would assist pilots in scheduling around any temporary disruption of flight activities in the area of operation. Launches and reentries would be infrequent, of short duration, and scheduled in advance to minimize interruption to air traffic.

[3] Ullage refers to the amount by which a container falls short of being full.

To comply with the FAA's licensing requirements, Eastern Range operations follow the procedures stated in the December 29, 2023, LOA between SLD 45 and the FAA and applicable local guidance. The LOA outlines the procedures and responsibilities applicable to operations, including notification of launch activity; communication procedures prior to, during, and after a launch; plans for contingencies/ emergencies; NOTAM issuance; and any other measures necessary to protect public health and safety. The LOA establishes responsibilities and describes procedures for SLD 45, Eastern Range operations, within airspace common to the Miami Center, Jacksonville Center, New York Center, San Juan Center Radar Approach Control, Central Florida Terminal Radar Approach Control, NASA Shuttle Landing facility, Fleet Area Control and Surveillance Facility Jacksonville, Air Traffic Control System Command Center, and Central Altitude Reservation (ALTRV) Function areas of jurisdiction. The LOA defines responsibilities and procedures applicable to operations that require the use of restricted areas, warning areas, air traffic-controlled assigned airspace, and/or ALTRVs within Eastern Range airspace. The Proposed Action would not require the FAA to alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations. All aircraft would use existing routes and procedures during temporary airspace closures.

The FAA conducts an analysis of the effects on airspace efficiency and capacity for each licensed launch operation. This analysis is documented in an Airspace Management Plan, which is completed from 3 to 5 days prior to launch or reentry. This information helps the FAA determine whether the proposed launch or reentry would result in an unacceptable limitation on air traffic. The FAA may need to work with the operator to identify appropriate mitigation strategies, such as shortening the requested launch or reentry window or shifting the launch or reentry time, if possible. The FAA often provides data to launch operators to avoid operations during days with high aviation traffic volume. Prior analyses have concluded that most commercial space launch operations result in minor or minimal impacts on commercial and private users of airspace. This outcome is primarily the result of FAA's ability to manage the airspace for all users.

Stoke would submit a Flight Safety Data Package to the FAA in advance of the launch or reentry. The package would include the launch or reentry trajectory and associated aircraft hazard areas. These aircraft hazard areas define the temporarily closed airspace that would be defined and published through a NOTAM prior to the launch or reentry. The FAA Air Traffic Organization Space Operations Office uses the aircraft hazard area information to produce an Airspace Management Plan, which describes the launch and/or reentry information and any associated impacts to the NAS. Airspace controlled by the FAA may be restricted through the activation of airspace closures.

The most common type of airspace closures are temporary flight restrictions and ALTRVs. The FAA generally uses temporary flight restrictions to protect airspace over land and up to 12 nautical miles offshore and ALTRVs to protect oceanic airspace beyond 12 nautical miles offshore. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The length of the window is primarily intended to account for the time needed for the operator to meet its mission objectives. The location and size of the closure area is defined to protect the public. For a launch or reentry, the keep-out period typically begins at the time of launch and ends when the mission has been completed, terminated, or cancelled. Airspace closures are immediately released once the mission has successfully cleared the area and no longer imposes a risk to the public. The actual duration of airspace closure is normally much less than the originally planned closure, especially if the launch or reentry window is relatively long and the launch or reentry occurs at the beginning of the window. The FAA typically begins to clear airspace and reroute aircraft in advance of a launch or reentry and directs aircraft back into the released airspace after the mission to recover to normal flow and volume.

The locations and sizes of airspace closures for commercial space operations also vary with each mission type and are influenced by multiple factors, including vehicle hardware reliability. The size of airspace closures shrinks as the results and analysis from each launch establishes reliability. For the initial launch of a new launch vehicle, the hazard areas and associated airspace closures are bigger to account for the increased risk of a vehicle failure, relative to a mature rocket. Subsequent launches of that launch vehicle will include smaller hazard areas compared to the initial launch. The airspace closures for Stoke's prelaunch testing (tank tests, wet dress rehearsals, and static fire engine tests) would be localized to an area near the pad and may extend up to approximately 13,000 feet in altitude.

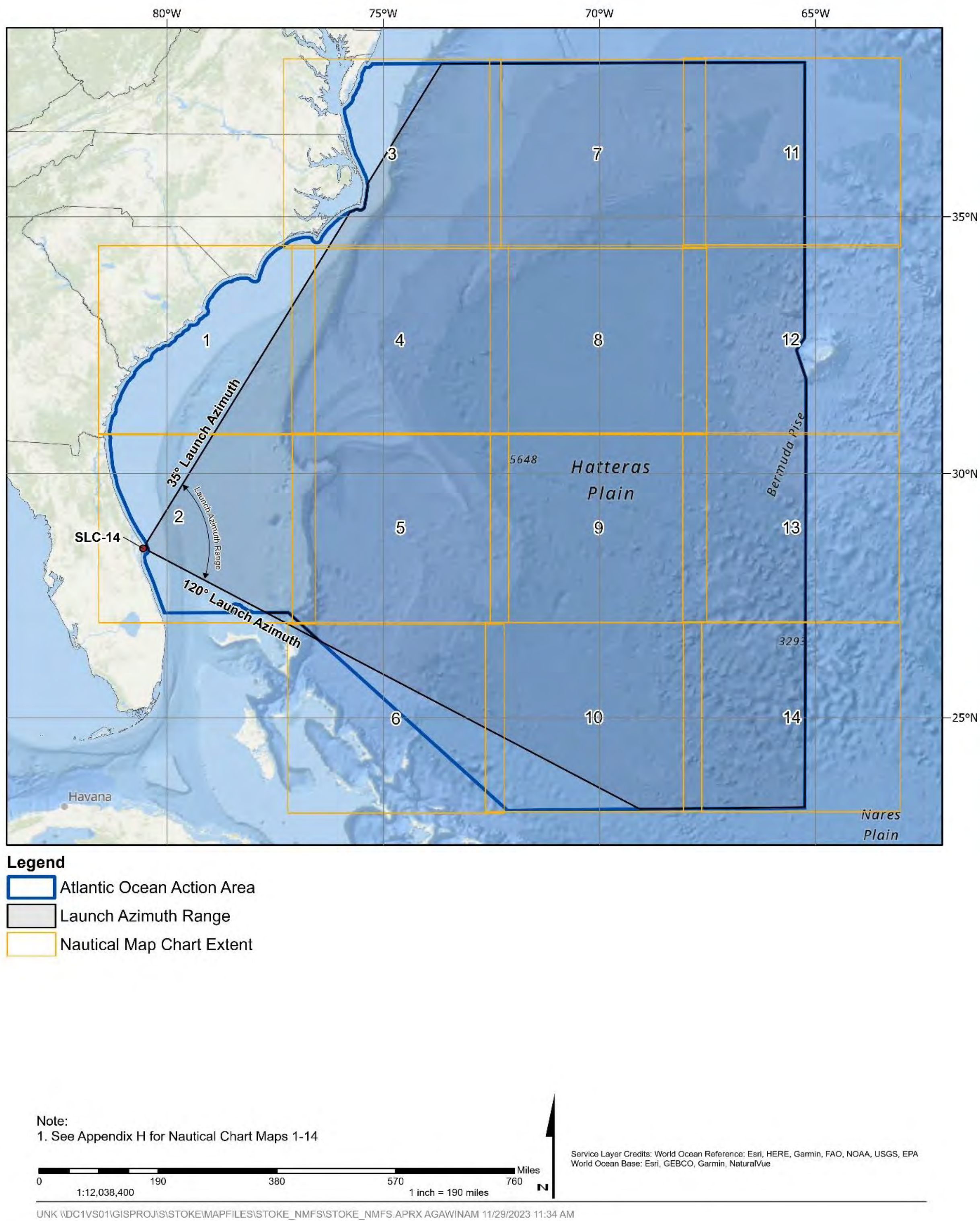
2.1.3.2 Maritime Protocols

All launch and reentry operations would comply with necessary maritime notification requirements, including issuance of NOTMARs, as defined in agreements required for a launch license issued by the FAA. A NOTMAR provides a notification regarding a temporary hazard within a defined area (a ship hazard area). A NOTMAR itself does not alter or close shipping lanes; instead, the NOTMAR provides a notification regarding a temporary hazard within a defined area.

To comply with FAA's licensing requirements, Stoke will enter into a Letter of Intent with appropriate USCG Districts in order to safely operate the launch vehicle over open ocean. The Letter of Intent would describe the required responsibilities and procedures for both Stoke and USCG during a launch, which can include a landing or reentry operation resulting in the issuance of a NOTMAR.

The USCG publishes NOTMARs weekly and as needed to inform the maritime community of temporary changes in conditions or hazards in navigable waterways. Stoke would coordinate with the National Geospatial Intelligence Agency to publish notices in international areas. Advance notice via NOTMAR and the identification of ship hazard areas would assist mariners in scheduling around any temporary disruption of shipping activities in the area of operation. Launches and reentries would be infrequent, of short duration, and scheduled in advance to minimize interruption to ship traffic.

1 **Figure 2-3. Launch Trajectory and Atlantic Ocean Action Area**



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2.1.4 Launch Trajectories

The launch trajectories of the Proposed Action would be specific to each mission and customer needs. All launches are expected to be oriented to the east over the Atlantic Ocean between allowable azimuths of 35 degrees to the northeast and 120 degrees to the southeast, as shown on Figure 2-3. Polar trajectories are not evaluated in this analysis.

2.1.5 Launch Schedule

The Proposed Action would conduct approximately 2 launches during the first year of operation in 2025, then the anticipated max launch cadence would be 10 launches per year. Preferably launches would occur during the daytime; however, up to 50% of launches may be conducted at night in accordance with FAA's airspace deconfliction policy (FAA 2023).

2.1.6 Payloads

The payloads for Stoke launches would be specific to each mission and would be processed in the payload integration facility. The mass of maximum payloads for the launch vehicle would range from 1,250 kg to 7,000 kg, depending on the destination orbit. The unique environmental effects for the specific payload would be analyzed once the payload and configuration are determined. If the payload activities are outside the completed analyses under existing NEPA documentation for payloads, such as the *Environmental Assessment for Launch of NASA Routine Payloads* (NASA 2011), then an additional NEPA assessment would be conducted. Nuclear payloads would not be anticipated.

2.1.7 Launch Operations Personnel

Stoke would anticipate having 50 personnel on site for vehicle, payload, and pad processing leading up to orbital launch attempt. Stoke would employ approximately 24 permanent engineering and technician staff at SLC-14. Additional Stoke employees would travel to the site for operations.

2.1.8 Launch Closures

The Proposed Action does not include altering the dimensions (shape and altitude) of any airspace. As discussed in greater detail in Section 2.1.3, Ground Support and Launch Operations, advance notice via NOTAMs would assist general aviation pilots in scheduling around any temporary disruption of flight in the area of operation. Launches would be less than 4 hours in duration, to the degree possible, to minimize interruption to airspace. An estimated 20% to 30% of launch attempts are scrubbed because of weather safety and/or mission assurance constraints.

SLD 45 and Stoke would coordinate with respective federal agencies for all launches to assess the risk and recommendation to limit the risk to maritime community. These actions may be in the form of the USCG implementing a Safety Zone, Security Zone and/or Regulated Navigation Area to restrict vessel transits in the flight trajectory risk evaluation. All actions associated with these restrictions will be in limited duration to minimize the effects on the local community.

On launch days, there would be a possibility of temporary restricted public access because of visitor volume on sections of MINWR and CNS. These temporary closures of MINWR and CNS would typically be related to crowd control and access for emergency services. They would be related to the volume of visitor traffic in an area and would not be related to a public safety hazard from a launch. Any potential closures due to visitor volume would be coordinated between CCSFS security, USFWS, and NPS by monitoring to ensure parking lot thresholds are not exceeded and that roadways allow for emergency egress for any form of emergency associated with large crowds. Such closures would not be expected to cause more than a minimal disturbance to the use of the resources of MINWR and CNS. All closures, whether dictated by public safety concerns or due to visitor volumes exceeding capacity, would last approximately 3 to 6 hours per launch.

Access to SLC-14 launch pad would be controlled by access gate(s) and/or a perimeter fence. Closures due to hazardous ground operation such as static fire tests, WDRs, and launches would be conducted in accordance with SLD 45's policies and procedures and would be expected to remain within federal installation boundaries, not impacting airspace, waterways, or public spaces. If a hazardous area were to extend beyond federal installation boundaries, appropriate hazard advisories and monitoring would be conducted.

2.2 No Action Alternative

Under the No Action Alternative, Stoke would not reactivate SLC-14 for the Stoke launch vehicle service and Stoke would not apply for an FAA license. The No Action Alternative would not allow Stoke to provide a low-cost launch service to meet the goals of the National Space Transportation Policy. Although the No Action Alternative would not allow Stoke to meet the purpose and need, this alternative is carried forward as a baseline condition for comparison in accordance with 40 CFR 1502.14(c).

2.3 Alternatives Considered but Eliminated from Further Consideration

In 2022, SLD 45 developed the Launch Pad Allocation Strategy (LPAS) (USSF 2022a) to account for the following priorities:

- Maximizing opportunities for the number of commercial launch service providers (CLSPs) that can be hosted at CCSFS.
- Maximizing the launch capacity of the Eastern Range.
- Minimizing the impacts that CLSPs create for other CLSPs during adjacent operations.

The following factors were considered during the planning process for LPAS for SLC-13, SLC-14, and SLC-15:

- Explosives safety quantity-distance (ESQD) arc impact to adjacent operations and ground transportation
- Frequency of launch
- Financial and technical maturity
- Environmental impacts
- Benefit to government and/or commercial industry

LPAS ensures the equitable allocation of excess launch property, while protecting and preserving National Security Space Launch and Major Range and Test Facility Base missions and addressing environmental concerns. The strategy supports the commercial space launch industry as directed by 51 U.S.C., National and Commercial Space Programs. Based on the previous criteria and delegated authority from SAF/IE, the SLD 45 Commander allocated SLC-14 to Stoke through LPAS (USSF 2022a). The allocation of SLC-14 to Stoke was an initial determination arrived at by weighing the previous factors and subject to the completion of, and compliance with, the Air Force Environmental Impact Analysis Process (EIAP) in accordance with 32 CFR Part 989. Even though Stoke was allocated SLC-14, Stoke is not precluded from carrying out the Proposed Action at another (unallocated) site at CCSFS or on KSC.

As part of the alternative development process, Stoke considered and evaluated various launch sites in accordance with 32 CFR Part 989. Potential reasonable alternatives were evaluated using the following selection standards:

- Uses an SLC on the Eastern Range with Range Safety support capabilities.
- Maximizes the use of existing suitable launch infrastructure by reactivating an SLC.
- Accommodates Stoke's launch vehicle and necessary infrastructure, taking into consideration Stoke's upcoming phased program approach, which involves landing[4].
- Minimizes conflicts with operational restrictions related to noise, lines of sight, air installation compatible use zones, exclusionary safety zones (that is, blast danger areas, flight hazard areas, flight caution areas, and special clear areas), airfield operation clear zone, accident potential zone, ESQD arcs, and antiterrorism/force protection standards.
- Maximizes physical distances between launch service providers using liquid methane due to the explosive standards, which require greater separation to minimize ESQD conflicts and impacts to launch operations.
- Minimizes impacts to undisturbed land and mitigation areas.
- Able to support launches in 2025.

The following potential alternatives were assessed but they did not meet the operational or technical requirements of the Proposed Action. Therefore, the following alternatives were determined not to meet the definition of a "reasonable" alternative in accordance with 32 CFR Part 989 and 40 CFR 1508.1(z):

- **SLC-13**: The USSF currently has a real property agreement with another CLSP that does not expire until January 2025. Therefore, this site would not meet the selection standard to support launches in 2025, given the lead time required to construct the required infrastructure, and was eliminated from further analysis.
- **SLC-15**: This SLC was eliminated because the proposed fuel type, which generates larger ESQDs, would have significant operational conflicts due to the proximity to neighboring operations with the same fuel type at SLC-16. Additionally, Stoke expects its program to mature to have a fully reusable rocket take off from and land at SLC-14 in the future. Because of safety constraints, landing zones are required to be offset by certain distances and avoid flyovers of the launch pad to the maximum extent as possible. As such, landing zones are required to be located east of the proposed launch pad. While SLC-15 has enough total acreage, the amount of land available east of the launch pad is not enough to accommodate Stoke's full future program with two landing pads. Based on these factors, SLC-15 was eliminated from further analysis.
- **SLC-19**: This SLC was eliminated because the undeveloped areas around SLC-19 are mitigation areas that have been, or are planned to be, restored to offset impacts to threatened and endangered species. As a result, SLC-19 has only approximately 24 acres of available land for development and 36 acres is necessary for construction. Therefore, this site was eliminated from further analysis.
- **SLC-20**: USSF has a real property license with Space Florida. SLC-20 is currently sub-licensed to another CLSP. Therefore, this alternative cannot accommodate Stoke's launch program and was eliminated from further analysis.

[4] Stoke's future landing zones are estimates based on the existing footprint of Landing Zone (LZ) 1 and LZ-2 at SLC-13, the assumption of the acreage for that future phase would be approximately 64 total acres to develop. To ensure enough acreage is included in the USSF real property agreement with Stoke, Stoke's full program (Phase 1 and 2) was considered. The potential buildout with the highest reasonably foreseeable acreage was used: construction of the launch pad, required infrastructure, and two landing pads.

- **SLC-46**: This SLC is a multi-user site, which launch service providers can use for their launches. Space Florida operates SLC-46 and does not allow permanent modifications to the pad infrastructure. Therefore, this alternative cannot accommodate Stoke's launch program or required infrastructure and was eliminated from further analysis.
- **SLC-50**: Although SLC-50 at CCSFS was considered, it is greenfield site with no existing infrastructure. This alternative is not an existing SLC, does not minimize costs or financial burden, and does not minimize impacts to undisturbed land. Therefore, this alternative was eliminated from further analysis.
- **SLC-48**: This SLC is an existing launch site on KSC, immediately north of CCSFS, and has a launch pad, paved roads, a fuel storage area, and a catch basin. This site was developed as a "clean pad" multi-user site for small-class vehicles that would allow each customer to bring their required resources for each launch to the site and then remove the resources after their vehicle launched, leaving an empty pad for the next user. While this site minimizes costs and impacts to undisturbed land, SLC-48 was developed for small-class vehicles with a maximum liftoff thrust of 300,000 pounds (lb). Stoke's launch vehicle is a medium-class vehicle with 500,000 lb of thrust at liftoff. Therefore, SLC-48 cannot accommodate Stoke's launch vehicle and required infrastructure and was eliminated from further analysis.

2.4 Alternatives Carried Forward for Analysis

Only SLC-14 on CCSFS was determined to meet all selection standards. As a result, the following two alternatives were carried forward for analysis in this EA:

- Stoke's Program at SLC-14, as described in Section 2.1
- No Action Alternative, as described in Section 2.2

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3. Affected Environment and Environmental Consequences

This section provides an explanation of the affected environment for each of the potentially impacted resources, along with an explanation of the potential environmental consequences associated with the Proposed Action.

The following Affected Environment sections provide an overview of the existing natural and cultural conditions within the Proposed Action area. In compliance with NEPA, the description of the affected environment focuses on those resources and conditions potentially impacted by the Proposed Action. The Affected Environment sections are organized by resource type and include a description of the existing environment and the region of influence for each resource. The region of influence is defined as the area in which project-related environmental impacts could occur. For most resources, the region of influence is limited to the CCSFS installation boundaries, as shown on Figure 3-1. However, for some resources, the potential effects of the project must be considered within the context of the surrounding vicinity. For example, the evaluation of infrastructure also includes the surrounding areas. Resources that occur across a broader area were considered on a regional scale.

The purpose of NEPA is to inform decision makers and the public of the likely environmental consequences of the Proposed Action. Consistent with these requirements, the Environmental Consequences section identifies the anticipated effects of the Proposed Action on each resource. The significance thresholds reflect FAA Order 1050.1F requirements, regulatory requirements, and standard practice. Mitigation measures or best management practices (BMPs) that would be implemented to avoid or minimize potential impacts are identified, where relevant. As required under NEPA, the environmental effects of the No Action Alternative are also evaluated.

3.1 Biological Resources

3.1.1 Regulatory Setting

The biological resource information was extracted from the SLD 45 Integrated Natural Resources Management Plan (INRMP) (USAF 2023a), the *Biological Assessment for the Environmental Assessment for the Reactivation of Space Launch Complex 14 at Cape Canaveral Space Force Station, Florida* (Appendix B; Jacobs 2023a), and from a natural resource survey of the project area (Appendix C; Jacobs 2023b). Biologists conducted the natural resources survey of habitat at the project area, completed a wetland delineation, and assessed the project area for the potential occurrence of federal and State-listed species.

Regulations concerning biological resources are discussed as follows:

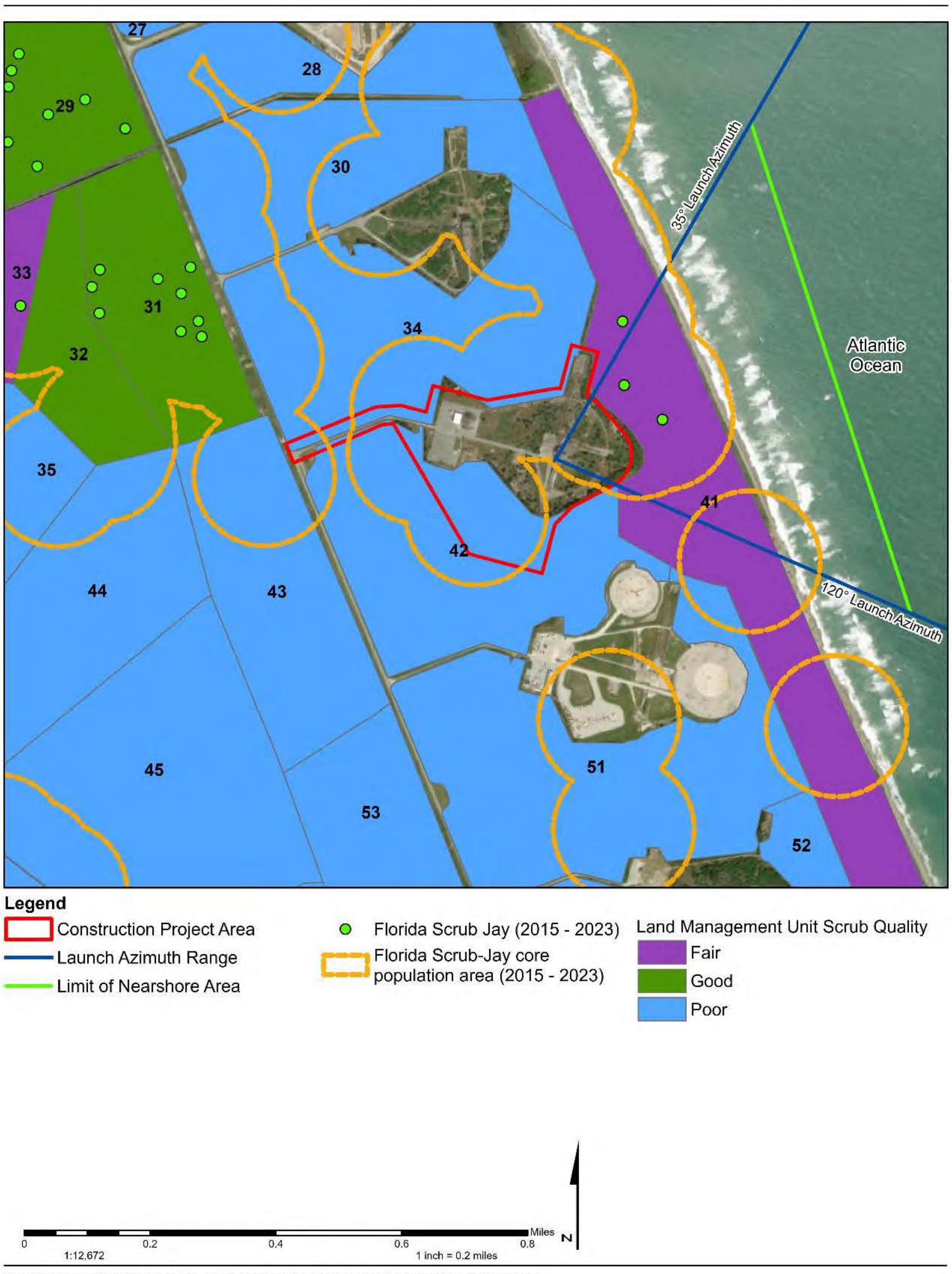
- ESA (16 U.S.C. Sections 17.1531 et seq.): The ESA was established to protect and allow for recovery of species in danger of extinction (threatened and endangered species) and their habitats. Section 7 of the ESA specifies that any agency that proposes a federal action that could affect a listed species or result in the destruction or adverse modification of its habitat must participate in an interagency cooperation and consultation process with the USFWS and/or the National Oceanic and Atmospheric Administration (NOAA) NMFS.
- Marine Mammal Protection Act (MMPA) (16 U.S.C. Sections 18.1361 through 18.1407): The MMPA protects marine mammals, including whales, dolphins, porpoises, manatees, and other marine species. Under this Act, it is unlawful to pursue, hunt, take, capture, wound, or kill a marine mammal by any means, unless otherwise authorized. USFWS and NMFS share responsibility for implementing MMPA.

- Migratory Bird Treaty Act (MBTA) (16 U.S.C. Sections 703 et seq.): The MBTA protects bird species that migrate between the U.S. and other countries. Under this Act, it is unlawful to pursue, hunt, take, capture, wound, or kill a migratory bird by any means, including any part, egg, or nest, unless otherwise authorized, such as within legal hunting seasons. The list of bird species protected by the MBTA is included in 50 CFR 10.13.
- Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. Sections 668a through 68d): This Act protects bald and golden eagles. Under this Act, it is unlawful to pursue, hunt, take, capture, wound, or kill a bald or golden eagle by any means, including any part, egg, or nest, unless otherwise authorized.
- Marine Wildlife and EFH: The Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600.305(b)(2)) requires interagency coordination if a federal agency may adversely affect EFH. The Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

3.1.2 Affected Environment

CCSFS is located on a barrier island that supports multiple plants, animals, and natural communities. The construction project area is located at SLC-14 within the CCSFS, approximately 1,000 feet west of the Atlantic Ocean and 12,000 feet east of the Banana River. The project area for launch operations includes SLC-14, where construction would occur; the vicinity of SLC-14, where noise, lighting and heat impacts may occur (Figure 3.1-1); and the Atlantic Ocean Action Area (Figure 2-3).

1 **Figure 3.1-1. SLC-14 Project Area**



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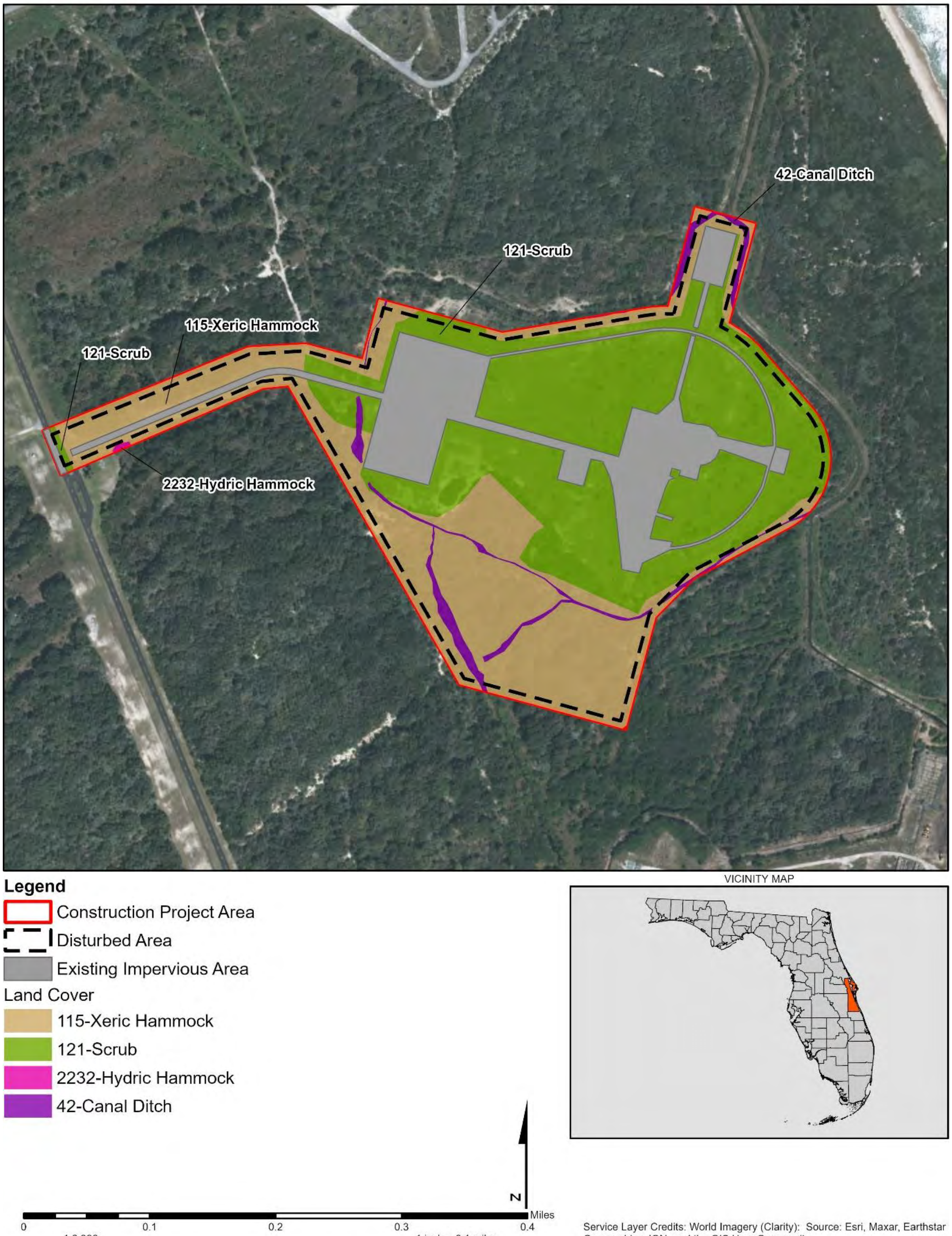
3.1.2.1 Vegetation

Figure 3.1-2 displays the Florida Land Use, Cover and Forms Classification System (FLUCCS) land cover types identified during the natural resources survey of SLC-14 and the proposed construction boundary (Jacobs 2023b). These land cover types include three upland habitats and two wetland habitats: the previously developed impervious area (9.5 acres), scrub (22.2 acres), xeric hammock (17.5 acres), canal ditch (1.6 acres), and hydric hammock (0.03 acre). The natural resources survey determined that the Brazilian pepper, a nonnative aggressive plant that can out-compete native species, has encroached upon the native vegetation communities (Jacobs 2023b). Vegetation located outside the construction boundary would not be affected by the proposed action.

1 **Figure 3.1-2. SLC-14 Land Cover**



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3.1.2.1.1 Developed Areas

The impervious area and canal ditch represent the areas previously developed within the original SLC-14 footprint. The previously developed impervious area lacks vegetation. The canal ditch within SLC-14 is overgrown with dense vegetation, including live oak (*Quercus geminata*), wax myrtle (*Myrica cerifera*), invasive Brazilian pepper (*Schinus terebinthifolia*), softstem bulrush (*Schoenoplectus tabernaemontani*), and mock bishopweed (*Ptilimnium capillaceum*) (Jacobs 2023b).

3.1.2.1.2 Xeric Hammock

Xeric hammock is an upland forest community found on well-drained sandy soils and in areas of fire exclusion. Vegetation typically consists of a closed canopy of sand live oak (*Quercus geminata*) and myrtle oak (*Quercus myrtifolia*), with an understory of shrubby oaks (multiple species), saw palmetto (*Serenoa repens*), and rusty lyonia (*Lyonia ferruginea*). Herbaceous plants typically are absent from this habitat type because of shading. (USAF 2023a)

3.1.2.1.3 Scrub

Scrub is an upland community typically found on dry, acidic, sandy ridges. Vegetation typically consists of saw palmetto, sand live oak, cabbage palm (*Sabal palmetto*), myrtle oak, and sea grape (*Coccoloba uvifera*). Groundcover usually is limited because of the density of the shrub layer. (USAF 2023a)

3.1.2.1.4 Hydric hammock

Hydric hammock is a freshwater, forested wetland with evergreen hardwoods or palm forest and a variable understory. Vegetation in hydric hammock communities typically include laurel oak (*Quercus laurifolia*), live oak, cabbage palm and red cedar. (USAF 2023a)

3.1.2.1.5 Marine or Estuarine

There are no marine or estuarine habitats within the SLC-14 project area, but additional community types (beach dune and coastal strand) occur landward from the coastline. Beach dune vegetation consists of sea oats (*Uniola paniculata*), beach elder (*Iva imbricata*), railroad vine (*Ipomoea pes-caprae*), beach croton (*Croton punctatus*), bitter panic grass (*Panicum amarum*), saltgrass (*Distichlis spicata*), camphorweed (*Heterotheca subaxillaris*), and beach cordgrass (*Spartina patens*). Coastal strand vegetation consists of bluestems (*Andropogon* spp.), camphorweed (*Heterotheca subaxillaris*), and earleaf greenbrier (*Smilax auriculata*). (USAF 2023a)

3.1.2.1.6 Wildlife

More than 25 mammalian species, 50 amphibian and reptile species, and more than 200 bird species are known to occur on or in the vicinity of CCSFS. CCSFS provides habitat for numerous resident and migratory bird species because it is situated along a major flyway route for neo-tropical migratory birds. The Atlantic Coast barrier islands are important to nesting sea turtles. (USAF 2023a)

The previously developed areas of SLC-14 may provide limited roosting or nesting habitat for bird and bat species and may also support limited foraging for terrestrial wildlife. The other areas in the project area, which consist of upland scrub and xeric hammock, provide roosting and nesting habitat for bird and bat species and support foraging and nesting habitat for wildlife. Common terrestrial wildlife species likely include the opossum (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), hispid cotton rat (*Sigmodon hispidus*), and raccoon (*Procyon lotor*). (Jacobs 2023b; USAF 2023a)

The beach dune and coastal strand community types occurring east of SLC-14 and landward from the coastline provide habitat for many mammals, reptiles, birds, and invertebrates species.

The nearshore environment, oceanward from the CCSFS coastline, is present along the Florida East Coast continental shelf and is characterized by sand and mud-covered plains with areas of hard-bottom habitats. The hard-bottom habitats are expected to harbor a diverse assemblage of reef fishes and macrocrustaceans. (NASA 2015)

The Atlantic Ocean Action Area (Figure 2-3) begins 5 nautical miles off the Atlantic Ocean coastline and consists of open ocean with habitat for various life stages of a wide range of species, including mammals, fish, reptiles, birds, and invertebrates (NMFS 2023). All marine mammals in the Atlantic Ocean Action Area, such as dolphins, whales, and seals, are protected under the MMPA and some are also protected under the ESA (USAF 2023a). EFHs occur in both the nearshore environment and open ocean (USAF 2023a).

3.1.2.2 Protected Species and Habitat

This subsection describes the wildlife species and habitats in the study area with legal protection status, including species and habitat protected by ESA, MMPA, MBTA, and BGEPA.

CCSFS contains habitat used by many federally listed ESA animal species, but no federally listed threatened or endangered plant species are known to occur there (USAF 2023a). The following information provides an overview of the 19 federally listed or candidate species under USFWS management. For additional details, refer to the biological assessment (BA) included as Appendix B.

Although there is the potential for these species to occur within the SLC-14 project area, vicinity of SLC-14, or Atlantic Ocean Action Area, it was confirmed that there is no habitat or species present for the eastern black rail (*Laterallus jamaicensis*), Carter's mustard (*Warea carteri*), or Lewis's polygala (*Senega* [*Polygala*] *lewisii*). Habitat descriptions are included in Section 6 of the BA (Appendix B). These three species are not considered further in this EA.

The Audubon's Crested Caracara (*Polyborus plancus audubonii*), southeastern beach mouse (*Peromyscus polionotus niveiventris*), Florida scrub-jay (*Aphelocoma coerulescens*), piping plover (*Charadrius melodus*), and red knot (*Calidris canutus*), wood stork (*Mycteria americana*), American alligator (*Alligator mississippiensis*), eastern indigo snake (*Drymarchon couperi*), tricolored bat (*Perimyotis subflavus*), and monarch butterfly (*Danaus plexippus*) have potential to occur within the project area. Habitat and species descriptions are included in Section 6 of the BA (Appendix B).

The gopher tortoise (*Gopherus polyphemus*) is a state-listed threatened species whose burrows provide refuge for other animal species, including the eastern indigo snake. Gopher tortoise burrows were recorded during the natural resources survey (Jacobs 2023b).

There is no habitat in the SLC-14 project area for marine turtles. The green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*) are known to nest on beaches at CCSFS and occur in nearshore waters to the east and within the Atlantic Ocean Action Area. Hawksbill sea turtle (*Eretmochelys imbricata*) does not nest at CCSFS but does occur in nearshore waters and the Atlantic Ocean Action Area. Habitat and species descriptions are included in Section 6 of the BA (Appendix B). The USSF is exempt from critical habitat designation for loggerhead sea turtle because of its INRMP, which specifies the implementation of beneficial sea turtle management actions at CCSFS (USAF 2023a). Critical habitat for the loggerhead sea turtle has been designated in the nearshore waters adjacent to CCSFS.

There is no habitat in the SLC-14 project area for the West Indian manatee (*Trichechus manatus latirostris*), but this species may occur nearby in the nearshore waters of the Atlantic Ocean to the east. Critical habitat for the West Indian manatee has been designated in the nearshore waters adjacent to CCSFS and the Banana River.

The Atlantic Ocean Action Area provides for EFH and 18 ESA species under NMFS management. The following species would occur in the Atlantic Ocean Action Area: the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), North Atlantic right whale (*Eubalaena glacialis*), sperm whale (*Physeter macrocephalus*), humpback whale (*Megatera novaeangliae*), West Indian manatee, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, Atlantic sturgeon (*Acipenser oxyrinchus*; south Atlantic distinct population segment), giant manta rays (*Manta birostris*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), shortnose sturgeon (*Acipenser brevirostrum*), and smalltooth sawfish (*Pristis pectinata*). Detailed species and habitat descriptions may be found in the Programmatic NMFS consultation (NMFS 2023).

Critical habitat for the North Atlantic right whale and loggerhead sea turtle has been designated along the Atlantic Coast, which includes the Atlantic Ocean Action Area (USAF 2023a). The bald eagle, which is protected by BGEPA, has the potential to occur in the vicinity of SLC-14. In addition, CCSFS provides many areas of suitable foraging and roosting habitat for migratory birds, which are protected by the MBTA.

3.1.3 Environmental Consequences

The effects on biological resources are considered significant if one or more of the following criteria are met with the implementation of the Proposed Action:

- Jeopardize the continued existence of a federally listed or proposed endangered or threatened species or its habitat, or would result in the destruction or adverse modification of critical habitat.
- Substantial loss of populations or habitat of a federal species of concern or otherwise regionally rare or sensitive species that could jeopardize the continued existence of that species in the project region.
- Substantial loss or long-term disruption of a major wildlife movement corridor.
- Substantial loss of native plant or animal species or community diversity.

3.1.3.1 Proposed Action

This section addresses potential impacts to biological resources from the Proposed Action. The areas assessed include SLC-14, surrounding land management units where indirect operational effects could occur, and the Atlantic Ocean Action Area where direct operational effects could occur.

3.1.3.1.1 Common Vegetation and Wildlife

Approximately 8.6 acres of native habitat would be permanently lost by construction of new facilities and infrastructure improvements, including scrub, xeric oak habitat, and portions of a canal ditch. Most wildlife species would be expected to vacate the site to other available habitat areas, though mortality to less mobile common wildlife could occur. Wildlife species may also be startled during launch operations due to human presence and noise from the rocket. Effects from the heat of the rockets are expected to be minimal because species would likely vacate due to noise at the launch pad during operations. The Proposed Action would result in less than significant impacts to common terrestrial vegetation and wildlife from disturbance during construction and operation activities, given the prevalence of the species elsewhere.

3.1.3.1.2 Protected Species

A BA was prepared and submitted to USFWS on August 1, 2023, to support Section 7 consultation with USFWS for reactivation of SLC-14. The BA provides a detailed assessment of the Proposed Action's effects on federally-listed species managed by USFWS. Table 3.1-1 summarizes the effects determinations and necessary mitigation measures for USFWS-managed ESA species. Details of the effects determinations for USFWS-managed species are included in of the BA (Appendix B).

Table 3.1-1. USFWS Protected Species Effects Determination

Species Type	Common Name	Scientific Name	Federal Status	Effects Determination	Mitigation Measures
Mammal	Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	Threatened	Likely to adversely affect	Stoke would contribute to SLD 45 offsite habitat restoration fund and monitor remaining habitat. SLD 45 would continue to implement its prescribed fire program.
Mammal	West Indian Manatee	*Trichechus manatus latirostris*	Threatened	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.
Mammal	Tricolored bat	*Perimyotis subflavus*	Proposed Endangered	May affect but is not likely to adversely affect (if listed)	Pre-construction surveys. Structures to be demolished or refurbished would be searched for roosting bats prior to work and no work would occur until bats vacate the structure and paths of entry to the building are sealed.
Bird	Florida Scrub-jay	*Aphelocoma coerulescens*	Threatened	May affect but is not likely to adversely affect	Comply with SLD 45 Scrub-jay Management Plan (USAF 2023a). Scrub habitat restoration, heat plume monitoring, and pre-clearing nest surveys. Flag scrub-jay nests and no clearing would be allowed within 300 feet until all birds have fledged. SLD 45 would continue to implement its prescribed fire program.
Bird	Audubon's Crested Caracara	*Caracara plancus audubonii*	Threatened	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.
Bird	Piping Plover	*Charadrius melodus*	Threatened	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.
Bird	Red Knot	*Calidris canutus rufa*	Threatened	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.

Species Type	Common Name	Scientific Name	Federal Status	Effects Determination	Mitigation Measures
Bird	Wood Stork	*Mycteria americana*	Threatened	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.
Reptile	American Alligator	*Alligator mississippiensis*	Threatened (by similarity of appearance)	May affect but is not likely to adversely affect	No conservation or compensation measures are proposed.
Reptile	Eastern Indigo Snake	*Drymarchon corais couperi*	Threatened	May affect and is likely to adversely affect	Complying with the SLD 45 Indigo Snake Protection/ Education Plan (USAF 2023a). Display educational posters prominently at the site; stop work in an area of eastern indigo snake; report all observations of live or dead indigo snakes to USFWS.
Reptile	Green Sea Turtle	*Chelonia mydas*	Threatened	May affect but is not likely to adversely affect	Permanent exterior lighting would comply with the SLD 45 Space Wing Instruction (SWI) 32-7001, *Exterior Lighting Management* (April 23, 2018). Employ turtle monitoring protocols per SLD 45 Sea Turtle Management Plan (USAF 2023a).
Reptile	Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	May affect but is not likely to adversely affect	Permanent exterior lighting would comply with the SLD 45 Instruction (SWI) 32-7001, *Exterior Lighting Management* (April 23, 2018). Employ turtle monitoring protocols per SLD 45 Sea Turtle Management Plan (USAF 2023a).
Reptile	Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	May affect but is not likely to adversely affect	Permanent exterior lighting would comply with the SLD 45 Instruction (SWI) 32-7001, *Exterior Lighting Management* (April 23, 2018). Employ turtle monitoring protocols per SLD 45 Sea Turtle Management Plan (USAF 2023a).
Reptile	Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	May affect but is not likely to adversely affect	Permanent exterior lighting would comply with the SLD 45 Instruction (SWI) 32-7001, *Exterior Lighting Management* (April 23, 2018). Employ turtle monitoring protocols per SLD 45 Sea Turtle Management Plan (USAF 2023a).

Species Type	Common Name	Scientific Name	Federal Status	Effects Determination	Mitigation Measures
Reptile	Loggerhead Sea Turtle	*Caretta*	Threatened	May affect but is not likely to adversely affect	Permanent exterior lighting would comply with the SLD 45 Instruction (SWI) 32-7001, *Exterior Lighting Management* (April 23, 2018). Employ turtle monitoring protocols per SLD 45 Sea Turtle Management Plan (USAF 2023a).
Insect	Monarch Butterfly	*Danaus plexippus*	Candidate	May affect but is not likely to adversely affect	No project-specific conservation or compensation measures are proposed. However, SLD 45 would continue to implement its prescribed fire program.

The gopher tortoise is a former federal candidate species and is proactively managed by SLD 45. To the extent possible, gopher tortoise burrows would not be disturbed in accordance with Florida Fish and Wildlife Conservation Commission (FFWCC) guidelines. No more than 90 days before and no fewer than 72 hours before any clearing or construction, a 100% pedestrian survey would be conducted to locate and flag/stake all burrows. Gopher tortoise burrows in areas to be cleared, areas for new construction, or on the shoulder of roads to be rebuilt would be excavated, and captured tortoises would be relocated in accordance with FFWCC guidelines to the SLD 45-approved recipient site on CCSFS.

The FAA, USSF, and NASA conducted programmatic consultations with NMFS that considered ESA-listed marine mammals, sea turtles, and fish and EFH protected under the Magnuson-Stevens Fishery Conservation and Management Act. A project-specific review was prepared and submitted to NMFS on February 1, 2024, to determine if the proposed activity is within the existing programmatic consultation with NMFS (Appendix D). The density of species is low in the open ocean and impacts to species under NMFS regulation would be unlikely. Appropriate environmental protection measures specified in Table A-1 of the project-specific review (Appendix D) would be implemented to avoid or minimize the effects on ESA-listed species and designated critical habitat in the Atlantic Ocean Action Area to assist in the conservation of these resources (NMFS 2023). On April 12, 2024, NMFS determined proposed action is covered under the programmatic letter of concurrence.

The SLD 45 has a MBTA federal depredation permit for CCSFS that covers all migratory bird species occurring on CCSFS. The Migratory Bird Permit (MB673776-0) issued by USFWS for CCSFS does not allow for the "take or release of any migratory birds, nests, or eggs on federal lands without additional prior written authorization from the applicable federal agency." To avoid potential effects on nesting birds, including birds protected under the MBTA, areas will be monitored for the presence of bird nests. If a nest with an egg is identified, SLD 45 biologists will be notified and a determination will be made regarding whether work must be adjusted to avoid impacts to the nest.

While effects to protected species are possible from the Proposed Action, these effects would be mitigated and mitigations would be approved by the appropriate regulatory authorities, including the USFWS and NMFS. Consequently, effects to protected species would be less than significant.

3.1.3.2 No Action Alternative

Under the No Action Alternative, Stokes would not construct or operate at SLC-14 and there would be no impact to vegetation or wildlife species, including special status species, or terrestrial communities in the Proposed Action area.

3.2 Cultural Resources

3.2.1 Regulatory Setting

Cultural resources consist of prehistoric and historic districts, sites, buildings, structures, objects, artifacts, and any other physical evidence of human activity considered important to a culture or community for scientific, traditional, religious, or other reasons. They include archeological resources, both prehistoric and historic; historic architectural resources; American Indian sacred sites; traditional cultural properties; and historic properties defined in 36 CFR 800.16(l)(1) as properties that are listed in, or are eligible for listing in, the National Register of Historic Places (NRHP).

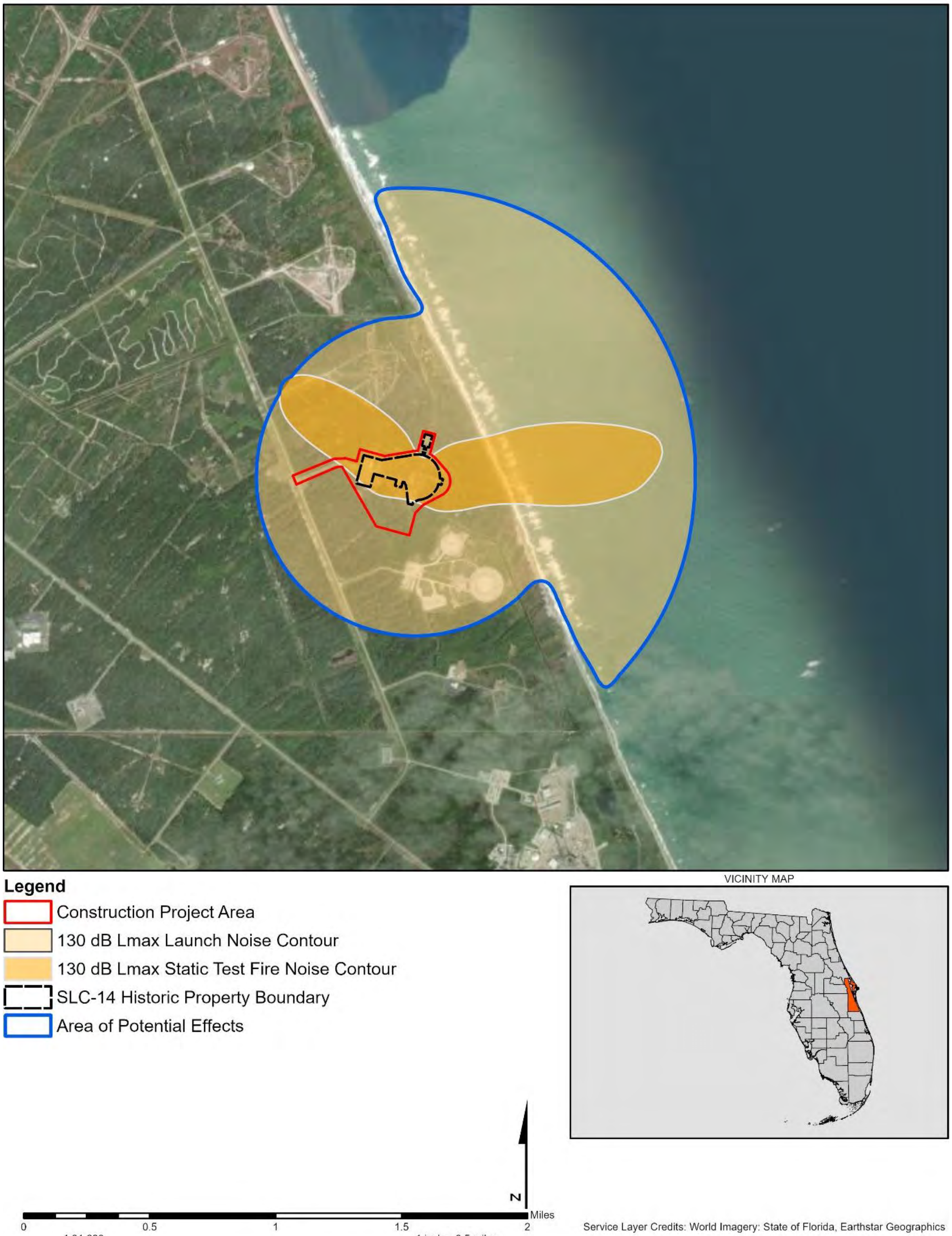
Regulations concerning cultural resources include the following:

- NHPA (54 U.S.C. Sections 300101 et seq.): NHPA includes two important sections: Section 106 and Section 110. Section 110 mandates that federal agencies assume responsibility for the preservation of historic properties that fall under the agency's jurisdiction and must carry out their undertakings in accordance with the purpose of the NHPA. Section 106 requires federal agencies to identify and assess effects from their undertakings on historic properties.
- Archaeological and Historic Preservation Act of 1974 (AHPA) (16 U.S.C. Section 469): AHPA requires the preservation of historical and archeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as the result of an alteration of the terrain caused by any federal construction project or federally licensed activity or program. It requires consultation with the SHPO, any potentially impacted Native American groups, and the responsible Department of Interior bureaus and offices.
- American Indian Religious Freedom Act of 1978 (AIRFA) (42 U.S.C. Section 1996). AIRFA protects the rights of Native Americans to exercise their traditional religions by ensuring access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Any effects that may occur by providing access to such sites may trigger Section 106 review under the NHPA. It requires consultation with the SHPO and any potentially impacted Native American groups.
- Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) (25 U.S.C. Sections 3001 et seq.). NAGPRA provides a process for museums and federal agencies to return certain Native American cultural items (human remains, funerary objects, sacred objects, or objects of cultural patrimony) to lineal descendants and culturally affiliated American Indian tribes and Native Hawaiian organizations. Under NAGPRA, permits for the excavation and/or removal of "cultural items" protected by the Act require Tribal consultation, as do discoveries of "cultural items" made during activities on federal or tribal lands.
- Air Force Manual (AFMAN) 32-7003, *Environmental Conservation.* AFMAN 32-7003 provides for the protection of cultural resources on USAF-managed lands.
- Department of the Air Force Instruction (DAFI) 90-2002, *Interactions with Federally Recognized Tribes.* DAFI 90-2002 provides procedures for the interaction with tribes who have a documented interest in DAF lands and activities. It assigns responsibilities and outlines procedures to guide DAF interactions with federally recognized tribes.

Compliance with Section 106 of the NHPA requires consultation with the SHPO, Tribal Historic Preservation Officer, American Indian tribes, and other consulting parties. It may also require consultation with the ACHP. The Section 106 process establishes the Area of Potential Effects (APE), identifies and evaluates historic properties in the APE, and assesses whether the undertaking or action would cause adverse effects on historic properties (36 CFR 800.3 through 800.6).

The APE is "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties if such properties exist. The APE is influenced by the scale and nature of the undertaking and may be different for various kinds of effects caused by the undertaking" (36 CFR 800.16(d)). For this EA, the APE is defined as the area where the Proposed Action would have the potential to affect historic properties. The APE includes all areas where demolition of existing facilities, construction of new facilities, improvements to existing infrastructure, and noise and vibration from launch activities could affect historic properties from the reactivation of SLC-14. The 130-decibel (dB) noise contour was used to conservatively assess the extent of potential effects of noise and vibration on buildings and structures, which is the threshold for potential structural damage used in the BRRC Noise Study (Appendix G). The 1,140-acre APE spans terrestrial and submerged areas, totaling 498 acres on land and 642 acres under water (Figure 3.2-1).

Figure 3.2-1. Area of Potential Effects



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3.2.2 Affected Environment

Numerous archeological and historical investigations and projects have been conducted for the launch complexes at CCSFS. The documents range from identification and evaluation reports to interpretive efforts and presentations. The following is a summary of the information provided in these reports.

3.2.2.1 Archeological Resources

CCSFS is within the archeological east and central cultural area that stretches from the Florida border with eastern Georgia to the northern terminus of the Kissimmee River drainage wetlands, and west to within 30 miles (48 km) of Tampa Bay (Milanich 1994). The earliest known evidence of human occupation at CCSFS dates to at least 5,000 Before Common Era, though exact dates are uncertain because of the lack of radiometric data. In addition to the potential for previously unrecorded prehistoric sites, undiscovered historic sites may also be present at CCSFS. Maritime transport was prevalent during the historical period in the region, and numerous shipwrecks have been submerged along the east coast of Florida (USAF 2023b).

As described in the SLD 45 Integrated Cultural Resources Management Plan (ICRMP) (USAF 2023b), CCSFS has zones of archeological potential where prehistoric sites will probably be located. The APE is in a low probability zone for archeological sensitivity (USAF 2023b). CCSFS is extensively covered by previous cultural resources surveys, and previous investigations have occurred in the APE (USAF 2023b). None of the previously identified archeological sites, cemeteries, or burials are in the APE. Ground-disturbing activities associated with SLC-14 have occurred within the APE in multiple episodes, and various fill and grading activities have occurred since the late 1950s. The APE is in Anclote complex and urban land soils with 0 to 2% slope and very poor draining marine terrace soils (USDA 2022). Therefore, the likelihood of encountering intact buried archeological resources is low.

3.2.2.2 Native American Tribes

Early cultural associations in the region are linked with the Ais people, who inhabited the area along the Indian River and east coast of Florida during the sixteenth and seventeenth centuries. Although no definitive lineage has been determined for the Ais, the Ais people are recognized as ancestors by the present-day Miccosukee and Seminole tribes. Thus, the Seminole Tribe of Florida, Seminole Nation of Oklahoma, and the Miccosukee Tribe of Florida are consulted in the treatment of Ais sites at CCSFS (USAF 2023b). The Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida stated that they do not wish to review or participate in any action unless it involves a prehistoric archeological site or a request under NAGPRA (25 U.S.C. Sections 3001 et seq.) (USAF 2023b). Given the limited likelihood of archeological resources, there is also a low potential of encountering resources of Native American concern. The Seminole Nation of Oklahoma did not respond to the invitation to consult.

3.2.2.3 Historic Period Resources

CCSFS contains extant buildings and structures related to the military period that began there after 1950. Numerous historic resources studies have documented the pre-military and military uses of CCSFS from the 1840s to 1950s, and the APE is fully documented. Many historic period sites are associated with U.S. missile testing and space launch programs, in particular those associated with the Cold War era (USAF 2023b). The Cape Canaveral Lighthouse is the only extant resource that predates CCSFS and is the earliest historic period site near SLC-14, though it is more than 2 miles (3.2 km) away from the APE (Cape Canaveral Lighthouse Foundation 2023).

The APE contains three launch complexes: SLC-13, SLC-14, and SLC-15. SLC-13 and SLC-15 are in the area where noise and vibrations from launch operations may occur. SLC-13 and SLC-15 are determined not eligible for listing in the NRHP by SLD 45 with the SHPO's concurrence. SLC-14 is the only launch complex in the project footprint where construction activities would occur for the Proposed Action. SLC-14 is a historic property and contributing resource to the CCAFS NHL district under Criteria A and C. It has also been determined individually eligible for listing in the NRHP by SLD 45, with the SHPO's concurrence. SLD 45 has determined that SLC-14 is also eligible under Criteria B and D. No important cultural resources are known to exist in the APE that are not also NHPA historic properties.

3.2.2.3.1 SLC-13

SLC-13 and SLC-14 were constructed from 1956 to 1958 from the same set of site plans for the Atlas program along with two other originally identical launch complexes (SLC-11 and SLC-12) in Missile Row. SLC-13 was modified in 1966 and was deactivated in 1978. The Mobile Tower was demolished in 2005, and the Blockhouse was demolished in 2012. In 2015, SLC-13 was reactivated for vertical orbital class rocket fly-back operations. All standing structures and buildings were removed prior to the reactivation of SLC-13, when it was renamed Landing Zone (LZ) 1 (Cape Canaveral Space Force Museum 2023b). The SLC-13 foundational remnants are determined not eligible for listing in the NRHP by SLD 45 with the SHPO's concurrence, though the site remains honorarily listed as one of the six launch complexes in the CCAFS NHL district (refer to Section 3.2.1.4 for further discussion).

3.2.2.3.2 SLC-14

SLC-14 was constructed from 1956 to 1958 to support the Atlas research and development program and is a contributing resource to the CCAFS NHL district for its use during the Atlas program when USAF developed the nation's first intercontinental ballistic missile. The Atlas was combined with a second stage Agena launch system to facilitate a variety of low Earth orbit to deep space missions. SLC-14 and the three originally identical launch complexes (SLC-11, SLC-12, and SLC-13) were used for the Atlas-Agena combination (NPS 1984). In total, SLC-14 supported 32 Atlas and Atlas-Agena launches, which included four crewed launches for the Mercury program and seven uncrewed launches for the Gemini program. The Mercury Memorial (Facility Number 13514) stands outside SLC-14. A time capsule is buried with the memorial and several bronze plaques are present at the site.

SLC-14 has been periodically changed, reused, or demolished and rebuilt to support the technical nature of operations. Built in 1957, the launch pad, ramp, and Blockhouse are the primary and oldest portions of the site. Various tower configurations were used for testing, though the tower is no longer present. Ancillary structures were erected throughout its use, including the Mercury Memorial/Mercury Memorial Monument (Facility Nos. 8600 and 13514) dedicated on November 10, 1964 (USSF Historical Foundation 2023). SLC-14 was deactivated in 1967, and the consoles, machinery, cabling, pipeline, and power, safety, lighting, and cooling systems were mostly removed and reused in other complexes. SLC-14 was abandoned in 1973 (Hinder 2003; USAF 2023b). In 1976, the northern portion of the launch stand was removed because of structural deterioration, and the remainder of the launch stand and ramp remain extant in poor condition from the corrosive environment. In 1998, the Blockhouse was restored and converted into a meeting space, while other features, such as the ready building, remain abandoned in place (Hinder 2003).

As noted earlier, SLC-14 is a contributing resource to the CCAFS NHL district under Criteria A and C and has also been determined individually eligible for listing in the NRHP by SLD 45 under Criteria A, B, C and D. An example of Cold War architecture and engineering, SLC-14 was the first of the four original Atlas launch pads to become operational and is the site of the first Atlas intercontinental ballistic missile (ICBM) launch that occurred on June 11, 1957. Between 1962 and 1963, the first four human-carrying orbital Mercury flights were launched from SLC-14. John Glenn was the first American to orbit the Earth aboard Friendship 7 on February 20, 1962, followed by Scott Carpenter, Walter Schirra, and Gordon Cooper. The Mercury Memorial and Mercury Memorial Monument commemorate the Mercury astronauts' significant life achievements, which include John Glenn's piloting of Friendship 7 after the auto-pilot function failed (NARA 2023; USSF Historical Foundation 2023). A time capsule containing important information from the Mercury program is buried near the memorials and is intended to be opened on the 500th anniversary of the program's conclusion in 2464. SLC-14 is accessed via ICBM Road, which has been separately recorded and determined eligible for listing in the NRHP with the SHPO's concurrence (Rogers et al. 2020). It was found eligible under Criterion A for its association with the launch complexes. From 1956 to 1957, ICBM Road was constructed for the four original complexes and provided access for early missile and space exploration programs.

A Historic American Engineering Record (HAER) was prepared for SLC-14 in 2003 (Hinder 2003). The HAER provides a chronological physical description and historical context for SLC-14. In 2008, updated HAER documentation was prepared by the SLD 45 Cultural Resources Manager (CRM) for SLC-14 and other launch complexes. Additional historic resource studies and 3D digital documentation including high-definition scanning were prepared by Heritage Documentation Programs of the NPS, CCSFS, USACE Construction Engineering Research Laboratory, and the SLD 45 CRM (Penders 2009). Historic preservation projects at CCSFS developed physical exhibits and presentations, as well as additional digital preservation projects, including multiple publicly accessible websites, web mapping tools, animations, virtual tours, documentaries, and videos.

A visual inspection of the existing launch pad ramp structure at SLC-14 was completed on May 15, 2023, and a Structural Assessment Services report was prepared on May 22, 2023. The Structural Assessment Services report details the results gathered by visual inspection (BRPH 2023). The report describes the existing deteriorated conditions of the launch pad and ramp, indicating that the steel is heavily corroded, with portions having been completely corroded away (BPRH 2023).

3.2.2.3.3 SLC-15

SLC-15 was built from 1957 to 1966 and used for Titan I and II test launches. SLC-15 was built from the same set of plans as three other complexes (SLC-16, SLC-19, and SLC-20) in Missile Row. The last launch from SLC-15 occurred in 1964, and the site was deactivated before it was partially demolished in 1967. In 2011, the remaining standing structures that had been abandoned in place, including the Blockhouse, were demolished (Lethbridge 2023). The SLC-15 foundational remnants are determined not eligible for listing in the NRHP by SLD 45 with the SHPO's concurrence (USAF 2023b).

3.2.2.4 National Historic Landmark Designation

SLC-14 is a contributing resource to the CCAFS NHL district. The NHL district nomination was prepared in 1983 at the recommendation of the Man in Space NHL Theme Study (Butowsky 1984). The NHL nomination identified the 132.5-acre CCAFS NHL district, which was designated on April 16, 1984, by the NPS. In 1993, SLD 45 determined that SLC-14 was also eligible for listing in the NRHP as an individual historic property (McCarthy et al. 1993). The discontinuous district that spans CCSFS and NASA properties included six launch complexes (SLC-5/6, SLC-26, SLC-13, SLC-14, SLC-19, and SLC-34), Hangar S, and the Mission Control Center at the time of listing (NASA owns SLC-5/6, Hangar S, and the Mission Control Center). The NHL district nomination indicates that the CCAFS NHL district is significant at the national level under NRHP Criterion A in the areas of communications, science, and space exploration, and under Criterion C for its engineering with a period of significance from 1949 to 1984 (the time of designation). The NHL nomination and SLD 45's commitment to documentation and public history programming recognizes the need for CCSFS to make contributions to future space missions and that this requirement should not be encumbered by the nomination; this applies not only to operational matters, but also to the use of existing facilities and the design flexibility needed to add or expand facilities. In the designation of the NHL district, the Department of the Interior recognized that future Air Force missions may require reactivation of SLC-14 and specifically included language to that effect in the designation. "It was the consensus of the Board that designation of these facilities should not interfere with the mission of the United States Air Force at Cape Canaveral Air Force Station."

SLC-14 is generally bounded by the physical constraints of the launch complex and Blockhouse (NPS 1984; USAF 2023b). Information compiled from the SLD 45 2023 ICRMP and SHPO files demonstrate it has 14 previously recorded contributing resources. Of the 14 previously recorded contributing resources, 11 contributing resources remain either partially or fully extant, and 3 contributing resources are nonextant or being removed by a separate action (refer to Table 3.2-1). The 14 previously recorded contributing resources are as follows:

- One site (SLC-14 site)
- Six structures (SLC-14 Launch Pad and Ramp, SLC-14 JP-4 Facility, SLC-14 LOX Storage Area, SLC-14 Flume and Skimming Basin, SLC-14 Rails and Service Tower Area, and SLC-14 Thrust Block and Valve Pit)
- Six buildings (Propellant Conditioning Facility/Propellant Transfer Unit Building, Paint Storage Building/POL Building, SLC-14 Blockhouse, Contractor Support Building/Ready Building, Communications Cable Building/Subcable Hut and Vault, and SLC -14 Water Demineralization Building)
- One discontinuous site (Mercury Memorial/Mercury Memorial Monument).

The Mercury Memorial/Mercury Memorial Monument is discontinuous with two locations, the Mercury Memorial and the Mercury Memorial Monument. The Mercury Memorial (Facility Number13514) is near ICBM Road, and the Mercury Memorial Monument (Facility Number 8600) is a plaque formerly located on the Launch Pad and Ramp that has been relocated from the Launch Pad and Ramp to storage. The three previously recorded contributing resources that are no longer extant are as follows:

- Paint Storage Building/POL Building
- Contractor Support Building/Ready Building
- Water Demineralization Building

Additional features, such as the cableway, retaining walls, fences, roads, walkways, and miscellaneous pipeline stands were not recorded separately and are counted as contributing features of the overall site. Other facilities within the site boundaries (Hazard Storage Shelter, Site Kiosk, Septic Tank, and Traffic CHK HSE/Sentry House) are considered not eligible and noncontributing to the site. Refer to Table 3.2-1 for a complete list of SLC-14 contributing resource facilities and Figure 3.2-2. for previously recorded historic properties identified in the APE.

1 **Table 3.2-1. Contributing Resources at SLC-14**

Florida Master Site Form Number	Facility Number	Feature	Type	NRHP Status	Extant/ Nonextant
8BR2209	Not applicable	SLC-14 site[a]	District	Individually NRHP-eligible district, and contributes to the CCAFS NHL district	Partially extant
8BR2210	8650	Launch Pad and Ramp	Structure	Contributing resource to both NRHP-eligible district and NHL district	Partially extant
8BR2211	8610	Propellant Conditioning Facility/ Propellant Transfer Unit Building	Building	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2212	1684H	JP-4 Facility	Structure	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2213	8692	Paint Storage Building/POL Building	Building	Contributing resource to both NRHP-eligible district and NHL district	Nonextant – demolition in process under separate action
8BR2214	1684M	LOX Storage Area	Structure	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2215	1684P	Flume and Skimming Basin	Structure	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2216	10905	Blockhouse[b]	Building	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2217	10911	Contractor Support Building/Ready Building	Building	Contributing resource to both NRHP-eligible district and NHL district	Nonextant
8BR2218	10907	Communications Cable Building/ Subcable Hut and Vault[b]	Building	Contributing resource to both NRHP-eligible district and NHL district	Extant
8BR2219	10915	Water Demineralization Building	Building	Contributing resource to both NRHP-eligible district and NHL district	Nonextant
8BR2220	Not applicable	Rails and Service Tower Area	Structure	Contributing resource to both NRHP-eligible district and NHL district	Extant

Florida Master Site Form Number	Facility Number	Feature	Type	NRHP Status	Extant/ Nonextant
8BR2221	8600 and 13514	Mercury Memorial Monument[c] and Mercury Memorial	Site	Contributing resource to both NRHP-eligible district and NHL district	Partially extant
8BR4187	Not applicable	Thrust Block and Valve Pit[d]	Structure	Contributing resource to both NRHP-eligible district and NHL district	Partially extant

[a] SLC-14 is an individually NRHP eligible historic property, and also a contributing resource to the CCAFS NHL District, Man in Space NHL Theme Study. SLC-14 is associated with the Cold War and Atlas Mercury crewed program, and had 14 previously recorded contributing resources. Of the 14 previously recorded contributing resources, 11 are partially or fully extant, and 3 are nonextant or being removed by a separate action.

[b] Historic building to be retained.

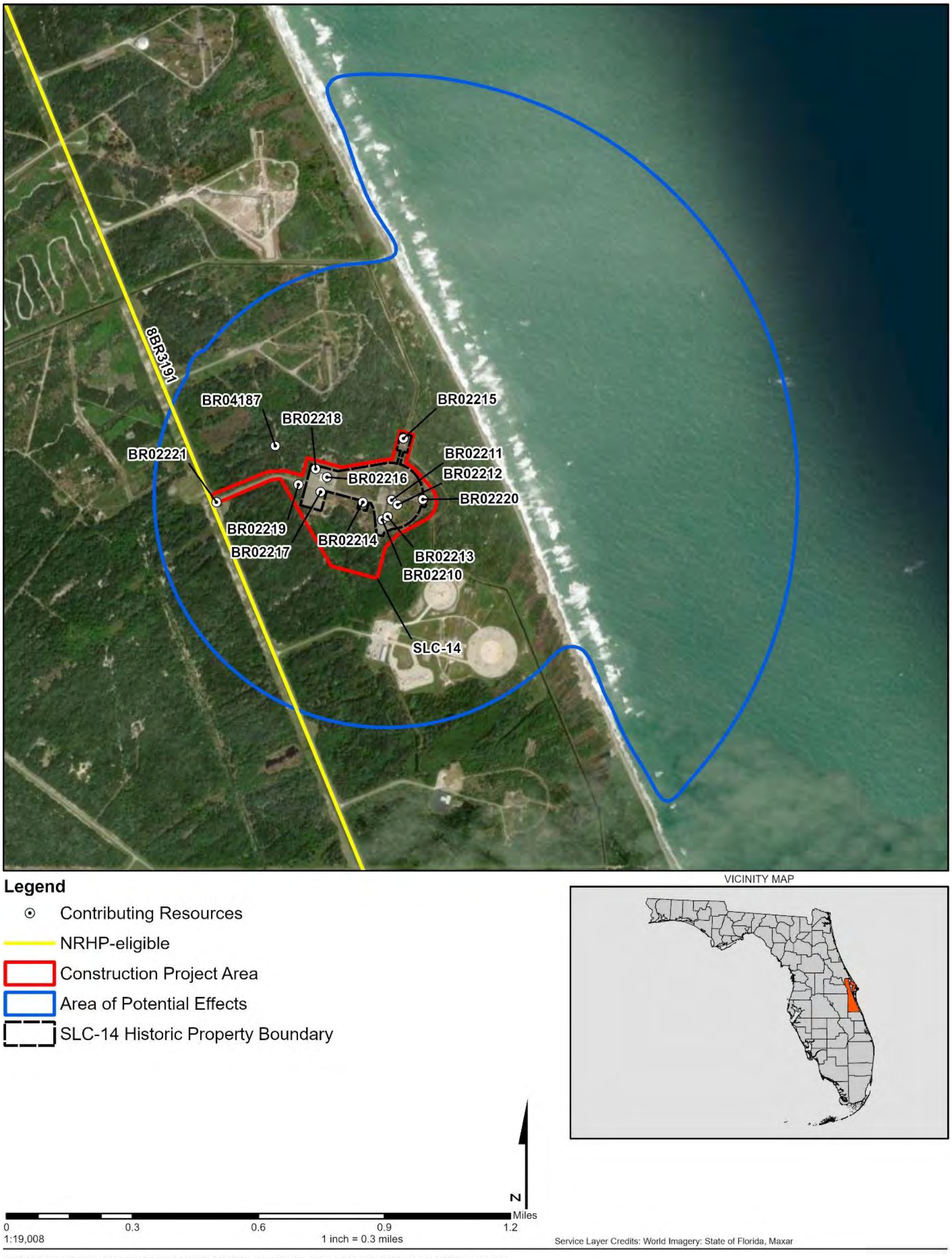
[c] Mercury Memorial Monument (Facility Number 8600) was relocated from the Launch Ramp and Pad to storage.

[d] The Thrust Block and Valve Pit is outside of the current SLC-14 district boundaries but is a contributing resource to the district. The Thrust Block and Valve Pit will remain in place and not be disturbed by the Proposed Action.

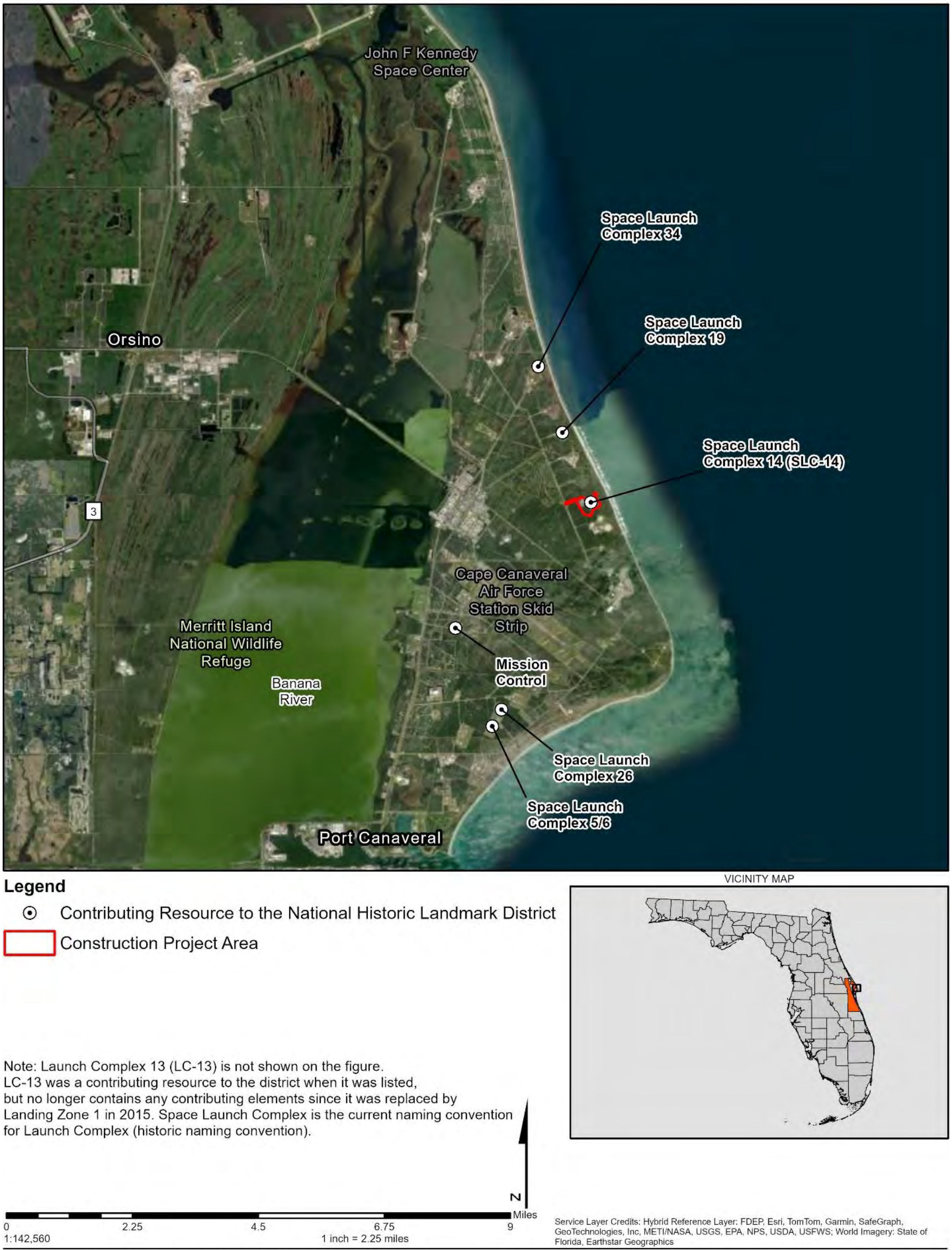
Notes:

All resources to be demolished unless otherwise noted.

Figure 3.2-2. Previously Identified Historic Properties in the APE



1 **Figure 3.2-3. CCAFS National Historic Landmark District**



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3.2.3 Environmental Consequences

This section documents potential effects on cultural resources within the APE (36 CFR 800.16(i) and 40 CFR 1508.1(g)). The Proposed Action is analyzed to consider whether the effects are adverse and/or significant (36 CFR 800.5(a), 40 CFR 1501.3(b), and AFMAN 32-7003, para. 2.4.5.4).

An adverse effect or significant impact to cultural resources and historic properties may occur if the Proposed Action:

- Alters, damages, or destroys the integrity of an NRHP-listed or eligible resource so that the significance is no longer conveyed by the resource.
- Alters the characteristics of the surrounding environment that contribute to a resource's significance.
- Results in neglecting the resource to the extent that it deteriorates or is destroyed.

Thresholds for determining impact significance are based on applicable compliance standards, federal- or state-recommended guidance, and professional standards.

3.2.3.1 Proposed Action

The Proposed Action includes demolition, construction of new facilities, improvements to existing infrastructure, ground support operations, and launch operations. Ground-disturbing activities would occur from facility demolition, road and security improvements, and construction of new facilities and utilities in the project footprint. The project footprint is limited to an approximately 50-foot to 450-foot buffered area from the existing launch complex boundary. Disturbance to surrounding structures could occur from noise and vibrations associated with launch operations. The APE contains the ground disturbance areas and is limited to the potential areas where disturbance from noise and vibrations could occur.

In the APE, SLC-14 will remain a launch complex, although some contributing elements would be demolished. The Blockhouse would remain in place and in use, and no physical changes are planned for the Blockhouse or for the Mercury Memorial and Mercury Memorial Monument. Surrounding structures and launch complexes including SLC-13 and SLC-15 would be exposed to increased noise and vibrations from the launch activities. Consultation in compliance with Section 106 of the NHPA will be completed prior to any demolition, construction, and operations as specified in the SLD 45 ICRMP (USAF 2023b). If a launch mishap were to affect a cultural resource, the SLD 45 CRM would contact the SHPO and an appropriate response and mitigation strategy would be developed through emergency consultation procedures (36 CFR 800.12).

As described in the SLD 45 ICRMP, SLC-14 has been extensively documented since it was abandoned in place in 1973 and is not physically accessible to the public. The corrosive environment at CCSFS has deposited a salt coat onto the launch complex's steel and concrete structures. Groundwater intrusion and a dismantled system of pumping stations from the 1950s and 1960s have seriously affected the hydrology and condition of SLC-14, leading to further compromises in the structural integrity of the launch complex (USAF 2023; BPRH 2023).

Figure 3.2-4. SLC-14 Existing Structures

Launch Ramp/Building Looking East

LOX Storage Area and Blast Wall

Launch Ramp

Launch Ramp Looking South

The Proposed Action would result in the reactivation of SLC-14 back to its historic use as a launch complex; the historic integrity of setting, location, association, and feeling of the SLC-14 district would be retained. The original layout would be maintained as much as possible. New technology would be employed to allow the site to be used as a modern launch complex. The new design would use similar materials and layout, in keeping with the historic appearance of the original SLC-14. Reactivation of SLC-14 fulfills national security and U.S. space goals of increasing access to space and brings renewed attention to U.S. space history and the history of SLC-14.

Although the potential to encounter archeological resources in the APE is low, the SLD 45 ICRMP outlines the standard operating procedures for the discoveries of archeological resources and NAGPRA cultural items (USAF 2023b). In the event of a prehistoric or historic artifact discovery during ground-disturbing activities, the contractor must immediately notify the SLD 45 CRM of the nature and location of the discovery; immediately cease potentially damaging activities; and take efforts to ensure protection of the artifact until arrival of the CRM or their designee (USAF 2023b).

The Proposed Action would not have a significant impact to cultural resources. The reactivation of SLC-14 would not alter the historic function or association of the launch complex; the site would be put back into active use as a launch complex with the Blockhouse intact. The CCAFS NHL district is significant for its contribution to space and military history, as well as science and engineering technological advancements. The Proposed Action would enable reactivation of the launch complex, returning it to its historic use, which would allow it to convey its significance, as well as that of the NHL district, through the continuation of the U.S. space program. The CCAFS NHL district has discontiguous boundaries that span six launch complexes (SLC-5/6, SLC-14, SLC-19, SLC-26, SLC-34, and the nonextant SLC-13) and Mission Control. Visual effects to the CCAFS NHL district would not be significant because the district is spatially discontiguous and the reconstruction of SLC-14 would not be visible from other contributing resources the district.

3.2.3.2 No Action Alternative

Under the No Action Alternative, the reactivation of SLC-14 would not be implemented. Impacts from deterioration on the site would persist in the corrosive environment, and SLC-14 would remain inoperable and abandoned in place. The Mercury Memorial and the Blockhouse would continue to be maintained, and the Blockhouse would continue its use as a meeting space. The extensive documentation of SLC-14 would continue to be available to the public, providing a virtual experience of the site. Thus, the No Action Alternative would result in no significant effects on cultural resources.

3.3 Air Quality and Climate Change

3.3.1 Regulatory Setting

In accordance with federal Clean Air Act (CAA) requirements, the air quality in a region or area is measured by the concentrations of criteria pollutants in ambient air. The air quality in a region is a result of not only the types and quantities of atmospheric pollutants and pollutant sources in an area, but also surface topography, the size of the topological "air basin," and the prevailing meteorological conditions.

Climate change is a fundamental environmental issue and its effects on the human environment must be addressed in NEPA. Climate change assessments are conducted through consideration of greenhouse gas (GHG) emissions from a proposed action as well as the effects of climate change on that proposed action.

3.3.1.1 Ambient Air Quality Standards

Under CAA, the U.S. Environmental Protection Agency (EPA) developed National Ambient Air Quality Standards (NAAQS) for pollutants that affect human health and the environment. NAAQS represent the maximum allowable concentrations for ozone (O_3), carbon monoxide (CO), oxides of nitrogen (NO_X) as nitrogen dioxide (NO_2), sulfur oxides as sulfur dioxide (SO_2), respirable particulate matter (including particulate matter equal to or less than 10 microns in diameter [PM_{10}] and particulate matter equal to or less than 2.5 microns in diameter [$PM_{2.5}$]), and lead (Pb) (40 CFR Part 50). CAA also gives states the authority to establish air quality rules and regulations aimed at meeting air quality standards. The State of Florida has adopted the NAAQS. Table 3.3-1 presents the EPA NAAQS and the State of Florida ambient air quality standards.

Table 3.3-1. National Ambient Air Quality Standards

Criteria Pollutant	Federal Standard (Averaging Period)	Form
CO	35 ppm (1 hour)	Not to be exceeded more than once per year
CO	9 ppm (8 hour)	Not to be exceeded more than once per year
NO_2	0.100 ppm (1 hour)	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
NO_2	0.053 ppm (1 year)	Annual mean

Table 3.3-1. National Ambient Air Quality Standards

Criteria Pollutant	Federal Standard (Averaging Period)	Form
O_3	0.070 ppm (8 hour)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
$PM_{2.5}$	9 mg/m^3 (1 year)	Annual mean, averaged over 3 years
$PM_{2.5}$	15 mg/m^3 (1 year, secondary standard)	Annual mean, averaged over 3 years
$PM_{2.5}$	35 mg/m^3 (24 hour)	98th percentile, averaged over 3 years
PM_{10}	150 mg/m^3 (24 hour)	Not to be exceeded more than once per year on average over 3 years
SO_2	0.075 ppm (1 hour)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
SO_2	0.5 ppm (3-hour, secondary standard)	Not to be exceeded more than once per year
Pb	0.15 mg/m^3 (rolling 3-month average)	Not to be exceeded

Source: EPA 2024
mg/m^3 = milligram(s) per cubic meter
ppb = part(s) per billion, by volume
ppm = part(s) per million, by volume
SO_2 = sulfur dioxide

3.3.1.2 General Conformity

The CAA General Conformity Rule (40 CFR Part 93 Subpart B) requires that federal actions conform with the requirements of the applicable state implementation plan or federal implementation plan. More specifically, CAA conformity is ensured when a federal action does not cause a new violation of the NAAQS; contribute to an increase in the frequency or severity of violations of NAAQS; or delay the timely attainment of any NAAQS, interim progress milestones, or other milestones toward achieving compliance with the NAAQS. The General Conformity Rule applies only to federal actions in nonattainment or maintenance areas. General Conformity Rule requirements are not applicable to the Proposed Action because the project area is designated as attainment for all pollutants.

3.3.1.3 Greenhouse Gas Emissions

GHGs are gaseous emissions that absorb energy in the atmosphere. These emissions occur from natural processes and human activities. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane, and nitrous oxide. GHGs are primarily produced by the burning of fossil fuels and through industrial and biological processes. Amounts of GHG emissions are commonly expressed relative to CO_2, using a metric called "carbon dioxide equivalent" (CO_2e).

3.3.1.4 Climate Change

The CEQ has issued guidance for the consideration of GHG emissions and climate change in NEPA documents (CEQ 2023). It recommends that agencies quantify GHG emissions, calculate the social cost of GHG (SC-GHG), and consider the effects of climate change on proposed actions. The SC-GHG is the monetary value of the net harm to society from emitting a metric ton of GHG into the atmosphere in a given year.

Federal proposals may be affected by climate change; therefore, they should be designed in consideration of resilience and adoption to a changing climate. The DAF has created a *Department of the Air Force Climate Campaign Plan* (DAF 2023a) that establishes the goal of supporting the Air Force mission in light of climate risks. It emphasizes optimizing energy use and building climate resilient installations, through modernization of facilities and infrastructure.

The scientific community is continuing efforts to better understand the impact of aviation emissions on the global atmosphere. The FAA is leading and participating in several initiatives intended to clarify the role that commercial aviation plays in GHG emissions and climate. The FAA, with support from the U.S. Global Change Research Program and its participating federal agencies, has developed the Aviation Climate Change Research Initiative to advance scientific understanding of regional and global climate impacts of aircraft emissions.

3.3.2 Affected Environment

CCSFS and SLC-14 are located in Brevard County, Florida. Brevard County is regulated by Florida's Central District, which is designated as in attainment/unclassified for all criteria pollutants. SLC-14 is located along the coast and is subject to the effects of sea level rise associated with climate change. Florida is especially susceptible to increases in heavy rainstorms, hurricanes, and flooding (EPA 2016).

3.3.3 Environmental Consequences

An air quality impact is considered insignificant if the Proposed Action does not cause or contribute to exceedance of one or more of the criteria pollutant thresholds. The DAF defines "insignificance indicators" for each criteria pollutant according to current air quality conditions. Table 3.3-2 summarizes the DAF insignificance indicators for areas in attainment, which is the case for Brevard County. If the worst-case annual emissions estimate for each pollutant of concern in the table are below the corresponding insignificance indicator values, a less than significant impact is indicated.

Table 3.3-2. Attainment Status and Permitting Thresholds for Brevard County, Florida

Criteria Pollutant	Brevard County Attainment Status	Applicable Prevention of Significant Deterioration/New Source Review Major Source Thresholds (tpy) Used as Insignificance Indicator Values
CO	Attainment /Unclassified	250
Pb	Attainment/ Unclassified	25
NO_2	Attainment/ Unclassified	250 (also refer to limits for O_3 and $PM_{2.5}$)
PM_{10}	Attainment/ Unclassified	250
$PM_{2.5}$	Attainment/ Unclassified	250
O_3	Attainment/ Unclassified	250 (of NO_X or VOC)
SO_2	Attainment/ Unclassified	250

Note:
Refer to 40 CFR 51.166(b)(1)(i)(b)
tpy = ton(s) per year
VOC = volatile organic compound

As stated in FAA Order 1050.1F, Exhibit 4-1, the FAA's significance threshold for air quality is whether "the action would cause pollutant concentrations to exceed one or more of NAAQS, as established by the Environmental Protection Agency under CAA, for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations".

The DAF GHG & Climate Change Assessment Guide (AFCEC 2023b) identifies 75,000 tons per year as a threshold for insignificance, meaning actions with a net change of emissions below this threshold are considered insignificant. FAA Order 1050.1F, exhibit 4-1, indicates that FAA has not established a significance threshold for climate. While CEQ guidance requires the calculation of SC-GHG, there are no established thresholds for significance regarding SC-GHG.

The effects of climate on the Proposed Action would be considered significant if they negatively affected the implementation of the *Department of the Air Force Climate Campaign Plan* (DAF 2023a).

3.3.3.1 Proposed Action

This NEPA analysis evaluates the potential air quality and climate impacts of the Proposed Action. The Proposed Action includes emissions from both stationary and mobile sources. Emissions sources associated with the Proposed Action are the responsibility of Stoke and do not affect the SLD 45 air permits. Responsibility for project-related emission sources, assignment of owner/operator roles and common control, definition of sources as stationary, mobile, or exempt, and associated air permitting requirements will be defined and overseen by the air quality agencies with jurisdiction. Required permits are discussed as relevant in the proceeding discussion.

3.3.3.1.1 Construction and Demolition

Construction and demolition activities would generate air pollutant emissions primarily from site-disturbing activities such as grading, filling, compacting, and trenching, and from the combustion of fuels in construction and demolition equipment. Fugitive dust emissions from ground-disturbing activities would be greatest during the initial site preparation activities including the demolition of the launch pad ramp and would vary from day to day depending on the construction phase, level of activity, and prevailing weather conditions. Construction and demolition activities would incorporate BMPs and control measures (such as frequent use of water for dust-generating activities) to minimize fugitive particulate matter emissions. Construction workers commuting daily to and from the construction site in their personal vehicles would also result in criteria pollutant emissions.

Stoke would obtain approval in the form of a Construction Air Permit from FDEP before beginning the project. Air permitting requirements are specified in Chapters 62-4, 62-204, 62-210, and 62-212 of the *Florida Administrative Code* (F.A.C.) (FDEP n.d.).

Construction and demolition emissions for both criteria pollutants and CO_2e were estimated using USAF's Air Conformity Applicability Model (ACAM) Version 5.0.23a. The ACAM Summary Report, ACAM Detail Report and SC-GHG report (Appendix F) are produced by ACAM and summarize the Proposed Action's projected total annual air emissions from construction and demolition activities. Table 3.3-3 summarizes ACAM results for criteria pollutants, including estimates for the peak construction year (2024). Lead emissions are estimated to be zero and are not included in the table.

Table 3.3-3. Estimated Construction and Demolition Emissions for Criteria Pollutants

Year	VOC (tpy)	CO (tpy)	NO_X (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
2024[a]	1.11	11.72	9.12	0.02	31.59	0.36
2025	1.07	4.36	3.25	0.01	3.62	0.13
Insignificance Indicators (tpy)	**250 (of NOX plus VOC)**	**250**	**250 (of NOX plus VOC)**	**250**	**250**	**250**
Threshold	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**

[a] 2024 is the peak year for construction emissions.

GHG emissions would be expected from the construction and demolition activities associated with the Proposed Action. Table 3.3-4 summarizes ACAM results for GHGs and the associated SC-GHG. SC-GHG estimates are made by applying a cost factor per metric ton of GHG emitted. ACAM is used to determine cost factors for each pollutant and calendar year. These can be found in the SC-GHG report in Appendix F. Estimated emissions are substantially less than the DAF Significance threshold of 75,000 metric tons of CO_2e and would not noticeably contribute to regional GHG emissions.

Table 3.3-4. GHG Emissions and the Social Cost for Construction and Demolition

Year	CO_2 Emissions (metric tons)	CH_4 Emissions (metric tons)	N_2O Emissions (metric tons)	CO_2e Emissions (metric tons)	Social Cost CO_2 ($)	Social Cost CH_4 ($)	Social Cost N_2O ($)	Total Social Cost of GHG ($)
Construction Activities (total)	**2,524**	**9.89E-02**	**3.91E-02**	**2,538**	**207,663**	**218**	**1,145**	**209,025**
2024 (peak year)	1,829	7.17E-02	2.84E-02	1,839	149,978	158	823	150,958
2025	695	2.72E-02	1.07E-02	699	57,685	60	322	58,067

The Proposed Action would align with all priorities identified in the *Department of the Air Force Climate Campaign Plan* (DAF 2023a), by improving infrastructure and constructing energy efficient buildings. The improvements to the historical launch pad would also make the facility more resistant to the impact of climate change.

The construction and demolition activities of the Proposed Action would not have a significant impact to air quality and GHG emissions within CCSFS and Brevard County. The effects of climate change on construction activities would also not be significant.

3.3.3.1.2 Operational Activities

Once construction is complete and the launch facility is functional, operation of the facility would result in criteria pollutant emissions from tests, launches, non-road equipment, flares, solvent use, facility heating, deliveries and commutes. An emissions study was conducted to estimate emissions from tests and launches (BRRC 2023). Emission estimates from the study were modified to reflect the launch and testing cadence identified in section 2.1.5 of10 launches per year. Emissions from the remaining sources were calculated using ACAM, Section 13.5 of EPA's AP-42 (EPA 2018), and Air Emissions Guide for Air Force

Mobile Sources (AFCEC 2023a). Rocket emissions during launches and static tests are considered mobile sources. Table 3.3-5 presents estimated calendar-year emissions for 2026 which is assumed to be steady-state operation or expected emission rates once construction is complete and facilities are operating at project capacities. Appendix F (Table F-1) provides steady-state emissions by activity type.

Table 3.3-5. Estimated Operational Criteria Pollutant Emissions

Year	VOC (tpy)	CO (tpy)	NO_X (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
2026 (Steady State)	0.16	6.17	72.26	1.5E-3	0.46	0.46
Insignificance Indicators (tpy)	**250 (of NO_X plus VOC)**	**250**	**250 (of NO_X plus VOC)**	**250**	**250**	**250**
Threshold	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**	**Below Insignificance Threshold**

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being rerouted and expending more fuel. Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA has rarely, if ever, received reportable departure delays associated with launches/reentries at CCSFS. Based on Stoke's proposal, airspace-related impacts could increase up to a maximum of 10 times per year. Any delays in aircraft departures from affected airports would be short-term. Thus, any increases in air emissions from grounded aircraft are expected to be minimal and would occur in attainment areas. Therefore, these emissions increases are not expected to result in an exceedance of a NAAQS for any criteria pollutant. Emissions from aircraft being rerouted would occur above 3,000 feet (the mixing layer) and thus would not affect ambient air quality. Therefore, airspace closures associated with commercial space operations are not expected to result in significant air quality impacts.

GHG emissions would primarily result from tests and launches. GHG scope 1 sources would include fuel combustion in tests and launches, flares, nonroad equipment (transport erector), facility heating, and delivery of the Stoke launch vehicles. GHG scope 2 emissions were estimated by assuming average power usage and continuous operation of the new facility, using the most recently published CO_2 emission intensity values for calendar year 2021 (NextEra Energy 2022). NextEra Energy has committed to providing carbon-free electricity by 2045 and CO_2 emissions are expected to decrease over time as NextEra Energy moves closer to that goal. CO_2 emission intensity values for power purchased from NextEra Energy may be reduced by the time construction is complete. GHG scope 3 emissions would include employee commutes and third-party compressed gas deliveries to the site. Table 3.3-6 summarizes GHG emissions and SC-GHG. Social cost factors from the ACAM SC GHG Report were applied to emissions not calculated in ACAM. Estimated emissions are below the insignificance threshold of 75,000 metric tons per year and would not noticeably contribute to regional GHG emissions.

The Proposed Action is to support space launch capabilities that decrease the carbon footprint of space vehicles and fuel sources per launch. The activities conducted at the new facility align with all priorities identified in the *Department of the Air Force Climate Campaign Plan* (DAF 2023a).

Climate change may affect the Proposed Action, and given the site's proximity to the Atlantic Coast, increased flooding from storm surges is a concern. As discussed in Section 3.2, Cultural Resources, the existing structures on site have been subjected to the effects of climate change and are deteriorating. As discussed in Section 3.6, Water Resources, floodplain impacts would be addressed through stormwater design and permitting.

Table 3.3-6. GHG Emissions and Social Cost for Operational Emissions

Year	CO_2 Emissions (metric tons)	CH_4 Emissions (metric tons)	N_2O Emissions (metric tons)	CO_2e Emissions (metric tons)	Social Cost CO_2 ($)	Social Cost CH_4 ($)	Social Cost N_2O ($)	Total Social Cost of GHG ($)
2026 (Steady State)	2,985	1.7	9.9E-03	3,030	250,709	3,916	296	254,921

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being rerouted and expending more fuel. These emissions include CO_2, which is a GHG. Based on Stokes's proposal, these temporary increases in aircraft emissions could increase up to a maximum of 10 times per year. The amount of time that affected aircraft spend being rerouted would be short-term. In addition, the number of aircraft that would be impacted per launch/reentry would not be expected to produce additional emissions that would have a notable impact on climate. Therefore, the increases in GHGs caused by short-term airspace closures during commercial space operations is not expected to result in significant climate-related impacts.

The operational emissions of the Proposed Action would not have a significant impact to air quality, and GHG emissions within CCSFS and Brevard County. The effects of climate change on operations would also not be significant.

3.3.3.2 No Action Alternative

Implementation of the No Action Alternative would not result in a change in current conditions. Therefore, **no impacts** to air quality and GHG emissions would occur. The existing structures at SLC 14 would be left in place and impacted by the effects of climate change.

3.4 Noise

Blue Ridge Research and Consulting, LLC (BRRC) conducted a noise study for the proposed project and generated noise contours for commercial space operations at SLC-14. The complete noise analysis is provided in Appendix G.

3.4.1 Regulatory Setting

A variety of acoustic metrics can be used to describe how noise from commercial space operations affects communities (people and structures) and the environment. Metrics can describe the effect of an individual operation (single event) or the cumulative noise of multiple events over a long time. The day-night average sound level (DNL) is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities. Despite the differences between aviation and commercial space vehicle noise, DNL is also the required metric to quantify cumulative exposure to noise from commercial space transportation activities. However, the DNL metric may not fully describe the noise experienced during a commercial space noise event, and the use of the following supplemental noise metrics is recommended.

The maximum sound level metrics are particularly useful in improving the public's understanding of exceptionally loud commercial space event(s). Maximum sound level metrics, including the maximum A-weighted sound level ($L_{A,max}$) and maximum unweighted sound pressure level (L_{max}) are used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures.

Additionally, A-weighted sound exposure level (SEL) and percent allowable daily noise dose are used to describe the potential noise impact from rocket operations.

The sound level metrics used to describe annoyance from sonic booms is the C-weighted DNL (CDNL) which is weighted to describe low-frequency noise sources and similarly to DNLs averaged over a 24-hour period with a 10-dB nighttime noise adjustment. The sound level metric used to describe the potential for noise-induced hearing impairment and vibration effects on structures by sonic booms is peak overpressure which is measured in pounds per square foot (psf).

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. These guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss. A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA), National Institute for Occupational Safety and Health (NIOSH), and 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 decibels (A-weighted scale) (dBA). At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. $L_{A,max}$ can be used to identify potential locations where hearing protection should be considered for rocket operations.

3.4.2 Affected Environment

CCSFS encompasses nearly 15,800 acres of land, the majority of which is open space. Other land use types include airfield operations, conservation, fuel munitions and storage, and launch support. Land use at SLC-14 specifically includes open space and an inactive launch complex with a paved road leading up to and circling around the complex. Existing noise levels at CCSFS are typical of industrial facilities and range from 60 dBA to 80 dBA. Additional onsite sources of noise are aircraft landings at the CCSFS Skid Strip and rocket launches at other CCSFS launch complexes. The existing condition DNL for CCSFS is not currently available. There are no residences in the immediate vicinity of the launch area. Closest residences are approximately 7 miles from the site in Cape Canaveral. Residential areas have a lower overall noise level from 45 to 55 dBA with occasional short term increased noise levels from aircraft flyover and rocket launches. The launch trajectories of the Proposed Action would be specific to each mission and customer needs. All launches are expected to be oriented to the east over the Atlantic Ocean between allowable azimuths of 35 degrees to the northeast and 120 degrees to the southeast.

3.4.3 Environmental Consequences

A significant noise impact would occur if the analysis showed that the Proposed Action, when compared with the No Action Alternative for the same time frame, would result in a noise increase of one or more of the following scenarios:

- DNL 1.5 dBA increase in noise-sensitive areas at DNL 65 dBA or greater noise exposure level
- DNL 1.5 dBA increase that results in 65 dBA or greater in noise-sensitive areas at less than 65 dBA noise exposure level
- DNL 3 dBA increase in noise-sensitive areas between DNL 60 dBA and DNL 65 dBA noise exposure levels and at least DNL 1.5 dBA increase in noise-sensitive areas at DNL 65 dBA or greater noise exposure level
- Would cause hearing or structural damage

3.4.3.1 Proposed Action

The Proposed Action would conduct approximately two launches during the first year of operation in 2025. The launch schedule is anticipated to increase to up to10 launches per year. Launches would occur preferably during the daytime; however, up to 50% of launches may be conducted at night in accordance with FAA'S airspace deconfliction policy (FAA 2023). Operations were conservatively modeled for 18 annual easterly launch operations and 18 pre-launch static fire tests. While18 launches were analyzed in the noise study, an increase in cadence above the 10 launches per year in the Proposed Action would require additional NEPA/EIAP evaluation.

The analysis consisted of modeling propulsion noise and sonic booms noise from the proposed commercial space operations to evaluate the potential for long-term community annoyance, noise-induced hearing impairment, and noise-induced vibration effects on structures (Appendix G).

Rocket propulsion noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Propulsion noise generated by Stoke operations from SLC-14 was modeled using RUMBLE 4.1, the Stoke launch vehicle acoustic simulation model created by BRRC under the Airport Cooperative Research Program project 02-66. Sonic booms generated by Stoke launch operations from SLC-14 were modeled using PCBoom 6.7b (Appendix G).

This section briefly summarizes the noise impact from the Proposed Action; the complete noise analysis and additional details on impacts and metrics are included in Appendix G. The potential for long-term community annoyance is assessed using DNL for propulsion noise. DNL accounts for all noise events in an average annual day and for increased sensitivity during the acoustical nighttime period. The DNL 65- and 60-dBA contours do not encompass any land area outside of CCSFS boundaries; therefore, no residences are impacted. The CNS is also outside the DNL 65- and 60-dBA boundaries. Additional noise metrics including A-weighted maximum sound level, $L_{A,max}$, and A-weighted SEL are included in Appendix G.

The $L_{A,max}$ 115-dBA contour can be used to identify potential locations where hearing protection should be considered for rocket operations. The modeled Stoke launch operations generate levels on land that are at or greater than an $L_{A,max}$ of 115 dBA within 0.56 mile of SLC-14. The entire land area encompassed by the 115-dBA noise contours is within the boundaries of CCSFS. Additionally, residential areas outside CCSFS will reach less than 1% of their daily noise dose when exposed to noise from a single Stoke operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

L_{max} values of 120 dB and 111 dB are used in this analysis as conservative thresholds for potential risk of structural damage claims. In addition, the L_{max} value of 130 dB is used to further assess potential damages to structures from propulsion noise. The 130-dB L_{max} contours do not include any land area outside of CCSFS boundaries. The 120- and 111-dB L_{max} contours do not encompass any land area outside of CCSFS and KSC boundaries. Modeled peak overpressure levels of sonic booms from Stoke launch operations are described in Appendix G, Section 5.1.

The potential sonic boom impacts from Stoke launch operations are negligible because the sonic booms for these events are entirely over water and, thus, will not affect any people or structures on land. Analysis of sonic booms over water is included in the informal consultation with NMFS No: OPR 2021-02908.

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 to offsite properties because of its temporary duration and the lack of sensitive receptors in proximity to SLC-14.

Airspace closures associated with the Proposed Action could result in temporarily grounded aircraft at affected airports and rerouting of enroute flights on established alternate flight paths. The FAA has rarely received reportable departure delays associated with commercial space transportation launches. Aircraft could be temporarily grounded if airspace above or around the airport is closed. Ground delays are also used under some circumstances to avoid airborne reroutes. If aircraft were grounded, noise levels at the airport could temporarily increase if the planes sit idle; some aircraft would likely shut down engines altogether until the closure has lifted. Also, depending on the altitude at which aircraft approach an airport, there could be temporary increases in noise levels in communities around the airports. Aircraft would travel on existing routes and flight paths that are used on a daily basis to account for weather and other temporary restrictions. Launch and reentry missions would not affect the same aircraft routes or the same airports, and rerouting associated with launch related closures represents a small fraction of the total amount of rerouting that occurs from all other reasons in any given year. Any incremental increases in noise levels at individual airports would only last the duration of the airspace closure on a periodic basis and are not expected to meaningfully change existing DNL average sound levels at the affected airports and surrounding areas.

Table 3.4-1. Noise Impacts Summary

Noise Type	Annoyance	Hearing Conservation	Structural Damages
Propulsion Noise	Less than significant (the 60-dBA contour does not encompass land outside the CCSFS boundary, and, thus, no residences are affected.)	Less than significant (land area encompassed by the 115-dBA contour is within the CCSFS boundary. People in the community will reach less than 1% of their daily noise dose when exposed to noise from a Stoke launch or static fire operation)	Less than significant (the 120-dB and 111-dB contours do not encompass any land outside of CCSFS and KSC boundaries.)
Sonic Boom	Less than significant (over water)	Less than significant (over water)	Less than significant (over water)
Construction Noise	Less than significant (lack of sensitive receptors in the vicinity of SLC-14)	Less than significant (lack of sensitive receptors in the vicinity of SLC-14)	Less than significant (lack of sensitive receptors in the vicinity of SLC-14)
Airspace Changes	Less than significant (noise would not meaningfully increase)	Less than significant (areas currently subjected to aircraft noise)	Not Applicable

Note: Detail provided in Appendix G.

As summarized in Table 3.4-1, there would be no significant impacts due to construction and operation of the Proposed Action.

3.4.3.2 No Action Alternative

Under the No Action Alternative, Stoke would not reactivate SLC-14 for the Stoke launch vehicle service, and Stoke would not apply for an FAA license. The No Action Alternative would not allow Stoke to provide a low-cost launch service to meet the goals of National Space Transportation Policy. The No Action Alternative would not contribute to new noise impacts or cumulative effects.

3.5 Hazardous Materials, Solid Waste, and Hazardous Waste

3.5.1 Regulatory Setting

Hazardous waste is any solid, liquid, or contained gas waste that is dangerous or potentially harmful to human health or the environment. Hazardous wastes are classified under the Resource Conservation and Recovery Act (RCRA) in 40 CFR Part 261, Identification and Listing of Hazardous Waste as either characteristic wastes or listed wastes. Characteristic hazardous wastes exhibit one or more of the following traits: ignitability, reactivity, corrosivity, or toxicity. Listed hazardous wastes are wastes specifically listed as being hazardous and are from either specific sources, non-specific sources, or discarded chemical products.

A toxic substance is a substance that when ingested or absorbed is harmful or fatal to living organisms. Toxicity is an attribute of some hazardous waste. Through the Toxic Substances Control Act, EPA regulates toxic substances such as asbestos, lead-based paint (LBP), polychlorinated biphenyls (PCBs), and radon.

Pesticides are substances that control pests; certain pesticides are toxic to humans. Pesticides include herbicides, insecticides, rodenticides, fungicides, and other categories, with herbicides being the most common type of pesticide used. The Federal Insecticide, Fungicide, and Rodenticide Act, as amended, is implemented in the military by DOD Directive 4150.07, DOD Pest Management Program. This directive applies to all military pest control activities, including contracted operations, and is implemented by the DAF in AFMAN 32-1053, Integrated Pest Management Program.

Solid waste is defined by the implementing regulations of 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.

The Installation Restoration Program (IRP) was developed by DOD to identify, characterize, and remediate contamination from past hazardous waste disposal operations and hazardous materials spills at DOD facilities. Depending on the circumstances, IRP sites are investigated and cleaned up in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or RCRA, or an integrated approach based on both laws. DAF currently addresses Military Munitions Response Program sites under CERCLA.

The Superfund Amendments and Reauthorization Act of 1986, Title III: Emergency Planning and Community Right-to-Know Act establishes standards for community right-to-know programs and requires the reporting of releases of certain toxic chemicals. Local planning committees, comprising government, news media, industry, environmental organizations, and medical representatives, receive right-to-know information from facilities. Facilities with Standard Industrial Classification codes between 20 and 39 that manufacture, process, or otherwise use listed toxic chemicals, must report a release of these toxic chemicals to the environment, in greater than reportable quantities, on a Form R.

Hazardous materials include Extremely Hazardous Substances listed in Appendix A of 40 CFR Part 355, Emergency Planning and Notification; those listed as hazardous if released, under the CERCLA in 40 CFR 302.4, Designation of Hazardous Substances; and by definition of hazardous chemicals by OSHA in 29 CFR 1910.1200, Hazard Communication. Hazardous materials are defined in AFMAN 32-7002, Environmental Compliance and Pollution Prevention, to include all items covered under the Emergency Planning and Community Right-to Know Act or other applicable federal, state, local or Final Governing Standards tracking or reporting requirements; all items covered by OSHA under 29 CFR 1910.1200, Hazardous Communication or 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories; and Class I or Class II Ozone Depleting Substances.

3.5.2 Affected Environment

SLC-14 was active between 1956 until 1967 and was utilized to support a series of launch programs. Asbestos products were widely used in the construction of facilities from 1940 through 1977 (USAF 2020a). LBP was widely used commercially until the federal government banned consumer uses of LBP in 1978 (EPA 2023c). Asbestos-containing material (ACM) and LBP have been documented in the existing structures at SLC-14. Additionally, hazardous materials were known to be used at the complex, including various propellants, fuels, solvents, and coatings on structures on the launch pad that contained PCBs. The operations conducted at SLC-14 were known to generate hazardous waste because of launch program activities (EPA n.d.). SLC-14 was designated as Solid Waste Management Unit (SWMU) 39. The EPA defines a SWMU as "any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste" (EPA 2021). The hazardous waste potentially generated as a result of previous mission activities includes deluge waters, waste fuels, and waste solvents. A complete list of all the hazardous materials and hazardous waste stored and generated at the complex is not available.

From 1990 through 2003, the extent of contamination at SLC-14 was evaluated under the IRP program because of historical operations at the complex. The primary cause of contamination at SLC-14 was identified to be a result of deluge waters used for cooling and suppressing vibrations; leaking transformers that contained PCB oil; sandblasting operations that dispersed paint chips containing PCBs, and petroleum released from historical storage tanks. Interim measures were performed to remove contaminated soil at the site. As part of the RCRA facility investigation, a human health preliminary risk evaluation and ecological risk assessment were conducted to evaluate the health and environmental risks in surface water, sediment, groundwater, and soil after the interim measures were performed. The preliminary risk evaluation recommended No Further Action for groundwater and soil. Surface water and sediment were not evaluated in the human health preliminary risk evaluation since there was no human exposure pathway. The ecological risk assessment recommended No Further Action for surface water, sediment, and soil. Groundwater was not evaluated in the ecological risk assessment since groundwater does not present an exposure pathway for ecological receptors. In 2003, the EPA issued a Memorandum of Decision of No Further Action for SLC-14. The site has no future land use or development restrictions (EPA n.d.).

SLC-14 is currently inactive. There is currently no hazardous waste being generated as a result of no operations onsite. CCSFS is classified as a Large Quantity Generator of hazardous waste. Wastes on CCSFS property are controlled and managed from the point of generation to the point of ultimate disposal. Wastes are temporarily stored at designated satellite accumulation points or hazardous waste accumulations sites at work locations. Within 90 days, the wastes are transported off-base and disposed in accordance with applicable regulations by a contractor. The Patrick ISS Fence-to-Fence Contractor (Patrick F2F) is responsible for the overall management of hazardous waste at CCSFS, including routine inspections of hazardous waste accumulations sites, spill response actions, waste characterization processes, and transportation and disposal coordination. Individual organizations and their contractors are responsible for ensuring containers are properly labeled and stored, managing records, and monitoring accumulation time limits for waste generated (USAF 2022).

CCSFS has developed environmental management plans to establish procedures to mitigate adverse effects to the environment from hazardous materials. The CCSFS Hazardous Waste Management Plan provides guidance on the proper handling and disposal of hazardous waste, including spill contingency and response requirements, on CCSFS property. Procedures and responsibilities for responding to a hazardous waste spill or other incident are also addressed in the Hazardous Waste Management Plan (USAF 2022). The CCSFS Spill Prevention, Control, and Countermeasures (SPCC) Plan establishes procedures on the proper management and storage of petroleum products. The SPCC Plan includes immediate response actions to take in the event of a release of petroleum products to the environment (USAF 2018). The CCSFS Stormwater Pollution Prevention Plan (SWPPP) establishes procedures and

BMPs for outdoor material storage areas and maintenance activities to prevent pollution to stormwater (USAF 2019b). The CCSFS Integrated Solid Waste Management Plan provides guidance on the proper handling and disposal of non-hazardous solid waste and source reduction procedures (USAF 2024). The CCSFS Asbestos Management Plan lists applicable regulations and policies for the management, notification, demolition, and disposal of ACM (USAF 2020a).

3.5.3 Environmental Consequences

Releases of hazardous materials or waste to the environment can result in human health and ecological risks from exposure. The risks associated with releases depends on the quantity released and the characteristics of the material or waste released. These risks can be mitigated through proper management and storage techniques.

The potential impacts associated with hazardous materials and waste from the reactivation of SLC-14 depend on the characteristics and quantities of the hazardous materials and waste used, stored and generated at SLC-14. The Proposed Action could result in a significant impact if it:

- Violated applicable federal, state, tribal, or local laws or regulations regarding hazardous materials and/or solid waste management.
- Produced an appreciably larger quantity or new type of hazardous waste.
- Generated an appreciably larger quantity or new type of solid waste or used a different method of collection or disposal and/or would exceed local capacity.
- Adversely affected human health and the environment.

3.5.3.1 Proposed Action

The reactivation of SLC-14 would involve the use of hazardous materials and produce solid or potentially hazardous wastes. Large quantities of hazardous materials would be used during operations to support SLC-14 activities, including petroleum-based products, paints, solvents, and fuels. These materials would be handled, stored, and disposed of in accordance with Safety Data Sheet recommendations, applicable federal and state regulations, and CCSFS environmental management plans. Hazardous materials such as propellants, chemicals, and other hazardous material payload components would be transported in accordance with DOT regulations governing interstate and intrastate shipment of hazardous materials, as applicable. These materials are routinely used at CCSFS and proposed operations do not deviate from current CCSFS operations or introduce new or different hazardous materials or operations.

Demolition of existing infrastructure and construction of new facilities would generate construction debris. Prior to demolition and renovation of the existing infrastructure, ACM and LBP surveys would be required. Based on the results of the ACM survey, demolition activities would be coordinated with the SLD 45 Asbestos Program Officer. The notification, storage, and disposal of ACM and LBP would be in accordance with all applicable federal and local regulations. Documentation for the transportation and disposal of ACM and LBP would be required to be maintained in accordance with federal regulations. Additionally, if any previously undocumented contamination is discovered during construction activities, work would cease and CCSFS environmental staff would be notified immediately.

Other solid waste generated from the proposed construction activities would consist of building materials such as solid pieces of concrete, metals, and lumber. Hazardous waste generated during construction activities may include empty hazardous substance or petroleum containers, spent solvents, paints, sealants, adhesives, waste oil, spill cleanup materials, lead acid batteries, and various universal wastes. Handling, storing, and disposing of hazardous materials and hazardous waste during construction activities, including taking measures to prevent releases, would be required in accordance with all applicable federal and state regulations and CCSFS environmental management plans. Mission activities on SLC-14 would be required to be conducted in accordance with all applicable CCSFS environmental management plans and procedures.

Pollution prevention practices reduce, eliminate, or prevent pollution at its source before it is created. This practice can be accomplished through a variety of methods and would be implemented to reduce the quantity of hazardous materials and hazardous waste stored and generated at the complex. Source reduction minimizes the quantity of hazardous materials and hazardous waste used, stored, and generated at the complex, and would also be employed.

Additional BMPs include storing materials and hazardous waste within secondary containment and storing adequate spill response supplies near storage areas. Routine inspections of material and waste storage areas would result in the early detection of spills and releases to the environment. Demolition- and construction-derived waste would be recycled to the maximum extent possible to reduce waste sent to landfills.

There would be no significant impacts from the Proposed Action associated with hazardous materials, solid waste, and hazardous waste.

3.5.3.2 No Action Alternative

Under the No Action Alternative, SLC-14 would not be reactivated. Therefore, there would be no hazardous materials or wastes stored or generated on the complex.

3.6 Water Resources

3.6.1 Regulatory Setting

Water resources analyzed in this EA include groundwater, surface waters, wetlands, and floodplains. The region of interest (ROI) for water resources includes CCSFS and the adjacent waterways, which includes the Atlantic Ocean to the east and the Banana River to the west.

Groundwater is defined as water below the land surface in a zone of saturation. Groundwater properties are often described in terms of depth to an aquifer or water table, water quality, and surrounding geologic composition. Groundwater is an essential resource, as 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.

Surface water resources include lakes, rivers, streams, and wetlands. These resources can be important 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.

EPA and the U.S. Army Corps of Engineers 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 2023a). As of 2023, jurisdictional determinations were issued by the FDEP to determine whether a water or wetland will be regulated under Clean Water Act (CWA) Section 404 or under Section 10 of the Rivers and Harbors Act. NEPA regulations require that impacts to wetlands be assessed and alternatives for protection of these resources be evaluated in accordance with EO 11990, "Protection of Wetlands." The responsibility for jurisdiction determination will change from FDEP to USACE in 2024.

In Florida, the Environmental Resource Permit (ERP) Program regulates activities involving the alternation of water resources, which includes new activities in uplands that generate stormwater runoff from upland construction, as well as dredging and filling in wetlands and other surface water (FDEP 2023a). ERPs are jointly administered by FDEP and one of Florida's five water management districts. The St. Johns River Water Management District (SJRWMD) is the district responsible for implementing the ERP program on CCSFS. Additionally, FDEP is responsible for designating Outstanding Florida Waters (OFWs). An OFW is a water designated worthy of special protection because of its natural attributes. This special designation is applied to certain waters and is intended to protect existing good water quality (FDEP 2023b).

Projects that involve the construction of more than 5,000 square feet of impervious surface must also meet the requirements of DOD Directive 310-2-10 Low Impact Development.

Floodplains are areas of land adjacent to rivers or the coast that flood during storm events. DOT Order 5650.2, Floodplain Management and Protection, implements the guidelines set forth in EO 11988, "Floodplain Management" (42 *Federal Register* 26951 [May 25, 1977]). EO 11988 requires agencies to ensure that proper consideration is given to avoid and mitigate adverse floodplain impacts in agency actions, planning programs, and budget requests. To comply with EO 11988, actions must avoid floodplains if a practicable alternative exists; if no practicable alternative exists, actions in a floodplain must be designed to minimize adverse impacts to the floodplain's natural and beneficial values. Under DOT Order 5650.2, a significant encroachment would occur if the encroachment would result in one or more of the following impacts:

- A high likelihood of loss of human life
- Substantial encroachment-associated costs or damage, including adversely affecting safe airport operations or interrupting aircraft services (e.g., interrupting runway or taxiway use, placing another facility such as a navigational aid out of service, or placing utilities out of service)
- A notable adverse impact on the floodplain's natural and beneficial floodplain values

3.6.2 Affected Environment

3.6.2.1 Groundwater

Brevard County has two interconnected aquifer systems: the surficial aquifer and the Floridan aquifer. The surficial aquifer comprises groundwater found just a few feet beneath the land surface. This aquifer is separated from the underlying Floridan aquifer by a confining layer composed of clays, sands, and limestone. The Floridan aquifer's confining layer limits hydraulic conductivity and prevents significant vertical water exchange between it and the surficial aquifer. The Floridan aquifer is a vital source of clean drinking water in central Florida. Deeper groundwater, situated below the surficial aquifer, is more influenced by geographical features such as the Atlantic Ocean and the Banana River (USAF 2023a).

3.6.2.2 Surface Waters

The CCSFS is located within the Indian River Lagoon (IRL) watershed and is positioned on a barrier island that separates the Banana River Lagoon (BRL) from the Atlantic Ocean. Within this watershed, there are three primary water bodies: the BRL to the west, Mosquito Lagoon to the north, and the IRL located west of Merritt Island. Several neighboring water features have been designated as OFWs, encompassing a significant portion of Mosquito Lagoon and the BRL, along with the Indian River Aquatic Preserve, Banana River Aquatic Preserve, Pelican Island National Wildlife Refuge, and CNS. Mosquito Lagoon and the IRL have been designated as Class II surface waters. The surface waters of the BRL subbasin have been classified as Class II waters. As outlined in Chapter 62-302, F.A.C., Class II waters are intended to possess water quality suitable for shellfish propagation or harvesting. The BRL is listed as an impaired waterbody for fecal coliform, Shellfish Environmental Assessment Section classification, according to the EPA-approved CWA Section 303(d) list for Florida (FDEP 2022).

In 1990, the IRL system received recognition as an Estuary of National Significance within EPA's National Estuary Program. This designation identifies estuaries of national importance, aiming to balance conflicting uses of these vital ecosystems while restoring or preserving their inherent characteristics (EPA 2023b).

In addition to the National Estuary Program, the Wild and Scenic Rivers system was created in 1968 through the Wild and Scenic Rivers Act to safeguard certain rivers with outstanding natural, cultural, and recreational values for the enjoyment of present and future generations. Through 2022, the National System has protected 13,467 miles of 228 rivers in 41 states. The Wild and Scenic Rivers Inventory through the NPS was reviewed and it confirmed there are no rivers protected under the Wild and Scenic Rivers Act on or near CCSFS (National Wild and Scenic Rivers System n.d.). Therefore, this resource was considered but not analyzed in this EA.

New development at CCSFS need to align with the installation's stormwater management program, which has a stated goal of reducing the discharge of pollutants to the maximum extent practicable to protect water quality. To achieve this, site planning should consider onsite stormwater retention locations or integration into part of an installation-wide stormwater retention system (USSF 2022). As facilities are built or improved, impervious areas are subject to F.A.C. and SJRWMD stormwater regulations. Stormwater systems must be built or upgraded to be consistent with the requirements of SJRWMD Rule 40C-4 of the F.A.C. An ERP issued by SJRWMD is required for all proposed work in, on, or over wetlands or other surface waters. National Pollutant Discharge Elimination System (NPDES) construction stormwater permits issued by FDEP are required for projects that disturb 1 or more acres. It is anticipated that construction at SLC-14 will require these permits.

3.6.2.3 Wetlands

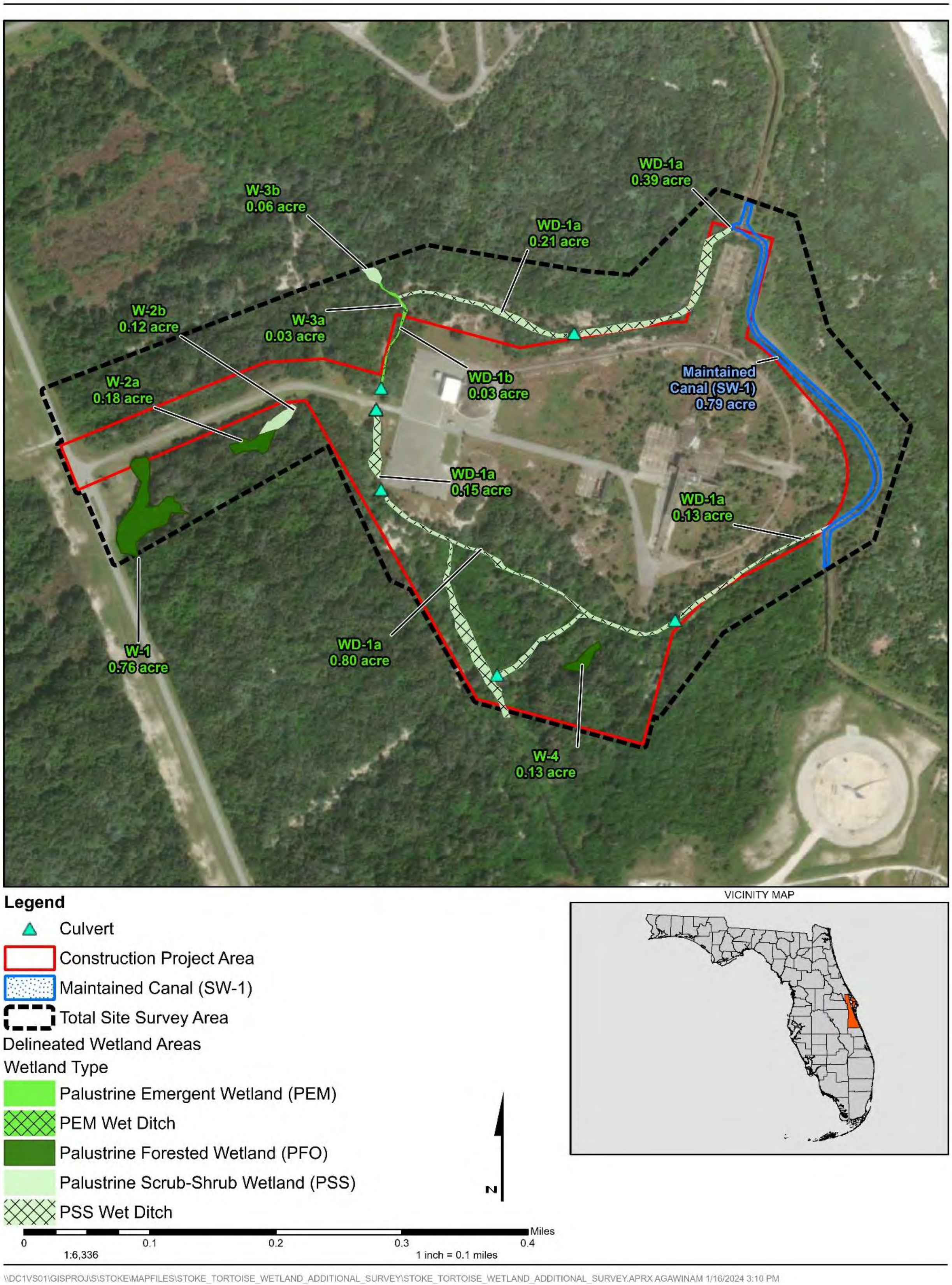
As shown on Figure 3.6-1, several delineated wetlands exist within the site review boundary. The wetland jurisdictional boundaries were based on FDEP Rule Chapter 62-331, F.A.C., as ratified in Section 373.4211, Florida Statutes for the estimated landward extent of State jurisdictional wetlands or other surface waters. A site visit was conducted with FDEP on December 7, 2023, to confirm the delineated wetlands, determine CWA WOTUS jurisdiction, and determine that "no permit required" from FDEP for the State 404 program. A site visit was conducted with SJRWMD on March 7, 2024, to review the wetland delineation for the ERP application.

All wetlands and surface waters that exist within the proposed project area have been previously disturbed to some degree through clearing, hydrologic alterations, or invasive exotic plant species encroachment. Specifically, the canal/ditch system identified during the 2023 field surveys was constructed during the original site development to manage surface water and groundwater (Appendix C). Over years of inactivity at the launch pad, the wet ditch sections (WD-1a and WD-1b) have become overgrown and wetland vegetation developed along all areas except the eastern portion that is maintained (Maintained Canal, SW-1). Further details of these wetlands and surface water may be found in *Technical Memorandum: Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys* (Appendix C; Jacobs 2023b).

3.6.2.4 Floodplains

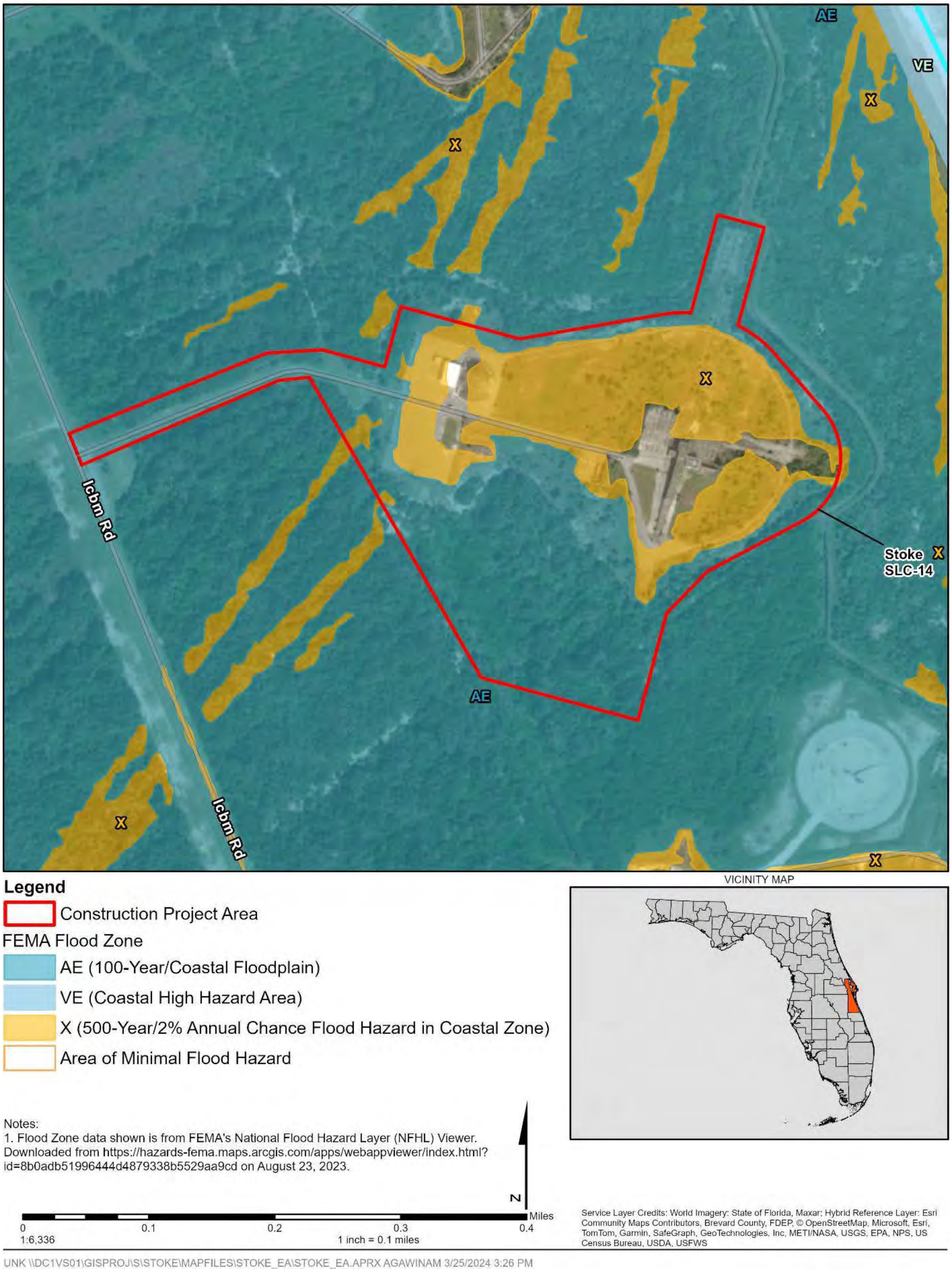
The Federal Emergency Management Agency (FEMA) defines geographic areas according to varying levels of flood risk, called flood zones. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map and are based on historic events and insurance claims. Each zone 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. FEMA's 100- and 500-year floodplains are displayed on Figure 3.6-2.

1 **Figure 3.6-1. SLC-14 Wetlands**



2

Figure 3.6-2. SLC-14 FEMA Flood Map



3.6.3 Environmental Consequences

The criteria for evaluating impacts to water resources include the loss of, or adverse impacts to, a resource and its functions and the adherence to applicable regulations. An impact to water resources would be significant if the Proposed Action:

- Exceeded water quality standards established by federal, state, local, and tribal regulatory agencies, or contaminated public drinking water supply (including associated aquifers) such that public health may be adversely affected.
- Adversely affected a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers.
- Substantially altered the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected.
- Substantially reduced the affected wetland's ability to retain floodwaters or storm runoff, thereby threatening public health, safety or welfare (the term welfare includes cultural, recreational, and scientific resources or property important to the public)
- Adversely affected the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands.
- Promoted development of secondary activities or services that would cause the circumstances listed above to occur.
- Is inconsistent with applicable state wetland strategies.
- Caused notable adverse impacts on the natural and beneficial floodplain values.

3.6.3.1 Proposed Action

3.6.3.1.1 Groundwater and Surface Water

The Proposed Action would not use groundwater for any purposes. Instead, potable water needs would be met through the established water distribution systems at CCSFS. Groundwater may be encountered during construction and any necessary dewatering efforts would be carefully coordinated with the CCSFS to prevent adverse effects on groundwater quality or flow.

The Proposed Action would add approximately 290,000 square feet of new impervious surface at SLC-14. As a result, an NPDES stormwater permit would be required by FDEP. Stormwater treatment measures consistent with the CCSFS SWPPP (USAF 2019b) would be implemented. The SWPPP would include mitigation measures related to stormwater treatment and soil erosion. Stoke would obtain and comply with SJRWMD and NPDES stormwater regulations.

The increase in surface water runoff due to the Proposed Action would be attenuated through a properly sized percolation pond in accordance with United Facilities Criteria 3-210-10, Low Impact Development and the Energy Independence and Security Act (42 U.S.C. Sections 17001 et seq.). SLC-14 is approximately 1,000 feet west of the Atlantic Ocean and over 2 miles east of the BRL and is far enough away to avoid any potential impacts from construction. Therefore, construction for the Proposed Action would have no significant impacts to surface waters.

As discussed in Section 3.5, Hazardous Material, Solid Waste, and Hazardous Waste, CCSFS developed environmental management plans, including the Hazardous Waste Management Plan (USAF 2022), the CCSFS SPCC Plan (USAF 2018), the CCSFS SWPPP (USAF 2019b), and the SLD 45 Integrated Solid Waste Management Plan (USSF 2024). The requirements in these plans would prevent contamination to groundwater and surface water during operations. Therefore, operation of the Proposed Action would have no significant impacts to groundwater or surface water.

3.6.3.1.2 Wetlands

Wetlands have been avoided to the degree possible during site design; however, approximately 0.5 acre of wetlands could be affected by the Proposed Action (portions of WD-1a and W-4). WD-1a wetlands are located in a manmade ditch and are of low quality. W-4 is an isolated forested wetland. During the ERP and CWA permitting process, it was determined that wetland mitigation is not required.

3.6.3.1.3 Floodplains

Based on the National Flood Hazard Layer FIRM Map for SLC-14 (Figure 3.6-2), there are the 100-year (1%) and 500-year (0.2%) annual flood hazard contours within SLC-14 (FEMA n.d.). Construction would impact these floodplains; however, low-impact development and BMPs for stormwater systems would be designed to treat and attenuate volumes associated with the impacted floodplains. Stoke will also obtain necessary ERP permits from SJRWMD. Therefore, no significant impacts to floodplains would occur as a result of the Proposed Action.

3.6.3.2 No Action Alternative

Under the No Action Alternative, SLC-14 would not be reactivated; therefore, there would be no change to water resources.

3.7 Geology and Soils

3.7.1 Regulatory Setting

Earth resources include the soil, underlying geology, and potential for geologic hazards and erosion within SLC-14.

3.7.2 Affected Environment

3.7.2.1 Geology

The Cape Canaveral Peninsula is part of the barrier island complex along the Atlantic coast. The peninsula is Holocene-aged and contains coastal sand deposits forming a series of beach-ridges separated by erosional surfaces, primarily shaped by waves and wind. Cape Canaveral is considered a cuspate foreland, which is a land formation characterized by a triangular extension from the coastline (USAF 2023a).

The sediments that comprise Cape Canaveral consist of quartz sand and carbonate sand- to pebble-size shell fragments. The geology underlying CCSFS is comprised of four stratigraphic units including surficial sands, Caloosahatchee Marl, Hawthorn Formation, and limestone formations of the Floridian aquifer.

Topography at CCAFS is relatively flat with elevations that range from sea level to 15 feet (5.0 meters) above mean sea level. The higher naturally occurring elevations occur along the east portion of CCAFS, with a gentle slope to lower elevations toward the marshlands along the BRL (USAF 2005).

3.7.2.2 Soils

The Natural Resources Conservation Service (NRCS 2023) identifies three different soil types within SLC-14, including the Canaveral-Anclote complex, Canaveral-Urban land complex, and Urban land.

The Canaveral series consists of very deep, somewhat poorly to moderately well-drained soils, on side slopes of dune-like ridges with water table depths of 10 to 40 inches. Anclote soils are very poorly drained, with a depth-to-water table of about 6 inches. The Urban land series occurs in flatwoods, rises, knolls, ridges, and hills on marine terraces. Canaveral-Urban complex is found primarily around structures and impenetrable surfaces within the SLC-14. These soils are moderately well-drained with a depth to surface water of 30 to 60 inches (NRCS 2023). There are no farms or agriculturally important soils or facilities at CCSFS (USSF 2024a).

3.7.3 Environmental Consequences

Impacts to geology and soils would be significant 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.
- Caused severe erosion or sedimentation from site preparation, construction/demolition, or operational activities.

3.7.3.1 Proposed Action

Most construction activities associated with the Proposed Action would occur within the original footprint of the existing SLC-14. The additional construction and expanded footprint necessary for the implementation of the Proposed Action would disturb approximately 36 acres of previously undisturbed soils. Increased erosion and sedimentation may be caused by these 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. An NPDES permit would be obtained and a SWPPP would be developed prior to construction that would provide detailed erosion prevention and control measures to be implemented during site preparation and construction activities. Soil disturbance would not result in foundational instability and no unique geologic features of exceptional interest mineral resources or farmland are present. Therefore, impacts to geology and soils would be less than significant.

3.7.3.2 No Action Alternative

Under the No Action Alternative, no construction or ground disturbing activities would occur; therefore, there would be no impacts on geology and soils.

3.8 Infrastructure

3.8.1 Regulatory Setting

Infrastructure includes transportation and utilities as further described in the next sections.

3.8.1.1 Transportation

Transportation infrastructure, as defined for this EA, includes the local and regional roadway, waterway, and aviation networks that provide access to and within CCSFS.

3.8.1.2 Utilities

Utility infrastructure refers to the system of public works that provides the underlying framework for a community. Utilities evaluated in this EA include water, wastewater, electric power, and stormwater.

Potable water utilities within CCSFS must adhere to F.A.C. water quality regulations for safe drinking water.

3.8.2 Affected Environment

3.8.2.1 Transportation

CCSFS is located on the Florida Coast, approximately 50 miles to the east of Orlando. Interstate 95 provides highway access to CCSFS via State Route (SR) 405 and SR 528. SR 405 becomes NASA Causeway at U.S. Highway 1. CCSFS is accessible via three controlled entry points. Gate 1 (South Gate) on SR 401 is the primary entry control point and the commercial vehicle inspection station. All commercial vehicles must access CCSFS through this gate. Two entry points provide access from KSC: one at the NASA Causeway on the west and the other via Phillips Parkway at the north end of CCSFS. Vehicles arriving at these points are screened at the KSC Badging Office. NASA Causeway is not designed to accommodate large vehicle transport (USSF 2022b).

Phillips Parkway is the primary roadway on CCSFS. It is a four-lane divided highway in some areas and a two-lane arterial in others. Phillips Parkway accommodates most of the north-south traffic and connects to KSC to the north. East-west roadways provide additional internal access. SLC-14 is located on ICBM Road, which runs northwest-southeast along the eastern edge of CCSFS. ICBM Road can be accessed via Heavy Launch Road to the north and Central Control Road to the south. At present, ICBM Road is a lightly traveled road. The use of the roadways at CCSFS is increasing because of new commercial development on CCSFS.

The roads and supporting structures, such as culverts, bridges, and pavement, were constructed to meet Florida Department of Transportation (FDOT) standards. According to a 2013 study (AMEC 2013), most road pavement conditions were indexed as good or fair; however, a section of Phillips Parkway was assigned an index condition of poor between approximately SLC-41 north to the turnoff to KSC Pad 39A. The study also indicated that the conditions of most culverts that may be transited appeared to be in good condition, though the condition of some older culverts could not be determined.

The waterways and associated port infrastructure at and near CCSFS can be used for the transportation of payloads, construction materials, and other large components required for operations. Facilities include Port Canaveral, the vehicle assembly building basin, Hangar AF Wharf, and Kennedy Athletic, Recreation, and Social park boat basin. Other key port assets include Air Force wharf, and the Evolved Expendable Launch Vehicle berth (Space Florida 2017).

Various nearby aviation facilities could be used to transport spacecraft components. Military installation airfields such as Patrick Space Force Base Airport and general aviation airports such as Melbourne International Airport are located in Brevard County. Two regional general aviation airports, Merritt Island Airport and the Space Coast Regional Airport, are also nearby. The Orlando International Airport and Orlando Sanford Airport are located in Orange County, about 50 miles west of CCSFS.

3.8.2.2 Utilities

Originally constructed in the 1950s, SLC-14 was deactivated in 1967 and was abandoned in place in 1973. Because of the age of the existing infrastructure at SLC-14 and the lack of ongoing maintenance, the condition of onsite utilities is unknown. For the purposes of this EA, it is assumed that all onsite utilities would need to be provided as part of the Proposed Action.

3.8.2.2.1 Potable and Nonpotable Water

The City of Cocoa's municipal water distribution system provides potable water to CCSFS via a connection at the South Gate. The City's water supply comes from groundwater wells in east Orange County and the Taylor Creek Reservoir in Orange and Osceola Counties. The water is treated by the City at the Claude H. Dyal Water Treatment Plant. The City of Cocoa has a water franchise agreement with CCAFS for the provision of water and wastewater services.

The CCSFS potable water system operates under FDEP Potable Water System Number 3054140. Based on the City's water supply plans, the City's largest wholesale water customer is the U.S. Government for a combined annual average daily flow of 5 million gallons per day (mgd) at three installations: KSC, CCAFS, and Patrick Air Force Base (AFB). The historical flows peak to 4.2 mgd, with the average being 3.7 mgd. Based on the City's Comprehensive Plan, the City has sufficient water production and storage capacity to accommodate future average daily and typical peak day demands generated by customers in its water service area (Space Florida 2017).

Water is used at CCSFS for potable and non-potable uses. Non-potable uses include fire protection, launch activities, and limited irrigation. Various storage systems and secondary pump systems on CCSFS supply water needs (USAF 2017). SLC-14 is serviced by an 8-inch fire main and a 4-inch potable main along ICBM Road.

3.8.2.2.2 Wastewater

Domestic wastewater is treated at the Regional Wastewater Treatment Plant (RWWTP) on CCSFS (FDEP permit number: FL0102920). The RWWTP is used by most facilities at CCSFS, though several areas, including legacy SLCs along ICBM Road, treat wastewater using septic tanks and drain field systems. Deluge discharge water either is sent to the RWWTP or is discharged to the ground in accordance with permitted water quality parameters (USSF 2022b).

There are currently no sanitary sewer services available at SLC-14. The nearest CCSFS sanitary sewer main is located at the intersection of ICBM Road and Central Control Road, approximately 1.3 miles from SLC-14.

3.8.2.2.3 Electrical Power

Florida Power and Light Company provides high-voltage (115-kilovolt) electrical power to several substations at CCSFS. Electrical transmission lines enter CCSFS at the southwest boundary coming across the BRL into the south substation and the Titan substation. The feeds can provide 59 megavolt-amperes to CCSFS, which exceeds current requirements (USSF 2022b). CCSFS maintains the local electrical distribution system, which provides 13.2 kilovolts to the launch complexes from load brake switches through a duct-bank system of conduit and manholes. On individual launch facilities, the medium-voltage power is stepped down through other load brake switches to the various low-voltage distribution transformers, which supply the required power for the existing facilities (USAF 2017). Electrical service is currently available at SLC-14.

3.8.3 Environmental Consequences

The infrastructure analysis evaluated the potential impacts to existing transportation systems and utilities that could occur as a result of the Proposed Action and No Action Alternatives.

Impacts to transportation systems would be significant if the Proposed Action:

- Resulted in a severe disruption of local traffic patterns.
- Increased vehicle trips on the roadway network, resulting in severely degraded levels of service.
- Resulted in readily apparent road damage that rendered a road unusable.

Impacts to utilities would be significant 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.
- 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.

3.8.3.1 Proposed Action

3.8.3.1.1 Transportation

During the 18-month construction period at SLC-14, there would be approximately 200 construction workers onsite, contributing an additional 200 vehicles traveling on the roadway system to and from locations within CCSFS. Construction vehicles are expected to be stored and maintained onsite and the occasional movement of cranes, dump trucks, and other large construction equipment to SLC-14 would not lead to substantial road damage on CCSFS. Construction activities would be in keeping with the normal roadway traffic and would result in no impacts to local roadways. Traffic on CCSFS could be affected by large equipment, but activities would be timed to avoid disruption to critical operations. Therefore, construction of the Proposed Action would not have a significant impact to transportation.

During operations of the Proposed Action, approximately 25 employees would support the Stoke program daily during program operation at CCSFS. During launch operations, it is anticipated that there would be 50 personnel onsite at SLC-14 for a duration of roughly 30 to 60 days for vehicle, payload, and pad processing through the launch attempt. Stoke is planning for 2 launch operations during the first year of operation, increasing to up to 10 launches per year. This relatively small number of additional daily trips would result in a negligible increase in traffic at CCSFS and on regional roadways.

Individual launch vehicle components would be transported to SLC-14 via DOT oversize load trucks. Individual truckloads would adhere to applicable state weight limits. Launch vehicle components would follow designated haul routes through CCSFS. It is anticipated that launch vehicle components would enter through the South Gate and follow Phillips Parkway to Heavy Launch Road to ICBM Road. Where possible, components would be transported to SLC-14 during off-peak hours to minimize the effect of oversize vehicle loads. Stoke will coordinate the transportation of launch vehicle components with the appropriate authorities at CCSFS, as necessary. The transportation of launch vehicle components or payloads is not anticipated to result in significant impacts to roadways or traffic. It is anticipated that launch vehicle components would primarily be transported using roadways. If the use of airport facilities were necessary, Stoke would coordinate with the proper authorities prior to transportation.

There is a possibility for increased traffic from visitors or public observers related to launch activity. Launch viewing-related traffic is routinely managed by CCSFS, KSC, and local authorities. Launch activities would be coordinated with CCSFS, KSC, and the local authorities as necessary in case roadway closures are necessary for visitors and public observers during a planned launch. Therefore, operation of the Proposed Action would not result in a significant impact to transportation.

3.8.3.1.2 Utilities

Water

The Proposed Action would connect to the existing 8-inch fire main along ICBM Road. A deluge system would accommodate approximately 100,000 gallons of water during a static test fire operation and 100,000 gallons during launches. This water would be sourced from the CCSFS fire water line, using the existing connection along ICBM Road at SLC-14.

The peak number of annual launches the Proposed Action is expected to have is 10 launches, requiring up to 1,000,000 gallons of water per year for deluge. Compared to the historic average consumption of 3.7 mgd for CCSFS, KSC, and Patrick AFB combined, the water needs for deluge and fire suppression at SLC-14 would not result in significant impact to water utilities.

Potable water would be provided to the facilities at SLC-14 by connecting new water lines on SLC-14 to the existing potable water main along ICBM Road. A FDEP permit would be obtained prior to construction of new water lines. The potable water demand needed to support 25 permanent personnel and 50 launch-related personnel would not result in a significant impact to water utilities at CCSFS.

Wastewater

Industrial wastewater has the potential to be produced by deluge activities associated with the Proposed Action. An onsite deluge water containment and disposal system would be designed to capture the deluge water for testing until water quality criteria outlined in the required FDEP Industrial Wastewater Permit for onsite disposal of launch-related wastewater were met. Remaining water that could not be treated through an onsite stormwater treatment system would be transported and disposed of offsite at an approved industrial wastewater treatment facility. An Industrial Wastewater Permit from FDEP would be required, and the resulting impacts on wastewater from the Proposed Action would be minor.

The Proposed Action would include the collection of wastewater at a central maintenance hole prior to discharge into a self-contained sanitary treatment package. A FDEP permit would be obtained prior to construction. The Proposed Action would not result in significant impacts to sanitary sewer systems.

Electrical Power

The Proposed Action includes the construction of new electrical infrastructure at SLC-14. A 480-volt 3-phase power system would be installed at the launch site. Connections to the CCSFS electrical system would be provided. The estimated annual average power usage for the Proposed Action would be 1.72 megawatt-hours. The electrical demand as a result of the Proposed Action would result in a negligible increase in energy use at CCSFS and would not result in significant impact to electrical power supply.

3.8.3.2 No Action Alternative

Under the No Action Alternative, SLC-14 would not be reactivated. There would be no additional construction traffic associated with the reactivation of SLC-14 or with launch activity at SLC-14. Additionally, there would be no impact to current utility services if the Stoke Space program did not occur. Therefore, there would be no impact to infrastructure under the No Action Alternative.

3.9 Health and Safety

3.9.1 Regulatory Setting

At CCSFS, range safety organizations assess, authorize, oversee, and if needed, implement safety stoppages on all pre-launch and launch activities. These actions are performed in accordance with Space Systems Command Manual (SSCM) guidelines (SSC 2022). The purpose of range safety is to ensure an acceptable safety standard for the public and installation resources. Additionally, it facilitates the full compliance of all pre-launch and launch operations with legal regulations.

3.9.2 Affected Environment

The safety categories discussed in this analysis include construction and operations safety, range safety, and security requirements.

3.9.2.1 Construction Safety

Construction site safety regulations are designed to safeguard employees and curtail the risk of harm, illness, fatality, and property destruction. All contractors performing construction and demolition activities at CCSFS must adhere to OSHA regulations at 29 CFR Part 1926. These standards mandate that work procedures be performed without increasing safety risks to the workers or the public.

3.9.2.2 Range Safety

Range safety at CCSFS adheres to USAF requirements and public laws that consider various domains, including the general public, personnel within the launch area, and adjacent launch complexes. The SSCM establishes the mission safety program requirements at USSF ranges, which includes safety requirements for launch vehicles, payloads, ground support equipment, systems, and materials used within the ranges (SSC 2022). In accordance with 14 CFR Part 450 *Launch and Reentry License Requirements*, the FAA would issue a safety approval to Stoke if it is determined that the launch can be conducted without jeopardizing public health and safety and safety of property.

3.9.2.3 Security Requirements

CCSFS access is controlled through manned guard stations and fencing, necessitating access badges for entry by employees and visitors. CCSFS upholds USSF security standards, which encompass the mitigation of terrorist threats.

3.9.3 Environmental Consequences

This section evaluates potential impacts resulting from the Proposed Action. The anticipated direct and indirect impacts, considering both short- and long-term project effects, were assessed for each resource.

An adverse impact to health and safety would result in an increased risk of bodily injury, illness, and death or property damage from the Proposed Action. An impact to health and safety would be considered significant if the Proposed Action:

- Substantially increased the safety risk to installation personnel, contractors, or the general public.
- Hindered the ability to respond to an emergency.
- Introduced new health or safety risks that installation personnel are not prepared to manage or respond to.

3.9.3.1 Proposed Action

3.9.3.1.1 Construction and Facility Safety

The Proposed Action involves inherent site safety risks resulting from loud noise, the operation of heavy machinery, debris, electricity, and potential contact with hazardous materials used or encountered during work. These risks necessitate the implementation of preventive measures for the well-being of workers. SLD 45 Range Safety Program oversees safety requirements, including compliance with all applicable regulations on CCSFS. These regulations set procedures for assessments, authorizations, and operational safety during launch activities. Operational safety includes safe distance area(s) to address the risks associated with a potential hazard contingency. The safe distance area(s) identify potential affects to associated support facilities, non-related facilities and roadways; all of the terrestrial components of these safety distances are located on CCSFS and would not extend into local communities. Typically, these safe distances (or hazard closure areas) include road closures at multiple points, evacuation of all personnel, and ceasing all operations within the closure areas on CCSFS. The closures will remain in place until the all-clear is determined by the provider in conjunction with SLD 45.

Construction activities conducted on CCSFS would be performed in accordance with CCSFS safety regulations, DAF Technical Orders, and OSHA-prescribed standards. Specifically, the Proposed Action would adhere to OSHA regulations 29 CFR Part 1926, *Safety and Health Regulations for Construction,* and 29 CFR Part 1910, *Occupational Safety and Health Standards,* and DAFI safety standards.

Fire protection systems would comply with National Fire Protection Association requirements as applied by the CCSFS Authority Having Jurisdiction, Unified Facilities Criteria and DOD Engineering Technical Letter guidance and direction. The CCSFS Fire Department would monitor fire protection alarms.

The launch mount/pad would include an LPS system to protect from lightning. The LPS system would be taller than the rocket and comply with 14 CFR Part 77, *Safe Efficient Use and Preservation of the Navigable Airspace*. The Proposed Action site does not pose a risk to human health or the environment from contaminant exposure during construction because SLC-14 received a No Further Action for SWMU 39 (USSF). Reference Section 3.5, *Hazardous Materials, Solid Waste, and Hazardous Waste,* for a detailed discussion.

3.9.3.1.2 Marine and Airspace Safety

All launches must comply with established government safety requirements and cannot jeopardize public safety or property (FAA 2006; SSC 2022). The public is defined as an individual outside the hazard areas around a launch site. The probability of a launch mishap affecting a member of public or their property is extremely unlikely, due to safety protocols in place and because the launch azimuth projects from the shore to the ocean. Given the established USCG procedures for maritime safety around launches, the potential safety risk to the maritime community is also extremely unlikely. As discussed in Section 2.1.3.1, Airspace Protocols, and Section 2.1.3.2, Maritime Protocols, all launch and reentry operations would comply with the necessary notification requirements, including issuance of NOTMARs and NOTAMs. In accordance with 14 CFR Part 450, Stoke would be required to enter into a Letter of Intent with appropriate USCG Districts for USCG to issue local NOTMARs for maritime hazard areas. Stoke would be responsible for coordination with the National Geospatial Intelligence Agency for the issuance of international NOTMARs.

SLD 45 will perform a risk analysis for each mission and generate required hazard areas (domestic and/or international). An approved surveillance plan by applicable government agencies is executed for launch compliance. Sea surveillance efforts may include the use of land-based, aerial, and/or seaborne assets to detect targets of interest within a hazard contour. For far downrange tracking of hazard areas, automatic identification system-based surveying could be conducted. Targets of interest within applicable contours are reported to the Space Force Risk Assessment Center for risk analysis input in compliance with risk thresholds in accordance with 14 CFR Part 450 and SSCM91-710. SLD 45 and/or launch service provider would coordinate with the USCG to implement a safety zone, security zone, and/or regulated navigation area to decrease the risk to the maritime community and reduce risk to public safety and the Maritime Transportation System (MTS).

The SLD 45 Flight Analysis notifies applicable agencies of areas that are hazardous to aircraft (that is, impact debris corridors) for all normally jettisoned and impacting stages prior to launch. The 1st Range Operations Squadron notifies the FAA so that the appropriate ALTRV or NOTAM can be disseminated. Restricted and warning areas would be active and controlled according to SSCM 91-710, Range Safety Requirements.

In summary, closure areas during launch are specific to each launch and will be coordinated with SLD 45 and the FAA based on the Flight Safety Analysis results, resulting in no significant health and safety impact to onsite personnel or the general public.

3.9.3.2 No Action Alternative

Under the No Action Alternative, the Proposed Action would not be implemented, and no changes to safety and occupational conditions would occur.

3.10 Department of Transportation Act Section 4(f)

3.10.1 Regulatory Setting

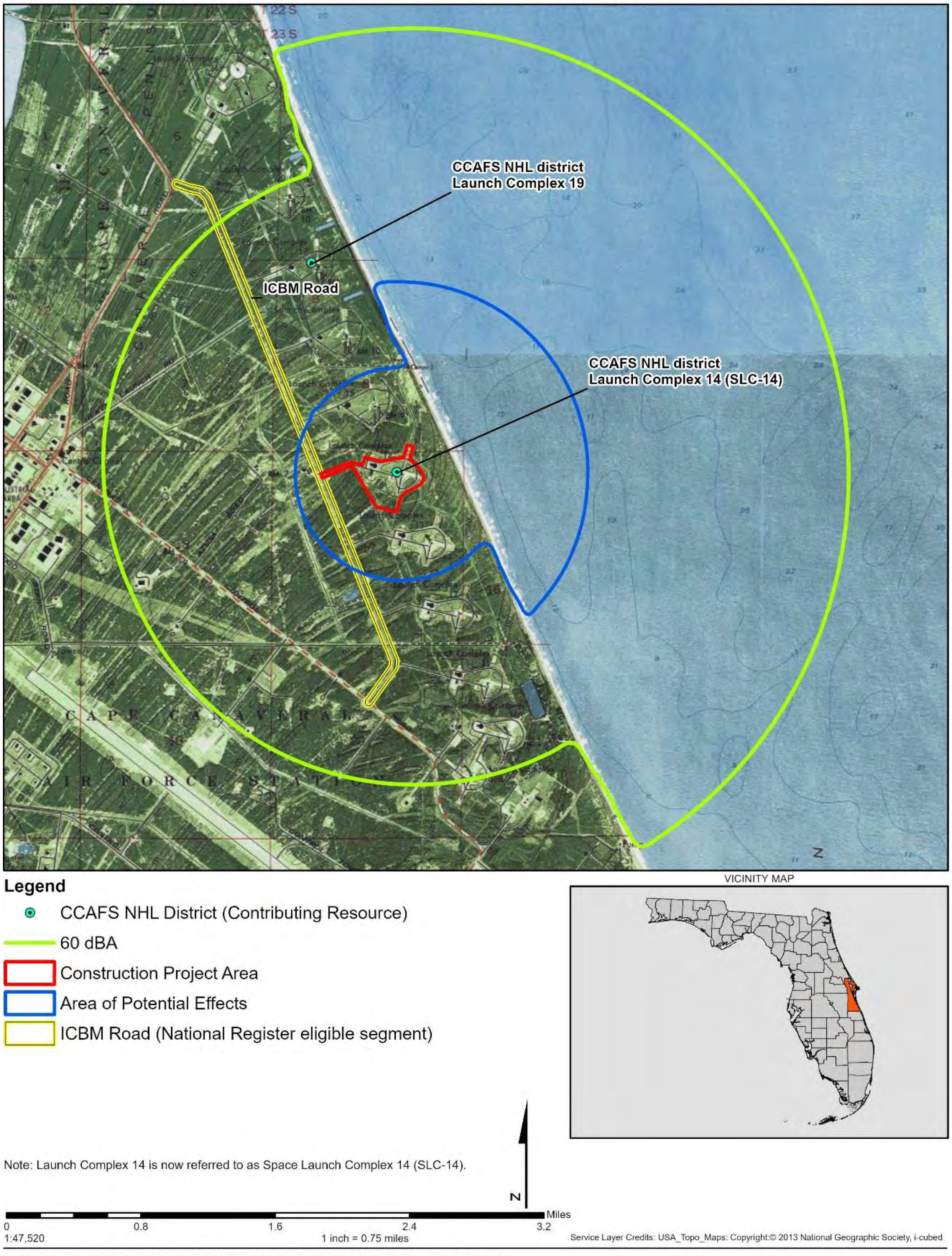
Federal agencies within the DOT are required to comply with Section 4(f) of the U.S. Department of Transportation Act of 1966 (49 U.S.C. Section 303). Section 4(f) provides that the Secretary of Transportation may approve a program or project requiring the use of publicly owned land of a public park, recreation area, or wildlife or waterfowl refuge of national, state, or local significance, or land of a historic site of national, state, or local significance, only if there is no feasible and prudent alternative to using that land and the program or project includes all possible planning to minimize harm resulting from the use. In compliance with the Memorandum of Understanding between DAF and the FAA, the FAA, as a cooperating agency on this NEPA review for a proposed project involving Section 4(f) resources, must take the lead on Section 4(f) compliance and ensure that a Section 4(f) evaluation is included.

The term "use" as it relates to Section 4(f) denotes an adverse impact to, or occupancy of, a Section 4(f) property (FHWA 2023). A use occurs when the project requires the permanent incorporation of a property, the temporary occupancy of a property that is adverse in terms of the statute's preservation purpose, or has a constructive use (23 CFR 774.17). Constructive use is when there is no physical incorporation of the property but the impacts on a Section 4(f) property (e.g., noise) are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired (FAA Order 1050.1F, Appendix B-2). Impacts to Section 4(f) properties can include constructive use or physical use, such as an actual physical taking of Section 4(f) property through the purchase of land or permanent easement, physical occupation of a portion or all the property, or alteration of structures or facilities on the property.

3.10.2 Affected Environment

The study area for Section 4(f) is the area that would be affected by the Proposed Action. The study area is centered around SLC-14 and is bounded by the DNL 60-dBA noise contour as shown on Figure 3.10-1. The DNL 60-dBA noise contour is the area where potential long-term community annoyance may occur from propulsion noise. The DNL is weighted for all average annual day noise events and accounts for increased sensitivity for nighttime noise events. The study area for Section 4(f) also includes MINWR and CNS, as shown on Figure 1-1, which are the nearest recreational areas near SLC-14. MINWR is managed by the USFWS and is regularly used for launch viewing, bird watching and nature study, fishing, and seasonal hunting. CNS is managed by the NPS and is regularly used for launch viewing, beach recreation, and nature study. Both MINWR and CNS are open to the general public, and the unique characteristics of these sites would not be altered by the Proposed Action. Possible effects include the potential closures of parks and recreation areas; noise impacts from testing and launch operations; and the use of historic properties.

Figure 3.10-1. Section 4(f) Properties Affected Environment



3.10.2.1 Historic Properties

Section 4(f) defines a historic site as one that has national, state, or local significance and is listed in, or is eligible for listing in, the NRHP. A historic site listed or eligible for listing on the NRHP is defined as a historic property under Section 106 of the NHPA (54 U.S.C. Section 300308) (refer to Cultural Resources, Section 3.2 for further discussion on historic properties). For consistency, this EA refers to a historic site as a historic property.

There are two historic launch complexes in the affected environment—SLC-14 and SLC-19—and ICBM Road. SLC 14 and SLC-19 are individually eligible for listing in the NRHP and also contribute to the CCSFS NHL. ICBM Road is eligible for listing in the NRHP. SLC-14 is the only historic property in the project footprint. SLC-14, SLC-19, and ICBM Road intersect with the area where launch noise and vibrations may affect structures, though these historic buildings and structures were designed and constructed to support and withstand launches. Archeological resources are present at CCSFS, though no known archeological resources would be disturbed by the Proposed Action.

3.10.2.2 Parks and Recreation Areas

Multiple public parks and recreation areas are adjacent to CCSFS, though none intersect with the affected environment.

3.10.3 Environmental Consequences

Impacts would reach the significance threshold if the Proposed Action involves more than a minimal physical use of a Section 4(f) property or constitutes a constructive use based on an FAA determination that the project would substantially impair the Section 4(f) property (FAA Order 1050.1F, Appendix B). Substantial impairment occurs when the significance and enjoyment of a Section 4(f) property is substantially reduced or lost.

3.10.3.1 Proposed Action

3.10.3.1.1 Permanent Incorporation

The Proposed Action would demolish the features inside the fenced area at SLC-14, which is a Section 4(f) historic property (refer to Section 3.2, Cultural Resources). However, these features are greatly deteriorated, with diminished structural integrity. The SLC-14 Blockhouse and Memorial Monument are the only features to be retained at SLC-14. The Proposed Action would result in the reactivation of SLC-14 back to its historic use as a launch complex, and the historic integrity of setting, location, association, and feeling of SLC-14 would be retained. The new design would use similar materials and layout in keeping with, but not duplicating, the historic appearance of the original SLC-14.

Noise greater than 130 dBA and vibrations from launch activities could affect nearby buildings and structures. However, the only historic buildings and structures within the 130-dBA noise contour are ICBM Road and SLC-14. ICBM Road and the Memorial Monument would not be affected by noise and vibration. The SLC-14 Blockhouse was constructed to withstand the noise and vibrations associated with launch activities. No other historic buildings or structures would remain at SLC-14.

For historic properties, a de minimis impact under Section 4(f) is one that results in a Section 106 determination of "no adverse effect" (23 CFR 774.17) (refer to Section 3.2, Cultural Resources, for more detailed discussion of impacts to cultural resources). The reactivation of SLC-14 back to its historic use, retaining its integrity of setting, location, association, and feeling, would result in no adverse effect on historic properties under Section 106 of the NHPA. CCSFS will request the SHPO's concurrence with this finding of no adverse effect and will notify the SHPO that the FAA intends to make a de minimis impact determination based on the FAA's concurrence with the finding of "no adverse effect." A de minimis impact is less than significant.

3.10.3.1.2 Temporary Use

The Proposed Action would not have a temporary use of any Section 4(f) properties.

3.10.3.1.3 Constructive Use

The Proposed Action would conduct approximately two launches during the first year of operation in 2025. The launch schedule may increase to 10 launches per year for the subsequent 2 years. Launch trajectories are expected to be oriented to the east over the Atlantic Ocean. The DNL 60-dBA contour is used to conservatively identify potential noise impacts from launches; the DNL 60-dBA noise contour for the Proposed Action does not extend to any of the identified parks around CCSFS. On launch days, sections of MINWR and CNS may be restricted for crowd control and access for emergency services.

There is minimal potential for annoyance from launch activities to affect the recreational experience around CCSFS. In fact, recreational activities associated with launch viewing would be improved by the Proposed Action. Temporary restrictions to MINWR and CNS are in keeping with regular launch activities from CCSFS and KSC and would not substantially affect these resources. Such closures would not be expected to cause more than a minimal disturbance to the use of resources at MINWR and CNS, and areas outside the safety exclusion zones would be available for nature study, bird watching, and other recreational activities. All closures would last approximately 3 to 6 hours per launch. There would be no impact from sonic booms during launches as these occur entirely over water. The Proposed Action would not result in the constructive use of any Section 4(f) properties.

3.10.3.2 No Action Alternative

Under the No Action Alternative, the reactivation of SLC-14 would not be implemented. SLC-14 would remain abandoned in place and inoperable. The No Action Alternative would not result in the use of Section 4(f) properties and thus there would be no impact from Section 4(f) use.

3.11 Land Use, Visual, and Coastal Resources

3.11.1 Regulatory Setting

3.11.1.1 Land Use

Land use is defined as the human use of land resources for activities such as economic production, natural resources protection, residential, commercial, or industrial uses. Compatible land use is achieved when the Proposed Action fits within the land use patterns, land ownership, and land use management plans.

3.11.1.2 Visual Resources

Visual resources and visual character are any naturally occurring or human-made features that contribute to the aesthetic value of an area. Visual resources may include buildings, sites, historic properties, and other natural or human-made landscape features that are visually important or have unique characteristics. Visual effects from light emissions may create annoyance or interfere with activities.

3.11.1.3 Coastal Resources

The Coastal Zone Management Act (CZMA) establishes a national policy to preserve, protect, develop, restore, and enhance the resources of the nation's coastal zones (16 U.S.C. Section 1452). A coastal zone is defined as the coastal waters and the adjacent shorelands, strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches (16 U.S.C. Section 1453); however, federal lands are excluded from the definition of coastal zone (16 U.S.C. Section 1453(1)). Under the CZMA, a federal action that may affect the coastal zone must be carried out in a manner that is consistent with the enforceable policies of a state's approved coastal zone management program to the maximum extent practicable (16 U.S.C. 1456(c)(1)(a)). Once an agency has determined that its proposed action is consistent with the enforceable policies of a state's approved coastal zone management program to the maximum extent practicable, the agency submits a consistency determination (CD) to the appropriate state agency. The state agency may concur with, or object to, the agency's determination, but the decision to proceed with the proposed action remains with the agency.

3.11.2 Affected Environment

3.11.2.1 Land Use

CCSFS includes approximately 25 square miles (16,200 acres) that support multiple land use types, such as administration, operations and maintenance, airfield clearance, airfield pavement, industrial use area, open space/buffer zone, outdoor recreation, and water (USAF 2017). Prime farmland does not exist within CCSFS. Open space includes areas managed for natural resources and is the largest land use category at CCSFS. The beaches along CCSFS are used for launch operations and are restricted from public use. Current land use at SLC-14 includes open space and an inactive launch complex with a paved access road leading up to, and circling around, the complex. SLD 45 manages all land uses at CCSFS. Undeveloped land surrounding SLC-14 would be managed in accordance with AFMAN 32-7003, *Environmental Conservation* and the *45th Space Wing Wildland Fire Management Plan* (USSF 2020a).

3.11.2.2 Visual Resources

The visual resources and visual character at CCSFS are typical of an industrialized area that supports rocket launches. The topography is relatively flat and tall, highly visible towers and related infrastructure that support launches are present. The Atlantic Ocean coast and surrounding streams and wetlands make up the natural landscape features of SLC-14.

Visual effects on people, wildlife, and land use may occur from light emissions of the Proposed Action. SLC-14 is within 2,000 feet of the Atlantic Ocean and nesting adult and hatchling sea turtles may be sensitive to artificial lighting produced by the Proposed Action. The USSF has developed exterior lighting requirements for areas on CCSFS.

3.11.3 Environmental Consequences

An impact to land use would be significant if the Proposed Action:

- Was inconsistent or noncompliant with applicable land use plans or policies.
- Precluded the viability of existing land use.
- Precluded continued use or occupation of an area.
- Was incompatible with land uses in the vicinity to the extent that public health or safety was threatened.

An impact to visual resources may be significant if the Proposed Action:

- Resulted in light emissions that interfered with normal activities or affected the visual character of the area.
- Affected the importance, uniqueness, or aesthetic value of visual resources.
- Obstructed the views of visual resources.

An impact to coastal resources may be significant if the Proposed Action:

- Substantially impacted a coastal barrier system or coastal reef ecosystem.
- Caused an unacceptable risk to human safety or property.
- Caused adverse impacts to the coastal environment that cannot be satisfactorily mitigated.

3.11.3.1 Proposed Action

3.11.3.1.1 Land Use

The reactivation of SLC-14 as described in the Proposed Action is consistent with, and supports, future land uses as noted in the USSF's CCSFS District Plans (USSF 2022b). The Proposed Action would not convert prime farmland to other uses; result in a decrease in the land's productivity; or conflict with existing uses or values of the project area or other base properties. The Proposed Action would not prevent the continued use, occupation, or viability of areas. Therefore, the impacts to land use would be less than significant.

3.11.3.1.2 Visual Resources

Potential visual resource and visual character effects of the Proposed Action include the Stoke launch vehicle and new facilities. These impacts would be consistent with the existing activities and infrastructure at CCSFS. The Proposed Action would not have significant impact to the visual character of CCSFS.

A Light Management Plan would be developed in accordance with SWI 32-7001 to minimize interference with normal activities or interfere with aesthetic value. The Light Management Plan would minimize impacts to nesting sea turtles on the nearby coastline. The Proposed Action would not have significant impacts from visual effects.

3.11.3.1.3 Coastal Resources

A No Development Zone has been established in Brevard County that reaches from the mean high-water level to 75 feet inland. CCSFS has additional siting and facility design standards for construction that require new facilities to be set back at least 150 feet from the coast. The SLC-14 launch pad is positioned approximately 1,400 feet west of the Atlantic Coast. Construction activities related to the Proposed Action would not impact marine ecosystems and would take place outside of the No Development Zone. The Proposed Action is consistent with CZMA and Florida Coastal Management Program requirements. CZMA consistency determination correspondence is included in Appendix A. The Proposed Action would not have significant impacts to coastal resources.

3.11.3.2 No Action Alternative

Under the No Action Alternative, no construction or changes to visual resources would occur, therefore, there would be no impacts on land use and visual resources.

3.12 Socioeconomics

3.12.1 Regulatory Setting

Socioeconomic resources include population and housing, employment, economy, income, education, and tourism. The ROI includes Brevard County, the State of Florida, and the maritime industry within the South Atlantic region of the Atlantic Ocean.

3.12.2 Affected Environment

As of 2022, Brevard County and the State of Florida had populations of approximately 631,000 and 22,000,000, respectively (USCB 2022). From 2017 to 2021, Brevard County and the State of Florida had a median household income (in 2021 dollars) of $64,000 and $62,000, respectively (USCB 2022). The aerospace industry is a large contributor to Florida's economy by employing approximately 13,000 people statewide and had a total economic impact of $2.6 billion from 2017 to 2021 (Space Florida 2022). The aerospace industry is expected to expand over the next 5-year time frame (2022-2026) for a total economic impact of $5.3 billion (Space Florida 2022).

Commercial fishing is another industry in the ROI that contributes substantially to Florida's economy by employing approximately 77,000 people; commercial fishing generated a total economic impact of $28.2 billion in the South Atlantic region of Florida in 2020 (NOAA 2023). The Atlantic Ocean Action Area occurs between the azimuth range of 35 degrees to the northeast and 120 degrees to the southeast as shown on Figure 2-3. As the commercial space industry expands, the fishing industry has expressed concern that increasing launches may affect commercial fishing, particularly for king and Spanish mackerel, and shrimp fleets, in the southern zone of the Atlantic Ocean (USSF 2024b). From 2015 to 2020, launches from Florida have increased from 17 (Spaceflight Now 2016) to 30 (SpaceNews 2022). From 2015 to 2020, the total landings (catches) of king mackerel increased from 931,000 lb to 2,305,000 lb and Atlantic Spanish mackerel increased from 2,103,000 lb to 2,745,000 lb (NOAA 2021). From 2015 to 2022, the total shrimp landings increased from 1,679,000 to 3,334,000 (FFWCC 2024).

3.12.3 Environmental Consequences

Socioeconomic impacts would be considered significant if the Proposed Action substantially changed population and housing, employment, economy, income, education, and tourism.

3.12.3.1 Proposed Action

3.12.3.1.1 Regional Effects

Construction of the Proposed Action would employ approximately 200 personnel over an 18-month period and the operation of the Proposed Action would employ approximately 24 permanent engineering and technician staff, with additional staff traveling to the site for launches. During launch events, there would be up to 50 personnel onsite for approximately 30 to 60 days for launch preparations. The quantity of employees associated with the Proposed Action would not be significant compared to the population of Brevard County, the State of Florida, and the number of aerospace industry employees statewide. The effect on the local housing market as it is proportional to population would also not be significant. Visitors to the region to view the Stoke launches are expected to be in keeping with the number of visitors for other launches. There would be a beneficial effect to the regional economy from construction and operations.

There would be the possibility of temporary restricted access to MINWR and CNS on launch days because of the increase in visitor volume. The restricted access would be coordinated between CCSFS security, USFWS, and the NPS to monitor parking lots and roadway access to ensure that emergency egress is maintained. These temporary restrictions would last between 3 to 6 hours per launch for up to 10 launches per year. Assuming a 30% scrub rate, access restrictions from launch operations would total up to 78 hours per year and would not have a significant impact to tourism.

3.12.3.1.2 Maritime Effects

The majority of commercial fishing and maritime traffic occurs within the U.S. exclusive economic zone (EEZ), which is within 200 nautical miles of the U.S. coastline (NOAA n.d.). Access restrictions within the EEZ for launch operations would be less than 4 hours per launch for up to 10 launches per year. Assuming a 30% scrub rate, this would equate to approximately 52 hours of restrictions per year during nominal operations within the EEZ. In the event of an anomaly, debris cleanup would require less than 50 hours of land, air, and/or sea access restrictions. As described in Section 3.9.3.2.3 Range Safety, Stoke would follow an approved surveillance plan and debris recovery protocol that would decrease risk to the maritime community.

Access restrictions would include temporary closures of existing navigable waters to provide public safety during launch operations. Temporary closures could affect businesses in the closure areas such as cruise ships, boat charters, and commercial fishing operations. Advance notice via NOTMARs would assist mariners in scheduling around any temporary disruption. Sonic boom peak overpressure higher than the noise-induced hearing impairment threshold level of 4 psf (NIOSH 1998) could impact the local fishing community in the Atlantic Ocean. The sonic boom peak overpressure model results for launch activities (Figures 15 and 16, Appendix G) indicate that there would be minimal area above 4 psf within the Atlantic Ocean, resulting in no hearing impairment impact. While the Proposed Action could represent an inconvenience to people in the commercial fishing industry, as described in Section 3.12.2, commercial fishing economic activity levels have increased during the increase in commercial launch activity (FFWCC 2024). A less than significant effect would be expected to the maritime community within the EEZ given the temporary nature of the closures, established NOTAM procedures, and lack of direct effects on fish populations.

Expendable components from Stoke Stage 1 and Stage 2 jettisons would occur outside the EEZ, and therefore, would have no impact on maritime activities.

3.12.3.1.3 Airspace Effects

Impacts from rerouting aircraft due to commercial space operations would be similar to rerouting aircraft for other reasons (e.g., weather issues, runway closures, wildfires, military exercises, and presidential flights). Potential socioeconomic impacts include additional airline operating costs for increased flight distances and times resulting from rerouting aircraft and increased passenger costs as a result of impacted passenger travel, including time lost from delayed flights, flight cancellations, and missed connections. Alternatively, restricting or preventing a launch event would have socioeconomic impacts on Stoke, commercial payload providers, and consumers of payload services. Operations would not result in the closure of any public airport during the operation or so severely restrict the use of the surrounding airspace as to prevent access to an airport for an extended period of time.

Given that expected airspace closures for Stoke operations are temporary and the FAA's previous analyses have concluded minimal impacts to airspace from commercial space launches, airspace closures from Stoke's proposal would not be expected to result in significant socioeconomic impacts. Furthermore, local air traffic controls would coordinate with airports and aircraft operators to minimize the effect of the launch operations on airport traffic flows, as well as traffic flows in enroute airspace.

3.12.3.2 No Action Alternative

Under the No Action Alternative, SLC-14 would not be reactivated. Therefore, socioeconomics resources would remain as existing, and no impact would be anticipated.

3.13 Environmental Justice and Children's Environmental Health and Safety Risks

3.13.1 Regulatory Setting

The White House defines environmental justice (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.

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 (USCB).

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 and 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 USAF has developed a *Guide for Environmental Justice Under the Environmental Impact Analysis Process* that provides a recommended approach to EJ analysis in accordance with NEPA (42 U.S.C. Sections 4321 et seq.); the CEQ's regulation (40 CFR Parts 1500 through 1508); and through USAF NEPA regulations (32 CFR Part 989, EIAP) (USAF 2020b).

The ROI for assessing EJ and protecting children is Brevard County, Florida.

3.13.2 Affected Environment

3.13.2.1 Minority Populations

Table 3.13-1 presents the total population, people of color, and low-income populations for the ROI, Florida, and the U.S. In 2022, within the ROI (Brevard County, Florida), the population reporting to be a race other than white was 29.7%, which is lower than both the Florida (50.2%) and U.S. (43.6%) averages. The Hispanic or Latino population in Brevard County (12.1%) is also lower than the population in Florida (27.1%) and the U.S. (19.1%). (USCB 2022).

Table 3.13-1. Demographic Information for ROI compared to the State and the Nation

Population Estimates	Brevard County (ROI)	Florida	United States
Total Population	630,693	22,244,823	333,287,557
Minority	29.7%	50.2%	43.6%
Hispanic or Latino	12.1%	27.1%	19.1%

Source: USCB 2022

3.13.2.2 Low-Income Populations

As summarized in Table 3.13-2, 11.3% of the ROI is living below the poverty level, which is slightly lower than the State (13.1%) and nearly equal to the U.S. (11.6%) averages (USCB 2022). Also, the median household income in the ROI is slightly higher than the State median, but it is lower than the U.S. median.

Table 3.13-2. Income and Poverty in ROI compared to the State and the Nation

Income Characteristics and Poverty Status	Brevard County (ROI)	Florida	United States
Total Population	630,693	22,244,823	333,287,557
Median Household Income	$63,632	$61,777	$69,021
Persons in Poverty	11.3%	13.1%	11.6%

Source: USCB 2022a

3.13.2.3 Children

Table 3.13-3 presents children, or populations under age 5, for the ROI, Florida, and the U.S. Within the ROI, the population under age 5 in 2022 was 4%, which is lower than both the Florida (5%) and U.S. (6%) averages.

Table 3.13-3. Children Population Estimates in the ROI, Florida, and the U.S.

Children Population Estimates	Brevard County (ROI)	Florida	United States
Under Age 5	4%	5%	6%

Source: USCB 2022

3.13.3 Environmental Consequences

This section evaluates potential impacts resulting from the Proposed Action. The anticipated direct and indirect impacts, considering both short- and long-term project effects, were assessed for each resource.

There would be significant impacts to EJ communities or children if it is determined that potential environmental impacts would disproportionately affect these communities.

3.13.3.1 Proposed Action

3.13.3.1.1 Environmental Justice

Construction of the Proposed Action would occur entirely on CCSFS. Because there are no residential neighborhoods located on or near CCSFS, there would be no impacts to residential areas, including minority or low-income communities. Although there is the potential for construction activities to increase traffic through some neighborhoods, these effects would be in keeping with normal traffic patterns. The communities surrounding CCSFS may benefit from the Proposed Action through increased employment opportunities and positive economic gains in the form of increased wages and spending. There would not be a disproportional impact to minority or low-income communities during launch activities. Therefore, there would be no significant impact on EJ.

3.13.3.1.2 Children's Environmental Health and Safety Risks

Implementation of the Proposed Action would not expose children to environmental health or safety risks, because the Proposed Action would occur on a controlled-access facility, where children are not permitted. There are no anticipated effects on the safety of children during the construction phase of the project or after SLC-14 becomes operational. Launch activities would not present environmental health or safety risks to children. Therefore, there would be no significant impacts to the safety of children from the Proposed Action.

3.13.3.2 No Action Alternative

The No Action alternative would not impact EJ populations or children. 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 or children.

3.14 Airspace and Marine Transportation Management

3.14.1 Regulatory Setting

The FAA designs and manages the NAS in accordance with 14 CFR Part 71 to ensure aircraft safety and efficient use.

The USCG manages the MTS and the mission statement is as follows (USCG 2023):

> The Marine Transportation System Management program ensures a safe, secure, efficient and environmentally sound waterways system. The Coast Guard minimizes disruptions to maritime commerce by assessing and mitigating risks to safe navigation and by providing waterway restoration capabilities after extreme weather events, marine accidents, or terrorist incidents. The Coast Guard works in concert with other Federal agencies, state and local governments, marine industries, maritime associations, and the international community to optimize balanced use and champion development of the Nation's marine transportation system.

3.14.2 Affected Environment

The airspace study area includes the airspace above CCSFS and the airspace above Atlantic Ocean Action Area (Figure 2-3). The MTS study area includes the water areas within the Atlantic Ocean Action Area (Figure 2-3).

3.14.3 Environmental Consequences

The significance of potential impacts to airspace management depends on the degree to which the Proposed Action would affect the structure, use, or management of the airspace environment. An impact to airspace would be significant if the Proposed Action imposed major restrictions on air commerce opportunities, substantially limited airspace access to a large number of users or required modifications to air traffic control systems.

An impact to MTS management would be considered significant if the Proposed Action imposed major restrictions on maritime commerce and substantially limited the access to the waterway to a large number of users.

3.14.3.1 Proposed Action

The Stoke Space launch program includes temporary closures of existing airspace and navigable waterways only. No changes to airspace dimensions, such as shape or altitude, are proposed. Advanced notice via NOTAMs and NOTMARs would allow general aviation pilots and mariners to anticipate temporary disruptions to flight and shipping activities during launch operations. Launch operations would be of short duration, up to nominally 4 hours, and scheduled in advance to minimize interruption to airspace and waterways. Therefore, significant environmental impacts because of temporary closures of airways and navigable waterways and the issuance of NOTAMs and NOTMARs under the Proposed Action are not anticipated.

3.14.3.2 No Action Alternative

Under the No Action Alternative, SLC-14 would not be reactivated. Therefore, airspace and marine transportation management would remain as existing, and no impact would be anticipated.

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4. Cumulative Impacts

This cumulative impact analysis follows the requirements of NEPA and CEQ guidance. The CEQ provides the implementing regulations for NEPA, which define a cumulative impact as follows:

> A cumulative impact is the impact on the environment, which results 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 the actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR 1508.7)

Cumulative impacts occur if the incremental effects of the Proposed Action result in an increased impact when added to the environmental effects of past, ongoing, and reasonably foreseeable future activities. Reasonably foreseeable future activities are defined as those that have an application for operations pending and would occur in the same time frame as the Proposed Action. Past activities are considered only when their impacts still would be present during implementation of the Proposed Action.

The cumulative impacts analysis for each resource involved the following process:

- Identifying past, present, and other reasonably foreseeable actions (or cumulative activities) that might occur in the same area and time frame as the Proposed Action (Section 2.1).
- Identifying the impacts associated with the Proposed Action that could combine with other activities to result in a noticeable increased impact. This was determined to be adverse impacts in the previous analysis (identified in Sections 3.1 through 3.14).
- Identifying the overall potential cumulative impacts of these activities when considered together with the project-related impacts.

The level of cumulative analysis for each resource studied in the EA varies, depending on the sensitivity of the resource to potential cumulative impacts.

4.1 Cumulative Activities

This section identifies any past, present, or reasonably foreseeable activities that could interact with the Proposed Action to contribute to cumulative impacts. The temporal boundary for past actions is 5 years for most resource areas. The future temporal boundary includes approximately the life of the Proposed Action (2024–2027). The ROI for cumulative impacts consists of CCSFS, KSC, the area immediately surrounding, and the Atlantic Ocean.

Table 4-1. Recent CCSFS Space Launch Operations with Approved NEPA Documentation

Approved Document	Launch Provider	Project Status	Approved Annual Launches from CCSFS
Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station	SpaceX	Active	50
Environmental Assessment for the Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations at Cape Canaveral Air Force Station	Space Florida	Under Construction	24

Approved Document	Launch Provider	Project Status	Approved Annual Launches from CCSFS
Environmental Assessment for the United Launch Alliance Vulcan Centaur Program Space Launch Complex 41 at Cape Canaveral Air Force Station	ULA	Active	20
Environmental Assessment for Blue Origin Orbital Launch Site at Cape Canaveral Air Force Station, Florida	Blue Origin	Under Construction	12
Environmental Assessment for Space Florida Launch Site Operator License at Launch Complex-46	Space Florida	Active	24
Supplemental Environmental Assessment (SEA) for the Relativity Space Terran R Launch Program Cape Canaveral Space Force Station (CCSFS), FL	Relativity	Under Construction	24
Total Approved Launch Cadence Approved Under NEPA	Not Applicable	Not Applicable	154

Note:

SLD 45 provided these numbers.

Table 4-2 provides a list of past and current vehicle launches at CCSFS and KSC. The reasonably foreseeable planned future and potential launch actions at CCSFS and KSC are listed in Table 4-3.

Table 4-2. Past Vehicle Launches at CCSFS and KSC

Year	Total Launches
2018	20
2019	15
2020	31
2021	31
2022	57
2023	72
Total Launches	226

Note:

SLD 45 provided these numbers.

Table 4-3. Planned Future and Potential Launch Actions at CCSFS and KSC

Year	Total Planned Launches
2024	110
2025	135
2026	165
2027	120
2028	115
Total Launches	645

Note:

SLD 45 provided these numbers as projections based on scheduling, the launch manifest, and other known information; therefore, these numbers are subject to change.

The following plans and documents were reviewed for present or reasonably foreseeable future actions within the ROI that could result in cumulative resource impacts when combined with the Proposed Action. A summary of the findings from the document reviews follows in Table 4-4.

- *2045 Long Range Transportation Plan and Amendments for Space Coast Transportation Planning Organization* (SCTPO 2023a)
- Brevard County Operating and Capital Budget: Capital Improvement Program from 2022-2027 (Brevard County 2022)
- *Canaveral Port Authority 30-Year Strategic Vision Plan 2017-2047* (Canaveral Port Authority 2018)
- *Cape Canaveral Spaceport Complex Master Plan* (Space Florida 2017)
- *Center Master Plan Final Programmatic Environmental Impact Statement, Kennedy Space Center, Florida* (NASA 2016)
- City of Cocoa Beach Adopted Annual Budget Fiscal Year 2023: Capital Improvement Program (Cocoa 2022)
- *Environmental Assessment for Eastern Range Planning and Infrastructure Development, Cape Canaveral Space Force Station, Florida* (USSF 2024a)
- Draft Supplemental EA for the Roberts Road SpaceX Operations Area Expansion and Supporting Infrastructure on Kennedy Space Center (NASA 2023b).
- EA for Blue Origin Orbital Launch Site at Cape Canaveral Air Force Station, Florida (USAF 2016)
- Final EA for the United Launch Alliance Vulcan Centaur Program Operations and Launch on Cape Canaveral Air Force Station (USAF 2019a)
- Final EA for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station (FAA 2020)
- Final EA for the Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations at Cape Canaveral Air Force Station, Florida (Space Florida 2020)
- EA for Space Florida Launch Site Operator License at Launch Complex-46 (FAA 2008)
- *Environmental Assessment for Exploration Park North at the John F. Kennedy Space Center, Kennedy Space Center, Florida* (NASA 2021)

- *Environmental Assessment for the Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL* (USSF 2020b)
- Record of Decision Launch Operator Licenses, Evolved Expendable Launch Vehicle (EELV) Program Atlas V and Delta IV (FAA 2011)
- *Annual Compendium of Commercial Space Transportation: 2018* (FAA 2018)
- Florida Department of Transportation Five Year Work Program (FDOT n.d.)
- Kennedy Space Center Master Plan Website (NASA 2023a)
- *Range of the Future: Cape Canaveral Space Force Station District Plans* (USSF 2022b)
- Resilient Cape Canaveral (City of Cape Canaveral 2019)
- *Space Coast Transportation Planning Organization FY24–FY28 Transportation Improvement Program* (SCTPO 2023b)
- *Supplemental Environmental Assessment for the Relativity Terran R Launch Program* (USSF 2024b)
- *U.S. Air Force Integrated Natural Resources Management Plan: Cape Canaveral Air Force Station, Patrick Air Force Base, Malabar Transmitter Annex, Jonathan Dickinson Missile Tracking Annex.* 45th Space Wing (USAF 2023a)
- *U.S. Air Force Integrated Cultural Resource Management Plan, 45th Space Wing* (USAF 2023b)

Table 4-4. Past, Present, and Reasonably Foreseeable Future Actions

Project	Project Summary	Location	Time Frame	Relevance to Proposed Action
Implement Falcon Program from SLC-39A and SLC-40 (SpaceX)	Construction and launch operations at SLCs 39A (KSC) and 40 (CCSFS): *EA and FONSI for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station* (July 2020)	KSC/CCSFS	Past	Existing conditions/ activity would be in proximity to the Proposed Action.
Refurbish SLC-39B to launch multiple vehicle types (NASA)	Construction and launch operations at SLC 39B, which supports NASA's Space Launch System. Complete in 2022.	KSC	Past	Existing conditions/ activity would be in proximity to the Proposed Action.
Launch operations at SLC-46 (Space Florida)	Launch operations at SLC 46: Environmental Assessment for Space Florida Launch Site Operator License at Launch Complex-46 (FAA 2008)	CCSFS	Past	Existing conditions/ activity would be in proximity to the Proposed Action.
Construct Cruise Terminal Three (Canaveral Port Authority)	Construction and operation of the largest terminal (185,000 square feet) at Port Canaveral with parking garage. Completed in 2021.	Port Canaveral	Past	Existing conditions/ activity would be in proximity to the Proposed Action.
Repair Cruise Terminals Five, Eight, & Ten (Canaveral Port Authority)	Repairs/upgrades moorings and facilities to accommodate larger cruise ships. Terminal 5 complete in 2019. Terminal 8 and 10 complete in 2021.	Port Canaveral	Past	Existing conditions/ activity would be in proximity to the Proposed Action.

Project	Project Summary	Location	Time Frame	Relevance to Proposed Action
Reconstruct Port Canaveral North Cargo Berth 3 Reconstruction (Canaveral Port Authority)	Reconstruction of berthing space to support cargo and space mission requirements. Complete in 2023.	Port Canaveral	Past	Existing conditions/ activity would be in proximity to the Proposed Action.
Construct Florida Power and Light solar farm (NASA)	Construction of a 500-acre solar farm north of the KSC Visitor Center. Completed in 2021.	KSC	Past	Activity would be in proximity to the Proposed Action.
Construct SLC-48 (NASA)	Construction and launch operations at SLC 48 for small-lift vehicles.	KSC	Present	Existing conditions/ activity would be in proximity to the Proposed Action
Develop NOTU campus (U.S. Navy)	Development of the NOTU campus on CCSFS.	CCSFS	Present	Existing conditions/ activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.
Refurbish and reuse SLC-11 and SLC-36 (Blue Origin)	Construction and launch operations at SLCs 11 and 36: *EA for the Blue Origin Orbital Launch Site Construction at Launch Complex 11 and 36 Cape Canaveral Air Force Station (CCAFS), FL* (December 2016)	CCSFS	Present	Existing conditions/ activity would be in proximity to the Proposed Action.
Upgrade SLC-41 and nearby facilities for the Vulcan Centaur launch program (ULA)	Construction and launch operations at SLC 41: Environmental Assessment for the United Launch Alliance Vulcan Centaur Program Space Launch Complex (SLC) 41 Cape Canaveral Air Force Station (CCAFS), FL (USAF 2019a)	CCSFS	Present	Existing conditions/ activity would be in proximity to the Proposed Action.
Develop Exploration Park (Space Florida)	Construction of facilities at Exploration Park.	KSC	Present	Existing conditions/ activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.
Roberts Road Operations Area (SpaceX)	Site development of approximately 67 acres of land for SpaceX Operations, and paving of Roberts Road and A Avenue.	KSC	Present	Existing conditions/ activity would be in proximity to the Proposed Action.

Project	Project Summary	Location	Time Frame	Relevance to Proposed Action
Refurbish SLC-39A (NASA)	Construction and launch operations of Starship Superheavy at SLC-39A.	KSC	Present	Activity would be in proximity to the Proposed Action. Construction is ongoing and timing could overlap with Proposed Action implementation.
Space Commerce Way Widening (FDOT)	Widening 2.7 miles of Space Commerce Way to four lanes to support future growth at KSC.	KSC	Present	Activity would be in proximity to the Proposed Action. Construction is ongoing and timing could overlap with Proposed Action implementation.
Refurbish and Enhance existing SLC-20 and associated facilities (Space Florida)	Construction of multi-user launch pad at SLC-20 and the associated improvements (roadways and utilities) needed to support future customers.	CCSFS	Present	Close proximity to the Proposed Action; operations would overlap on ICBM Road. Construction is ongoing and timing could overlap with Proposed Action implementation.
Refurbish SLC 16 for Terran R launch program (Relativity), implement Terran R Launch Program	Refurbish SLC-16 for Terran R launch program.	CCSFS	Present	Existing conditions/ activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.
Repair/construct airfield infrastructure (USSF)	Repairs and new construction at Skid Strip, including paved overruns, administrative facility, hangar, and apron for future DOD mission.	CCSFS	Future	Activity would be in proximity to the Proposed Action. Construction period could overlap with Proposed Action implementation.
Range of the Future Infrastructure Improvements (CCSFS)	The USSF plans to update Cape Canaveral in terms of infrastructure and processes over the next decade. As part of this effort, SLD 45 is working on a collection of work called the Range of the Future, which includes improvements to infrastructure, operations, and policies; continuously developing and deploying new technology; and innovating at every level.	CCSFS	Future	Activity would be in proximity to the Proposed Action. Construction period could overlap with Proposed Action implementation.

Project	Project Summary	Location	Time Frame	Relevance to Proposed Action
Starship/Super Heavy Operations (SpaceX)	Construction of a new launch complex to support Starship/Super Heavy launch operations to provide redundancy and capacity and allow SpaceX to increase the flight rate of Starship and minimize potential disruptions to Falcon, Falcon Heavy, and Dragon missions at SLC-39A.	KSC	Future	Activity would be in proximity to the Proposed Action.
Reactivation of SLC-13 (Phantom/ Vaya Space)	Refurbishment of existing inactive SLC for Phantom and Vaya Space Launch operations.	CCSFS	Future	Close proximity to the Proposed Action; operations would overlap on ICBM Road. Construction period would overlap with Proposed Action implementation.
SLC-14 Landing Operations	As the Stoke program matures into Phase 2, landing operation of the future reusable rocket may include the construction of landing pads similar to LZ-1 and LZ-2 at SLC-13 at SLC14.	CCSFS	Future	Adjacent to the Proposed Action; operations would overlap on ICBM Road and SLC-14. Construction period would overlap with the operations of the Proposed Action.
Reactivation of SLC-15 (ABL Space Systems)	Refurbishment of existing inactive SLC for ABL Space Systems launch operations.	CCSFS	Future	Close proximity to the Proposed Action; operations would overlap on ICBM Road. Construction period would overlap with Proposed Action implementation.
Construct new SLC on CCSFS (USSF)	Construction of new SLC-50 to support future launch operations.	CCSFS	Future	Close in proximity to the Proposed Action, operations would overlap on ICBM Road. Construction period could overlap with Proposed action implementation, if developed.
Construct new SLC on KSC (NASA)	Construction of new SLC-49 to support future launch operations.	KSC	Future	Activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.

Project	Project Summary	Location	Time Frame	Relevance to Proposed Action
Improve shuttle landing facility (NASA/Space Florida)	Construction at the shuttle landing facility to support commercial spaceflight and, aviation testing, research, development, and training.	KSC	Future	Activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.
Natural Gas Pipeline on KSC (Florida City Gas)	Construction of a natural gas pipeline operated by Florida City Gas which would provide natural gas to KSC.	KSC	Future	Activity would be in proximity to the Proposed Action. Construction period may overlap with Proposed Action implementation.
Replace SR 401 Drawbridge (FDOT)	Evaluate alternatives to replace the drawbridge on SR 401 over the Canaveral Barge Canal.	Port Canaveral	Future	Activity would be in proximity to the Proposed Action. Construction period may overlap with Proposed Action implementation.
Redevelopment of SLC 37 on CCSFS (Commercial Launch Service Provider)	Refurbishment of existing SLC to support future heavy-lift launch vehicle operations.	CCSFS	Future	Activity would be in proximity to the Proposed Action. Construction period would overlap with Proposed Action implementation.

Source: USSF 2024a, 2023; NASA 2023b; USAF 2023a, 2024; FDOT n.d.

NOTU = Naval Ordnance Test Unit

For the scenarios under consideration to have a cumulatively significant impact to a resource area the combined impacts of all identified past, present, and reasonably foreseeable actions, including the Proposed Action, must be significant. It is anticipated that the reasonably foreseeable actions would proceed regardless of whether the Proposed Action is implemented. Under the No Action Alternative, the Proposed Action would not occur and there would be no contribution to cumulative impacts within the ROI.

This environmental analysis and pad allocation does not guarantee launch rates. SLD 45 and Stoke are aware there may be other effects on non-environmental resources on CCSFS, such as logistical and operational constraints, that occur directly or indirectly as a result of the heightened launch activity at CCSFS. TheSLD45 will manage those effects to ensure compliance with all relevant statutes, regulations, and other requirements. Safety requirements requiring installation maintenance, along with other requirements, may impose restrictions on site access because of concurrent operations by other launch service providers and other installation functions, potentially leading to construction delays or necessitating operational deconfliction along ICBM road.

4.2 Cumulative Impacts to Individual Resources

The launch actions listed in Table 4-3 and past, present, and reasonably foreseeable future actions in Table 4-4 were considered in conjunction with the Proposed Action and form the basis for the cumulative impacts analysis. This section analyzes the incremental interaction that the Proposed Action may have with the actions described in Section 4.1, Cumulative Activities, and evaluates the potential cumulative impacts resulting from these interactions. The following subsections explain the cumulative impacts of the Proposed Action and cumulative activities to individual resources.

4.2.1 Biological Resources

Future habitat removal and disturbances to biological resources from planned launch activities and other cumulative activities at CCSFS is likely. However, these actions would comply with Section 7 of the ESA and consultations with the USFWS would be required; additionally, all activities affecting biological resources would be conducted in agreement with the Integrated Natural Resource Management Plan (USAF 2023a). Mitigation measures would be developed during consultation with the USFWS on a project-by-project basis that would minimize potential future impacts. Implementation of the Proposed Action, in conjunction with other cumulative activities, specifically the incremental increase of activity on ICBM road could result in a cumulative impact to biological resources, but this impact would be less than significant. Therefore, implementation of the Proposed Action in conjunction with other past, present, or reasonably foreseeable projects could result in a decrease of land management access at times but would not result in significant cumulative impacts to biological resources.

4.2.2 Cultural Resources

Cumulative impacts to the CCSFS NHL could occur for current and future actions within legacy SLCs; however, if these impacts were adverse, a mitigation plan would be developed and approved by the SHPO prior to the implementation of any actions effecting the NHL. Furthermore, the current and future actions would allow for the continued use of CCSFS as a launch complex, which is recognized as important by the NHL designation. The implementation of the Proposed Action in conjunction with planned launches and other activities could result in a cumulative impact to the NHL and other cultural resources at CCSFS, but this impact would be less than significant.

4.2.3 Air Quality and Climate Change

Brevard County is in an attainment area for all pollutants. Criteria pollutant emissions related to the construction and operation of the Proposed Action would not result in any CAA violations or risk a change in the attainment status. While the cumulative activities would result in increased emissions of NAAQS criteria pollutants, these increases are not anticipated to change the attainment status of Brevard County.

GHG emissions during construction and operation activities are anticipated to be negligible, but any emission of GHGs represents an incremental increase in global GHG concentrations. These emissions in combination with future launches and cumulative activities contribute incrementally to climate change. The DAF and local communities are developing sustainability and climate change support initiatives to reduce GHG emissions.

When considered with other cumulative activities and the support initiatives to reduce GHG emissions locally and improve climate resiliency, the Proposed Action would not result in significant cumulative impacts to air quality, GHG emissions, or climate change.

4.2.4 Noise

The noise from planned launches would be in keeping with the current noise conditions at CCSFS and would not occur simultaneously with Stoke launch activities. Additionally, Stoke's anticipated launches are a small fraction of overall planned launches (less than 7% of total approved launch cadence approved under NEPA, Table 4-1) and would not significantly contribute to the noise environment at CCSFS. Therefore, the Proposed Action in combination with planned launches and cumulative activities would not contribute to a noticeable increase in noise, and significant cumulative impacts would not occur.

4.2.5 Hazardous Materials, Solid Waste, and Hazardous Waste

The management of hazardous materials, solid waste, and hazardous waste is the responsibility of each launch operator or entity and is regulated as described in Section 3.5, Hazardous Materials, Solid Waste, and Hazardous Waste. A substantial cumulative impact from hazardous materials spills and contamination associated with cumulative activities and planned launches is not expected. Safeguards, management plans, and emergency response plans would be in place for all launch operators to minimize impacts from the use of hazardous materials. Therefore, planned launches and other cumulative activities combined with the Proposed Action would not contribute to a significant cumulative impact from hazardous materials, solid waste, and hazardous waste.

4.2.6 Water Resources

Construction and launch activities are expected to increase at CCSFS and KSC. As a result, incremental impacts to water resources are expected. The effect on groundwater, surface water, wetlands, and floodplains would depend on the specific construction requirements and launch vehicle fuels. Alternatives to prevent future development within the 100-year floodplain would be challenging because much of CCSFS is within the 100-year floodplain. CCSFS would continue to consider alternative locations for construction outside the floodplain unless no practical alternative exists. Mitigation measures, BMPs, and low-impact development standards would be implemented to minimize impacts. Impacts outside CCSFS would also be minimized through state and local building code requirements.

Incremental increases in impervious surfaces are also expected with the cumulative activities within CCSFS, KSC, and Brevard County. Increased stormwater treatment, water control, and retention would be required throughout the county. The USSF's ongoing efforts to reduce total maximum daily loads and improve water quality regionally would minimize the impacts of future developments and cumulative activities.

Cumulative impacts to water resources at CCSFS would occur if future projects inadequately address water resource issues within the ROI. Compliance with state, federal, and local requirements for proper management of materials would minimize impacts to water resources. Therefore, the Proposed Action would not have a significant cumulative impact to water resources as long as mitigation measures and BMPs required by federal, state, and local agencies were implemented for the Proposed Action as well as other planned launches and cumulative activities. Projects requiring ERPs and/or 404 permits must demonstrate that there will be no significant adverse effects to function, quality, or quantity of water resources prior to the permits being issued and commitment of resources.

4.2.7 Geology and Soils

The Proposed Action would have negligible impacts on geology and soil resources would occur during site preparation and construction activities. Therefore, there is little likelihood of the Proposed Action combining with the cumulative activities to contribute to significant cumulative impacts.

4.2.8 Infrastructure

4.2.8.1 Transportation

The planned launch activities and other cumulative activities would contribute incrementally to transportation impacts. The transportation of large loads would contribute to roadway damage and increased frequency of delays on CCSFS roadways. However, because an increase in launches at CCSFS over the next 20 years was anticipated, the Range of the Future 2028 initiative (USSF 2022b) was developed to address the infrastructure needs. The CCSFS District Plans (USSF 2022b) and Eastern Range Planning and Infrastructure Development EA (USSF 2024a) identify improvements, including multiple infrastructure projects that would support more efficient operations at CCSFS, with a focus on optimizing haul routes and traffic flow for oversized vehicle movement. Additionally, the improvements would relocate nonessential personnel and functions outside the launch exclusionary safety zones to minimize the impacts of launch mission traffic closure for CCSFS personnel. These improvements would constitute a beneficial effect on transportation at CCSFS. Therefore, planned launches and other cumulative activities combined with the Proposed Action would not contribute to a significant cumulative impact to transportation infrastructure.

4.2.8.2 Utilities

Cumulative actions and planned launch activities would cause an incremental increase in water demand at CCSFS. The amount of water demand for future launch providers is unknown and would be unique to each provider or mission. Utility improvements would be constructed as part of the CCSFS District Plans (USSF 2022b) to improve potable water resiliency and decrease pressure variations within the distribution system. These improvements would minimize the impacts on water supply at CCSFS. Therefore, when combined with planned launches and cumulative activities, the Proposed Action would not contribute to a significant cumulative impact to water utilities.

Similar to the increased demand for water, wastewater supply would increase incrementally because of increased activity at CCSFS. The CCSFS District Plans (USSF 2022b) include planned improvements to wastewater infrastructure and treatment capabilities at CCSFS, resulting in a beneficial effect on wastewater. Therefore, when combined with planned launches and cumulative activities, the Proposed Action would not contribute to a significant cumulative impact to wastewater.

Cumulative activities include projects to upgrade the electrical systems and utility infrastructure, increasing power distribution resiliency and redundancy, which constitutes a beneficial effect on electrical infrastructure. Therefore, when combined with planned launches and cumulative activities, the Proposed Action would not contribute to a significant cumulative impact to electrical utilities.

The cumulative activities at CCSFS include improvements and upgrades to support future mission requirements, resulting in a beneficial effect on utility infrastructure. As a result, the Proposed Action, when combined with planned launches and other cumulative activities, is not anticipated to contribute to a significant cumulative impact to utilities.

4.2.9 Health and Safety

The Proposed Action and other cumulative activities would have the potential for minor health and safety risks during construction and operation. However, the Proposed Action will require implementation of appropriate protocols, including CCSFS safety regulations, Air Force Technical Orders, and OSHA-prescribed standards, would establish and maintain a safe working environment. As a result, the Proposed Action, when combined with planned launches and other cumulative activities, is not anticipated to contribute to a significant cumulative impact to health and safety.

4.2.10 Section 4(f) Properties

There would be no use, including constructive use, of any publicly owned parks, MINWR, or CNS from the Proposed Action, so there would be no impacts to contribute to cumulative impacts to these resources. SLC-14 and the CCAFS NHL district are the only Section 4(f) historic properties that would experience a use and that would be limited to a de minimis impact based on a finding of no adverse effect under Section 106 of NHPA. As a de minimis impact is not adverse, it would not contribute to cumulative impact to historic properties. The implementation of the Proposed Action in conjunction with planned launches and other cumulative activities would not result in a significant cumulative impact to Section 4(f) properties.

4.2.11 Land Use, Visual, and Coastal Resources

The CCSFS District Plans (USSF 2022b) considers land use compatibility, consolidation of facilities, mission sustainability, safety, and security. Future projects must comply with Light Management Plans to minimize the amount of sky glow and impacts on nesting sea turtles. The reasonably foreseeable future projects are consistent with the reviewed comprehensive and land use plans listed in Section 3.15.1. Cumulative actions and planned launch activities would undergo CZMA federal Consistency Determination to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources. When considered with planned launches and other cumulative activities, the Proposed Action would not contribute to significant adverse cumulative impacts to land use, visual, or coastal resources.

4.2.12 Socioeconomics

The Proposed Action and other launch programs at CCSFS and KSC would be beneficial to the regional economy through increased jobs and tourism.

The Proposed Action could combine with other cumulative activities within the Atlantic Ocean and regional airspace to restrict commercial maritime and airspace activities. However, considering efforts to limit airspace and maritime restrictions, established notification procedures (NOTMAR and NOTAM) that allow for advanced planning, and socioeconomic benefits associated with the improvements of the CCSFS launch complex, the Proposed Action is not anticipated to contribute to significant adverse socioeconomic impacts.

4.2.13 Environmental Justice and Children's Environmental Health and Safety Risks

Possible adverse effects from construction activities could include increased traffic and noise levels and decreased air quality. These effects would be short-term and minor in nature and are not anticipated to impact off-installation populations. Similarly, the Proposed Action is not anticipated to impact children or increase exposure of environmental health or safety risks to children because the Proposed Action would occur on a controlled-access facility where children are not permitted. Therefore, there is little likelihood of the Proposed Action combining with the cumulative activities to contribute to significant cumulative EJ impacts.

4.2.14 Airspace and Marine Transportation Management

As shown in Tables 4-2 and 4-3, launches at CCSFS and KSC have been increasing in the past 5 years and are expected to continue to increase, with a total of 645 planned potential launches over the next 5 years. Future launches would abide by the same advance notice procedures discussed in Section 2.1.3, Ground Support and Launch Operations, and would not result in an increase in size of the airspace travel corridor or substantial closure of the navigable waterways around CCSFS. However, launches are no longer infrequent at CCSFS; Stoke's future launches would incrementally increase as the program matures (up to 10 launches per year), be of a short duration (less than 4 hours per launch), and scheduled in advance to minimize interruptions to air and marine traffic. Therefore, the overall cumulative effect of other cumulative activities combined with the Proposed Action constitutes a less-than-significant impact to airspace and navigable waterways.

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5. List of Agencies, Organizations, and Persons Contacted

Tribal Contacts

Tribe	Address	City	State	Zip Code
Miccosukee Tribe of Indians of Florida	Tamiami Station P.O. Box 440021	Miami	Florida	33144
Seminole Nation of Oklahoma	P.O. Box 1498	Wewoka	Oklahoma	74884
Seminole Tribe of Florida	30290 Josie Billie Highway PMB 1004	Clewiston	Florida	33440

Agency Contacts

Agency	Address	City	State	Zip Code
Brevard County	Viera Government Center 2725 Judge Fran Jamieson Way Building A	Viera	Florida	32940
City of Cocoa	65 Stone St.	Cocoa	Florida	32922
City of Titusville	P.O. Box 2806	Titusville	Florida	32781
City of Cape Canaveral	100 Polk Ave.	Cape Canaveral	Florida	32920
East Central Florida Regional Planning Council	Emailed Only	Emailed Only	Emailed Only	Emailed Only
EPA Region 4	Emailed Only	Emailed Only	Emailed Only	Emailed Only
FAA	Emailed Only	Emailed Only	Emailed Only	Emailed Only
FDEP	3319 Maguire Boulevard	Orlando	Florida	32803
FDEP Florida State Clearinghouse	Emailed Only	Emailed Only	Emailed Only	Emailed Only
FDOT	Emailed Only	Emailed Only	Emailed Only	Emailed Only
Florida Division of Historical Resources	Bureau of Historic Preservation R.A. Gray Building 500 South Bronough Street	Tallahassee	Florida	32399-2590
MINWR	Emailed Only	Emailed Only	Emailed Only	Emailed Only
NASA KSC	Emailed Only	Emailed Only	Emailed Only	Emailed Only
NPS CNS	Emailed Only	Emailed Only	Emailed Only	Emailed Only
National Marine Fisheries Service Habitat Conservation Division Essential Fish Habitat	Emailed Only	Emailed Only	Emailed Only	Emailed Only
Space Coast Transportation Planning Organization (SCTPO)	Emailed Only	Emailed Only	Emailed Only	Emailed Only

Agency	Address	City	State	Zip Code
Space Florida	Emailed Only	Emailed Only	Emailed Only	Emailed Only
St. Johns River Water Management District	525 Community College Parkway, SE	Palm Bay	Florida	32909
U.S. Army Corps of Engineers	701 San Marco Boulevard	Jacksonville	Florida	32207
USFWS, Florida Ecological Services Office	Emailed only	Emailed Only	Emailed Only	Emailed Only
NPS	Emailed only	Emailed Only	Emailed Only	Emailed Only
USCG	Emailed only	Emailed Only	Emailed Only	Emailed Only
U.S. Navy	Emailed only	Emailed Only	Emailed Only	Emailed Only

6. List of Preparers

Table 6-1. Preparers of Stoke SLC-14 Environmental Assessment

Name	Education and Experience	Primary Responsibilities
Michelle Rau, PMP	M.S., Business Administration; B.S., Ecology and Evolutionary Biology 26 years of experience	Project Manager
Christina McDonough, PE	M.E., Environmental Engineering; B.S., Civil Engineering 31 years of experience	NEPA lead
Jessica Wobig	M.A., Historic Preservation 14 years of experience	Cultural Resources
Michelle York	B.S. Chemical Engineering 23 years of experience	Air Quality, ACAM Model
Laura Dreher	B.S., Civil Engineering 22 years of experience	Infrastructure, Cumulative
Paige Grossman	M.S., Environmental Resource Management; B.S., Environmental Studies 4 years of experience	Water Resources; Health and Safety; EJ
Betsy Jorgensen	B.S., Biology 18 years of experience	Biology
Chelsie Spadoni	B.S., Environmental Engineering 5 years of experience	Hazardous Materials, Solid Waste, and Hazardous Waste
Julie Philippon	M.S., Aviation Science; M.S., Aerospace Engineering 14 years of experience	Noise
Sarah Jarzombek	B.S., Wildlife and Fisheries 2 years of experience	Geology and Soils; Land Use and Visual Resources
Lori Price	M.F.A., Historic Preservation; B.A., English and Political Science 28 years of experience	Senior Technical Review
Rich Reaves	Ph.D., Wetland Ecology; B.S., Ecology and Resource Management 30 years of experience	Senior Technical Review
Pamela Vanderbilt	M.A., Biology; B.S., Biology 40+ years of experience	Senior Technical Review
Sara Jackson, PMP	B.S., Environmental Studies 23 years of experience	Senior Technical Review

Name	Education and Experience	Primary Responsibilities
Mark Bastasch, P.E. (OR), INCE Bd. Cert.	B.S., Environmental Engineering; M.S., Environmental Engineering 25+ years of experience	Senior Technical Review
Emily Gulick	B.A., Environmental Science 6 years of experience	Senior Technical Review
Karen Sanders	J.D., Law; B.A., Anthropology 25 years of experience	Lead Editor

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Appendix A. Agency Coordination and Public Involvement

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Appendix A-1 Early Newspaper Notices

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

McCarthy reflects on 'bittersweet' departure

Calls Gaetz 'psychotic,' says new speaker is doing a 'good job'

Sudiksha Kochi
USA TODAY

In an exit interview, former House Speaker Kevin McCarthy, R-Calif., called his departure "bittersweet." "It's not the timing I wanted to leave," he said. JACK GRUBER/USA TODAY FILE

WASHINGTON – After he delivered his farewell address to lawmakers Thursday, former House Speaker Kevin McCarthy, R-Calif., reflected on his time in Congress in an exit interview, calling Rep. Matt Gaetz "psychotic" and praising new Speaker Mike Johnson.

"It's kind of bittersweet," McCarthy told reporters. "It's not the timing I wanted to leave."

McCarthy was ousted from the speakership in October by eight hard-line conservatives – an effort led by Gaetz, R-Fla. – and 208 Democrats. He acknowledged that the House Republican Conference remains divided, according to ABC News.

"What really sealed it was I told Johnson when he won, I said, 'Look, I'm not going to go to conference,' " McCarthy said. "If I go, I'm undercutting you or, you know, people are looking to me instead of looking at you, you got to carry on.

"But before I made my final decision, I went to conference that week to ... make sure if my decision was right. Spending a few moments in conference kind of sealed it."

McCarthy called Gaetz "psychotic," referring to the time the lawmaker demanded that the motion to vacate threshold be brought down by a member, according to The Hill.

He later added in the interview, "People study that type of crazy mind, right? Mainly the FBI."

McCarthy also acknowledged Johnson, R-La., in the interview, saying he's doing a "good job"

"Let's be fair to Mike, right," McCarthy said. "Mike hasn't been the majority leader, he hasn't been the minority leader, he didn't get to build up to be Speaker, he's thrown in the middle while we're in the middle of the fight, right. That's a tough place to be in."

BIKES FOR TYKES

Roy Goslin with the IT department at the port counts the bikes before heading out to Toys for Tots. MALCOLM DENEMARK/FLORIDA TODAY

Timing of GOP's impeachment probe of Biden still unclear

Aide: Investigation to be finished 'expeditiously' as election year looms

Ken Tran
USA TODAY

WASHINGTON – Republican investigators are projecting confidence about their impeachment investigation into President Joe Biden after the House formally authorized the push, even as it lacks evidence supporting their allegations.

House Oversight Committee Chair James Comer, R-Ky., told reporters Wednesday that House Republicans' unanimous vote formalizing the impeachment inquiry "shows we're united."

"We expect to have people honor our subpoenas. We want to wrap this investigation up," Comer said in a news conference alongside House Judiciary Committee Chair Jim Jordan, R-Ohio, and House Ways and Means Committee Chair Jason Smith, R-Mo.

It's not clear when Republicans hope to wrap up their investigation into the president. But a senior House Republican aide said they hope to finish it "expeditiously" and come to a decision about whether to draft articles of impeachment against Biden.

Republicans have accused Biden of leveraging his previous position as vice president to influence and benefit from his family's foreign business dealings. Though the inquiry has turned up evidence showing the president's son, Hunter Biden, used his family name to his advantage, GOP lawmakers have not directly implicated the president.

House Republicans have made the president's son a focal point of their investigation.

The House Oversight Committee issued a subpoena calling on him to testify behind closed doors on Wednesday. But Hunter Biden instead defied the subpoena and delivered remarks on Capitol Hill criticizing the inquiry and accusing GOP lawmakers of weaponizing his battles with drug addiction to attack his father.

House Republicans zeroed in on a key part of Hunter Biden's remarks after his rare public comments, when he said "my father was not financially involved in my business." Comer and Jordan have pointed to the word "financially," questioning whether the president may have been involved but not directly tied to handling money.

Biden

"Joe Biden was not financially involved in his family's business dealings. Exactly how was Joe Biden involved?" Comer and Jordan said in a joint statement.

Ian Sams, the White House spokesperson for oversight and investigations, pushed back on that argument in an interview on CNN on Thursday morning, saying Comer and Jordan were misrepresenting a "semantic thing."

"The president was not in business with his son, period," Sams said. "They're trying to make up all sorts of allegations."

Whether House Republicans will begin actual impeachment proceedings stretching beyond their initial investigation also isn't clear. House Democrats have called Republican efforts to remove Joe Biden from office inevitable, but some GOP lawmakers from swing districts are keeping their cards close to the vest after approving the inquiry.

"Not the politics. The facts and evidence will determine any next steps," Rep. Mike Lawler, R-N.Y., who represents a district Biden won in the 2020 election, said Wednesday evening. "We didn't have a vote on impeachment."

‘I miss all the noise of the sea’

Climate change, rising waters force residents of coastal Mexican town to flee from their homes

Daniel Shailer
ASSOCIATED PRESS

EL BOSQUE, Mexico – People moved to El Bosque in the 1980s to fish. Setting out into the Gulf of Mexico in threes and fours, fishermen returned with buckets of tarpon and long, streaked snook. There was more than enough to feed them, and build a community – three schools, a small church and a basketball court on the sand.

Then climate change set the sea against the town.

Flooding driven by some of the world’s fastest sea-level rise and by increasingly brutal winter storms has all but destroyed El Bosque, leaving piles of concrete and twisted metal rods where houses used to line the sand.

Forced to flee the homes they built, locals are waiting for government aid and living in rentals they can scarcely afford.

The United Nations climate summit known as COP28 finally agreed this month on a multimillion-dollar loss-and-damage fund to help developing countries cope with global warming. It will come too late for the people for El Bosque, caught between Mexico’s economically vital national petroleum company and the environmental peril that it fuels.

A rusting sign at the town’s entrance says more than 700 people lived in El Bosque two years ago. Now there are barely a dozen. In between those numbers lie the relics of a lost community. At the old, concrete fishing cooperative, one of the few solid buildings left, enormous, vault-like refrigerators have become makeshift storage units for belongings – pictures, furniture, a DVD of Guinness World Records 3 – that families left behind.

Guadalupe Cobos is one of the few still living in El Bosque. She has diabetes, and improvises a cooler for her insulin after each flood cuts power. Residents’ relationship with the sea is “like a toxic marriage,” Cobos said, sitting facing the waves on a recent afternoon.

Debris from collapsed homes and felled trees litter the shoreline of the coastal community of El Bosque, Mexico. The United Nations climate summit known as COP28 finally agreed this month on a multimillion-dollar loss-and-damage fund to help developing countries cope with global warming. But it will come too late for the people for El Bosque. FELIX MARQUEZ/AP

“I love you when I’m happy, right? And when I’m angry I take away everything that I gave you,” she said.

Up to 8 million Mexicans will be displaced by climate change-driven flooding, drought, storms and landslides within the next three decades, according to the Mayors Migration Council, a coalition researching Mexican internal migration.

Along with rapidly rising water levels, winter storms called “nortes” have eaten more than 0.3 miles inland since 2005, according to Lilia Gama, an ecology professor and coastal vulnerability researcher at Tabasco Juarez State University.

“Before, if a norte came in, it lasted one or two days,” said Gama, sitting above the university’s crocodile enclosure. “The tide would come in, it would go up a little bit and it would go away.”

Now winter storms stay for several days at a time, trapping El Bosque’s few remaining locals in their houses if they don’t evacuate early enough. A warming climate spins up more frequent storms as it slams into ultra-cold polar air, and then storms last longer – fueled by hotter air, which can hold more moisture.

Local scientists say one more powerful storm could destroy El Bosque for good. Relocation, slowed by bureaucracy and a lack of funding, is still months away.

As the sun sets over the beach, Cobos, known as Doña Lupe to neighbors, pointed to a dozen small, orange stars on the line of the horizon – oil platforms burning off gas they have failed to capture.

“There is money here,” she said, “but not for us.”

As El Bosque was settled, state oil company Pemex went on an exploration spree in the Gulf – tripling crude oil production and making Mexico into a major international exporter.

As the international community clamors for countries to wind down fossil fuel use, the single leading cause of climate change, Mexico next year plans to open a new refinery in its biggest oil-producing state, just 50 miles west of El Bosque.

Gulf of Mexico sea levels are already rising three times faster than the global average, according to a study co-authored by researchers from the United Kingdom’s National Oceanography Center and universities in New Orleans, Florida and California this March.

The stark difference is partly caused by changing circulation patterns in the Atlantic as the ocean warms and expands.

The acceleration has also strengthened massive coastal storms like hurricanes Sandy and Katrina, researchers said, and doubled records of high-tide flooding from the Gulf up to Florida.

“In the 10 years before the acceleration, you might have had a period of rather slow sea-level rise. So people might have gotten a feeling of safety along the coastline, and then the acceleration kicks in. And things change very rapidly,” said lead scientist Sönke Dangendorf.

When Eglisa Arias Arias, a grandmother of two, moved to El Bosque, she was excited to have her own garden for the first time, and it was rarely troubled by the sea. Her house was flooded in a storm on Nov. 3 and she has rented an apartment a short drive inland.

“I miss everything. I miss all the noise of the sea. I mean the noise of this sea,” she said.

Swathes of the coast known as the Emerald Coast in the state of Veracruz are storm-battered, flooded and falling into the sea, and one-quarter of neighboring Tabasco state will be inundated by 2050, according to one study.

Around the world, coastal communities facing similar slow-motion battles with the water have begun beating what is called “managed retreat.” Locals on the Gaspé peninsula of Quebec have been gradually fleeing the coast for more than a decade, and just last year New Zealand’s government promised financial aid for some of the 70,000 homes it said will soon need to seek higher ground.

Very little, however, seems managed about the retreat from El Bosque. When the Xolo family fled their home on Nov. 21, they left in the middle of the night, all 10 children under a tarpaulin in pouring rain.

Now they practice math on an app. In the carcass of El Bosque’s primary school, attendance books are still on the floor with sodden pages and, in the preschool, alphabet cutouts cling to the wall.

First Áurea Sanchez, the Xolo family matriarch, took her family to a shelter at the local recreation center inland. Then, a few days later, a moving van arrived unannounced to remove the center’s only refrigerator and the shelter was closed.

“It can’t be,” Sanchez remembers thinking. “They can’t leave us without food without telling us right?”

Later that afternoon, an official arrived to announce the closure.

When The Associated Press visited El Bosque at the end of November, a moderate storm had flooded the one road to the community so that it was accessible only by foot, or motorbike. That same day the shelter was closed, apparently permanently, with papered-over windows and a government sign advertising “8 steps to protect your health in the event of a flood.”

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

PUBLIC NOTICE
FOR POTENTIAL IMPACT TO HISTORIC PROPERTIES, THE FLOODPLAIN, AND WETLANDS AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA

The U.S. Space Force (USSF) is preparing an Environmental Assessment (EA) in compliance with the National Environmental Policy Act (NEPA) to analyze the environmental impact of reactivating an existing launch complex and developing a new space transportation system for Stoke Space Technologies, Inc. (Stoke) at Cape Canaveral Space Force Station (CCSFS), Florida. In accordance with Section 106 of the National Historic Preservation Act (54 United States Code Section 306108) and its implementing regulations at 36 Code of Federal Regulations Part 800, USSF has identified this action as an undertaking with the potential to affect historic properties.

The purpose and need of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015, USSF’s Launch Pad Allocation Strategy, and continued fulfillment of the National Space Policy to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs; to develop a more cost-competitive commercial space launch system to advance U.S. space launch capability and provide redundancy; and to ensure the U.S. remains a leader in space launch technology. The Proposed Action includes the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations at Space Launch Complex 14 (SLC-14). The new facilities include a launch mount/pad, propellent tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features.

Space Launch Complex (SLC) 14 was deactivated in 1967 and abandoned in 1973; most of its components were removed and reused in other complexes. The northern portion of the launch stand was removed due to structural deterioration in 1976, and the remainder of the launch stand and ramp are in poor condition. In 1998, the blockhouse was restored and converted into a meeting and event space, which will not be impacted by the proposed reactivation. In recognition of its nationally significant contribution to the crewed and uncrewed space programs of the United States, SLC-14 was listed as part of the Cape Canaveral Air Force Station National Historic Landmark district and is also individually eligible for listing in the National Register of Historic Places. In February 1962, John Glenn became the first American to orbit the Earth aboard Friendship 7 after launching from SLC-14. This historic mission has been memorialized by the Mercury Memorial, which will not be affected by the proposed reactivation of SLC-14. Project Mercury’s legacy is further documented in historical records, including a Historic American Engineering Record and a series of 3D models produced from laser scans. A wealth of scholarship and virtual engagement is available to the public, including virtual tours, videos, and interactive maps.

Reactivation of the launch complex will require demolition of some existing structures. In the designation of the National Historic Landmark district, the Department of the Interior recognized that future Air Force missions may require reactivation of SLC-14 and specifically included language to that effect in the designation. “It was the consensus of the Board that designation of these facilities should not interfere with the mission of the United States Air Force at Cape Canaveral Air Force Station.” As part of this mission, USSF intends to continue the legacy of SLC-14 and reuse the complex for its historic and intended purpose.

This Proposed Action is subject to the requirements and objectives of Executive Order (EO) 11990, “Protection of Wetlands,” EO 11988, “Floodplain Management,” and EO 13690, “Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input,” as the proposed infrastructure improvements could potentially impact wetlands and could occur within the 100-year floodplain. Impacts to wetlands and the floodplain would be minimized to the greatest extent practicable. Mitigation would be provided for unavoidable impacts to prevent any net loss of wetland or floodplain function in accordance with federal and state regulations.

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FT-38180749

‘Mean Girls’ tour is just as fun as movie

By Brittany Ó Ruacháinn
For Hometown News

BREVARD COUNTY — There’s only one word to describe the touring “Mean Girls” musical right now and that is it’s so “fetch.”

The musical show came to the Maxwell C. King Center for the Performing Arts on Dec. 11 and 12. If you were on stage, you’d be looking at waves of pink from the orchestra and up.

For the unfamiliar, Mean Girls tells the story of homeschooled 16-year-old Cady Heron, who moves from the wild landscape of the African savanna to suburban Illinois.

The teen is excited to socialize with people her age but finds that high school is kind of just like living among wild animals.

As a fan of the movie, I wasn’t sure at all how Mean Girls would translate on stage as a musical. It’s a classic among my generation for phrases such as “On Wednesdays, we wear pink,” and “Get in, loser, we’re going shopping.”

The movie even kick-started Rachel McAdams’ career and made her a star. (Well, her movie “The Notebook” probably had a hand in that, too.) It also featured Lindsay Lohan, a household name at the time, and Amanda Seyfried, who went on to star in “Mamma Mia!” and other movies.

It didn’t take long for the show to begin before I realized I was going to have a lot of fun with it.

I thought the casting for the musical show was excellent, and each voice was spectacular. No role was too small, and it felt like each character had a decent amount of stage and solo time.

The music and lyrics were written by Jeff Richmond and Nell Benjamin, and each musical number was fun, memorable, and fit right in.

Jenny Anderson, 2023/For Hometown News
The Plastics take new girl Cady Heron under their wing and reveal the infamous Burn Book.

I think some of my favorite songs were Gretchen’s “What’s Wrong with Me?”, Cady and Aaron’s “More Is Better” and Janis’ “I’d Rather Be Me.”

Each were powerful numbers that not just showcased these actors’ voices, but brought a realness to their characters.

Even with the musical numbers added, there was still room for nostalgic lines with a sprinkling of fresh and original dialogue.

The cast included a few national debuts, such as Maya Petropoulos as Regina George, Maryrose Brendel as Karen Smith, Alexys Morera as Janis Sarkisian, Ethan Jih-Cook as Damian Hubbard, Kristen Seggio as Mrs. Heron/Ms. Norbury/Mrs. George, Joseph Torres as Aaron Samuels, and Shawn Mathews as Kevin G.

Starring as new girl Cady Heron was Natalie Shaw and playing one third of The Plastics as Gretchen Weiners was Kristen Amanda Smith.

Anyone who missed this hilarious and fresh take on the 2004 classic movie by Tina Fey will get the opportunity to see it in theaters this January, but there was nothing like seeing it live.

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

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Out & about

FRIDAY, DEC. 22

“IT’S A WONDERFUL LIFE” - A screening of “It’s A Wonderful Life” (1946) will be at Historic Cocoa Village Playhouse, 300 Brevard Ave., Cocoa on Friday, Dec. 22 at 6:30 p.m. Tickets: $10. Call 321-636-5050; go to www.cocoavillageplayhouse.com/.

DEC. 22-JAN. 13

LINEUP AT HEIDI’S JAZZ CLUB - Singers and bands planned through Jan. 13 at Heidi’s Jazz Club, 7 N. Orlando Ave., Cocoa Beach include Annika Chambers and Paul DesLauriers, Friday, Dec. 22 at 7 p.m.; Steve Kirsner & Friends, Saturdays, Dec. 23 & 30

See OUT, page 10

Palm Bay woman charged in fatal hit-and-run accident in Vero Beach

Shanice Person, 24, booked into Indian River County Jail on Dec. 10

By Chris Bonanno
For Hometown News

A Palm Bay woman was charged in relation to the death of a pedestrian in Vero Beach on Sunday morning, according to an arrest affidavit from the Indian River County Sheriff's Office.

Shanice Person, 24, was arrested and charged with failing to stop/remain at a crash involving death and driving with a suspended license.

Police say they responded before 2:30 a.m. on Sunday to the intersection of the Barber Bridge and Indian River Boulevard they received a report that the pedestrian had been struck by a vehicle. When they arrived, they saw a male that was deceased in the grass media that runs north and south on Indian River Blvd.

The victim was identified as 39-year-old Jhovan Edgardo Diaz Rojas.

Police later caught up with a black Toyota 4-door vehicle that had heavy damage to the front side and a shattered windshield on the driver's side. After a traffic stop, police took the suspect, alleged to be the driver, along with two others to the Vero Beach Police Department.

One of the passengers told police the trio had been at a bar and that prior to leaving, they had a round of shots.

The suspect was observed by police to have bloodshot and watery eyes, along with a strong odor of marijuana that emanated from her. The suspect allegedly admitted to police that she had "two cups of Patron," also telling police as part of her statement that "I ain't gon lie, smoking weed at (the bar),"

She allegedly had her last drink at 1 a.m. that morning and at one point told police that she doesn't drive because she's a habitual traffic offender and that her license is suspended. She later allegedly told police that she was driving the vehicle to start but then expressed to a passenger that she was too intoxicated, at which point she says she switched with the passenger.

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The suspect added that she closed her eyes and that the next thing she remembered was being pulled over by law enforcement. She added that she did not recall a crash.

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Calendar

From page 4

CHRISTMAS EVE AT EMMANUEL METHODIST - Emmanuel United Methodist Church, 2800 W. Eau Gallie Blvd., Melbourne. Christmas Eve services on Sunday, Dec. 24 at 5 and 7 p.m. Admission: Free. Info: 321-254-0010.

CHRISTMAS EVE AT RESURRECTION CHURC H - Lutheran Church of the Resurrection, 525 Minuteman Causeway, Cocoa Beach, Christmas Eve services on Sunday, Dec. 24 at 5 p.m. (family service) and 7 p.m. (traditional service). Admission: Free. Call 321-783-0852.

CHRISTMAS EVE AT LIGHTHOUSE CHRISTIAN - Lighthouse Christian Church, 1250 N. Banana River Drive, Merritt Island, Christmas Eve service on Sunday, Dec. 24 at 5:30 p.m. Admission: Free. Call 321-452-1012; go to ourlighthouse.net.

CHRISTMAS EVE AT COVENANT PRESBYTERIAN - Covenant Presbyterian Church Christmas Eve service at Lockmar Elementary School, 525 Pepper St., Palm Bay on Sunday, Dec. 24 at 6 p.m. Admission: Free. Info: www.covenantpalmbay.org/

CHRISTMAS EVE AT ST. TIMOTHY - St. Timothy Lutheran Church, 1903 Croton Road, Melbourne, Christmas Eve service on Sunday, Dec. 24 at 7 p.m. Admission: Free. Info: 321-259-3443

SUNDAY, DEC. 24 & w MONDAY, DEC. 25

CHRISTMAS AT HOLY TRINITY - Holy Trinity Episcopal Church, 50 W. Strawbridge Ave., Melbourne, will have Christmas Eve services on Sunday, Dec. 24 at 3 p.m.

Holiday Market and Snow Fest is great fun

Families gathered for shops, games at Melbourne Auditorium

Julian Leek/For Hometown News

Kids enjoyed rides on a snow slide at the City of Melbourne Parks and Recreation Department's Holiday Market and Snowfest event on Dec. 15.

By Chris Bonanno
For Hometown News

MELBOURNE — Vendors gathered to sell a bevy of items while kids enjoyed fun activities as the City of Melbourne's Parks and Recreation Department held its Holiday Market and Snowfest event at the Melbourne Auditorium, at 625 E. Hibiscus Blvd. on Dec. 15-16.

The Auditorium had more than 60 vendors selling goods inside, according to Kristen Swenson, recreation manager with the department.

"We also have a concession stand, so there's everything that you could possibly think of for a Christmas present in there. A lot of good ideas and unique craft ideas as well, so not something you can find in the regular store," said Swenson, who added that the majority of vendors were either from Melbourne or the surrounding areas.

Patricia Kern was at one of the tables in the auditorium with her business, "Original Designs by Trish Kern," selling hand-painted porcelain and dichroic blast-fueled jewelry.

"They have done an amazing job decorating and making each area feel individual. Wonderful programming, and I love the ice slide and the stuff for the kids," said Kern, who is also a member of the Brevard Porcelain Artists Club.

The event also had a Kids Zone, which included cookie decorating, a letter writing opportunity with Santa, who wrote back to kids, and kids also had the opportunities to take photos with Santa, according to Swenson.

On Dec. 15 only, it also included a snow slide where kids, sometimes accompanied by parents, would go to the top of a slide and then ride down the slide, which was covered with shaved ice, on an inflatable tube.

"It makes the Christmas spirit come out in everybody," Swenson said, "Everyone's just so happy, and not only do the kids enjoy it, but the parents are thoroughly enjoying watching their kids having a ball. Their kids want to go on the slide again and again."

Swenson also noted that it was the second year the event had taken place, and on Friday, she indicated attendance was well ahead of the turnout for the first year.

"This is a great event," Swenson added, "We love to do these kinds of events for the community, to get everybody involved and just have a good time, especially build community. You see how the kids are talking with each other and playing with each other,

The City of Melbourne's Holiday Market and Snow Fest made the Christmas spirit come out in everyone.

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CHRISTMAS AT CHURCH OF OUR SAVIOR - Church of Our Savior, 5301 N. Atlantic Ave., Cocoa Beach will have Christmas Eve services on Sunday, Dec. 24 at 4 and 6 p.m. (mass) and a midnight mass; and on Christmas Day, Monday, Dec. 25, services will be at 8:30 and 11

Palm Bay woman charged in fatal hit-and-run accident in Vero Beach

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By Chris Bonanno
For Hometown News

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Indian River County Sheriff's Office/For Hometown News

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FOR POTENTIAL IMPACT TO HISTORIC PROPERTIES, THE FLOODPLAIN, AND WETLANDS AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA

The U.S. Space Force (USSF) is preparing an Environmental Assessment (EA) in compliance with the National Environmental Policy Act (NEPA) to analyze the environmental impact of reactivating an existing launch complex and developing a new space transportation system for Stoke Space Technologies, Inc. (Stoke) at Cape Canaveral Space Force Station (CCSFS), Florida. In accordance with Section 106 of the National Historic Preservation Act (54 United States Code Section 306108) and its implementing regulations at 36 Code of Federal Regulations Part 800, USSF has identified this action as an undertaking with the potential to affect historic properties.

The purpose and need of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015, USSF's Launch Pad Allocation Strategy, and continued fulfillment of the National Space Policy to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs; to develop a more cost-competitive commercial space launch system to advance U.S. space launch capability and provide redundancy; and to ensure the U.S. remains a leader in space launch technology. The Proposed Action includes the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations at Space Launch Complex 14 (SLC-14). The new facilities include a launch mount/pad, propellent tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features.

Space Launch Complex (SLC) 14 was deactivated in 1967 and abandoned in 1973; most of its components were removed and reused in other complexes. The northern portion of the launch stand was removed due to structural deterioration in 1976, and the remainder of the launch stand and ramp are in poor condition. In 1998, the blockhouse was restored and converted into a meeting and event space, which will not be impacted by the proposed reactivation. In recognition of its nationally significant contribution to the crewed and uncrewed space programs of the United States, SLC-14 was listed as part of the Cape Canaveral Air Force Station National Historic Landmark district and is also individually eligible for listing in the National Register of Historic Places. In February 1962, John Glenn became the first American to orbit the Earth aboard Friendship 7 after launching from SLC-14. This historic mission has been memorialized by the Mercury Memorial, which will not be affected by the proposed reactivation of SLC-14. Project Mercury's legacy is further documented in historical records, including a Historic American Engineering Record and a series of 3D models produced from laser scans. A wealth of scholarship and virtual engagement is available to the public, including virtual tours, videos, and interactive maps.

Reactivation of the launch complex will require demolition of some existing structures. In the designation of the National Historic Landmark district, the Department of the Interior recognized that future Air Force missions may require reactivation of SLC-14 and specifically included language to that effect in the designation. "It was the consensus of the Board that designation of these facilities should not interfere with the mission of the United States Air Force at Cape Canaveral Air Force Station." As part of this mission, USSF intends to continue the legacy of SLC-14 and reuse the complex for its historic and intended purpose.

This Proposed Action is subject to the requirements and objectives of Executive Order (EO) 11990, "Protection of Wetlands," EO 11988, "Floodplain Management," and EO 13690, "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input," as the proposed infrastructure improvements could potentially impact wetlands and could occur within the 100-year floodplain. Impacts to wetlands and the floodplain would be minimized to the greatest extent practicable. Mitigation would be provided for unavoidable impacts to prevent any net loss of wetland or floodplain function in accordance with federal and state regulations.

Pursuant to 40 CFR 1501.5(e), EOs 11990, 11988, 13690 and Air Force Manual 32-7003, USSF requests public comment in advance of preparation of the EA to determine if there are any public concerns regarding the Proposed Action's potential to impact floodplains and wetlands. USSF also requests public comment on the Proposed Action's potential effects on contributing resources of SLC-14 and the National Historic Landmark district. The Proposed Action will be analyzed in the EA, which will be made available for public review and comment. Comments may be submitted to Ms. Taylor Janise, 45 CES/CEIE, 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 or via email at taylor.janise.1@spaceforce.mil. Comments are requested by January 21, 2024, within 30 days from the publication of this notice.

Arrests

From page 5

or blackmail.

Trevor Dean Zag Stillwell, of Cocoa, possession of controlled substance without prescription, driving while license suspended – habitual offender, possession of drug paraphernalia.

Patrick Shayne Niemann, of Merritt Island, failure to appear – felony.

Charles Edward John, of Palm Bay, possession of firearm or weapon or ammunition by convicted felon, use or display of firearm or carrying concealed firearm during commission of felony, possession of cocaine, possession of controlled substance without prescription – three counts, possession of marijuana – more than 20 grams, attempt to flee or elude police officer, resisting officer without violence, warrant arrest – out of county.

Ronald Samuel Fayson, of Titusville, possession of firearm or weapon or ammunition by convicted felon.

Ashley Michelle Matthews, of Aurora, Colo., out-of-state fugitive – two counts.

Suzanne Elizabeth Atnip, of Rockledge, possession of controlled substance without prescription, failure to appear – felony (two counts), possession of drug paraphernalia, violation of probation.

Laticia Lashaye Fishmon, of Titusville, sale of cocaine within 1,000 feet of school or place of worship or business, possession of cocaine with intent to sell or distribute within 1,000 feet of school or place of worship or business.

Jessiah Lamar Pickens, of Titusville, grand

Appendix A-2 Early Newspaper Notice Public Comments

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Indian River Lagoon Roundtable
An environmental discussion group
www.irlroundtable.com

Ms. Taylor Janise, 45 CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base, Florida 32925
taylor.janise.1@spaceforce.mil

January 10, 2024

To Whom It May Concern,

The Indian River Lagoon Roundtable is a grassroots environmental discussion group that realizes the importance of both America's natural resources and its space program. We seek a synergistic relationship between the IRL National Estuary and America's premier spaceport.

The Roundtable is concerned that on-going development at CCSFS does not fully consider its impact on the National Estuary. The Banana River lagoon is a badly impaired watershed where millions of dollars will be spent "to repair and correct development practices of the past".

We recognize that the proposed action is the reactivation of SLC-14 and are confident that important historic features of the site will be preserved as much as possible. This action is also an opportunity to apply Low Impact Development technology that will correct past development practices and reduce future environmental impact to the Banana River lagoon.

Below are our comments on the Potential Impact to Historic Properties, the floodplain and Wetlands at Cape Canaveral Air Force Station, Florida.

- Paragraph 2: The description of new facilities is extensive and strongly indicates that the total footprint of the proposed action will exceed 5000 sqft. It therefore must meet the requirements of DOD Directive 310-2-10 Low Impact Development.

- Paragraph 5: Executive Orders are listed that the proposed action must meet requirements for Protection of Wetlands, Floodplain Management and Stakeholders Input. We request that DOD Directive 3-210-10 Low Impact Development be included in the forthcoming EA and specified for the protection of the Indian River Lagoon.

Thank you for this opportunity to comment on the Potential Impact to Historic Properties, the floodplain and Wetlands at Cape Canaveral Air Force Station, Florida.

Sincerely,

David C. Botto, Lt. Col (Ret.), USAF for the Indian River Lagoon Roundtable

Email: irlroundtable@gmail.com

Appendix A-3 Example Early Agency and Tribe Notices

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

January 16, 2024

Michael Blaylock
Chief, Environmental Conservation, Patrick Space Force Base
U.S. Space Force, Space Launch Delta 45
1224 Jupiter Street, Mail Stop 9125
Patrick Space Force Base, FL 32925

Amanda Elmore
Deputy Director, Natural Resources
Brevard County
Viera Government Center 2725 Judge Fran Jamieson Way Building A
Viera, FL 32940

Dear Amanda Elmore,

The U.S. Space Force (USSF) is preparing an Environmental Assessment (EA) to evaluate potential environmental impacts associated with implementing Stoke Space Technologies, Inc.'s (Stoke) proposed Nova Space Launch Program at an existing launch complex on Cape Canaveral Space Force Station (CCSFS). A location map (Figure 1) is attached for your reference.

The U.S. Commercial Space Launch Competitiveness Act of 2015 was developed to promote the growth of a competitive space launch industry; therefore, the purpose of the Proposed Action is to facilitate USSF deployment of a medium-class space transportation system. The Proposed Action is needed to develop a more cost-competitive commercial space launch system to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology. In so doing, the Proposed Action allows for the continued fulfillment of the National Space Policy (85 *Federal Register* 81755, 2020) to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs.

The Proposed Action would reactivate Space Launch Complex 14 (SLC-14) in support of the Nova Space Launch Program through the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations. The new facilities would include a launch mount/pad, propellant tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features.

The EA will assess the potential environmental impacts that would result from the Proposed Action as well as the No Action Alternative, which reflects the status quo as a baseline for comparison of potential effects from the Proposed Action. The cumulative effects associated with the Proposed Action when combined with past, present, and future (reasonably foreseeable) actions will also be examined.

USSF is the lead federal agency and is preparing this EA in accordance with the National Environmental Policy Act (NEPA), as amended (*United States Code* Title 42, Section 4321, et seq.); the Council on Environmental Quality's regulations for Implementing the Procedural Provisions of NEPA

(*Code of Federal Regulations* [CFR] Title 40, Parts 1500 through 1508); the U.S. Air Force's NEPA implementing regulations (32 CFR Part 989) and policy; and Federal Aviation Administration Order 1050.1F Environmental Impacts: Policies and Procedures, and FAA Order 1050.1F Desk Reference. Because of their jurisdiction and special expertise related to the Proposed Action, the National Aeronautics and Space Administration, Federal Aviation Administration, and U.S. Coast Guard are cooperating agencies in the development of the EA.

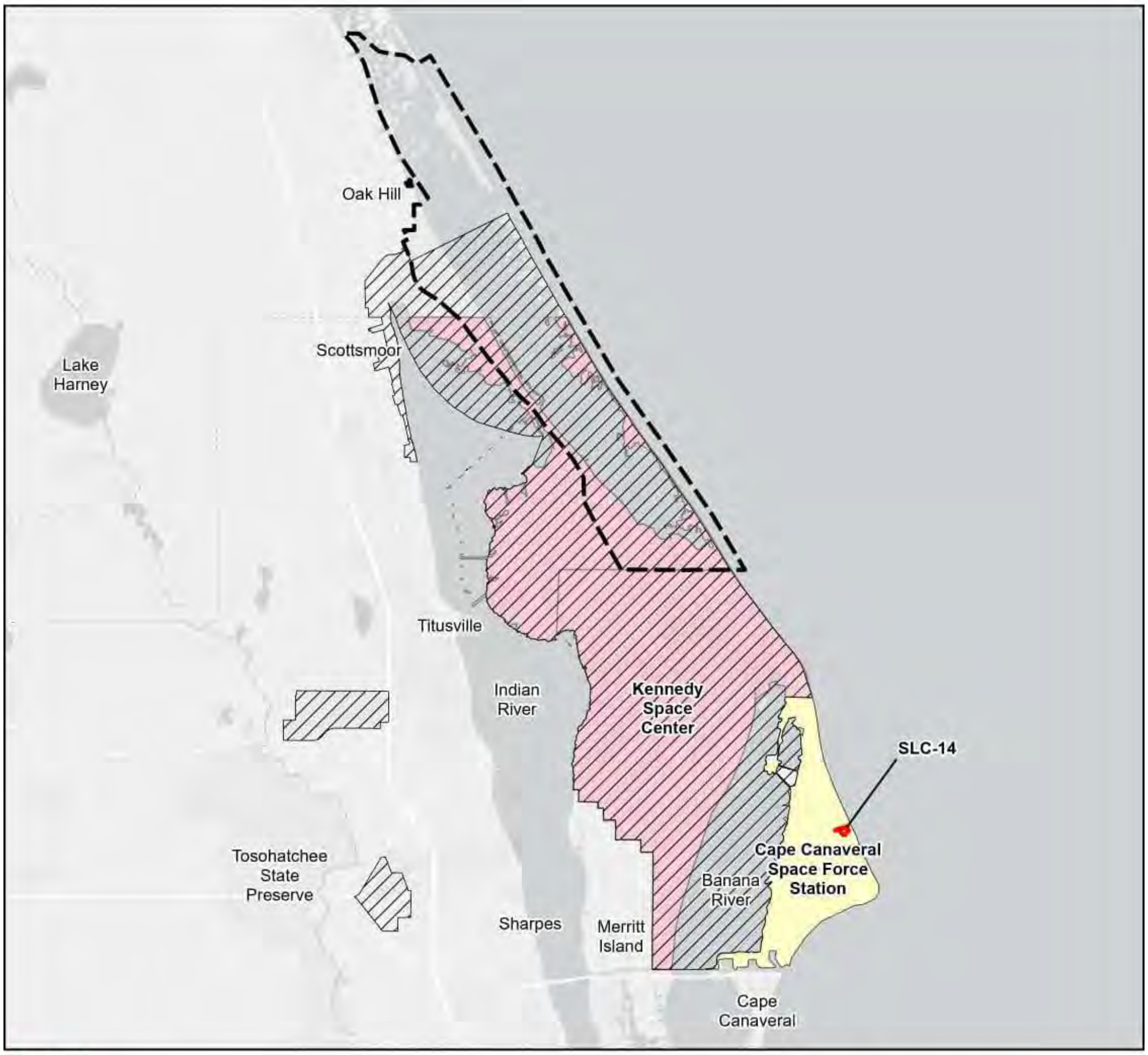
As required by 32 CFR Part 989, we request your input on the Proposed Action and assistance in identifying any potential areas of environmental impact to assess in this analysis. If you have any specific items of interest about this proposal, please contact Ms. Taylor Janise at 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 or via email at taylor.janise.1@spaceforce.mil and courtesy copy megan.nicely.1@spaceforce.mil, within 30 days of receipt of this letter. Thank you in advance for your assistance in the effort.

Sincerely

Michael Blaylock, NH-03, DAF
Chief, Environmental Conservation

Attachment:
Figure 1. Location of SLC-14 at CCSFS

Figure 1. Location of SLC-14 at CCSFS



Legend

- Construction Project Area
- Kennedy Space Center
- Cape Canaveral Space Force Station
- Merritt Island National Wildlife Refuge Complex
- Canaveral National Seashore

Notes:
1. Merritt Island National Wildlife Refuge Complex boundary shown is from U.S. Fish & Wildlife Service. Downloaded from https://gis-fws.opendata.arcgis.com/datasets/dae48a3dcd654e7ea09d386cae052eab/explore?location=28.370782%2C-80.516762%2C11.62 on August 17, 2023.
2. Canaveral National Seashore boundary shown is from the National Parks Service. Downloaded from https://public-nps.opendata.arcgis.com/datasets/nps-boundary-1/explore?location=28.813847%2C-80.732930%2C10.00 on August 17, 2023.

0 7 14 21 28 Miles N
1:443,520 1 inch = 7 miles

Service Layer Credits: Light Gray Base: FDEP, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS

UNK \\DC1VS01\GISPROJ\S\STOKE\MAPFILES\STOKE_DOPAA_UPDATE\STOKE_DOPAA_UPDATE.APRX AGAWINAM 8/30/2023 9:57 AM

Appendix A-4 Early Agency and Tribe Notice Responses

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

McDonough, Christina

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Monday, January 22, 2024 4:09 PM
To: McDonough, Christina
Subject: [EXTERNAL] FW: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

-----Original Message-----
From: Chase, Kelly L. <Kelly.Chase@dos.myflorida.com>
Sent: Monday, January 22, 2024 10:50 AM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; Lotane, Alissa Slade <Alissa.Lotane@dos.myflorida.com>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Subject: [Non-DoD Source] RE: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Mr. Blaylock,

Thank you for notifying our office of the in progress Environmental Assessment (EA) for the reactivation of Space Launch Complex 14 (SLC-14) on Cape Canaveral Space Force Station (CCSFS). We note there are historic properties within the Area of Potential Effect (APE). In development of the EA, CCSFS will need to address how the undertaking will effect historic properties. We look forward to receiving the EA and working with CCSFS to ensure that the project avoids, minimizes, or, if necessary, mitigates potential adverse effects to historic properties.

Kind regards,
Kelly

Kelly L. Chase
Compliance and Review Supervisor | Deputy State Historic Preservation Officer Division of Historical Resources | Florida Department of State
Office: 850.245.6344 | Cell: 850.274.9121 (cannot receive text messages)
500 South Bronough Street | Tallahassee, Florida 32399 dos.myflorida.com/historical

-----Original Message-----
From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Wednesday, January 17, 2024 4:39 PM
To: Lotane, Alissa Slade <Alissa.Lotane@dos.myflorida.com>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>; Chase, Kelly L. <Kelly.Chase@dos.myflorida.com>
Subject: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL
Importance: High

EMAIL RECEIVED FROM EXTERNAL SOURCE

McDonough, Christina

From:	JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent:	Wednesday, January 24, 2024 6:48 AM
To:	McDonough, Christina
Subject:	FW: [EXTERNAL] Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

From: Kneifl, Kristen R <Kristen_Kneifl@nps.gov>
Sent: Wednesday, January 24, 2024 8:47 AM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; West, Ben <Ben_West@nps.gov>
Subject: [Non-DoD Source] Re: [EXTERNAL] Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Hello,
Thank you for the opportunity to participate in the NEPA process. Canaveral National Seashore does not have any comments.
Kristen

Kristen Kneifl
Canaveral National Seashore
Chief of Resource Management
212 S. Washington Avenue
Titusville, Fl 32796
321-267-1110 ext 14
321-403-5680 (cell)

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Wednesday, January 17, 2024 4:17 PM
To: Kneifl, Kristen R <Kristen_Kneifl@nps.gov>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; West, Ben <Ben_West@nps.gov>
Subject: [EXTERNAL] Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

McDonough, Christina

From:	JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent:	Tuesday, February 20, 2024 6:04 AM
To:	McDonough, Christina
Cc:	Rau, Michelle; Julia Black
Subject:	[EXTERNAL] FW: Nova Space Launch Program Scoping Comments
Attachments:	Stoke Nova Launch Scoping EPA Comments.docx

From: White, Douglas <White.Douglas@epa.gov>
Sent: Friday, February 16, 2024 6:25 PM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Cc: NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; Kajumba, Ntale <Kajumba.Ntale@epa.gov>; Buskey, Traci P. <Buskey.Traci@epa.gov>; Bowen, Kristina <Bowen.Kristina@epa.gov>
Subject: [Non-DoD Source] Nova Space Launch Program Scoping Comments

Hi Ms. Janise,

Please see attached the EPA's comments on the Nova Launch LOI.

Douglas White
U.S. Environmental Protection Agency / Region 4
Strategic Programs Office / NEPA Section
61 Forsyth Street, SW
Atlanta, GA 30303-8960
404-562-8586

REGION 4
ATLANTA, GA 30303

February 16, 2024

Ms. Taylor Janise
45 CES/CEIE
1224 Jupiter Street, Mail Stop 9125
Patrick Space Force Base, Florida 32925

Re: EPA Comments on the Letter of Intent to Prepare an Environmental Assessment for the Nova Space Launch Program at Cape Canaveral Space Force Station, Brevard County, Florida

Dear Ms. Janise:

The U.S. Environmental Protection Agency has reviewed the referenced document in accordance with Section 309 of the Clean Air Act and Section 102(2)(C) of the National Environmental Policy Act. According to the letter, dated January 16, 2024, the United States Space Force is preparing an Environmental Assessment to evaluate potential environmental impacts resulting from the implementation of Stoke Space Technologies, Inc.'s proposed Nova Space Launch Program at Space Launch Complex 14 at Cape Canaveral Space Force Station in Brevard County, Florida. The Proposed Action is needed to develop a more cost-competitive commercial space launch system to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology.

The Proposed Action would reactivate SLC-14 in support of the Nova Space Launch Program through the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations. The new facilities would include a launch mount/pad, propellent tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features.

Based on the EPA's review of available information, the following comments are provided for your consideration.

Air Quality and Climate Change: The Proposed Action is located in Brevard County, Florida which is in attainment with the National Ambient Air Quality Standards. The EPA recommends using tools such as the Air Conformity Applicability Model to determine if, and to what extent, the Proposed Action will produce emissions that contribute toward exceeding local air emissions permits, or otherwise impact air quality or human health. Facility construction and operational activities such as storage tanks, fueling operations, and use of maintenance materials containing volatile organic compounds should be accounted for by the appropriate air emissions model. The EPA recommends controlling fugitive dust emissions and implementing measures to reduce diesel emissions, such as switching to cleaner fuels, retrofitting current equipment with emission reduction technologies, repowering older equipment with modern engines, replacing older vehicles, and reducing idling through operator training and contracting policies. The EPA also recommends that USSF quantify greenhouse gas emissions resulting from construction and operation of proposed projects, and complete analysis of resulting social impacts due to climate change.

Wetlands and Streams: CCSFS is located on developed land between the Banana River and Atlantic Ocean with onsite wetlands and ditches that flow to the Banana River. The EPA recommends that design proposals and construction avoid impacting Waters of the United States to the maximum extent practicable by locating permanent infrastructure and temporary construction measures away from WOTUS and respective buffers. WOTUS should be delineated, and coordination with the U.S Army Corps of Engineers should be made where proposed activities might enter or affect WOTUS. Mitigation may be required where impacts to WOTUS cannot be avoided. Flood zone and flood inundation maps should be used to help ensure proposed activities do not take place in floodplains except where alternatives are not practicable.

Stormwater Management: Soil disturbance may necessitate issuance of construction stormwater permits before construction projects can begin. Coverage under a statewide National Pollutant Discharge Elimination System construction stormwater general permit will be needed if the project disturbs one acre or more of contiguous land. The EPA recommends that erosion and sediment control measures be implemented in accordance with the State's NPDES construction general permit requirements, and that the measures be addressed during the design and construction phases of the project. The EPA also encourages USSF to consider using a variety of stormwater management practices often referred to as "green infrastructure" or "low impact development" practices to comply with Section 438 of the Energy Independence and Security Act of 2007. Construction of rainwater runoff control structures, designed to leave existing stormwater runoff profiles of respective areas unchanged, may be required to mitigate the impacts of land development and construction of impervious surfaces.

Hazardous Materials and Containment: For the protection of WOTUS, critical habitats, and as required by the Clean Water Act, the EPA recommends the use of secondary containment where storage and handling of Petroleum, Oils, and Lubricants will take place, including maintenance bays and storage sites of single wall POL tanks. Where secondary containment is not directly practicable, spill ponds and oil water separators should be constructed downstream of POL related activities. During construction, and operation, the EPA recommends that Resource Conservation and Recovery Act regulated solid wastes are disposed of in accordance with federal regulations. Department of Defense Installation Restoration Program databases should be consulted prior to construction, alongside federal and state databases. Details of relevant contamination and land-use site restrictions should be included in the EA.

Biological Resources: Critical habitat for Loggerhead Sea Turtles and West Indian Manatees exists in the waters on both sides of CCSFS. The EPA principally defers to the National Marine Fisheries Service and U.S. Fish and Wildlife Service regarding compliance with the Marine Mammal Protection Act and Endangered Species Act and recommends early coordination with NMFS and FWS. The EPA recommends that conservation measures identified by NMFS and FWS be included in the EA.

Environmental Justice: Executive Order 12898 directs federal agencies to identify and address the disproportionately high and adverse human health and environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. In accordance with the Executive Order, the EPA recommends that the environmental document identify and address any disproportionate impacts on minority and low-income populations. The Environmental Justice Interagency Working Group *Promising Practices for EJ Methodologies in NEPA Reviews* (*Promising Practices)*, dated March 2016, provides guiding principles agencies can consider in identifying disproportionately high and adverse impacts on minority and low-income populations. Environmental Justice analysis of the Proposed Action should also be completed in accordance with Executive Order 14096*, Revitalizing Our Nation's Commitment to Environmental Justice for All*, published April 21, 2023.

The EPA strongly encourages the use of EJScreen (https://www.epa.gov/ejscreen), the EPA's nationally consistent environmental justice screening and mapping tool, when conducting environmental justice scoping efforts. The tool provides information on environmental and socioeconomic indicators as well as pollution sources, health disparities, critical service gaps, and climate change data. The tool can help identify potential community vulnerabilities by calculating EJ Indexes and displaying other environmental and socioeconomic information in color-coded maps and standard data reports (e.g., pollution sources, health disparities, critical service gaps, climate change data).

Energy Efficiency and Recycling: The EPA recommends the use of sustainable building practices that maximize energy and water conservation, and the use of renewable energy including solar power for supplemental electricity and lighting for infrastructure, launch pads, and buildings that may be constructed. Implementation of renewable energy sources and operational efficiency measures should be included in climate change analysis. USSF should consult the appropriate federal agencies (https://www.energy.gov/eere/femp/sustainable-federal-buildings) for energy conservation requirements. Efforts should be made to reuse and divert recyclable materials such as concrete, steel, and asphalt away from landfills.

Thank you for the opportunity to provide comments on the United States Space Force's proposed Nova Space Launch Program. Upon completion of the draft EA, please submit an electronic version to the EPA for review. If you have any questions regarding the EPA's comments, please contact me through the contact information provided in my email.

McDonough, Christina

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Monday, January 29, 2024 7:55 AM
To: McDonough, Christina
Subject: [EXTERNAL] FW: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C
Sent: Monday, January 29, 2024 9:55 AM
To: State_Clearinghouse <State.Clearinghouse@dep.state.fl.us>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Subject: RE: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Good morning Chris,

This is just an internal agency letter making you aware of the action at this time. When I submit the actual document for review I will specify if a CZMA determination will be needed.

Thank you!

v/r

Taylor Janise
SLD 45 NEPA Lead
45 CES/CEIE
CP: 979-429-1221

From: State_Clearinghouse <State.Clearinghouse@dep.state.fl.us>
Sent: Thursday, January 18, 2024 9:49 AM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Cc: State_Clearinghouse <State.Clearinghouse@dep.state.fl.us>
Subject: [Non-DoD Source] RE: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Are you wanting a CZMA consistency determination for this? Sorry but you have to ask specifically for it.
Chris

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Wednesday, January 17, 2024 4:26 PM
To: State_Clearinghouse <State.Clearinghouse@dep.state.fl.us>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; Stahl, Chris <Chris.Stahl@FloridaDEP.gov>

Subject: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL
Importance: High

Good afternoon,

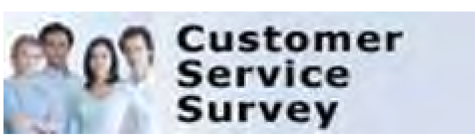
The U.S. Space Force (USSF) is preparing an Environmental Assessment (EA) to evaluate potential environmental impacts associated with implementing Stoke Space Technologies, lnc.'s (Stoke) proposed Nova Space Launch Program at an existing launch complex on Cape Canaveral Space Force Station (CCSFS). The Proposed Action would reactivate Space Launch Complex 14 (SLC-14) in support of the Nova Space Launch Program through the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations. The new facilities would include a launch mount/pad, propellent tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features. The full Description of the Proposed Action and Alternatives (DOPAA) is available upon request.

As part of the USAF Environmental Impact Analysis Process, we request your input on the Proposed Action and assistance in identifying any potential areas of environmental impact to be assessed in this analysis. If you have any specific items of interest about this proposal, please contact Ms. Taylor Janise at 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 or via email at taylor.janise.1@spaceforce.mil and courtesy copy megan.nicely.1@spaceforce.mil, within 30 days of receipt of this letter.

Thank you in advance for your assistance with this effort.

v/r

Taylor Janise
SLD 45 NEPA Lead
45 CES/CEIE
CP: 979-429-1221



McDonough, Christina

From:	JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent:	Monday, January 29, 2024 7:53 AM
To:	McDonough, Christina
Subject:	[EXTERNAL] FW: [Non-DoD Source] Re: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C
Sent: Thursday, January 18, 2024 11:38 AM
To: Emily Chou - NOAA Federal <emily.chou@noaa.gov>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Cc: pace.wilber@noaa.gov; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; CHAMBERS, ANGY L CIV USSF SSC 45 CES/CEIE <angy.chambers@spaceforce.mil>; Mary.Wunderlich@noaa.gov; Lisamarie Carrubba - NOAA Federal <lisamarie.carrubba@noaa.gov>
Subject: RE: [Non-DoD Source] Re: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Thank you, I will update my distro list to include that org box.

v/r

Taylor Janise
SLD 45 NEPA Lead
45 CES/CEIE
CP: 979-429-1221

From: Emily Chou - NOAA Federal <emily.chou@noaa.gov>
Sent: Thursday, January 18, 2024 9:56 AM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Cc: pace.wilber@noaa.gov; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; CHAMBERS, ANGY L CIV USSF SSC 45 CES/CEIE <angy.chambers@spaceforce.mil>; Mary.Wunderlich@noaa.gov; Lisamarie Carrubba - NOAA Federal <lisamarie.carrubba@noaa.gov>
Subject: [Non-DoD Source] Re: Stoke Space's Nova Launch Program Environmental Assessment (EA) Coordination Letter for Cape Canaveral Space Force Station, FL

Hi Taylor,

Confirming receipt of your email and scoping letter.

For future reference, please send all requests to nmfs.hq.esa.consultations@noaa.gov as well.

Best,
Emily

On Wed, Jan 17, 2024 at 4:34 PM JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil> wrote:

Good afternoon,

The U.S. Space Force (USSF) is preparing an Environmental Assessment (EA) to evaluate potential environmental impacts associated with implementing Stoke Space Technologies, Inc.'s (Stoke) proposed Nova Space Launch Program at an existing launch complex on Cape Canaveral Space Force Station (CCSFS). The Proposed Action would reactivate Space Launch Complex 14 (SLC-14) in support of the Nova Space Launch Program through the construction of new facilities and improvements to existing infrastructure, ground support operations, and launch operations. The new facilities would include a launch mount/pad, propellent tank farm, launch vehicle maintenance hangar, utility infrastructure, roads, and security features. The full Description of the Proposed Action and Alternatives (DOPAA) is available upon request.

As part of the USAF Environmental Impact Analysis Process, we request your input on the Proposed Action and assistance in identifying any potential areas of environmental impact to be assessed in this analysis. If you have any specific items of interest about this proposal, please contact Ms. Taylor Janise at 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 or via email at taylor.janise.1@spaceforce.mil and courtesy copy megan.nicely.1@spaceforce.mil, within 30 days of receipt of this letter.

Thank you in advance for your assistance with this effort.

v/r

Taylor Janise

SLD 45 NEPA Lead

45 CES/CEIE

CP: 979-429-1221

--

Emily Chou (chow) she/her
Biologist, ESA Interagency Cooperation Division
Office of Protected Resources | NOAA Fisheries | U.S. Department of Commerce
office: (301) 427-8483
www.fisheries.noaa.gov

Appendix B. Biological Consultation

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Biological Assessment for the Reactivation of Space Launch Complex 14 at Cape Canaveral Space Force Station, Florida

Stoke Space Technologies, Inc.

May 2024

Contents

Appendices

Tables

Figures

Photographs

Acronyms and Abbreviations

Acronym	Definition
45th SW	45th Space Wing
BO	Biological Opinion
CCAFS	Cape Canaveral Air Force Station
CCSFS	Cape Canaveral Space Force Station
CFR	*Code of Federal Regulations*
dB	Decibel(s)
DOD	Department of Defense
ECS	Environmental Control System
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FLUCCS	Florida Land Use Cover Classification System
FWC	Florida Fish and Wildlife Conservation Commission
INRMP	Integrated Natural Resources Management Plan
kg	Kilogram(s)
km	Kilometer(s)
kN	Kilonewton(s)
lbf	Pound-force
lbm	Pound(s) Mass
LH2	Liquid Hydrogen
LMP	Light Management Plan
LMU	Land Management Unit
LN2	Liquid Nitrogen
LNG	Liquified Natural Gas
LOX	Liquid Oxygen
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
PBO	Programmatic Biological Opinion
SLC-14	Space Launch Complex 14
SLD 45	Space Launch Delta 45
Stoke	Stoke Space Technologies, Inc.
SWI	Space Wing Instruction
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USSF	U.S. Space Force
WDR	Wet Dress Rehearsal

1. Summary

The U.S. Space Force (USSF) is proposing to reactivate Space Launch Complex 14 (SLC-14), an existing launch complex at Cape Canaveral Space Force Station (CCSFS) in Florida. Space Launch Delta 45 (SLD 45) manages CCSFS as the primary launch site for the Eastern Range. The Proposed Action would include the redevelopment of SLC-14 and the operation of launches from that site up to 10 times each year. The Proposed Action would include construction activities resulting in land disturbance of 36.4 acres of undeveloped land and redevelopment of 9.5 acres of existing buildings and impervious surface, along with associated increases in noise, light, and vehicle traffic to and from SLC-14. The operational activities (launches) would result in heat exhaust, noise, light, and vibration from the launch vehicle, and increased vehicle traffic along existing roadways. The action area evaluated by this Biological Assessment is defined by the areal extent of the potential for effects of these activities on listed species.

Seventeen animal species listed as threatened or endangered under the Endangered Species Act (ESA) or classified as candidate species for listing under the ESA were identified as reasonably certain to occur within the action area (Table 1-1). Two plant species, Carter's mustard (*Warea carteri*) and Lewis's polygala (*Senega* [*Polygala*] *lewisii*), were identified as potentially occurring in the action area; however, SLD 45 confirmed that neither species occurs on CCSFS, and that potential occurrence was based on historical misidentification of the species. Consequently, these two plant species are not further addressed in this Biological Assessment because they are not expected to occur in the action area. There is also no habitat present for the eastern black rail on CCSFS; therefore, this species is not discussed further because it is not expected to occur within the action area. Listed or candidate species identified as reasonably certain to occur within the action area include the southeastern beach mouse, tricolored bat, West Indian manatee, Audubon's crested caracara, Florida scrub-jay, piping plover, red knot, wood stork, black-capped petrel, American alligator, eastern indigo snake, monarch butterfly, green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, hawksbill, and loggerhead sea turtle.

Based on the analysis in this Biological Assessment, SLD 45 has determined that the **Proposed Action may affect, but is not likely to adversely affect**, the West Indian manatee, Audubon's crested caracara, Florida scrub-jay, wood stork, red knot, piping plover, black-capped petrel, monarch butterfly, American alligator, and tricolored bat. These effects would result from construction activities and noise from launches. The Proposed Action would not jeopardize the tricolored bat, which is proposed for listing under the ESA. If the tricolored bat is eventually listed, SLD 45 has determined that the Proposed Action would require seasonal constraints on roosting habitat clearing to avoid impacts and to continue to have minimal effect on the species.

There would be no loss of sea turtle habitat from the proposed construction and the project will comply with the programmatic Biological Opinion (BO) for outdoor lighting. SLD 45 has determined that the **Proposed Action may affect, but is not likely to adversely affect**, the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles.

Based on the analysis in this Biological Assessment, SLD 45 has determined that the **Proposed Action may affect, and is likely to adversely affect**, the southeastern beach mouse and eastern indigo snake from the potential for direct mortality and habitat loss from construction activities.

No critical habitat has been designated within the terrestrial portion of the action area. Critical habitat has been designated for the West Indian manatee within the Banana River and nearshore Atlantic Ocean and the loggerhead sea turtle within the Atlantic Ocean portions of the action area. The Proposed Action will not cause any destruction or adverse modification of critical habitat for the West Indian manatee or the loggerhead sea turtle. Therefore, the effects of the **Proposed Action will have no effect** on designated critical habitat for these species.

1 **Table 1-1. Special Status Species Reasonably Certain to Occur and Designated Critical Habitat within the SLC-14 Action Area**

Type	Common Name	Latin Name	Status	Finding[a]	Temporary Construction Disturbance (acres)	Noise Disturbance (acres)	Permanent Habitat Loss (acres)
Bird	Florida Scrub-jay	*Aphelocoma coerulescens*	Threatened	Not Likely to Adversely Affect	0	12,578.0	0
Bird	Wood Stork	*Mycteria americana*	Threatened	Not Likely to Adversely Affect	1.0	796.5	0.2
Bird	Audubon's crested Caracara	*Caracara plancus audubonii*	Threatened	Not Likely to Adversely Affect	0	0	0
Bird	Red Knot	*Calidris canutus rufa*	Threatened	Not Likely to Adversely Affect	0	0	0
Bird	Piping Plover	*Charadrius melodus*	Threatened	Not Likely to Adversely Affect	0	0	0
Bird	Black-capped Petrel	*Pterodroma hasitata*	Endangered	Not Likely to Adversely Affect	0	0	0
Insect	Monarch Butterfly	*Danaus plexippus*	Candidate	Not Likely to Adversely Affect	35.4	0	9.8
Mammal	Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	Threatened	Adverse Effect	35.4	12,578.0	9.8
Mammal	Tricolored Bat	*Perimyotis subflavus*	Proposed Endangered	Not Likely to Adversely Affect (if listed)	39.3	0	9.0
Mammal	West Indian Manatee	*Trichechus manatus latirostris*	Threatened	Not Likely to Adversely Affect	0	0	0
Reptile	Eastern Indigo Snake	*Drymarchon corais couperi*	Threatened	Adverse Effect	36.4	3,136.9	8.7
Reptile	Green Sea Turtle	*Chelonia mydas*	Threatened	Not Likely to Adversely Affect	0	0	0
Reptile	Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	Not Likely to Adversely Affect	0	0	0
Reptile	Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	Not Likely to Adversely Affect	0	0	0
Reptile	Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Not Likely to Adversely Affect	0	0	0
Reptile	Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Not Likely to Adversely Affect	0	0	0
Reptile	American Alligator	*Alligator mississippiensis*	Threatened	Not Likely to Adversely Affect	1.4	194.3	0.2

2 [a] Finding is based on consideration of all potential to affect and not limited to habitat disturbance/loss.

2. Purpose and Need

USSF is proposing to reactivate existing SLC-14 at CCSFS. SLC-14 will be used solely for the Stoke Space Technologies, Inc. (Stoke) launch system. Stoke is a space and technology company founded in 2019 and headquartered in Kent, Washington. Stoke's program goal is to deliver satellites to orbit for government and private sector clients using 100% reusable rockets designed for rapid reuse. Stoke has a focus on sustainability and its commitment to reusable space systems reduces the environmental impact associated with space launches through reduction in waste and direct ocean impacts associated with expendable launches.

The purpose of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015 (Public Law 114–90, November 25, 2015), which was developed to promote the growth of a competitive space launch industry. Cost-competitive commercial space launch systems are needed to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology. The Proposed Action is needed to deliver satellites to orbit for government and private sector clients. In doing so, the Proposed Action allows for the continued fulfillment of the National Space Policy (85 *FR* 81755) to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs. The Proposed Action would contribute to meeting the goals of the National Space Transportation Policy (Executive Office of the President, November 21, 2013) and Department of Defense (DOD) policy pursuant to DOD Directive 3230.3, "DOD Support for Commercial Space Launch Activities" (October 14, 1986).

USSF is the landowner for the real property agreement at SLC-14 where the Proposed Action would occur. The Federal Aviation Administration (FAA) expects to receive a Vehicle Operator License application from Stoke for launch operations at SLC-14. The FAA's federal action includes the following:

1. Issuing a Vehicle Operator License to Stoke, as well as potential future renewals or modifications to the Vehicle Operator License for operations that are within the scope analyzed in the Environmental Assessment.

2. Developing Letters of Agreement with Stoke to outline notification procedures before, during, and after an operation, as well as procedures for issuing a Notice to Air Missions.

3. Introduction and Description of the Proposed Action

3.1 Project Location

CCSFS occupies approximately 15,800 acres along the Atlantic Coast of Brevard County, Florida, southeast of the National Aeronautics and Space Administration's (NASA's) Kennedy Space Center on adjacent Merritt Island (Figure 3-1). It includes 81 miles of paved roads and a 10,000-foot runway (Skid Strip). Natural areas near CCSFS include the Merritt Island National Wildlife Refuge and the Canaveral National Seashore. SLC-14 is located on CCSFS, approximately 12,000 feet east of the Banana River and 1,000 feet west of the Atlantic Ocean, as shown on Figure 3-1.

SLD 45 manages CCSFS as the primary launch site for the Eastern Range. The Eastern Range of the National Security Space Launch program serves operational space lift, providing passage to and from space and supporting U.S. national security, commercial, and civil space missions (AFSPC 2020).

The project is in the Southern Florida Flatwoods Major Land Resource Area that stretches across the midsection of the state from the Gulf of Mexico to the Atlantic Ocean (USDA 2022). This landscape consists of nearly level to gently sloping marine terraces, with large areas of wetlands and marshes. The project is on the Silver Bluff Terrace.

3.2 Action Area

The action area includes all areas where the Proposed Action could directly or indirectly cause modifications to the land, water, or air. The action area evaluated in this Biological Assessment includes the following Proposed Action components:

- The construction area within SLC-14
- The heat plume area. The heat and exhaust plume generated during static test fires and launch operations
- The noise area. The area encompassing elevated noise from the proposed launch pad where effects may occur from launches. The noise area also encompasses the light and vibration effects associated with launches.
- The existing roadways at CCSFS where increased vehicle traffic during construction and operations would occur
- The nearshore area. The Atlantic Ocean seaward to the 10-meter depth contour
- The Atlantic area. The Atlantic Ocean, approximately 49 miles offshore where the sonic boom from launches would occur and debris from expendable launches could fall

The action area is shown on Figure 3-2 and includes each of the Proposed Action components except for the sonic boom noise contours which occur over the open ocean. The location of the project construction area and heat exhaust plume within the action area is shown on Figure 3-3. The approximate 51-acre area includes the areas of relic buildings and launch pad infrastructure along with vegetated habitats that will be modified or removed. The project construction area will include new buildings, launch pad and associated infrastructure, and areas of impervious surface.

The heat plume generated from Stoke's launches would travel away from the launch pad via a diverter and concrete flume. Because of the diverter and concrete flume's angle, the heat plume would extend above the tree line (Figures 3-4 and 3-5). As a result, it is anticipated that the heat plume would have minimal impacts at ground level. The heat plume and increased temperatures in this area would be temporary in nature and would occur only during engine ignition and dissipate rapidly. A deluge system would supply water from an elevated aboveground infrastructure to the flame duct and launch pad area at engine start up and launch. The deluge system would be sized and configured to both cool the launch pad from the heat of the engine plume and reduce the noise level. All deluge water would be captured and contained in a retention basin included as part of the launch pad infrastructure.

The effects of noise from the launch operations on animals would vary depending on an animal's hearing ability and sensitivity to noise. The area of elevated noise within the action area is bound by the 110 decibel (dB [L_{max}]) and greater noise contours, (Figure 3-2). The 110 dB (L_{max}) approximates the amplitude of fighter jet flyovers, which are a common occurrence at USAF facilities (Bowels et al. 1995). Organisms present between the launch pad and the noise contour could be exposed to these episodic, short-term noise events that could last up to 3 minutes per launch and test activity. While the 1110 dB (L_{max}) contour represents the furthest extent of noise effects from launch activities, noise would radiate from the launch pad out (Figure 3-2).

The nearshore waters of the Atlantic Ocean (Nearshore Atlantic Ocean Area), which are defined as extending from shore to the 10-meter contour, and the Atlantic Ocean (oceanward of the 10-meter contour) within the defined launch azimuths (Figures 3-2 and 3-3) are included in the action area. The Atlantic Ocean area depicted on Figure 3-6 represents the potential area for expendable launches.

Figure 3-1. Location of SLC-14 at CCSFS

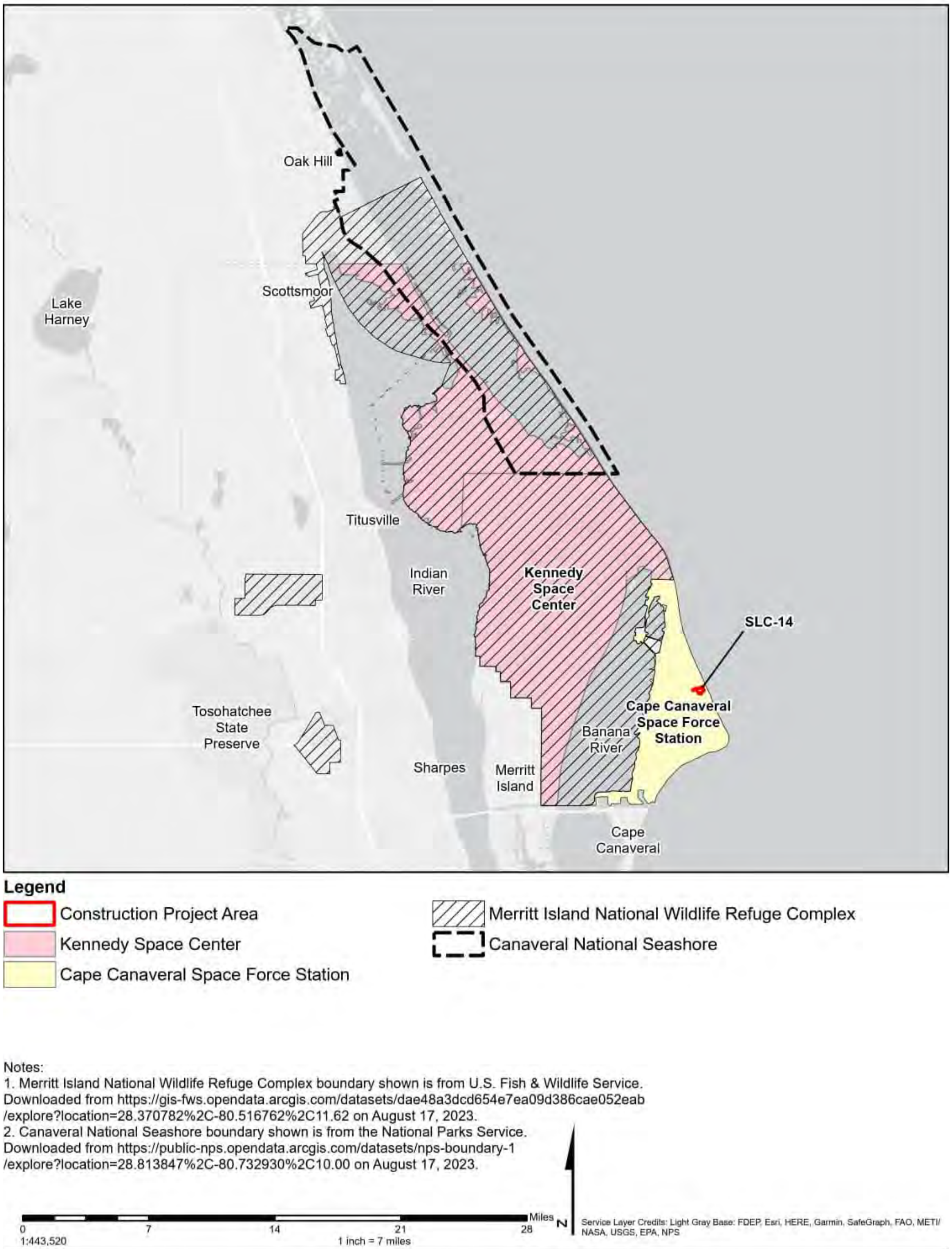


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Figure 3-2. SLC-14 Action Area (GIS Data Layers Shared With USFWS on 16 May 2024)

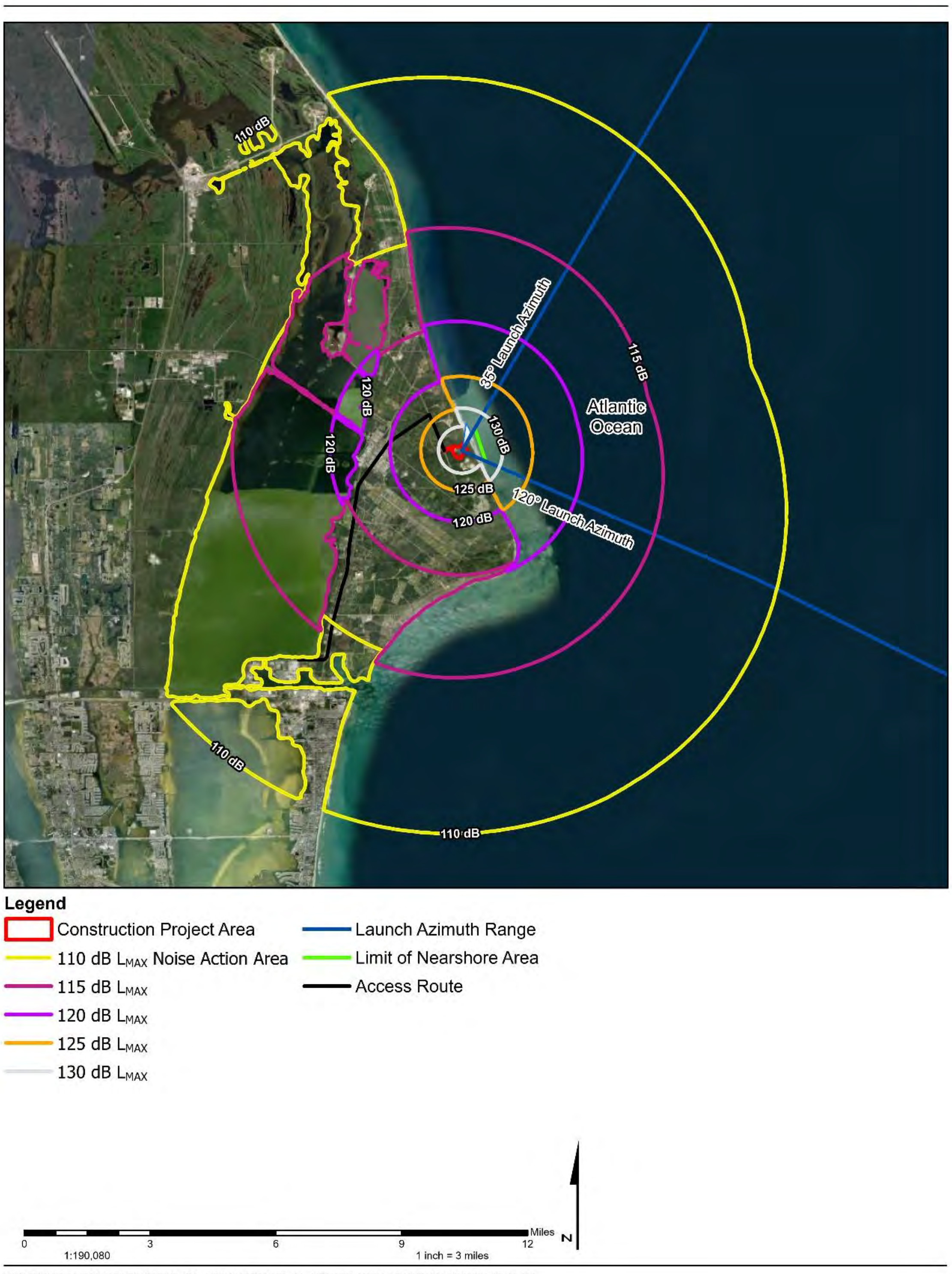

Figure 3-3. Construction Area and Heat Plume

Figure 3-4. Heat Plume Action Area – Plan View

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Figure 3-5. Heat Plume Action Area – Profile Depiction

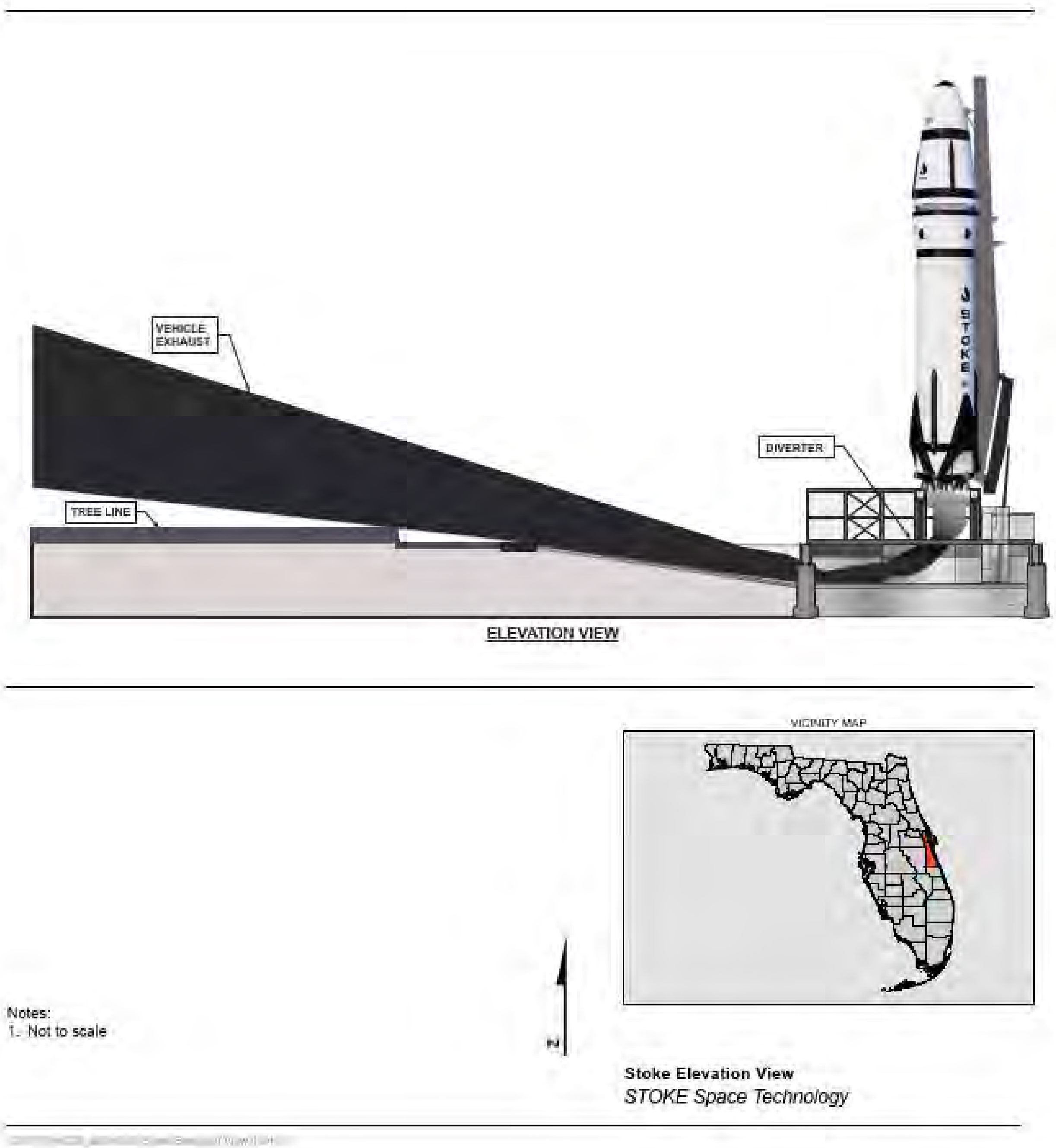
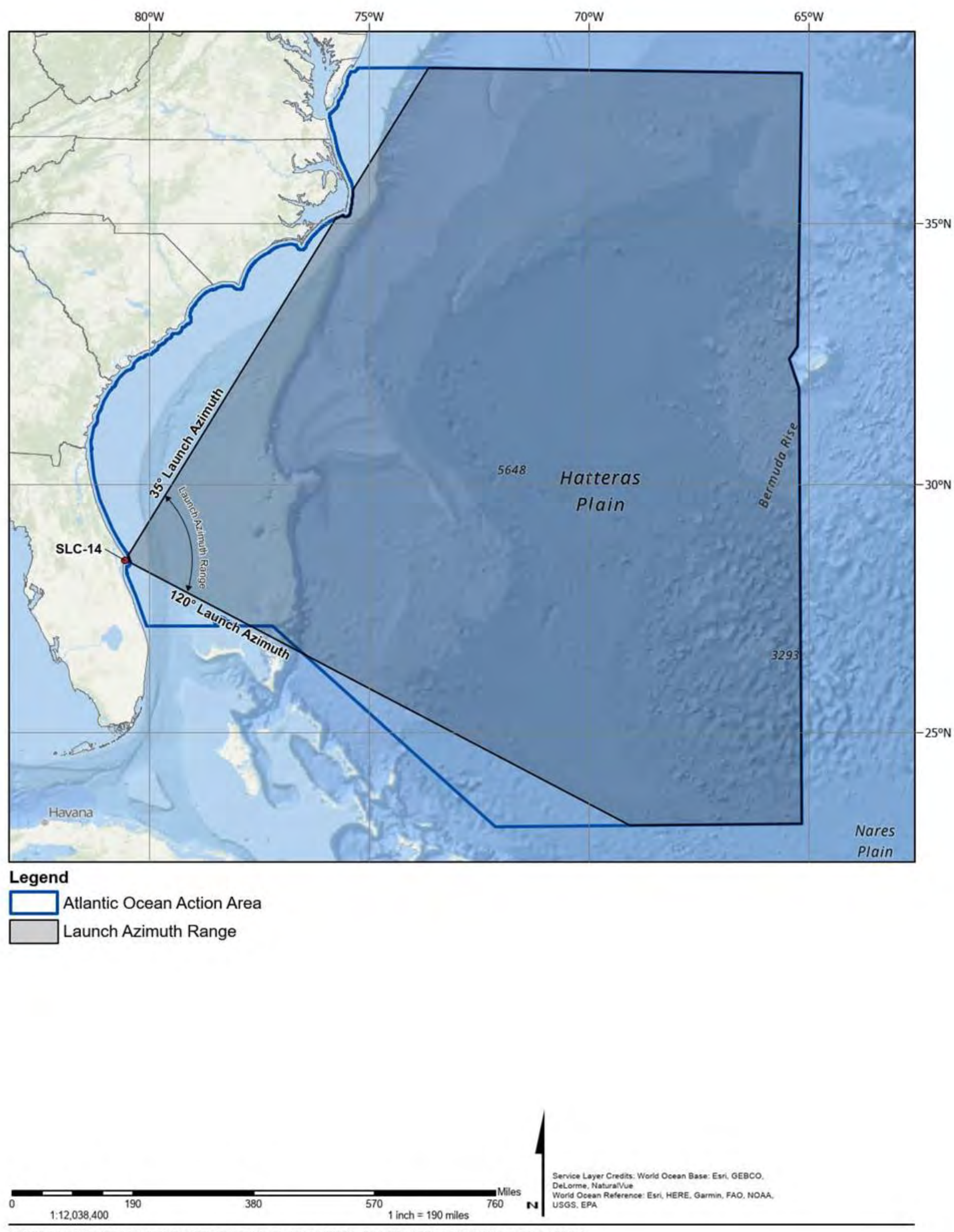


Figure 3-6. Launch Trajectory and Atlantic Ocean Area



3.3 Launch Vehicle

The Stoke launch vehicle, named Nova and shown on Figure 3-7, would consist of a two-stage liquid-fueled launch vehicle for commercial and government payloads. The medium-class two-stage launch vehicle would be 132 feet tall, with a gross liftoff weight of 500,000 pounds. Stage 1 would have 7 engines, a height of 89 feet, and a diameter of 12 feet; it would be fueled with 315,000 pound mass (lbm) of liquid oxygen (LOX) and 90,000 lbm of liquified natural gas (LNG). Stage 2, including payload fairing, would have one engine with a height of 43 feet and a diameter of 14 feet. It would be fueled with 33,600 lbm of LOX and 6,060 lbm of liquid hydrogen (LH2). Stage 2 would have a unique actively cooled heat shield for reentry. Stage 1 would have a sea level thrust of 3,110 kilonewton (kN) (700,000 pound-force [lbf]) and Stage 2 would have a vacuum thrust of 111 kN (25,000 lbf). Stages 1 and 2 would break up upon reentry and would be expended into the ocean under the Proposed Action. The potential reuse of the rocket would be analyzed in a separate National Environmental Policy Act (NEPA) document as the program matures.

Figure 3-7. Stoke Launch Vehicle

4. Site Development

4.1 SLC-14 Facilities

SLD 45 allocated SLC-14 at CCSFS to Stoke in 2023. SLC-14 was one of four launch complexes built in support of Atlas missile testing in the 1950s and was then modified to support the launch of Atlas-based space launch vehicles. SLC-14 became inactive in 1966 and was deactivated in 1967. SLC-14 was abandoned in place in 1973, and the northern portion of the launch stand was removed due to structural deterioration in 1976 (CCSFS Museum 2023).

The notional site layout of the Proposed Action is shown on Figure 4-1. New constructed ground elements would include a launch mount and pad, propellent tank farm, engineering support facility, launch vehicle and payload processing and maintenance hangar, utilities, and roads and security.

The leased area would be approximately 130 acres. Less than 372,000 square feet (8.6 acres) of new impervious surfaces would be added to the existing impervious area of approximately 412,000 square feet (9.5 acres). Construction would begin in 2024 and would be expected to take between 12 and 18 months. During construction, 36.4 acres (1.583 million square feet) of pervious ground surface comprising mostly disturbed upland habitats and relic surface water management systems would be disturbed.

4.1.1 Launch Mount and Pad

The launch mount and pad would include a lightning protection system (catenary) on the existing impervious surface. The new ramp grade would support the horizontal transport of the launch vehicle via transporter erector to and from the hangar and launch mount. The launch mount would be a fixed structural interface to support the vertical vehicle loads and would be positioned over the flame duct, at the end of the ramp. The launch pad would be made of refractory concrete, which is able to withstand heat exposure.

A transporter erector would transport the integrated vehicle from the launch vehicle processing facility to the launch pad. The launch pad would include a fixed interface that would allow the vehicle to be placed at the same location for each launch. A configuration of hydraulic cylinder and power systems would rotate the vehicle from horizontal to vertical at the launch pad.

The Environmental Control System (ECS) building equipment would supply clean, conditioned air to the vehicle and separately to the payload. Backup vehicle power would be provided at the launch pad to support launch or abort in the event of a loss of range power.

The launch vehicle and payload would maintain connections to the ground at the launch pad through umbilical connections. There would be umbilical connections for ECS, vehicle and payload power, communications, inert gases, and propellants. The umbilical connections would disconnect at lift off.

A deluge system would supply water from an elevated aboveground infrastructure to the flame duct and launch pad area at engine start up and launch. The deluge system would be sized and configured to both cool the launch pad from the heat of the engine plume and reduce the noise level.

Propellant transfer valving would be located close to the vehicle at the launch pad.

4.1.2 Propellent Tank Farm

The estimated propellent tank farm amounts are provided in the following list; however, final tank configurations are dependent on the explosive site plan, as follows:

- 60,000 gallons of LNG with the LNG flare. An LNG impoundment basin would be constructed to contain 110% of the volume in the event of a leak or spill
- 107,000 gallons of LOX and 1,300 gallons of gaseous oxygen (generated on site from LOX)
- 151,000 gallons of LH2 and 31,000 gallons of gaseous hydrogen (generated on site from LH2) surrounded on three sides by a berm and barricade
- 35,000 gallons of cold (liquid) nitrogen (LN2) and tank(s) for gaseous nitrogen (generated on site from LN2)
- 2,100 gallons of gaseous helium
- Hydrogen and methane flame stack(s)

4.1.3 Engineering Support Facility

An engineering support building would be constructed on the existing impervious surface near the existing block house. Launch control would be located within an existing facility at CCSFS or nearby facility offsite.

4.1.4 Launch Vehicle Processing and Maintenance Hangar

The launch vehicle processing and maintenance hangar would include an adjacent payload integration facility, as well as an overflow storage building and new parking areas. The hangar would house three 30-ton cranes, one 10-ton crane, Stoke engineering and payload processing support space, restrooms, necessary vehicle and payload processing storage space, a dedicated machine shop, and an avionics and electrical rework space.

4.1.5 Utilities

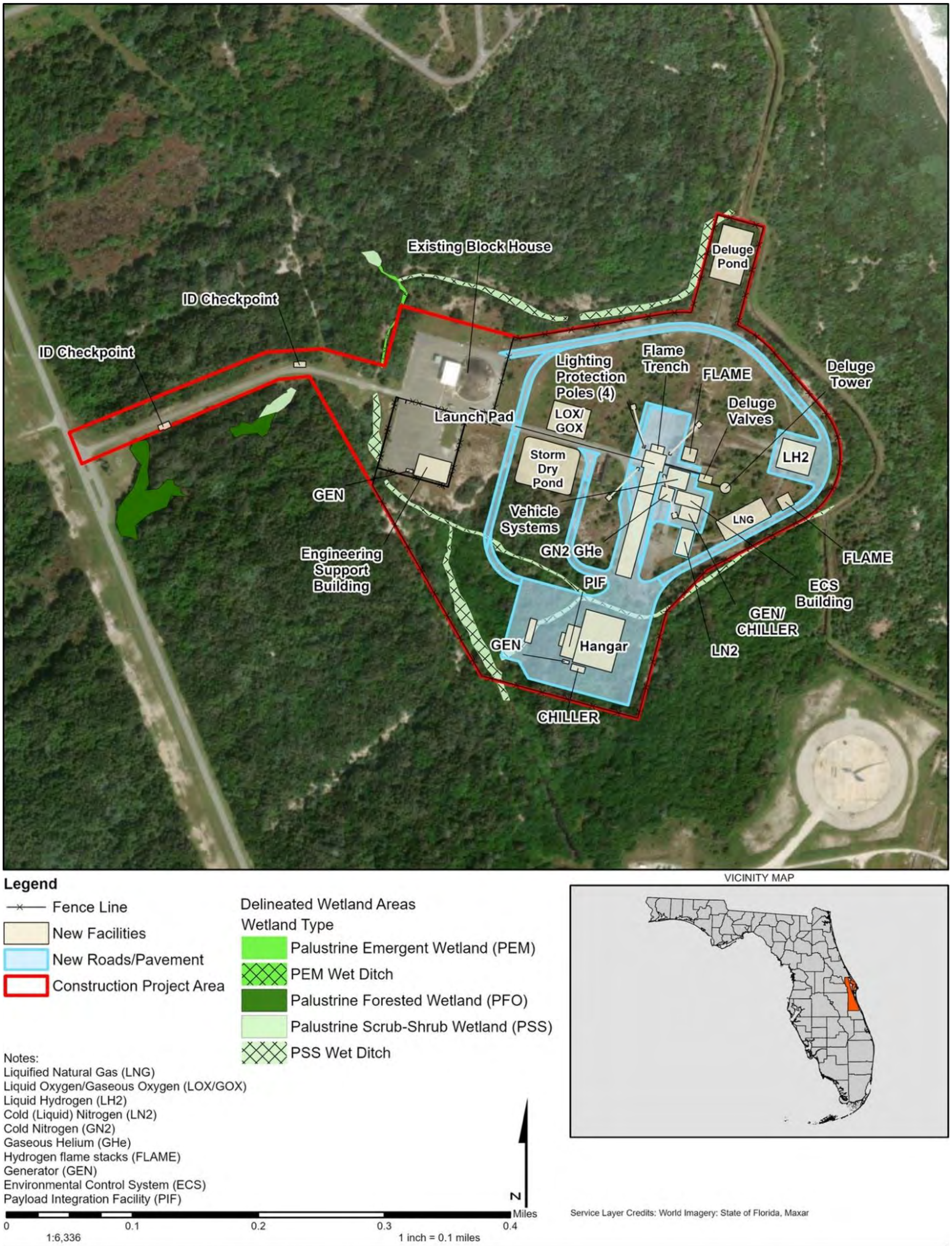
Utilities would include the following:

- Deluge system, including valves and a water storage tower, on the existing impervious area
- Electrical system with 480-volt, 3-phase power at the launch site
- Potable water, fire hydrants, and sewer at the launch site
- Pumphouse connection for fire suppression, is not available; fire suppression would be provided by a connection to the potable water and necessary changes to water pressure would be provided at the launch pad

4.1.6 Roads and Security

The existing SLC14 access road would be improved to maintain access to the existing Blockhouse during Stoke nonhazardous operations such as vehicle integration, vehicle transportation, and system checkouts. Security would be provided by a new guard house and an estimated 6-foot-tall and 6,000-foot-long perimeter fence with an access gate. Additional 12-foot-wide roads would be added within the site, as shown on Figure 4-1, to connect operational areas.

Figure 4-1. Notational SLC-14 Site Layout



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4.1.7 Ground Support and Launch Operations

A typical mission sequence would include the following steps:

1. Engine and initial stage acceptance testing would be performed and planned at the Stoke test site operated by Stoke in Washington state.
2. The new launch vehicle would be delivered from Washington to the hangar at CCSFS SLC-14. Individual launch components would be transported via Department of Transportation oversize load truck ground options. Air options exist, if necessary, for contingency. Air options would use existing airports depending on availability and then transport via Department of Transportation oversize load truck ground options. All applicable transportation regulations would be followed, and the transportation of the vehicle would be in keeping with existing transportation systems.
3. The launch vehicle would exit the hanger horizontally on a transporter and then be erected vertically on the launch pad.
4. Checkouts would be completed at the launch pad, including propellant system leak checks, valve checkouts, and Stage 1 hold-down-and-release system checkouts.
5. Applicable review would be conducted for the operation, whether it would be Wet Dress Rehearsal (WDR) (on and offload propellants), static fire of Stage 1 (on and offload propellants and ignite engines for no longer than 150 seconds), or orbital launch attempt. Stoke anticipates one static fire for each new booster, and one integrated (Stage 1 and Stage 2) WDR upon pad activation, approximately three to five days prior to launch. WDRs are not currently planned for every mission, but when accomplished, the fully integrated vehicle may remain on the pad until the launch attempt (and would likely roll back), barring any operational need to bring the vehicle horizontal and roll it back to the hangar. When Stage 1 static fires are accomplished, the booster would go horizontal and be rolled back to the hangar for final mission integration. The launch vehicle would enter the automated countdown operations on the launch pad for WDR or integrated static fire before launch. Static fire tests would be limited to daytime hours or range availability.
6. Upon successful completion of Stage 1 static fire or WDR, the launch attempt would be scheduled and proceed into terminal count. The launch vehicle would lift off upon confirmation that safety criteria for launch have been met. The launch and static fire would result in the expulsion of heat, exhaust, light, and noise to the surrounding environment.
7. Stage separation would occur and Stage 1 would return to Earth. Stage 1 would break up upon reentry and the debris not consumed during break up would land within the Atlantic Ocean, in the area depicted on Figure 3-6.
8. Stage 2 would complete orbital insertion burns. Payload fairing doors would open and the payload would separate.
9. Stage 2 would close payload fairing doors and initiate a deorbit and disposal burn to begin Earth reentry.
10. Stage 2 would perform a passivation maneuver[1] after the deorbit and disposal burn, which would vent all remaining propellant. There would be no residual liquid propellant onboard at the time of reentry, and the residual ullage[2] gas would be very low.

[1] Passivation maneuver refers to the process of removing stored energy from a space vehicle to reduce the risk of high-energy releases.

[2] Ullage refers to the amount by which a container falls short of being full.

For both stages, the vehicle would be expected to break up due to aerodynamic and aerothermal loading during reentry. While the vehicles are designed to reenter Earth's atmosphere intact for long-term reusable mission scenarios, doing so would require active cooling (for Stage 2) or active engine operation (for Stage 1), which would not occur during early phase expendable missions. Additionally, the tank pressure would be reduced during reentry, which further reduces the vehicle's structural capability. This would result in the external loads exceeding the vehicle's capability during reentry and result in breakup. The propellant onboard Stage 1 would disperse while still high up in the atmosphere. Stage 1 would have a nominal flight performance reserve of 1% of the full propellant load, or 1,802 kilograms (kg) of propellant, with a maximum residual propellant of 2% of the nominal propellant load or 3,604 kg. The predicted point of maximum aerothermal heating on Stage 1 during reentry would occur at approximately 25 to 35-kilometers (km) altitude, and on Stage 2 the point of maximum aerothermal heating would occur at approximately 60 to 70-km altitude. Rocket material would be mostly stainless steel and other dense metallic materials; therefore, any debris that survived reentry and impact with the ocean would sink. In the unlikely case that debris create a maritime hazard, Stoke would work with the U.S. Coast Guard and employ an Oil Spill Removal Organization contractor to remove or dispose of the hazard. Stoke would visually confirm that the debris are clear, with no hazards to navigation remaining.

The launch trajectories of the Proposed Action would be specific to each mission and customer needs. All launches are expected to be oriented to the east over the Atlantic Ocean between allowable azimuths of 35 degrees to the northeast and 120 degrees to the southeast, as shown on Figure 3-2. Polar trajectories are not evaluated in this analysis.

Compliance with Section 7 of the ESA in accordance with regulations at 50 *Code of Federal Regulations* (CFR) Part 402 and the implementing regulations requires communication with the National Marine Fisheries Service (NMFS) in cases where a federal action could affect listed threatened or endangered species, species proposed for listing, or candidates for listing. The NMFS is also responsible for evaluating potential impacts to Essential Fish Habitat and enforcing the provisions of the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR Section 600.905 et seq.). The FAA is consulting with the NMFS (informal consultation with NMFS No: OPR-2021-02908, dated April 14, 2023) regarding this Proposed Action.

The Proposed Action would conduct approximately two launches during the first year of operation in 2025. The launch schedule may increase to 10 launches per year for the subsequent 2 years. Preferably, launches would occur during the daytime; however, up to 50% of launches may occur at night in accordance with the FAA's airspace deconfliction policy (FAA 2023). White light usage could last from dusk to dawn up to 5 times a year to ensure personnel safety and hazards are secure.

The payloads for Stoke launches would be specific to each mission and would be processed in the payload integration facility. The mass of maximum payloads for the launch vehicle would range from 1,250 kg to 7,000 kg, depending on the destination orbit. The unique environmental effects for the specific payload would be analyzed once the payload and configuration are determined. If the payload activities are outside the completed analyses under existing NEPA documentation for payloads, such as the *Environmental Assessment for Launch of NASA Routine Payloads* (NASA 2011), then an additional NEPA assessment would be conducted. Nuclear payloads are not anticipated.

Stoke would anticipate having 50 personnel on site for vehicle, payload, and pad processing leading up to orbital launch attempt. Stoke would employ approximately 24 permanent engineering and technician staff at SLC-14. Additional Stoke employees would travel to the site for operations.

An unintended launch failure (referred to as a launch anomaly) is possible during launch operations. Accidental failure could result in an explosion or breakup of a rocket booster or spacecraft on or near the launch pad or landing area. Anomalies could also occur later, during flight. Since 1989, there have been 415 commercial launches and 27 have resulted in mishaps.

Stoke is the responsible party and would work within the National Response Framework and with local law enforcement and regulatory agencies, as applicable, to secure the hazards as quickly as possible to mitigate risk to the public and hazards to various commerce. As a launch service provider on a federal range, a contingency procedure would be developed. As the responsible party in case of a mishap, Stoke would bring the necessary resources for contingency and recovery actions to restore the area to normal operations as soon as possible after the anomalous event.

5. Description of the Area Impacted by the Proposed Action

The action area includes all areas where the Proposed Action could directly or indirectly cause modifications to the land, water, or air. The Proposed Action components include clearing or modification of existing land uses from construction activities, elevated heat, noise, vibration, and light from construction and operations, and sonic booms and the potential for fall debris over the Atlantic Ocean. Some of these actions cause permanent physical impacts on habitats while others create temporary effects to wildlife.

5.1 Land Cover

5.1.1 Construction Area

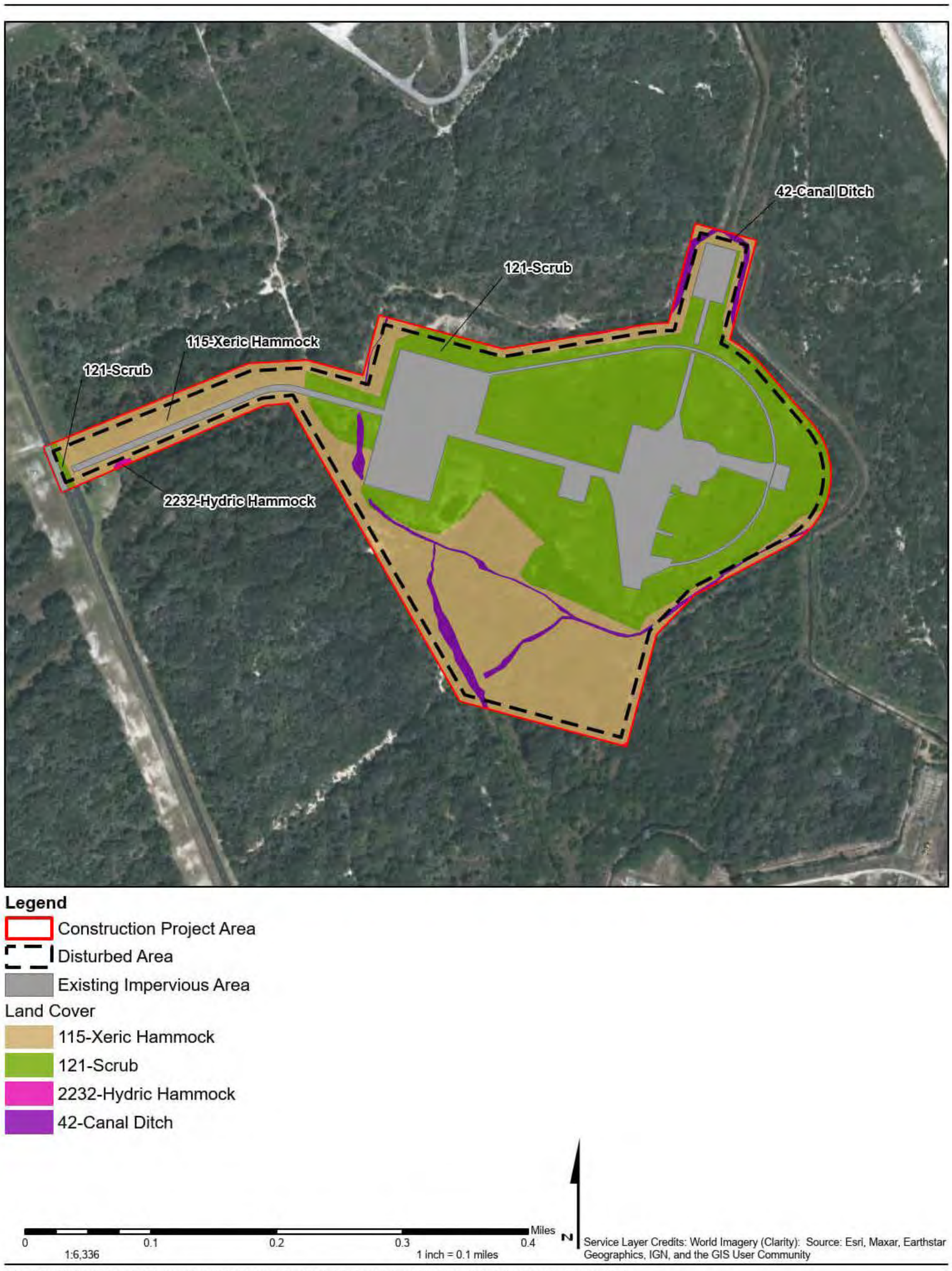
The Proposed Action would reactivate and redevelop the abandoned SLC-14 complex within the existing fence line. Pedestrian surveys were conducted in May and September of 2023 within the construction area to map vegetation communities, determine the presence of wetlands and surface waters subject to regulation under the Clean Water Act, and document the occurrence of habitats that could support listed wildlife species. Field surveys provided refined land use and habitat type descriptions within the construction area.

Table 5-1 provides the total habitat and land use types within the construction area along with approximate acreages of disturbance and the amount of habitat permanently lost post-construction. Figure 5-1 depicts the land use and habitat types within the construction area. The construction area encompasses approximately 50.6 acres. Reactivation of SLC-14 would require disturbance of 36.4 acres of undeveloped land and 9.6 acres of previously developed land within the construction area (Table 5-1); 4.7 acres within the construction area would remain undisturbed. An additional 8.6 acres of impervious area (buildings and other hard infrastructure) would be added to the existing 9.6 acres of impervious area, for a total of 18.2 acres of impervious area. Following construction, upland habitat in the construction area would be allowed to regrow into southeastern beach mouse habitat.

Table 5-1. Acreages of Habitat by Type within the Construction Area

Habitat Type	Construction Area (acres)	Disturbed During Construction (acres)	Permanent Impervious Area (acres)
Coastal scrub	22.2	21.5	4.3
Xeric hammock	17.5	13.9	4.1
Canal and ditch	1.4	1.0	0.2
Subtotal	**41.1**	**36.4**	**8.6**
Existing impervious area	9.6	9.6	9.6
Total	**50.6**	**45.9**	**18.2**

Figure 5-1. Land Cover within the Construction Area



5.1.1.1 Uplands

Three upland habitats occur within the construction area: previously developed impervious area, scrub, and xeric hammock (Figure 5-1). Coastal strand habitat occurs southeast of SLC-14 and within the larger action area, but it does not occur within the construction boundary. The 9.6 acres of previously developed impervious areas lack vegetation and provide no habitat for wildlife, other than potential roosting areas for bats in unused structures.

Scrub and xeric hammock habitat cover most of the undeveloped portions of the construction area. These habitats intergrade with indistinct boundaries and may be indicative of a shifting continuum based on disturbance history. Together, scrub and xeric hammock habitat cover 39.7 acres within SLC-14 and the construction area boundary.

Vegetation in scrub habitat type typically consists of hairawn (*Muhlenbergia capillaris*), bluestem (*Andropogon virginicus*), coastal sand-spur (*Cenchrus spinifex*), Hercules-club (*Zanthoxylum clava-herculis*), Spanish needles (*Bidens alba*), natal grass (*Melinis repens*), camphorweed (*Heterotheca subaxillaris*), tough buckthorn (*Sideroxylon tenax*), prickly pear cactus (*Opuntia humifusa*), and sabal palm (*Sabal palmetto*).

Photograph 5-1. Scrub Habitat

Xeric hammock typically consists of a canopy of sand live oak (*Quercus geminata*), eastern red cedar (*Juniperus virginiana*), hog plum (*Ximenia americana*), sabal palm, invasive Brazilian pepper (*Schinus terebinthifolia*), and wax myrtle (*Morella cerifera*).

Photograph 5-2. Xeric Hammock Habitat

5.1.1.2 Wetlands

The canal and ditch habitat within the construction area is made up of emergent and shrub scrub wetland vegetation. The canal and ditch wetland occurs around the launch pad to the north, south, and west. The ditch is connected by culverts from the initial construction at SLC-14, but currently none of the culverts provide a connection between segments due to sedimentation. The canal and ditch wetland is overgrown by dense vegetation and the dominant vegetation includes live oak, wax myrtle (*Morella cerifera*), Brazilian pepper (*Schinus terebenthifolius*), softstem bulrush (*Schoenoplectus tabernaemontani*), and mock bishop weed (*Ptilimnium capillaceum*). This canal and ditch wetland covers 1.4 acres within the construction area, with 0.03 acre consisting of forested wetland habitat that has developed because the ditch system has not been maintained.

There is 0.03 acre of hydric hammock forested wetland along the access road to SLC-14 near the western edge of the construction area. This wetland extends beyond the construction area. Vegetation included live oak (*Quercus virginiana*), red bay (*Persea borbonia*), cabbage palm, and horned beaksedge (*Rhynchospora colorata*).

5.1.1.3 Surface Waters

The canal and ditch feature within the construction area contains 0.2 acre of constructed, maintained canal, where aquatic vegetation is removed for stormwater conveyance along the eastern side of the launch site. The maintained canal continues to the north and to the south within the noise action area and connects to other surface waters (maintained canals) and ultimately to the Banana River as part of the larger stormwater management system at CCSFS. This canal would not be disturbed during project construction and operation, and it would continue to function to move stormwater away from the launch site(s).

5.1.2 Noise Area

Land cover categories within 110 dB L_{max} noise contour were mapped using the Florida Land Use and Cover Classification System (FLUCCS) GIS layers available from the St Johns River Water Management District (SJRWMD 2014-2019). These habitat classifications provide general info regarding upland versus aquatic habitats, forested vs herbaceous habitats, and developed areas such as buildings, roadways, and existing launch complex infrastructure. For the purposes of this Biological Assessment, FLUCCS labeling for habitats was reviewed for consistency with aerial imagery available for the action area. Minor inconsistencies or inaccurate labeling are possible with Level 3 FLUCCS GIS layers, but the data generally provides a reasonable assessment of available habitats. Mapped FLUCCS were then considered for habitat suitability for the listed species described in the sections that follow.

Table 5-2 provides types and acreages of land uses mapped for the noise area, along with the percent contribution of the land use to the total. The largest land use types within the 110 dB L_{max} noise contour are *special classifications* (24,208.9 acres [FLUCCS 9990]) which is the Atlantic Ocean and *bays and estuaries* (21,918.6 acres [FLUCCS 5400]) which is the Banana River. When those land uses are excluded, the largest land use contributions within noise area are xeric oak (4,478.1 acres [FLUCCS 4210]), governmental (3,427.5 acres [FLUCCS 1750]), and shrub and brushland (2,819.0 acres [FLUCCS 3200]).

Figure 5-2 depicts the land uses within the noise area. Each of these land uses and habitats would be subject to elevated noise from launch and static test fire operations. While noise would not directly affect existing land uses and habitats, it could affect species using these habitats for nesting and foraging.

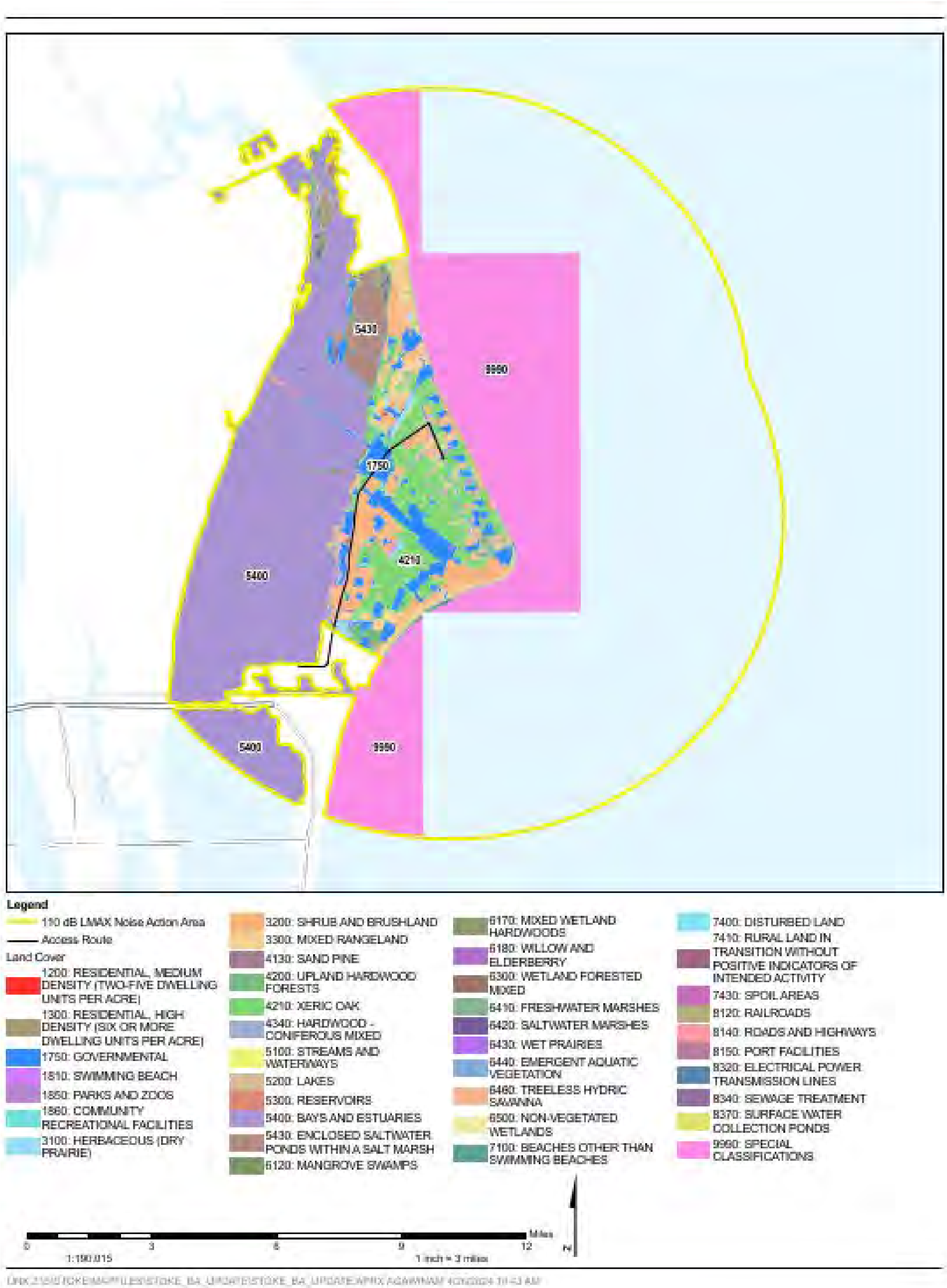
Table 5-2. Acreages of Land Use and Habitat by Type within the Noise Area

FLUCCS	Level 3	Acres	Percent Contribution (All)	Percent Contribution (CCSFS)
1200	Residential, medium density (2 to 5 dwelling units per acre)	0.2	0.0%	0.0%
1300	Residential, high density (6 or more dwelling units per acre)	0.3	0.0%	0.0%
1750	Governmental	3,427.5	5.5%	20.7%
1810	Swimming beach	19.7	0.0%	0.1%
1850	Parks and zoos	0.8	0.0%	0.0%
1860	Community recreational facilities	0.2	0.0%	0.0%
3100	Herbaceous (dry prairie)	317.9	0.5%	1.9%
3200	Shrub and brushland	2,819.0	4.5%	17.0%
3300	Mixed rangeland	1,421.2	2.3%	8.6%
4130	Sand pine	14.6	0.0%	0.1%

FLUCCS	Level 3	Acres	Percent Contribution (All)	Percent Contribution (CCSFS)
4200	Upland hardwood forests	301.6	0.5%	1.8%
4210	Xeric oak	4,478.1	7.1%	27.0%
4340	Hardwood – coniferous mixed	65.6	0.1%	0.4%
5100	Streams and waterways	8.5	0.0%	0.1%
5200	Lakes	5.1	0.0%	0.0%
5300	Reservoirs	76.9	0.1%	0.5%
5400	Bays and estuaries – Banana River	21,918.6	34.9%	--
5430	Enclosed saltwater ponds within a salt marsh	1,496.5	2.4%	9.0%
6120	Mangrove swamps	608.6	1.0%	3.7%
6170	Mixed wetland hardwoods	85.1	0.1%	0.5%
6180	Willow and elderberry	33.1	0.1%	0.2%
6300	Wetland forested mixed	9.2	0.0%	0.1%
6410	Freshwater marshes	103.8	0.2%	0.6%
6420	Saltwater marshes	127.3	0.2%	0.8%
6430	Wet prairies	89.0	0.1%	0.5%
6440	Emergent aquatic vegetation	1.0	0.0%	0.0%
6460	Treeless hydric savanna	600.2	1.0%	3.6%
6500	Nonvegetated wetlands	2.5	0.0%	0.0%
7100	Beaches other than swimming beaches	231.3	0.4%	1.4%
7400	Disturbed land	10.1	0.0%	0.1%
7410	Rural land in transition without positive indicators of intended activity	6.9	0.0%	0.0%
7430	Spoil areas	13.9	0.0%	0.1%
8120	Railroads	5.2	0.0%	0.0%
8140	Roads and highways	132.7	0.2%	0.8%
8150	Port facilities	19.9	0.0%	0.1%
8320	Electrical power transmission lines	48.5	0.1%	0.3%
8340	Sewage treatment	0.0	0.0%	0.0%
8370	Surface water collection ponds	9.2	0.0%	0.1%
9990	Special classifications – Atlantic Ocean	24,208.9	38.6%	--
Total		**62,718.5**	**100%**	**100%**

Source: USFWS 2023; SJRWMD 2014–2019

Figure 5-2. Land Cover within the Noise Area



6. Listed Wildlife Species

Seventeen species listed as threatened or endangered under the ESA, proposed for listing under the ESA, or classified as candidate species for listing under the ESA have been identified as reasonably certain to occur within the action area (Table 6-1). The action area includes the construction area (Figure 3-2); the heat and exhaust plume (Figures 3-3 through Figure 3-5); the noise area as defined by the 110 dB (L_{max}) contour (Figure 3-2); existing roadways at CCSFS (Figures 3-2 and 5-2); the nearshore waters of the Atlantic Ocean, and the Atlantic action area (Figure 3-6) where the sonic boom from launches would occur.

Habitats for aquatic dependent species such as marine turtles and the West Indian manatee exist within the noise area beyond the limits of the construction area. These locations include the Banana River and nearshore Atlantic Ocean for the West Indian manatee. For the marine turtles, including the green sea turtle, hawksbill sea turtle, leatherback sea turtle, loggerhead sea turtle, and Kemp's ridley sea turtle, this includes the nearshore waters of the Atlantic Ocean. Furthermore, green, leatherback, loggerhead, and Kemp's Ridley sea turtles are known to use the beaches within the noise area for nesting. These habitats within the noise area would be subject to increased light, and noise and vibration during operations. No physical modifications to these habitats from construction activities are proposed.

Habitat exists within the noise area for the black-capped petrel, Florida scrub-jay, piping plover, red knot, and Audubon's Crested Carcara beyond the construction area. These habitats would be subject to increased light, noise and vibration, and heat and exhaust during operations. No physical modifications to these habitats from project construction activities are proposed.

Habitat for the southeastern beach mouse, tricolored bat, wood stork, American alligator, eastern indigo snake, and monarch butterfly occur within the construction area. Documented occurrence of these species and their habitats occur within the construction area and within the noise area.

Table 6-1. Federally Listed and Candidate Threatened and Endangered Species Reasonably Certain to Occur in the Noise Area

Species Type	Common Name	Scientific Name	Habitat	Federal Status
Mammal	Southeastern Beach Mouse	Peromyscus polionotus niveiventris	Coastal scrub, oak, and sand dunes that are vegetated by sea oats and dune panic grass. May also occur in structures.	Threatened
Mammal	Tricolored Bat	Perimyotis subflavus	Forested habitats, also summer roosts in artificial structures like barns, porch roofs, bridges, and in concrete bunkers.	Proposed Endangered
Mammal	West Indian Manatee	Trichechus manatus latirostris	Shallow, slow-moving waters of rivers, estuaries, saltwater bays canals, and coastal areas. Occurs in fresh water, brackish water, and salt water.	Threatened
Bird	Audubon's Crested Caracara	Caracara plancus audubonii	Dry and wet prairies with scattered cabbage palms, improved pasture lands, and wooded areas with stretches of grassland.	Threatened
Bird	Black-capped Petrel	Pterodroma hasitata	Pelagic seabird, foraging in open ocean in areas of persistent upwelling near Gulf Stream. Only known nesting in island of Hispanola.	Endangered

Species Type	Common Name	Scientific Name	Habitat	Federal Status
Bird	Florida Scrub-jay	Aphelocoma coerulescens	Low growing (< 6.5 feet tall) oak scrub and scrubby flatwoods with open bare patches of sand.	Threatened
Bird	Piping Plover	Charadrius melodus	Coastal beaches, sandflats, barrier islands, gently sloped foredunes, sparsely vegetated dunes, and wash over areas cut into or between dunes.	Threatened
Bird	Red Knot	Calidris canutus rufa	Occurs in Florida out of breeding season in intertidal marine habitats.	Threatened
Bird	Wood Stork	Mycteria americana	Fresh water and brackish water forested wetlands for breeding; wetlands, swamps, ponds, roadside ditches, and marshes especially with an open canopy for foraging.	Threatened
Reptile	American Alligator	Alligator mississippiensis	Fresh water and brackish water wetlands with permanent water.	Threatened (by similarity of appearance)
Reptile	Eastern Indigo Snake	Drymarchon couperi	Xeric pine-oak sandhills, typically sharing burrows with gopher tortoise.	Threatened
Reptile	Green Sea Turtle	Chelonia mydas	Sandy sloping coastal beaches for laying eggs, coastal waters with lush seagrass beds, inshore bays, lagoons, and shoals with abundant seagrass meadows and algae.	Threatened
Reptile	Kemp's Ridley Sea Turtle	Lepidochelys kempii	Typically occurs in Gulf of Mexico, but regularly occurs along the Atlantic seaboard. Nesting typically occurs in Mexico.	Endangered
Reptile	Hawksbill Sea Turtle	Eretmochelys imbricata	Tropical and subtropical waters, predominantly around coral reefs. Nesting occurs on beaches.	Endangered
Reptile	Leatherback Sea Turtle	Dermochelys coriacea	Occurs in Atlantic, Pacific, and Indian Oceans. Nesting occurs on beaches primarily in tropical latitudes.	Endangered
Reptile	Loggerhead Sea Turtle	Caretta caretta	Occurs in subtropical and temperate regions of the Atlantic, Pacific, and Indian Oceans and in the Mediterranean Sea. Feeds in coastal bays and estuaries. Nests on sandy beaches in tropical and subtropical areas.	Threatened
Insect	Monarch Butterfly	Danaus plexippus	Breeding areas include any patches of milkweed. Coastal regions are important flyways and nectar plants (wild or in gardens) are an important resource.	Candidate

Source: USFWS 2023a; USAF 2023

6.1 Southeastern Beach Mouse

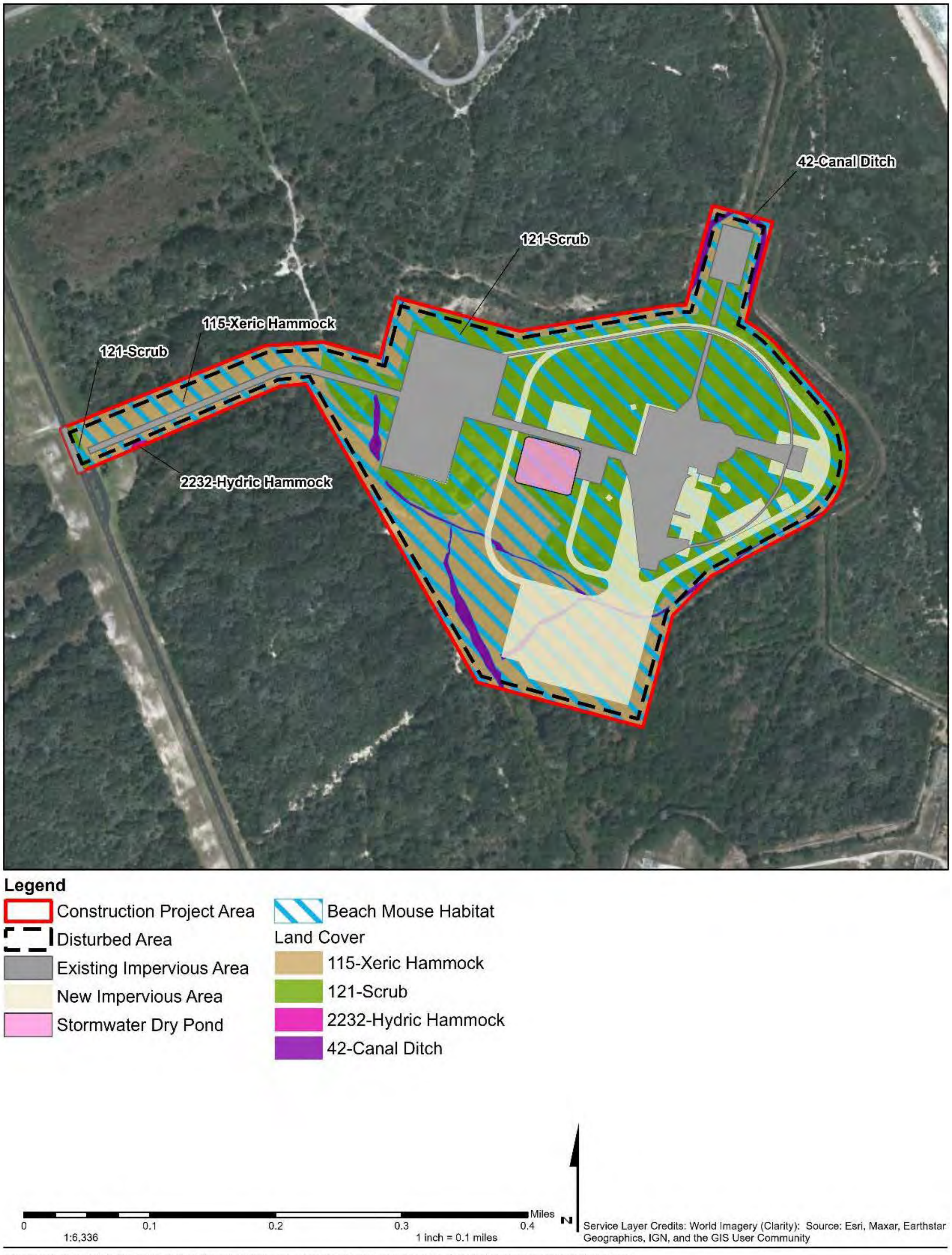
The southeastern beach mouse (*Peromyscus polionotus niveiventris*) is a subspecies of the widely distributed old field mouse and this distinct subspecies has been designated as threatened under the ESA. The species is restricted to sand dunes vegetated primarily by sea oats (*Uniola paniculata*) and dune panic grass (*Paspalum amarulum*) and adjacent areas of scrub dominated by oaks (*Quercus* spp.), sand pine (*Pinus calusa*) or palmetto (*Serenoa repens*) (USFWS 1989). Critical habitat has not been designated for the southeastern beach mouse. Human alteration of the coastal barrier islands has resulted in extirpation of the southeastern beach mouse from the majority of its historical range. Current pressures leading to population decline include continuing loss or alteration of dunes due to human development. Climate change and associated sea level rise also threaten this species (USFWS 2019a). Other mortality factors near the Canaveral National Seashore consist of predation from house cats and competition from house mice (USFWS 1993).

The most viable populations of the remaining southeastern beach mice are on federal lands, including CCSFS. The species typically occurs in coastal dune and strand communities with low vegetative density and areas of bare sand; these communities provide medium- to high-quality habitat for the species on CCSFS. The southeastern beach mouse occurs throughout suitable habitat on CCSFS. Historically, southeastern beach mouse populations within CCSFS were restricted to the coastal dune and coastal strand communities, but research has shown that southeastern beach mice also occur within all habitat types on CCSFS, as well as in buildings. The inland areas provide landward habitat that increases resilience of the southeastern beach mouse on CCSFS and may also serve as refuge during extreme weather events (USAF 2023).

Southeastern beach mouse population numbers fluctuate with the season. The highest numbers occur in the winter and the lowest occur in the summer. Reproductively active females are most abundant in autumn and limited in summer. The species exhibits fast turnover, surviving 4 months or less after capture (USFWS 1993). Population trends for the southeastern beach mouse have not been determined, but the Canaveral Complex population, which includes CCSFS, is considered stable (USFWS 2019a).

The noise area includes suitable habitat for the southeastern beach mouse and the species is reasonably certain to occur within the undeveloped habitats within the 110 dB L_{max} contour. Within the construction area, there are 39.7 acres of suitable southeastern beach mouse habitat (coastal shrub and xeric oak habitats) (Table 5-1) of which 35.4 acres of this habitat would be disturbed by construction activities (Figure 6-1). The noise area (beyond the construction area) contains 12,578.0 acres of variously poor, fair, and good quality habitat for the southeastern beach mouse (Table 5-2 and Figure 5-2).

Figure 6-1. Southeastern Beach Mouse Habitat in Construction Area



6.2 Tricolored Bat

The tricolored bat (*Perimyotis subflavus*) is proposed for listing under the ESA. A determination on critical habitat has not been made for this species as it is not yet listed. During the spring, summer, and fall, tricolored bats tend to roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. In Florida, tricolored bats also will roost in Spanish moss (*Tillandsia usneoides*). Tricolored bats have been observed roosting in artificial roosts like barns, porch roofs, bridges, and concrete bunkers, but roosting in structures has not been documented on CCSFS (USAF 2023). Female tricolored bats exhibit high site fidelity, returning year after year to the same summer roosting locations where they form maternity colonies and regularly switch roost trees. Males roost singly. In the southern part of their range, tricolored bats will hibernate in road-associated culverts, tree cavities, and abandoned water wells (USFWS 2023b).

Until the introduction of white-nose syndrome, populations of the tricolored bat were stable. Factors of decline for the tricolored bat include white-nose syndrome, mortality related to wind power generation, effects from climate change, and habitat loss. White-nose syndrome is the greatest threat, resulting in population declines of more than 90% across 59% of tricolored bat range (USFWS 2021a).

Acoustic surveys conducted in 2019 detected tricolored bats at various locations on CCSFS (USAF 2023). Roost locations on CCSFS are unknown, but the species has not been observed roosting in structures on the facility (USAF 2023). Numbers of tricolored bats on CCSFS are unknown.

The construction and noise areas provide suitable habitat for the tricolored bat and the species is presumed to occur in the area. There are 41.3 acres of suitable tricolored bat foraging habitat (all undeveloped habitats) and 14 potential roost trees within the construction area; 39.3 acres of foraging habitat would be disturbed by construction activities and all potential roost trees would be removed. Additionally, the tricolored bat may roost in one building that has entry routes for bats and underneath the gangway within the existing developed portion of the construction area. These two structures would be disturbed by construction. Tree clearing would be avoided during tricolored bat maternity season (1 May-15 July) and when ambient day time temperatures are 45 degrees Fahrenheit or below.

6.3 West Indian Manatee

The West Indian manatee (*Trichechus manatus*) is listed as threatened under the ESA and also is protected under the Marine Mammal Protection Act, which prohibits the take (that is, harass, hunt, capture, or kill) of all marine mammals. Manatees occur in marine, estuarine, and freshwater environments. The West Indian manatee includes two distinct subspecies, the Florida manatee (*T.m. latirostris*) and the Antillean manatee (*T.m. manatus*). While morphologically distinctive, the subspecies have many common features including large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically gray in color and occasionally spotted with barnacles or colored by patches of green or red algae. Manatees feed on aquatic plants in both fresh and salt water and also enter freshwater areas to drink (USAF 2023).

West Indian manatee populations have steadily increased at the Blue Spring and Crystal River warm-water refugia in Florida since the 1970s. Annual adult survival at these refugia is 96% and calf survival averages 63.5%. Factors of decline for the West Indian manatee include boat strikes and availability of warm-water refugia. Long-term threats consist of the consequences of increasing human population and intensive coastal development (USFWS 2001).

The turning basin west of CCSFS facility Hangar AF typically has an exceptionally high concentration of manatees and is within designated critical habitat for the species (USAF 2023). The construction area contains no habitat for the West Indian manatee, but the species may occur in the nearshore waters of the

Atlantic Ocean approximately 1,000 feet east of the construction area within the noise area or within other brackish waters along the Banana River (Figure 3-6).

6.4 Audubon's Crested Caracara

The Audubon's crested caracara (*Caracara plancus audubonii*) is listed as threatened under the ESA. The scientific name of this species was changed from *Polyborus plancus audubonii* to *Caracara plancus audubonii* by USFWS through a final rule published in the *Federal Register* on July 31, 2023 (USFWS 2023c). Critical habitat has not been designated for this species. The Audubon's crested caracara occurs in a wide variety of semi-open habitats offering open ground for hunting and dense cover for nesting (Audubon 2023). In Florida, the species inhabits wet prairies with cabbage palms, and may occur in pastures and wooded areas with saw palmetto, cypress, scrub oaks (FWC 2023).

Habitat loss and fragmentation along with alteration of the natural fire regime, which results in habitat becoming unsuitable for the species, have been the primary historical pressures on the species (USFWS 2009). Urbanization and the conversion of cattle ranching to crop production, particularly sugar cane, or development are the main factors that continue to cause habitat fragmentation and loss (USFWS 2009).

Audubon's crested caracara is occasionally observed on CCSFS, but it has not been documented nesting there (USAF 2023). Population trends for Audubon's crested caracara are uncertain due to low detectability of the species, limited access to suitable habitat on private lands, and the lack of data on recruitment rates USFWS 2009).

The construction area provides no suitable habitat for the Audubon's crested caracara because of the dense understory that precludes the birds from getting a sufficient runup to take off from the ground. Emergent marsh and other open areas within the noise area could support foraging by this species. The Audubon's crested caracara has been observed around launch areas on CCSFS. The more open habitats in the noise area are likely to support this species.

6.5 Black-capped Petrel

The black-capped petrel (*Pterodroma hasitata*) was recently listed as endangered on January 29, 2024, under the ESA (88 FR 89611). The only known breeding location for this species is on the island of Hispaniola; however, it is believed that breeding populations may exist on Dominica and Martinique (NatureServe 2014). This is a medium sized pelagic seabird with long wings and a distinctive black cap that travels long distances. The black-capped petrel generally resides in areas of deep water or areas of persistent upwelling near the gulf stream (USFWS 2018). Foraging areas include the western Atlantic, southern Caribbean basins, and potentially the northern Gulf of Mexico (USFWS 2018).

The black-capped petrel has faced a decline due to anthropogenic factors such as deforestation and introduction of invasive species at breeding locations. Furthermore, this species typically only lays a single egg every year making population increases slow (NatureServe 2014).

There is no nesting habitat for the black-capped petrel within the construction area or noise area. No observations of the black-capped petrel have been made at CCSFS. The species may forage adjacent to the coast of CCSFS but would be a considered a transient visitor to the Atlantic action area.

6.6 Florida Scrub-jay

The Florida scrub-jay is endemic to oak-dominated scrub habitats in Florida. Degradation and loss of habitat from human activities have resulted in substantial declines in the abundance and distribution of the species. Remaining populations are reproductively isolated, of small size, and are projected to continue to decline. Kennedy Space Center is home to one of three designated core populations of the species and this population represents more than half of the remaining population of the species (USAF 2023).

Florida scrub-jay populations have declined to less than 10% of their historical, pre-European numbers. Population numbers have continued to decrease since their listing in 1987. Factors of decline for the Florida scrub-jay include the availability of territories, disruption of natural fire regimes, habitat loss and fragmentation, disease, and predation (USFWS 2019b). CCSFS conducts annual monitoring of scrub-jay numbers and distribution, but detailed monitoring of specific groups is not conducted (USAF 2023). The 2022 census on CCSFS documented 459 birds, including 85 juveniles, from 142 family groups (USAF 2023).

The 45th Civil Engineering Squadron, Environmental Conservation Element has primary responsibility for overseeing Florida scrub-jay management and addressing Section 7 consultation with USFWS under the ESA for SLD 45. Annual population counts of Florida scrub-jays are conducted, with the number of groups of Florida scrub-jays ranging between 104 and 157 in a given year (USAF 2023).

Undeveloped portions of the construction area are classified as poor habitat for the Florida scrub-jay (Figure 6-2). Habitats within the noise area provide 2,819 acres (Table 5-2) of fair, good, and poor scrub habitat (Figure 6-3). Based on 2023 Florida scrub-jay survey data and SLD 45 INRMP, one active Florida scrub-jay group has been identified on the border of Land Management Unit (LMU) 32 and LMU 31 (CCSFS 2023), which is adjacent to the construction area. While the Florida scrub-jay is not currently active in the construction area (Figure 6-2), the species is a highly mobile and, therefore, its presence may extend into the construction area (Gillikin, pers. comm. 2024).

Figure 6-2. Florida Scrub-jay Habitat within the Construction Area

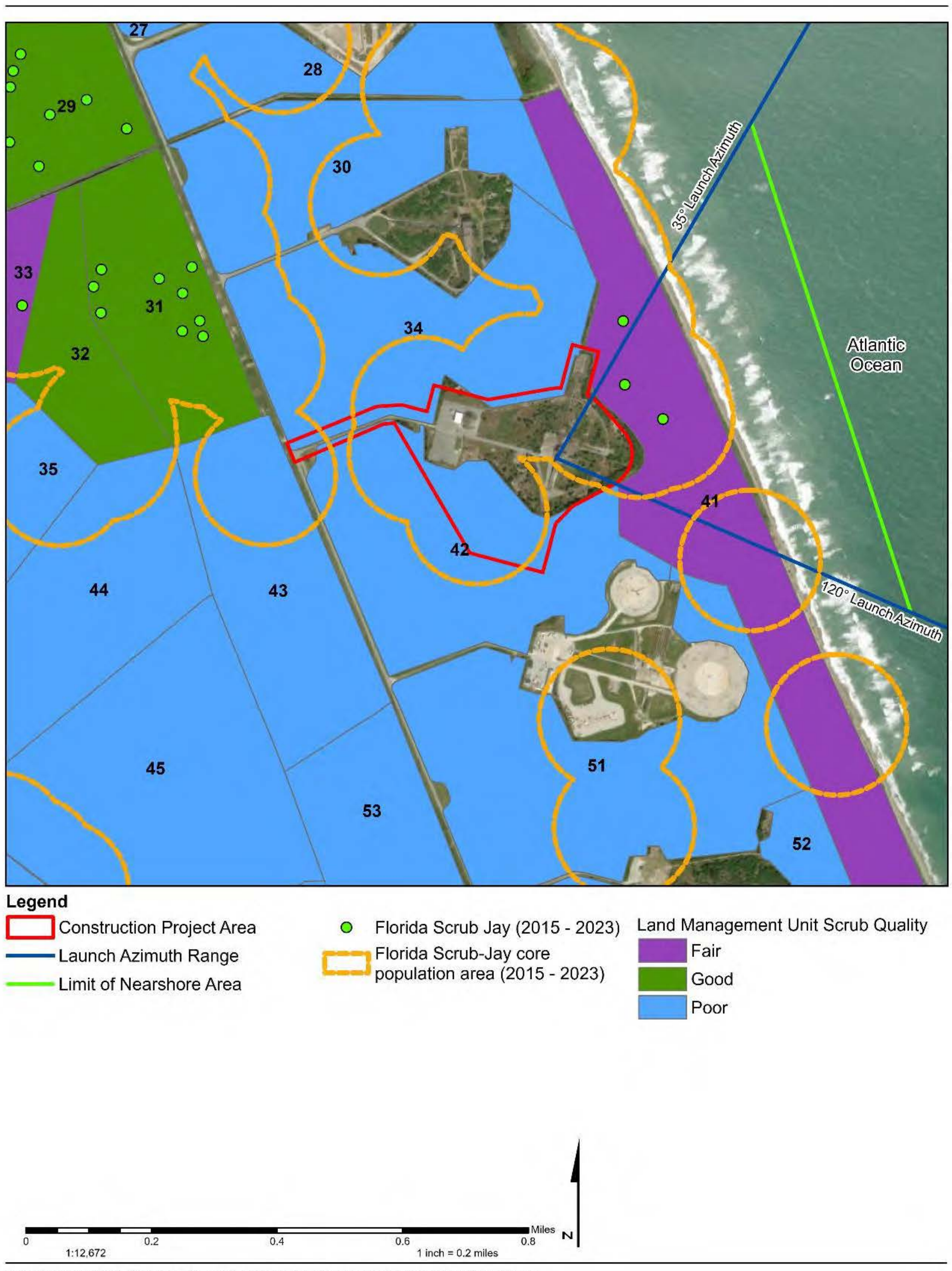
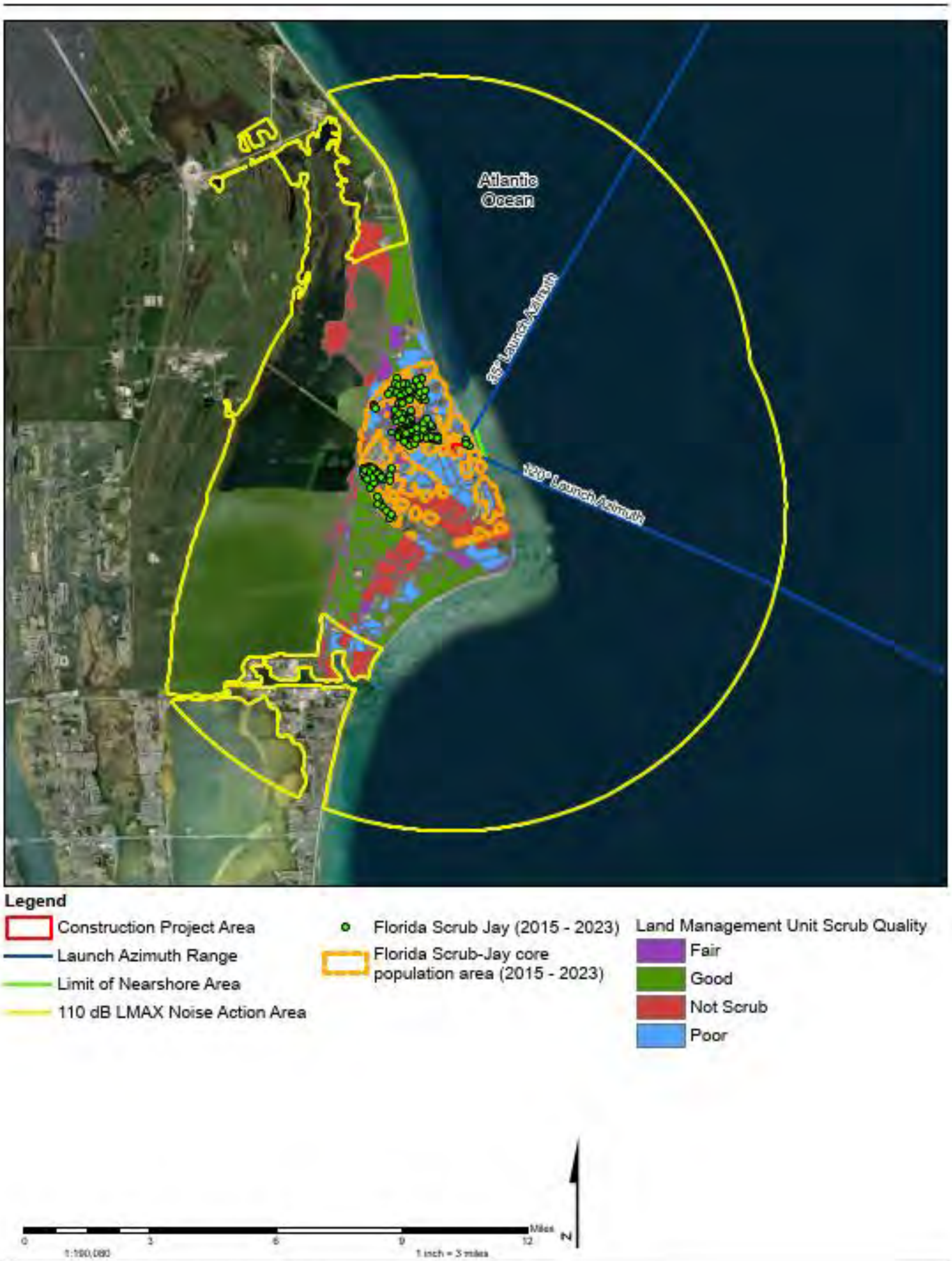


Figure 6-3. Florida Scrub-jay Habitat within the Noise Area



6.7 Piping Plover

The Atlantic Coast and Northern Great Plains populations of the piping plover (*Charadrius melodus*) are listed as threatened under the ESA. The Great Lakes watershed distinct population segment of piping plover is listed as endangered under the ESA. The piping plover is a small, sand-colored shorebird that nests and feeds along coastal sand and gravel beaches. The species forages around the high tide wrack zone and along the ocean edge as areas are exposed, eating mainly arthropods and marine worms (USAF 2023).

Factors of decline for the piping plover include changes in quality or quantity of riverine habitat due to damming and water withdrawals, habitat destruction and degradation, human disturbance, predation, and spread of invasive plants (USFWS 2016).

There is no habitat for the piping plover within the construction area. The piping plover does not nest in Florida but may occur along the shoreline and intertidal area within the noise area outside its breeding season.

6.8 Red Knot

The red knot (*Calidris canutus rufa*) is listed as threatened under the ESA. This species breeds in the northern arctic region. Overwintering typically occurs in the southern hemisphere, but some birds overwinter in Florida. The Atlantic Coast of Florida also is a common stopover during spring and fall migrations. The red knot forages along the shoreline (USAF 2023)

In the southeastern U.S., the red knot population is believed to be moderately resilient. Regional abundance estimates suggest the populations in this region have been mostly stable since the 1980s. Factors of decline for the red knot include loss of habitat, disruption of natural predator cycles on breeding grounds, reduced prey availability, and asynchronies in timing of their migratory cycle (USFWS 2020a).

The red knot is not known to winter on CCSFS, but it has been observed as an occasional forager along the coastline (USAF 2023). There are no population estimates of this species on CCSFS.

There is no habitat for the red knot within the construction area. The red knot may occur along the shoreline and intertidal area within the noise area outside the breeding season.

6.9 Wood Stork

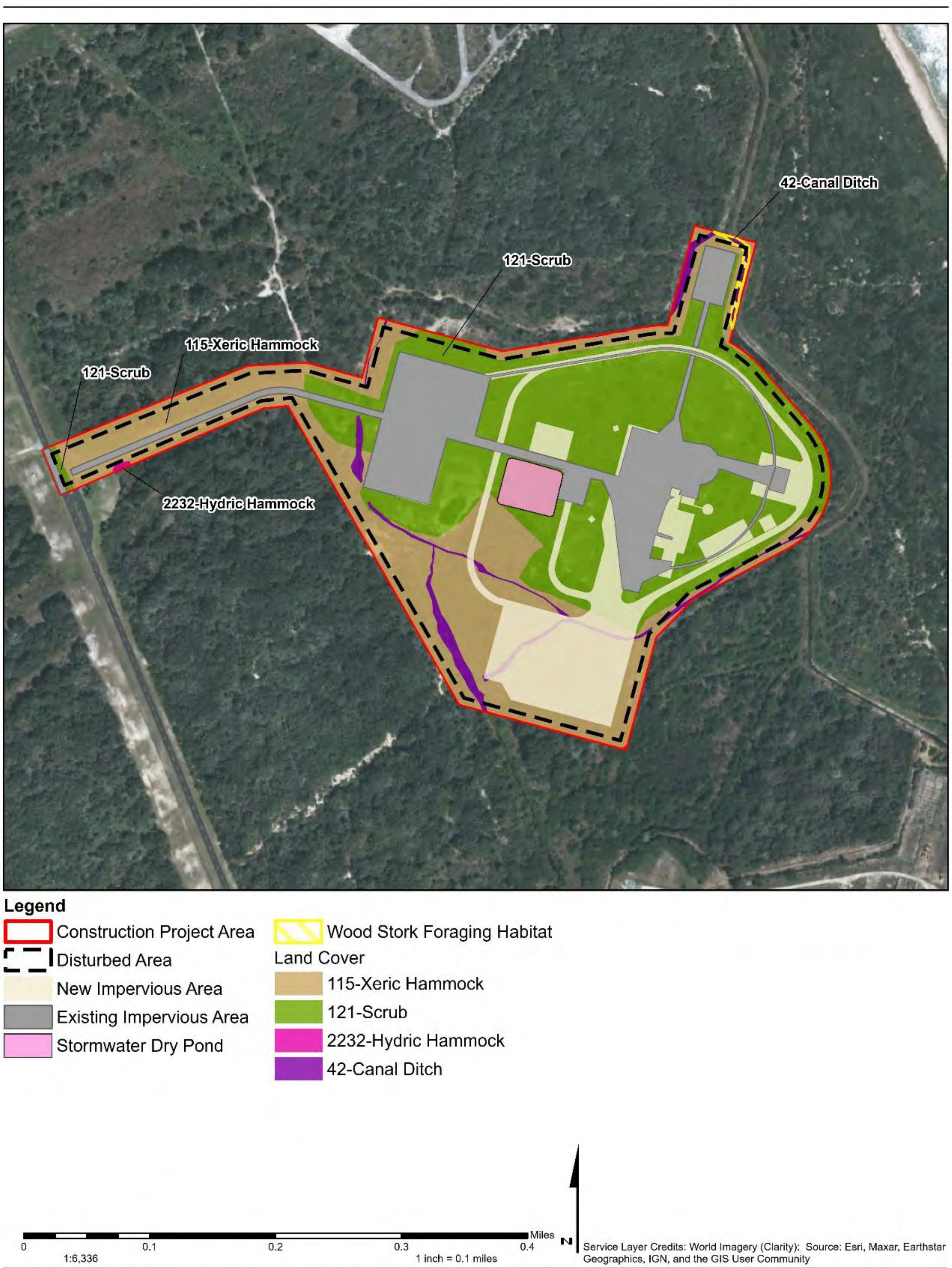
The wood stork (*Mycteria americana*) is listed as threatened under the ESA, but it is proposed for delisting because of its recovery throughout its range. The wood stork is the only stork that occurs in North America. Wood storks are large, thick wading birds with long legs. They have a long neck and a long, thick bill. The birds are white with black flight feathers and tail. The head lacks feathers, is dark, and appears scaly (USAF 2023). Wood stork prey on fish and crustaceans in both fresh and saltwater habitats. They generally nest near wetland habitats using bald cypress, sweetgum, and mangroves for nesting (USFWS 2021b).

Annual nest counts in the U.S. from 1974 through 2019 have been relatively stable. Productivity rates (number of fledglings and nests) varied in Florida from 2010 through 2019 but remained stable with a 10-year average of 1.6 fledglings per nest. Factors of decline for the wood stork include habitat loss and degradation, land conversion, and changing climate conditions (USFWS 2021b).

The construction and noise areas contain no nesting habitat for the wood stork. The maintained canal and ditch (0.2 acres [Table 5-1 and Figure 6-4]) on the east side of the construction area is deeper than wood storks typically prefer for foraging and offers poor-to-moderate quality foraging habitat.

Good foraging conditions for wood storks are characterized by water that is relatively calm, open, and having water depths between 5 and 15 inches (5 and 38 cm) (USACE 2008). An additional 1.2 acre of poor-quality wood stork foraging habitat occurs within the construction area (Table 5-1). Of the available foraging habitat within the construction area, 1.0 acres would be disturbed during construction with a net permanent loss of 0.2 acres post-construction (Table 5-1). Ditches, canals, and emergent wetlands in the remainder of the noise area provide 796.5 acres (Table 5-2) of foraging habitat for the wood stork.

Figure 6-4. Wood Stork Habitat in Construction Area



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6.10 American Alligator

The American alligator (*Alligator mississippiensis*) is listed as threatened under the ESA because of its similar appearance to the American crocodile (*Crocodylus acutus*). Historically, overharvesting and habitat loss led to the American alligator being listed as endangered in 1967 under the Endangered Species Preservation Act of 1966. This status was continued under the ESA when it was passed in 1973. The American alligator made a strong recovery throughout its range and now is classified as threatened by similarity of appearance. American alligators are common inhabitants of wetlands on CCSFS and reproduce throughout the facility in appropriate habitat. The American alligator is an apex predator that feeds on fish, amphibians, birds, reptiles, and mammals. The species contributes to ecosystem diversity through the creation of alligator holes that provide wet and dry habitats for numerous other species (USAF 2023).

The American alligator was not observed during two site surveys during May and September 2023. The species was observed during a site visit in December 2023 near the canal and ditch habitat in the southern section of the construction area. The canals and wetlands in the construction area mostly unsuitable for the American alligator because of the lack of permanent water and the dense growth of woody vegetation within the channels. The maintained canal and ditch on the eastern side of the construction area provides more suitable habitat for the American alligator. However, there is potential for the species to occur within 1.4 acres of the canal and ditch habitat within the construction area. The species likely occurs in suitable habitats in the noise area, outside the construction area.

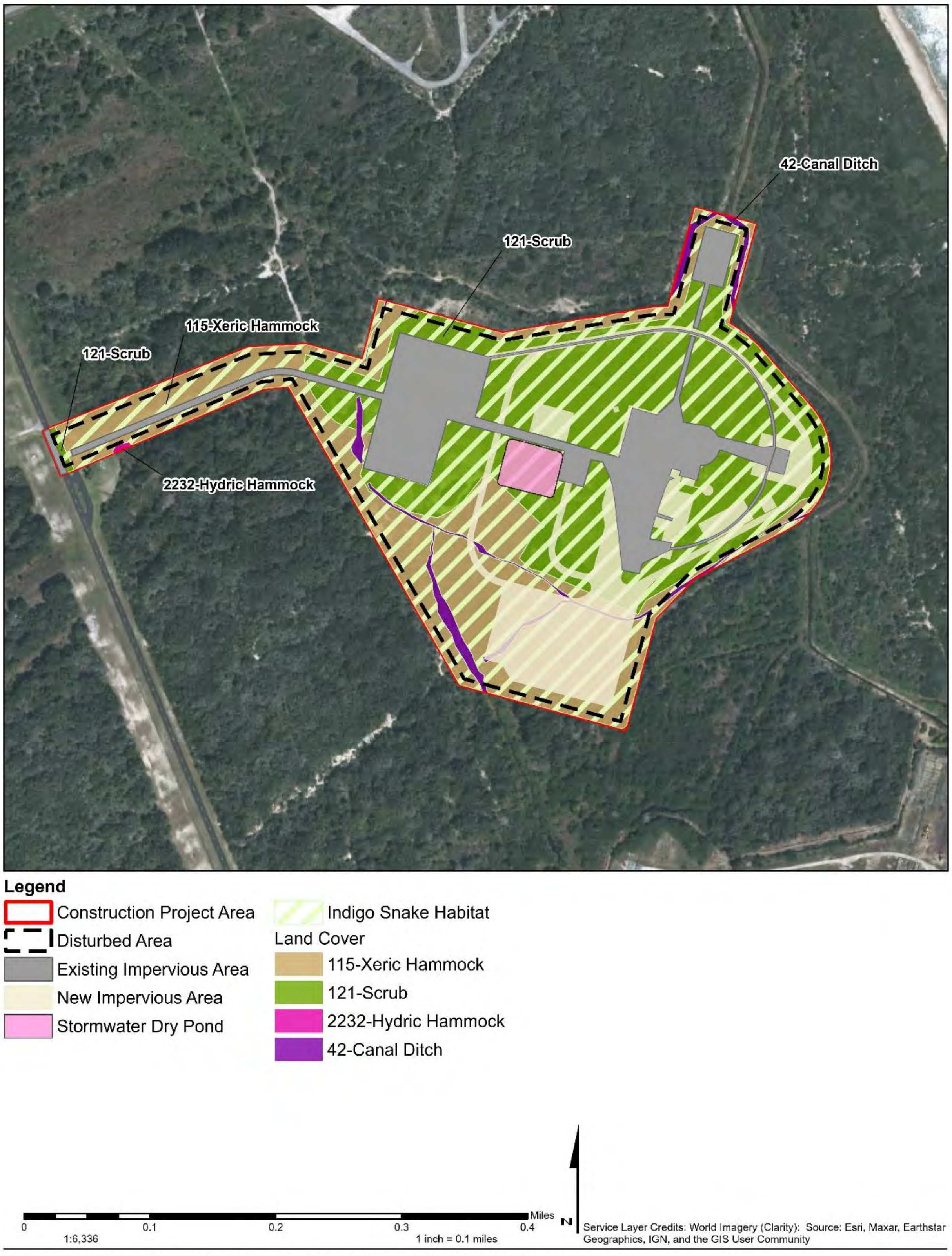
6.11 Eastern Indigo Snake

The eastern indigo snake is a nonvenomous, bluish-black colored snake that can reach a length of 8 feet and that is listed as threatened on the ESA. The chin, cheek, and throat are mostly red or brown but can also be white or black. The eastern indigo snake feeds on a variety of species, including small mammals, birds, toads, frogs, turtles and their eggs, lizards, and small alligators. Eastern indigo snakes breed between the months of November and April and nest between the months of May and August. Females may have the ability to hold sperm, which would allow them to defer fertilization of an egg. Females lay 4 to12 eggs, with the eggs hatching 90 days after being laid. The eastern indigo snake is a commensal species of the gopher tortoise and females usually deposit their eggs in gopher tortoise burrows (USAF 2023).

Historically, the eastern indigo snake was classified as a subspecies (*Drymarchon corais couperi*) and it was listed as threatened under this classification. Post-listing of the eastern indigo snake was elevated to a distinct species (*Drymarchon couperi*) (USFWS 2019c). Eastern indigo snake populations have declined between 32% and 97% across Florida and Georgia. Population resiliency is low to very low, and 13% of extant populations are likely to be extirpated in the foreseeable future. Factors of decline for the eastern indigo snake include habitat fragmentation, habitat destruction, habitat degradation, direct mortality from domestic animals, chemicals, and roadways, climate conditions, diseases, and a decrease of gopher tortoise populations (USFWS 2019c).

The eastern indigo snake is rarely observed on CCSFS and there is no data on the size of the population on CCSFS. The eastern indigo snake occurs in xeric pine-oak sandhills and commonly shares burrows with the gopher tortoise. Numerous gopher tortoise burrows are within the construction area and natural habitats in the construction area are suitable for the eastern indigo snake. The eastern indigo snake likely occurs in the construction area and the surrounding land management units within the noise area, as it is a frequent commensal species with the gopher tortoise and may use burrows in poor-quality habitat as refugia. There are 39.6 acres of eastern indigo snake habitat (coastal shrub and xeric oak habitats plus wetland habitat suitable for foraging) in the construction area (Table 5-1) and 36.4 acres of this habitat would be disturbed by the Proposed Action (Figure 6-5). The remainder of the noise area contains approximately 3,136.9 acres (Table 5-2) of eastern indigo snake habitat of varying quality.

Figure 6-5. Eastern Indigo Snake Habitat in Construction Area



6.12 Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) is a candidate species for listing under the ESA. Consultation with USFWS under Section 7 of the ESA is not required for candidate species, but USFWS encourages agencies to take advantage of opportunities to conserve the species. Monarch butterflies are large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. The black border has a double row of white spots on the upper side of the wings.

Monarch butterflies lay their eggs on milkweed host plants (primarily *Asclepias* spp.), and larvae emerge after 2 to 5 days. Larvae develop through five larval instars, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. Multiple generations of monarchs are produced during the breeding season, with most adult butterflies living approximately 2 to 5 weeks. In many regions, monarchs breed year-round, and Florida has both year-round resident monarch butterflies as well as those that migrate. Monarch butterflies in temperate climates undergo long-distance migration and live for an extended period of time. In the fall, in both eastern and western North America, Monarch butterflies begin migrating to their respective overwintering sites, a journey that can be more than 1,850 miles and last for over 2 months. In early spring (February to March), surviving monarchs break diapause and mate at the overwintering sites before dispersing. The individuals that undertook the initial southward migration return to their breeding grounds and the offspring start the cycle of generational migration over again (USFWS 2023e).

Monarch butterfly populations have steadily declined over the last 20 years and are expected to continue to decline. Factors of decline for the monarch butterfly include loss and degradation of habitat, exposure to insecticides, and effects of climate change (USFWS 2020b).

The construction area contains multiple plant species that offer nectaring opportunities for the monarch butterfly, up to 35.4 acres of potential nectaring habitat could be affected. No milkweeds or remnant milkweed stalks were observed during the site surveys conducted in May and September of 2023. Any occurrence of the monarch butterfly in the construction area likely would be as a forager or transient. Open areas within the land management units comprising the noise area likely have plant species that offer nectaring opportunities for the monarch butterfly and milkweeds may occur in some of these areas.

6.13 Marine Turtles

Loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and leatherback (*Dermochelys coriacea*) sea turtles nest on the beaches at CCSFS, creating between 1,400 and 5,000 nests in any given year (USAF 2023; SLD 45 2023). The Kemp's ridley sea turtle was documented to nest on CCSFS beaches (two nests) in 2015 and two nests in 2024 (SLD 45 personal communication). However, Kemp's ridley sea turtle nesting at CCSFS is considered a rare event as this species typically only nests on beaches in northeastern Mexico in the Gulf of Mexico (USAF 2020). The hawksbill sea turtle (*Eretmochelys imbricata*) has not been documented to nest on CCSFS (USAF 2023). Each of these five species of marine turtles may be found in the nearshore Atlantic Ocean within the noise area.

The construction area contains no habitat for marine turtle species, but all five species may occur in the nearshore waters of the Atlantic action area. Marine turtle species occur with the noise area approximately 1,000 feet east of the construction area or nest along beaches adjacent to the ocean.

CCSFS has developed and implemented Light Management Plans (LMPs) for various facilities to protect sea turtles. A BO issued by USFWS in 1991 and revised multiple times requires LMPs for any new facility that is close to the beach, not constructed in accordance with SLD 45 Instruction (SWI) 32-7001, has lighting directly visible from the beach, or may cause significant sky glow. A 2008 modification to the BO authorized a 3% take of nesting females and hatchlings from disorientation and misorientation, as determined from a representative sample of surveyed marked nests. The BO also requires five light surveys be conducted at night during the peak of nesting season. Because it has been abandoned, there is currently no exterior lighting in operation at SLC-14 and no source of light to disorient or misorient sea turtles (USAF 2023).

Loggerhead Sea Turtle: The loggerhead turtle is the most common nesting sea turtle on CCSFS. Adult and subadult loggerheads have reddish-brown carapaces and dull brown to yellowish plastrons. Adult loggerheads in the Southeastern U.S. have an average straight carapace length of approximately 3 feet and a mean body weight of about 250 pounds. The brown hatchlings weigh approximately 0.70 ounce and are 1.7 inches long.

There is no estimate on the number of loggerhead sea turtles that may occur in nearshore waters of the Atlantic Ocean within the action area. Nests are deposited on CCSFS each year between April and September. A record number (3,804) of loggerhead nests were documented on CCSFS in 2022. Based on nest surveys at CCSFS from 1986 through 2022, the average annual number of loggerhead turtle nests is 2,332 (USAF 2023).

Loggerhead turtle population in Florida has decreased by 26% from 1988-2008. Factors of decline include bottom trawling, longline and gill net fishing, legal and illegal harvesting, vessel strikes, beach armoring, beach erosion, debris ingestion, oil and light pollution, and predation (USFWS 2008).

Green Sea Turtle: The green sea turtle is a hard-shelled sea turtle, with the adults carapace varying in color from black to gray to greenish or brown, often with bold streaks or spots, and a yellowish white plastron. On average, a green sea turtle belonging to the Florida population has a straight carapace length of 3.3 feet and weighs 300 pounds. Characteristics that distinguish them from other sea turtles are their small, rounded head and smooth carapace. Hatchlings weigh approximately 0.88 ounce, their black carapace is about 2 inches long, and the ventral surface is white (USAF 2023).

From 1986 through 2022, the number of green sea turtle nests deposited on CCSFS beaches ranged from 4 to 675, with the record high number in 2019. Based on surveys from 1986 through 2022, the average annual number of green sea turtle nests deposited was 128. The 2019 nesting season was a record year, with 675 green sea turtle nests deposited on the beaches of CCSFS (USAF 2023).

Population threats for the green sea turtle include directed take of eggs and individuals, increased human presence, coastal construction, beach erosion, nest predation, and habitat degradation (USFWS 1998).

Leatherback Sea Turtle: The leatherback sea turtle is the largest of all sea turtles, attaining a straight carapace length of 5 to 5.5 feet and a weight that occasionally reaches 1,100 pounds. Its unique shell is covered with a continuous layer of thin, black, and often white-spotted skin, instead of keratinized scutes. The carapace is raised into a series of seven longitudinal ridges. Other distinctive features are the absence of claws, the absence of scales, the long forelimbs, a reduced skeleton, and a notable pink spot on the dorsal surface of the head in adults (USAF 2023).

Based on data from 1986 through 2022, the highest number of leatherback sea turtle nests observed in any given year on CCSFS was 15 in 2019. For many years during this survey period, no leatherback sea turtle nests were observed at CCSFS. A total of 157 leatherback nests have been documented on CCSFS since surveys began. The number of loggerhead nests has declined each year since the high of 15 recorded in 2019 (USAF 2023).

Common threats to the leatherback sea turtle include ingestion and entanglement in debris, incidental take, and predation (USFWS 1998b).

Hawksbill Sea Turtle: Hawksbills typically weigh around 176 pounds or less; hatchlings average about 1.6 inches straight length and range in weight from 0.5 to 0.7 ounce. The carapace is heart shaped in young turtles and becomes more elongated or egg-shaped with maturity. The top scutes are often richly patterned with irregularly radiating streaks of brown or black on an amber background. The head is elongated and tapers sharply to a point. The lower jaw is V-shaped (USAF 2023).

The hawksbill sea turtle has not been documented nesting on CCSFS and there is no estimate on the number of this species that may occur in nearshore waters of the Atlantic Ocean within the action area (USAF 2023).

The main threats for the hawksbill sea turtle include harvesting, increasing human populations, and destruction of habitat (USFWS 1998c).

Kemp's Ridley Sea Turtle: The Kemp's ridley turtle is the smallest of the sea turtles, with adults reaching about 2 feet in length and weighing up to 100 pounds. The adult Kemp's ridley has an oval carapace that is almost as wide as it is long and usually olive-gray in color. The carapace has five pairs of costal scutes. In each bridge adjoining the plastron to the carapace, there are four inframarginal scutes, each of which is perforated by a pore. The head has two pairs of prefrontal scales. Hatchlings are black on both sides. The Kemp's ridley has a triangular-shaped head with a somewhat hooked beak with large crushing surfaces. This turtle is a shallow water benthic feeder with a diet consisting primarily of crabs. In 2015, two Kemp's ridley nests were recorded at CCSFS, both by the same female. This is the only time that a Kemp's ridley has been observed nesting on CCSFS and it is not expected to recur with any regularity (USAF 2023).

Threats to the turtle include illegal harvest, beach cleaning, human presence, ecosystem alterations, pollution, predation, climate change, and natural catastrophes (USFWS 2011).

7. Critical Habitat

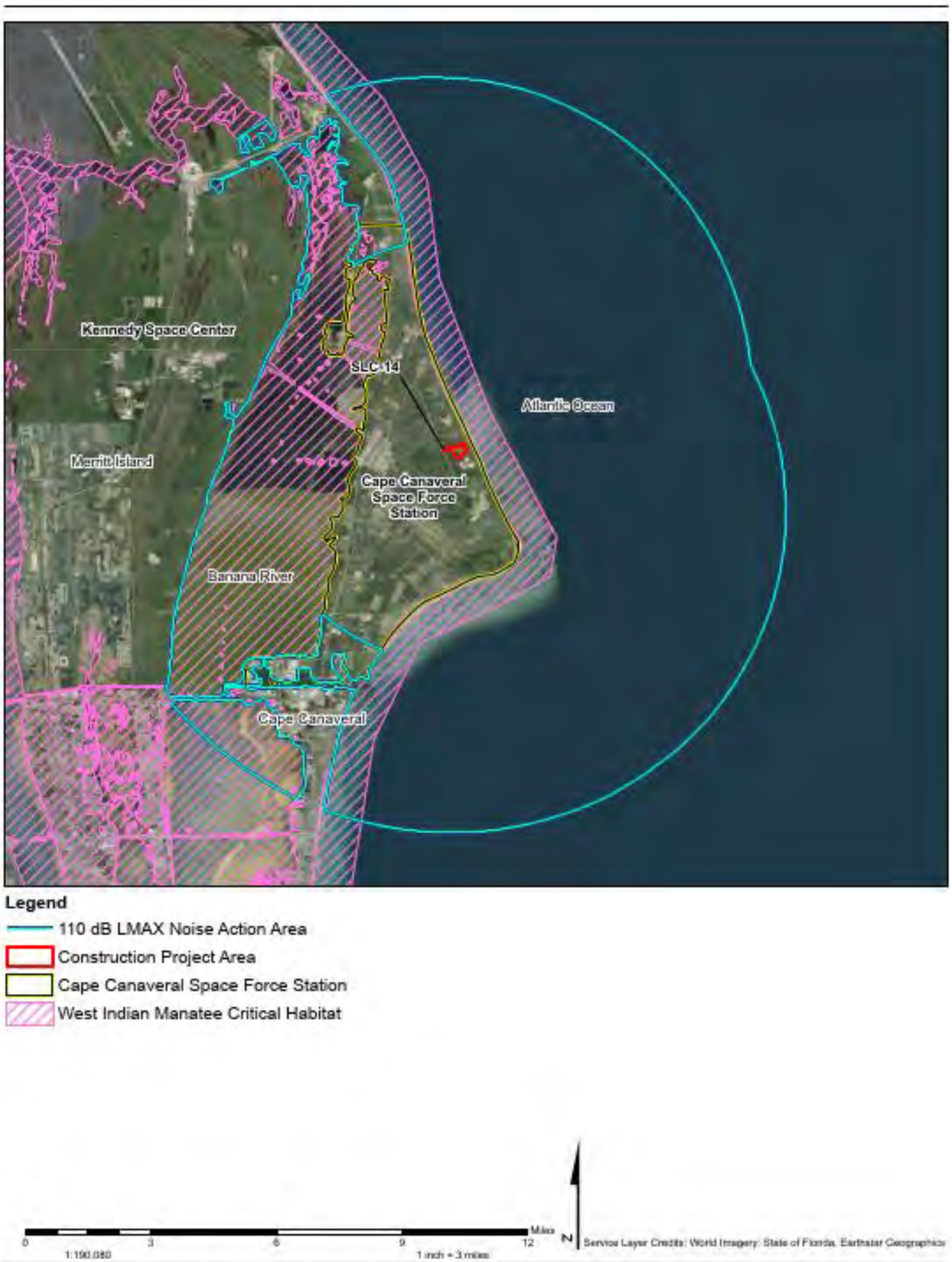
Critical habitat has been designated for the West Indian manatee and the loggerhead sea turtle within the noise area (USFWS 2023a) where elevated light, noise and vibration would occur during operations. Critical habitat for these species does not occur within the construction area where physical alterations to habitats will occur from project construction activities (USFWS 2023a).

Critical habitat for the red knot has been designated on Merritt Island National Wildlife Refuge (USFWS 2023a), but this critical habitat is more than 10 miles from the construction area and would not be affected by the Proposed Action.

7.1 West Indian Manatee Critical Habitat

The Banana River to the west of CCSFS and the nearshore waters of the Atlantic Ocean adjacent to the beaches of CCSFS have been designated as critical habitat for the West Indian manatee and a portion of this designated critical habitat for the West Indian manatee is within the noise area (Figure 7-1). The Banana River is approximately 10,500 feet west of the construction area and approximately 12,500 feet from the launch site. The nearshore waters of the Atlantic action area are approximately 1,000 feet east of the project site and launch pad, outside of the limits of construction but within the noise area where elevated light, noise, and vibration will occur during operations.

Figure 7-1. West Indian Manatee Critical Habitat



7.2 Loggerhead Sea Turtle Critical Habitat

CCSFS is exempted from the area designated as critical habitat for marine turtles because of its Integrated Natural Resources Management Plan (INRMP) (USAF 2023), which specifies the implementation of measures to benefit the conservation of this species. The nearshore waters of the Atlantic action area adjacent to the beaches of CCSFS have been designated as critical habitat for the Northwest Atlantic Distinct Population Segment of the loggerhead sea turtle and a portion of this designated critical habitat for the loggerhead sea turtle is within the noise area (Figure 7-2). The nearshore waters of the Atlantic action area are approximately 1,000 feet east of the project site and launch pad outside of the limits of construction but within the noise area where elevated light, noise, and vibration will occur during operations.

Figure 7-2. Loggerhead Sea Turtle Critical Habitat

8. Baseline Conditions

The purpose of this section it to present past, present, and future launch operations at CCSFS and summarize the ESA Section 7 consultations that have occurred or are occurring at CCSFS.

8.1 Past, Present, and Future Launch Operations

Table 8-1 represents the total launches from 2018 through 2023. Table 8-2 represents the anticipated launch activities from 2024 through 2028. None of the previous launches occurred at SLC14 and the Proposed Action would only result in up to 10 launches per year starting in 2025. The environmental baseline for SLC14 encompasses the noise and other indirect effects from the launches outside of SLC14.

Table 8-1. Past Vehicle Launches at CCSFS and Kennedy Space Center

Year	Total Launches
2018	20
2019	15
2020	31
2021	31
2022	57
2023	72
Total Launches	226

Table 8-2. Planned Future and Potential Launch Actions at CCSFS and Kennedy Space Center

Year	Total Planned Launches
2024	110
2025	135
2026	165
2027	120
2028	115
Total Launches	645

Note: SLD 45 provided these numbers as projections based on scheduling, the launch manifest, and other known information; therefore, these numbers are subject to change.

8.2 Previous Consultations in the Action Area

In December 2020, Cape Canaveral Air Force Station (CCAFS) changed its name to Cape Canaveral Space Force Station (CCSFS). Consultations before this date refer to the Air Force. Additionally, Space Launch Delta 45 (SLD 45) was previously the 45th Space Wing (45th SW). This list excludes consultations with NMFS in the action area.

1. December 19, 2023: The Service issued a final BO to the Space Force for the Terran R Launch Program (Relativity Space, Inc) at SLC-16. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse and the tricolored bat. The action has not yet occurred to date.

2. December 12, 2023: The Service issued a final programmatic BO and conference report to the Space Force for the CCSFS Range of the Future infrastructure improvements. It was determined that the Proposed Action was not likely jeopardize the continued existence of the Florida scrub-jay, eastern indigo snake, and the southeastern beach mouse. This action is ongoing. An annual report with a mitigation ledger will be submitted to the Service to track project status.

3. March 9, 2023: The Service issued a final BO to the Space Force for the Ghost Crab Removal Study Project. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the green, Kemp's ridley, leatherback, and loggerhead sea turtles. This project has been completed.

4. June 22, 2022: The Service issued a final BO to NASA for the Air Sparging System at CCSFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is ongoing.

5. February 14, 2022: The Service issued a final amended BO to the existing BO FWS log No. 04EF1000-2016-F-0164 dated May 2016 for SLC 11 and 36, for the addition of test stand operations at SLC 12. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mice, eastern indigo snake, and loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles. This project has not yet occurred.

6. February 8, 2022: The Service issued a final BO to the Space Force for Runway B50305 Repair. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is ongoing.

7. June 14, 2021: The Service issued a BO to the Space Force for the Shoreline Stabilization at SLC 46. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. Additionally, the project was determined to adversely affect the leatherback, green, loggerhead, Kemp's ridley, and hawksbill sea turtles. However, the 45th SW agreed to implement conservation measures to avoid impacts to marine turtles. This action has started but is currently on hold.

8. July 17, 2020: The Service issued a final BO to the Air Force for Space Florida's Construction and Operations at SLC 20. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. Additionally, it was determined that the project is likely to adversely affect the leatherback, green, loggerhead, Kemp's ridley, and hawksbill sea turtles. However, the applicant and the 45th SW agreed to implement the terms and conditions of the programmatic lighting BO, FWS Log. 2009-F-0087. The Service has determined that such actions that implement all the terms and conditions of the BO will not jeopardize the continued existence of nesting marine turtles. This project is ongoing.

9. March 20, 2020: The Service issued a final BO to the Air Force for the Terran 1 Launch Program (Relativity Space, Inc) at SLC 16. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. The action has been completed. The Terran 1 Program has been decommissioned. The Terran 1 Program will be replaced with the Terran R Program.

10. February 23, 2017: The Service issued a final BO to the Air Force for archaeological surveys at multiple locations on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is ongoing.

11. August 30, 2016: The Service issued a BO to the Air Force for the construction of an emergency egress road at Munitions Storage Area 5. It was determined that the Proposed Action was not likely to

jeopardize the continued existence of the southeastern beach mouse and the Florida scrub-jay. This action has not yet occurred to date.

12. May 27, 2016: The Service issued a final BO to the Air Force for the construction of an Orbital Launch Site at SLC 11 and 36, and the launch of the Blue Origin Orbital Launch Vehicle from SLC 36. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles as well as the southeastern beach mouse, eastern indigo snake, and Florida scrub-jay. This project is ongoing.

13. February 12, 2016: The Service issued a second amendment to the September 17, 2014, BO and its November 4, 2015 amendment for the removal of four contingency pads and the construction of two additional large landing pads to support the landing of the Falcon Heavy first stage vehicles. Additional minimization measures and terms and conditions were established.

14. November 4, 2015: The Service issued an amendment to the final BO for the SpaceX Landing Zone at LC-13 (LZ-1). After review of the light management plan, the Service requested the 45th SW re-initiate consultation due to the orientation of operational white lighting directly visible from the beach. Loggerhead, green, leatherback, Kemp's ridley, and hawksbill sea turtles were added to the incidental take statement from lighting effects. It was determined that the project, with the implementation of terms and conditions, would not exceed the 45th SW's 3% annual allowable threshold for take from lighting. This project is ongoing.

15. September 17, 2014: The Service issued a final BO to the Air Force for the SpaceX Landing Zone at SLC 13. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay, southeastern beach mouse, and the eastern indigo snake. The construction for this project is complete and operations are ongoing.

16. November 18, 2008: The Service issued a final BO to the Air Force for light management on CCAFS. It was determined that the Proposed Action, with the implementation of minimization measures, was not likely to jeopardize the continued existence of loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles.

17. October 20, 2008: The Service issued a second amendment to the October 19, 2005, BO for the proposed sand borrow site on CCAFS. New "Reasonable and Prudent Measures" and "Terms and Conditions" were established and replaced those outlined in the October 2005 BO and the July 2006 amendment. All other parts of the original BO remained the same.

18. June 4, 2007: The Service issued concurrence to the Air Force that the addition of a substation for the National Reconnaissance Office (NRO) Eastern Processing Facility (EPF) would not alter the findings and conclusions described in the August 2005 BO. The project is complete.

19. July 20, 2006: The Service issued an amendment to the October 19, 2005, BO for the proposed sand borrow site on CCAFS. New "Reasonable and Prudent Measures" and "Terms and Conditions" were established and replaced those outlined in the October 2005 BO. All other parts of the original BO remained the same.

20. October 19, 2005: The Service issued a final BO to the Air Force for the establishment of a sand borrow source on CCAFS for shore protection at Patrick Air Force Base. Minimization measures were established to avoid incidental take the eastern indigo snake and sea turtles. It was determined the project was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is recurring as needed.

21. August 1, 2005: The Service issued a final BO to the Air Force for the NRO EPF. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay,

southeastern beach mouse, and the eastern indigo snake. As required, the 45th SW established a prescribed burn plan. Construction of the project is complete, and operations are ongoing.

22. March 1, 2005: The Service issued a final BO to the Air Force for the removal of concrete rubble from the beach at the end of Camera Rd A and east of SLC 34 and 37 on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

23. December 16, 2004: The Service issued a final BO to the Air Force for the construction of an earthen berm behind SLC 37. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

24. December 15, 2004: The Service issued a final BO to the Air Force for the installation of a lightning detector antenna. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse and the Florida scrub-jay. This project is complete.

25. August 22, 2002: The Service issued a programmatic BO to the Air Force for future projects on CCAFS that will not result in the permanent loss of southeastern beach mouse habitat. It was determined that the Proposed Action as not likely to jeopardize the continued existence of the southeastern beach mouse. This is currently ongoing.

26. August 22, 2002: The Service issued a final BO to the Air Force for rodent control and pest management at CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is ongoing.

27. August 22, 2002: The Service issued a final BO to the Air Force for the expansion of a protective berm at the Explosives Ordnance Disposal range at CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

28. June 20, 2002: The Service issued a final BO to the Corps to sand tighten and elevate 940 feet of the existing north jetty at Canaveral Harbor, Brevard County. Work would occur from CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse, or the loggerhead, green, hawksbill, and leatherback sea turtles. This project is complete.

29. February 21, 2002: The Service issued a final BO to the Air Force for an upgrade of the sanitary sewer system at CCSFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

30. May 18, 1998: The Service issued a final BO to the Air Force for refurbishment of abandoned Space Launch Complex 37 at CCAFS to initiate the new Delta IV Evolved Expendable Launch Vehicle program. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

31. April 10, 1998: The Service issued a final BO to the Air Force for the remediation of contaminated soil at Launch Complex 37. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the southeastern beach mouse. This project is complete.

32. September 13, 1994: The Service issued a final BO to the Air Force to modify the existing Launch Complex 46 at CCSFS in order to launch vehicles using CASTOR 120 first stages such as Taurus or Lockheed Launch Vehicle (LLV-II) and similar vehicles. It was determined that the Proposed Action

was not likely to jeopardize the continued existence of the eastern indigo snake, loggerhead, green, and leatherback sea turtles, southeastern beach mouse and Florida scrub-jay. This project is complete.

33. February 22, 1994: The Service issued a final BO to the Air Force for construction of a new 800,000 gallon per day wastewater treatment plant and effluent disposal facility (percolation pond) on CCSFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay or eastern indigo snake. This project is complete.

34. January 20, 1994: The Service issued a final BO to the Air Force for construction of a new two-stary, 48,000 square foot administrative and launch operations facility to support the Delta II program on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay or eastern indigo snake. This project is complete.

35. January 8, 1993: The Service issued a final BO to the Corps for the beach renourishment on Cape Canaveral from the excavation of sand from an offshore borrow area on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of loggerhead sea turtles. This project is ongoing as needed but is covered under a Programmatic Biological Opinion (PBO).

36. December 31, 1992: The Service issued a final BO to the Air Force for the continued operation of the landfill at CCAFS through expansion of the site by approximately 20 acres over the next 10 years for disposal of construction and demolition debris and asbestos containing material. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay. The project is complete.

37. December 30, 1992: The Service issued BOs to the Air Force for the following actions at CCAFS: construction of hazardous waste storage building, installation of an antenna mount, construction of an addition to fire station #3, and construction of a main wastewater treatment plant. It was determined that the proposed actions were not likely to jeopardize the continued existence of the Florida scrub-jay or eastern indigo snake. These projects are complete.

38. August 7, 1991: The Service issued a final BO to the Air Force for the construction of a 12,400 square foot chemical lab on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay. This project is complete.

39. July 11, 1991: The Service issued a final BO to the Air Force for the construction of a Payload Spintest Support Facility on CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay. This project is complete.

40. January 25, 1991: The Service issued a final BO to the Air Force for the Florida scrub-jay Management Plan for CCAFS. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay. This Plan and BO is no longer valid.

41. February 1, 1990: The Service issued a final BO for upgrade of existing Launch Complexes 40 and 41 and construction of a Solid Rocket Motor Assembly Building on CCAFS to support the Titan IV launch program. It was determined that the proposed actions would not likely jeopardize the continued existence of the Florida scrub-jay or the southeastern beach mouse. This project is complete.

42. December 4, 1987: The Service issued a final BO for the construction of a 124,800 square foot building for support of missile launches. It was determined that the Proposed Action was not likely to jeopardize the continued existence of the Florida scrub-jay or eastern indigo snake. This project is complete.

9. Effects of Action on Listed Species and Critical Habitat

This section discusses the potential effects on listed species and critical habitat from implementation of the Proposed Action. Effects may result from construction activities or from operation of the project (testing and launches) following construction. The potential for effects was minimized through selection of the abandoned SLC-14 for redevelopment and minimizing the extent of new disturbance that would occur; however, some new disturbance is unavoidable because the existing disturbed area at SLC-14 is insufficient to accommodate all mission requirements.

9.1 Construction Effects

Reactivation of SLC-14 would require the disturbance of 36.4 acres of undeveloped land and 9.6 acres of previously developed land within the construction area (Table 5-1). An additional 8.6 acres of impervious area (buildings and other hard infrastructure) would be added to the existing 9.6 acres of impervious area. Construction activities would include the use of heavy equipment to remove existing structures and vegetated communities, the transportation of construction materials along existing roadways at CCSFS resulting in increased vehicle traffic and stockpiling of construction materials at the construction site. Construction activities taking place at night would require lighting the construction area. Noise would be generated from the use of heavy equipment.

Construction activities have the potential to affect listed species if the organisms do not disperse into neighboring habitats outside the construction area. Direct impacts to species may occur through crushing by heavy vehicle traffic or entombment within burrows during site clearing and grading. However, most mobile organisms would flee ongoing construction activities before being directly impacted. Impacts to listed species would also occur from the removal of suitable habitats through construction activities. The removal of habitats would reduce the species' ability to forage, nest, or roost and seek refuge from predators, increasing species mortality.

9.2 Operational Effects

The Proposed Action includes the static test fire and launch of rockets from SLC-14. These episodic activities would generate potential effects on listed species through exposure to heat and exhaust within the heat plume, noise, light, and vibration within the 110 dB (L_{max}) noise contour.

During static test fires and launches, heat and exhaust would be directed approximately 3,400 feet through the flame trench and away from the launch pad in a northeast direction toward the Atlantic Ocean (Figure 3-4 and Figure 3-5). Mobile organisms would likely disperse from the area of the heat plume during increased activities during fueling, venting, and startup of the deluge system before heat and exhaust are expelled. Any organisms remaining within the heat plume during launch could be exposed to lethal temperatures. However, given the upward trajectory of the heat (Figure 3-5), only organisms immediately near the launch site should be affected.

Operational activities from static test fires and launches would also produce increased noise. Noise from launches would be episodic and short-term (up to 3 minutes). SLD-45 has determined that a noise contour of 110 dB (L_{max}) would represent noise impacts to the terrestrial species identified in the BA. Given proximity of launch sites to documented species habitats, it is assumed noise could only directly impact the Florida scrub-jay and the Southeastern beach mouse behaviorally (startle response). Within the 110 dB (L_{max}) contour, sound pressure exposures would be similar to fighter jet flyovers, which are typical for USAF installations, in addition to the launch noise from surrounding SLCs that has been occurring since the late 1950s, albeit at a lower cadence. Noise exposure within the110 dB (L_{max}) contour would be expected to cause a startle effect in both people and animals (Manci 1988). It is unclear, at present, if these animals are exposed to impulse noises with similar characteristics on a regular basis they would become conditioned to the stimulus (FAA 2002). Animal responses to noise exposures range from no reaction to detectable responses. Typical responses generally range from temporary changes in body position, to more pronounced responses, such as panic and fleeing the sound source. Long-term changes in species behavior are strongly influenced by factors other than short-term noise exposure, such as weather, predation, disease, and other disturbances to animal populations (FRA 2005). In studies of aircraft overflights and small mammals, the effects from exposure to noise were smaller than the natural variability of life spans of rodents in the study (Bowels et al. 1995). Exposure to noise within the noise area would startle organisms, which may respond by temporarily relocating, remaining sessile, or stopping foraging, but they would be expected to continue their activities once the noise abated. Because of the episodic and short-term duration noise exposure, it is unclear the effect noise will have on present animal species.

Sonic booms would be created from the launch vehicle after liftoff. Based on modeling results of a launch of the proposed Stoke vehicle from SLC-14, the sonic boom footprint would occur approximately 49 miles downrange over the Atlantic Ocean for a nominal due east launch azimuth, well away from CCSFS (BRRC 2023). Sonic booms may affect species transiting the action area, but impacts are anticipated to be insignificant and discountable due to the transient nature of the species and the infrequency of launches over the course of each year.

Pre-launch patrol aircraft overflights may be conducted as part of operational activities. These overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998).

Lighting from operational activities, including light poles to illuminate the launch pad and light from the rocket engines during launch, has the potential to disrupt wildlife foraging and nesting activities, particularly nocturnal species. Night launches are anticipated to occur up to five times per year. White light usage could last from dusk to dawn to ensure personnel safety and hazards are secure.

Species within the noise area would also be exposed to increased vibrations during launch activities. These exposures would be expected to be similar to vibrations from other launch activities at CCSFS and would be episodic and short-term. Vibration, like noise, could elicit a startle response from organisms, causing them to flee the area or remain sessile until the vibration abates.

9.3 Southeastern Beach Mouse

9.3.1 Direct Effects

9.3.1.1 Habitat Loss

Project activities would result in direct impacts to the southeastern beach mouse through the removal of foraging habitat within the construction and heat plume area. Within the construction area up to 36.4 acres of suitable southeastern beach mouse foraging habitat, including coastal scrub and xeric hammock could be affected. Construction activities and the heat plume could result in a permanent loss of 9.8 acres of beach mouse habitat (8.6 areas of impervious area and 0.8 acres from heat). The remaining 26.6 acres within the construction area that would be temporarily cleared would be allowed to redevelop into natural habitats post-construction that may be used by the southeastern beach mouse.

The heat and exhaust plume will be directed upward away from surface habitats and scorching of vegetation would not be expected, but heat wilt of peripheral canopy branches and leaves likely would result. The Stoke launch vehicle is a medium-class, liquid-fueled rocket that is smaller than the current, frequently launched vehicles at CCSFS, which would result in less heat exhaust and noise. In the report *Monitoring Direct Effects of Delta, Atlas, and Titan launches from CCAS* (USAF 1998) it was noted that no wildlife mortality resulted from 46 launches monitored over a 4-year period, however the study did not specifically target southeastern beach mice. Historically, vegetation scorching from launch events has been limited to small areas within 495 feet of the launch pad (USAF 2023). The heat plume temperature would be 309 degrees Fahrenheit (°F) at the end of the flame trench (Figures 3-4 and 3-5). Flash ignition of standing woody vegetation typically requires a temperature of 710°F or greater (Durda and Kring 2004).

With the diverter directing the heat up and away from the ground, scorching of vegetation would not be expected, but heat wilt of peripheral canopy branches and leaves would likely result. Any effects at ground level are expected to be insignificant and discountable on the southeastern beach mouse because of the heat being directed upward, the short duration of the heat exposure, and the additional insulation that canopy vegetation would provide to lower areas. Due to the use of the heat diverter, the effects from the heat and exhaust plume would have an insignificant effect on the southeastern beach mouse.

The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts on the beach mouse. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45, and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS.

9.3.1.2 Noise

Noise and vibration from operational activities would likely interrupt foraging behavior but direct impacts from elevated noise and vibration on the species have not been determined. Peer-reviewed data identifying sound frequency or amplitude thresholds for physiological or behavioral effects on southeastern beach mice does not exist. A review of available scientific peer-reviewed literature and regulatory documentation for proposed actions with elevated noise exposures is provided in Appendix A.

What relatable (surrogate species and noise stimuli) information that could be found was published from the 1960s through 1990s for small mammals and rodents and was inconclusive (Bowels et al. 1995). A noise study that is relatable to the Stoke launch activities was conducted from 1991 through 1994 at the Barry M. Goldwater Air Force Range on the kit fox and its prey base, specifically, Merriam's kangaroo rat (*Dipodomvs merriami)*, the Arizona pocket mouse (*Perognathus amplus*), the desert pocket mouse (*Chaetodipus penicillatus*), the banner-tailed kangaroo rat (*Dipodomvs spectabilis*), and the white-throated woodrat (*Neotoma albigula*). However, the study outcomes were inconclusive on whether low-level military jet noise (exceeding 120 dB) had a physiological or behavioral effect on the species studied (Bowels et al. 1995). The description of noise impacts associated with the Terran I Environmental Assessment and subsequent BO were also reviewed. The Terran I rocket is a medium heavy rocket similar to the rocket that will be used by Stoke. The BO states that during facility operations, rocket launches may startle southeastern beach mice, and noise associated with landing, though not as loud, may do the same. The BO further stated that the noise impact to wildlife is expected to be minimal and discountable (USFWS 2020c).

Based on the review of available literature and documents (Appendix A), it was determined that noise and vibration from launch events may startle southeastern beach mice within the noise area, but these events would not result in adverse impacts to the southeastern beach mouse. The noise generated by the launch activities would be episodic (10 launches annually) and short-term (up to 3 minutes).

Additionally, pre-launch aircraft overflights may startle the species. Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Southeastern beach mice would be expected to resume behaviors such as foraging once noise levels returned to ambient conditions. Noise effects from operational activities would be negative and insignificant given the episodic and short-term duration of the exposure. Sonic booms associated with launch events would occur many miles offshore within the Atlantic action area, so any effects would be discountable on southeastern beach mice.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the southeastern beach mouse.

9.3.1.3 Vehicle Mortality

Increased vehicle traffic on existing roadways and during construction may result in direct take to the species. However, most operation and construction activities would take place during daylight hours and the beach mouse forages at night when traffic volume is minimal. Mortality by vehicles is a rare occurrence due to the species ability to avoid being run over when crossing roads, the nocturnal nature of the species, and the natural tendency of the species to flee from noise, and human presence.

9.3.1.4 Lighting

Light during construction and operation activities may deter the southeastern beach mouse from foraging in suitable habitats. Foraging would be suspended while light is present if the launch pad was lit during nighttime. It is currently unknown how often nighttime operations would be necessary, but nighttime operations are generally avoided due to the inherent logistical challenges and increased safety concerns. These negative effects are considered temporary and insignificant as the species would continue to use suitable habitats post-construction and operational activities.

9.3.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered species and to reduce wildfire risk. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. The Stoke launch schedule will not preclude suitable windows for prescribed burning activities. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, in accordance with the SPOTF Range User Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation's prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke. Users will not place smoke restrictions on their facilities, equipment, or real property assets located on CCSFS. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide positive long-term effects to the southeastern beach mouse.

9.3.3 Cumulative Effects

CCSFS anticipates futures increases launch cadence above baseline conditions from multiple launch providers who are currently developing or have plans to develop space launch complexes (Tables 8-1 and 8-2). These activities will increase anthropogenic noise within beach mouse foraging and nesting habitats within the Stoke SLC-14 Noise Area in addition to those effects discussed for the Proposed Action evaluated in this Biological Assessment. Elevated noise is anticipated to have a behavioral response (startle response) on the southeastern beach mouse which would be expected to amplify in effect in correlation with increased launch cadences at CCSFS. However, the magnitude of increase in startle response on the species from the increased launches cannot be quantified through review of available scientific and commercially available literature.

Physiological responses to the southeastern beach mouse from increased anthropogenic noise are not expected, as previously discussed; therefore, these effects would not be amplified by increased launch cadence. Cumulative increases in anthropogenic noise have the potential to negatively affect southeastern beach mice.

Loss of southeastern beach mouse foraging habitat at CCSFS would increase through physical habitat removal as space launch complexes are developed. The loss of these habitats would further impact the southeastern beach mice currently using the noise area where the foraging ranges of mice overlap within other space launch complexes being developed, with a net overall reduction in available foraging habitats. These habitat losses are expected to have a negative impact to the species but cannot be quantified at this time.

9.3.4 Determination

Because of the potential for incidental take from vehicles and reduction in available habitat, SLD 45 has determined that the Proposed Action may affect, and is likely to adversely affect, the southeastern beach mouse. Impacts to southeastern beach mouse habitat within the construction area would be mitigated offsite at a 1:1 ratio in accordance with USSF Range of the Future Programmatic BO; therefore, the Proposed Action would result in no long-term loss of southeastern beach mouse habitat. Elevated noise within the noise area may startle foraging mice, but quantified behavioral and physiological effects determinations were ultimately inconclusive based on the review of scientific literature and regulatory documents (Appendix A).

9.4 Tricolored Bat

9.4.1 Direct Effects

Construction activities would result in disturbance to 39.3 acres of foraging habitat (upland and canal ditch) for the tricolored bat. Habitat disturbances include the permanent loss of 8.5 acres and the temporary loss of 30.8 acres of foraging habitat within the construction area. Site preparation would also remove 14 potential roost trees for the tricolored bat. The temporarily disturbed acreage would redevelop into natural habitats over time. Tricolored bats displaced from the lost roosting trees would be able to find other roosts in the vicinity.

Should tricolored bats be found roosting in structures, these bats would be relocated or allowed to leave the structures before replacement or renovation. There could be a loss of available roosting habitat, but no bat mortality would be expected from renovation or replacement of existing structures. Bats would not be expected to roost in buildings in active use following project implementation. Surveying for and relocation of roosting bats would minimize the potential for bats to experience incidental mortality during construction activities. Therefore, clearing of foraging habitats and roosting trees from project construction activities would have an insignificant effect on tricolored bats.

Increased vehicle traffic on existing roadways during construction and operational activities would have no effect on the tricolored bat as the bat forages at night when traffic volume is minimal, and bat strikes by vehicles are a rare occurrence due to the species ability to navigate with echolocation. Increased light from construction and operational activities would have no effect on the tricolored bat as the species forages at night by echolocation. Lights from construction activities may serve to increase bat foraging near SLC14 by attracting prey items (insects) to lighted areas. Increased light from the Proposed Action will have no effect on the tricolored bat.

Night launches and static tests could cause incidental mortality to the tricolored bat if it were foraging in the immediate vicinity of the launch because of extreme heat from the exhaust plume. However, exposure of this species to the heat plume while foraging is considered unlikely due to the small footprint and short duration of the heat plume. Historically, vegetation scorching from launch events has been limited to small areas within 495 feet of the launch pad (USAF 2023). The heat plume temperature would be 309°F at the end of the flame trench (Figure 3-4 and Figure 3-5) and flash ignition of standing woody vegetation typically requires a temperature of 710°F or greater (Durda and Kring 2004). With the diverter directing the heat up and away from the ground, scorching of vegetation would not be expected, but heat wilt of peripheral canopy branches and leaves likely would result.

Tricolored bat foraging habitat in tree canopy at the end of the flame trench likely would be adversely affected during launches. This could result in an additional reduction of tricolored bat foraging habitat, up to 0.5 acre (USAF 1998), which would bring the total permanent foraging habitat loss to 9.0 acres. Tree clearing would be avoided during tricolored bat maternity season (1 May-15 July) and when ambient day time temperatures are 45 degrees Fahrenheit or below. This loss is considered to have an insignificant effect on the species as ample foraging habitats remain outside of the heat plume area. No population level effects would be expected. The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45, and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS. The heat and exhaust plume is expected to have a negative insignificant effect on the tricolored bat.

Noise from launch events would not affect tricolored bats near the launch site. The tricolored bat is a high-frequency echolocator, and noise frequencies from launches would be in a frequency lower than the bat can hear. Bat species that use echolocation for foraging are only affected by ambient noise generated during launch activities if the species uses low-frequency echolocation (Louise et al. 2021, Jinhong et al. 2015). Because the tricolored bat uses high-frequency echolocation, increased ambient noise would not alter its activity (Bunkley et al. 2015). Noise from construction and operations would have a discountable effect on tricolored bats. Sonic booms associated with launch events would occur many miles offshore in Atlantic action area and would have no effect on the species.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). However, aircraft overflights would not interfere with the tricolored bats ability to echolocate while foraging. Effects from patrol flights associated with launches would have no effect on tricolored bats.

Expended stages would drop into the open ocean many miles from shore and would have no effect on the tricolored bat.

9.4.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered Species and to reduce wildfire risk. The tricolored bat may benefit from prescribed burning from the increased foraging opportunities from the increased open space. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, in accordance with the SPOTF Range User

Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation's prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke. Users will not place smoke restrictions on their facilities, equipment, or real property assets located on CCSFS. Because other foraging areas are available on CCSFS, no population level effects to this species would be expected. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide long-term positive effects to the tricolored bat.

9.4.3 Determination

Because the construction and operational activities will have mostly insignificant effects on the tricolored bat, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the tricolored bat.

9.5 West Indian Manatee

9.5.1 Direct Effects

The construction area contains no habitat for the West Indian manatee; therefore, construction activities would have no effect on the species.

Increased roadway traffic from construction and operations would have no effect on this aquatic species.

Light from construction and operational activities would not alter the West Indian manatee's typical diurnal behaviors as the species spends most of its time below the water's surface; therefore, light would have a discountable effect on the species.

Heat from the exhaust plume would be directed upward away from the water surface of the Atlantic Ocean by the flame diverter and would have no effect on the West Indian manatee.

Noise and vibration from launch events is expected to have discountable effects on the West Indian manatee because the species typically is unresponsive to human-generated noise and spends most of its time below the water surface. Noise from launch events may startle the West Indian manatee but the exposure to this stressor would be short in duration and episodic. Noise from operational events would have a discountable effect on the species. Sonic booms associated with launch events would occur many miles offshore and since the manatee is typically found in coastal waters of the Atlantic Ocean, sonic booms would have a discountable effect on West Indian manatees within the Atlantic action area.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Aircraft overflights may cause West Indian manatee to startle but would have a discountable effect on the species.

Debris from expended stages would drop into the open ocean many miles from shore and would be very unlikely to strike a West Indian manatee and therefore would have a discountable negative effect on the West Indian manatee.

9.5.2 Indirect Effects

No indirect effects on the West Indian manatee would be expected.

9.5.3 Determination

Based on the potential for startle from noise generated by launches and static tests, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the West Indian manatee.

9.6 Audubon's Crested Caracara

9.6.1 Direct Effects

No foraging or nesting habitat will be lost for the Audubon's crested caracara due to project construction. Construction activity may cause birds to temporarily relocate foraging areas, if present. No incidental mortality would occur from construction equipment. Construction activities would have a discountable effect on the Audubon's crested caracara.

Increased vehicle traffic from construction and operational activities would not increase the likelihood of a vehicle strike as the species is rare on CCSFS and would be expected to avoid collisions with vehicles.

Light from construction and operational activities would not be expected to interfere with Audubon's crested caracara foraging activities as the species forages only during the day when light from launches would not have an increased affect above ambient conditions. Light from night launches would have no effect on the species as it is not known to nest at CCSFS. Increased light from the Proposed Action would have a discountable effect on Audubon's crested caracara.

The heat and exhaust plume would have no effect on the Audubon's crested caracara as there is no foraging habitat within the footprint of the plume and the species would not be expected to occur within this portion of the noise area.

Launch vehicle noise and vibration within the noise area could cause the Audubon's crested caracara to startle during launch operations but would not result in significant physiological or behavioral effects. Audubon's crested caracara would return to foraging activities soon after the short duration and episodic increase in noise and vibration. Sonic booms associated with launch events would occur many miles offshore, so any effects would be negligible. Noise from operational activities would have an insignificant effect on the Audubon's crested caracara.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Patrol flights associated with launches are expected to have a discountable effect on Audubon's crested caracara.

Debris from expended stages would drop into the open ocean many miles from shore where the species does not occur and would have no effect on the Audubon's crested caracara.

9.6.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered species and to reduce wildfire risk. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, per the SPOTF Range User Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation's prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke.

Users will not place smoke restrictions on their facilities, equipment or real property assets located on CCSFS. Launches associated with the Proposed Action will not preclude a prescribed burn under suitable weather conditions. Because other foraging areas are available on CCSFS, no population level effects to this species would be expected. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide a positive long-term effect on the Audubon's crested caracara.

9.6.3 Determination

Because the Audubon's crested caracara may be startled during launch activities, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the Audubon's crested caracara.

9.7 Black-capped Petrel

9.7.1 Direct Effects

The construction area contains no habitat for the black-capped petrel and thus construction activities would have no effect on this species. The presence of the black-capped petrel within the Atlantic action area would be intermittent where elevated noise, and expendable launch debris would occur during operational activities. This species would be unlikely to occur in the nearshore Atlantic action area due to its foraging habitat preferences and would be considered a transient visitor if present. Project construction would have no effect on the black-capped petrel.

Increased roadway traffic during project construction and operations would have no effect on the black-capped petrel.

Light from construction and operational activities would not be expected to interfere with the black-capped petrel foraging activities as the species forages only during the day when light from launches would not have an increased affect above ambient conditions. The species also is very unlikely to occur within the noise area where elevated light from launches would occur, particularly at night. Increased light from the Proposed Action would have a discountable effect on the black-crapped petrel.

Heat from the exhaust plume would extend over the nearshore Atlantic Ocean temporarily during launch operations. However due to the preferred foraging habitat of the black-capped petrel and the short duration of the heat exhaust plume, exposure to elevated heat is expected to have a discountable effect on this species.

Launch vehicle noise and vibration within the noise area could cause the black-capped to startle, if present, during launch operations but would not result in permanent physiological or behavioral effects. Sonic booms associated with launch events may also startle the black-capped petrel which may temporarily suspend foraging. Noise impact to this species would be considered short in duration and episodic and would have an insignificant effect on the black-capped petrel.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species and may startle the black-capped petrel which may temporarily suspend foraging. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Patrol flights associated with launches are expected to be an insignificant negligible effect.

Debris from expended stages would drop into the Atlantic Ocean within the potential foraging habitat for the black-capped petrel. However, debris striking an individual bird foraging at sea would be extremely unlikely and would be considered a discountable effect.

9.7.2 Indirect Effects

No indirect effects on the black-capped petrel would be expected.

9.7.3 Determination

Because the black-capped petrel may be startled by launch activities, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the black-capped petrel.

9.8 Florida Scrub-Jay

9.8.1 Direct Effects

Poor-quality Florida scrub-jay habitat is located within the construction area but is not currently being used by the Florida scrub-jay; therefore, incidental mortality of the Florida scrub-jay would not occur during clearing activities because the species is not actively using the construction area (Figure 6-2). Pre-construction surveys for the Florida scrub-jay would be completed before land-disturbing activities. If the species were detected in the construction area, additional consultation with USFWS would be completed before the work.

Increased vehicle traffic from construction and operational activities would not increase the likelihood of a vehicle strike as the species would be expected to continue to avoid collisions with vehicles on CCSFS.

Light from launch operations would not be expected to interfere with Florida scrub-jay activities including foraging, breeding, or socializing. The Florida scrub-jay is active only during the day when light from launches would not have an increased affect above ambient light conditions. Light from night launches may temporarily disturb Florida scrub-jays who are inactive during the night but would be short in duration. Light from launch activities would have an insignificant effect on Florida scrub-jays.

The Florida scrub-jays do not currently use the area at the end of the flame trench for nesting or foraging and would not be exposed to heat from launches or static tests. Heat from the exhaust plume has been designed to be directed upwards and away from the ground to minimize localized impacts on the environment (Figure 3-4 and Figure 3-5). It is unlikely that Florida scrub-jays would be present within the area of the heat exhaust plume during launches or static tests. Increased heat from the exhaust plume would have an insignificant effect on the Florida scrub-jay.

Launch vehicle noise and vibration within the noise area could cause Florida scrub-jay to startle during launch operations and may result in the species temporarily suspending foraging. Laboratory studies indicate birds decreased their general activity and increased stationary and social behaviors in response to episodic noise stimuli (Corbani et al. 2021). In its BO regarding the effects of noise exposure from the increased cadence of rocket launches on snowy plovers and California least terns at Vandenberg Space Force Base, California, the USFWS acknowledged it was unable to determine direct physiological effects (hearing trauma) and instead provided qualified discussions of potential behavioral effect (starling response). However further effects from the starling response anticipated were not detailed, as the Service stated that responses would be unknown without monitoring (USFWS 2023d and Appendix A).

Noise and vibration from the launch would be temporary, short in duration, and episodic and would not result in permanent physiological or behavioral effects that would affect its ability to nest, feed or shelter in the area and would have an insignificant effect on Florida scrub-jays. Sonic booms associated with launch events would occur many miles offshore and would have no effect on Florida scrub-jays. Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998).

Patrol flights associated with launches would be expected to temporarily startle Florida scrub-jays and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the Florida scrub-jay.

9.8.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered species and to reduce wildfire risk. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, per the SPOTF Range User Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation’s prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke. Users will not place smoke restrictions on their facilities, equipment or real property assets located on CCSFS. Launches associated with the Proposed Action will not preclude a prescribed burn under suitable weather conditions. Less frequent use of fire management in these areas could lead to a decline in habitat suitable for the Florida scrub-jay. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide long-term benefit to the Florida scrub-jay. The continued, unimpeded implementation of scrub habitat management will have a positive effect on the Florida scrub-jay.

9.8.3 Determination

Clearing of habitats during construction would have minimal effect on the Florida scrub-jay due to the low-quality habitat types present within the construction area. Because Florida scrub-jays are likely to startle from noise during launch activities within the noise area, SLD 45 has determined that that the Proposed Action may affect, but is not likely to adversely affect, the Florida scrub-jay.

9.9 Piping Plover

9.9.1 Direct Effects

The construction area contains no habitat for the piping plover and the presence of this species within the noise area would be limited to the Atlantic Ocean beaches approximately 1,000 feet to the east of construction activities. Construction activities will have no effect on piping plover or habitats that the species uses.

Increased roadway traffic from construction and operational activities will have no effect on the piping plover as its foraging habitat does not occur adjacent to any roadways at CCSFS.

Increased light during launch operations within the noise area would not be expected to interfere with piping plover foraging activities. Piping plover are active only during the day when light from launches would not have an increased affect above ambient light conditions. Light from night launches may temporarily disturb piping plover who are inactive during the night but would be short in duration. Light from launch activities would have an insignificant effect on piping plover.

Heat from the exhaust plume will extend out toward the shoreline where piping plover foraging habitat occurs within the noise area. However, the exhaust plume has been designed to be directed upwards and away from the ground to minimize localized impacts on the environment (Figure 3-4 and Figure 3-5). It is unlikely that piping plover would be present within the area of the heat exhaust plume during launches or static tests. Increased heat from the exhaust plume would have an insignificant effect on the piping plover.

Noise and vibration associated with construction activity are not expected to affect the species because it does not occur in the construction portion of the action area. Launch vehicle noise and vibration within the noise area could cause the piping plover to temporarily startle during launch operations but would not result in permanent physiological or behavioral effects as the noise stimulus is of short duration and episodic. Sonic booms associated with launch events would occur many miles offshore and have no effect on this species. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on the piping plover.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle piping plover and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the piping plover.

9.9.2 Indirect Effects

No indirect effects on the piping plover would be expected.

9.9.3 Determination

Because the piping plover may be startled by launch activities, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the piping plover.

9.10 Red Knot

9.10.1 Direct Effects

The red knot occasionally forages along the shoreline east of the construction area during migration. The construction area contains no habitat for the red knot and the presence of this species would be limited to the Atlantic Ocean beaches approximately 1,000 feet to the east of construction activities. Construction activities will have no effect on piping plover or habitats that the species uses.

Increased roadway traffic from construction and operational activities will have no effect on the red knot as its foraging habitat does not occur adjacent to any roadways at CCSFS.

Increased light during launch operations within the noise area would not be expected to interfere with red knot foraging activities. Red knots are active only during the day when light from launches would not have an increased affect above ambient light conditions. Light from night launches may temporarily disturb red knot who are inactive during the night but would be short in duration. Light from launch activities would have an insignificant effect on red knot.

Heat from the exhaust plume will extend out toward the shoreline where piping plover foraging habitat occurs within the action area. However, the exhaust plume has been designed to be directed upwards and away from the ground to minimize localized impacts on the environment (Figures 3-4 and 3-5). It is unlikely that piping plover would be present within the area of the heat exhaust plume during launches or static tests. Increased heat from the exhaust plume would have an insignificant effect on the piping plover.

Noise and vibration associated with construction is not expected to affect the species because it does not occur in the construction area. Launch vehicle noise and vibration within the noise area could cause red knot to temporarily startle during launch operations but would not result in permanent physiological or behavioral effects as the noise stimulus is of short duration and episodic. Sonic booms associated with launch events would occur many miles offshore and would have no effect on this species. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on the red knot.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle red knot and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the red knot.

9.10.2 Indirect Effects

No indirect effects on the red knot would be expected.

9.10.3 Determination

Because the red knot may be startled by launch activities, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the red knot.

9.11 Wood Stork

9.11.1 Direct Effects

The construction area contains 0.2 acres of poor-to-moderate quality wood stork foraging habitat (canal ditch) that would be removed and 1.0 acres that would be temporarily disturbed from construction activities No wood stork nesting colonies are located within the construction area where habitats will be cleared. No mortality of individuals would result from construction activities. The loss of foraging habitat will have an insignificant impact to wood storks.

Increased roadway traffic from construction and operational activities may slightly increase the chance for vehicle strikes on wood storks in areas where wood stork foraging habitats (ditches and canals) are adjacent to roadways. However, the likelihood of vehicle strikes is mitigated by the low-speed limits at CCSFS. Increased roadway traffic from construction and operation will have an insignificant effect on wood storks.

Increased light during launch operations within the noise area would not be expected to interfere with wood stork foraging activities. Wood storks are active only during the day when light from launches would not have an increased affect above ambient light conditions. Light from night launches would not disturb wood storks as they do not nest on CCSFS. Light from launch activities would have a discountable effect on wood storks.

Launches and static tests could reduce the quality of wood stork foraging habitat at the end of the flame trench. In the report *Monitoring Direct Effects of Delta, Atlas, and Titan launches from CCAS* (USAF 1998) it was noted that no wildlife mortality resulted from 46 launches monitored over a 4-year period, however this study did not target wood storks. Historically, vegetation scorching from launch events has been limited to small areas (less than 2.5 acres) within 495 feet of the launch pad (USAF 2023). The heat plume temperature would be 309°F at the end of the flame trench (Figure 3-4 and Figure 3-5) and flash ignition of standing woody vegetation typically requires a temperature of 710°F or greater (Durda and Kring 2004). With the diverter directing the heat up and away from the ground, scorching of vegetation would not be expected along the canal would not occur, but heat wilt of peripheral canopy branches and leaves likely would result near the end of the flame trench. Any effects at ground level are expected to be insignificant with the heat being directed upward and the short duration of the heat exposure. No mortality of foraging wood storks would be expected. The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45, and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS. Increased heat from the exhaust plume would have an insignificant effect on the wood stork.

Launch vehicle noise and vibration within the noise area could cause wood stork to startle and temporarily suspend foraging during launch operations and static test fires but would not result in significant physiological or behavioral effects as the noise stimulus is of short duration and episodic. Sonic booms associated with launch events would occur many miles offshore and would have no effect on this species. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on wood storks.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle red knot and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the wood stork.

9.11.2 Indirect Effects

No indirect effects on the wood stork would be expected.

9.11.3 Determination

Because the wood stork may experience some foraging habitat loss within the construction area and because the species is likely to startle during operational activities, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the wood stork.

9.12 American Alligator

9.12.1 Direct Effects

The construction area contains 1.4 acres of American alligator habitat (canal ditch) of which 0.2 acres would be removed from project construction. Other wetlands and waters within the construction area are not considered alligator habitat due to the lack of permanent water and dense growth of woody vegetation. No mortality of individuals would result from construction activities. The loss of foraging habitat will have an insignificant impact to American alligators.

Increased roadway traffic from construction and operational activities may slightly increase the chance for vehicle strikes on American alligators in areas where wood stork foraging habitats (ditches and canals) are adjacent to roadways. However, the likelihood of vehicle strikes is mitigated by the low-speed limits at CCSFS and incidental mortality from increased vehicle traffic is considered minimal. Increased roadway traffic from construction and operation will have an insignificant effect on American alligators.

Increased light during launch operations within the noise area would not be expected to interfere with American alligator foraging or breeding activities. During the day, light from launches would not have an increased affect above ambient light conditions. Light from night launches may startle American alligators causing a temporary suspension of foraging activities. However, the short duration of the increased light during nighttime launch events would be expected to have an insignificant effect on American alligators.

The American alligator may occur in the canal at the end of the flame trench. Heat from launches and static tests would generate temperatures of 309°F at the end of the flame trench (Figure 3-4 and Figure 3-5). In the report *Monitoring Direct Effects of Delta, Atlas, and Titan launches from CCAS* (USAF 1998) it was noted that no wildlife mortality resulted from 46 launches monitored over a 4-year period, however this study did not target American alligators. With the diverter directing the heat up and away from the ground, any effects at ground level are expected to be insignificant with the heat being directed upward and the short duration of the heat exposure. No mortality of American alligator would be expected. The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45, and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS. Increased heat from the exhaust plume would have an insignificant effect on the wood stork.

Reptiles are sensitive to vibrations, and noise and vibration associated with construction activity could displace American alligator from foraging in the 1.2 acre of habitat that would remain post-construction (Table 5.1) within the construction area. American alligators likely occur within the 194.3 acres (Table 5-2) of suitable habitat in the noise area outside the construction area. Launch vehicle noise and vibration within the noise area could cause American alligator to startle and temporarily suspend foraging during launch operations and static test fires but would not result in permanent physiological or behavioral effects as the noise stimulus is of short duration and episodic sonic booms associated with launch events would occur many miles offshore and would have no effect on American alligators within the action area. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on American alligators.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle American alligators and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the American alligator.

9.12.2 Indirect Effects

No indirect effects on the American alligator would be expected.

9.12.3 Determination

Because the loss of habitat for the American alligator within the construction area, and because the species may be startled within the noise area during launches and stating test fires, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the American alligator.

9.13 Eastern Indigo Snake

9.13.1 Direct Effects

Because gopher tortoise burrows occur throughout the construction area, use of this area by eastern indigo snakes is likely. During construction of the project, 36.4 acres of eastern indigo snake habitat would be disturbed and 8.7 acres of this habitat would be permanently lost. The loss of habitat could contribute to reduced population levels by reducing foraging and breeding opportunities.

Tortoise burrows would be excavated before construction and, if an eastern indigo snake is encountered, work would stop in the vicinity of the snake until it voluntarily left the work area. Qualified biologists would monitor tortoise relocations ahead of construction. To further minimize construction impacts, eastern indigo snake standard USFWS protection measures shall be implemented during construction activities. The potential does exist however for incidental mortality of the species from land clearing activities through crushing or entombment from heavy machinery. Construction activities are likely to have an insignificant effect on eastern indigo snakes within the construction area. The potential for incidental mortality would be minimized through pre- and during construction surveys and protection measures.

Increased roadway traffic from construction and operational activities may slightly increase the chance for vehicle strikes on eastern indigo snakes where habitats are adjacent to roadways. However, the likelihood of vehicle strikes is mitigated by the low-speed limits at CCSFS and incidental mortality from increased vehicle traffic is considered minimal. Increased roadway traffic from construction and operation will have an insignificant effect on eastern indigo snakes.

Launches and static tests could cause incidental mortality to the eastern indigo snake in the immediate vicinity of the launch because of extreme heat from the exhaust plume. In the report *Monitoring Direct Effects of Delta, Atlas, and Titan launches from CCAS* (USAF 1998) it was noted that no wildlife mortality resulted from 46 launches monitored over a 4-year period, however this study did not target eastern indigo snakes. The heat plume temperature would be 309°F at the end of the flame trench (Figures 3-4 and 3-5) and flash ignition of standing woody vegetation typically requires a temperature of 710°F or greater (Durda and Kring 2004). With the diverter directing the heat up and away from the ground, scorching of vegetation would not be expected, but heat wilt of peripheral canopy branches and leaves likely would result. Any effects at ground level are expected to be insignificant with the heat being directed upward, the short duration of the heat exposure, and the additional insulation that canopy vegetation would provide to lower areas. Exposure from the heat exhaust plume on the eastern indigo snake would be an insignificant effect.

The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45, and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS.

Reptiles are sensitive to vibrations, and noise and vibration associated with construction and operational activities. Launch vehicle noise and vibration within the noise area could cause eastern indigo snakes to startle and temporarily suspend foraging during launch operations and static testfires but would not result in permanent physiological or behavioral effects as the noise stimulus is of short duration and episodic.

Eastern indigo snakes within burrows would be relatively unaffected by noise and vibration due to the attenuation of sound through the soil. Sonic booms associated with launch events would occur many miles offshore and would have no effect on eastern indigo snakes. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on eastern indigo snakes.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle eastern indigo snakes and have an insignificant effect.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the eastern indigo snake.

9.13.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered species and to reduce wildfire risk. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, in accordance with the SPOTF Range User Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation's prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke. Users will not place smoke restrictions on their facilities, equipment, or real property assets located on CCSFS. Launches associated with the Proposed Action will not preclude a prescribed burn under suitable weather conditions. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide long-term positive benefits to the eastern indigo snakes.

9.13.3 Determination

Because of the potential for incidental take from construction activities and loss of habitat, SLD 45 has determined that the Proposed Action may affect, and is likely to adversely affect, the eastern indigo snake.

9.14 Monarch Butterfly

9.14.1 Direct Effects

There are no milkweeds plants (*Asclepias spp*.) known to occur within the in the construction area that monarch butterflies could use as host plants in part of their reproductive lifestyle. Multiple nectarplant species seasonally occur within the construction area where project construction activities will clear habitats. Approximately 9.8 acres of nectaring plant habitat would be permanently lost to construction of impervious area and a stormwater pond. An additional 25.6 acres of habitat would be temporarily disturbed but allowed to regrow post-construction. The permanent and temporary loss of flowing nectar plant habitat would reduce monarch butterfly foraging opportunities within the construction area. However, large amounts of suitable foraging habitat that support nectar plants would continue to exist within the noise area, outside of the construction area. Loss of foraging habitat is considered to be a discountable effect on the monarch butterfly.

Increased vehicle traffic from project construction and operational activities on existing CCSFS roadways, could potentially result in vehicle strikes of monarch butterflies. However, due to the preference and availability of foraging habitats at CCSFS, roadways would not typically be visited by transient butterflies as the roadway rights-of-way are maintained by mowing and flowing plants generally absent. Vehicle strikes by cars would be similar in frequency to baseline conditions and increased traffic would have a discountable effect on monarch butterflies.

Light, noise, and vibration from construction and operational activities would have no effect on monarch butterflies, habitat for host plants, or foraging habitats.

Monarch butterflies foraging near the heat exhaust plume could encounter elevated heat during launch and static testfires resulting incidental mortality. The potential for the species to be incinerated during these activities is considered small, as frequency and duration of the heat exhaust plume affecting the neighboring habitats is low and short. Incidental mortality from the heat exhaust plume would be much less than what is likely incurred through the CCSFS prescribed fire program which has a net benefit for scrub habitat that supports monarch butterfly host and nectaring forage plants. Exposure to the heat exhaust plume would have an insignificant effect on the monarch butterfly.

Debris from expended stages would drop into the open ocean many miles from shore and would have no effect on the monarch butterfly or its habitats.

9.14.2 Indirect Effects

Prescribed burning on CCSFS is required to meet environmental habitat management requirements for threatened and endangered species and to reduce wildfire risk. Prescribed fire must be done when fuel moistures and weather conditions are within acceptable ranges. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres of prescribed fire to manage habitat for listed species, including the southeastern beach mouse and the Florida scrub-jay. As the frequency of range operations increases, in accordance with the SPOTF Range User Requirements, routine payload processing and hardware movement cannot place undue restrictions on the installation’s prescribed burning program. Users will be responsible for the protection of their spacecraft, flight hardware, and other critical systems from smoke. Users will not place smoke restrictions on their facilities, equipment, or real property assets located on CCSFS. Launches associated with the Proposed Action will not preclude a prescribed burn under suitable weather conditions. Less frequent use of fire management in these areas could lead to a decline in habitat suitable for the monarch butterfly because of reduced abundance of nectaring and reproductive plant species. In order to minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, the Range User (Stoke) will coordinate with SLD 45 to deconflict operations in order for SLD 45 to continue to implement prescribed burning, which would provide long-term positive benefits to the monarch butterfly.

9.14.3 Determination

Because of the potential for permanent loss of foraging habitat, SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the monarch butterfly.

9.15 Effects on Marine Turtles

9.15.1 Direct Effects

Approximately 5,400 feet of beach habitat, where marine turtles may nest is within the noise area. Sea turtles also occur within the nearshore Atlantic action area. No disturbance would occur from construction activities to sea turtle nesting habitat or to the nearshore Atlantic action area, as these areas are outside of the construction area.

Increased traffic from project construction and operational activities would have no effect on marine turtles.

Artificial light associated with the infrastructure and additional light associated with night launch events may result in disorientation or misorientation of marine turtle adults and hatchlings that nest on the beaches within the action area. A LMP would be required for the construction and operation of the Proposed Action and the LMP would be consistent with the existing programmatic BO for exterior lighting. The construction LMP would address temporary lighting during predawn hours to accommodate activities such as concrete pours. Adherence to the LMP would reduce the effects of construction lighting on nesting marine turtles and hatchlings. Light from launches and testfires may also result in the disorientation or misorientation of marine turtle adults and hatchlings causing turtles to head inland and not reach the sea. Adults would typically survive but nesting success could be reduced. Hatchlings could become disoriented such that they do not reach the sea, resulting in incidental mortality. However, the frequency and duration of light during nighttime operational events would be low and short. Lighting from construction and operational would have an insignificant effect on marine turtles.

Heat from the exhaust plume would be directed upward away from beaches the water surface of the Atlantic Ocean by the flame diverter and would have a discountable effect on marine turtles.

Construction noise would be limited to daytime hours except for limited predawn work for concrete pours, which would generate less noise than typical construction. Noise from construction is unlikely to affect sea turtles because the construction area is more than 750 feet from nesting beaches, with intervening vegetation to further reduce the noise. Launch vehicle noise and vibration within the noise area could cause marine turtle species to startle during launch operations but would not result in significant physiological or behavioral effects as the noise stimulus is of short duration and episodic. Noise and vibration from launch activities would be comparable to military jet aircraft overflights, which occurs frequently on USAF installations, Sea turtles hearing peaks between 200 and 750 Hz, which make them susceptible to low-frequency noise which may harm their hearing and maybe even interfere with their nesting patterns. However, there is not enough available data to understand the full extent of the damages to sea turtles from sound exposure (ANSI 2016). Sonic booms associated with launch events would occur many miles offshore and would have no effect on marine turtles within the Atlantic action area. Noise and vibration impact to this species would be considered short in duration and episodic and would have an insignificant effect on marine turtles.

Pre-launch patrol aircraft overflights can be an acoustic and visual disturbance to wildlife species. Wildlife regularly subjected to aircraft overflights tend to habituate to the recurrent stimulus (USAF 1998). Effects from patrol flights associated with launches are expected to temporarily startle marine turtles and have an insignificant effect.

Debris from expended stages would drop into the Atlantic action area many miles from shore and would be very unlikely to strike marine turtles and therefore would have a discountable effect.

Stoke would conduct appropriate consultation with NMFS regarding species under its jurisdiction, including marine turtles at sea.

9.15.2 Indirect Effects

Because no marine turtle habitat is in the construction area and the nesting habitat is separated from the construction area by more than 750 feet, no indirect effects on marine turtles would be expected.

9.15.3 Determination

Because construction and operational lighting would be consistent with the programmatic BO for exterior lighting SLD 45 has determined that the Proposed Action may affect, but is not likely to adversely affect, the loggerhead, green sea, leatherback, Kemp's ridley, and hawksbill sea turtles.

9.16 Effects on Critical Habitat

9.16.1 West Indian Manatee Critical Habitat

The construction area would be approximately 1,000 feet from critical habitat for the West Indian manatee in the Atlantic Ocean and more than 12,000 feet from critical habitat in the Banana River. Site-specific stormwater management during construction would prevent sedimentation from being transported from temporarily disturbed areas into critical habitat. Operations would not disturb critical habitat for the West Indian manatee because effects would be confined to the launch site for launches and testing and farther at sea for expending the first and second stages of the launch vehicle.

No destruction or adverse modification of critical habitat for the West Indian manatee would result from the construction and operation of the Proposed Action.

9.16.2 Loggerhead Sea Turtle Critical Habitat

The construction area would be approximately 1,000 feet from critical habitat for the loggerhead sea turtle in the Atlantic Ocean. Site-specific stormwater management during construction would prevent sedimentation from being transported from temporarily disturbed areas into critical habitat. Operations would not disturb critical habitat for the loggerhead sea turtle because effects would be confined to the launch site for launches and testing and farther at sea for expending the first and second stages of the launch vehicle.

Any potential impacts to loggerhead sea turtle critical habitat would be addressed during consultation with NMFS.

No destruction or adverse modification of critical habitat for the loggerhead sea turtle would result from the construction and operation of the Proposed Action.

10. Conservation Measures to be Implemented as Part of the Project

The section discusses conservation measures that would be implemented as part of the project to avoid or minimize effects on listed species.

10.1 Southeastern Beach Mouse

The heat plume region of influence will be monitored during launch events and static tests to better understand any potential impacts. Monitoring will include temperature sensors and a visual review of the potentially affected area. Results from this monitoring will be reviewed with SLD 45 and, if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the USFWS.

SLD 45 would continue to implement its prescribed fire program, which would provide long-term benefit to the southeastern beach mouse. In addition to the continued implementation of the prescribed fire program. Stoke has agreed to allow for the establishment of the habitat within the construction area that would be disturbed, but not hardened with roads or facilities, thus providing a benefit southeastern beach mouse (Table 11-1). Stoke has furthermore agreed to conduct southeastern beach mouse monitoring within the perimeter of SLC-14. This monitoring may contribute to the science of how the southeastern beach mouse is using the SLC-14 site post-construction.

Table 10-1. Acreages of Southeastern Beach Mouse Habitat by Type Allowed to Regrow in the Construction Area

Habitat Type	Within Construction Area (acres)	Habitat Regrowth
Coastal Scrub	22.2	17.2
Xeric Hammock	17.5	9.8
Total	41.1	27.0

10.2 Tricolored Bat

Structures that would be demolished or refurbished would be surveyed for roosting bats before work. If tricolored bats are found in a building, paths of bat entry to the building would be sealed after bats had voluntarily left the building as part of their daily activity. No work would occur until it is verified that the building is free of tricolored bats.

10.3 West Indian Manatee

Minimal effects to the West Indian manatee from the Proposed Action were determined. There would be no effect on the species' habitat. No conservation measures are proposed to be implemented for the West Indian manatee.

10.4 Audubon's Crested Caracara

Minimal effects to the Audubon's crested caracara and its habitat were determined. No conservation measures for this species are proposed to be implemented.

10.5 Black-capped Petrel

Minimal effects to the black-capped petrel were determined. There would be no effect on the species' habitat. No conservation measures for this species are proposed to be implemented.

10.6 Florida Scrub-jay

Although the construction area is not currently occupied, Florida scrub-jay surveying would be conducted before clearing to ensure that no jays are nesting within 300 feet of clearing activities. All suitable scrub-jay habitat would be surveyed for nesting jays. Any nests encountered would be flagged and no clearing would be allowed within 300 feet until all birds have fledged.

SLD 45 would continue to implement its prescribed fire program, which would benefit the Florida scrub-jay.

10.7 Piping Plover

Minimal effects to the piping plover were determined. There would be no effect on the species' habitat. No conservation measures for this species would be implemented.

10.8 Red Knot

Minimal effects to the piping plover were determined. There would be no effect on the species' habitat. No conservation measures for this species are proposed to be implemented.

10.9 Wood Stork

Because effects would be limited to temporary displacement from foraging habitat and startle from noise, no conservation measures for wood stork would be implemented.

10.10 American Alligator

SLD 45 would require all construction and operations personnel to complete environmental training on the potential presence of the American alligator in the vicinity of the project, the requirement to avoid disturbing any alligator nests, and the laws regarding feeding alligators.

10.11 Eastern Indigo Snake

SLD 45 Indigo Snake Protection and Education Plan would be provided to the Stoke project manager, their construction manager, and construction personnel. Educational signs and posters would be displayed at the site to inform personnel of the appearance and protected status of the eastern indigo snake. Information on whom to contact if an eastern indigo snake is seen in the area would be prominently displayed. If any eastern indigo snake is encountered during clearing activities, work in the area would stop and the snake would be allowed to move safely out of the construction area of its own volition. Observations of live or dead indigo snakes would be reported to SLD 45 immediately and SLD 45 would report them to USFWS, if appropriate.

The gopher tortoise is a former federal candidate species, and the eastern indigo snake is a known commensal of the gopher tortoise. SLD 45 implements conservation measures for the gopher tortoise that would minimize the potential for effects on the eastern indigo snake. To the extent possible, gopher tortoise burrows would not be disturbed if a minimum 25-foot (7.6-meter) buffer around the mouth of the burrow can remain to connect the burrow to foraging areas in accordance with Florida Fish and Wildlife Conservation Commission (FWC) guidelines. Following FWC guidelines, no more than 90 days before and no fewer than 72 hours before any clearing or construction, a 100% pedestrian survey would be conducted to locate and flag and stake all burrows. Gopher tortoise burrows in areas to be cleared, areas for new construction, or on the shoulder of roads to be rebuilt would be excavated, and captured tortoises would be relocated in accordance with FWC guidelines to SLD 45-approved recipient site on CCSFS. Any eastern indigo snake present would be allowed to voluntarily leave the area before excavation continuing.

Photograph 10-1. Gopher Tortoise Burrow

10.12 Monarch Butterfly

Minimal effects to the monarch butterfly and on the species' habitat (nectaring plants) were determined. No conservation measures are proposed to be implemented for this species.

SLD 45 would continue to implement its prescribed fire program, as defined in the INRMP, which would benefit the monarch butterfly by maintaining host and nectaring plant habitats.

10.13 Marine Turtles

To minimize potential impacts to sea turtles from facility lighting, the exterior lighting proposed for this project would be in accordance with the 2018 45th SWI 32-7001, *Exterior Lighting Management*. An LMP would be completed by Stoke and submitted to SLD 45 and USFWS for approval before new or temporary lighting construction.

The LMP will specify that any variance to allow noncompliant lighting would limit operation between 9:00 p.m. and dawn from May 1 through October 31 unless essential to support launch-related activities. SLD 45 will monitor disorientation around SLC 14 as part of the normal daily sea turtle monitoring program and per the PBO for exterior lighting. Incidental take as a result of SLC 14 lighting will be tracked and provided to USFWS on an annual basis. If the SLD 45 observes any problematic lighting during light inspections, they will work with Stoke to address the issue as quickly as possible. If the incidental take nears the amount authorized in the PBO as the result of SLC 14 lighting, the SLD 45 will initiate conversations with Stoke and USFWS to resolve any source lighting causing the issues. SLD 45 would follow all requirements of the PBO in the event that live or dead hatchlings or adults are found as a result of any disorientation.

11. Compensation for Affected Species

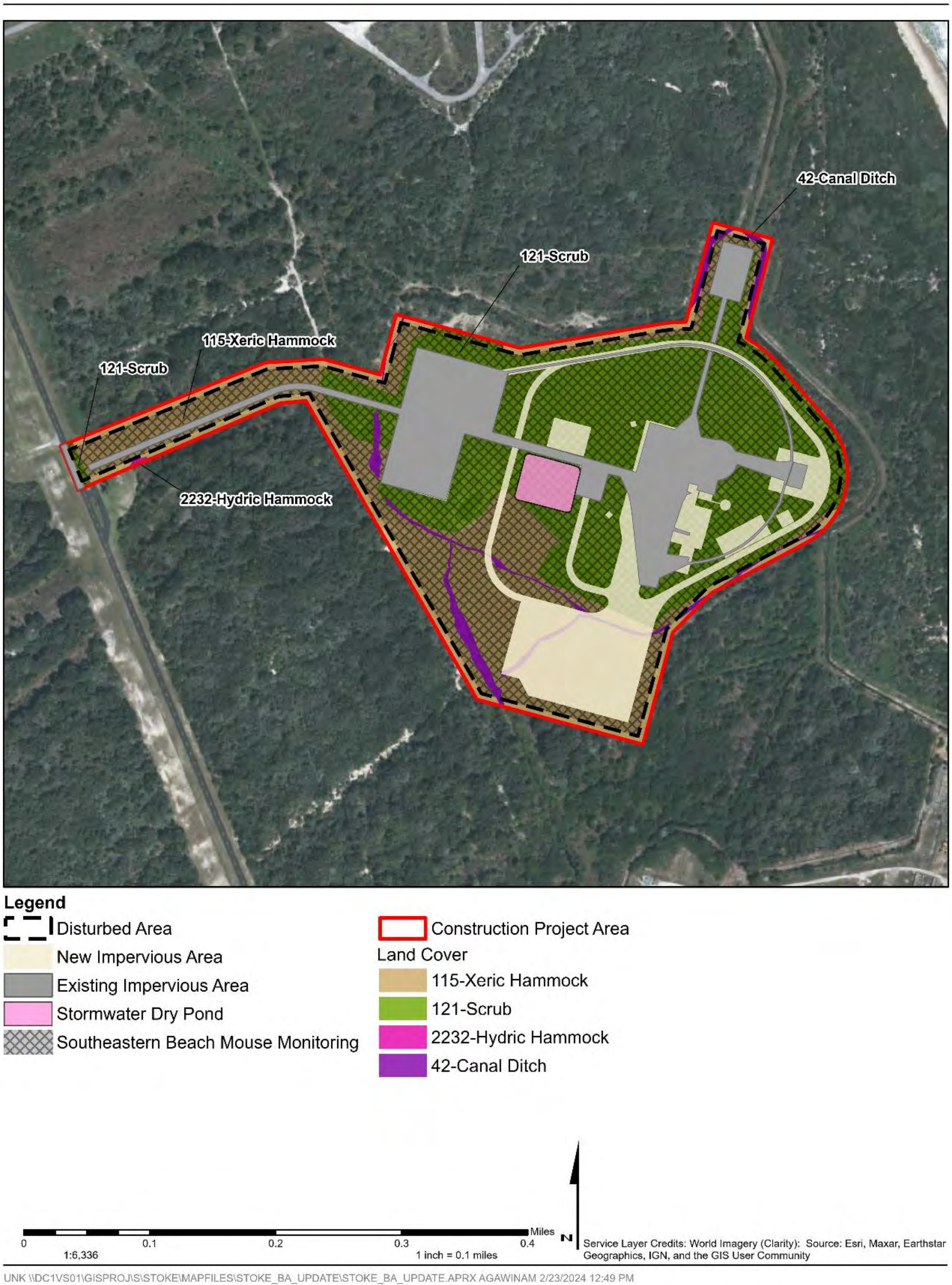
The section discusses compensation that would be implemented to avoid or minimize any effects on listed species.

11.1 Southeastern Beach Mouse

The Proposed Action would result in the temporary disturbance of 21.5 acres of coastal scrub habitat and 13.9 acres of xeric hammock habitat.

SLD 45 has recently concluded a programmatic consultation with USFWS on the Range of the Future (USFWS 2023f), where mitigation for the southeastern beach mouse is required for habitat impacts at a 1:1 ratio. Stoke will mitigate for the permanent loss of 9.8 of southeastern beach mouse habitat at a 1:1 ratio. This mitigation will consist of restoration of habitat on CCSFS outside the projected area of impact in a land management unit to be determined by SLD 45 and USFWS. Restoration may include but not be limited to mechanical cutting of overgrown scrub, treatment of invasive vegetation, creation of openings, prescribed burning, and plantings. Stoke would be required to provide funding for the initial restoration as well as any annual maintenance to ensure the site is maintained as suitable beach mouse habitat. As a potential alternative, the SLD 45 and USFWS are working on creation of a species fund which would enable Stoke to deposit money into an account annually that would then be used to fund pre-identified projects related to beach mouse recovery efforts. Since this program has not yet been established, restoration of habitat on CCSFS remains the preferred option at this time. Stoke has also committed to monitoring the 27 acres of habitat following construction (Figure 11-1). Stoke will work with SLD 45 and USFWS to determine the appropriate measures for monitoring and the necessary duration to determine southeastern beach mouse use of habitat within the construction area. The details of specific monitoring methods, frequency, and duration are not available at this time.

1 **Figure 11-1. Southeastern Beach Mouse Monitoring**



2

11.2 Tricolored Bat

No compensation measures would be implemented for the tricolored bat.

11.3 West Indian Manatee

No compensation measures would be implemented for the West Indian manatee.

11.4 Audubon's Crested Caracara

No compensation measures for Audubon's crested caracara would be implemented.

11.5 Black-capped Petrel

No compensation measures for black-capped petrel would be implemented.

11.6 Florida Scrub-jay

No compensation measures for the Florida scrub-jay are proposed.

11.7 Piping Plover

No compensation measures for the piping plover would be implemented.

11.8 Red Knot

No compensation measures for the red knot would be implemented.

11.9 Wood Stork

No incidental mortality to the wood stork would result from construction and operation of the Proposed Action. Although 1.0 acre of poor-quality wood stork foraging habitat would be temporarily unavailable because of project construction, no roosting and nesting habitat for the wood stork would be affected. Because only 0.2 acres of foraging habitat would be permanently lost, and because there is a large amount of comparable or greater quality foraging habitat in the vicinity of the construction area, no compensation is proposed for the wood stork.

11.10 American Alligator

No compensation measures for the American alligator would be implemented.

11.11 Eastern Indigo Snake

No compensation measures for the eastern indigo snake would be implemented.

11.12 Monarch Butterfly

No compensation measures for the monarch butterfly are proposed. Restoration and enhancement for the southeastern beach mouse habitat would result in more open scrub habitat with a more diverse understory that could provide greater host and nectaring plant habitats for the monarch butterfly.

11.13 Marine Turtles

No compensation measures for marine turtles would be implemented.

12. Cumulative Impacts

The project is on federal land and the project site is surrounded by federal land. As defined under 50 CFR 402.02 cumulative effects “are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation.” Future federal actions that are unrelated to the Proposed Action are not considered cumulative effects since they require separate consultation pursuant to section 7 of the Act.

There are no known non-federal actions that would occur in this area that could contribute to cumulative effects on listed species.

13. List of Preparers

The primary persons responsible for preparing and reviewing this report are listed in Table 13-1.

Table 13-1. List of Preparers

Name	Role	Years of Experience
Richard P. Reaves, Ph.D., CEP	Senior Ecologist and Jacobs Lead Author	30
Steve Eakin	Senior Ecologist	26
JT Hesse	Senior Biologist, Jacobs Senior Review	23
Michelle Rau	Biologist, Jacobs Project Manager	26

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Appendix A
Summary of Available Literature Regarding the Effects of Noise Exposure on Rodents

Summary of Available Literature Regarding the Effects of Noise Exposure on Rodents

Date: April 26, 2024

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1. Overview

This technical memorandum (TM) summarizes available information regarding the effects of anthropogenic (human-induced) noise exposure on small mammals, particularly rodents. The purpose of the TM is to quantify and qualify the potential effects of elevated noise on the federally threatened southeastern beach mouse (*Peromyscus polionotus niveiventris*) (SEBM) through an evaluation of the available body of knowledge. The SEBM species is known to occur at Cape Canaveral Space Force Station, Florida, where anthropogenic noise from rocket launches is a consideration for consultations through Section 7 of the Endangered Species Act for proposed activities.

Information reviewed included publicly available peer-reviewed literature from scientific journals, other literature reviews of noise effects on wildlife, textbooks, and regulatory evaluations for facilities and actions where noise was a stimulus on wildlife.

1.1 Scientific Studies

Studies specific to the SEBM and noise stimuli were found to be absent from the available body of scientific literature. Other species of "beach mice," which are subspecies of oldfield mice occurring in the southeastern U.S., are also not specifically addressed through scientific studies on noise stimuli. Available studies have focused more generally on various taxa of rodents either in field conditions or laboratory-controlled experiments measuring responses to noise stimuli. Field studies typically evaluated in situ ecological attributes such as behavioral responses (foraging, vigilance, call alarms, predation) to anthropogenic noise while laboratory-controlled experiments typically focused on physiological effects of noise (hearing trauma, brain trauma, body condition, fitness), with some studies evaluating both aspects (behavioral and physiological).

Studies into acoustic ecology began in the 1970s and have provided generalized evidence of anthropogenic noise effects on animals. A literature review by Larkin et al. (1996) regarding the effects of military noise on wildlife stated that there is some evidence that young animals are more susceptible than adults to hearing loss from exposure to loud sounds (Abrams 1980). The review also provided that wildlife is more apt to be exposed to low-frequency intense sound than to high-frequency intense sound because of greater atmospheric attenuation of high frequency components (Bass et al. 1972; Hartley 1989; Kulichkov 1992).

The effect of noise on wildlife is complicated, however, because responses vary between species and between individuals of a single population. The variation in responses is due to the characteristics of the noise and its duration, the species life history, habitat variability, season, sex and age of the individual, previous exposure, and whether other physical stresses are covariant (Busnel 1978). Generalized information regarding wildlife responses to noise stimuli were thus not incorporated into this summary. Rather available studies regarding rodent species (order Rodentia) were utilized as surrogates for the SEBM where possible.

In the textbook *Exploring Animal Behavior Through Sound: Volume 1* (Erbe and Thomas 2022), which compiled general bioacoustical information regarding wildlife research, the authors discussed the difficulty in linking short-term, individual impacts to long-term population level impacts considering animals might travel and be exposed to aggregate noise from multiple sources. The authors further stated that interpolating temporary effects on individuals to population-level effects is problematic. Thus, even interpreting the results from studies that focus on an individual species must consider ecological covariables in addition to the noise stimulus in inferring population level effects. Several studies reviewed acknowledged the variability of response to noise was likely less than other ecological variables not controlled within the studies.

The type of anthropogenic sound evaluated in most studies was chronic rather than acute. Chronic sources of sound in field studies were most commonly traffic from roadways (Bednarz 2020; Shannon et al. 2014 and 2016; Buxton et al. 2020; Rabin et al. 2003). One field study evaluated chronic noise from power generators at substations (Willems et al. 2021). Laboratory studies evaluated noise effects on animals at various exposure durations and levels, but most studies had longer-duration stimuli consistent with chronic noise (Ou et al. 2000; Sans et al. 2015, Korsós et al. 2023; Du et al. 2010). Most laboratory studies were focused on physiological responses such as hearing trauma through temporary and permanent threshold shifts in hearing frequency (Ou et al. 2000; Sanz et al. 2015). Short-duration, episodic, high-intensity sound exposure studies were largely lacking from the available studies, particularly with field studies that evaluated behavioral responses in rodents.

The most relevant field study evaluated exposure to military jet aircraft flyovers at the Barry M. Goldwater Air Force Range in Arizona (Bowles et al. 1995). This study provided both field and laboratory evaluations of behavioral and physiological responses in kangaroo rats and their predator, the desert kit fox (*Vulpes macrotis arsipus*). Sound exposures (typically reported as decibels [dB]) for most studies were often reported as ranges of noise stimulus. Thresholds for impact levels regarding behavioral and physiological effects on rodents were not presented in the available literature.

Specific types of responses of various species of rodents to noise stimuli summarized from available scientific reviewed literature are provided in the following sections.

1.2 Species Abundance

In a review of studies on traffic noise effects on terrestrial small mammals and bats (Bednarz 2020), a study was reported where the Mount Graham red squirrel (*Tamiasciurus fremonti grahamensis*) demonstrated a clear decrease in abundance in response to chronic, low-intensity traffic noise at levels continuous above 43 dB (Chen and Koprowski 2015).

1.3 Behavioral Responses

Noise stimuli can be attributed to direct behavioral responses in wildlife that include changes in activities such as foraging, vigilance, and social communications. Changes in these behaviors can then have indirect effects on predator and prey interactions which can be of benefit or detriment to rodents who are prey species. In the textbook *Exploring Animal Behavior Through Sound: Volume 1* (Erbe and Thomas 2022), the authors discussed some of these behavioral responses on mammals. The authors state that in noisy environments, behavioral shifts tend to be movement away from noisy habitats. They further state that there is no mortality directly from noise exposure but that organisms spend increased time being vigilant and less time foraging, and less predation occurs. The authors provided an example of *Peromyscus* mice being more successful collecting pine seeds because competing jays had abandoned the noisy site (Erbe and Thomas 2022). Studies generally reported contrary findings for small mammal behavior and in comparison, to established hypotheses for behavioral ecology and noise.

One lab study evaluated the acute exposure to repeated noise on mice of different sexes. The mice were exposed to 90 dB sound pressures initially for 3 minutes in duration and then for 10 hours per day. The study reported that the noise treatment did not cause significant changes in mice behavior either between sexes or between treatment groups (sound versus no sound) in terms of locomotive behavior in a maze (Korsós et al. 2023).

A literature review on traffic noise and small mammals (Bednarz 2020) evaluated ten studies on rodent activity and behavior and three studies on rodent foraging behavior with noise stimuli ranging from 26 to 87.5 dB. The literature review summarized studies reporting that the effects of traffic noise typically consisted of detrimental changes in vigilance foraging trade-off. Studies within the literature review reported findings that rodents were more vigilant when traffic noise was emitted (Shannon et al. 2014 and 2016; Buxton et al. 2020). Shannon et al. (2014) also reported that traffic noise at 77 dB reduced black-tailed prairie dog foraging by 18 percent and that traffic noise affected wild rodent activity and in consequence reduced foraging time (2014 and 2016). The results were stated to be in keeping with the risk-disturbance hypothesis stating that disturbance by humans indirectly affects survival and reproduction of animals through trade-offs between responses to the perceived risk and energy intake analogous to predation risk (Frid and Dill 2002; Peters and Otis 2005). An unpublished study found that traffic noise increased food intake of nonhabituated small foraging mammals in a forest in Poland (Bednarz et al. 2020). These findings were themselves noted to be contrary to the distracted prey hypothesis stating that the anthropogenic sound reallocates an animal's finite attention, effectively distracting it and preventing it from responding to predator threats (Chan et al. 2011)

The literature reviewed studies also found that traffic noise changed alarm calls of habituated animals. California ground squirrels (*Spermophilus beecheyi*) changed alarm calls by shifting acoustic energy to harmonics that did not overlap with the noise (Rabin et al. 2003).

The same literature review provided summary information from studies that contradicted rodent behavioral changes to traffic noise stimuli. The previously referenced study by Shannon et al. (2014) reported that Australian giant white-tailed rat related to new noise stimuli differently than black-tailed prairie dogs by not avoiding speakers playing simulated traffic noise and that noise had no effect on activity. Shannon et al. (2014) further stated that there were no negative effects of simulated traffic noise on the movement of the species. The authors proposed that for solitary, nocturnal rodents, there may be a benefit form the external noise concealing effects of their activity versus social diurnal rodents that use vocalization for communication and warning calls. A separate field study found contrary information in that foraging activity among *Peromyscus* mice increased at noisier sites relative to quieter ones (Francis et al. 2012).

Increased vigilance and decreased movement were interpreted by Willems et al. (2021) to reflect noise-induced increases in perceived predation risk which came at the cost of decreases in foraging activity for pinyon mice (*Peromyscus truei*). This study on night lighting and anthropogenic noise effects on pinyon mice found no change in trapping success along a noise gradient of quiet and noisy locations. The chronic noise exposure was from large compressors running 24 hours per day and 365 days per year, and no noise thresholds were provided. The study also found no synergistic effects from night lighting and noise on trapping success (Willems et al. 2021). Another study investigating the effects of chronic noise from wind turbines on California ground squirrels found no difference in time spent above ground between quiet and noisy sites. However, the study reported increased vigilance of individuals in the noisy sites, and that ground squirrels spent more time near burrows (Rabin et al. 2006).

Several field studies evaluated the interaction of noise and the effects on predator and prey interactions. Berger (2007) reported that animals experience benefits from increased human activity through predation shielding. Studies proposed that noise can interfere with predator detection of adventitious acoustic cues generated by prey, resulting in reduced hunting success (Mason et al. 2016; Senzaki et al. 2016), which would be a benefit to prey such as rodents not being detected by predators (owls in the studies reviewed). The type of sound source (chronic versus acute) and its predictableness may affect the level of habituation of rodents exposed to the noise. A literature review regarding the effects of noise from various military training activities (artillery, vehicles, helicopters, blasts) provided summaries of effects but excluded fixed wing aircraft and sonic booms. The review stated that military training situations in which similar noise-producing exercises are carried out in the same habitat at frequent intervals may affect locally breeding wildlife to a smaller degree, than less frequent or less predictable noise-producing exercises (Larkin et al. 1996). A study by Ward and Stehn (1989) within that literature review stated that more predictable sources of disturbance can lead to greater apparent habituation in field situations than less predictable disturbance sources.

If the prey species' ability to detect predators is diminished through hearing loss from chronic exposure, anthropogenic noise would have a negative impact on the prey species. Bowles (1994) states that attraction to sources of noise and habituation to noise can have negative effects on wildlife. Desert kangaroo rats' ability to detect predators at distance was reported to be significantly diminished for about 3 weeks after noise exposure (95 dBA) from military off-road vehicles. The chronic noise exposure produced a temporary threshold shift in the kangaroo rats hearing due to their highly specialized ears (Brattstrom and Michael 1983).

One study reviewed did evaluate acute, short-duration, high-intensity noise exposure effects on rodent populations and their predators. The study was undertaken to determine whether auditory effects of intermittent low-altitude jet overflights affect predatory/prey interactions and population dynamics. Low-flying military aircraft at Barry M. Goldwater Air Force Range provided an acute noise exposure to natural rodent populations (desert rats, mice, and squirrels) and their predator the desert kit fox (Bowles et al. 1995). Jet flyovers produced a maximum noise exposure of 115.5 dB with mean loudest 103.4 dB (30 events). The 4-year study reported that differences between noise exposed areas and controls of kit fox and kangaroo populations smaller than the natural variability observed during the study. The three most abundant species were indistinguishable from exposed to control plots for density, reproduction, mean body weight. A statistically significant difference in survival rates and life spans between exposed and control plots among rodent species was detected; however, the study found that the species compensated with higher recruitment rates in exposed area. The study attributed the finding to more food availability (natural variability) within the exposed habitats (Bowles et al. 1995). Bowles et al (1995) went on to state that the findings were not consistent with laboratory noise exposure in humans and lab animals where decreased reproduction rates are a consequence as reported in Kryter (1985).

1.4 Physiological

Physiological responses to elevated noise stimuli can be expressed as hearing trauma through shifts in hearing ranges (either temporary or permanent), damage to tissue and cell damage in the ear or brain, changes in hormones, or through more general changes in body condition (fitness) over time. Most studies on the physiological effects of anthropogenic noise on rodents occurred in laboratory experiments while some paired field behavioral studies with a physiological examination component. Physiological noise studies evaluated included both chronic and acute noise exposures. Most studies were conducted on mice. Using the specific results from laboratory studies of one species to infer the effects on another species was cautioned, however. In the literature review of the effects of military noise on wildlife, the author summarized that responses to noise are species specific and provided that it is not safe to make exact predictions about hearing thresholds of particular species based on data from another species (Larkin et al. 1996).

A laboratory study examined noise damage to the cochlea in particular genetic strains of mice. Mice were exposed from 1 to 24 hours at various frequencies (2, 4, and 8 kilohertz [kHz]) and at sound pressure levels of 100 to 120 dB. All mice had temporary threshold shifts in hearing. Some recovered after 4 days post-exposure while 10 of the 39 mice exposed were left with permanent threshold shifts. The study also found that mice sustained their maximum threshold shift up to two octaves higher than the frequency of exposure. Increasing the intensity of the stimulus causes a shift in the maximum effect toward higher frequencies (Ou et al. 2000). A discussion of intense noises such as explosions (>140 dB) provided that the sudden sound pressure damages the cochlea instantaneously. Explosions result in abrupt severe hearing loss from which there is little recovery of function post-exposure (Ward and Glorig 1961).

Another study exposed mice to swept frequency ranges (2 to 20 and 9 to 13 kHz) at levels of 105 to 120 dB for 30 minutes in duration. The mice were then tested 2, 14, and 28 days later after noise exposure to assess cochlear pathology, particularly loss of hearing hair cells. The study noted the mice had partial hearing recovery up to 105 dB exposure and that permanent cochlear damage resulted from exposure to 120 dB (Sanz et al. 2015).

A laboratory study examined the effect of acute and repeated noise exposure on the behavior and lipid peroxidation in brain tissue of male and female mice. The behavioral component was previously discussed. In the experiment, the mice were exposed to noise for 3 minutes at 90 dB initially, then exposed to the same sound pressure level for 10 hours per day. The results indicated that the 3-week noise treatment did not cause clinically manifested stress in the mice (male or female), no histopathological lesions were detected, and body weight was not affected. Mental stress in mice increases lipid peroxidation activity in the brain. Noise exposure did result in less lipid peroxidation in the brain of female mice with no difference in male mice test groups. Noise habituation and noise exposure did not induce stress and noise habituation significantly improved nose tolerance in female mice, but not males (Korsós et al. 2023).

The literature on the effects of traffic noise on terrestrial small mammals found that rats exposed to chronic traffic noise ate more, drank more water, and gained more body weight (Bednarz 2020). The study cited that traffic noise can change organ weight or size in Norway rats. The weight of thymus and adrenal was higher in noise-exposed rats (Bosquillon de Jenlis et al. 2019). In addition, the literature review provided that chronic noise exposure above 100 dB significantly decreases serum testosterone levels and the effects were correlated to exposure and duration (Dzhambov and Dimitrova 2015).

In the previously discussed field study on night lighting and anthropogenic sound effects (generators) on pinyon mice, body condition (weight and length metrics) was assessed in addition to behavioral responses. The study cited that increases in low-frequency noise can have physiological effects on rodents by triggering stress responses (Du et al. 2010) and altering organ tissue (Branco et al. 2004). Results from the study showed that individuals captured in noisier areas at the beginning of the season had lower body condition than quieter areas; however, this difference was not observed later in the season. While no conclusive explanation of the result was provided, it was hypothesized that later season activity had lower metabolic costs due to increased milder temperatures during nighttime foraging (Willems et al. 2021).

In the textbook *Exploring Animal Behavior Through Sound: Volume 1*, physiological chemical responses to chronic anthropogenic noise were provided. The textbook cited that male rats exposed to chronic noise showed decreases in testosterone (Ruffoli et al. 2006); pregnant mice exposed to 85 to 95 dB alarm bells had pups with lower serum IgG levels indicating impaired immune responses (Sobrian et al. 1997); and chronic noise exposure in rats affected calcium regulation leading to detrimental changes at the cellular level (Gesi et al. 2002).

1.5 Regulatory Evaluations

A review of regulatory evaluations included documents prepared in accordance with the National Environmental Policy Act and through Section 7 of the Endangered Species Act consultations with the U.S. Fish and Wildlife Service (USFWS or the Service). The actions evaluated were either taken or authorized by federal entities. Most of the documents reviewed were environmental assessments (EAs) for actions on military installations where aircraft flyovers and associated military training resulted in short-duration, episodic, and high-intensity anthropogenic noise exposure to wildlife and listed species. Also reviewed were biological opinions rendered by the USFWS on the effects of a proposed action where anthropogenic sound was stimulus, on listed species known to occur within the action area.

One biological opinion reviewed provided an example of the interpretation of the effects of a rocket launch and associated elevated noise impacts on listed species (USFWS 2023). The document provided an example of an action area defined by noise stimuli. Further, the document provided an example of how the Service interpreted the potential effects from short-duration, episodic, high-intensity noise stimuli on several species, their application of available scientific literature, and how they formulated effects determinations when available scientific literature on the specific species or surrogate species were lacking.

None of the documents provided specific information regarding the southeastern beach mouse and none of the documents provided impact assessments on small mammals and rodents. Thresholds for noise exposure were discussed in some documents but not utilized for direct effects determinations. Instead, behavioral responses were the most common qualified metric utilized when impact was determined and take of a species rendered.

1.5.1 Biological Opinion (Reinitiation) – Launch, Boost-Back, and Landing of the Falcon 9 First Stage at Space Launch Complex 4 (SLC-4) at Vandenberg Space Force Base, California (USFWS 2023)

A biological opinion was rendered by the USFWS on Space Force’s authorization of SpaceX’s increase in cadence of launches of the Falcon 9 first stage and the effects on the federally listed California least tern, California red-legged frog, western snowy plover, marbled murrelet, southern sea otter, and California Condor. The later three species were determined “Not Likely to Adversely Affect” and the Service concurred. Noise effects for the marbled murrelet and southern sea otter were relegated to “startle.”

The other three species (former) were more thoroughly evaluated in the biological opinion. The increase in launch cadence was from 1 launch per month to up to 3 launches per month (from 12 to 36 per year).

The action area included all areas subject to noise generated from individual launches, an area that considered noise exposure out to the 100 dB contour approximately 14.5 miles away from SLC-4. The launch was reported to have maximum noise exposures as high as 150 dB SPL_{max} (or maximum sound pressure level) lasting for 1 minute during launch, 30 seconds during landings, and approximately 7 seconds during static test fires.

The biological opinion discusses the potential launch increased cadence noise effects on the three species evaluated further by describing the noise exposure for each species based on the proximity to SLC-4. The biological opinion also describes the SPL_{max} exposure and expected duration. However, for each species, the Service was unable to determine direct physiological effects (hearing trauma) and instead provided more qualified discussions of potential behavioral effect, or in some cases stated that they were unable to anticipate responses from the proposed activity.

The Service stated for each species evaluated, that due to the lack of available information regarding refined specific acoustic threshold information, they were unable to determine if the proposed project would result in physiological responses. When surrogate species studies were reviewed, as in the case of the California red-legged frog, the Service found them nonanalogous because exposure levels were higher and longer.

The biological opinion suggested significantly more bioacoustic monitoring for this species to better determine impacts. Qualitative descriptions of anticipated responses included increased stress from starling leading to biochemical changes that could lead to long-term population impacts such as reduced reproductive success, survival fitness, and spatial displacement. However, these statements were caveated by saying the results would be unknown without monitoring.

In conclusion, the Service stated that for the California red-legged frog, Western snowy plover, and California least tern, "…until the novel effects of the project activity are studied, we are unable to anticipate the magnitude of response at this time." Further, the Service "cannot adequately determine the anticipated impacts of the proposed project's 36 disturbance events annually" on these species. For each of the species, the proposed action was determined to not diminish the Vandenberg Space Force Base population's contribution to the recovery of the species and the amount of authorized take was provided. The Service did provide conditions for each species under which they should be contacted or consultation reinitiated.

1.5.2 Environmental Assessment – Air Force Small Launch Vehicle, Vandenberg Air Force Base, Edwards Air Force Base, and San Nicolas Island, CA (Engineering Science 1991)

An EA was conducted to evaluate potential launch sites for a small launch vehicle. The action evaluated was for a single vehicle (rocket) launched a maximum of 5 times per year for a total of over 40 launches over a period of either years (through 2000). The document evaluated the potential sites and launch systems that may be selected, but at the time, were not determined.

The evaluation estimated that the overall sound pressure level for the launch vehicle 120 dB contour extended outward 0.5 mile from the source. The document stated that the most significant impact on fauna expected due to launch of the vehicle would be a temporary startle effect. Further, a hearing threshold shift (hearing trauma) resulting in partial or total hearing loss was not expected as the noise exposure was episodic and of insufficient high intensity. The evaluation did note that an area of uncertainty was the effect of low-frequency nose levels on reproductive behavior and development in wildlife.

The document provided that no listed species were found directly within proximity to the evaluated locations such that no effects from launches were expected. A discussion was provided regarding sound sensitivity of California least tern and sea lions as the species occur in the general vicinity of the evaluated locations. The evaluation concluded that the maximum sound pressures from the vehicle would likely be inaudible to seals, sea lions, and birds. Instead, frequencies at the low end of the discernible range from the launch vehicle would be most easily heard over ambient noise.

1.5.3 Biological Opinion – Activities and Operations at Yuma Proving Ground, Arizona (USFWS 2014)

A biological opinion rendered by USFWS on the activities and operations at the U.S. Army Garrison Yuma Proving Ground (YPG) in Arizona evaluating the effects of aircraft (rotary and fixed wing) operations, air delivery, firing and impact of munitions, and munitions demolition on the Sonoran pronghorn antelope was reviewed. In that Section 7 consultation, the USFWS concluded that noise from aircraft and munitions would not adversely affect the species. Overflights typically occur at altitudes ranging from 8,000 to 32,000 feet and these flights do not disturb pronghorn. Noise exposure for pronghorn on the refuge from munitions would be less than 57 dB for most actual explosions within the impact area on YPG.
For comparison, normal conversation between two people 3 feet apart is approximately 60 to 65 dB. Because munitions testing and training is relatively constant in this area, the noise from these events may be perceived by Sonoran pronghorn as part of the background noise. USFWS stated Sonoran pronghorn likely become habituated to such noise and are less likely to exhibit startle responses as a result of it.

The conclusion of the biological opinion was that the proposed action is not likely to jeopardize the continued existence of the Sonoran pronghorn. The adverse effects that occurred in the action area did not reach the scale where recovery of the species would be significantly delayed or precluded (USFWS 2014). The degree of disturbance was evaluated relative to the overall population throughout the species range with the Service stating, "The number of pronghorn that may potentially be disturbed is relatively small in comparison to the estimated number of Sonoran pronghorn throughout their range." The Service concluded that the proposed action would result in incidental take of a total of four Sonoran pronghorn on Kofa National Wildlife Refuge over the life of the project (10 to 20 years). However, the issued take was from direct impacts such as fire, munitions blasts, and habitat degradation (fire), and not from noise impacts.

1.5.4 Final Range Environmental Assessment, Overland Air Operations, Eglin Air Force Base, Florida (CH2M HILL 2014)

A finding of no significant impact (FONSI) was concluded for the Final Range EA conducted by the U.S. Air Force at Eglin Air Force Base in Florida. The EA evaluated noise from overland flights of aircraft under two alternatives of flight frequency. Noise levels evaluated ranged from 45 – 66 dBL_{dnmr} (onset-rate adjusted monthly day-night average sound level). The primary means by which Eglin overland air operations could potentially impact biological resources included aircraft noise. A biological assessment was prepared to assess potential increases in overland flights (Alternative 2) on listed species. The BA evaluated the terrestrial species eastern indigo snake and reticulated flatwoods salamander in addition to aquatic species. The BA concluded that the proposed action may affect but would not likely adversely affect each of the species. USFWS concurred with the findings in their subsequent biological opinion. With respect to the red-cockaded woodpecker (RCW), USFWS stated that Eglin overland air operations are covered under USFWS' 2013 RCW programmatic biological opinion for Eglin AFB mission activities (USFWS 2013) (see following summary).

1.5.5 Programmatic Biological Opinion – Red-Cockaded Woodpecker, Eglin Air Force Base, NE Gulf of Mexico Walton, Okaloosa, Santa Rosa Counties, Florida (USFWS 2013)

A programmatic biological opinion for the listed species was rendered by USFWS to Eglin AFB activities with the potential to affect the RCW, both adversely and beneficially, and establishes a process by which Eglin evaluates potential impacts and determines applicable restrictions. The biological opinion stated that RCWs may be harassed by noise and human presence associated with range operations. Foraging RCWs may avoid these areas, and pioneering RCWs may not colonize or immigrate to new areas near the disturbance. This could affect the growth of the RCW population around the activity area, and loud noises during nesting season may affect RCW reproduction. Eglin's RCWs are routinely exposed to noise associated with military testing and training, and Eglin has numerous healthy clusters in close proximity to test areas that receive frequent bombing and aircraft traffic; thus it appears that Eglin's RCWs are fairly resilient to noise impacts as long as suitable habitat is present.

The programmatic biological opinion, stated through implementation, incidental take of RCWs would not cause Eglin to drop below its recovery goal and that action implementation, as proposed, is not likely to jeopardize the continued existence of the RCW. Notably incidental take under the programmatic biological opinion was expected to be associated with harm or mortality of cavity trees and birds (eggs, nestlings, fledglings, and adults) and harm from degraded cavity trees and reduced quality foraging habitat, removal of foraging habitat, and disruption of normal behavior patterns (e.g., roosting, or incubating, brooding or feeding nestlings), which could result in nest failure or adult mortality. Noise exposure was not listed as associated with incidental take.

1.5.6 Final Environmental Assessment of Proposed White Lakes Drop Zones for Kirtland Air Force Base (Lopez Garcia Group 2005)

A FONSI was concluded for the final EA for three new C-130 aircraft drop zones near White Lakes in Sante Fe County, New Mexico, by the 58th Special Operations Wing (58 SOW), a unit of Air Education and Training Command, and the Air Force Special Operations Command. The finding stated that implementation of the Proposed Action could result in minor negative impacts to air quality, noise, soils, and biological resources for the duration of use of the drop zones.

Most federally listed species evaluated in the EA were found not to occur with the action area. The only exceptions were the avian species Baird's sparrow and the mountain plover, both of which were federally listed as species of special concern at the time. The EA found that noise impacts to wildlife from C-130s would not be significant and cited studies showing that wildlife disturbed by aircraft noise return to prenoise behavioral activities shortly after (usually within a few seconds and generally less than 1 minute) the disturbance has finished.

1.5.7 Final Environmental Assessment – Deployment to Roswell Industrial Air Park, New Mexico (USAF Strategic Air Command 1989)

An EA of the potential impacts from the proposed use of Roswell Industrial Air Park, Roswell, New Mexico as a forward operating base for select period of time, was conducted by the U.S. Air Force Strategic Air Command. The proposed action would include bomber aircraft flying multiple sorties each day, dropping inert practice explosives at various ranges. Refueling aircraft would also fly multiple sorties each day within the action area.

The EA stated that the startle effect of noise and the physical disturbance of habitat are the primary potential sources of impacts to wildlife from the proposed action. Noise and visual intrusion by aircraft could startle wildlife populations in the area. The New Mexico Fish and Game Department stated that antelope are acclimated to aircraft noise by the existing flight operations. Generally, aircraft altitude within the action area was assessed by the EA as being high enough to not impact wildlife. Deployments were expected to be outside of bird migrations making encounters unlikely. No impact to wildlife was anticipated from the proposed action, particularly from noise. The USFWS further determined that no Section 7 consultation was needed regarding sensitive species (least tern) as the proposed action would occur outside of the breeding season.

1.5.8 Final Range Environmental Assessment – Air and Ground Gunnery: Test Areas A-73, A-77, A-78, A-79, B-7, and B-75, Eglin Air Force Base, Florida (SAIC 2013)

A FONSI was concluded for the Final Range EA for air and ground gunnery test areas at Eglin Air Force Base in Florida. The EA assessed several alternatives of military air-mission activities such as dispensing bombs, missiles, small arms, and countermeasures in addition to ground combat simulations.

The EA stated that noise would cause behavioral responses in wildlife, including sensitive bird and mammal species, such as startle reaction, flushing, and temporary are avoidance. Noise impacts to RCWs were a primary concern. RCWs were expected to exhibit similar behavioral responses but the EA noted that individuals as well as the overall population on Eglin AFB are tolerant of noise as evidenced by continued nesting close to test areas resulting in net population gains.

1.5.9 Legislative Environmental Impact Statement (LEIS) – Renewal of the Nellis Air Force Range Land Withdrawal (USAF 1999)

The LEIS evaluated multiple alternatives for the renewal and continued use of the Nellis Air Force Range Land (NAFR) for test and training of military equipment and personnel. Operations at NAFR include the testing of weapon systems on target ranges for live munitions for air combat training. Aircraft flyovers are intensive with 200,000 to 300,000 annual aircraft sortie-operations over the larger 3 million acres of the Nellis Range Complex (NRC) federal land. The LEIS stated that noise levels on all lands under the NRC were calculated to be 61 dB or below.

The LEIS states that the use of NAFR results in increased noise levels and episodic noise. The document summarizes other studies generally stating that individual wildlife reactions to jet aircraft or simulated jet aircraft noise have shown little to no effect beyond temporary startle responses. Those studies further concluded that there is no evidence suggesting that wildlife populations are reduced on the range relative to adjacent similar habitats or diminished in areas subject to overflight by military aircraft in general.
The LEIS summarized that alternatives evaluated where military overflights continue at or below the existing and historic conditions would not be expected to significantly affect wildlife. Given that, existing memorandums of understanding and standard operation procedures governing special use airspaces associated with NAFR continue.

1.5.10 Environmental Assessment – Vertical Gun Test (Missile Defense Agency 2004)

A FONSI was concluded for the EA for the vertical gun test, which evaluated the consequences of a chemical agent simulant experiments conducted at the Energetic Materials Research and Testing Center in New Mexico.

The evaluation stated that noise is unlikely to elicit startle responses in wildlife. Wildlife would be expected to vacate the immediate site prior to the tests due to increased human activity, including noise produced by vehicles and generators. No estimates of noise exposure (ranges or thresholds) were provided.

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Appendix C. Field Surveys

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys

Date:	October 25, 2023
Project name:	Stoke Space Technologies, Inc. Space Launch Complex 14
Attention:	Cape Canaveral Space Force Station, Florida
Prepared by:	Jacobs

Stoke Space Technologies, Inc. (Stoke) intends to develop a new space transportation system and build out an orbital launch capability at Cape Canaveral Space Force Station (CCSFS) in Brevard County, Florida (Attachment 1, Figure 1). Stoke is leasing Space Launch Complex (SLC)-14 from the U.S. Space Force as the site to develop this project. The purpose of this technical memorandum (TM) is to describe the existing conditions of the upland and aquatic ecological communities at the SLC-14 project area for anticipation of regulatory permitting requirements that may be needed as part of the proposed project.

Jacobs' biologists conducted an assessment of the existing habitats within and adjacent to the proposed project area by performing site surveys from April 9 through 14, and September 11 through 15, 2023. The site surveys included review of wetland and surface water limits, delineation of wetland and surface water boundaries, and assessment of the proposed project area for the potential occurrence of any federal species and gopher tortoises (*Gopherus polyphemus*). The initial survey (April 2023, Initial Survey Area) included a preliminary gopher tortoise survey along with wetland and surface water delineations within the area around the launch complex (approximately 74 acres). The subsequent survey (September 2023, Proposed Project Area) included a 100 percent survey of all gopher tortoise habitats previously identified in the initial survey along with additional wetland and surface water delineations in an approximately 10-acre area to the south of the launch complex (Attachment 1, Figure 2). The results of the pre-site literature review and site assessment surveys are provided in this TM.

1. Project Location, History, and Purpose

The proposed project area is located within CCSFS, approximately 750 feet from the Atlantic Ocean (Attachment 1, Figure 1; USGS 1971). The proposed project area is in the Southern Florida Flatwoods Major Land Resource Area that stretches across the mid-section of the state from the Gulf of Mexico to the Atlantic Ocean. This landscape consists of nearly level to gently sloping marine terraces, with large areas of wetlands and marshes. The project is located on the Silver Bluff Terrace, which fringes all but the mid-Gulf coastline of Florida (MacNeil 1949). The Silver Bluff Terrace ranges in width from several hundred yards to approximately 2 miles (USGS 1975).

CCSFS is on Cape Canaveral, which is a barrier island feature between the Atlantic Ocean and the Banana River lagoon to the east. Historically, the habitats would have been predominately upland coastal scrub with areas of maritime hardwood hammock. Surface water streams and rivers would have been typically absent. Wetland features typically would have been coastal salt marsh associated with the Banana River lagoon along the western side of Cape Canaveral. The eastern coast is a high-energy beach and dunes associated with the Atlantic Ocean.

SLC-14 is south of SLC-15 and north of SLC-13 and includes historic Launch Pad 14. This launch pad was constructed in 1956 and first used in June 1957. The launch pad was used for 32 Atlas launches, including the historic February 1962 Friendship 7 flight in which John Glenn became the first American to orbit the earth. Stoke plans to reactivate the site for its launch service. This TM evaluates the existing habitats with a focus on wetlands and surface waters, federally listed species, and gopher tortoise within and in the vicinity of the proposed project area to support environmental compliance for the reactivation of SLC-14.

2. Existing Conditions

The assessment included pedestrian site surveys of approximately 79 acres of the inactive launch complex on the northeast area of CCSFS near the Atlantic Ocean (Attachment 1, Figures 1 and 2). The proposed project area is made up of mostly disturbed upland habitat with a few small, isolated wetlands scattered along the western portion of the site and a constructed canal/ditch system. Upland habitats and communities are described in Section 2.2.1, Uplands Habitat. A review of the aerial photographs (1972) (Attachment 1, Figure 3) shows the constructed launch complex with significant upland habitat disturbances from grading activities. Linear transects appear to cross the site. Two historical wetlands can be seen along the entrance road to the launch pad. Remnants of these wetlands were observed during the site surveys and are described in Section 2.2.2, Wetlands and Surface Water Habitats.

A canal/ditch system surrounding the launch complex was excavated in 1956, when the complex was built with the intent of controlling and draining surface and subsurface water. Construction of the canal/ditch system has altered the site hydrology and is directly connected to some onsite wetland features. A section of the canal/ditch system within the survey area, designated as Maintained Canal (SW-1) (Attachment 1, Figure 4), is actively maintained (vegetation removal, potential dredging) to convey stormwater away from the neighboring active launch complexes. This canal section conveys flowing water during periods of greater rainfall and has permanent standing water throughout the season. Other sections of the canal/ditch system (WD-1a and WD-1b) (Attachment 1, Figure 4) around SLC-14 that are not actively maintained are moderately to heavily vegetated, providing wetland habitat. These sections have ponding water, small amounts of flowing water, or no water depending on rainfall conditions and are categorized as the wet ditches with 50 percent or more coverage by exotic and invasive vegetation. The canal hydrological pattern flows offsite in three locations, northwest, southeast, and south of the inactive launch complex, ultimately connecting with other canals that drain to the Banana River to the west.

2.1 Soil and Topography

Topography in the vicinity of the proposed project area (Attachment 1, Figure 2; USGS 1971) ranges from approximately -1 to 12 feet North American Vertical Datum of 1988 (NAVD 88). The launch complex is a flat, graded area surrounded by a concrete walkway, multiple concrete pads, a maintained and unmaintained canal, and lower xeric community with minimal trees and disturbed soil. Before the original site development, the presence of dunes and interdunal swales created undulating topography. According to the Natural Resources Conservation Service's soil survey (NRCS 2023; Attachment 2), three soil type map units are in the proposed project area: Canaveral-Anclote complex (9), Canaveral-Urban land complex (10), and Urban land (69) (Attachment 1, Figure 5). The following list provides a brief description of the soil types within the proposed project area, including the soil name and its map unit identification number in parentheses:

- **Canaveral-Anclote complex, gently undulating (9) (13.3 acres)**: The upland soil, Canaveral, of this soil complex makes up 60 percent of the map unit. Slopes range from 0 to 5 percent. The natural drainage class is somewhat poorly drained. Depth of the water table ranges from 12 to 36 inches. This soil complex component occurs in dunes or ridges on marine terraces. The Anclote component makes up 30 percent of the map unit and is classified as hydric soil. Slopes range from 0 to 2 percent. The natural drainage class is very poorly drained. The depth of the water table ranges from 0 to 6 inches. This component occurs in sandy soil on flats of mesic or hydric lowlands.

- **Canaveral-Urban land complex (10) (19.2 acres)**: The upland soil, Canaveral, is also the primary component of this soil complex and makes up 50 percent of the map unit. Slopes range from 0 to 2 percent. The natural drainage class is moderately well-drained. The depth of the water table ranges from 30 to 60 inches. This component occurs in flats or ridges on marine terraces. The Urban land component makes up 40 percent of the map unit and is not classified as native soil. Slopes range from 0 to 2 percent. The natural drainage class is not ranked. This component occurs in flatwoods on marine terraces, rises on marine terraces, knolls on marine terraces, ridges on marine terraces, and hills on marine terraces.
- **Urban land, 0 to 2 percent slopes (69) (18.1 acres)**: The Urban land component makes up 85 percent of the map unit and is not considered a native soil. Slopes range from 0 to 2 percent. The natural drainage class is not ranked. This component occurs in flatwoods on marine terraces, rises on marine terraces, knolls on marine terraces, ridges on marine terraces, and hills on marine terraces.

2.2 Land Uses

Land uses, including developed and natural upland and aquatic habitats, surrounding the launch pad within the vicinity of the proposed project area were characterized during the site surveys. Figure 6 (Attachment 1) shows and Table 1 summarizes the various land use and land covers mapped by St. Johns River Water Management District (SJRWMD) in accordance with the Florida Land Use Cover Classification System (FLUCCS) within the project site boundary.

2.2.1 Upland Habitats

The survey areas within the vicinity of the proposed project area contain two different upland community types: disturbed land (7400)/coastal shrub (3220) and xeric oak (4210). According to the SJRWMD FLUCCS, the launch pad and immediate surrounding area are classified as governmental; however, because the area has not been active for years, portions of it would be better classified as disturbed land (7400)/coastal shrub (3220) because previously cleared areas have revegetated. Table 1 provides a brief description (from the SJRWMD FLUCCS descriptions) of the land use types within the project survey area.

Table 1. Florida Land Use Cover Classification System with the Proposed Project Area

FLUCCS Code	Habitat Description	Acreage
Disturbed Land (7400)/ Coastal Shrub (3220)	Areas where soil and/or substrate has been altered or removed by human activity. Naturally vegetated areas include stable, wind-deposited coastal dunes that are vegetated by salt-tolerant shrubs, especially saw palmetto (*Serenoa repens*). Other common vegetation includes sand live oak (*Quercus geminata*), sabal palm (*Sabal palmetto*), myrtle oak (*Quercus myrtifolia*), and sea grape (*Coccoloba uvifera*). Hydrological xeric conditions are primary except for occasional washover during heavy storm surges.	31.71

Table 1. Florida Land Use Cover Classification System with the Proposed Project Area

FLUCCS Code	Habitat Description	Acreage
Xeric Oak (4210)	Forest communities are dominated by xeric oaks with a canopy closure of 25 percent or more and 67 percent dominance by xeric oak species. Trees are not tall or dense in coverage. Common vegetation includes bluejack oak (*Quercus incana*), turkey oak (*Quercus laevis)*, sand post oak (*Quercus stellata*), wire grass (*Aristida stricta*), saw palmetto, and prickly pear cactus (*Opuntia basilaris*). Land cover type is excessively drained, available water is low, and inundation does not occur. These referenced oak species were not observed within the proposed project area, though live oak (*Quercus virginiana*) was.	17.48
Streams and Waterways (5100)	Constructed canals and other linear water bodies cut through upland communities.	1.40
Exotic Wetland Hardwoods (6190)	Wetlands are dominated by the exotic species such Brazilian pepper.	0.03

Source: SJRWMD 2021

Upland plant species within the previously cleared areas that have revegetated as upland scrub are dominated by hairawn (*Muhlenbergia capillaris*), bluestem (*Andropogon virginicus*), coastal sand-spur (*Cenchrus spinifex*), Hercules-club (*Zanthoxylum clava-herculis*), Spanish needles (*Bidens alba)*, natal grass (*Melinis repens*), camphorweed (*Heterotheca subaxillaris*), tough buckthorn (*Sideroxylon tenax*), prickly pear cactus (*Opuntia humifusa*), and sabal palm (*Sabal palmetto*). These upland habitats included interspersed open sandy patches among vegetation and had the highest density of gopher tortoise burrows identified during the surveys.

Upland communities dominated by canopy and subcanopy vegetation strata were associated with areas farther from the developed SLC-14 complex where clearing was not conducted or not maintained when the site was active. These areas are densely vegetated with near-complete canopy coverage. Dominant vegetation species included sand live oak (*Quercus geminata*), eastern red cedar (*Juniperus virginiana*), hog plum (*Ximenia americana*), sabal palm, invasive Brazilian pepper (*Schinus terebinthifolia*), and wax myrtle (*Morella cerifera*).

2.2.2 Wetland and Surface Water Habitats

Wetlands and surface waters were identified, and their boundaries were delineated within the total site survey area. Table 2 summarizes the acreage within the proposed project area of these habitats identified. The wetland boundaries, which are shown on Figure 4 (Attachment 1), were located with a Global Positioning System R1 and iPad. The wetland jurisdictional boundaries were based on Florida Department of Environmental Protection (FDEP) Rule Chapter 62-331, *Florida Administrative Code* (F.A.C.), as ratified in Section 373.4211, Florida Statutes, for the estimated landward extent of state jurisdictional wetlands or other surface waters.

All wetlands and surface waters that exist within the proposed project area have been previously disturbed to some degree through clearing, hydrologic alterations, or invasive exotic plant species encroachment. Specifically, the canal/ditch system identified was constructed during the original site development to manage surface water and groundwater. Over years of inactivity at the launch pad, the wet ditch sections (WD-1a and WD-1b) have become overgrown and wetland vegetation developed along all areas except the eastern portion that is maintained (Maintained Canal, SW-1).

The following list describes the wetland and surface water features identified and delineated with the total site survey area. Attachment 3 provides the wetland determination data forms for each feature. Attachment 1 provides representative photographs.

- **Wetland W-1** is an isolated palustrine forested wetland (FLUCCS 6190, Exotic Wetland Hardwoods, 0.76 acre within the total site survey area) that occurs along the southwestern boundary of the entrance road to SLC-14. This feature was identified and delineated during the April 2023 survey. A portion of W-1 is within the proposed project area, with the majority of the wetland occurring outside of the proposed project area to the south. Dominant vegetation of W-1 includes Brazilian pepper, live oak, red bay (*Persea borbonia*), sabal palm, and horned beaksedge (*Rhynchospora colorata*). Saturation at 2 inches below ground surface, drift deposits, and geomorphic position were identified as hydrologic indicators. Hydric soil was present based on visual characteristics and field indicators according to the Field Indicators of Hydric Soils in the United States 2018 handbook (NRCS 2018).
- **Wetland W-2a** is a small isolated palustrine forested wetland (FLUCCS 6190, Exotic Wetland Hardwoods, 0.18 acre within the total site survey area) that is south of the entrance road to SLC-14 and borders W-2b. This feature was identified and delineated during the April 2023 survey. Feature W-2a borders the proposed project area, with all of the wetland occurring beyond the proposed project area boundary. Dominant vegetation is similar to W-1 and includes live oak, wax myrtle, Brazilian pepper, and sawgrass (*Cladium jamaicense*). Visible saturation at the surface, drift deposits, and geomorphic position were identified as hydrologic indicators. Hydric soil was present within the wetland. Past human activity has resulted in the loss of hydrologic connection to other features for this isolated wetland, and it contains approximately 30 percent exotic invasive species.
- **Wetland W-2b** is a small isolated palustrine scrub-shrub wetland (FLUCCS 6310, Wetland Shrub, 0.12 acre within the total site survey area) that is south of the entrance road to SLC-14 and borders W-2a and the proposed project area boundary. This feature was identified and delineated during the April 2023 survey. Feature W-2b borders the proposed project area, with all of the wetland occurring beyond the proposed project area boundary. Dominant vegetation includes wax myrtle, Brazilian pepper, pennywort (*Hydrocotyle umbellata*), and sawgrass. Visible saturation at the surface, water-stained leaves, and geomorphic position were identified as hydrologic indicators. Hydric soil was present within the wetland. Past human activity has resulted in the loss of hydrologic connection to other features for this isolated wetland, and it contains approximately 20 percent exotic invasive species.
- **Wetland W-3a** is a very small palustrine emergent wetland (FLUCCS 6440, Emergent Aquatic Vegetation, 0.03 acre within the total site survey area) along a drainage ditch (designated as WD-1b; refer to subsequent bullet) north of the launch pad along the constructed canal/ditch system and is outside of the proposed project area boundary. This feature was identified and delineated during the April 2023 survey. Dominant vegetation includes sawgrass, marsh fimbry (*Fimbristylis castanea*), and mock bishopweed (*Ptilimnium capillaceum).* Inundation of up to 1 inch, saturation, and geomorphic position were identified as hydrological indicators. Hydric soil was present in the wetland.
- **Wetland W-3b** is a small palustrine scrub-shrub wetland (FLUCCS 6310, Wetland Shrub, 0.06 acre within the total site survey area) that occurs along a drainage ditch (designated as WD-1b) north of the launch pad potentially in the previously constructed canal/ditch system that continues offsite to the north. This feature was identified and delineated during the April 2023 survey. This wetland feature occurs outside of the proposed project area boundary. Dominant vegetation includes wax myrtle, Brazilian pepper, sawgrass, and marsh fimbry. Saturation present at the surface, water-stained leaves, and geomorphic position were identified as hydrological indicators. Hydric soil was present within the wetland. This wetland is of lower quality as a result of past disturbances from the original construction and the encroachment of exotic invasives.

- **Surface Waters WD-1a and WD-1b** are part of a canal/ditch system that was constructed during the original launch complex development. These segments are classified as wet diches and contain predominately a palustrine scrub-shrub wetland habitat (FLUCCS 5100, Streams and Waterways, 1.68 acres within the total site survey area) for the majority of its length, with one small section being a palustrine emergent wetland ditch (0.03 acre). These features were identified and delineated during both the April and September 2023 surveys. The ditches surround the launch pad to the north, south, and west, with some segments occurring within the proposed project area and some outside of the proposed project area. The ditches are connected by old, unmaintained culverts from the original construction. At the time of the survey, the culverts appeared clogged with sedimentation limiting or restricting flow between ditch segments. These ditches connect to the Maintained Canal (SW-1) and ultimately to the Banana River to the west.

  WD-1a and WD-1b are overgrown by dense vegetation. Dominant vegetation includes live oak, wax myrtle, Brazilian pepper, softstem bulrush (*Schoenoplectus tabernaemontani*), and mock bishopweed. Inundation ranges from 0.5 to 48 inches, with some portions only saturated, which were identified as hydrological indicators. Portions of the channel are eroded, have an average top of bank (TOB) width of 30 feet and TOB height of 6 feet, and are only saturated. The ditches appear to convey surface water from north to south during periods of increased rainfall. Ditch bottoms are made up of primarily organic materials and sandy silt substrate. Hydric soil was present at the toe of slope. This upland cut ditch appears to intercept groundwater and historically served to manage stormwater runoff. The quality of this surface water feature is low as a result of past disturbance by clearing and creating the canal and the encroachment of exotic invasives.

- The **Maintained Canal (SW-1)** is part of the constructed surface water management system around SLC-14 and neighboring launch complexes. The Maintained Canal (SW-1) is an open-water habitat (FLUCCS 5100, Streams and Waterways, 0.79 acre) that borders the proposed project area along the north and eastern boundaries with only a portion (0.16 acre) occurring within. The canal appears to be regularly maintained (vegetation removal, possible dredging) to convey surface water and stormwater ultimately to the Banana River to the west. This surface water feature is connected to WD-1a and WD-1b through relic culverts.

2.3 Wetland and Surface Water Regulatory Jurisdiction and Functional Assessment

Wetlands and surface waters WD-1a, WD-1b, W-3a, and W-3b are considered federal jurisdictional features and are regulated under Section 404 of the *Clean Water Act* administered by state and federal laws under the State 404 Program under F.A.C. Chapter 62-331 (Table 2). These features are considered federal jurisdictional features because they meet the definition of a wetland and have a relatively permanent surface water connection to other waters outside of the United States. The Maintained Canal (SW-1) feature is also considered a federal jurisdictional surface water but does not contain wetland habitat.

The State 404 Program is responsible for overseeing the permitting of any project proposing dredge or fill activities within state-assumed waters; FDEP typically takes the lead on the State 404 Program. The State 404 Program is separate from the state's Environmental Resource Permit (ERP) Program. Projects within state-assumed waters require both ERP and State 404 Program authorization. All of the features identified are also considered state jurisdictional features, including the isolated wetlands W-1, W-2a, and W-2b because they meet the state's definition of wetlands and surface waters under Section 373.019(25), *Florida Statute*, and Subsection 62-340.200(19), F.A.C. (FDEP 2021), and would be regulated under the state's ERP Program.

Table 2. Regulatory Jurisdiction of Identified Features

Feature ID	Habitat Type	Regulatory Jurisdiction		Proposed Project Area Acreage	Total Site Survey Acreage
		Federal	State		
W-1	6190: Exotic Wetland Hardwoods		X	0.03	0.76
W-2a	6190: Exotic Wetland Hardwoods		X	0	0.18
W-2b	6310: Wetland Shrub		X	0	0.12
W-3a	6440: Emergent Aquatic Vegetation	X	X	0	0.03
W-3b	6310: Wetland Shrub	X	X	0	0.06
WD-1a	5100: Streams and Waterways	X	X	1.22	1.68
WD-1b	5100: Streams and Waterways	X	X	0.02	0.03
Maintained Canal (SW-1)	5100: Streams and Waterways	X	X	0.16	0.79

ID = identification

Any unavoidable direct or secondary impacts to wetlands or surface waters as part of the proposed project may require compensatory mitigation to offset the functional loss the wetlands and/or surface waters are providing in their existing conditions. The Uniform Mitigation Assessment Method (UMAM) is used to assess existing (pre-) and after-project (post-) ecological values and functions of wetlands and other surface waters. Table 3 provides a summary of existing condition UMAM scores for wetland and surface water features identified within the total site survey area, and Attachment 4 provides individual scoring sheets. Overall, all wetlands and surface waters identified and assessed were of low functional value due to the disturbed nature of the site, the construction and limited connection of the surface water ditch system affecting hydrology, and the presence of invasive species (Brazilian pepper) dominating much of the vegetation community. Final UMAM scores must be approved by regulatory agencies as part of permit application reviews and are thus subject to change.

Compensatory mitigation activities may include, but are not limited to, onsite mitigation, offsite mitigation, or the purchase of mitigation credits from permitted mitigation banks. If mitigation is required for unavoidable wetland impacts, regional mitigation banks within the same watershed may be contacted to assess availability of mitigation credits. The best approach is to design a footprint that minimizes or avoids encroachment in wetlands as much as practical. Permitting and final wetland impacts will be determined during the design and permitting stage of the project.

Table 3. Wetland and Surface Water Existing Condition Uniform Mitigation Assessment Method Scores

Feature ID	Habitat Type	Location and Landscape Support	Water Environment	Community Structure	Score
Forested Wetlands					
W-1	6190: Exotic Wetland Hardwoods	6	3	4	0.43
W-2a	6190: Exotic Wetland Hardwoods	6	3	4	0.43

Table 3. Wetland and Surface Water Existing Condition Uniform Mitigation Assessment Method Scores

Feature ID	Habitat Type	Location and Landscape Support	Water Environment	Community Structure	Score
Herbaceous Wetlands					
W-2b	6310: Wetland Shrub	5	5	5	0.50
W-3a	6440: Emergent Aquatic Vegetation	5	6	6	0.57
W-3b	6310: Wetland Shrub	5	6	4	0.50
Surface Waters					
WD-1a	5100: Streams and Waterways	5	4	3	0.40
WD-1b	5100: Streams and Waterways	5	4	4	0.43

3. Listed Species

Jacobs conducted an online literature review and field site surveys to determine the potential for the presence of federally listed species and gopher tortoises within the vicinity of the proposed project area. The following sections provide results of these reviews and surveys.

3.1 Federally Listed Species

Jacobs' scientists performed an online search of the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) database for the presence of federally listed species potentially occurring within the project vicinity before conducting field site surveys. The list of species included federally endangered, threatened, or candidate species, or species of special concern (state only). Attachment 5 presents and Table 4 summarizes the list obtained from the database search.

Site surveys were conducted in April and September 2023 in the vicinity of the proposed project area to assess the presence and/or absence of federally listed species and to assess the habitats known to be used by these species obtained from the online IPaC database. The proposed project area and its vicinity are heavily disturbed from previous clearing for construction activities, launch activities, and storage activities. SLC-14 has not been maintained since it was retired from use in the late 1960s.

No other listed species were observed during the site surveys. Although not observed, there is potential for the Southeastern beach mouse (*Peromyscus polionotus niveiventris*) within FLUCCS 3220, Coastal Shrub, for foraging habitat. Colonies of Florida scrub jays (*Aphelocoma coerulescens*) are known to be present in nearby scrub habitats outside of the proposed project area but were not observed during the site surveys, and their preferred habitat was not present within the project boundaries. CCSFS actively monitors and maintains the locations of Florida scrub jay colonies onsite. The eastern indigo snake (*Drymarchon corais couperi*) is a federally listed threatened species in Florida that is commensal with the gopher tortoise. Its habitat is primarily high pineland and flatwoods near streams or swamp edges (USFWS 1982; Mount 1975). These snakes rely heavily on gopher tortoise burrows for overwintering sites and generally occur in similar habitats as the tortoise (Mount 1975). It is unlikely that the eastern indigo snake would be present within the proposed project area due to the lack of preferred habitat and the disturbed nature of the site. However, with the presence of gopher tortoises or burrows, this species should be considered potentially present. Standard protection measures for the eastern indigo snake will be implemented during construction (Attachment 5).

Birds protected under the *Migratory Bird Treaty Act* and the *Bald and Golden Eagle Protection Act* are also listed in the IPaC Report for the proposed project area. No bald eagle nests were observed or are known to be within the proposed project area. The nearest bald eagle's nest is approximately 6 miles to the west of the proposed project area. The proposed project area is also located within the USFWS Florida species consultation areas for piping plover (*Charadrius melodus),* red knot (*Calidris canutus rufa*), Florida scrub jay, and West Indian manatee (*Trichechus manatus latirostris*). Piping plovers and red knots would be expected to be transient species within the proposed project area using beach habitat, intertidal flats, and open dunes for foraging; these species do not nest in Florida. The West Indian manatee is unlikely to occur within the project boundary because there are no direct connections to surface water bodies onsite. A review of FDEP's Florida wood stork colony and foraging area online geographic information system sources shows no nearby wood stork colonies and that the wetlands identified within the proposed project area are outside of the wood stork's foraging area.

Because of the potential for the occurrence of federally listed species within the proposed project area, consultation under Section 7 of the *Endangered Species Act* will be conducted. This consultation should be coordinated with USFWS and regulatory agencies responsible for the issuance of Section 404 permits and ERPs.

3.2 Gopher Tortoises

The gopher tortoise is a State of Florida-listed threatened species. CCSFS relocates gopher tortoises within the installation boundaries that may be affected by activities such as construction. Numerous gopher tortoises and their burrows were observed with the survey areas during the initial site survey (April 2023) and during the subsequent 100 percent site survey (September 2023). During the 100 percent survey, 68 burrows were located with coordinates, and the direction of the burrows and photographs were recorded. As shown on Figure 7 (Attachment 1), the observed burrows were mostly within disturbed portions of the site.

Table 4. Listed Threatened and Endangered Species Potentially Found Near SLC-14

Species Type	Common Name	Scientific Name	Habitat	Status
Mammals	Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	The Southeastern beach mouse inhabits sand dunes that are vegetated by sea oats and dune panic grass. May also occur in structures.	Threatened
Mammals	West Indian Manatee	*Trichechus manatus latirostris*	The West Indian manatee inhabits shallow, slow-moving waters of rivers, estuaries, saltwater bays, canals, and coastal areas, as well as fresh water, brackish water, and salt water.	Threatened
Mammal	Tricolored Bat	*Perimyotis subflavus*	The tricolored bat inhabits forested habitats, also summer roosts in artificial structures like barns, porch	Proposed Endangered

Table 4. Listed Threatened and Endangered Species Potentially Found Near SLC-14

Species Type	Common Name	Scientific Name	Habitat	Status
			roofs, bridges, and concrete bunkers.	
Birds	Audubon's Crested Caracara	*Polyborus plancus audubonii*	Audubon's crested caracara inhabits open, dry prairies with scattered cabbage palms, improved pasture lands, and wooded areas with stretches of grassland.	Threatened
Birds	Eastern Black Rail	*Laterallus jamaicensis*	The eastern black rail inhabits tidally or non-tidally influenced, saltwater, brackish water, or freshwater marshes with dense cover and upland areas surrounding these marshes.	Threatened
Birds	Florida Scrub Jay	*Aphelocoma coerulescens*	The Florida scrub jay habitat consists of low-growing (less than 6.5 feet) oak scrub and scrubby flatwoods with open, bare patches of sand.	Threatened
Birds	Piping Plover	*Charadrius melodus*	The piping plover's habitat consists of coastal beaches, sandflats, barrier islands, gently sloped foredunes, sparsely vegetated dunes, and washover areas cut into or between dunes.	Threatened
Birds	Red Knot	*Calidris canutus rufa*	The red knot's habitat consists of drier tundra areas, like sparsely vegetated hillsides for breeding and intertidal marine habitats out of breeding season.	Threatened
Birds	Wood Stork	*Mycteria americana*	The wood stork's habitat consists of fresh water and brackish forested wetlands for breeding and wetlands, swamps, ponds, roadside ditches, and marshes, especially with an open canopy, for foraging.	Threatened
Reptiles	Eastern Indigo Snake	*Drymarchon corais couperi*	The eastern indigo snake's habitat consists of xeric pine-oak sandhills, typically sharing burrows with the gopher tortoise.	Threatened
Reptiles	Gopher Tortoise	*Gopherus polyphemus*	The gopher tortoise's habitat consists of oak sandhills, scrub, pine flatwoods, and coastal dunes with deep, well-drained soil.	State-listed Threatened

Table 4. Listed Threatened and Endangered Species Potentially Found Near SLC-14

Species Type	Common Name	Scientific Name	Habitat	Status
Reptiles	Green Sea Turtle	*Chelonia mydas*	The green sea turtle inhabits sandy sloping coastal beaches for laying eggs and coastal waters with lush seagrass beds. Adults frequent inshore bays, lagoons, and shoals with abundant seagrass meadows and algae.	Threatened
Reptiles	Hawksbill Sea Turtle	*Eretmochelys imbricata*	The hawksbill sea turtle's habitat consists of tropical and subtropical waters, predominantly coral reefs. Nesting occurs on beaches.	Endangered
Reptile	Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	The Kemp's ridley sea turtle typically occurs in Gulf of Mexico, but regularly occurs along the Atlantic seaboard. Nesting typically occurs in Mexico.	Endangered
Reptiles	Leatherback Sea Turtle	*Dermochelys coriacea*	The leatherback sea turtle inhabits the Atlantic, Pacific, and Indian Oceans. Nesting occurs on beaches primarily in tropical latitudes.	Endangered
Reptiles	Loggerhead Sea Turtle	*Caretta*	The loggerhead sea turtle inhabits primarily subtropical and temperate regions of the Atlantic, Pacific, and Indian Oceans, and the Mediterranean Sea. Feeding occurs in coastal bays and estuaries. Nesting occurs on sandy beaches in tropical and subtropical areas.	Threatened
Insects	Monarch Butterfly	*Danaus plexippus*	In general, breeding areas are virtually all patches of milkweed in North America and some other regions. The critical conservation feature for North American populations is the overwintering habitats, which are certain high-altitude Mexican conifer forests or coastal California conifer or eucalyptus groves. Coastal regions are important flyways, so nectar (wild or in gardens) is an important resource in such places.	Candidate

Sources: USFWS 2023; USAF 2020

4. References

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U.S. Geological Survey (USGS). 1975. *Terraces and Shorelines of Florida* [map]. Map Series No. 71. Prepared in cooperation with Bureau of Water Resources Management, Florida Department of Environmental Regulation and Bureau of Geology, Florida Department of Natural Resources, Tallahassee.

5. Statement of Limitations

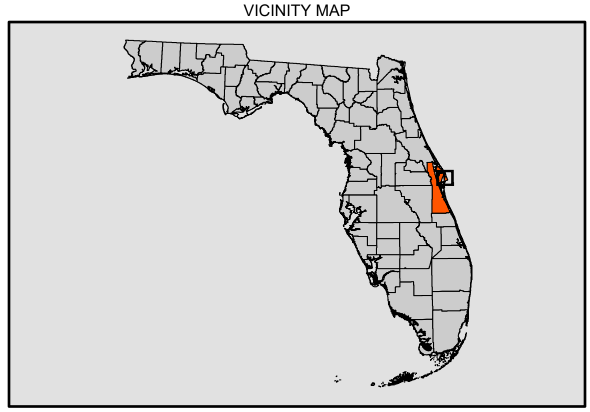
These field investigation results are intended for Stoke's use exclusively. No liability is accepted for any use or reliance on the report by third parties. The accuracy of the field data is limited to the specific dates and locations noted and is based on the direct observations by Jacobs' biologists conducting the field work.

Attachment 1. Figures and Photographs

Legend

- Cape Canaveral Space Force Station
- Proposed Project Area
- Total Site Survey Area

VICINITY MAP



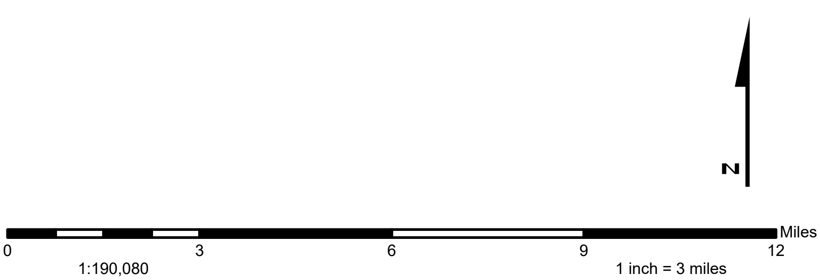
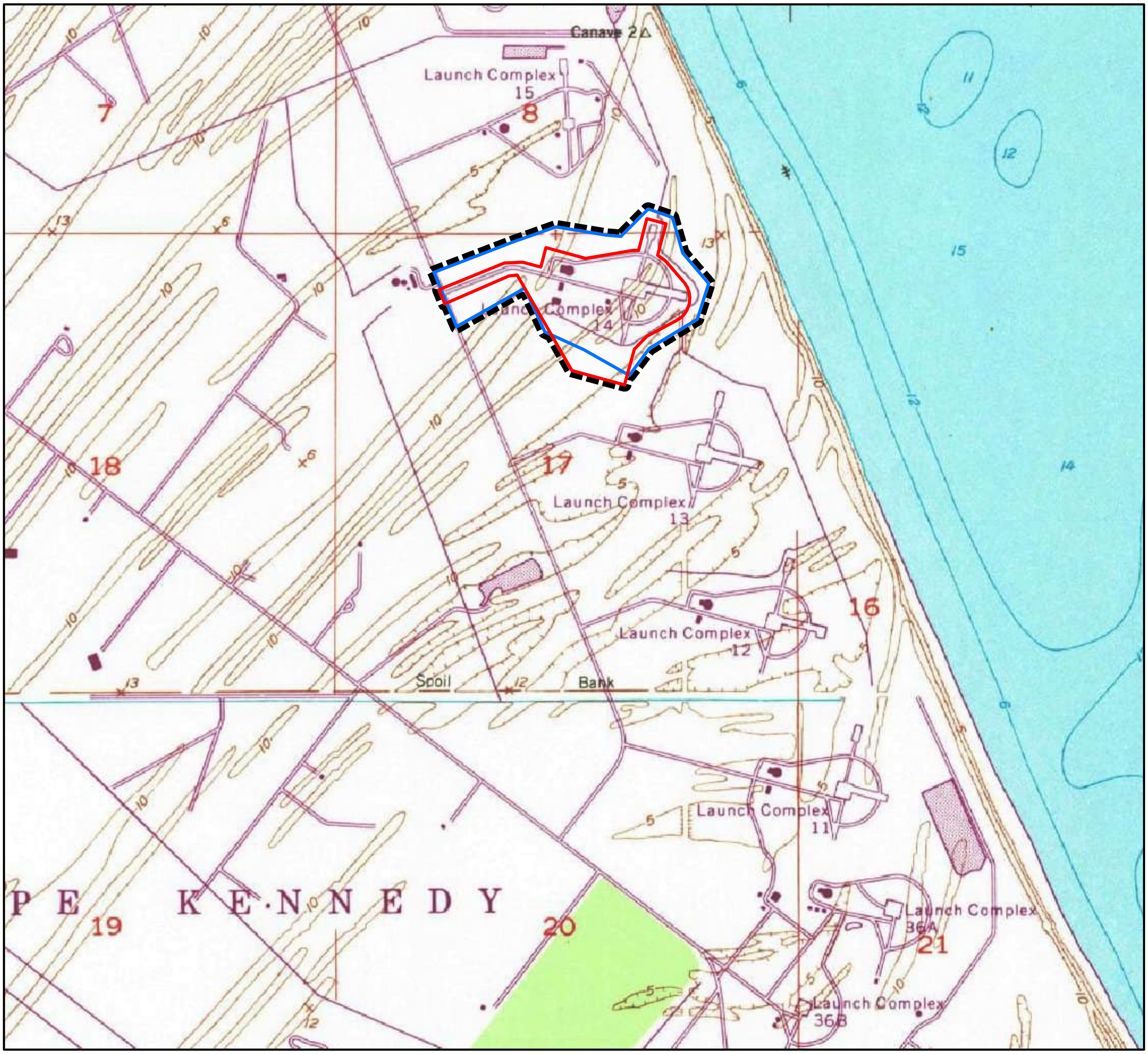


FIGURE 1
Project Location Map
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.



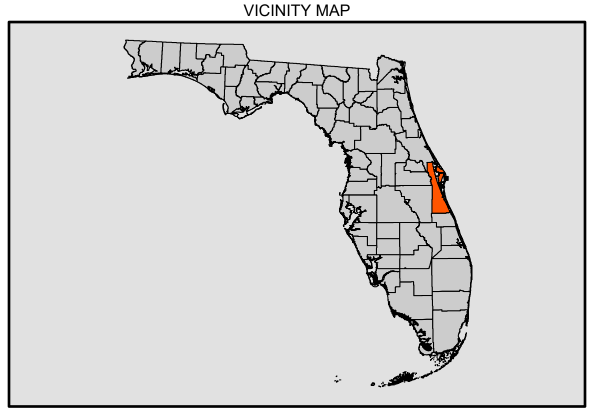
Legend

Proposed Project Area (50.62 acres)

Initial Survey Area (74.33 acres)

Total Site Survey Area (78.47 acres)

VICINITY MAP



Notes:
1. Project is located within the USGS 7.5-Minute Quadrangle: Cape Canaveral
2. Basemap used is U.S. Geological Survey, Cape Canaveral, 1:24000, Topographic Quadrangle Map, Cape Canaveral, FL, 1971

N

0 0.38 0.76 1.14 1.52 Miles

1:24,000

1 inch = 0.38 miles

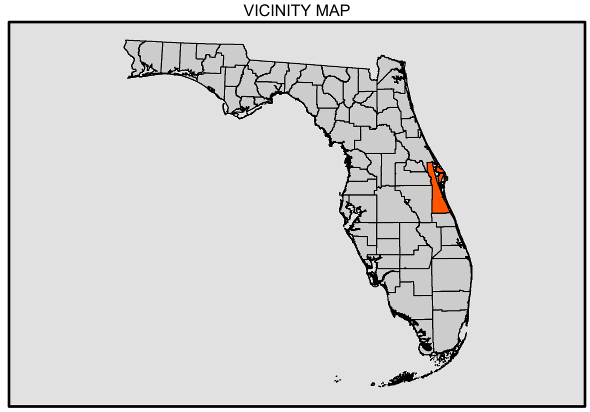
FIGURE 2
Project Location USGS Topographic Map
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.

Legend

Proposed Project Area

Total Site Survey Area

VICINITY MAP



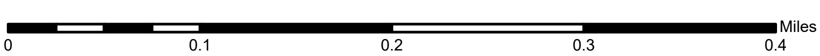
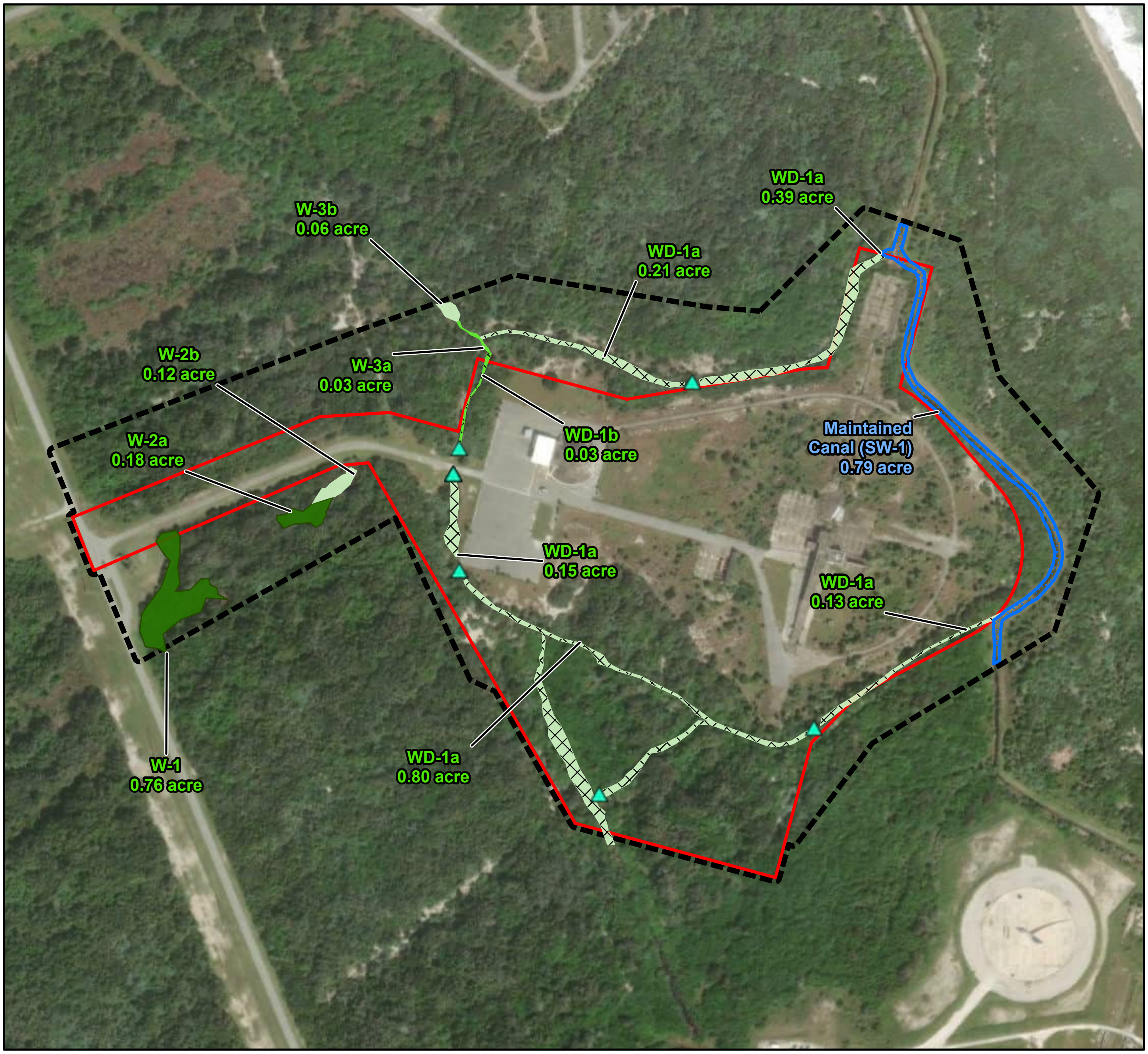


FIGURE 3
Historical Imagery from 1972
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.



Legend

- Culvert
- Proposed Project Area
- Maintained Canal (SW-1)
- Total Site Survey Area

Delineated Wetland Areas

Wetland Type

- Palustrine Emergent Wetland (PEM)
- PEM Wet Ditch
- Palustrine Forested Wetland (PFO)
- Palustrine Scrub-Shrub Wetland (PSS)
- PSS Wet Ditch

N

0 0.1 0.2 0.3 0.4 Miles

1:6,336

1 inch = 0.1 miles

VICINITY MAP

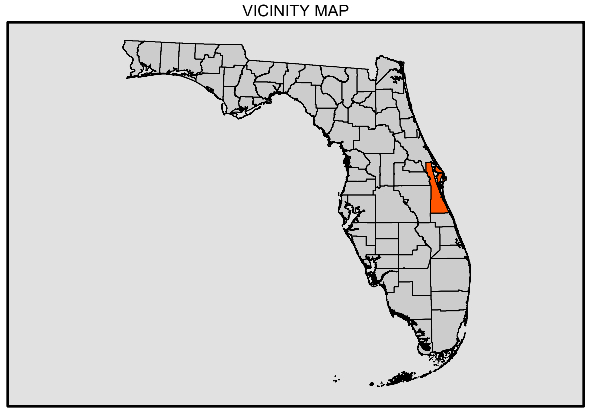


FIGURE 4
Delineated Areas Map
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.

Legend

Proposed Project Area

Total Site Survey Area

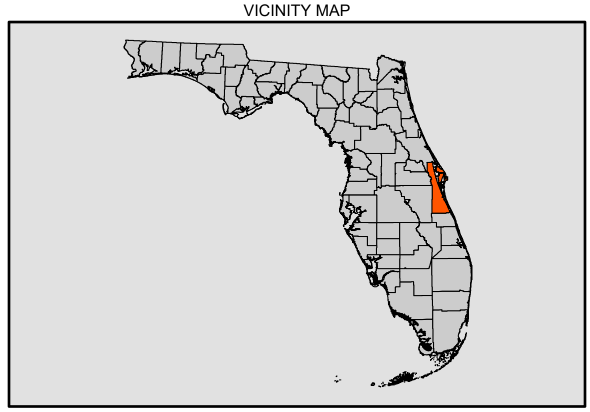
Nonhydric Soils and Unranked Soils

10: Canaveral-Urban land complex (19.24 acres)

69: Urban land, 0 to 2 percent slopes (18.06 acres)

9: Canaveral-Anclote complex, gently undulating (13.32 acres)

VICINITY MAP



Notes:
1. Soils data shown is from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO). Downloaded from https://www.arcgis.com/apps/View /index.html?appid=cdc49bd63ea54dd2977f3f2853e07fff on April 19, 2023.

N

0 0.1 0.2 0.3 0.4 Miles

1:6,336

1 inch = 0.1 miles

FIGURE 5
Soils Map
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.

Legend

Proposed Project Area

Total Site Survey Area

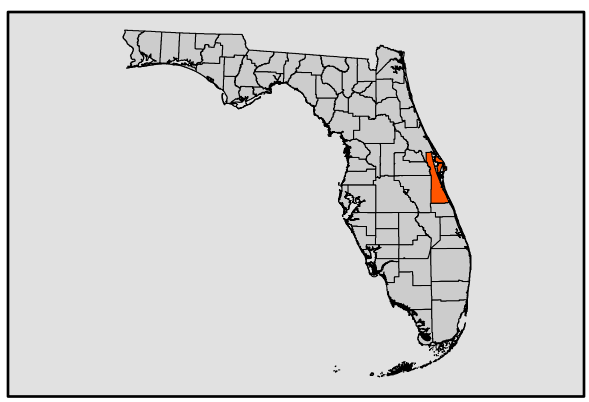
Land Use and Cover

7400/3220: Disturbed Land/Coastal Shrub (31.71 acres)

4210: Xeric Oak (17.48 acres)

5100: Streams and Waterways (1.40 acres)

6190: Exotic Wetland Hardwoods (0.03 acres)



Notes:
1. Land Use and Cover shown is the WMD Land Use and Cover (FLUCCS Level 3) by Water Management District in Florida 2014-2019, source date May 21, 2021, information ground truth by Jacobs biologist April 9th through 14th.

N

0 0.1 0.2 0.3 0.4 Miles

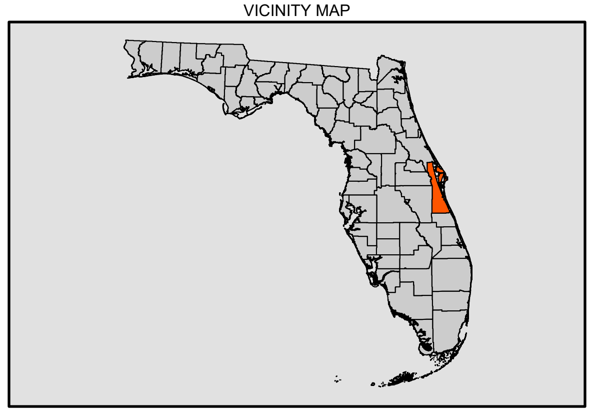
1:6,336 1 inch = 0.1 miles

FIGURE 6
Land Use and Cover
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.

Legend

- Gopher tortoise burrow
- Proposed Project Area
- Total Site Survey Area

VICINITY MAP



N

0 0.1 0.2 0.3 0.4 Miles

1:6,336 1 inch = 0.1 miles

FIGURE 7
Species Observations Map
Preliminary Gopher Tortoise, Wetland, and Surface Water Surveys
Stoke Space Technologies, Inc.

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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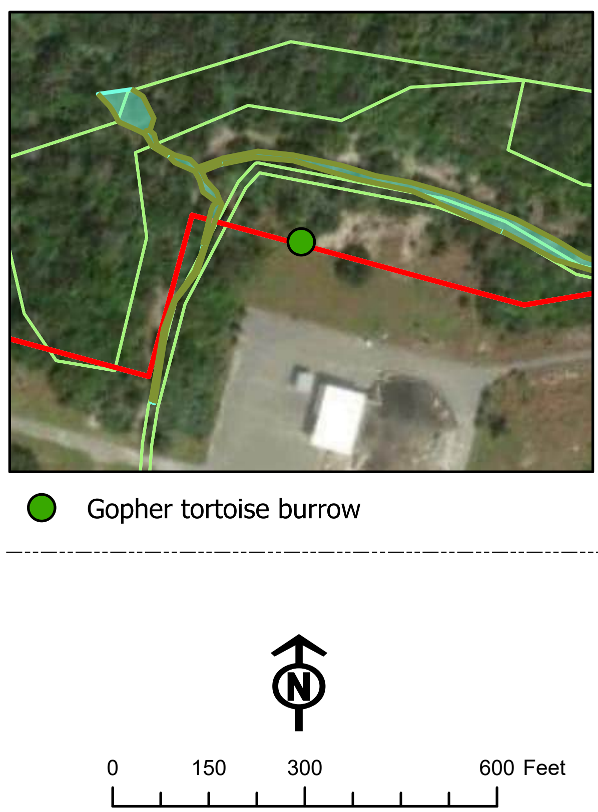
Photo Direction: East
Photo ID: 201



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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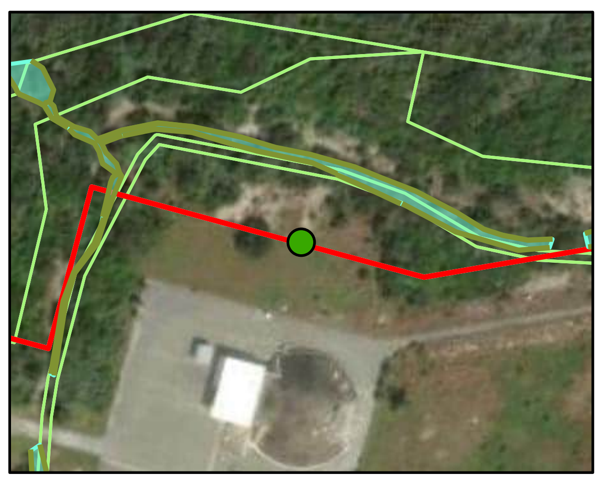
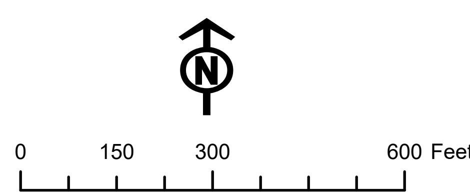


Gopher tortoise burrow



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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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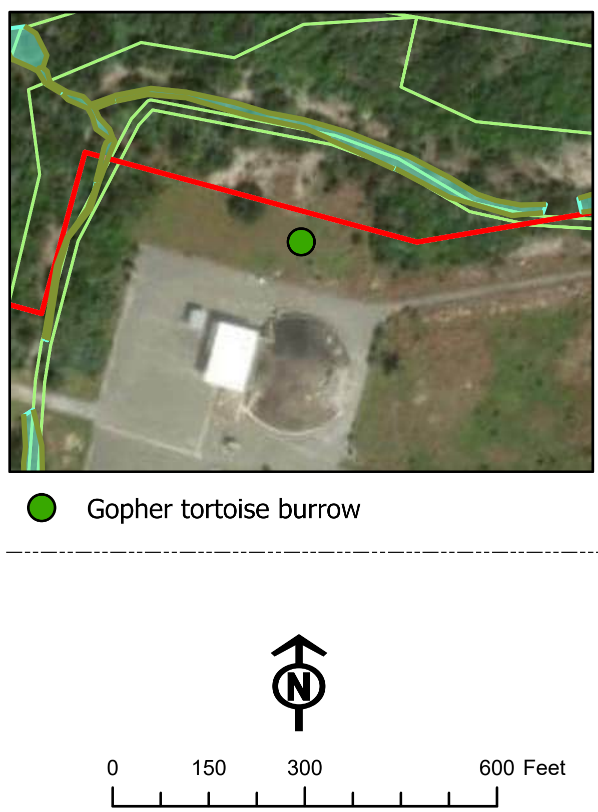

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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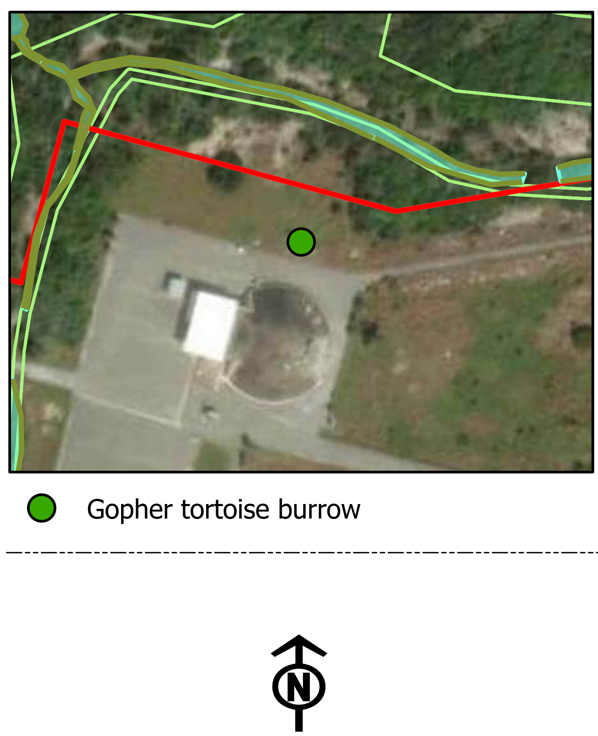

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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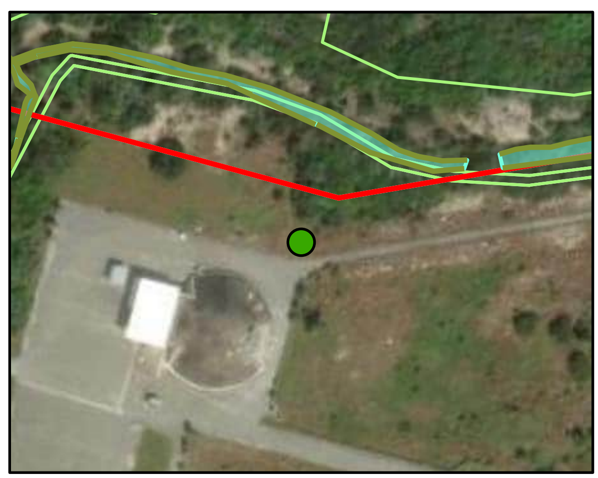
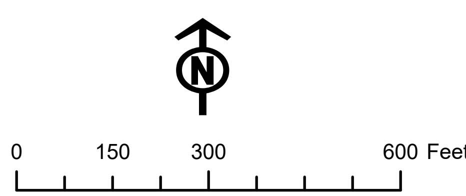


Gopher tortoise burrow



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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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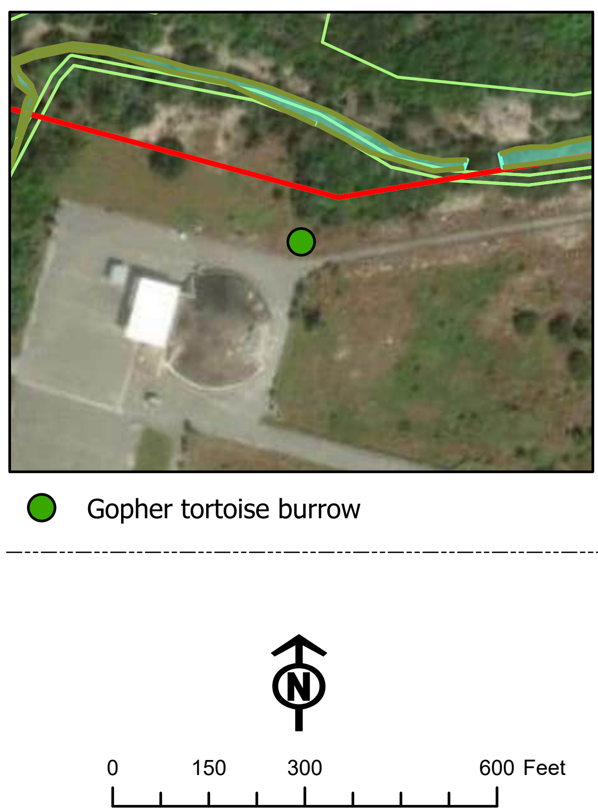

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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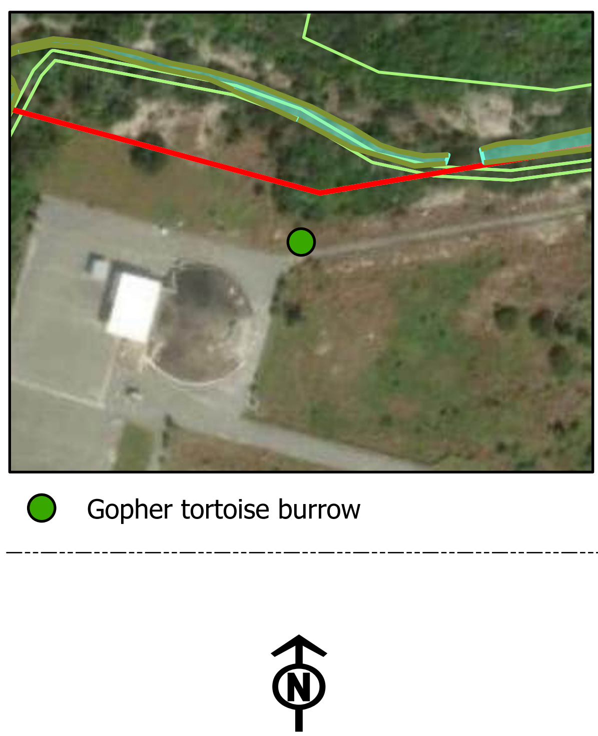

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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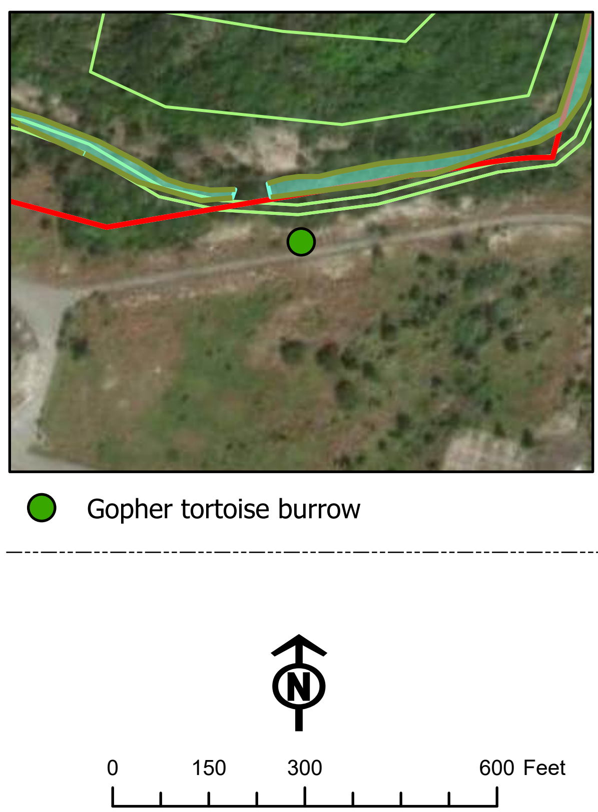

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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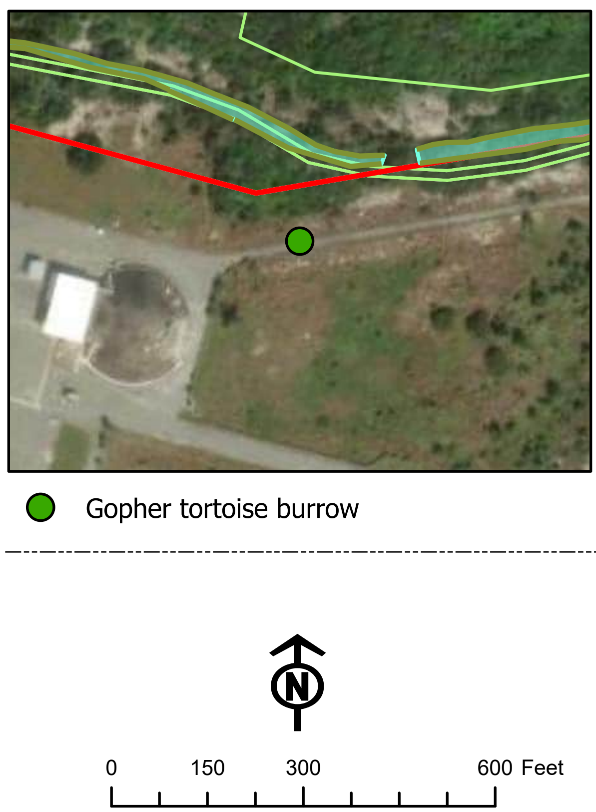

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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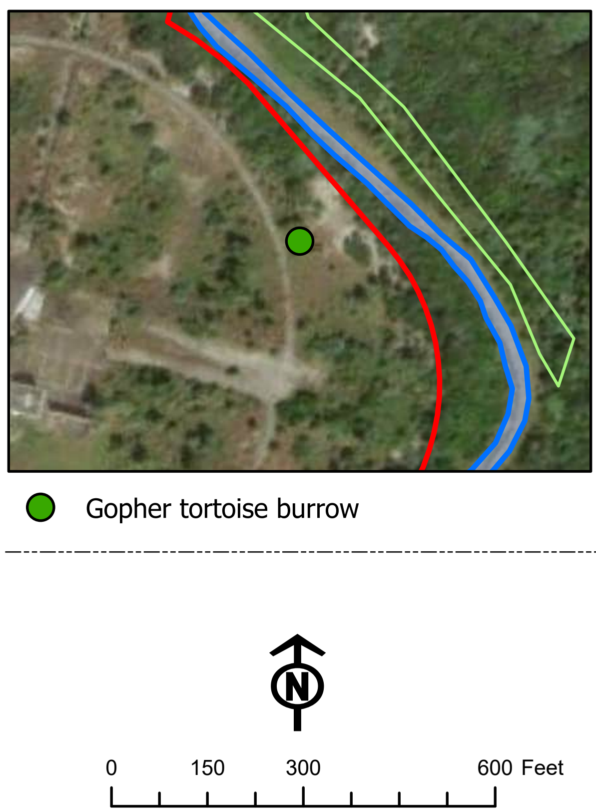

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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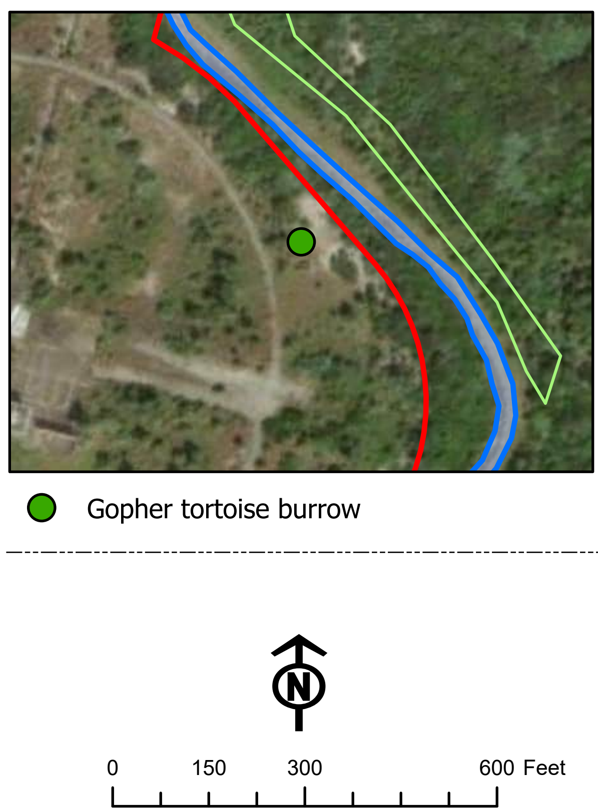

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 11
Photo Direction: W
Photo ID: 211

Gopher tortoise burrow

N

0 150 300 600 Feet

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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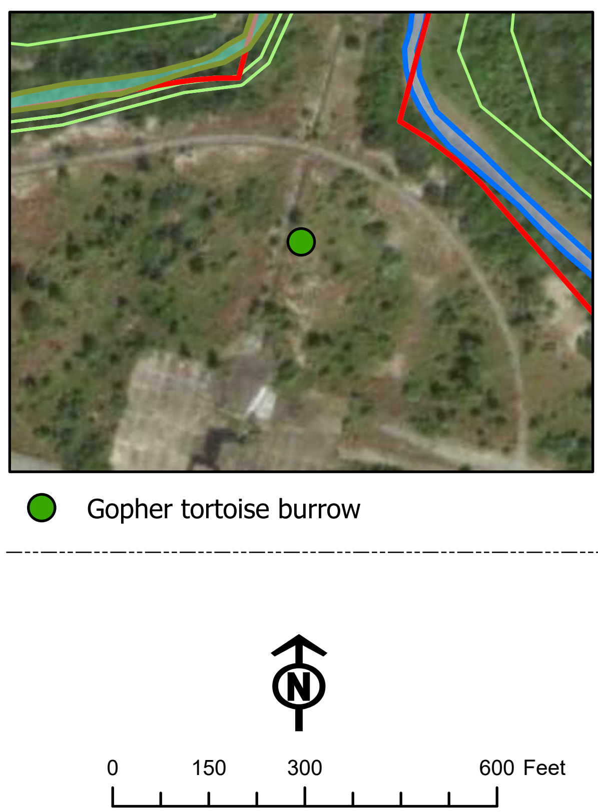
Photo ID: 212



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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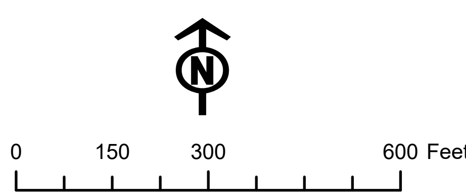
Gopher tortoise burrow



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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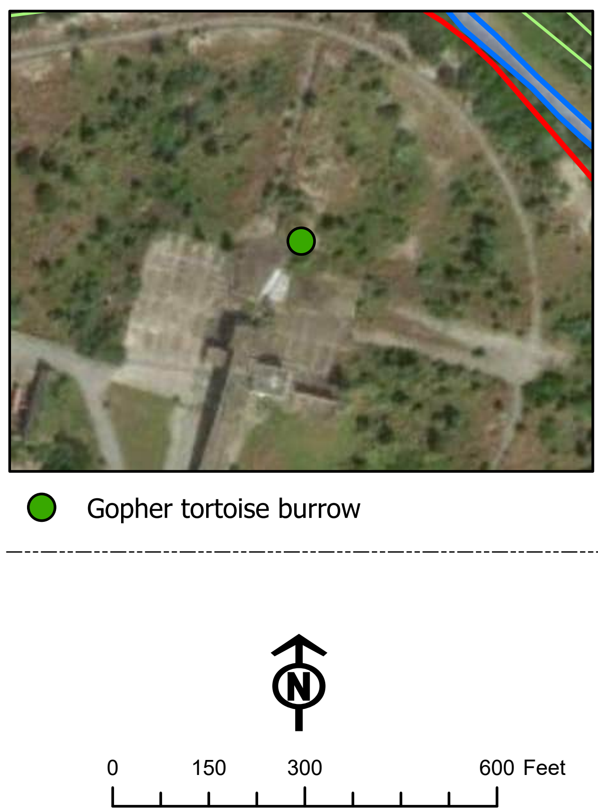

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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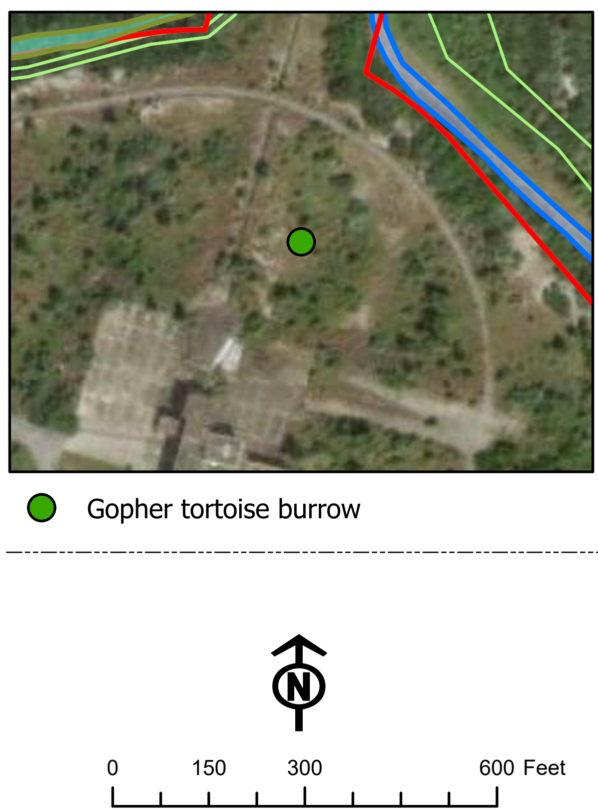

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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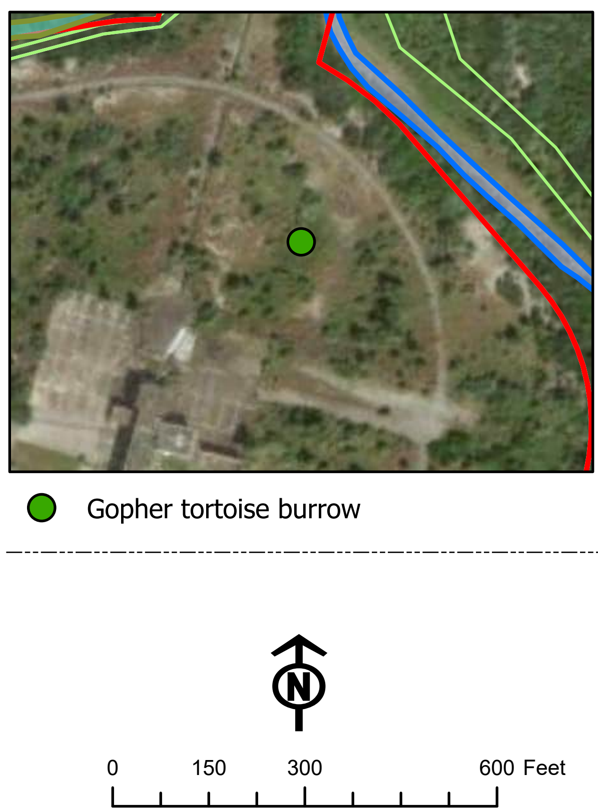

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Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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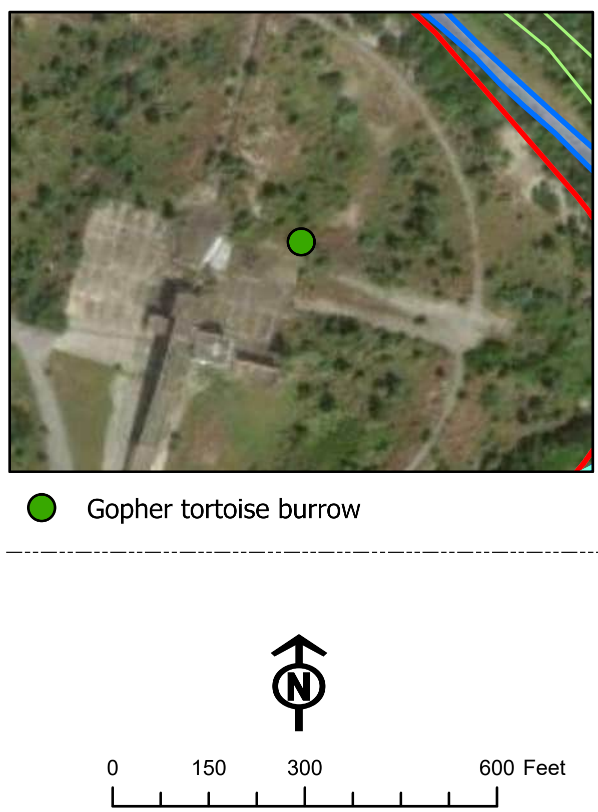

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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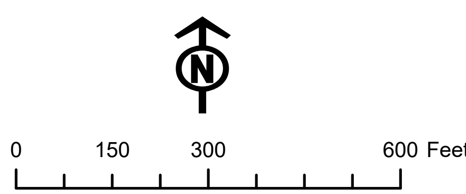
Photo ID: 218

Gopher tortoise burrow



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

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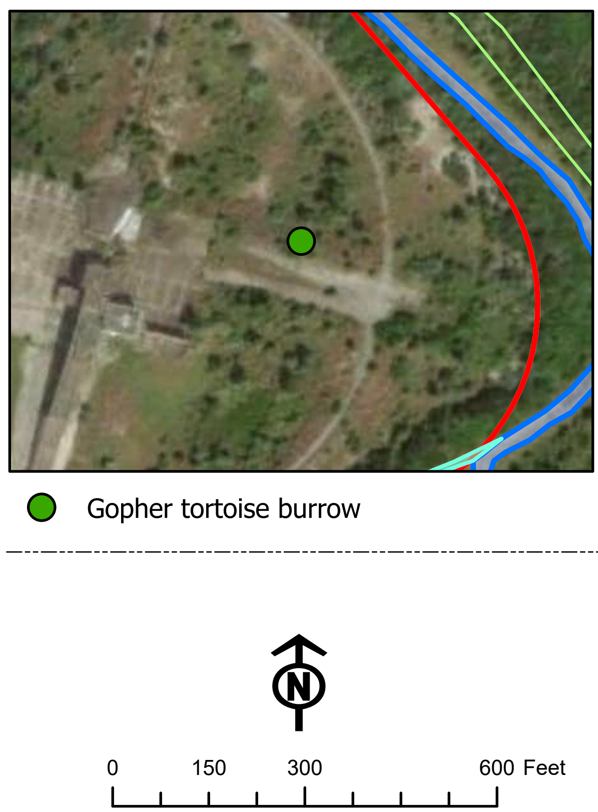

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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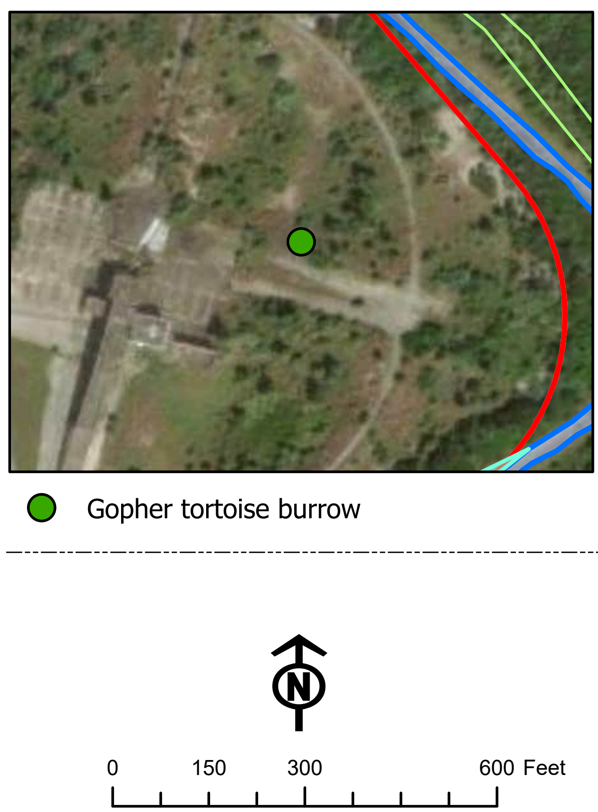


STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 21
Photo Direction: South
Photo ID: 221

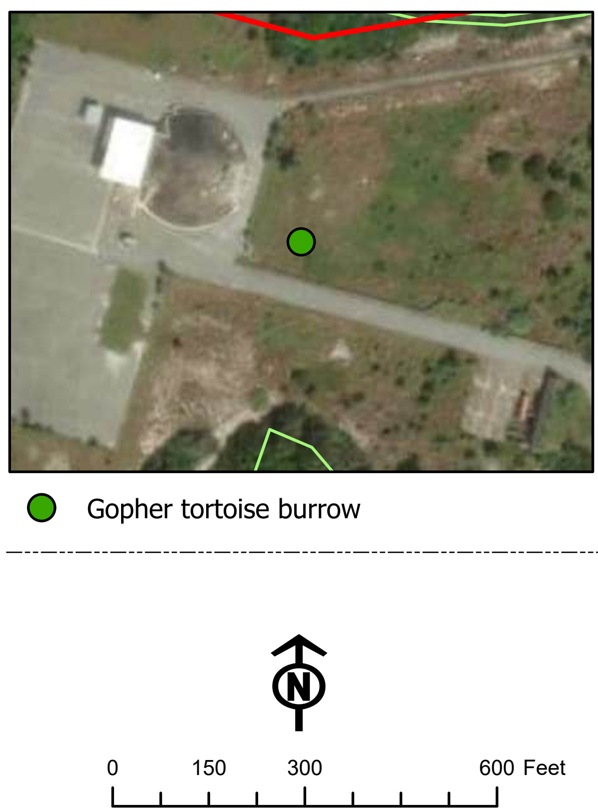
Gopher tortoise burrow

N

0 150 300 600 Feet

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 22
Photo Direction: SE
Photo ID: 222



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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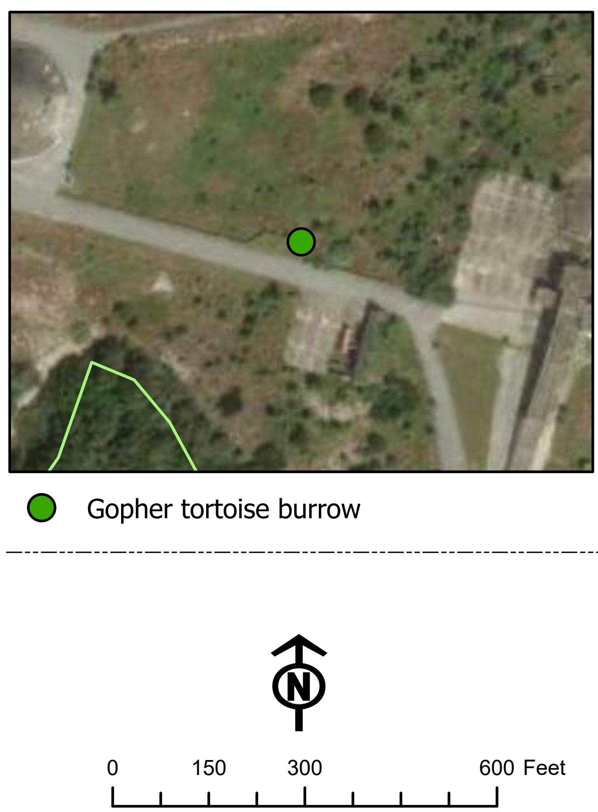

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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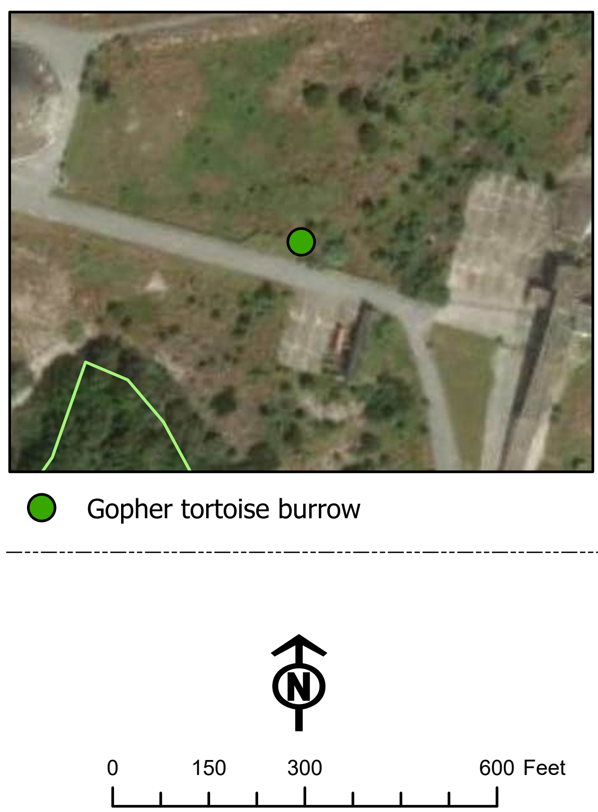

STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
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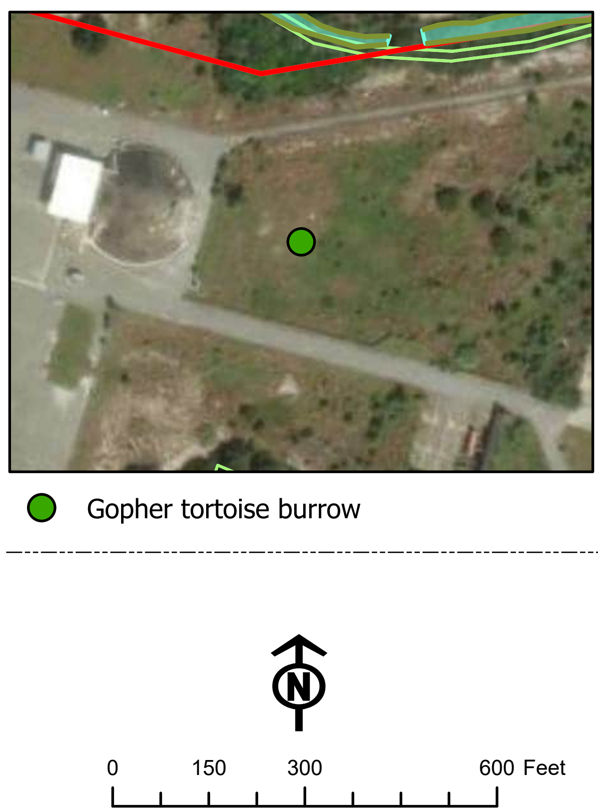
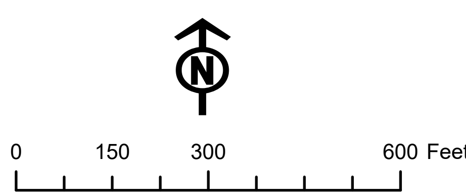


STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 26
Photo Direction: S
Photo ID: 226

Gopher tortoise burrow



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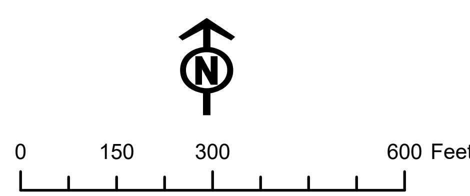
Date: September 11 - 14, 2023
Photo Number: 27
Photo Direction: N
Photo ID: 227

Gopher tortoise burrow



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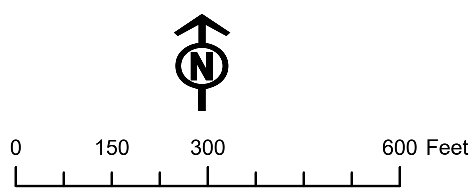
Date: September 11 - 14, 2023
Photo Number: 28
Photo Direction: W
Photo ID: 228

Gopher tortoise burrow



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Date: September 11 - 14, 2023
Photo Number: 29
Photo Direction: S
Photo ID: 229

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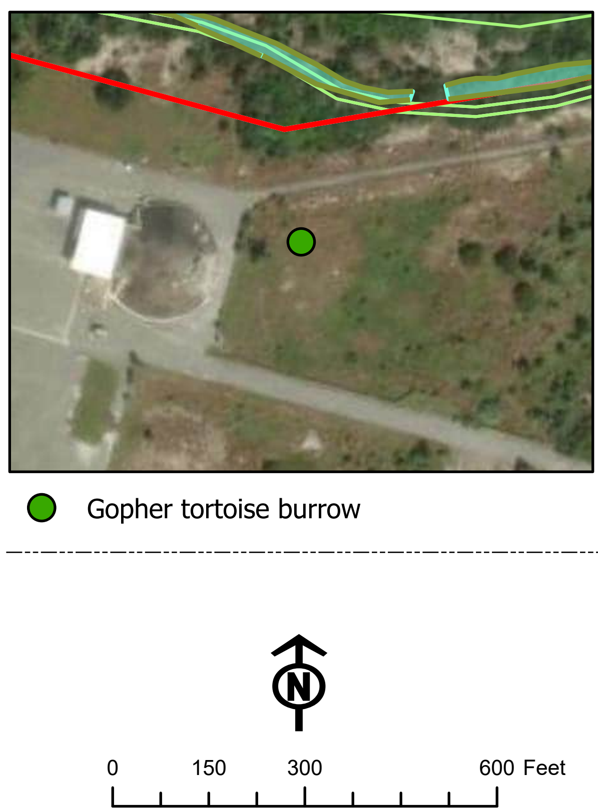
Date: September 11 - 14, 2023
Photo Number: 30
Photo Direction: E
Photo ID: 230



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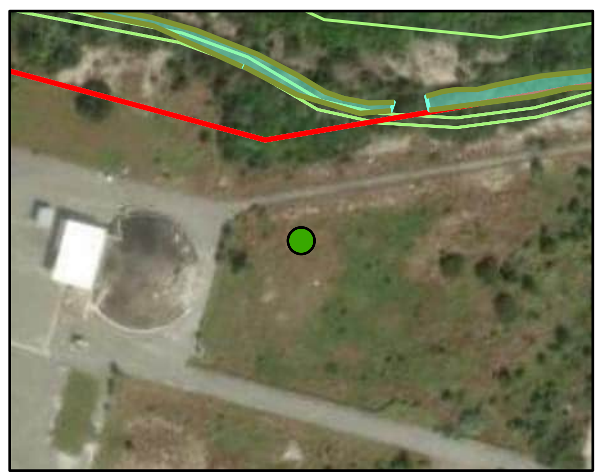
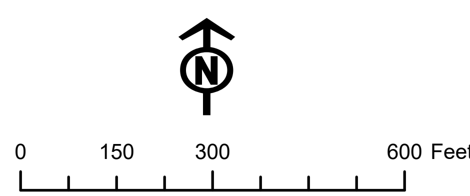
Date: September 11 - 14, 2023
Photo Number: 31
Photo Direction: Se
Photo ID: 231



Gopher tortoise burrow



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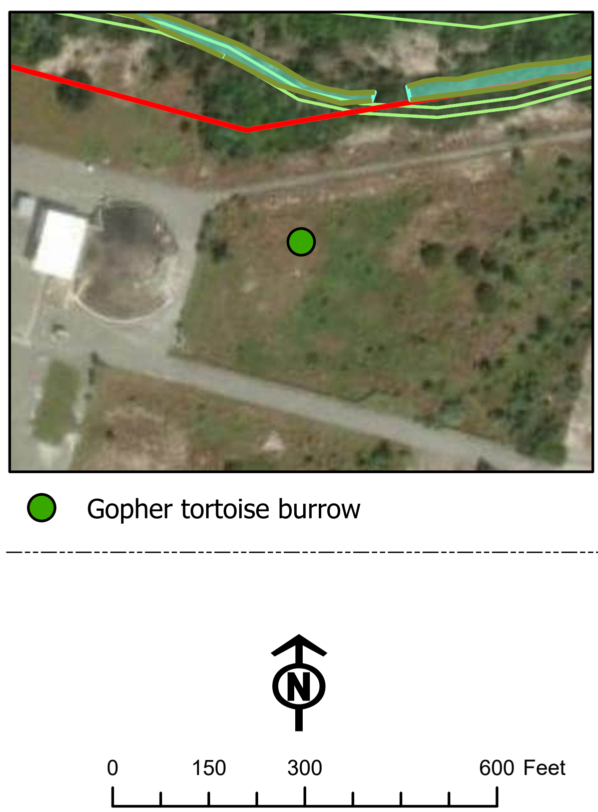
Date: September 11 - 14, 2023
Photo Number: 32
Photo Direction: Nw
Photo ID: 232



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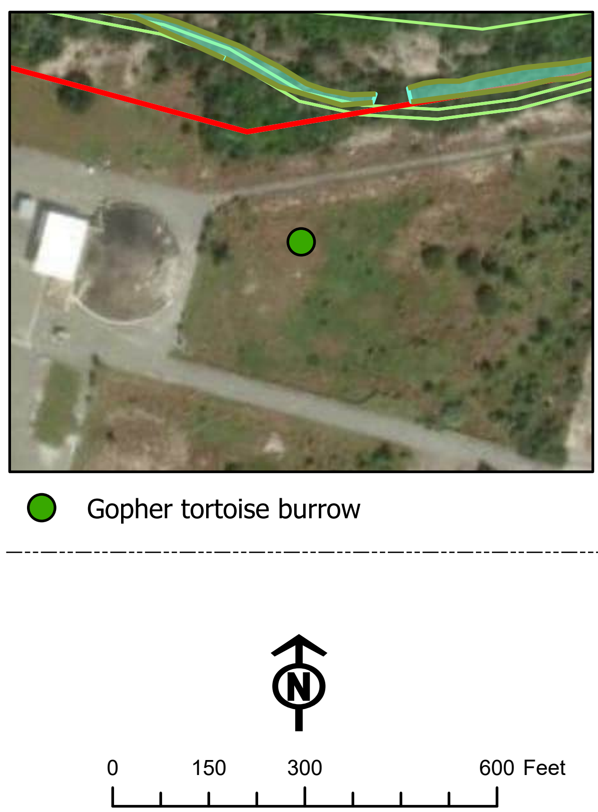
Date: September 11 - 14, 2023
Photo Number: 33
Photo Direction: NW
Photo ID: 233



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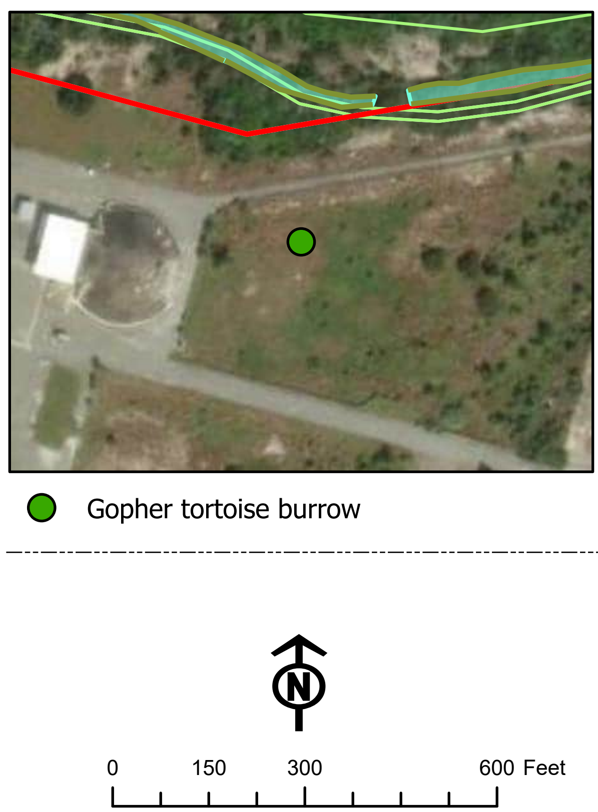
Date: September 11 - 14, 2023
Photo Number: 34
Photo Direction: NE
Photo ID: 234



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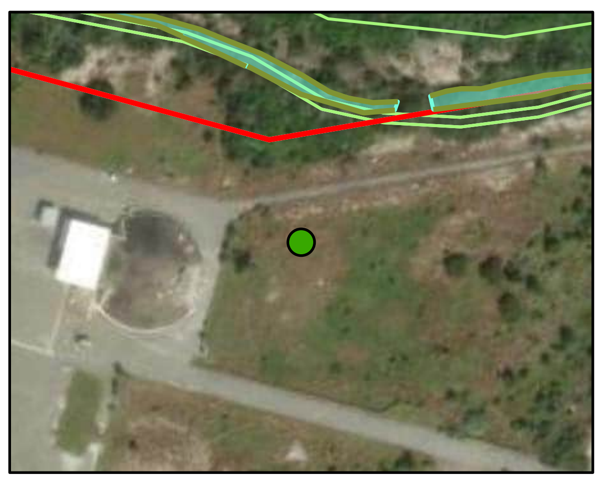
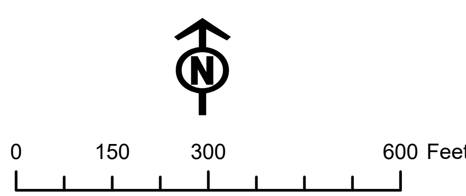
Date: September 11 - 14, 2023
Photo Number: 35
Photo Direction: S
Photo ID: 235



Gopher tortoise burrow



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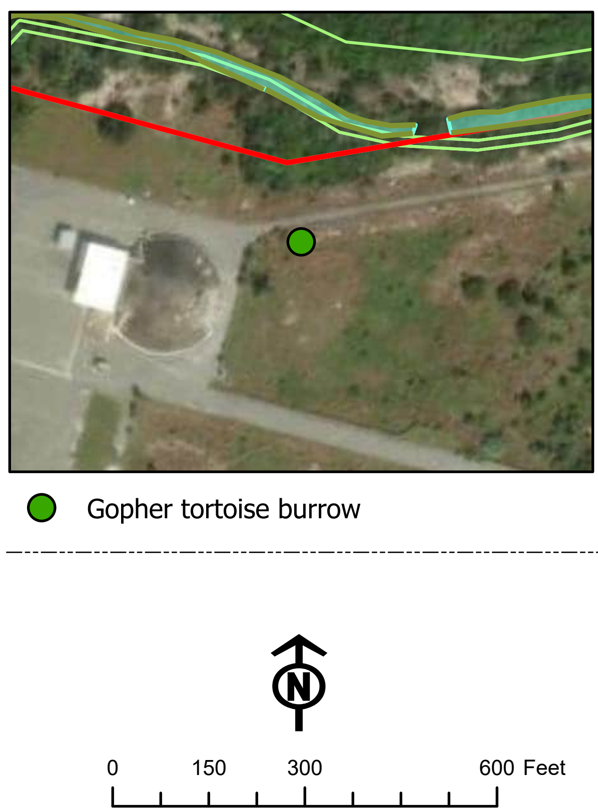
Date: September 11 - 14, 2023
Photo Number: 36
Photo Direction: Be
Photo ID: 236



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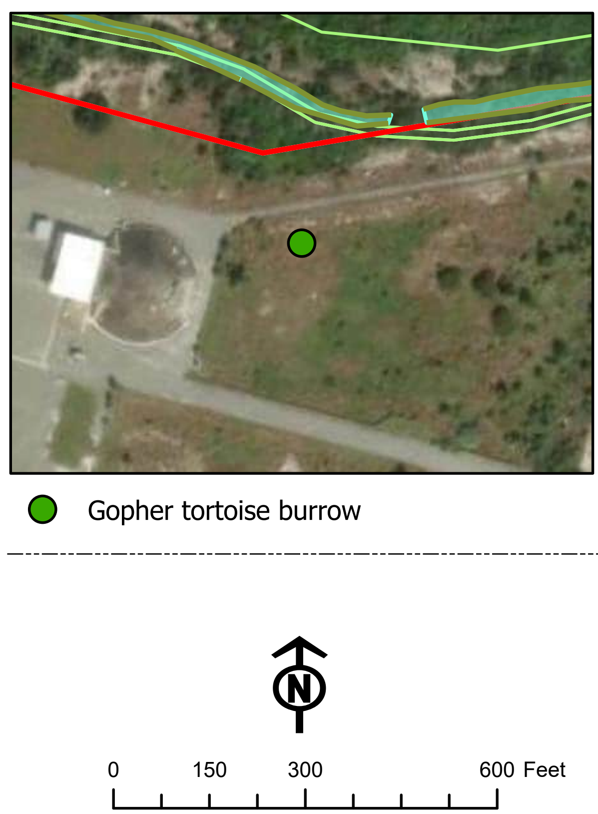
Date: September 11 - 14, 2023
Photo Number: 37
Photo Direction: W
Photo ID: 237



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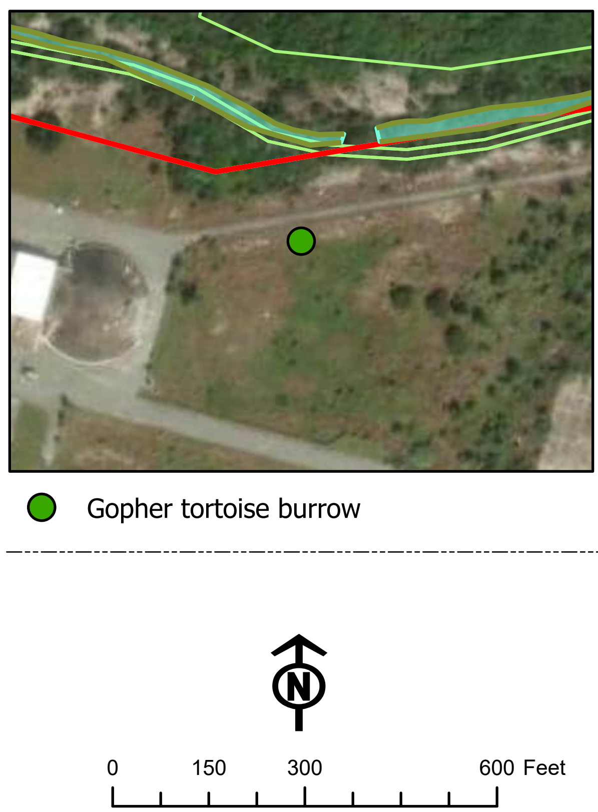
Date: September 11 - 14, 2023
Photo Number: 38
Photo Direction: N
Photo ID: 238



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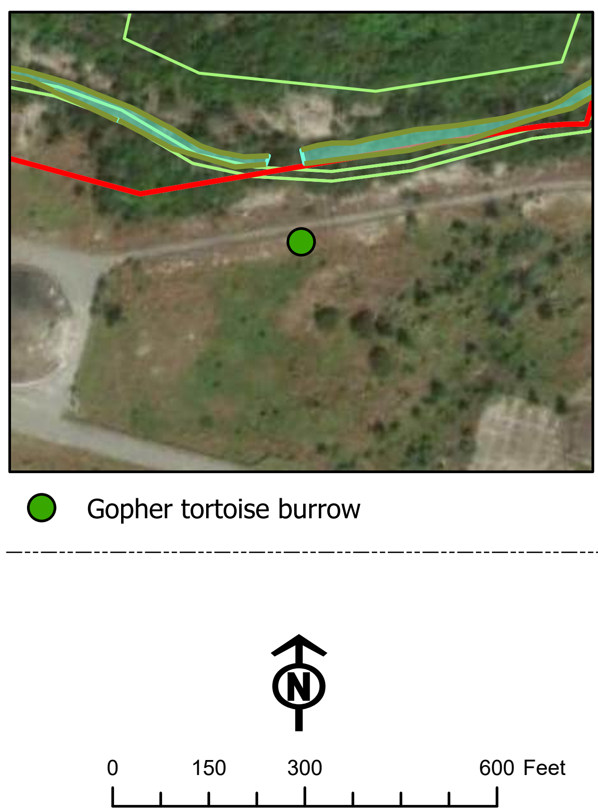
Date: September 11 - 14, 2023
Photo Number: 39
Photo Direction: N
Photo ID: 239



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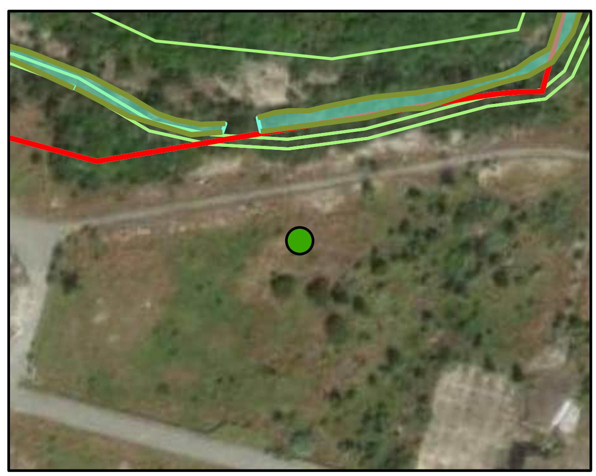
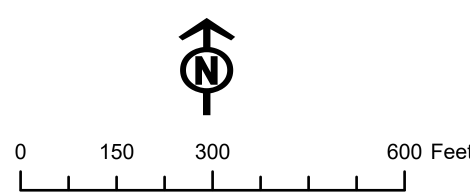
Date: September 11 - 14, 2023
Photo Number: 40
Photo Direction: SE
Photo ID: 240



Gopher tortoise burrow



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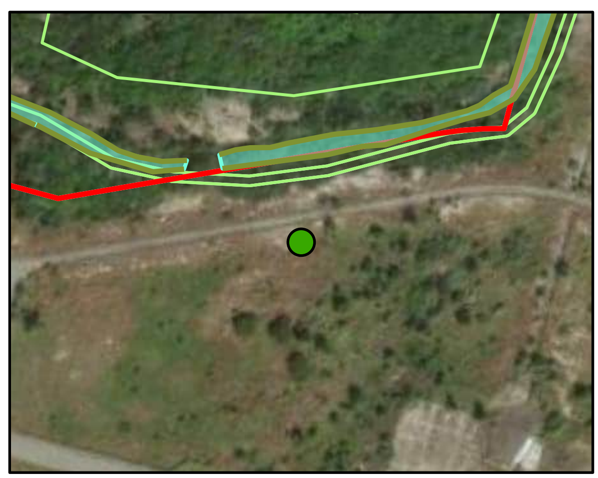
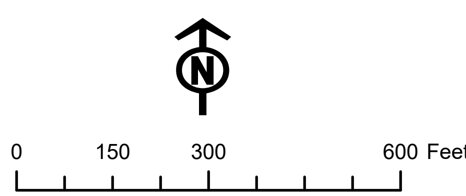
Date: September 11 - 14, 2023
Photo Number: 41
Photo Direction: NE
Photo ID: 241



Gopher tortoise burrow



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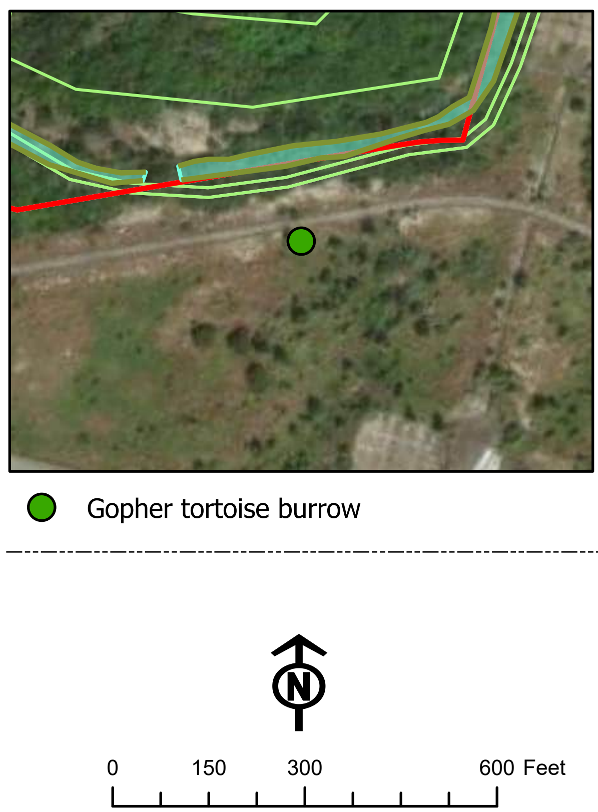
Date: September 11 - 14, 2023
Photo Number: 42
Photo Direction: N
Photo ID: 242



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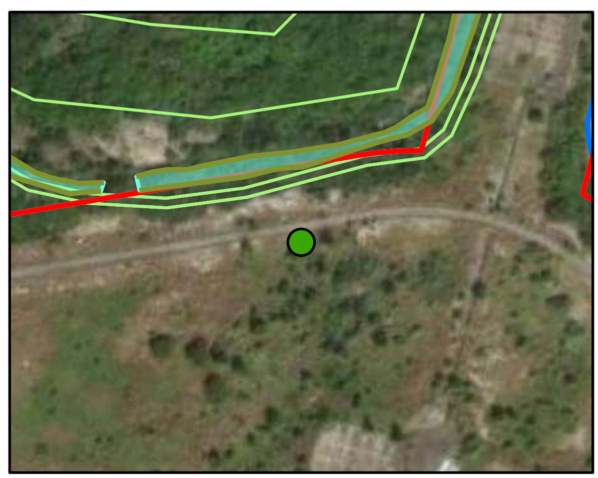
Date: September 11 - 14, 2023
Photo Number: 43
Photo Direction: N
Photo ID: 243



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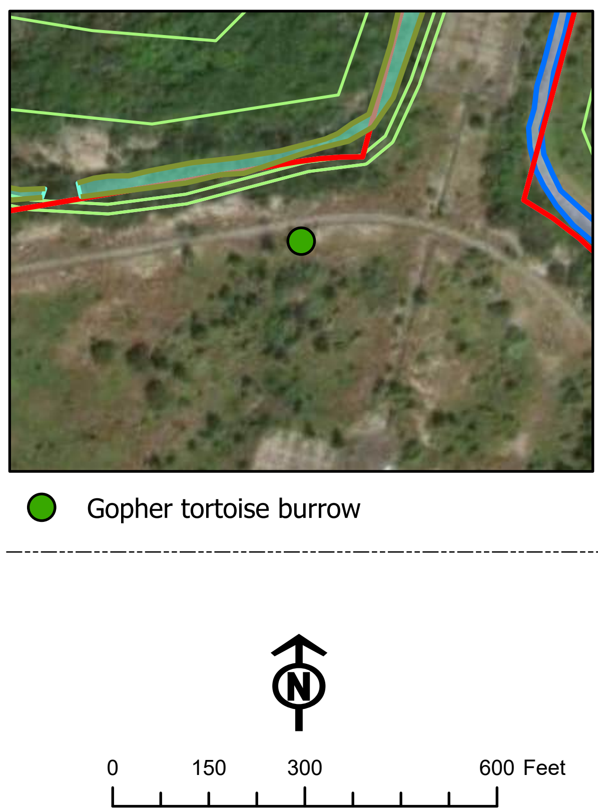
Date: September 11 - 14, 2023
Photo Number: 44
Photo Direction: Sw
Photo ID: 244



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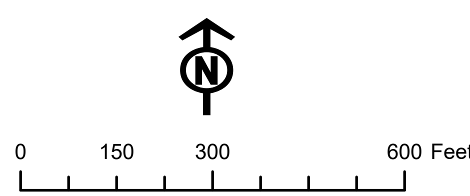
Date: September 11 - 14, 2023
Photo Number: 45
Photo Direction: Ne
Photo ID: 245

Gopher tortoise burrow



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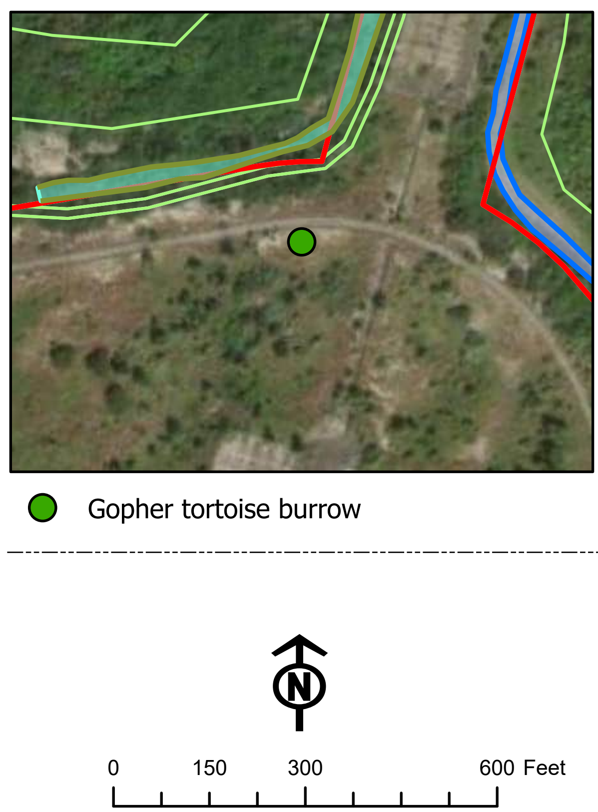
Date: September 11 - 14, 2023
Photo Number: 46
Photo Direction: NE
Photo ID: 246



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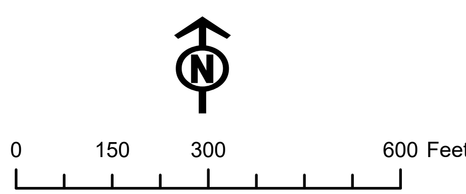
Date: September 11 - 14, 2023
Photo Number: 47
Photo Direction: E
Photo ID: 247

Gopher tortoise burrow



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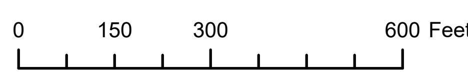
Date: September 11 - 14, 2023
Photo Number: 48
Photo Direction: E
Photo ID: 248

Gopher tortoise burrow



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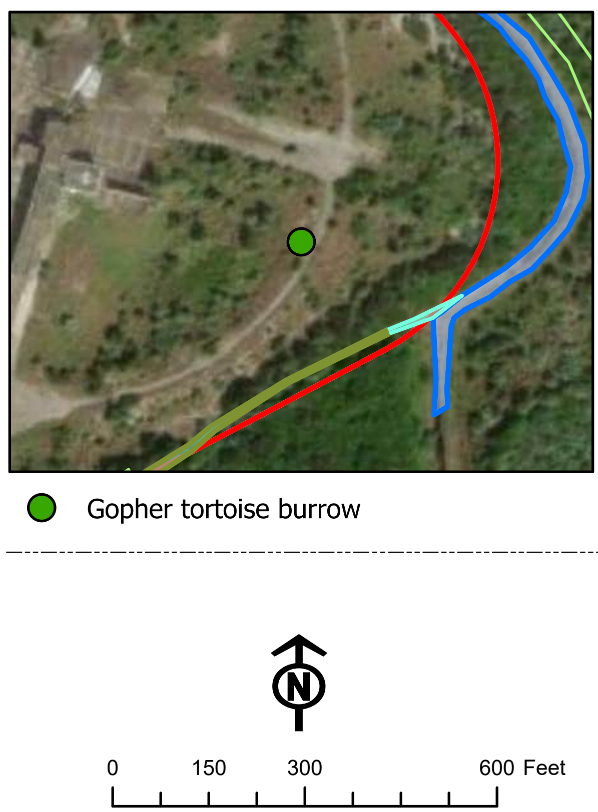
Date: September 11 - 14, 2023
Photo Number: 50
Photo Direction: E
Photo ID: 250



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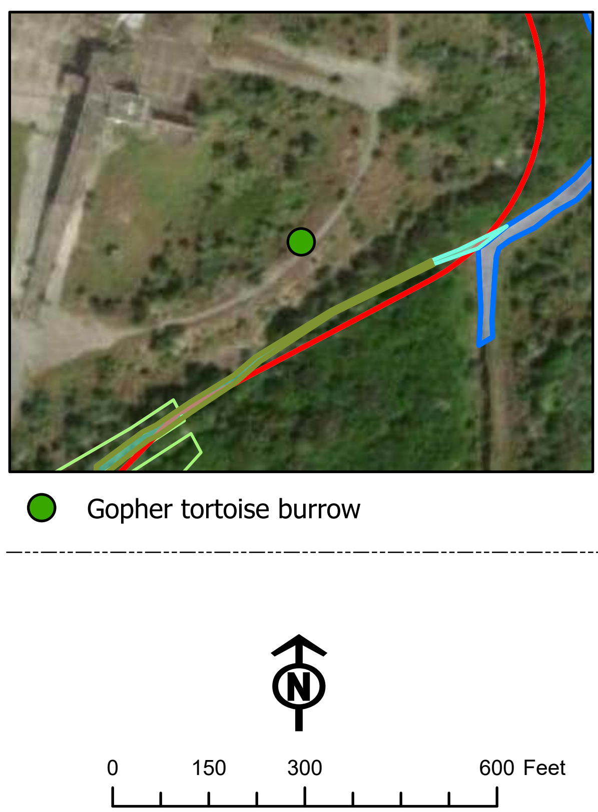
Date: September 11 - 14, 2023
Photo Number: 51
Photo Direction: East
Photo ID: 251



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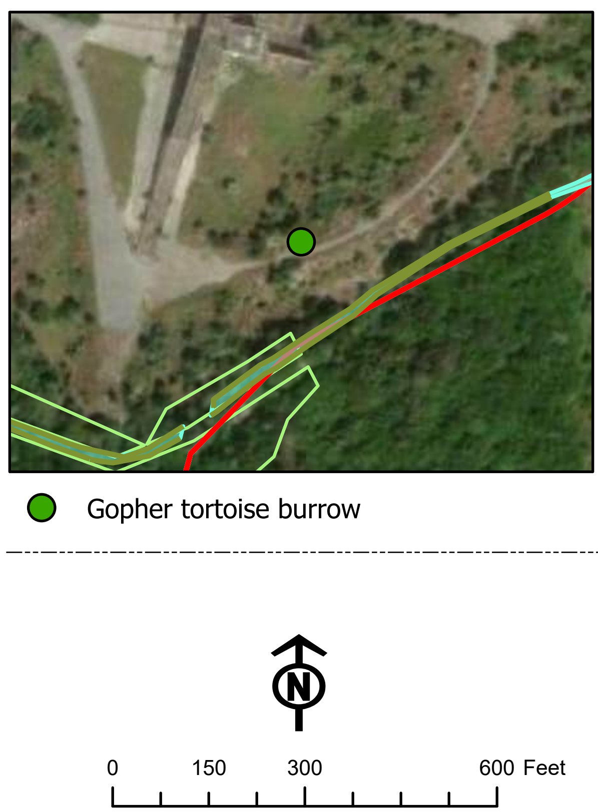
Date: September 11 - 14, 2023
Photo Number: 52
Photo Direction: SE
Photo ID: 252



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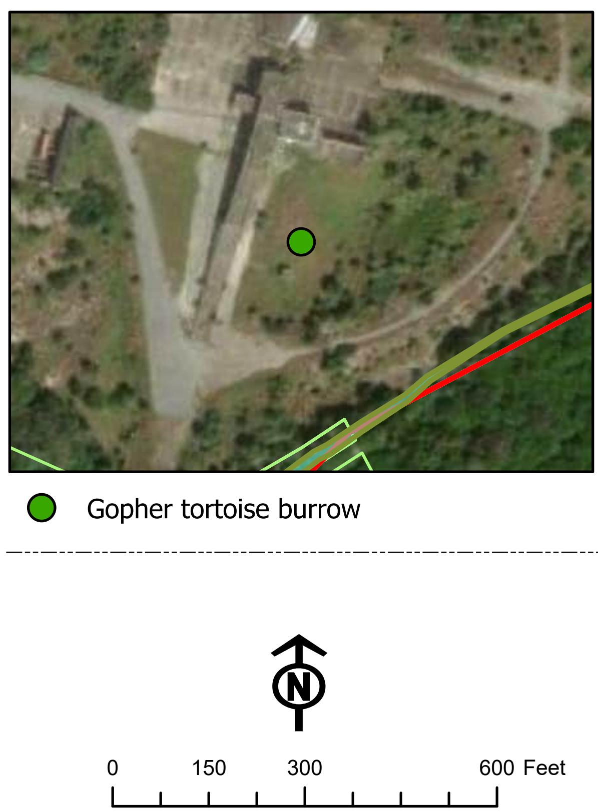
Date: September 11 - 14, 2023
Photo Number: 53
Photo Direction: N
Photo ID: 253



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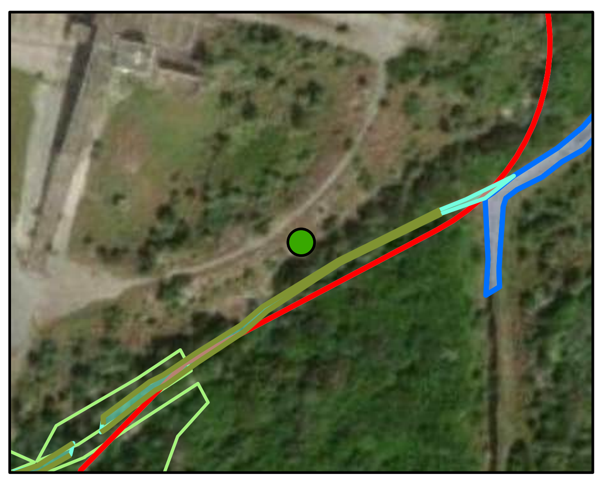
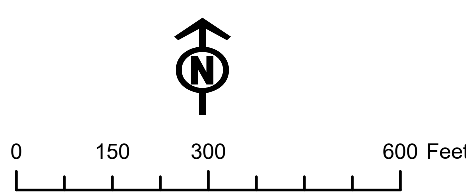
Date: September 11 - 14, 2023
Photo Number: 54
Photo Direction: NW
Photo ID: 254



Gopher tortoise burrow



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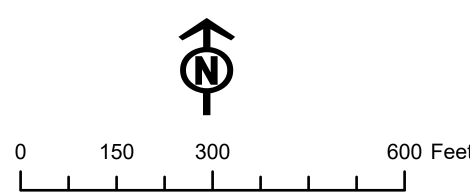
Date: September 11 - 14, 2023
Photo Number: 55
Photo Direction: E
Photo ID: 255

Gopher tortoise burrow



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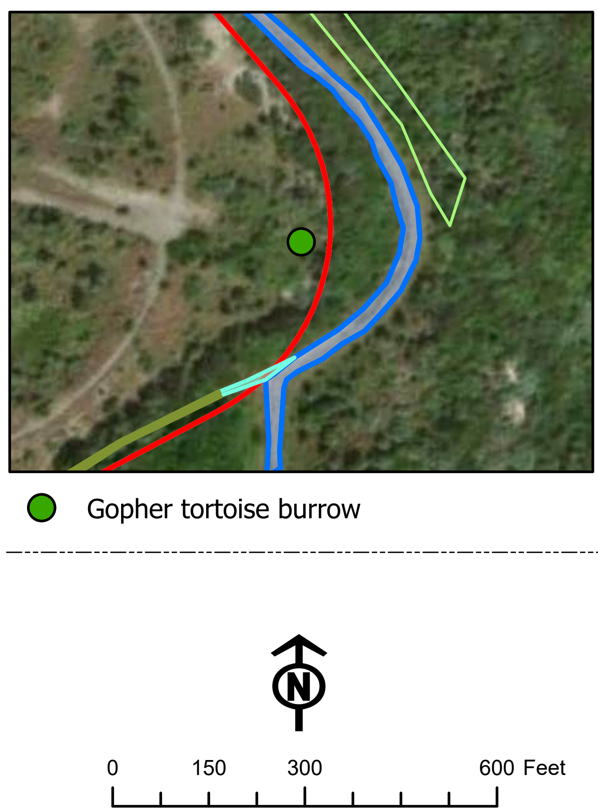
Date: September 11 - 14, 2023
Photo Number: 56
Photo Direction: E
Photo ID: 256



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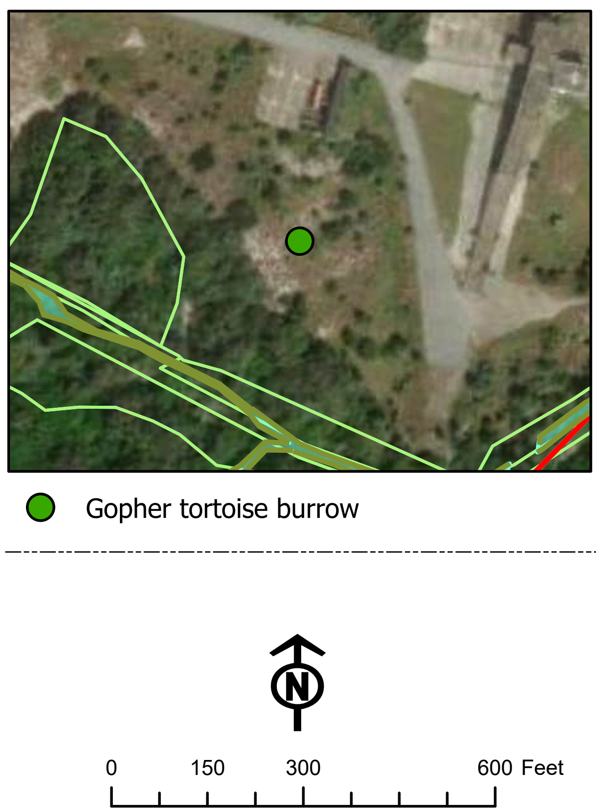
Date: September 11 - 14, 2023
Photo Number: 57
Photo Direction: S
Photo ID: 257



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Date: September 11 - 14, 2023
Photo Number: 58
Photo Direction: S
Photo ID: 258

Gopher tortoise burrow

N

0 150 300 600 Feet

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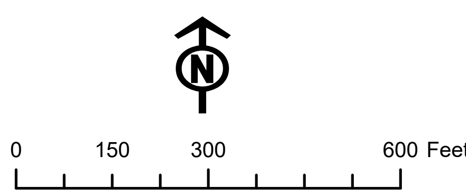
Date: September 11 - 14, 2023
Photo Number: 59
Photo Direction: SW
Photo ID: 259

Gopher tortoise burrow



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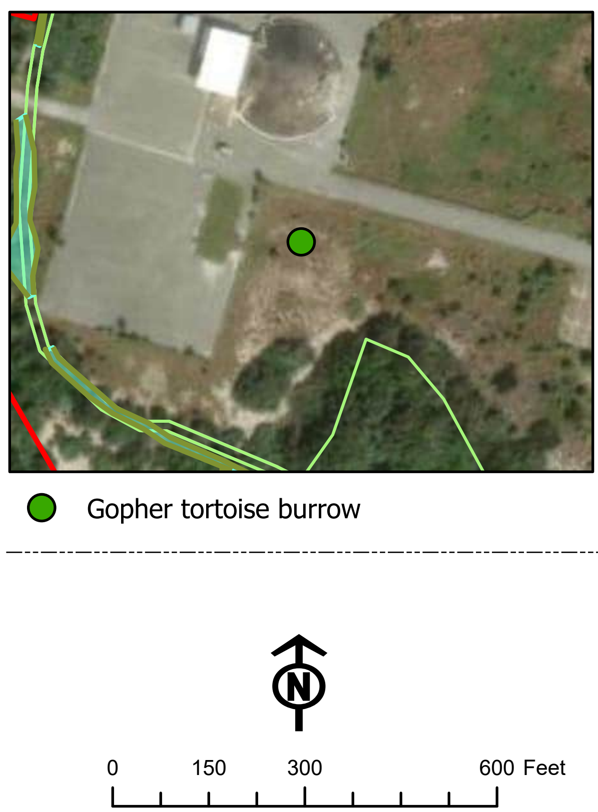
Date: September 11 - 14, 2023
Photo Number: 60
Photo Direction: S
Photo ID: 260



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Date: September 11 - 14, 2023
Photo Number: 61
Photo Direction: NE
Photo ID: 261

Gopher tortoise burrow

0 150 300 600 Feet

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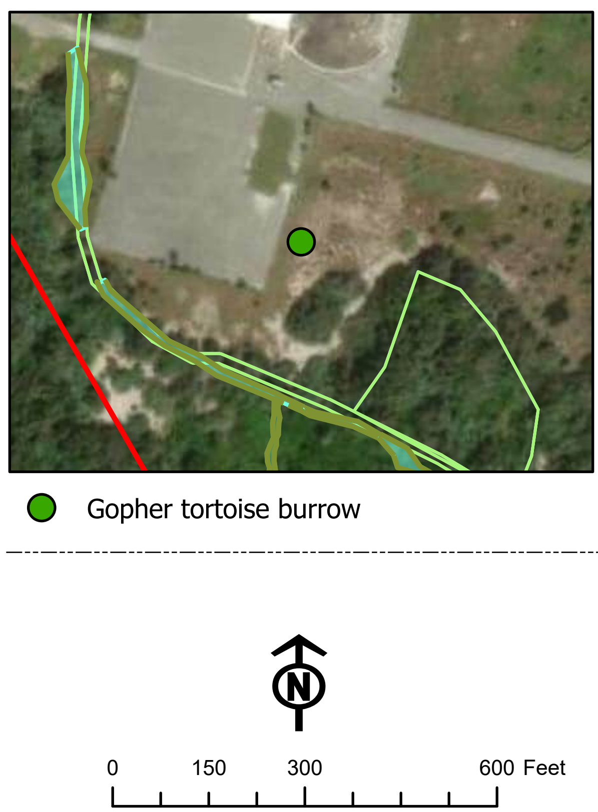
Date: September 11 - 14, 2023
Photo Number: 62
Photo Direction: W
Photo ID: 262



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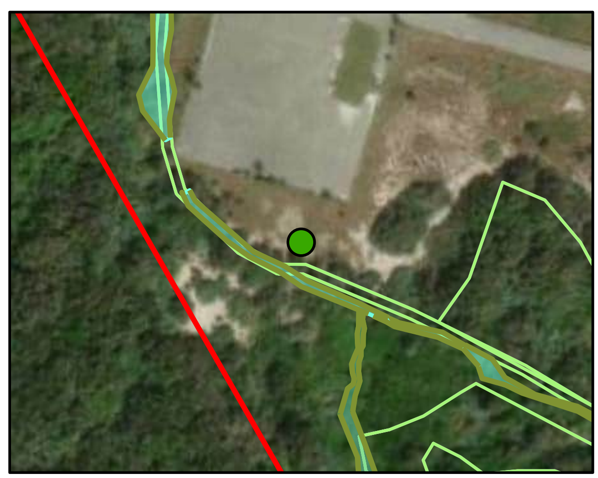
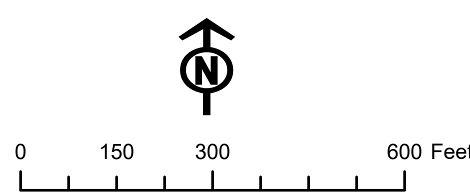
Date: September 11 - 14, 2023
Photo Number: 63
Photo Direction: NE
Photo ID: 263



Gopher tortoise burrow



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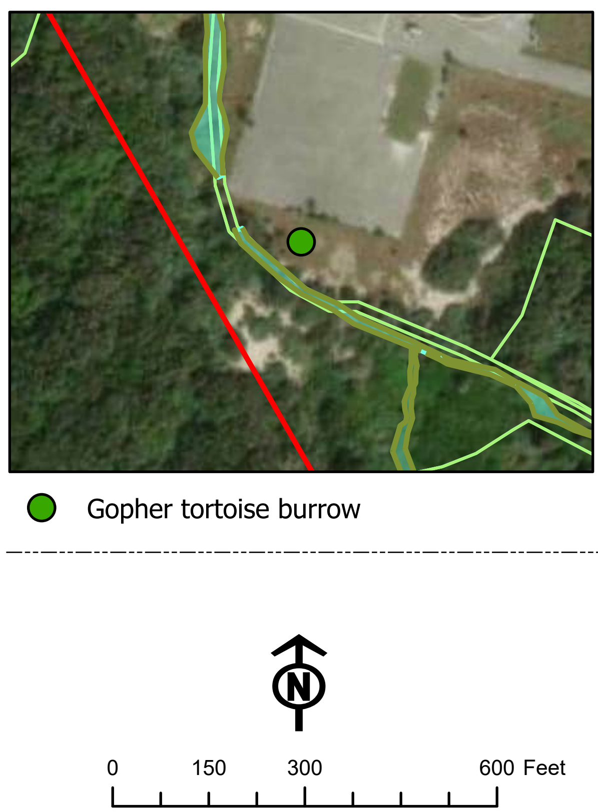
Date: September 11 - 14, 2023
Photo Number: 64
Photo Direction: E
Photo ID: 264



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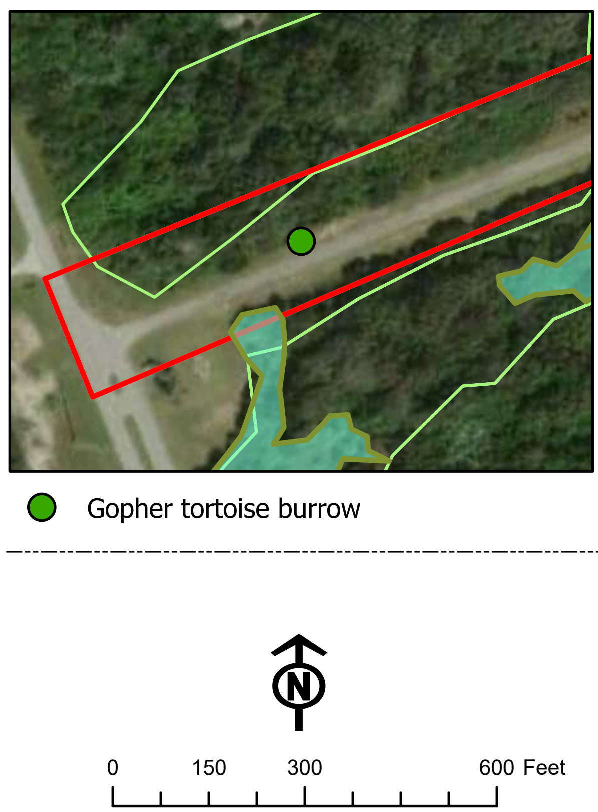
Date: September 11 - 14, 2023
Photo Number: 65
Photo Direction: S
Photo ID: 265



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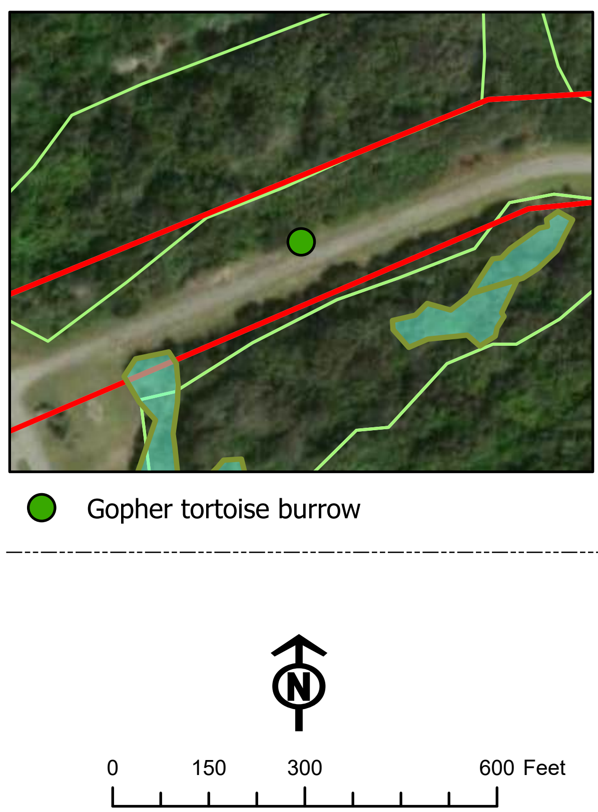
Date: September 11 - 14, 2023
Photo Number: 66
Photo Direction: S
Photo ID: 266



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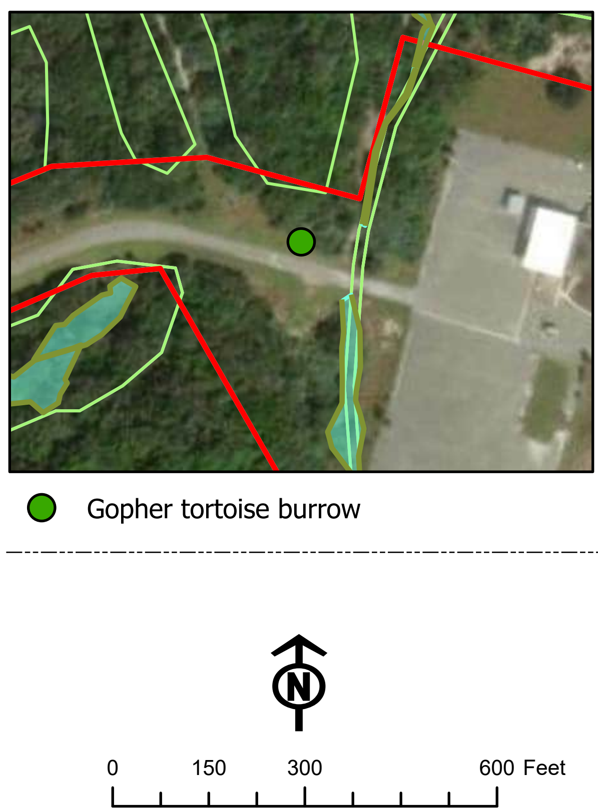
Date: September 11 - 14, 2023
Photo Number: 67
Photo Direction: N
Photo ID: 267



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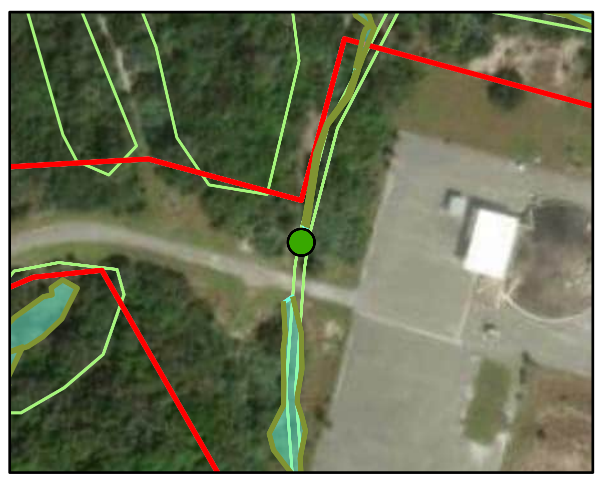
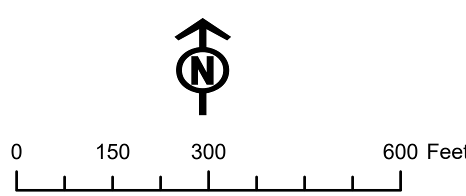
Date: September 11 - 14, 2023
Photo Number: 68
Photo Direction: W
Photo ID: 268



Gopher tortoise burrow



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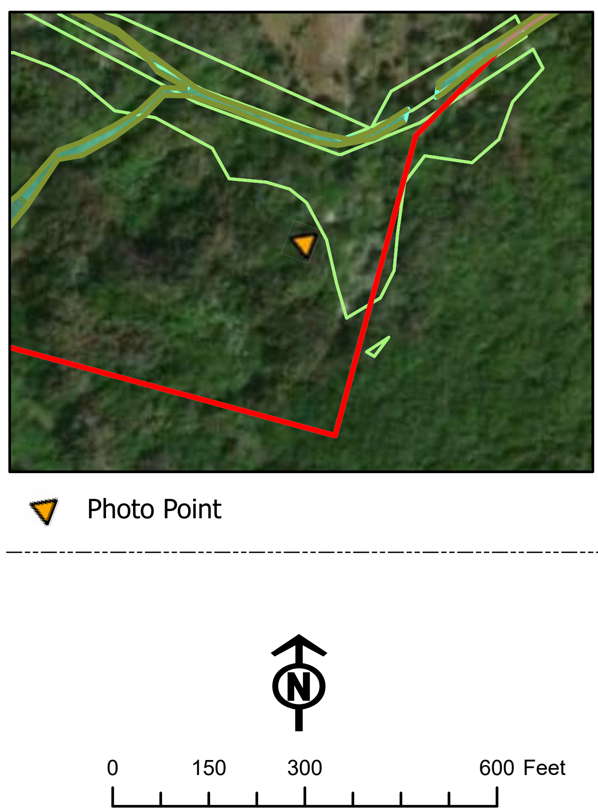
Date: September 11 - 14, 2023
Photo Number: 74
Photo Direction: No Data
Photo ID: No Data



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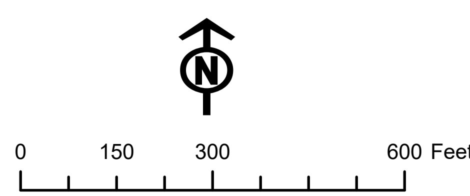
Date: September 11 - 14, 2023
Photo Number: 75
Photo Direction: NE
Photo ID: No Data

Photo Point



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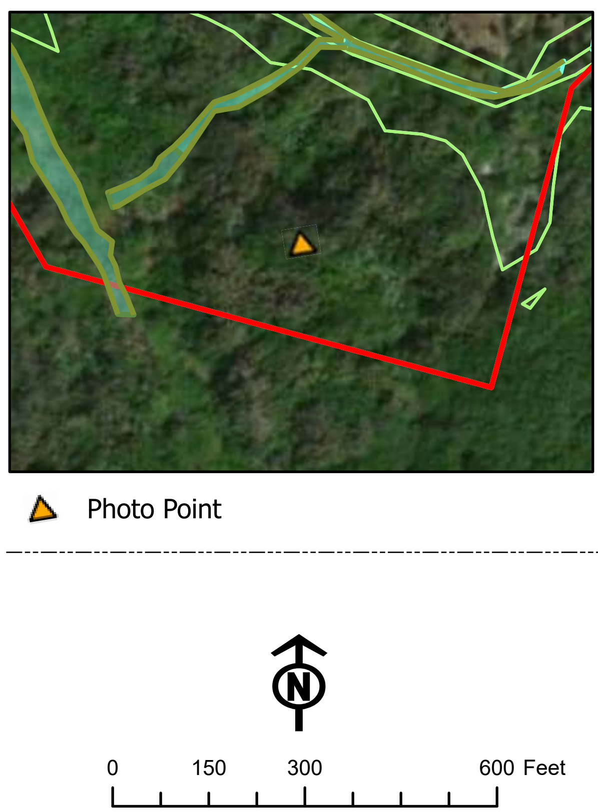
Date: September 11 - 14, 2023
Photo Number: 76
Photo Direction: No Data
Photo ID: No Data



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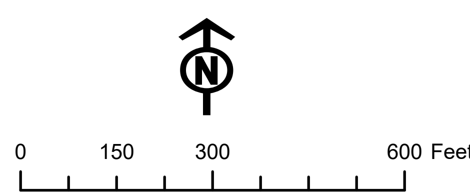
Date: September 11 - 14, 2023
Photo Number: 77
Photo Direction: NE
Photo ID: No Data

Photo Point



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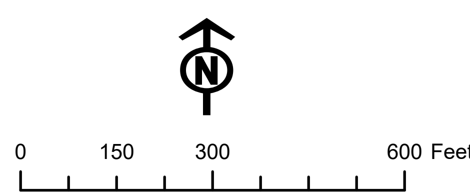
Date: September 11 - 14, 2023
Photo Number: 78
Photo Direction: SE
Photo ID: No Data

Photo Point



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Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 79
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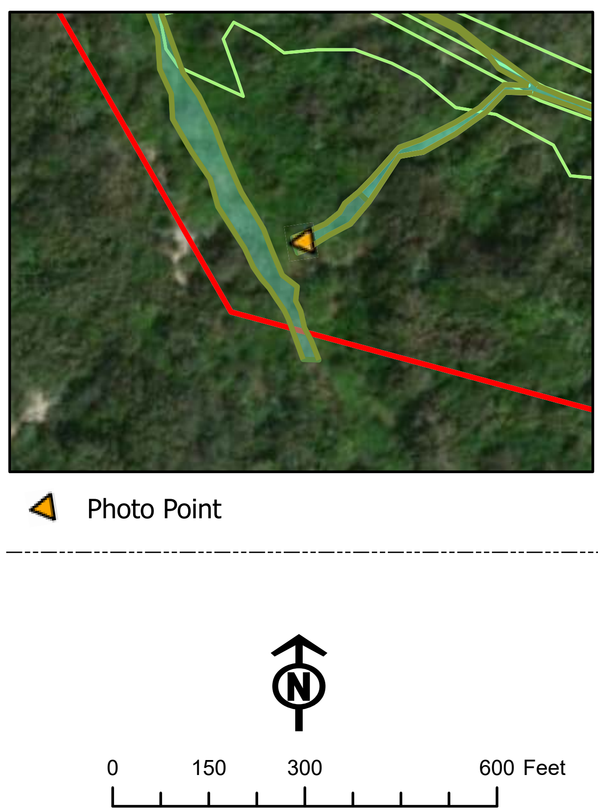
Photo ID: Culvert



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Date: September 11 - 14, 2023
Photo Number: 80
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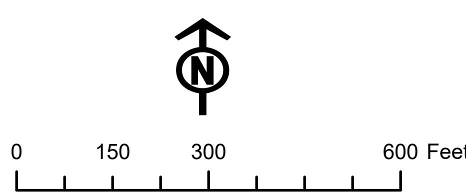
Photo ID: No Data

Photo Point



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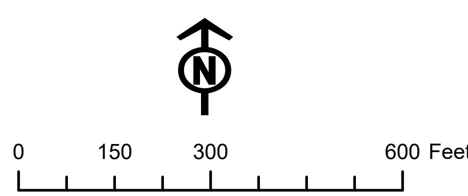
Date: September 11 - 14, 2023
Photo Number: 81
Photo Direction: N
Photo ID: No Data

Photo Point



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Date: September 11 - 14, 2023
Photo Number: 82
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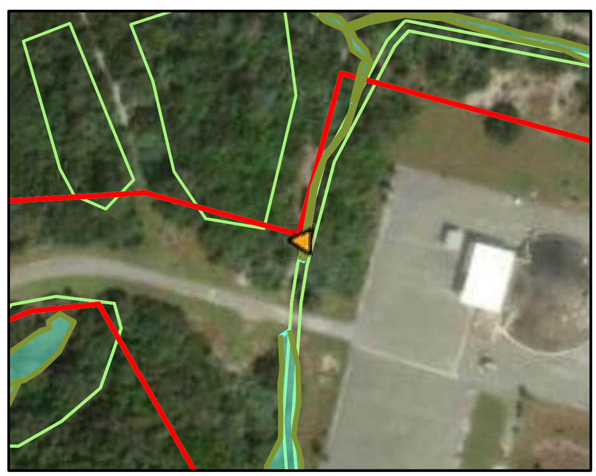
Photo ID: No Data



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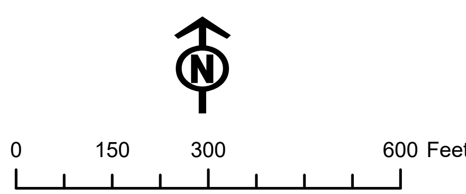

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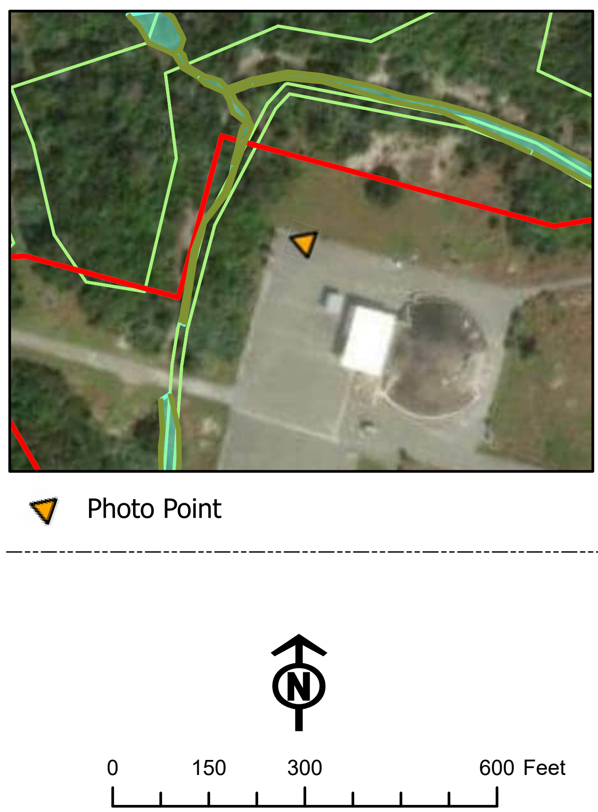
Date: September 11 - 14, 2023
Photo Number: 83
Photo Direction: N
Photo ID: No Data



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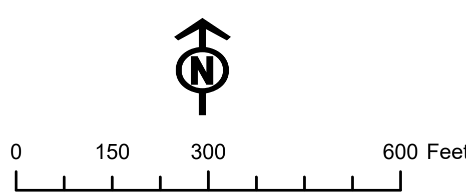
Date: September 11 - 14, 2023
Photo Number: 84
Photo Direction: SE
Photo ID: No Data

Photo Point



STOKE Space Technologies Launch Pad 14
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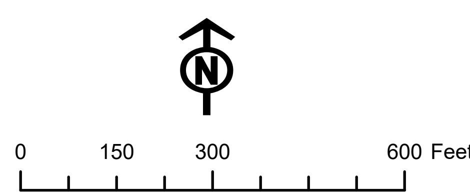
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 85
Photo Direction: E
Photo ID: No Data

Photo Point



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Date: September 11 - 14, 2023
Photo Number: 86
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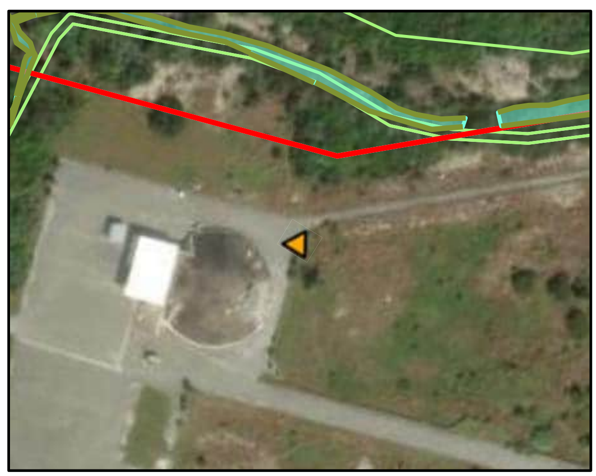
Photo ID: No Data



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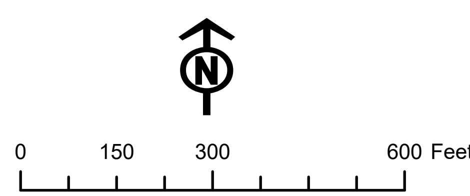

STOKE Space Technologies Launch Pad 14
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Date: September 11 - 14, 2023
Photo Number: 87
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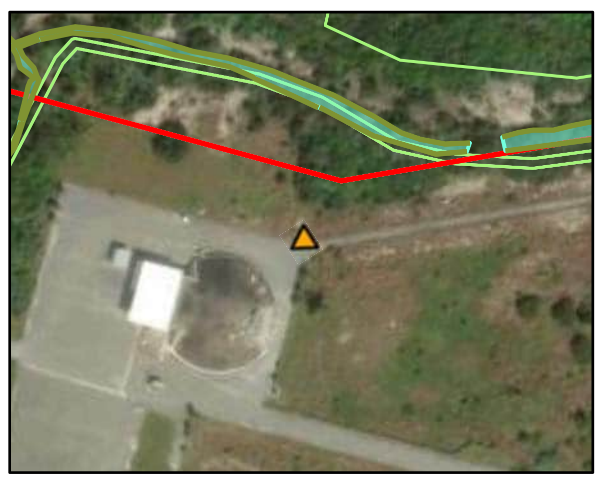
Photo ID: No Data



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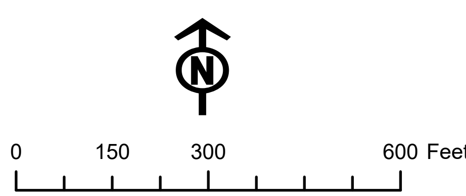

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Date: September 11 - 14, 2023
Photo Number: 12
Photo Direction: NE
Photo ID: No Data

Wetland Point

N

0 150 300 600 Feet

STOKE Space Technologies Launch Pad 14
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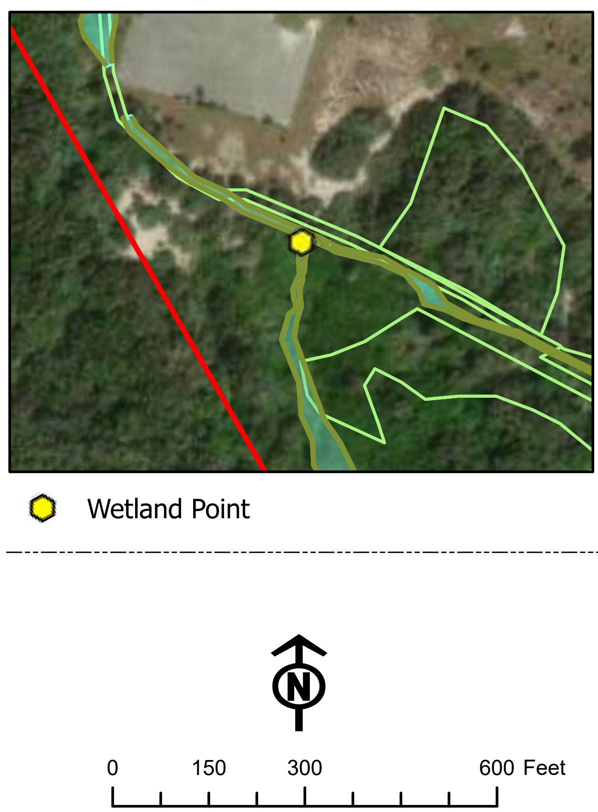
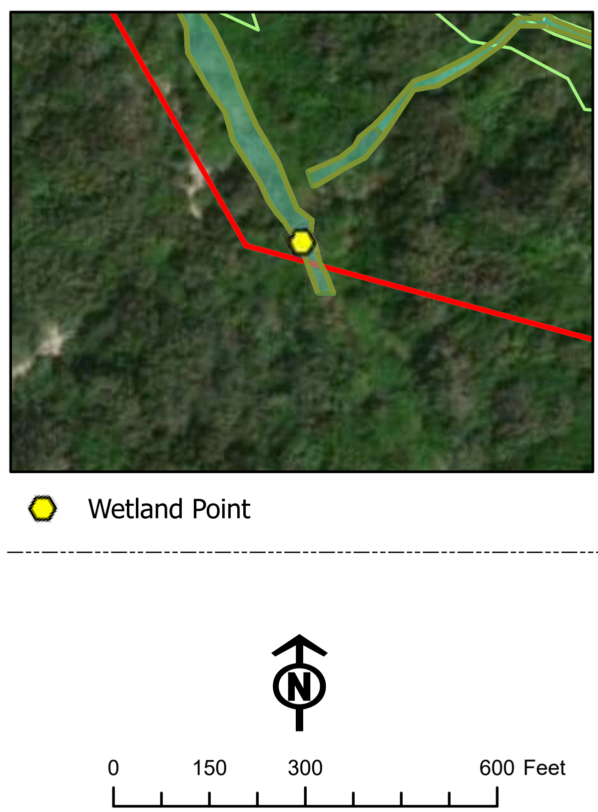
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 13
Photo Direction: South
Photo ID: No Data



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

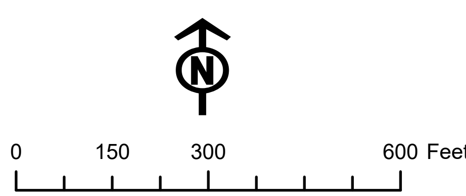
Date: September 11 - 14, 2023
Photo Number: 14
Photo Direction: No Data
Photo ID: No Data



STOKE Space Technologies Launch Pad 14
Wetland Delineations and Environmental Surveys
Environmental Technical Memorandum

Date: September 11 - 14, 2023
Photo Number: 15
Photo Direction: No Data
Photo ID: No Data

Wetland Point



Attachment 2. Natural Resources Conservation Service Soil Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Brevard County, Florida

October 5, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,940 if printed on A landscape (11" x 8.5") sheet.

N

0 50 100 200 300 Meters

0 200 400 800 1200 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brevard County, Florida
Survey Area Data: Version 23, Aug 28, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 19, 2022—Mar 2, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
9	Canaveral-Anclote complex, gently undulating	13.3	26.3%
10	Canaveral-Urban land complex	19.2	38.0%
69	Urban land, 0 to 2 percent slopes	18.1	35.7%
Totals for Area of Interest		**50.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Brevard County, Florida

9—Canaveral-Anclote complex, gently undulating

Map Unit Setting

National map unit symbol: 1lg2n
Elevation: 10 to 60 feet
Mean annual precipitation: 49 to 57 inches
Mean annual air temperature: 68 to 75 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Canaveral and similar soils: 60 percent
Anclote and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canaveral

Setting

Landform: Dunes on marine terraces, ridges on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

A - 0 to 6 inches: sand
C - 6 to 12 inches: sand
C - 12 to 80 inches: coarse sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 50.02 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 6.0
Available water supply, 0 to 60 inches: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A/D
Ecological site: R155XY170FL - Sandy Coastal Grasslands and Forests
Forage suitability group: Forage suitability group not assigned (G156BC999FL)
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Hydric soil rating: No

Description of Anclote

Setting

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

A - 0 to 19 inches: sand
Cg - 19 to 72 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: R155XY070FL - Sandy Freshwater Isolated Marshes and Swamps
Forage suitability group: Sandy soils on flats of mesic or hydric lowlands (G156BC141FL)
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G156BC141FL)
Hydric soil rating: Yes

Minor Components

Pomello

Percent of map unit: 5 percent
Landform: Rises on marine terraces, flats on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: F155XY150FL - Sandy Upland Mesic Flatwoods and Hammocks on Rises and Knolls
Other vegetative classification: Sand Pine Scrub (R155XY001FL), Sandy soils on rises and knolls of mesic uplands (G156BC131FL)
Hydric soil rating: No

Palm beach

Percent of map unit: 5 percent

Landform: Dunes on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R155XY220FL - Sandy Coastal Beach Dunes
Other vegetative classification: Sandy soils on ridges and dunes of xeric uplands (G156BC111FL)
Hydric soil rating: No

10—Canaveral-Urban land complex

Map Unit Setting

National map unit symbol: 1lg2p
Elevation: 0 to 100 feet
Mean annual precipitation: 49 to 57 inches
Mean annual air temperature: 68 to 75 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Canaveral and similar soils: 50 percent
Urban land: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canaveral

Setting

Landform: Ridges on marine terraces, flats on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

A - 0 to 6 inches: sand
C - 6 to 12 inches: sand
C - 12 to 80 inches: coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 50.02 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 6.0
Available water supply, 0 to 60 inches: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: R155XY170FL - Sandy Coastal Grasslands and Forests
Forage suitability group: Forage suitability group not assigned (G156BC999FL)
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Marine terraces
Landform position (three-dimensional): Interfluve, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: No parent material

Interpretive groups

Land capability classification (irrigated): None specified
Ecological site: R155XY170FL - Sandy Coastal Grasslands and Forests
Forage suitability group: Forage suitability group not assigned (G156BC999FL)
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)
Hydric soil rating: Unranked

Minor Components

Anclote

Percent of map unit: 4 percent
Landform: — error in exists on —
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R155XY070FL - Sandy Freshwater Isolated Marshes and Swamps
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)
Hydric soil rating: Yes

Myakka

Percent of map unit: 3 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: South Florida Flatwoods (R155XY003FL), Forage suitability group not assigned (G156BC999FL)
Hydric soil rating: No

Pompano

Percent of map unit: 3 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: Slough (R155XY011FL), Forage suitability group not assigned (G156BC999FL)
Hydric soil rating: Yes

69—Urban land, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2x9fc
Elevation: 0 to 200 feet
Mean annual precipitation: 40 to 68 inches
Mean annual air temperature: 68 to 79 degrees F
Frost-free period: 345 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Hills on marine terraces, ridges on marine terraces, knolls on marine terraces, rises on marine terraces, flatwoods on marine terraces
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope, riser, rise, talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: No parent material

Interpretive groups

Land capability classification (irrigated): None specified
Forage suitability group: Forage suitability group not assigned (G155XB999FL)
Other vegetative classification: Forage suitability group not assigned (G155XB999FL)
Hydric soil rating: Unranked

Minor Components

Matlacha

Percent of map unit: 3 percent
Landform: Flats on marine terraces

Landform position (three-dimensional): Tread, talf
Down-slope shape: Convex, linear
Across-slope shape: Linear
Other vegetative classification: Forage suitability group not assigned (G155XB999FL)
Hydric soil rating: No

St. augustine

Percent of map unit: 3 percent
Landform: Marine terraces
Landform position (three-dimensional): Tread, rise
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: Forage suitability group not assigned (G155XB999FL)
Hydric soil rating: No

Paola

Percent of map unit: 1 percent
Landform: Ridges on marine terraces, knolls on marine terraces
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on ridges and dunes of xeric uplands (G155XB111FL), Sand Pine Scrub (R155XY001FL)
Hydric soil rating: No

Adamsville

Percent of map unit: 1 percent
Landform: Rises on marine terraces, knolls on marine terraces
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G155XB131FL), Upland Hardwood Hammock (R155XY008FL)
Hydric soil rating: No

Eaugallie

Percent of map unit: 1 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: South Florida Flatwoods (R155XY003FL), Sandy soils on flats of mesic or hydric lowlands (G155XB141FL)
Hydric soil rating: No

Immokalee

Percent of map unit: 1 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Riser, talf
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: No

Myakka

Percent of map unit: 1 percent
Landform: Drainageways on flatwoods on marine terraces
Landform position (three-dimensional): Tread, dip, talf
Down-slope shape: Linear
Across-slope shape: Linear, concave
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: No

Pomello

Percent of map unit: 1 percent
Landform: Ridges on marine terraces, knolls on marine terraces
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G155XB131FL), Sand Pine Scrub (R155XY001FL)
Hydric soil rating: No

Apopka

Percent of map unit: 1 percent
Landform: Hills on marine terraces, ridges on marine terraces
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope, riser
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on ridges and dunes of xeric uplands (G155XB111FL), Longleaf Pine-Turkey Oak Hills (R155XY002FL)
Hydric soil rating: No

Brynwood

Percent of map unit: 1 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: Yes

Cypress lake

Percent of map unit: 1 percent
Landform: Flats on marine terraces, drainageways on marine terraces
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Convex, linear
Across-slope shape: Linear, concave
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: Yes

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Attachment 3. Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/10/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_U001_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): Convave Slope (%): 5

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.490782 Long: -80.552848 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: NA

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?**	**Yes** ___ **No** X
Hydric Soil Present?	Yes ___ No X		
Wetland Hydrology Present?	Yes ___ No X		

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)	
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**	
___ Saturation (A3)	___ Hydrogen Sulfide Odor (C1)	
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots (C3)	
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)	
___ Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)	
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)	
___ Iron Deposits (B5)	___ Other (Explain in Remarks)	
___ Inundation Visible on Aerial Imagery (B7)		
___ Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
? Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No x	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_U001_DP1

Tree Stratum (Plot size: 10 m)

	Absolute % Cover	Dominant Species?	Indicator Status
1. *Sabal palmetto*	40	Yes	FAC
2. *Quercus virginiana*	30	Yes	FACU
3. *Schinus terebinthifolia*	10	No	FAC
4.			
5.			
6.			
	80 =Total Cover		

50% of total cover: 40 20% of total cover: 16

Sapling Stratum (Plot size: 10 m)

	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	15	Yes	FACU
2. *Sabal palmetto*	5	No	FAC
3. *Schinus terebinthifolia*	12	Yes	FAC
4.			
5.			
6.			
	32 =Total Cover		

50% of total cover: 16 20% of total cover: 7

Shrub Stratum (Plot size: ______)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
	=Total Cover		

50% of total cover: ______ 20% of total cover: ______

Herb Stratum (Plot size: ______)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	=Total Cover		

50% of total cover: ______ 20% of total cover: ______

Woody Vine Stratum (Plot size: ______)

	Absolute % Cover	Dominant Species?	Indicator Status
1. *Nekemias arborea*	15	Yes	FAC
2. *Vitis rotundifolia*	8	Yes	FAC
3.			
4.			
5.			
	23 =Total Cover		

50% of total cover: 12 20% of total cover: 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	90	x 3 =	270
FACU species	45	x 4 =	180
UPL species	0	x 5 =	0
Column Totals:	135 (A)		450 (B)

Prevalence Index = B/A = 3.33

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
_X_ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** _X_ **No** ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_U001_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 2	10yr 3/1	100					Mucky Sand	
2 - 12	2.5yr 5/1	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) (**MLRA 150A)**
___ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_U002_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): None Slope (%): 0

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.491499 Long: -80.551731 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: PSS

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___ , Soil ___ , or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___ , Soil ___ , or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X	**Is the Sampled Area within a Wetland?**	**Yes** ___ **No** X
Hydric Soil Present?	Yes ___	No X		
Wetland Hydrology Present?	Yes ___	No X		

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)	
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**	
___ Saturation (A3)	___ Hydrogen Sulfide Odor (C1)	
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots (C3)	
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)	
___ Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)	
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)	
___ Iron Deposits (B5)	___ Other (Explain in Remarks)	
___ Inundation Visible on Aerial Imagery (B7)		
___ Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No x	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_U002_DP1

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	80	Yes	FACU
2. *Sabal palmetto*	10	No	FAC
3. *Schinus terebinthifolia*	5	No	FAC
4.			
5.			
6.			
	95	=Total Cover	
50% of total cover: 48		20% of total cover: 19	

Sapling Stratum (Plot size: 10 m)			
1.			
2.			
3.			
4.			
5.			
6.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Herb Stratum (Plot size:)			
1. *Stenotaphrum secundatum*	75	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	75	=Total Cover	
50% of total cover: 38		20% of total cover: 15	

Woody Vine Stratum (Plot size:)			
1.			FAC
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	90	x 3 =	270
FACU species	80	x 4 =	320
UPL species	0	x 5 =	0
Column Totals:	170 (A)		590 (B)

Prevalence Index = B/A = 3.47

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_U002_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 12	10yr 3/1	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.
[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
___ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_U003_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): None Slope (%): 0

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.492762 Long: -80.550466 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: NA

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** ___ **No** X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15) **(LRR U)**
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No x	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_U003_DP1

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	20	Yes	FACU
2. *Sabal palmetto*	45	Yes	FAC
3. *Schinus terebinthifolia*	35	Yes	FAC
4.			
5.			
6.			
	100	=Total Cover	
50% of total cover:	50	20% of total cover:	20

Sapling Stratum (Plot size: 10 m)			
1.			
2.			
3.			
4.			
5.			
6.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Herb Stratum (Plot size:)			
1. *Aristida stricta*	70	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70	=Total Cover	
50% of total cover:	35	20% of total cover:	14

Woody Vine Stratum (Plot size:)			
1.			FAC
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	150	x 3 =	450
FACU species	20	x 4 =	80
UPL species	0	x 5 =	0
Column Totals:	170 (A)		530 (B)

Prevalence Index = B/A = 3.12

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_U003_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0 - 12	2.5yr 5/2	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
___ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? Yes ___ No X

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_UD001_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): none Slope (%): 3

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.490446 Long: -80.545264 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: ____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No x	**Is the Sampled Area within a Wetland?** **Yes** ___ **No** X
Hydric Soil Present?	Yes ___ No x	
Wetland Hydrology Present?	Yes ___ No x	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)	
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**	
___ Saturation (A3)	___ Hydrogen Sulfide Odor (C1)	
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots (C3)	
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)	
___ Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)	
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)	
___ Iron Deposits (B5)	___ Other (Explain in Remarks)	
___ Inundation Visible on Aerial Imagery (B7)		
___ Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No x	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_UD001_DP1

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	15	Yes	FACU
2. *Myrica cerifera*	4	No	FAC
3. *Schinus terebinthifolia*	30	Yes	FACU
4.			
5.			
6.			
	49	=Total Cover	
50% of total cover: 25		20% of total cover: 10	

Sapling Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Schinus terebinthifolia*	5	Yes	FAC
2.			
3.			
4.			
5.			
6.			
	5	=Total Cover	
50% of total cover: 3		20% of total cover: 1	

Shrub Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Sabal palmetto*	65	Yes	FAC
2. *Rottboellia cochinchinensis*	5	No	FACU
3.			
4.			
5.			
6.			
	70	=Total Cover	
50% of total cover: 35		20% of total cover: 14	

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Apium graveolens*	15	Yes	UPL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	15	=Total Cover	
50% of total cover: 8		20% of total cover: 3	

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = 0
FACW species	0	x 2 = 0
FAC species	74	x 3 = 222
FACU species	50	x 4 = 200
UPL species	15	x 5 = 75
Column Totals:	139 (A)	497 (B)

Prevalence Index = B/A = 3.58

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_UD001_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	2.5yr 5/2	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
___ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/10/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_W001_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): Convave Slope (%): 5

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.490882 Long: -80.552576 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)	
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**	
x Saturation (A3)	___ Hydrogen Sulfide Odor (C1)	
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots (C3)	
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)	
x Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)	
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)	
___ Iron Deposits (B5)	___ Other (Explain in Remarks)	
x Inundation Visible on Aerial Imagery (B7)		
___ Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- x Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes x	No ___	Depth (inches): 2

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_W001_DP1

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	20	Yes	FACU
2. *Persea borbonia*	45	Yes	FACW
3. *Schinus terebinthifolia*	10	No	FAC
4. *Sabal palmetto*	3	No	FAC
5. *Celtis laevigata*	10	No	FACW
6.			
	88	=Total Cover	
50% of total cover: 44		20% of total cover:	18

Sapling Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Persea borbonia*	20	Yes	FACW
2. *Schinus terebinthifolia*	2	No	FAC
3. *Sabal palmetto*	30	Yes	FAC
4. *Myrica cerifera*	5	No	FAC
5. *Celtis laevigata*	5	No	FACW
6.			
	62	=Total Cover	
50% of total cover: 31		20% of total cover:	13

Shrub Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Pteridium aquilinum*	5	Yes	FACU
2.			
3.			
4.			
5.			
6.			
	5	=Total Cover	
50% of total cover: 3		20% of total cover:	1

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Juncus effusus*	2	Yes	OBL
2. *Rhynchospora colorata*	7	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	9	=Total Cover	
50% of total cover: 5		20% of total cover:	2

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Nekemias arborea*	10	Yes	FAC
2. *Vitis rotundifolia*	30	Yes	FAC
3.			
4.			
5.			
	40	=Total Cover	
50% of total cover: 20		20% of total cover:	8

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 77.8% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	2	x 1 =	2
FACW species	87	x 2 =	174
FAC species	90	x 3 =	270
FACU species	25	x 4 =	100
UPL species	0	x 5 =	0
Column Totals:	204 (A)		546 (B)

Prevalence Index = B/A = 2.68

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_W001_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 4	10yr 3/1	100					Mucky Sand	
4 - 16	2.5yr 5/1	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
_X_ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
___ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
_x_ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** _X_ **No** ___

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_W002b_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): Convave Slope (%): 10

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.491519 Long: -80.551556 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: PSS

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**
x Saturation (A3)	___ Hydrogen Sulfide Odor (C1)
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots (C3)
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)
x Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)
___ Iron Deposits (B5)	___ Other (Explain in Remarks)
___ Inundation Visible on Aerial Imagery (B7)	
___ Water-Stained Leaves (B9)	

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- x Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes x	No ___	Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_W002b_DP

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	5	No	FACU
2. *Myrica cerifera*	45	Yes	FAC
3. *Schinus terebinthifolia*	8	No	FAC
4.			
5.			
6.			
	58	=Total Cover	
50% of total cover: 29		20% of total cover:	12
Sapling Stratum (Plot size: 10 m)			
1. *Myrica cerifera*	15	Yes	FAC
2. *Schinus terebinthifolia*	2	No	FAC
3.			
4.			
5.			
6.			
	17	=Total Cover	
50% of total cover: 9		20% of total cover:	4
Shrub Stratum (Plot size:)			
1. *Cladium mariscus*	95	Yes	OBL
2.			
3.			
4.			
5.			
6.			
	95	=Total Cover	
50% of total cover: 48		20% of total cover:	19
Herb Stratum (Plot size:)			
1. *Hydrocotyle umbellata*	10	Yes	OBL
2. *Rhynchospora colorata*	3	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	13	=Total Cover	
50% of total cover: 7		20% of total cover:	3
Woody Vine Stratum (Plot size:)			
1. *Vitis rotundifolia*	25	Yes	FAC
2.			
3.			
4.			
5.			
	25	=Total Cover	
50% of total cover: 13		20% of total cover:	5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	105	x 1 =	105
FACW species	3	x 2 =	6
FAC species	95	x 3 =	285
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	208 (A)		416 (B)

Prevalence Index = B/A = 2.00

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_W002b_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-4	10YR 3/1	95					Mucky Sand	95% masked
4-16	2.5yr 5/3	90					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
x Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
x Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:

This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_W003a_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): Convave Slope (%): 15

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.492775 Long: -80.550266 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: PSS

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
x Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
x Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ Marl Deposits (B15) **(LRR U)**
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
x Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes x	No ___	Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_W003a_DP

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	5	No	FACU
2. *Myrica cerifera*	30	Yes	FAC
3. *Schinus terebinthifolia*	15	Yes	FAC
4.			
5.			
6.			
	50 =Total Cover		
50% of total cover: 25		20% of total cover: 10	

Sapling Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Myrica cerifera*	20	Yes	FAC
2. *Schinus terebinthifolia*	5	Yes	FAC
3.			
4.			
5.			
6.			
	25 =Total Cover		
50% of total cover: 13		20% of total cover: 5	

Shrub Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Cladium mariscus*	70	Yes	OBL
2. *Kosteletzkya pentacarpos*	15	No	OBL
3.			
4.			
5.			
6.			
	85 =Total Cover		
50% of total cover: 43		20% of total cover: 17	

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Hydrocotyle umbellata*	7	No	OBL
2. *Rhynchospora colorata*	10	No	FACW
3. *Fimbristylis castanea*	60	Yes	OBL
4. *Ptilimnium capillaceum*	35	Yes	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	112 =Total Cover		
50% of total cover: 56		20% of total cover: 23	

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	187	x 1 =	187
FACW species	10	x 2 =	20
FAC species	70	x 3 =	210
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	272 (A)		437 (B)

Prevalence Index = B/A = 1.61

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_W003a_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4		85					Mucky Sand	2.5YR 2/0 85% Masked
4-16	2.5yr 5/2	90					Sandy	5-10% masked no visible oxidization around roots, no visible stripping.

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
_x_ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
_x_ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** _X_ **No** ___

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: STOKE Launch Pad 14 City/County: Cape Canaveral Sampling Date: 04/11/2023

Applicant/Owner: STOKE Space Technologies State: FL Sampling Point: ST_WD001_DP1

Investigator(s): Catie Donisi / Sarah Jarzombek Section, Township, Range: S17, T23, R38E

Landform (hillside, terrace, etc.): Barrier Island Local relief (concave, convex, none): Convave Slope (%): 15

Subregion (LRR or MLRA): LRR U, MLRA 155 Lat: 28.490403 Long: -80.5457202 Datum: WGS84

Soil Map Unit Name: Canaveral-Anclote Complex, gently Undulating NWI classification: PSS

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:
Historically a canal was built around the launch pad that could of changed the hydrology of the site by draining it into the canal and off site.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- x Surface Water (A1)
- ___ High Water Table (A2)
- x Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- x Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15) **(LRR U)**
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- x Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum Moss (D8) **(LRR T,U)**

Field Observations:

Surface Water Present?	Yes x	No ___	Depth (inches): 6
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes x	No ___	Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Constructed stormwater conveyance feature. Drains stormwater and lowers water table, to Banana River to the east. Connections to other canal/ditch segments may be limited by roadway culverts which were observed to be clogged with sediments during surveys. Hydrology ranged from deeply inundated during Spring 2023 to only saturated at the soil surface during Fall 2023.

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: ST_WD001_DP

Tree Stratum (Plot size: 10 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus virginiana*	2	Yes	FACU
2. *Myrica cerifera*	4	Yes	FAC
3. *Schinus terebinthifolia*	3	Yes	FACU
4.			
5.			
6.			
	9	=Total Cover	
50% of total cover: 5		20% of total cover: 2	

Sapling Stratum (Plot size: 10 m)			
1. *Myrica cerifera*	2	Yes	FAC
2. *Schinus terebinthifolia*	3	Yes	FAC
3.			
4.			
5.			
6.			
	5	=Total Cover	
50% of total cover: 3		20% of total cover: 1	

Shrub Stratum (Plot size:)			
1. *Schoenoplectus tabernaemontani*	75	Yes	OBL
2. *Rottboellia cochinchinensis*	15	No	FACU
3. *Sabal palmetto*	10	No	FAC
4.			
5.			
6.			
	100	=Total Cover	
50% of total cover: 50		20% of total cover: 20	

Herb Stratum (Plot size:)			
1. *Apium graveolens*	5	Yes	UPL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5	=Total Cover	
50% of total cover: 3		20% of total cover: 1	

Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 57.1% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	75	x 1 =	75
FACW species	0	x 2 =	0
FAC species	19	x 3 =	57
FACU species	20	x 4 =	80
UPL species	5	x 5 =	25
Column Totals:	119 (A)		237 (B)

Prevalence Index = B/A = 1.99

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: ST_WD001_DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12		85					Mucky Sand	2.5 y 2/0 95% masked

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Organic Bodies (A6) **(LRR, P, T, U)**
___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
___ Muck Presence (A8) **(LRR U)**
___ 1 cm Muck (A9) **(LRR P, T)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Coast Prairie Redox (A16) **(MLRA 150A)**
_x_ Sandy Mucky Mineral (S1) **(LRR O, S)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
_x_ Dark Surface (S7) **(LRR P, S, T, U)**
___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
___ Thin Dark Surface (S9) **(LRR S, T, U)**
___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
___ Loamy Mucky Mineral (F1) **(LRR O)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) **(LRR U)**
___ Depleted Ochric (F11) **(MLRA 151)**
___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
___ Umbric Surface (F13) **(LRR P, T, U)**
___ Delta Ochric (F17) **(MLRA 151)**
___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) **(LRR O)**
___ 2 cm Muck (A10) **(LRR S)**
___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (F22)
___ Barrier Islands Low Chroma Matrix (TS7) **(MLRA 153B, 153D)**
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ______
Depth (inches): ______

Hydric Soil Present? **Yes** _X_ **No** ___

Remarks:
This data form is revised from Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0 to include the NRCS Field Indicators of Hydric Soils, Version 7.0, 2015 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

Attachment 4. Uniform Mitigation Assessment Method Sheets

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		**W-1**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
6190 - Exotic Wetland Habitats	**PFO03 Palustrine forested with unconsolidated bottom**		**0.76 acres**

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Indian River Lagoon Basin 21	**III**	**None**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The assessment area (AA) is a palustrine forested wetland that occurs along the southeast boundary of the entrance road to SLC-14, to the east of Icbm Rd, and continues just outside the project impact area to the south. The AA is an isolated wetland located within the project review area. The AA was historically hydrologically connected to a wetland syetem to the west of Icbm Rd according to the NWI layer. A site review in March of 2023 determined this connection is no longer viable.

Assessment area description

The AA is in Brevard County on the Cape Canaveral Space Force installation. The wetland is charachterized as a disturbed forested wetland bordered by two paved roads. The AA is a highly disturbed wetland containing a mixture of native and invasive species. The wetland contains approximately 10% exotic invasives. The wetland has been affected by the construction of a canal system in 1956 with the intent of controlling surface and subsurface water. The construction of the canal altered the site hydrology. The construction of Icbm Rd also altered the site hydrology and disconnected the wetland.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Banana River, Atlantic Ocean	**None**

Functions	Mitigation for previous permit/other historic use
Surface water storage, filtration of upland runoff, foraging for small mammals, reptiles, wading birds, and amphibians.	**None**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
Small reptiles, raccoon, armadillo, passerine birds, raptors.	**Foraging by wading birds (ST) when rainfall is abundant.**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None during site assessment.

Additional relevant factors:

LC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by:	Assessment date(s):
Catie Donisi	**9/27/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		W-1
Impact or Mitigation	**Assessment conducted by:**	**Assessment date:**
	Catie Donisi	9/27/2023

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface water functions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	6		The AA is bordered by two different paved access roads. Wildlife access to and from the AA is limited due to lack of connectivity. Surrounding uplands provide little protection to the wetland functions. Discharges and runoffs from the roads can briefly filter in the AA.
.500(6)(b)Water Environment (n/a for uplands)	3		Saturation (2 inches deep), geomorphic position, and evidence of aquatic fauna was observed in the wetland at the time of the site visit (March 03, 2023). Flow and innundation highly dependant on rainfall events as the AA is isolated.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	4		The dominant species are Brazilian pepper (Schinus terebinthifolia), live oak (Quercus geminata), red bay (Persea borbonia), sabal palm (sabal palmetto), and horned beaksedge (Rhynchospora colorata).

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.43	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas	
FL = delta x acres =	

Delta = [with-current]
-0.43

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		**W-2a**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
6190 - Exotic Wetland Habitats	**PFO03 Palustrine forested with unconsolidated bottom**		**0.18**

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Indian River Lagoon Basin 21	**III**	**None**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The assessment area (AA) is a palustrine forested wetland that occurs along the southeast boundary of the entrance road to SLC-14, to the east of Icbm Rd, and is outside the project impact area to the south. The AA is an isolated wetland located within the project review area. The AA does not appear to historicallt be connected according to the NWI layer and historical aerials. A site review in March of 2023 determined there i no connection.

Assessment area description

The AA is in Brevard County on the Cape Canaveral Space Force installation. The wetland is charachterized as a disturbed forested wetland bordered by a paved entrance road. The AA is a highly disturbed wetland containing a mixture of native and invasive species. The wetland contains approximately 30% exotic invasives. The wetland has been affected by the construction of a canal system in 1956 with the intent of controlling surface and subsurface water. The construction of the canal altered the site hydrology. The construction of Icbm Rd also altered the site hydrology and disconnected the wetland.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Banana River, Atlantic Ocean	**None**

Functions	Mitigation for previous permit/other historic use
Surface water storage, filtration of upland runoff, foraging for small mammals, reptiles, wading birds, and amphibians.	**None**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
Small reptiles, raccoon, armadillo, passerine birds, raptors.	**Foraging by wading birds (ST) when rainfall is abundant.**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None during site assessment.

Additional relevant factors:

SLC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by:	Assessment date(s):
Catie Donisi	**9/27/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		**W-2a**
Impact or Mitigation	Assessment conducted by: **Catie Donisi**	Assessment date: **9/27/2023**

Scoring Guidance
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed

Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface water functions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	6		The AA is bordered by a paved access roads. Wildlife access to and from the AA is limited due to lack of connectivity. Surrounding uplands provide little protection to the wetland functions. Discharges and runoffs from the roads can briefly filter in the AA.
.500(6)(b)Water Environment (n/a for uplands)	3		Saturation at the surface, geomorphic position, and evidence of drift depsoites were observed in the wetland at the time of the site visit (March 03, 2023). Flow and innundation highly dependant on rainfall events as the AA is isolated.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	4		The dominant species are Brazilian pepper (Schinus terebinthifolia), live oak (Quercus geminata), wax myrtle (Morrella cerifera), and sawgrass (Cladium jamaicense).

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.43	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas	
FL = delta x acres =	

Delta = [with-current]
-0.43

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

Form 62-345.900(2), F.A.C. [effective date]

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		**W-2b**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
6310 - Wetland Shrub	**PEM03 Palustrine emergent with unconsolidated bottom**		**0.12 ac**

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Indian River Lagoon Basin 21	**III**	**None**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The assessment area (AA) is a palustrine scrub-shrub wetland that occurs along the southeast boundary of the entrance road to SLC-14, to the east of Icbm Rd, and is outside the project impact area to the south. The AA is an isolated wetland located within the project review area. The AA does not appear to be historically connected according to the NWI layer and historical aerials. A site review in March of 2023 determined there is no connection.

Assessment area description

The AA is in Brevard County on the Cape Canaveral Space Force installation. The wetland is charachterized as a disturbed forested wetland bordered by a paved entrance road. The AA is a highly disturbed wetland containing a mixture of native and invasive species. The wetland contains approximately 20% exotic invasives. The wetland has been affected by the construction of a canal system in 1956 with the intent of controlling surface and subsurface water. The construction of the canal altered the site hydrology. The construction of Icbm Rd also altered the site hydrology and disconnected the wetland.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Banana River, Atlantic Ocean	**None**

Functions	Mitigation for previous permit/other historic use
Surface water storage, filtration of upland runoff, foraging for small mammals, reptiles, wading birds, and amphibians.	**None**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
Small reptiles, raccoon, armadillo, passerine birds, raptors. When rainfall is abundant, wildlife use could include frogs and amphibians.	**Foraging by wading birds (ST) when rainfall is abundant.**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None during site visit.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Catie Donisi	**3/11/2022**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
STOKE SLC-14		**W-2b**
Impact or Mitigation	Assessment conducted by:	Assessment date:
	Catie Donisi	**9/29/2023**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface water functions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	5		The AA is bordered by a paved access roads. Wildlife access to and from the AA is limited due to lack of connectivity. Surrounding uplands provide little protection to the wetland functions. Discharges and runoffs from the roads can briefly filter in the AA.
.500(6)(b)Water Environment (n/a for uplands)	5		Saturation at the surface, geomorphic position, and evidence of drift depsoites were observed in the wetland at the time of the site visit (March 03, 2023). Flow and innundation highly dependant on rainfall events as the AA is isolated.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	5		The dominant vegetation includes wax myrtle (Morella cerifera), Brazilian pepper (Shcinus terebinthifolia), pennywort (Hydrocotyle umbellata), and sawgrass (Cladium jamaicense).

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.5	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas
FL = delta x acres =

Delta = [with-current]
-0.5

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name: **Stokes SLC-14**	Application Number	Assessment Area Name or Number: **WD-1A**	
FLUCCs code **5100- Streams and Waterways**	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size: **1.68 acres**
Basin/Watershed Name/Number **Northern Indian River Lagoon Basin 21**	Affected Waterbody (Class) **III**	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance):	

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands:
Stormwater enters ditch through overland and subsurface flow from adjacent pervious upland communities. Ditch system ultimately flows to the Banana River and the Atlantic Ocean.

Assessment area description: **These areas are man-made linear water bodies in the form of ditches and swales. They are part of the original site development of SLC-14. The assessment type varies throughout the project area WD-1A has a palustrine shrub/scrub wetland community in the ditch bottom.**

Significant nearby features: **Banana River, Atlantic Ocean**	Uniqueness (considering the relative rarity in relation to the regional landscape.): **None**
Functions: **Surface Water**	Mitigation for previous permit/other historic use: **None**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found): **Amphibians, reptiles, macroinvertebrates, wading birds.**	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area): **None**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.): **Leopard frogs, small wetland fish (likely Gambusia)**

Additional relevant factors:

SLC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by: **SBE**	Assessment date(s): **09/11/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Stokes SLC-14		**WD-1A**
Impact or Mitigation	Assessment conducted by:	Assessment date:
	SBE	**9/11/2023**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	5		Ditch is a constructed stormwater feature. Slopes are generally steep and abrupt reducing the transition zone from the surface water to the upland. Surrounding uplands well vegetated but dominated by invasive species (Brazilian pepper). Ditch likely flows during rainfall events but functions more as a lentic palustrine wetland system during most conditions. Upstream and downstream connections for wildlife utilization may be limited by roadway culverts.
.500(6)(b)Water Environment (n/a for uplands)	4		Ditches were observed to have deeper standing water during Spring 2023 survey. During Fall 2023, most sections of the ditch had saturation to the soil surface or shallow standing water. Ditches appear to maintain enough annual hydrology for wetland dependent plant species to persist however the hydrology appears to be highly variable fluctuating several feet within the banks of the ditch throughout the year. Flow and inundation highly dependent on rainfall events as these ditches were constructed to convey surface water and lower the surrounding water table.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	3		Hydrology highly variable throughout the year and primarily dependent on rainfall events. Surface water inundation ranges between saturated soils during low rainfall periods and up to approx. 6ft. during higher rain-fall events. Vegetation zonation and community structure generally not appropriate due to hydrologic variability. Encroachment of invasive species such as Brazilian pepper observed.

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.40	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas
FL = delta x acres =

Delta = [with-current]
0.40

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name: **Stokes SLC-14**	Application Number	Assessment Area Name or Number: **WD-1B**	
FLUCCs code **5100- Streams and Waterways**	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size: **0.03 acres**
Basin/Watershed Name/Number **Northern Indian River Lagoon Basin 21**	Affected Waterbody (Class) **III**	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance):	

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands: **Stormwater enters ditch through overland and subsurface flow from adjacent pervious upland communities. Ditch system ultimately flows to the Banana River and the Atlantic Ocean.**

Assessment area description: **These areas are man-made linear water bodies in the form of ditches and swales. They are part of the original site development of SLC-14. The assessment type varies throughout the project area WD-1B has palustrine emergent wetland habitat in the ditch bottom.**

Significant nearby features: **Banana River, Atlantic Ocean**	Uniqueness (considering the relative rarity in relation to the regional landscape.): **None**
Functions: **Surface Water**	Mitigation for previous permit/other historic use: **None**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found): **Amphibians, reptiles, macroinvertebrates, wading birds.**	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area): **None**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.): **None during assessment**

Additional relevant factors:

SLC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by: **SBE**	Assessment date(s): **09/11/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Stokes SLC-14		**WD-1B**
Impact or Mitigation	Assessment conducted by:	Assessment date:
	SBE	**9/11/2023**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	5		Ditch is a constructed stormwater feature. Slopes are generally steep and abrupt reducing the transition zone from the surface water to the upland. Surrounding uplands well vegetated but dominated by invasive species (Brazilian pepper). Ditch likely flows during rainfall events but functions more as a lentic palustrine wetland system during most conditions. Upstream and downstream connections for wildlife utilization may be limited by roadway culverts.
.500(6)(b)Water Environment (n/a for uplands)	4		Ditches were observed to have deeper standing water during Spring 2023 survey. During Fall 2023, most sections of the ditch had saturation to the soil surface or shallow standing water. Ditches appear to maintain enough annual hydrology for wetland dependent plant species to persist however the hydrology appears to be highly variable fluctuating several feet within the banks of the ditch throughout the year. Flow and inundation highly dependent on rainfall events as these ditches were constructed to convey surface water and lower the surrounding water table.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	4		Hydrology highly variable throughout the year and primarily dependent on rainfall events. Surface water inundation ranges between saturated soils during low rainfall periods and up to approx. 6ft. during higher rain-fall events. Vegetation zonation and community structure generally not appropriate due to hydrologic variability. Lack of invasive Brazilian pepper in this location, predominately emergent vegetation.

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.43	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas
FL = delta x acres =

Delta = [with-current]
0.43

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name: **Stokes SLC-14**	Application Number	Assessment Area Name or Number: **W-3A**	
FLUCCs code **5100- Streams and Waterways**	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size: **0.03 acres**
Basin/Watershed Name/Number **Northern Indian River Lagoon Basin 21**	Affected Waterbody (Class) **III**	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance):	

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands:
Connected to wetland W-3B and the constructed surface water ditch system WD-1A.
Ditch system ultimately flows to the Banana River and the Atlantic Ocean.
Likely receives inputs from rainfall and baseflow from grundwater.

Assessment area description: **W-3A is a palustrine emergent wetland habitat that is connected to wetland W-3B and to the constructed surface water ditch system WD-1A.**
This wetland feature may have been developed during the original site development of SLC-14.

Significant nearby features: **Banana River, Atlantic Ocean**	Uniqueness (considering the relative rarity in relation to the regional landscape.): **None**
Functions: **Aquatic organism habitat. Support of terrestrial species. Wading bird foraging stormwater attenuation, downstream nutrient source.**	Mitigation for previous permit/other historic use: **None**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found): **Amphibians, reptiles, macroinvertebrates, wading birds.**	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area): **None**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.): **None during assessment**

Additional relevant factors:

SLC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by: **SBE**	Assessment date(s): **09/11/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Stokes SLC-14		**W-3A**
Impact or Mitigation	Assessment conducted by:	Assessment date:
	SBE	**9/11/2023**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	5		Surrounding uplands well vegetated but dominated by invasive species (Brazilian pepper). Moderate to good buffer surrounding wetland. Connected to ditch WD-1A which collects stormwater and likely affects hydrology for this feature. Surrounding uplands previously developed and heavily impacted.
.500(6)(b)Water Environment (n/a for uplands)	6		Increased surface water in wetland during Spring 2023 survey. During Fall 2023, water levels lower indicating interaction with ditch system. Wetland maintains enough annual hydrology for wetland dependent plant species to persist, but hydrology variable.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	6		Vegetation zonation and community structure generally appropriate due to hydrologic variability but likely affected by variable hydrology. Some invasive species (Brazilian pepper) observed.

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.57	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas
FL = delta x acres =

Delta = [with-current]
0.57

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

Form 62-345.900(2), F.A.C. [effective date 02-04-2004]

PART I – Qualitative Description
(See Section 62-345.400, F.A.C.)

Site/Project Name: **Stokes SLC-14**	Application Number		Assessment Area Name or Number: **W-3B**
FLUCCs code **5100- Streams and Waterways**	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size: **0.06 acres**
Basin/Watershed Name/Number **Northern Indian River Lagoon Basin 21**	Affected Waterbody (Class) **III**	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance):	

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands:
Connected to wetland W-3A and to the constructed surface water ditch system WD-1A.
Ditch system ultimately flows to the Banana River and the Atlantic Ocean.
Likely receives inputs from rainfall and baseflow from groundwater.

Assessment area description: **W-3B is a palustrine scrub-shrub wetland habitat**
This wetland feature may have been developed during the original site development of SLC-14.

Significant nearby features: **Banana River, Atlantic Ocean**	Uniqueness (considering the relative rarity in relation to the regional landscape.): **None**
Functions: **Aquatic organism habitat. Support of terrestrial species. Wading bird foraging stormwater attenuation, downstream nutrient source.**	Mitigation for previous permit/other historic use: **None**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found): **Amphibians, reptiles, macroinvertebrates, wading birds.**	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area): **None**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.): **None during assessment**

Additional relevant factors:

SLC-14 is a heavily disturbed site due to the original construction of the launch facilities and the land use. The upland communities are disturbed and dominated by invasive species. The ditches appear to have been constructed to control surface water and lower the local water table. Due to the historic use of the site, there is a high probability of localized groundwater and soil contamination.

Assessment conducted by: **SBE**	Assessment date(s): **09/11/2023**

PART II – Quantification of Assessment Area (impact or mitigation)
(See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Stokes SLC-14		**W-3B**
Impact or Mitigation	Assessment conducted by:	Assessment date:
	SBE	**9/11/2023**

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Indicator	w/o pres or current	with	Description
.500(6)(a) Location and Landscape Support	5		Surrounding uplands well vegetated but dominated by invasive species (Brazilian pepper). Moderate to good buffer surrounding wetland. Connected to ditch WD-1A which collects stormwater and likely affects hydrology for this feature. Surrounding uplands previously developed and heavily impacted.
.500(6)(b)Water Environment (n/a for uplands)	6		Increased surface water in wetland during Spring 2023 survey. During Fall 2023, water levels lower indicating interaction with ditch system. Wetland maintains enough annual hydrology for wetland dependent plant species to persist, but hydrology variable.
.500(6)(c)Community structure 1. Vegetation and/or 2. Benthic Community	4		Vegetation zonation and community structure generally appropriate but likely affected due to hydrologic variability Invasive species (Brazilian pepper) dominating the shrub layer.

Score = sum of above scores/30 (if uplands, divide by 20)	
current or w/o pres	with
0.50	

If preservation as mitigation,
Preservation adjustment factor =
Adjusted mitigation delta =

For impact assessment areas
FL = delta x acres =

Delta = [with-current]
0.50

If mitigation
Time lag (t-factor) =
Risk factor =

For mitigation assessment areas
RFG = delta/(t-factor x risk) =

Attachment 5. Threatened and Endangered Species

STANDARD PROTECTION MEASURES FOR THE EASTERN INDIGO SNAKE
U.S. Fish and Wildlife Service

March 23, 2021

The eastern indigo snake protection/education plan (Plan) below has been developed by the U.S. Fish and Wildlife Service (USFWS) in Florida and Georgia for use by applicants and their construction personnel. At least **30 days prior** to any clearing/land alteration activities, the applicant shall notify the appropriate USFWS Field Office via e-mail that the Plan will be implemented as described below (North Florida Field Office: jaxregs@fws.gov; South Florida Field Office: verobeach@fws.gov; Panama City Field Office: panamacity@fws.gov; Georgia Field Office: gaes_assistance@fws.gov). As long as the signatory of the e-mail certifies compliance with the below Plan (including use of the attached poster and brochure), no further written confirmation or approval from the USFWS is needed and the applicant may move forward with the project.

If the applicant decides to use an eastern indigo snake protection/education plan other than the approved Plan below, written confirmation or approval from the USFWS that the plan is adequate must be obtained. At least 30 days prior to any clearing/land alteration activities, the applicant shall submit their unique plan for review and approval. The USFWS will respond via e-mail, typically within 30 days of receiving the plan, either concurring that the plan is adequate or requesting additional information. A concurrence e-mail from the appropriate USFWS Field Office will fulfill approval requirements.

The Plan materials should consist of: 1) a combination of posters and pamphlets (see **Poster Information** section below); and 2) verbal educational instructions to construction personnel by supervisory or management personnel before any clearing/land alteration activities are initiated (see **Pre-Construction Activities** and **During Construction Activities** sections below).

POSTER INFORMATION

Posters with the following information shall be placed at strategic locations on the construction site and along any proposed access roads (a final poster for Plan compliance, to be printed on 11 x 17in or larger paper and laminated, is attached):

DESCRIPTION: The eastern indigo snake is one of the largest non-venomous snakes in North America, with individuals often reaching up to 8 feet in length. They derive their name from the glossy, blue-black color of their scales above and uniformly slate blue below. Frequently, they have orange to coral reddish coloration in the throat area, yet some specimens have been reported to only have cream coloration on the throat.

These snakes are not typically aggressive and will attempt to crawl away when disturbed. Though indigo snakes rarely bite, they should NOT be handled.

SIMILAR SNAKES: The black racer is the only other solid black snake resembling the eastern indigo snake. However, black racers have a white or cream chin, thinner bodies, and WILL BITE if handled.

LIFE HISTORY: The eastern indigo snake occurs in a wide variety of terrestrial habitat types throughout Florida and Georgia. Although they have a preference for uplands, they also utilize some wetlands and agricultural areas and often move seasonally between upland and lowland habitats, particularly in the northern portions of its range (North Florida and Georgia). Eastern indigo snakes will often seek shelter inside gopher tortoise burrows and other below- and above-ground refugia, such as other animal burrows, stumps, roots, and debris piles. Reliance on xeric sandhill habitats throughout the northern portion of the range in northern Florida and Georgia is due to the dependence on gopher tortoise burrows for shelter during winter. Breeding occurs during October through February. Females may lay from 4 - 12 white eggs as early as April through June, with young hatching in late July through October.

PROTECTION UNDER FEDERAL AND STATE LAW: The eastern indigo snake is classified as a Threatened species by both the USFWS and the Florida Fish and Wildlife Conservation Commission. Taking of eastern indigo snakes is prohibited by the Endangered Species Act without a permit is defined by the USFWS as an attempt to kill, harm, harass, pursue, hunt, shoot, wound, trap, capture, collect, or engage in any such conduct. Penalties include a maximum fine of $25,000 for civil violations and up to $50,000 and/or imprisonment for criminal offenses, if convicted.

Only individuals currently authorized through an issued Incidental Take Statement in association with a USFWS Biological Opinion, or by a Section 10(a)(1)(A) permit issued by the USFWS, to handle an eastern indigo snake are allowed to do so.

IF YOU SEE A <u>LIVE</u> EASTERN INDIGO SNAKE ON THE SITE:

- Cease clearing activities and allow the live eastern indigo snake sufficient time to move away from the site without interference;
- Personnel must NOT attempt to touch or handle snake due to protected status.
- Take photographs of the snake, if possible, for identification and documentation purposes. Â
- Immediately notify supervisor or the applicants designated agent, **and** the appropriate USFWS office, with the location information and condition of the snake.
- If the snake is located in a vicinity where continuation of the clearing or construction activities will cause harm to the snake, the activities must halt until such time that a representative of the USFWS returns the call (within one day) with further guidance as to when activities may resume.

IF YOU SEE A DEAD EASTERN INDIGO SNAKE ON THE SITE:

- Cease clearing activities and immediately notify supervisor or the applicants designated agent, **and** the appropriate USFWS office, with the location information and condition of the snake.
- Take photographs of the snake, if possible, for identification and documentation purposes.
- Thoroughly soak the dead snake in water and then freeze the specimen. The appropriate wildlife agency will retrieve the dead snake.

Telephone numbers of USFWS Florida Field Offices to be contacted if a live or dead eastern indigo snake is encountered:

North Florida Field Office: (904) 731-3336
Panama City Field Office: (850) 769-0552
South Florida Field Office: (772) 562-3909
Georgia Field Office: (706) 613-9493

PRE-CONSTRUCTION ACTIVITIES

1. The applicant or designated agent will post educational posters in the construction office and throughout the construction site, including any access roads. The posters must be clearly visible to all construction staff. A sample poster is attached.

2. Prior to the onset of construction activities, the applicant/designated agent will conduct a meeting with all construction staff (annually for multi-year projects) to discuss identification of the snake, its protected status, what to do if a snake is observed within the project area, and applicable penalties that may be imposed if state and/or federal regulations are violated. An educational brochure including color photographs of the snake will be given to each staff member in attendance and additional copies will be provided to the construction superintendent to make available in the onsite construction office (a final brochure for Plan compliance, to be printed double-sided on 8.5 x 11in paper and then properly folded, is attached). Â Photos of eastern indigo snakes may be accessed on USFWS and/or FWC or GADNR websites.

3. Construction staff will be informed that in the event that an eastern indigo snake (live or dead) is observed on the project site during construction activities, all such activities are to cease until the established procedures are implemented according to the Plan, which includes notification of the appropriate USFWS Field Office. The contact information for the USFWS is provided on the referenced posters and brochures.

DURING CONSTRUCTION ACTIVITIES

1. During initial site clearing activities, an onsite observer may be utilized to determine whether habitat conditions suggest a reasonable probability of an eastern indigo snake sighting (example: discovery of snake sheds, tracks, lots of refugia and cavities present in the area of clearing activities, and presence of gopher tortoises and burrows).

2. If an eastern indigo snake is discovered during gopher tortoise relocation activities (i.e. burrow excavation), the USFWS shall be contacted within one business day to obtain further guidance which may result in further project consultation.

3. Periodically during construction activities, the applicants designated agent should visit the project area to observe the condition of the posters and Plan materials, and replace them as needed. Construction personnel should be reminded of the instructions (above) as to what is expected if any eastern indigo snakes are seen.

POST CONSTRUCTION ACTIVITIES

Whether or not eastern indigo snakes are observed during construction activities, a monitoring report should be submitted to the appropriate USFWS Field Office within 60 days of project completion. The report can be sent electronically to the appropriate USFWS e-mail address listed on page one of this Plan.

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Brevard County, Florida

Local office

Florida Ecological Services Field Office

(772) 562-3909
(772) 562-4288
fw4flesregs@fws.gov

1339 20th Street
Vero Beach, FL 32960-3559

https://www.fws.gov/office/florida-ecological-services

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Southeastern Beach Mouse Peromyscus polionotus niveiventris Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3951	Threatened
West Indian Manatee Trichechus manatus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened Marine mammal

Birds

NAME	STATUS
Crested Caracara (audubon''s) [fl Dps] Polyborus plancus audubonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8250	Threatened
Eastern Black Rail Laterallus jamaicensis ssp. jamaicensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10477	Threatened

Everglade Snail Kite Rostrhamus sociabilis plumbeus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/7713	Endangered
Florida Scrub-jay Aphelocoma coerulescens Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6174	Threatened
Red Knot Calidris canutus rufa Wherever found There is **proposed** critical habitat for this species. https://ecos.fws.gov/ecp/species/1864	Threatened

Reptiles

NAME	STATUS
Eastern Indigo Snake Drymarchon couperi Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/646	Threatened
Green Sea Turtle Chelonia mydas There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6199	Threatened
Hawksbill Sea Turtle Eretmochelys imbricata Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered
Leatherback Sea Turtle Dermochelys coriacea Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1493	Endangered
Loggerhead Sea Turtle Caretta caretta There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1110	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Carter's Mustard Warea carteri No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5583	Endangered
Lewton's Polygala Polygala lewtonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6688	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

There are no documented cases of eagles being present at this location. However, if you believe eagles may be using your site, please reach out to the local Fish and Wildlife Service office.

Additional information can be found using the following links:

- Eagle Managment https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds

- Nationwide conservation measures for birds [https://www.fws.gov/sites/default/files/ documents/nationwide-standard-conservation-measures.pdf](https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf)
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Great Blue Heron *Ardea herodias occidentalis* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Jan 1 to Dec 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

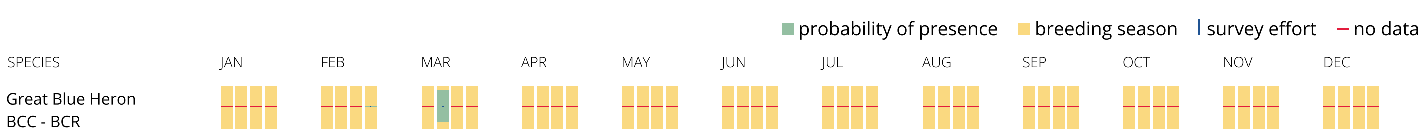
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Marine mammals

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take (to harass, hunt, capture, kill, or attempt to harass, hunt, capture or kill) of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following marine mammals under the responsibility of the U.S. Fish and Wildlife Service are potentially affected by activities in this location:

NAME

West Indian Manatee Trichechus manatus
https://ecos.fws.gov/ecp/species/4469

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND
PEM1Fx

FRESHWATER FORESTED/SHRUB WETLAND
PSS3/EM1C

RIVERINE

- R2UBHx
- R5UBFx

A full description for each wetland code can be found at the National Wetlands Inventory website

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix D. NMFS Project Specific Review

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

April 10, 2024

National Marine Fisheries Service
NMFS Office of Protected Resources ESA Interagency
Cooperation Division
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Project Specific Review Request, OPR-2021-02908,
Programmatic Concurrence for Launch Vehicle & Reentry Operation

The U.S. Space Force (USSF) is preparing an environmental assessment (EA) to analyze the environmental impacts of reactivating an existing launch complex and developing a new space transportation system for Stoke Space Technologies, Inc. (Stoke) at Cape Canaveral Space Force Station (CCSFS) in Florida (Proposed Action). Stoke is a space and technology company founded in 2019 and headquartered in Kent, Washington. While Stoke's program goal is to deliver satellites to orbit for government and private sector clients using fully reusable rockets, the EA will consider the use of expendable use rockets, as that is the current need.

The USSF, FAA, and NASA would like NMFS to consider whether the Stoke vehicle is similar enough in nature to the launch vehicles to also be regulated under OPR-2021-02908 for launch and reentry vehicle operations in the marine environment. As noted in OPR-2021-02908, "upon receipt of a new proposal that involves operations in the marine environment, the lead action agency (USSF) will review the proposal and coordinate with NMFS to determine if the proposed launch operations fall within the scope of this consultation." The USSF, FAA, and NASA is requesting a project-specific review by NMFS under OPR-2021-02908 for the Stoke Launch Program because it involves launch and reentry vehicle operations in the marine environment. In execution of the Stoke Launch Program, Stoke will comply with all requirements of OPR-2021-02908. All components of the Stoke launch vehicle would be expended in the Atlantic Ocean. Appendix A provides a summary of requirements set forth in OPR-2021-02908 and their applicability to the Stoke Launch Program.

The following sections present information regarding the similarities between the launch vehicles and the Stoke launch vehicle and the region of influence (ROI) affected environment within the Atlantic Ocean.

1. Stoke Launch Vehicle

The Stoke launch vehicle, named Nova and shown on Figure 1, would consist of a two-stage liquid-fueled launch vehicle for commercial and government payloads. The medium class two-stage launch vehicle would be 132 feet tall, with a gross liftoff weight of 500,000 pounds. Stage 1 would have 7 engines, a height of 89 feet, and a diameter of 12 feet; it would be fueled with 315,000-pound mass (lbm) of liquid oxygen (LOX) and 90,000 lbm of liquefied natural gas (LNG). Stage 2, including payload fairing, would have one engine, a height of 43 feet, and a diameter of 14 feet. It would be fueled with 33,600 lbm of LOX and 6,060 lbm of liquid hydrogen (LH_2). Stage 2 would have a unique actively cooled heat shield for reentry. Stage 1 would have a sea level thrust of 3,110 kilonewtons (kN) (700,000 pound-force [lbf]) and Stage 2 would have a vacuum thrust of 111 kN (25,000 lbf). Stage 1 and Stage 2 would break up upon reentry and would be expended into the ocean under the Proposed Action.

Figure 1. Stoke Launch Vehicle

Table 1 provides a description of the propellant requirements for the Stoke launch vehicle. Table 2 provides a comparison between the Stoke launch vehicle and OPR-2021-02908-listed vehicles. As noted previously, the Stoke launch vehicle, while not reusable, is similar in nature to the reusable vehicles analyzed within the programmatic consultation.

Table 1. Proposed Stoke Launch Vehicle

Propellant Requirements	Stoke
Stage 1 (feet)	89
Stage 2 (feet)	31
Payload (feet)	12
Interstage (feet)	Not Applicable
Total Vehicle (feet)	132
Diameter of Stage 1 (feet)	12
Diameter of Payload (feet)	12
Stage 1, Number of Engines	7
Max Thrust at Sea Level (single engine, lbf)	100,000
Stage 2, Number of Engines:	1
Stage 1 LOX Mass (lbm)	315,000
Stage 2 LOX Mass (lbm)	33,600
Total LOX Mass (lbm)	341,300
Stage 1 LNG Mass (lbm)	90,000
Stage 2 Mass (lbm)	6,060 (LH_2)
Total LNG Fuel (lbm)	90,000
Total Thrust at sea level (lbf)	700,000
Total Length (feet)	132
Stage 1 Fuel	LNG
Stage 2 Fuel	LH_2
Reusable	No

Table 2. Stoke vs Programmatic Consultation Launch Vehicles

Propellant Requirements	Stoke	Terran 1	Falcon 9	Falcon Heavy	Starship-Super Heavy
Total Thrust at sea level (lbf)	700,000	207,000	1,710,000	5,130,000	16,635,861
Total Length (feet)	132	111	229	229	400
Stage 1 Fuel	LNG	LNG	RP-1	RP-1	LNG
Stage 2 Fuel	LH_2	LNG	RP-1	RP-1	LNG
Reusable	No	No	Yes	Yes	Yes

RP-1 = rocket propellant-1

2. Ground Support and Launch Operations

A typical mission sequence would include the following steps:

1. Engine and initial stage acceptance testing would be performed and planned at the Stoke test site operated by Stoke in Washington state.

2. The new Stoke launch vehicle would be delivered from Washington state to CCSFS Space Launch Complex 14. Individual launch components would be transported via Department of Transportation over-size load truck ground options. Air option exists, if necessary, for contingency. Air option would use existing airports depending on availability and then transport via Department of Transportation over-size load truck ground options. All applicable transportation regulations would be followed, and the transportation of the vehicle would be in keeping with existing transportation systems.

3. The Stoke launch vehicle would exit the hanger horizontally on a transporter and then be erected vertically on the launch pad.

4. Checkouts would be completed at the launch pad, including propellant system leak checks, valve checkouts, and Stage 1 hold-down-and-release system checkouts.

5. Applicable review would be conducted for the operation, whether it would be wet dress rehearsal (WDR) (on-/off-load propellants), static fire of Stage 1 (on-/off-load propellants and ignite engines no longer than 150 seconds), or orbital launch attempt. Stoke anticipates one static fire with nominal results for new boosters and one integrated (Stage 1 and Stage 2) WDR upon pad activation. WDRs are currently not planned for every mission; but when accomplished, the fully integrated vehicle may remain on the pad until the launch attempt (and would likely roll back), barring any operational need to bring the vehicle horizontal and roll it back to the hangar. When Stage 1 static fires are accomplished, the booster would go horizontal and be rolled back to the hangar for final mission integration.

6. The Stoke launch vehicle would enter the automated countdown operations on the launch pad for WDR and/or integrated static fire before launch. Static fire tests would be limited to daytime hours and/or range availability.

7. Upon successful completion of Stage 1 static fire and/or WDR, the launch attempt would be scheduled and proceed into terminal count. The Stoke launch vehicle would lift off upon confirmation that safety criteria for launch have been met.

8. Stage separation would occur and Stage 1 would return to Earth. Stage 1 would break up upon reentry and the inert debris would land within the Atlantic Ocean Action Area shown on Figure 2. Stage 1 would perform a passivation maneuver[1] to vent residual propellant and tank pressures during coast between stage separation and Stage 1 reentry to ensure Stage 1 breaks up upon reentry.

9. Stage 2 would complete orbital insertion burns. Payload fairing doors (halves) would open, jettisoned from Stage 2, and the payload would separate. Payload fairing doors would burn up during reentry.

10. Stage 2 would initiate a de-orbit/disposal burn to begin Earth reentry.

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[1] Passivation maneuver refers to the process of removing stored energy from a space vehicle to reduce the risk of high-energy releases.

11. Stage 2 would perform a passivation maneuver after the de-orbit/disposal burn which would vent all remaining propellant. There would be no residual liquid propellant onboard at the time of reentry, and the residual ullage[2] gas would be very low. This mitigates risk of distant overpressure occurring upon impact due to lack of propellants available to mix for detonation in the remote chance the stage remained intact during reentry.

12. Stage 2 would break up upon reentry and any remaining inert debris would land within the Atlantic Ocean Action Area as shown on Figure 2 and expected to rapidly sink.

For both stages, the vehicle would be expected to break up due to aerodynamic and aerothermal loading during reentry. While the vehicles are designed to reenter Earth's atmosphere intact for long-term reusable mission scenarios, doing so would require active cooling (for Stage 2) or active engine operation (for Stage 1), which would not occur during early phase expendable missions. Additionally, the tank pressure would be reduced during reentry, which further reduces the vehicle's structural capability. This would result in external loads exceeding the vehicle's capability during reentry and result in breakup. The propellant onboard Stage 1 would disperse while still high up in the atmosphere. Stage 1 would have a nominal Flight Performance Reserve of 1% of the full propellant load, or 1,802 kilograms (kg) of propellant, with a maximum residual propellant of 2% of the nominal propellant load or 3,604 kg. The predicted point of maximum aerothermal heating on Stage 1 during reentry would occur at approximately 25 to 35-kilometers (km) altitude, and on Stage 2 the point of maximum aerothermal heating would occur at approximately 60 to 70-km altitude. Rocket material would be mostly stainless steel and other dense metallic materials; therefore, any debris that survived reentry and impact with the ocean would sink. In the unlikely case that debris creates a maritime hazard, Stoke would work with the USCG and employ an Oil Spill Removal Organization (OSRO) contractor to remove and/or dispose of the hazard.

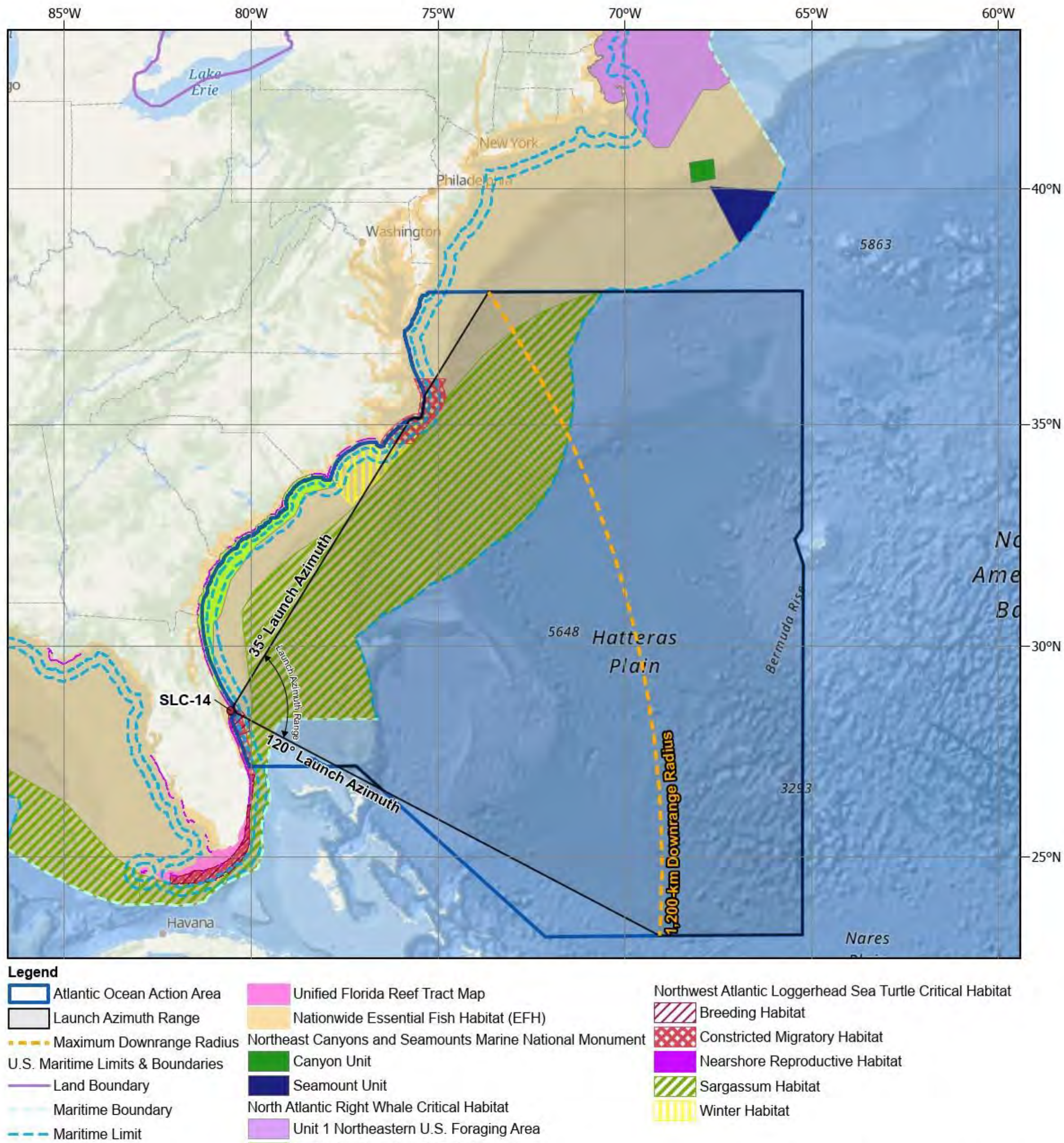
The Proposed Action would conduct approximately two launches during the first year of operation in 2025, then the anticipated maximum launch cadence is 10 launches per year. Preferably, launches would occur during the daytime; however, night launches may be necessary on occasion in accordance with FAA's airspace deconfliction policy (FAA 2023).

The payloads for Stoke launches would be specific to each mission and would be processed in the payload integration facility. The mass of maximum payloads for the Stoke launch vehicle would range from 1,250 kg to 7,000 kg, depending on the destination orbit. The unique environmental effects on the specific payload would be analyzed once the payload and configuration are determined.

In the unlikely event of a launch anomaly, Stoke is the responsible party and would work within the National Response Framework and with local law enforcement and regulatory agencies, as applicable, to secure the hazards as quickly as possible to mitigate risk to the public and hazards to various commerce. As a launch service provider on a federal range, a contingency procedure would be developed. As the responsible party in case of a mishap, Stoke would bring the necessary resources for contingency and recovery actions to restore the area to normal operations as soon as possible after the anomalous event.

[2] Ullage refers to the amount by which a container falls short of being full.

Figure 2. Launch Trajectory and Atlantic Ocean Action Area



Notes:
1. Unified Florida Reef Tract Map data shown is from the Florida Fish and Wildlife Conservation Commission. Downloaded from https://myfwc.com/research/gis/fisheries/unified-reef-map/ on August 28, 2023.
2. U.S. Maritime Limits & Boundaries data shown is from the National Oceanic and Atmospheric Administration (NOAA). Downloaded from https://nauticalcharts.noaa.gov/data/us-maritime-limits-and-boundaries.html on August 28, 2023.
3. North Atlantic Right Whale Critical Habitat data shown is from NOAA Fisheries. Downloaded from https://www.fisheries.noaa.gov/resource/map/north-atlantic-right-whale-critical-habitat-map-and-gis-data on August 28, 2023.
4. Nationwide Essential Fish Habitat data shown is from NOAA Fisheries. Downloaded from https://www.habitat.noaa.gov/protection/efh/newInv/index.html on August 28, 2023.
5. Northeast Canyons and Seamounts Marine National Monument data shown is from NOAA Fisheries. Downloaded from https://www.fisheries.noaa.gov/resource/map/northeast-canyons-and-seamounts-marine-national-monument-map-gis-data on August 28, 2023.
6. Northwest Atlantic Loggerhead Sea Turtle Critical Habitat data shown is from NOAA Fisheries. Downloaded from https://www.fisheries.noaa.gov/resource/map/loggerhead-turtle-northwest-atlantic-ocean-dps-critical-habitat-map on December 4, 2023.

N 0 250 500 750 1,000 Miles
1:15,840,000 1 inch = 250 miles

Service Layer Credits: World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA; World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

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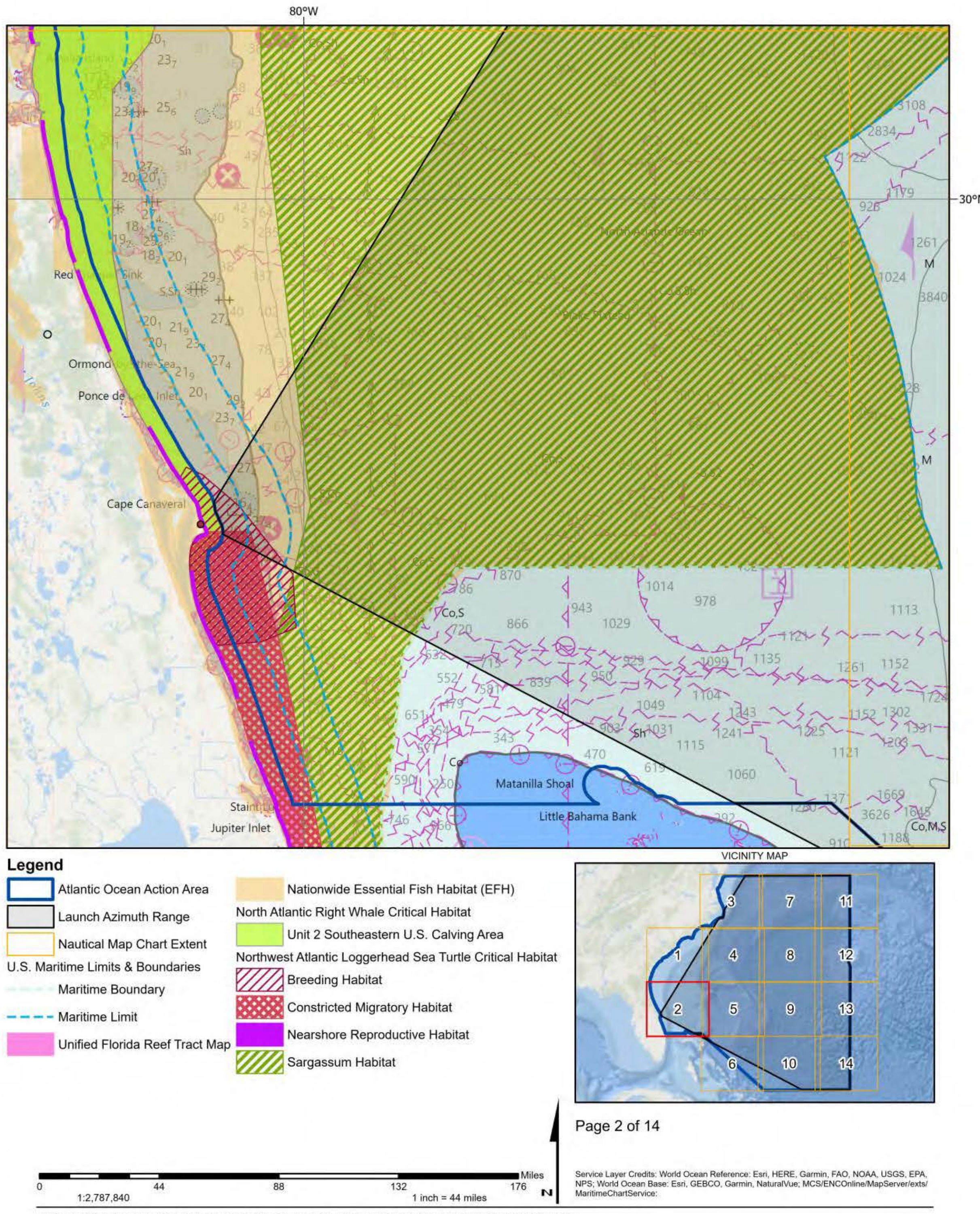
Figure 3. North Atlantic Right Whale and Loggerhead Sea Turtle Habitats



2.1 Region of Influence

The Proposed Action region of influence (ROI) is illustrated on Figure 2 and extends to 1,200 km downrange within the action area defined in the 2023 NMFS Programmatic Consultation. The specifics of the trajectory and mission plan for the first and subsequent flights of the Stoke launch vehicle are not presently defined, so this ROI is intended to cover a variety of mission types that will be flown on the Stoke launch vehicle. Figures 2 and 3 describes the northern extent of North Atlantic Right whale and loggerhead sea turtle within the ROI.

During a Stoke launch, Stage 1 will continue traveling downrange after jettison and break up during reentry. The debris will land within the proposed ROI.

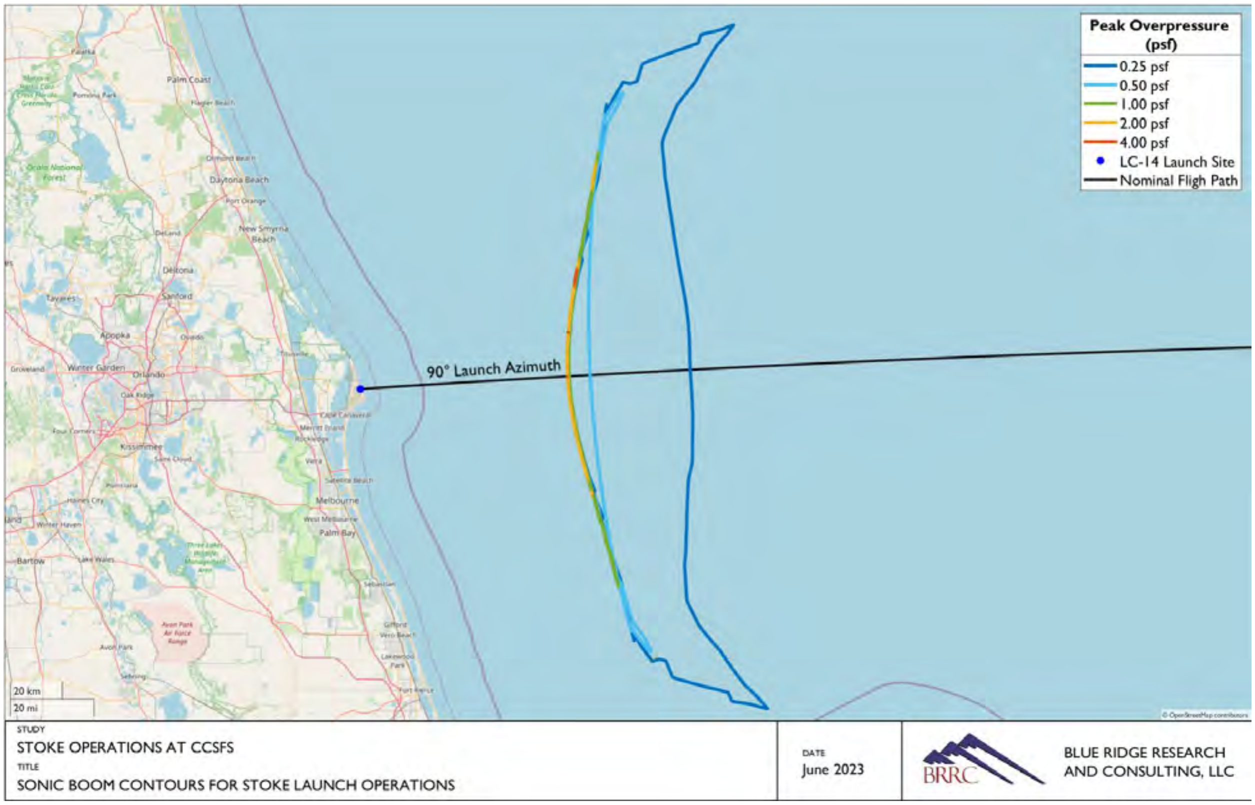
Following fairing separation, two jettisoned payload fairing halves are uncontrolled and would become debris, landing in the ocean less than 1,200 km downrange. The fairing debris footprint for any Stoke mission will be bounded by the proposed ROI, with the debris footprint of a particular mission trajectory being much smaller. Like Stage 1, the fairing's landing location varies with the mission trajectory launch azimuth, insertion orbit, atmospheric conditions, and Stage 2 reentry constraints.

Nominal launch and reentry activities occurring in the marine environment would occur in deep waters greater than 5 nautical miles (NM) offshore the coast of the U.S. or islands, with most activity occurring hundreds of miles offshore. The only component of the launch and reentry operations that occurs near (less than 5 NM offshore) the coast of the U.S. is watercraft (vessels) transiting to and from the Port of Cape Canaveral during pre-launch surveillance. Watercraft would be in keeping with normal maritime shipping and comply with USCG requirements, including the use of licensed vessels and appropriately licensed ship captains. Assets are contracted based on schedule and mission requirements, such as larger vessel with crane lift capability for a salvage scenario, and are subject to asset availability, which will influence ports utilized. Ocean waters within the ROI include offshore, deep, high-salinity waters defined by prevailing currents. Water quality in ocean waters may be characterized by temperature, salinity, dissolved oxygen, and nutrient levels. U.S. territorial seas extend 12 NM from the coast. In the event of a non-nominal launch scenario, Stoke will coordinate with USCG and U.S. Environmental Protection Agency (EPA) (in compliance with 40 *Code of Federal Regulations* [CFR] Part 220) in the identification of debris identified within 5 NM of launch site.

2.1.1 Sonic Booms

As stated in the *Final Noise Study for Stoke Operations at CCSFS LC-14* (BBRC 2023) (Appendix B), "the location and intensity of the sonic boom footprint produced by Stoke launch operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. Figure 4 presents the Stoke launch sonic boom contours modeled for a nominal due -east launch azimuth. The modeled sonic boom begins approximately 49 miles downrange of LC-14 with a narrow, forward-facing crescent shaped focus boom region. The maximum modeled peak overpressures occur within this focus boom region. Figure 4 presents peak overpressure contours up to 4 pounds per square foot (psf), although higher peak overpressure levels up to 6 psf are modeled to occur over smaller areas along the focus line. The focus boom region is generated when the vehicle continuously accelerates and pitches downward as it ascends. As the vehicle continues to ascend, the sonic boom levels decrease, and the crescent shape becomes slightly longer and wider."

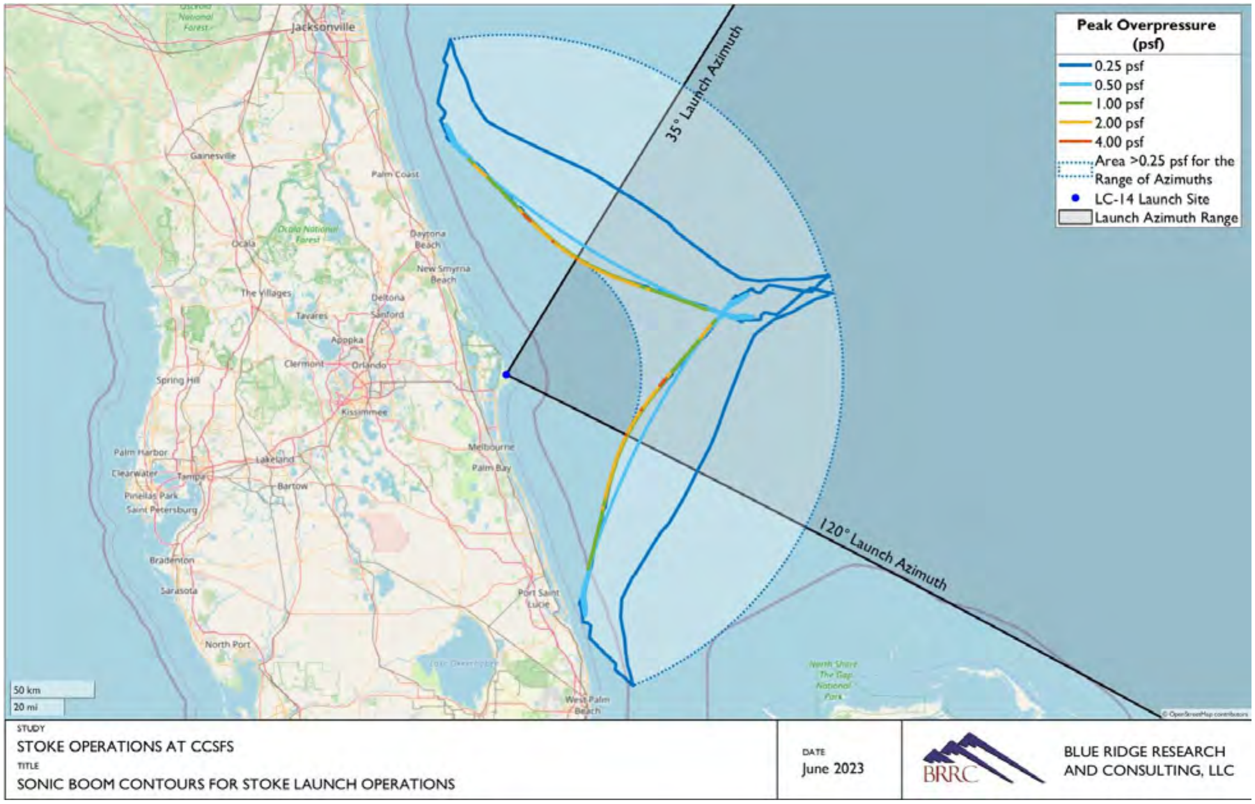
Figure 4. Sonic Boom Peak Overpressure Contours for a Nominal Due-East Launch Azimuth



Source: BRRC 2023

Figure 5, which is taken from the *Final Noise Study for Stoke Operations at CCSFS LC-14* (BBRC 2023) (Appendix B), displays "the sonic boom contours at the extents of the launch azimuth range (35 degrees (°) to 120°) and shows the area potentially exposed to peak overpressures greater than 0.25 psf from this range of launch azimuths. Sonic booms with peak overpressures greater than 0.25 psf from Stoke launch operations are modeled to occur entirely over the Atlantic Ocean."

Figure 5. Sonic Boom Peak Overpressure Contours for Stoke Launch Operations over the Azimuth Range (35° to 120°)



Source: BRRC 2023

2.1.2 Essential Fish Habitat

Stoke expects debris to sink because it is made primarily of stainless steel and other heavy metals, but the debris would not result in permanent changes to physical parameters, such as temperature, salinity, or oxygen concentration, of the water column. All vehicle propellants are non-toxic cryogenic fluids (liquid hydrogen, liquid oxygen, and LNG), which would vaporize upon exposure to ambient air or sea water and evaporate into the atmosphere without impacting marine life. The metals or other substances that could leach or dissolve into the water column or substrate after the vehicle sinks to the ocean floor would be minimal and would not result in detectable changes to water or sediment quality. Additionally, the probability of Stage 1 or Stage 2 debris generated by reentry breakup impacting essential fish habitat would be considered negligible given the small numbers of expendable stages that would break up upon reentry in the study area and the size of debris fragments. Therefore, there would be no adverse impacts to essential fish habitat.

2.1.3 Marine National Monuments

No landings in marine national monuments are expected to occur as part of the Stoke launch program as shown on Figure 2.

2.2 Stage Fate

Stage 1 and Stage 2 would be expected to break up because of aerodynamic and aerothermal loading during reentry. The rocket material would be stainless steel and other heavy metals. In the unlikely event any debris survived reentry, it would be expected to sink to the ocean floor. Stage 1 would have a nominal "Flight Performance Reserve" of 1% of the full propellant load, or 1,802 kg of propellant, with a maximum residual propellant of 2% of the nominal propellant load or 3,604 kg.

Space Launch Delta 45 (SLD 45) will do a risk analysis for each mission and generate required hazard areas (domestic and/or international). An approved surveillance plan by applicable government agencies is executed for launch compliance. Sea surveillance efforts could include the use of land-based aerial and/or seaborne assets for eyes on detection targets of interest within a hazard contour. For far downrange tracking of hazard areas, automatic identification system-based surveilling could be conducted. Targets of interest within applicable contours are reported to the Space Force Risk Assessment Center for risk analysis input in compliance with risk thresholds in accordance with 14 CFR Part 450 and SSCM91-710. SLD 45 and/or launch service provider would coordinate with USCG to implement a safety zone, security zone, and/or regulated navigation area to decrease the risk to the maritime community and reduce risk to public safety and the Maritime Transportation System.

In the unlikely case that debris create a maritime hazard, Stoke would work with USCG and its retained OSRO contractor to take actions to protect the public if necessary and then steps to mitigate the maritime traffic hazard. Stoke would verify last known vehicle state from all accessible data sources, that is, passivation, residual propellant amounts, flight termination status to discern physical hardware and potential hazard(s) status. This is similar to any contingency response where impacts are evaluated first to determine resources needed for restoral of nominal conditions. Assuming there is no immediate national security threat, Stoke with the OSRO contractor will deploy assets to assess/secure maritime traffic hazard whether by physical recovery or sinking item(s) by conventional means as demonstrated in other various industry search and salvage efforts to remove obstacles to maritime traffic ways.

2.3 Vehicle Debris

For non-nominal launches, the debris footprint for Stage 1, Stage 2, and fairings would be bounded by the proposed ROI shown on Figure 2. Stoke would use last state vectors and range assets to approximate a primary debris field. Using local weather and current drift analysis, Stoke would estimate the location of debris and make best efforts to redirect recovery vessels or charter third party vessel to perform debris recovery operations. Because of the nature of the vehicle's design, debris will sink rapidly and there will be minimal surface level debris to recover. Unlike other vehicles, the rocket is not planned to use large carbon fiber segments, which yield a majority of surface debris.

If surveying is required, applicable assets would be utilized to survey potential debris areas. The initial survey area would be determined based on last known data location point received from the telemetry on the vehicle upon splashdown. Weather and ocean current data would be used to further characterize the debris field as the operation is conducted. Marking of floating debris would occur in accordance with 33 CFR Part 67 and disposal of debris would occur in accordance with 40 CFR Part 220 and EPA regulation. Stoke with an OSRO contractor and, when applicable, the USCG, will determine the most appropriate method of recovery or sinking, as described previously, and would be on a case-by-case basis depending on personnel safety, vessel safety, and capability. Stoke would act to mitigate the debris to verify the debris sinks within 10 days as stated in the NMFS Letter of Concurrence (NMFS 2023).

2.4 Impact by Fallen Objects

Launch debris from expended boosters, payload fairings, and any launch failure anomalies have the potential to affect MMPA-protected and ESA-listed marine species. The primary concern is a direct impact from an object landing on a marine mammal, sea turtle, or fish. The Proposed Action ROI, where vehicle debris could splashdown, encompasses vast expanses of ocean, as shown on Figure 2.

If an early launch abort or failure occurs, spacecraft and Stoke launch vehicle debris would fall onto the land surface or into the ocean and cause potential impacts. Impacts from residual liquid propellant within the Stoke launch vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air, and only structural debris would strike the water. In a destruct action, the Stoke launch vehicle may survive to impact the water essentially intact. The Stoke propellant storage on the Stoke launch vehicle is designed to break up due to the action of the onboard flight termination system, and as previously mentioned, would vaporize when exposed to the atmosphere. Exposure to MMPA-protected and ESA-listed marine mammals, sea turtles, and fish in the action area is not likely to adversely affect these species.

Marine mammals and ESA-listed species are sparsely distributed across the ocean, resulting in very low densities of species overall. Direct strikes by debris from a Stoke launch vehicle are extremely unlikely for all species of concern (fish, sea turtles, and marine mammals) because of the small size of the components compared to the vast open ocean. If debris from the vehicle struck an animal near the water's surface, the animal would be injured or killed. Given the vehicle will break up upon reentry, and the fact that marine wildlife, marine mammals, and special status species spend the majority of their time submerged instead of on the surface, it is extremely unlikely they would be adversely affected. The relative availability of these animals at the ocean surface, spatially and temporally, combined with the low frequency of the Proposed Action, reduce the likelihood of impacts to extremely low. Spatial distribution data are not readily available for all ESA-listed species; however, the Marine Geospatial Ecology Lab at Duke University modeled the population density of some ESA-listed species along the Atlantic Coast (Marine Geospatial Ecology Lab, Duke University 2022). The most abundant cetacean species identified in this study within the bounds of the programmatic letter of concurrence was observed to be the sperm whale. The highest density of sperm whales observed during a single month in the study was 0.0256 individuals per square kilometer (km^2). Using this value as a worst-case scenario estimate representative of the entirety of the potential impact area, the probability of debris impacting a sperm whale across the potential launch area was calculated to be approximately 7 in 1,000,000, as shown in the probability estimate in Table 3. Impact probability for other ESA-listed and MMPA-protected species is expected to be lower because of lower densities and less frequent surfacing. Therefore, the cumulative probability of impacting an ESA-listed or MMPA-protected species is expected to be negligible. The probability of a direct impact to protected marine mammal, sea turtle, or fish is extremely unlikely.

Table 3. Probability Estimate – Direct Strike to Sperm Whale

Description	Value	Units	Notes/Source
Maximum Observed Population Density[a]	0.0256[b]	Individual/km^2	Maximum observed density during month with highest observed sperm whale sightings
Conversion ft^2 to km^2	9.29E-08	ft^2/km^2	Conversion factor
100-km downrange area	7,331	km^2	Ranging between azimuths 35° to 120° and extending to 100 km offshore
Total assumed individuals within 100-km downrange area	188	individuals	Maximum observed density[a] total downrange area
Whale surface area is area buffer around each individual	3,014	ft^2	Assumed 60-foot-long by 8-foot-wide cylinder or approximate 62-foot-diameter buffer surrounding individual
Total buffer area for all individuals	565,648	ft^2	Maximum observed density[a] total downrange area
Total buffer area for all individuals	0.05	km^2	Using conversion factor
Probability of impacting whale	7E-06	Not applicable	Not applicable

[a] Marine Geospatial Ecology lab at Duke University 2022

[b] 0.0256 individuals per km^2 is a conservative estimate representing the maximum observed concentration of sperm whales within the study area. The mean sperm whale density throughout the entire study area during month 9 (month with highest observed density) was 0.005386 individuals/km^2.

ft^2 = square foot (feet)

ft^2/km^2 = square foot (feet) per square kilometer

Furthermore, the projected landing areas for the Stoke launch vehicle debris are well offshore, where density of marine species decreases compared to coastal environments and upwelling areas. Because it would be extremely unlikely for an MMPA-protected or ESA-listed species to be directly struck by Stoke launch vehicle components, spacecraft, or any launching or landing-related debris, the potential for effects on marine life from a direct impact by those fallen objects are discountable. Therefore, direct impacts from fallen objects to MMPA-protected marine mammals, ESA-listed marine mammals, sea turtles, and fish in the action area because of launch activities may affect, but are not likely to adversely affect, these animals (NMFS 2023). Table 4 summarizes the potential MMPA-protected and ESA-listed marine species present within the ROI.

Table 4. ROI Federal Species

Species Type	Common Name	Scientific Name	Federal
Sea Turtles	Loggerhead Turtle	*Caretta caretta*	Threatened
Sea Turtles	Green Sea Turtle	*Chelonia mydas*	Threatened
Sea Turtles	Kemp’s Ridley Sea Turtle	*Lepidochelys kempii*	Endangered
Sea Turtles	Leatherback Turtle	*Dermochelys coriacea*	Endangered
Sea Turtles	Hawksbill Turtle	*Eretmochelys imbricata*	Endangered

Species Type	Common Name	Scientific Name	Federal
Fish	Smalltooth Sawfish	*Pristis pectinata*	Endangered
Fish	Oceanic Whitetip Shark	*Carcharhinus longimanus*	Threatened
Fish	Giant Manta Ray	*Manta birostis*	Threatened
Fish	Atlantic Sturgeon	*Acipenser oxyrhynchus*	Endangered
Fish	Nassau Grouper	*Epinephelus striatus*	Threatened
Fish	Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered
Mammals	North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Mammals	Humpback Whale	*Megatera novaeangliae*	Endangered
Mammals	Florida Manatee	*Trichechus manatus*	Threatened
Mammals	Blue Whale	*Balaenoptera musculus*	Endangered
Mammals	Fin Whale	*Balaenoptera physalus*	Endangered
Mammals	Sei Whale	*Balaeoptera borealis*	Endangered
Mammals	Sperm Whale	*Physeter macrocephalus*	Endangered

2.5 Exposure to Sonic Booms and Impulse Noise

Other potential impacts to marine habitats and wildlife from Stoke launch vehicle launches are associated with the resulting sonic booms. These potential impacts are fully described by NMFS as part of FAA's 2023 ESA Section 7 consultation (NMFS 2023). This consultation addressed comparable commercial space Stoke vehicle launch, reentry, and landing in the Atlantic Ocean. The consultation resulted in NMFS concurring that commercial Stoke vehicle launch and reentry operations may affect but, are not likely to adversely affect, ESA-listed species and designated critical habitat. The same impact mechanisms and effects described and assessed as part of the 2023 NMFS consultation are directly applicable to the Proposed Action.

Previous research conducted by the U.S. Air Force supports this conclusion with respect to sonic booms, indicating the lack of harassment risk for protected marine species in water (USAF Research Laboratory 2000). The researchers were using a threshold for harassment of marine mammals and sea turtles by impulsive noise of 12 pounds per square inch peak pressure and/or 182 decibels referenced to the standard unit of acoustic pressure underwater, 1 micro-Pascal, which is an older threshold used by NMFS and Department of Defense at the time. The researchers pointed out that to produce the 12 pounds per square inch in the water, there would need to be nearly 900 psf at the water surface, assuming excellent coupling conditions. As noted in the Noise Study for Stoke Operations at CCSFS (BBRC 2023) (Appendix B), the maximum modeled peak overpressures reach 6 psf for Space Launch Complex 14 northeasterly launches. The impacts resulting from the sonic booms generated by Stoke launch operations are, therefore, not expected to affect marine species underwater. Stoke launches would have no significant impact to wildlife and marine life resources.

2.6 Impacts to Special Status Species

The Proposed Action may affect, but is not likely to adversely affect, ESA-listed species and designated critical habitat. Reporting and monitoring requirements will comply with the U.S. Fish and Wildlife Service and NMFS following the conclusion of consultations. Stoke will adhere to all education and observation requirements set forth in OPR-2021-02908. Reporting of stranded, dead, or injured animals will be conducted in accordance with OPR-2021-02908. During a nominal launch, the Stoke launch vehicle would be carried over the coastal waters of the Atlantic Ocean and through the Earth's atmosphere. Following stage separation, Stage 1 would be maneuvered into position for retrograde burn and would break up upon reentry. Stage 2 would deliver the payload into orbit and would break up upon reentry.

In accordance with Title 14 CFR Part 450, Stoke will submit a Post-Jettison Operation Memo as part of the 14 CFR Part 450 licensing process that will describe Stage 1 reentry behavior and breakup. Stoke will use engineering analysis to determine potential for explosion, breakup, and possible impacts for a nominal launch/reentry. Vehicle debris that impacts with the ocean surface will have minimal LOX and LNG onboard, resulting in no release of toxics or hydrocarbons. In an anomalous condition, the risks could include a detonation event of remaining propellant or a release of high-pressure gas stored inside the vehicle's composite overwrapped pressure vessel, presenting the potential to affect localized surface water if the spacecraft contains hypergolic propellants that is released into the water. Any resulting pH changes would be temporary and localized.

10-Apr-2024

Michael Blaylock, NH-03, DAF
Chief, Environmental Conservation

Date

3. References

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Appendix A
Summary of OPR-2021-02908 Requirements

Table A-1. Summary of OPR-2021-02908 Requirements

Project Design Criteria	Description	Stoke Launch Program Adherence
General	Launch and reentry operations will be conducted by the U.S. Space Force, National Aeronautics and Space Administration, or an FAA-licensed (or permitted) commercial operator from a launch site identified in Table 1 of the NMFS's programmatic letter of concurrence to the FAA, also referred to as OPR-2021-02908 (NMFS 2023). Launch preparations will occur in compliance with standard operating procedures and best management practices currently implemented at these existing launch vehicle facilities.	Yes
General	Launch operations will use launch vehicles identified in Table 3 of OPR-2021-02908 (NMFS 2023).	Not applicable; approximately two launches during the first year of operation in 2025. The launch schedule may increase to 10 launches a year for the subsequent 2 years.
General	Launch activities, including suborbital landings and splashdowns, and orbital reentry activities will occur in the Proposed Action area at least 5 NM offshore the coast of the U.S. or islands.	Yes
General	No launch operator will site a landing area in coral reef areas.	Yes
General	No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.	Yes
General	Landing operations will not occur in the aquatic zone extending 20 NM (37 kilometers) seaward from the baseline or basepoint of each major rookery and major haul-out of the Western Distinct Population Segment Steller sea lion located west of 144 degrees west.	Not applicable; launch abort testing is not planned as part of the Stoke Launch Program.
General	Launch abort testing will occur only in the Atlantic Ocean from Cape Canaveral Space Force Station or Kennedy Space Center as previously analyzed (SER-2016-17894, FPR-2017-9231).	Not applicable; launch abort testing is not planned as part of the Stoke Launch Program.

Project Design Criteria	Description	Stoke Launch Program Adherence
General	Launch abort testing will not occur in designated critical habitat for the North Atlantic right whale	Not applicable; launch abort testing is not planned as part of the Stoke Launch Program.
General	Use all feasible alternatives and avoid landing in Rice's whale core habitat distribution area as much as possible. No more than one splashdown, reentry, and recovery of the capsule will occur in Rice's whale core habitat distribution area per year. No other operations; spacecraft, launch, or reentry vehicle landings; or expended components will occur in Rice's whale core habitat distribution area.	Not applicable; Rice's whale does not occur in the ROI.
Education and Observation	Each launch operator will instruct all personnel associated with launch operations about marine species and any critical habitat protected under the ESA and species protected under the MMPA that could be present in the operations area. The launch operator will advise personnel of the civil and criminal penalties for harming, harassing, or killing ESA-listed and MMPA-protected species.	Yes
Education and Observation	As necessary each launch operator will provide dedicated observer(s) (for example, biologist or person other than the watercraft operator that can recognize ESA-listed and MMPA-protected species) responsible for monitoring ESA-listed and MMPA-protected species with the aid of binoculars during all in-water activities, including transiting marine waters for surveillance or to retrieve boosters, spacecraft, other launch-related equipment or debris.	Yes
Education and Observation	When an ESA-listed or MMPA-protected species is sighted, the observer will alert vessel operators to apply the Vessel Operations protective measures.	Yes
Education and Observation	Dedicated observers will record the date, time, location, species, number of animals, distance and bearing from the vessel, direction of travel, and other relevant information for all sightings of ESA-listed or MMPA-protected species.	Yes
Education and Observation	Dedicated observers will survey the launch recovery area for any injured or killed ESA-listed or MMPA-protected species and any discoveries will be reported.	Yes
Reporting Stranded, Injured, or Dead Animals	Each launch operator will immediately report any collision(s), injuries or mortalities and any strandings of ESA-listed or MMPA-protected species to the appropriate NMFS contact listed in this section and to Cathy Tortorici, Chief, ESA Interagency Cooperation Division by email at cathy.tortorici@noaa.gov.	Yes
Reporting Stranded, Injured, or Dead Animals	In the Gulf of Mexico and Atlantic Ocean waters near Florida, each launch operator will report any smalltooth sawfish sightings to 941-255-7403 or via email Sawfish@MyFWC.com.	Yes; only in the Atlantic Ocean.

Project Design Criteria	Description	Stoke Launch Program Adherence
Reporting Stranded, Injured, or Dead Animals	Each launch operator will report any giant manta ray sightings via email to manta.ray@noaa.gov.	Yes
Reporting Stranded, Injured, or Dead Animals	Each launch operator will report any injured, dead, or entangled North Atlantic right whales to the U.S. Coast Guard via VHF Channel 16.	Yes
Vessel Operations	Maintain a minimum of 150 feet from sea turtles.	Yes
Vessel Operations	In the Atlantic Ocean, slow to 10 knots or less and maintain a minimum distance of 1,500 feet (500 yards) from North Atlantic right whales.	Yes
Vessel Operations	In the Gulf of Mexico, slow to 10 knots or less and maintain a minimum distance of 1,500 feet (500 yards) from Rice's whale (formerly Gulf of Mexico Bryde's whale). If a whale is observed but cannot be confirmed as a species other than a Rice's whale, the vessel operator must assume that it is a Rice's whale.	Not applicable
Vessel Operations	Maintain a minimum distance of 300 feet (100 yards) from all other ESA-listed and MMPA-protected species. If the distance ever becomes less than 300 feet, reduce speed and shift engine to neutral. Do not engage the engines until the animals are clear of the area.	Yes
Vessel Operations	Watercraft operators will reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.	Yes
Vessel Operations	Watercraft 65 feet long or longer will comply with the Right Whale Ship Strike Reduction Rule (*Code of Federal Regulations* Title 50, Subpart 224.105), including reducing speeds to 10 knots or less in Seasonal Management Areas or in Right Whale Slow Zones, which are dynamic management areas established where right whales have been recently seen or heard.	Yes
Vessel Operations	Check various communications media for general information regarding ship strikes and specific information regarding North Atlantic right whale sightings in the area. These include National Oceanic and Atmospheric Administration weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notice to Mariners.	Yes
Vessel Operations	Attempt to remain parallel to an ESA-listed or MMPA-protected species course when sighted while the watercraft is underway (for example, bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.	Yes
Vessel Operations	Avoid vessel transit in the Rice's whale core distribution area. If vessel transit in the area is unavoidable, stay out of the depth range of 100 meters to 425 meters (where the Rice's whale has been observed; Rosel et al. 2021) as much as possible and go as slow as practical, limiting vessel speed to 10 knots or less.	Not applicable; Rice's whale does not occur in the ROI.

Project Design Criteria	Description	Stoke Launch Program Adherence
Vessel Operations	No operations or transit will occur at night in Rice's whale core distribution area.	Not applicable; Rice's whale does not occur in the ROI.
Aircraft Procedures	Spotter aircraft will maintain a minimum of 1,000 feet over ESA-listed or MMPA-protected species and 1,500 feet over North Atlantic right whales. Additionally, aircraft will avoid flying in circles if marine mammals or sea turtles are spotted to avoid any type of harassing behavior.	Yes
Hazardous Materials Emergency Response	If a launch operation fails, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts. In most launch failure scenarios, at least a portion (if not most) of the propellant will be consumed by the launch/failure, and any remaining propellant will evaporate or be diluted by seawater and biodegrade over time (timeframes are variable based on the type of propellant and environmental conditions, but generally hours to a few days).	Yes

FAA = Federal Aviation Administration

ESA = Endangered Species Act

MMPA = Marine Mammal Protection Act

NM = nautical mile(s)

NMFS = National Marine Fisheries Service

ROI = region of influence

Appendix B
Stoke Noise Study

Blue Ridge Research and Consulting, LLC

BRRC Report 23-10 (Final)

Noise Study for Stoke Operations at CCSFS LC-14

5 June 2023

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ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in the report:

ASEL	A-weighted Sound Exposure Level
BRRC	Blue Ridge Research and Consulting, LLC
CCSFS	Cape Canaveral Space Force Station
CDNL	C-weighted Day-Night Average Sound Level
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
DI	Directivity Indices
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DSM-1	Distributed Source Method 1
EA	Environmental Assessment
FAA	Federal Aviation Administration
ft	Foot/Feet
Hz	Hertz
KSC	Kennedy Space Center
LC-14	Launch Complex 14
lbf	Pound Force
lbs	Pound Mass
$L_{A,max}$	Maximum A-weighted Sound Level in Decibels
L_{max}	Maximum Unweighted Sound Level in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Rocket Propulsion Noise and Emissions Simulation Model
SEL	Sound Exposure Level
S.L.	Sea Level

1 INTRODUCTION

This report documents the noise study performed as part of Stoke Space's efforts on the Environmental Assessment (EA) for their proposed operations at Cape Canaveral Space Force Station (CCSFS) Launch Complex 14 (LC-14). The first stage of Stoke's launch vehicle (Figure 1) is powered by seven liquid natural gas (LNG) and liquid oxygen (LOX) engines which generate a combined thrust of 700,000 lbf. Stoke's proposed operations at LC-14 include 18 annual easterly launch operations and 18 pre-launch static fire tests.

Figure 1. Conceptual rendering of the Stoke launch vehicle in flight. (Image Credit: Stoke)

This noise study describes the environmental noise associated with the proposed Stoke operations. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage. The following sections of this report are outlined below.

- Section 2 defines the proposed Stoke operations.
- Section 3 reviews the noise metrics and effects discussed throughout this report.
- Section 4 presents the propulsion noise and sonic boom modeling results.
- Section 5 summarizes the notable findings of this noise study.
- Appendix A gives an overview of the basics of sound.
- Appendix B provides definitions of the noise metrics discussed throughout this report.
- Appendix C describes the propulsion noise and sonic boom modeling methods.

2 STOKE OPERATIONS

Stoke plans to launch from LC-14 on an easterly launch azimuth within the Eastern Range's allowable range of azimuths, approximately 35° to 120° as shown in Figure 2. The Stoke launch trajectory will be unique to the vehicle configuration, mission, and environmental conditions. Stoke provided a nominal launch trajectory for the noise and sonic boom modeling.

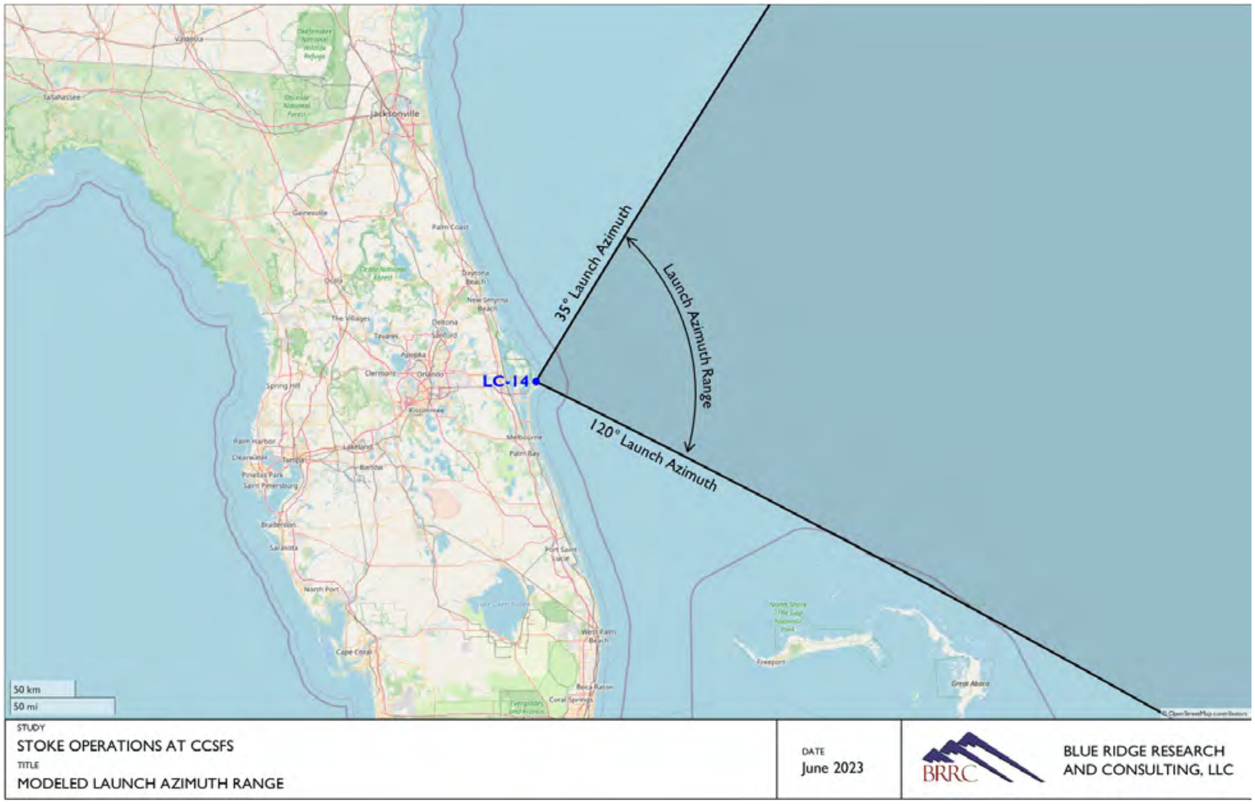

Figure 2. Range of Stoke launch azimuths from LC-14.

Table 1 presents the proposed Stoke operations at CCSFS. Stoke plans to conduct up to 18 launch operations from LC-14 per year. Prior to each launch, Stoke will conduct a pre-launch static fire test with a duration up to 175 seconds. Table 1 also presents the distribution of the Stoke operations between acoustic day (0700 to 2200) and acoustic night (2200 – 0700). The acoustic time of day distribution is used to account for increased sensitivity to noise at night when computing the Day-Night Average Sound Level (DNL) metric, which applies an additional 10 dB adjustment to events during the acoustical nighttime period.

Table 1. Proposed Stoke operations at LC-14.

		Annual Operations		
Event	Description	Daytime 0700 – 2200	Nighttime 2200 – 0700	Total
Static Fire	175 second static fire	18	0	18
Launch	Launch from LC-14	10	8	18

Table 2 presents the vehicle and engine modeling data for a nominal configuration of the Stoke launch vehicle. The first stage of Stoke's launch vehicle (Figure 3) is powered by seven LNG/LOX engines which generate a combined thrust of 700,000 lbf at the surface of the earth (i.e. sea level). The vehicle's weight and thrust vary with altitude, thus the noise and sonic boom modeling of the launch operations use the time varying weight and thrust profiles provided in the trajectory. The thrust profile increases with altitude, from 700,000 lbf at sea level to a maximum thrust of approximately 780,000 lbf at altitude.

Table 2. Vehicle and engine modeling parameters for a nominal configuration of the Stoke launch vehicle.

Modeling Parameters	Values
Manufacturer	Stoke
Length	132 ft
Diameter	12 ft
Gross Weight	500,000 lbs
1st Stage Thrust (Max S.L)	700,000 lbf (100,000 lbf x Qty. 7 LNG/LOX engines)

Figure 3. Conceptual rendering of the Stoke launch vehicle (Image Credit: Stoke)

3 NOISE METRICS AND EFFECTS

A variety of acoustic metrics can be used to describe how noise from commercial space operations affects communities and the environment. Metrics can describe the effect of an individual operation (single event) or the cumulative noise of multiple events over a long time. An overview of the basics of sound and definitions of the noise metrics discussed throughout this report are provided in Appendix A and Appendix B, respectively. Additionally, a comprehensive listing of acoustical terminology and definitions is available in the American National Standards Institute's (ANSI) "Acoustical Terminology" standard (ANSI S1.1-2013).

The Day Night Average Sound Level (DNL) is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities [1]. Despite the differences between aviation and commercial space vehicle noise, DNL is the required metric to quantify cumulative exposure to noise from commercial space transportation activities, too. However, the DNL metric may not fully describe the noise experienced during a commercial space noise event, and the use of supplemental noise metrics is recommended.

The metrics and effects relevant to propulsion noise and sonic booms from commercial space operations are presented in Sections 3.1 and 3.2, respectively. The noise effects described in the following sections are associated with the effects on people and structures.

3.1 Propulsion Noise Metrics and Effects

Table 3 presents metrics and associated effects relevant to the analysis of propulsion noise from commercial space operations. The associated effects referenced in Table 3 are discussed in more detail in Sections 3.1.1 through 3.1.3. For more detailed definitions of the metrics, beyond the descriptions provided in Table 3, see Appendix B.

In addition to the FAA's primary noise metric, DNL, Table 3 provides supplemental metrics that are used to evaluate potential impacts to people and structures. The maximum sound level metrics are particularly useful in improving the public's understanding of exceptionally loud commercial space event(s). Maximum sound level metrics are used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures. Additionally, A-weighted Sound Exposure Level (SEL), and Percent Allowable Daily Noise Dose are used to describe the potential noise impact from rocket operations.

Table 3. Metrics for propulsion noise analysis.

Metric	Description	Effect	Level
Day-Night Average Sound Level (DNL)	A cumulative (A-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.1.1)	65 dBA Ref. [1]
Maximum A-weighted Sound Level ($L_{A,max}$)	A single-event metric that describes the highest A-weighted sound level during an event in which the sound changes with time. (Appendix B)	Hearing Impairment (Section 3.1.2)	115 dBA Ref. [2]
Maximum Unweighted Sound Pressure Level (L_{max})	A single-event metric that describes the highest unweighted sound pressure level during an event in which the sound changes with time. (Appendix B)	Vibration on Structures (Section 3.1.3)	111 dB and 120 dB Ref. [3]
A-weighted Sound Exposure Level (SEL)	A single-event metric that accounts for the noise level and duration of the event, referenced to a standard duration of one second. (Appendix B)	--	--
Percent Allowable Daily Noise Dose	A single-event metric that describes the sound exposure normalized to an 8-hour working day, expressed as a percentage of the allowable daily noise dose. (Appendix B)	Hearing Impairment (Section 3.1.2)	--

3.1.1 Annoyance

DNL is based on long-term cumulative noise exposure and has been found to correlate with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [4, 5]. Noise studies used in the development of the DNL metric did not include rockets, which can have significant low-frequency noise energy and are historically irregularly occurring events. Thus, the suitability of DNL for rocket noise events is uncertain [6]. Additionally, the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [1]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance.

DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities. Exhibit 4-1 of FAA Order 1050.1F [1] defines the FAA's significance threshold for noise. An action is considered significant if it would increase noise in a noise-sensitive area by DNL 1.5 dBA or more and the resulting noise exposure level is at least DNL 65 dBA. For example, an increase from DNL 65.5 dBA to 67 dBA is considered a significant impact, as is an increase from DNL 63.5 dBA to 65 dBA.

3.1.2 Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. These guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [2], National Institute for Occupational Safety and Health (NIOSH) [7], and the Department of Defense (DoD) Occupational Hearing Conservation Program [8]. 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 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. $L_{A,max}$ can be used to identify potential locations where hearing protection should be considered for rocket operations.

In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). Although the daily noise dose metric was established to protect workers against NIHL, the results can also help contextualize the noise exposure in the community. The level of exposure is typically calculated in terms of a daily noise dose, which is a function of the sound exposure normalized to an 8-hour workday. For example, a person will reach 100% of their daily noise dose after 15 minutes of exposure to 115 dBA. A person will also reach 100% of their daily noise dose after 8 hours of exposure to 90 dBA.

3.1.3 Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element.

A National Aeronautics and Space Administration (NASA) technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The conclusions were based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB (unweighted) and one in 1,000 households exposed to 111 dB (unweighted).

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the rocket engine remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [3] damage claim criteria represent the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

3.2 Sonic Boom Metrics and Effects

Table 4 presents metrics and associated effects relevant to the analysis of sonic booms from commercial space operations. The associated effects referenced in Table 4 are discussed in more detail in Sections 3.2.1 through 3.2.4. For more detailed metric definitions beyond the descriptions provided in Table 4, see Appendix B.

In addition to the FAA's primary noise metric for sonic booms, C-weighted DNL (CDNL), Table 4 provides supplemental metrics that can be used to evaluate potential impacts to people, and structures. The peak overpressure is particularly useful in improving the public's understanding of the impulsive sonic boom event(s). The peak overpressure is used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures.

Table 4. Metrics for sonic boom analysis.

Metric	Description	Effect	Level
C-weighted Day-Night Average Sound Level (CDNL)	A cumulative (C-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.2.1)	60 dBC [9]
Peak Overpressure	A single-event metric that describes the highest instantaneous sound pressure level, characterized for sonic booms by the front shock wave. (Appendix B)	Physiological Effects (Section 3.2.2)	
		Hearing Impairment (Section 3.2.3)	140 dB (4 psf) [7]
		Vibration on Structures (Section 3.2.4)	2 psf [10, 11]

3.2.1 Annoyance

Similar to propulsion noise (see Section 3.1.1), DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to sonic booms. However, for impulsive noise sources with significant low frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [12]. In terms of percentage of people who are highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [9].

3.2.2 Physiological Effects

The unexpected, loud impulsive noise of sonic booms tends to cause a startle effect in people. However, when people are exposed to impulsive noises with similar characteristics on a regular basis, they tend to become conditioned to the stimulus and no longer display the startle reaction. The physiological effects of single sonic booms on humans [13] can be grouped as presented in Table 5.

Table 5. Physiological effects of a single sonic booms on humans. [13]

Overpressure	Behavioral effects
< 0.3 psf	Orienting, but no startle response; eyeblink response in 10% of subjects; no arm/hand movement.
0.6–2.3 psf	Mixed pattern of orienting/startle responses; eyeblink in about half of subjects; arm/hand movements in about a fourth of subjects, but not gross bodily movements.
2.7–6.5 psf	Predominant pattern of startle responses; eyeblink response in 90 percent of subjects; arm/hand movements in more than 50 percent of subjects with gross body flexion in about a fourth of subjects.

3.2.3 Noise-Induced Hearing Impairment

Multiple U.S. government agencies provide guidelines on permissible noise exposure limits for impulsive noise such as sonic booms. NIOSH [7] and OSHA [2] state that impulsive or impact noise levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom peak overpressure level of approximately 4 psf.

3.2.4 Noise-Induced Vibration Effects on Structures

The potential for damage from sonic booms is generally confined to brittle objects, such as glass, plaster, roofs, and bric-a-brac. Table 6 provides a summary of potential damage to conventional structures at various overpressures. Additionally, Table 6 describes example impulsive events for each level range. A large degree of variability exists in damage types and amounts, and much of the potential for damage depends on the sonic boom overpressure and the pre-existing condition of a structure. Generally, the potential for damage to well-maintained structures from sonic boom overpressures less than 2 psf is unlikely [10, 11]. The probability of the potential for damage to well-maintained structures by overpressures less than 4 psf is low (see Table 6) and increases for levels greater than 4 psf. Ground motion resulting from sonic boom is rare and is considerably below structural damage thresholds accepted by the United States Bureau of Mines and other agencies.

Table 6. Possible damage to structures from sonic booms. [10]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf *piledriver at construction site*	Glass	Extension of existing cracks; potential for failure for glass panes in bad repair; failure potential for existing good glass panes is less than 1 out of 10,000 at 2 psf.
	Ceiling Plaster	Fine cracks; extension of existing cracks; mostly from fragile areas.
	Wall Plaster	Fine cracks; extension of existing cracks (less than in ceilings); over doorframes; between some plasterboards; mostly fragile areas.
	Roof	Older roofs may have slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole; New and modern roofs are rarely affected.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
2 – 4 psf *cap gun/ firecracker near ear*	Glass	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
	Ceiling Plaster	Estimated rate of cracking ranges from less than 1 out of 5,000 (2 psf) to 1 out of 625 (4 psf).
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 10,000 (2 psf) to 1 out of 1,000 (4 psf).
	Roof	Potential for nail-peg failure if eroded.
	Bric-a-brac	Increased risk of tipping or falling objects.
4 – 10 psf *handgun at shooter's ear*	Glass	Regular failures within a large population of well-installed glass (1 out 50 (10 psf) to 500 (4 psf)); Failure potential in industrial and greenhouses glass panes.
	Ceiling Plaster	Estimated rate of cracking ranges from 1 out of 625 (4 psf) to 1 out of 10 (10 psf). Potential for partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 1,000 (4 psf) to 1 out of 50 (10 psf). Measurable movement of inside ("party") walls at 10 psf.
	Roof	Regular failures within a large population of nominally good slate, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Bric-a-brac	Increased risk of tipping of falling objects

Table 6. Possible damage to structures from sonic booms. [10] (continued)

Nominal level	Damage Type	Item Affected
> 10 psf *fireworks display from viewing stand*	Glass	Some good glass will fail regularly (great than 1 out of 10) to sonic booms and at an increase rate when the wavefront is normal to the glass panel. Glass with existing faults could shatter and fly. Large window frames move.
	Ceiling Plaster	Plasterboards displaced by nail popping.
	Wall Plaster	Most plaster affected. Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Roof	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; rarely domestic chimneys dislodged if not in good condition.
	Bric-a-brac	Some nominally secure items can fall, e.g., large pictures, especially if fixed to party walls.

4 STOKE NOISE AND SONIC BOOM MODELING RESULTS

The following section presents the propulsion noise and sonic boom modeling results with respect to the potential environmental impacts associated with Stoke operations at CCSFS.

4.1 Propulsion Noise Results

Rocket propulsion noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Propulsion noise generated by Stoke operations from LC-14 was modeled using RUMBLE 4.1, BRRC's Rocket Noise and Emissions Model (see Appendix C.1).

The propulsion noise results are presented in the form of noise contours, where a noise contour is a line drawn on a map that connects points of equal noise level. The noise contours are overlaid on map tiles from OpenStreetMap which contain helpful orienting features such as places, roads and boundaries, including the state and international water boundaries (shown parallel to the coastline). The single-event noise contour maps are presented for each event type, where the launch noise contours represent the maximum sound levels over the range of launch azimuths between 35° and 120°. The noise contours extend further over water than over land because water surfaces reflect more sound energy than land. Thus, the sound levels over water are elevated relative to the sound levels over land at comparable distances.

The noise levels are presented in Section 4.1.1 to provide additional context regarding the intensity of the sound and its duration. The noise effects are discussed in Section 4.1.2 with respect to annoyance, hearing conservation, and structural damage.

4.1.1 Propulsion Noise Levels

The modeled noise levels generated by Stoke operations at CCSFS are presented for three noise metrics: Unweighted Maximum Sound Level, A-weighted Maximum Sound Level, and A-weighted Sound Exposure Level. Although the maximum sound level provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard. Thus, A-weighted SEL contours are provided in addition to the $L_{A,max}$ contours, as SEL represents both the intensity of a sound and its duration. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. The A-weighted SEL is also used in the calculation of DNL.

A-weighted Maximum Sound Level ($L_{A,max}$)

The modeled A-weighted maximum sound level ($L_{A,max}$) contours are presented for Stoke launch and static fire operations in Figure 4 and Figure 5, respectively.

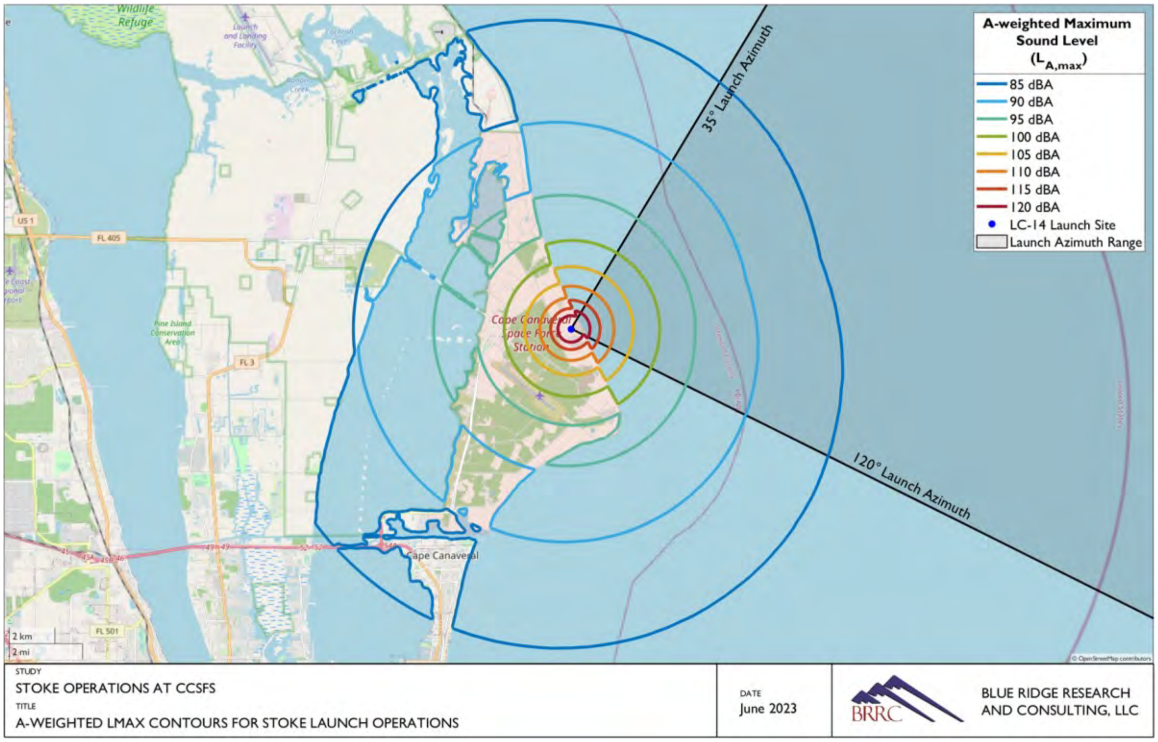

Figure 4. $L_{A,max}$ contours for Stoke launch operations over the azimuth range (35° - 120°).

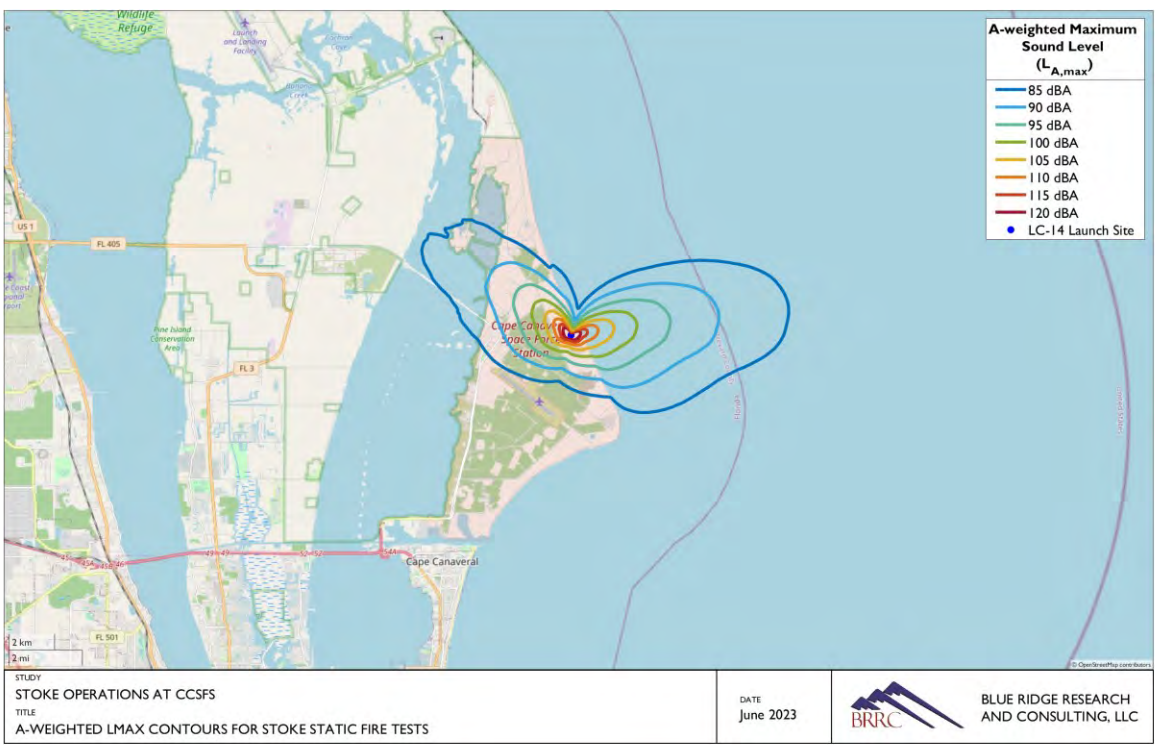

Figure 5. $L_{A,max}$ contours for Stoke static fire tests.

Unweighted Maximum Sound Level

The modeled unweighted maximum sound level contours (L_{max}) contours for Stoke launch and static fire operations are presented in Figure 6 and Figure 7, respectively.

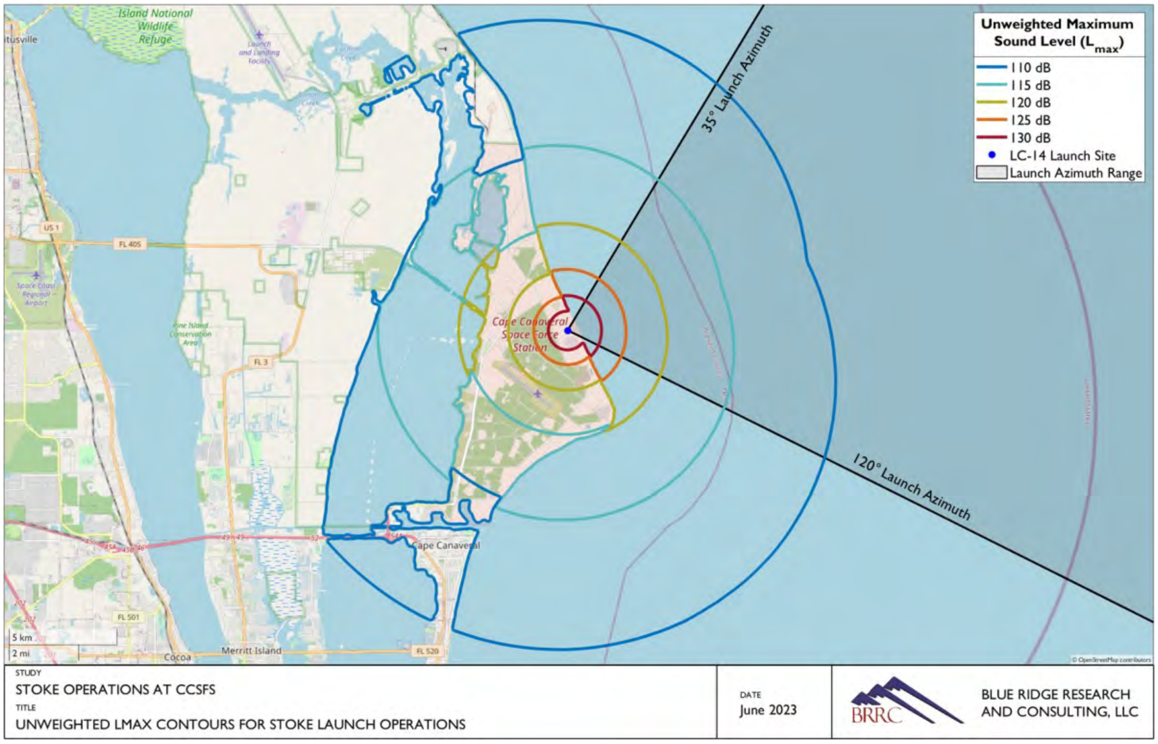

Figure 6. L_{max} contours for Stoke launch operations over the azimuth range (35° - 120°).

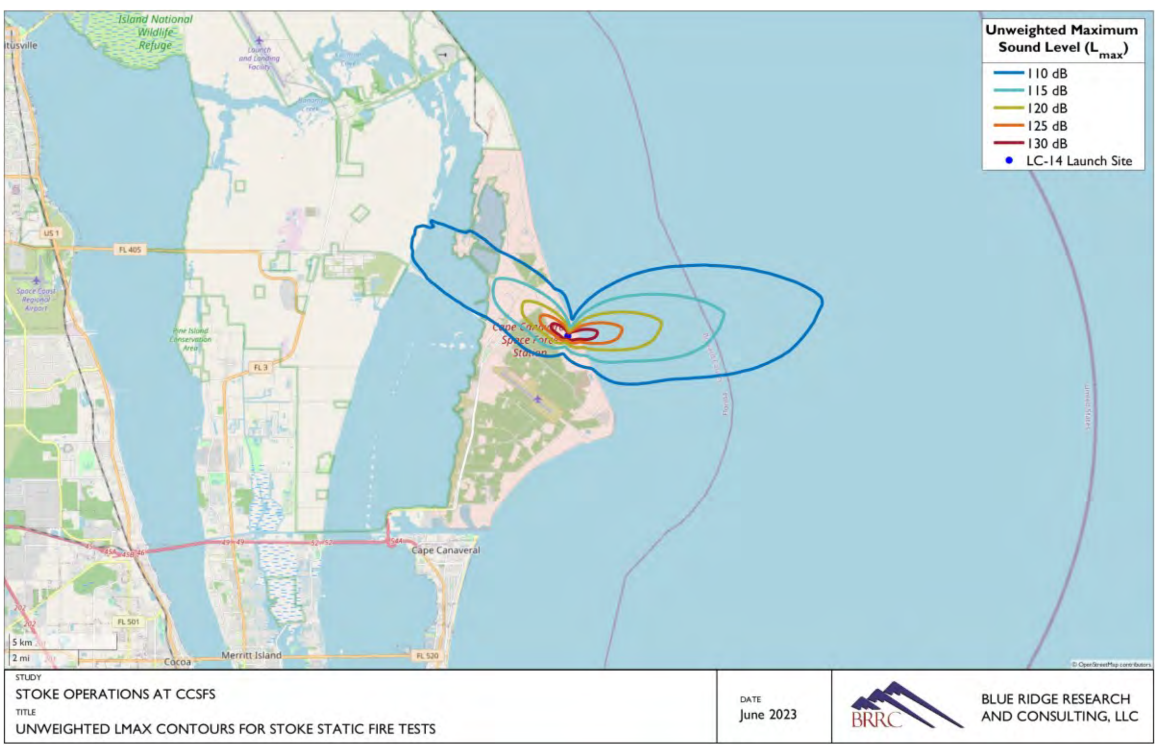

Figure 7. L_{max} contours for Stoke static fire tests.

A-weighted Sound Exposure Level

The modeled A-weighted sound exposure level (SEL) contours are presented for Stoke launch and static fire operations in Figure 8 and Figure 9, respectively.

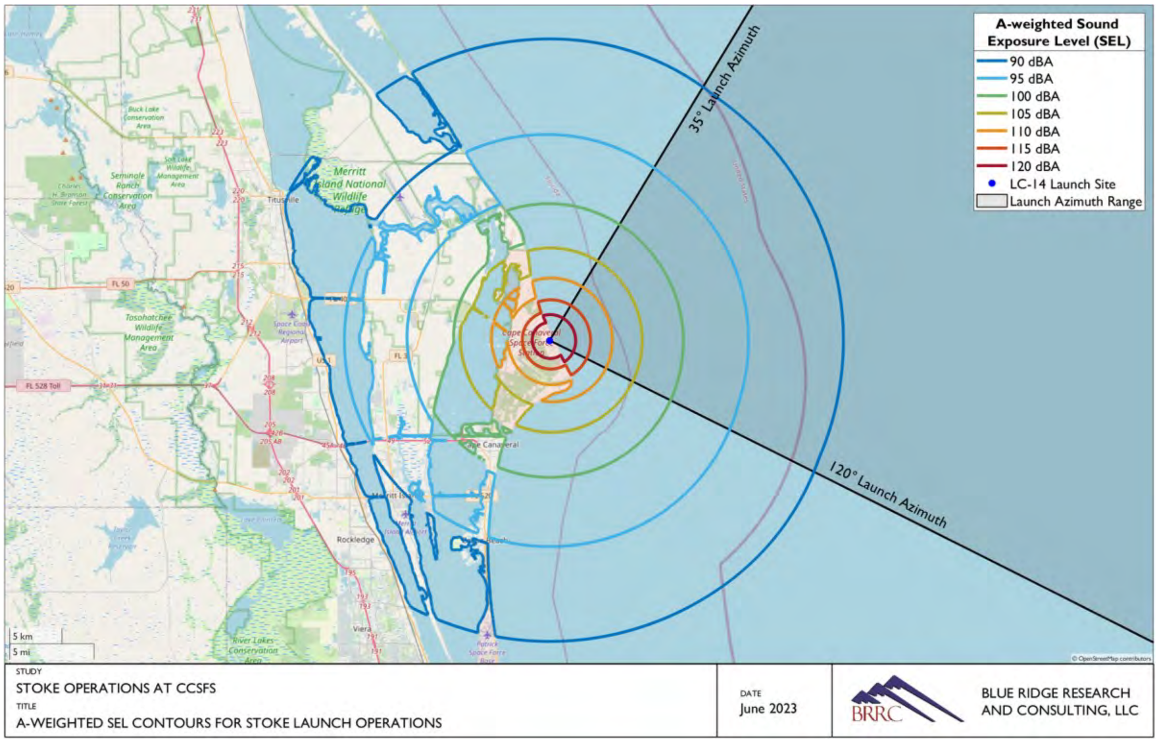

Figure 8. SEL contours for Stoke launch operations over the azimuth range (35° - 120°).

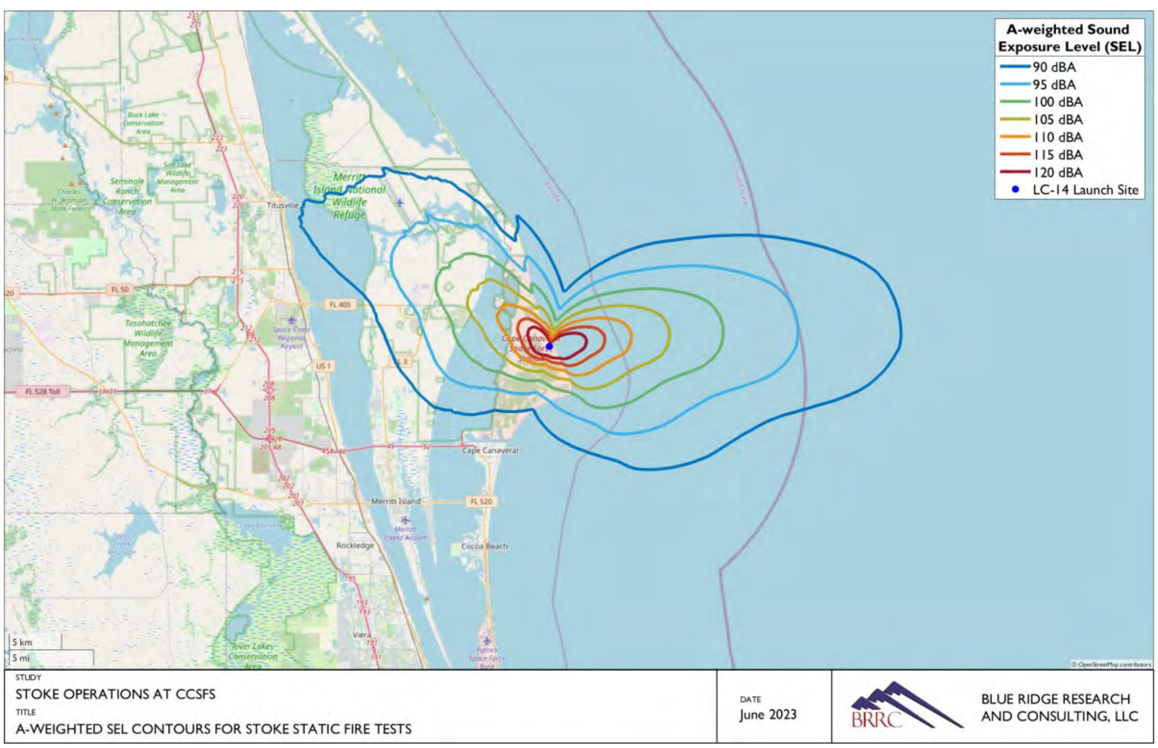

Figure 9. SEL contours for Stoke static fire tests (175 seconds).

4.1.2 Propulsion Noise Effects

The modeled noise generated by Stoke operations at LC-14 is presented with respect to three noise effects: annoyance, hearing conservation, and structural damage.

Annoyance

The potential for long-term community annoyance is assessed using DNL for propulsion noise. DNL accounts for the A-weighted SEL of all noise events in an average annual day; and accounts for increased sensitivity during the acoustical nighttime period. The DNL contours from 60 dBA to 85 dBA are presented in Figure 10 for the proposed Stoke operations at LC-14: 18 launch operations and 18 static fire tests.

DNL contours representing the no action alternative at CCSFS are unavailable, thus, an alternative technique is used to identify the potential for significant noise impacts. The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts, as 60 dBA is the smallest level that could increase noise by DNL 1.5 dBA or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dBA noise exposure level, or that will be exposed at or above this level due to the increase. The DNL 65 and 60 dBA contours do not encompass any land area outside of CCSFS boundaries, and thus no residences are impacted.

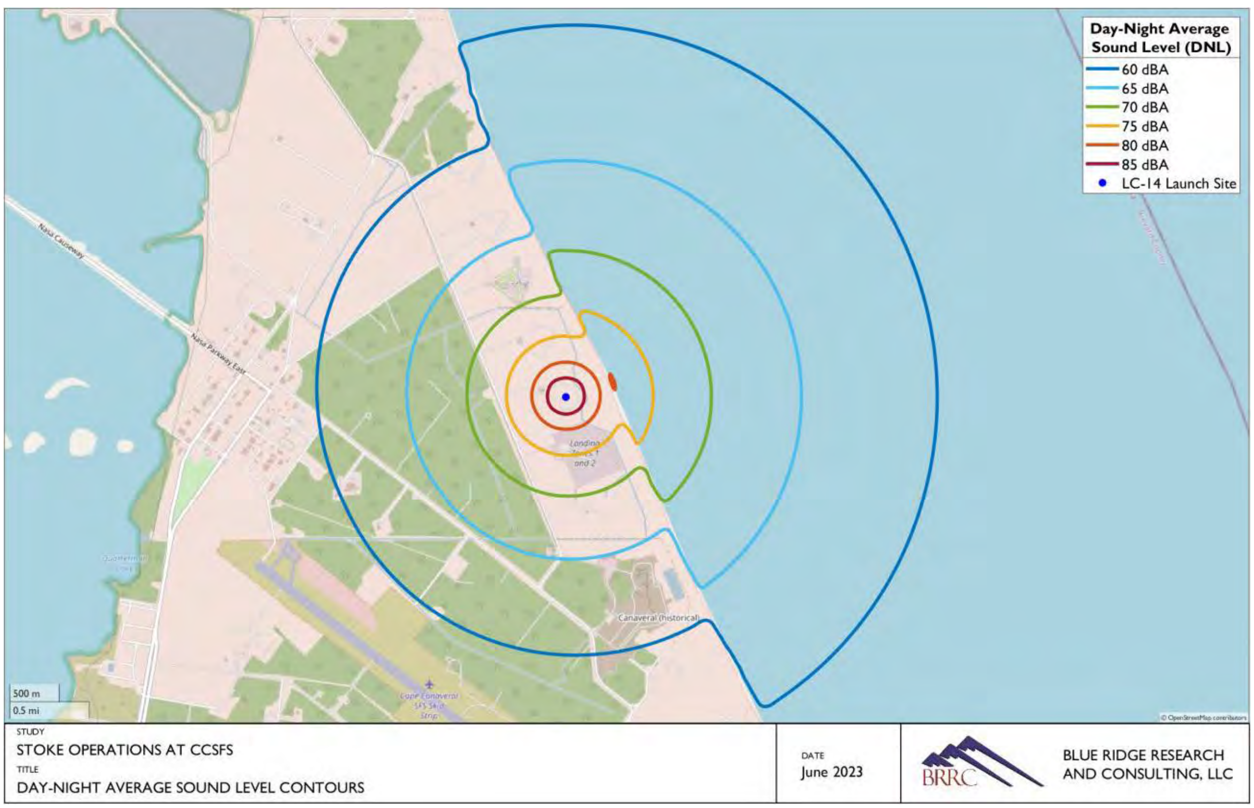

Figure 10. DNL contours for Stoke operations at LC-14.

Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. The most conservative upper noise level limit is the OSHA standard, which specifies that exposure to continuous steady-state noise is limited to a maximum of 115 dBA. The $L_{A,max}$ 115 dBA contour can be used to identify potential locations where hearing protection should be considered for rocket operations. In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). The modeled allowable daily noise dose contours and the $L_{A,max}$ 115 dBA contour associated with Stoke launch and static fire operations at LC-14 are presented in Figure 11 and Figure 12, respectively.

The modeled Stoke launch operations generate levels on land that are at or above an $L_{A,max}$ of 115 dBA within 0.56 miles of LC-14. The modeled Stoke static fire noise contours are more directive than the launch noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located on land along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.4 miles of LC-14 for static fire tests. Note, the levels produced by static fire tests will remain constant over the duration of the event, whereas the levels produced by launch operations will decrease as the rocket moves further away from the receptor. The entire land area encompassed by the 115 dBA noise contours is within the boundaries of CCSFS. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a single Stoke operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

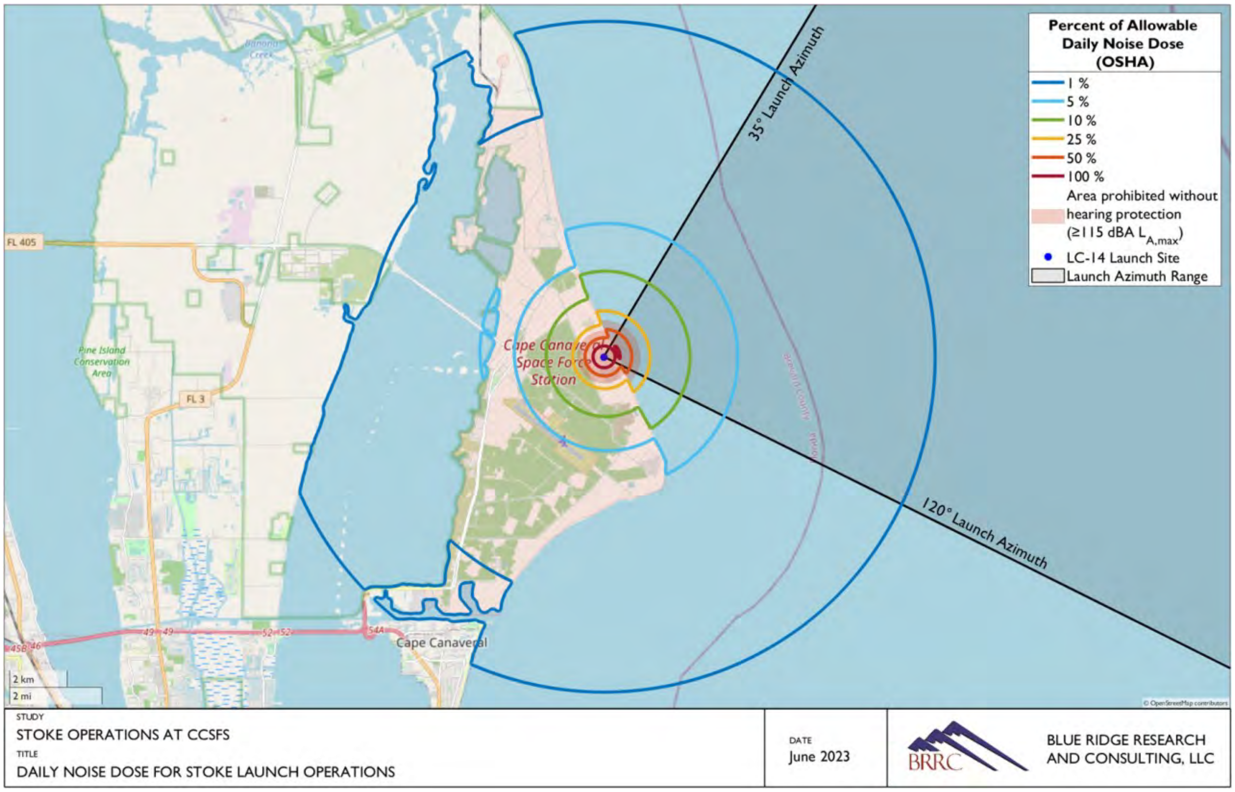

Figure 11. Allowable daily noise dose contours for Stoke launch operations over the azimuth range (35° - 120°).

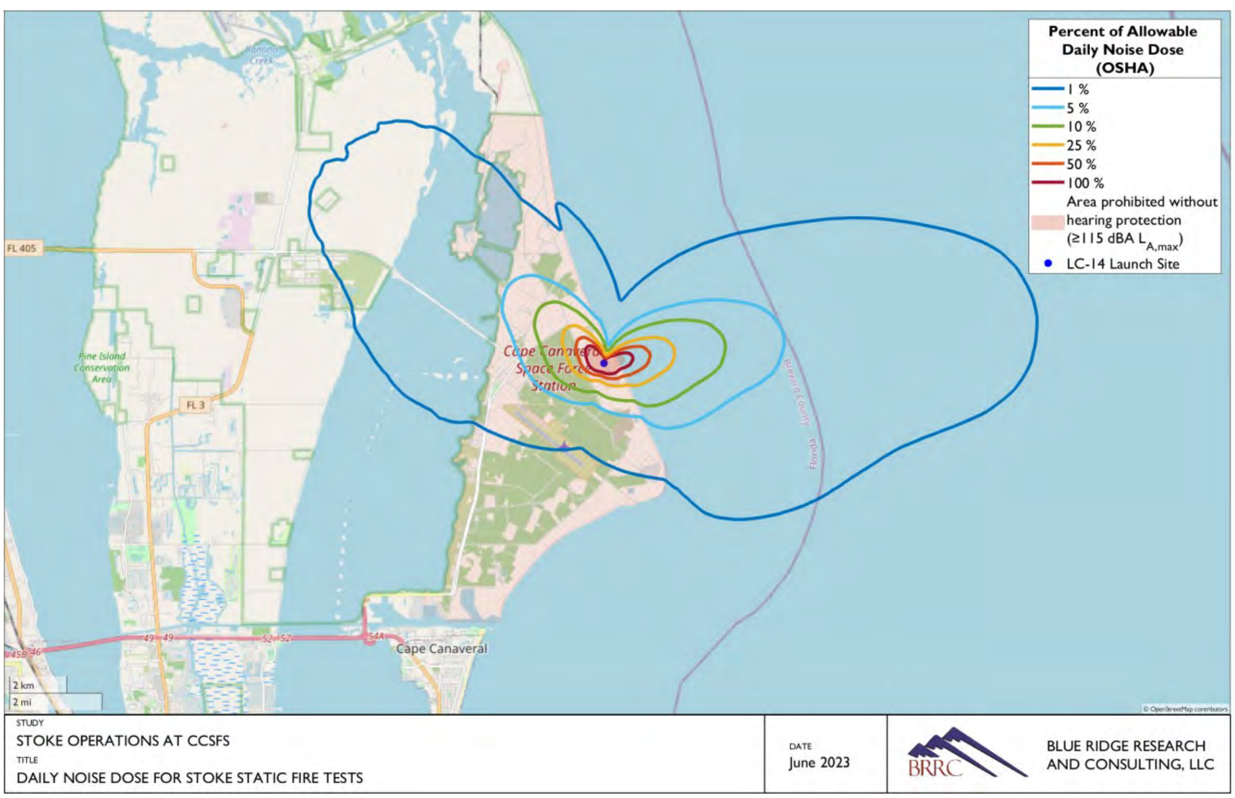

Figure 12. Allowable daily noise dose contours for Stoke static fire tests.

Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element. A NASA technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB and one in 1,000 households exposed to 111 dB. L_{max} values of 120 dB and 111 dB are used in this report as conservative thresholds for potential risk of structural damage claims. The contours associated with 1:1,000 damage claims (111 dB) and 1:100 damage claims (120 dB) for Stoke launch and static fire operations are presented in Figure 13 and Figure 14, respectively. Both the 1:1,000 and 1:100 damage claims contours do not encompass any land area outside of CCSFS and Kennedy Space Center (KSC) boundaries.

The L_{max} value of 130 dB is used to further assess potential impacts to structures based on a report from the National Research Council which states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. The 130 dB L_{max} contours do not include any land area outside of CCSFS boundaries.

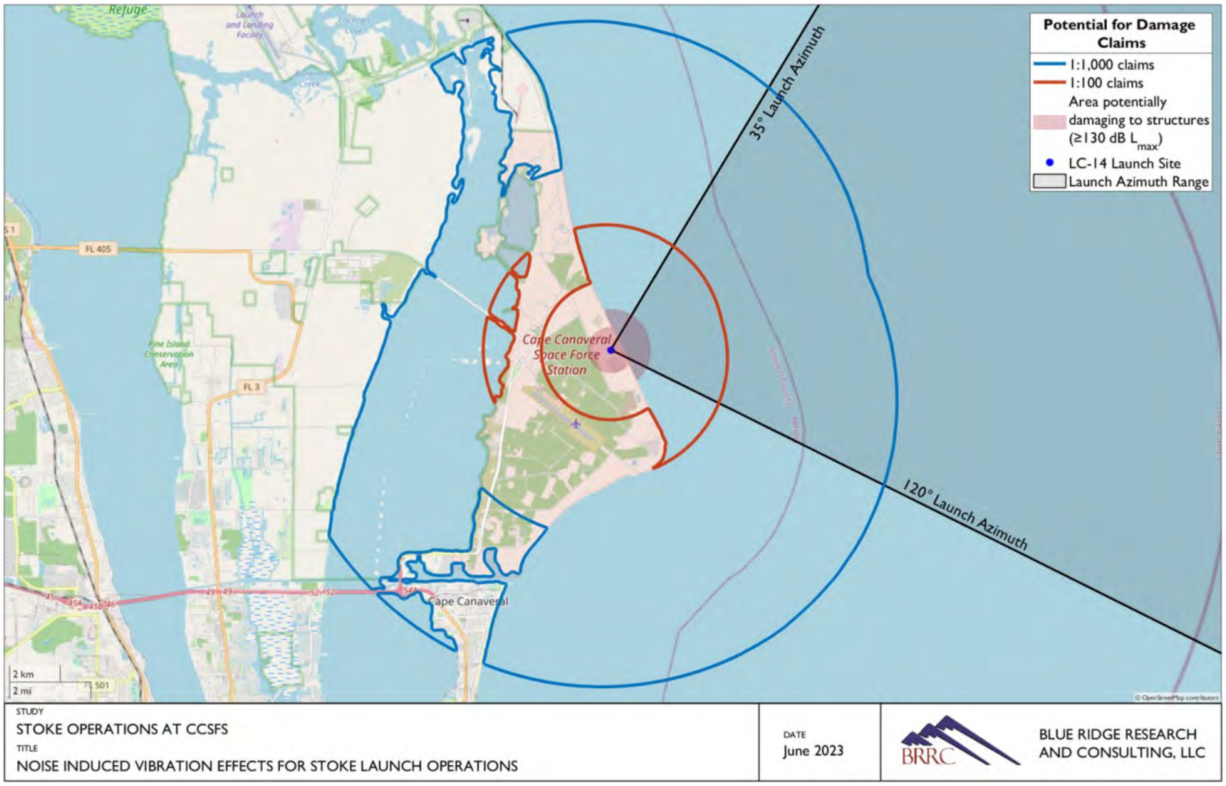

Figure 13. Potential for damage claims contours for Stoke launch operations over the azimuth range (35° - 120°).

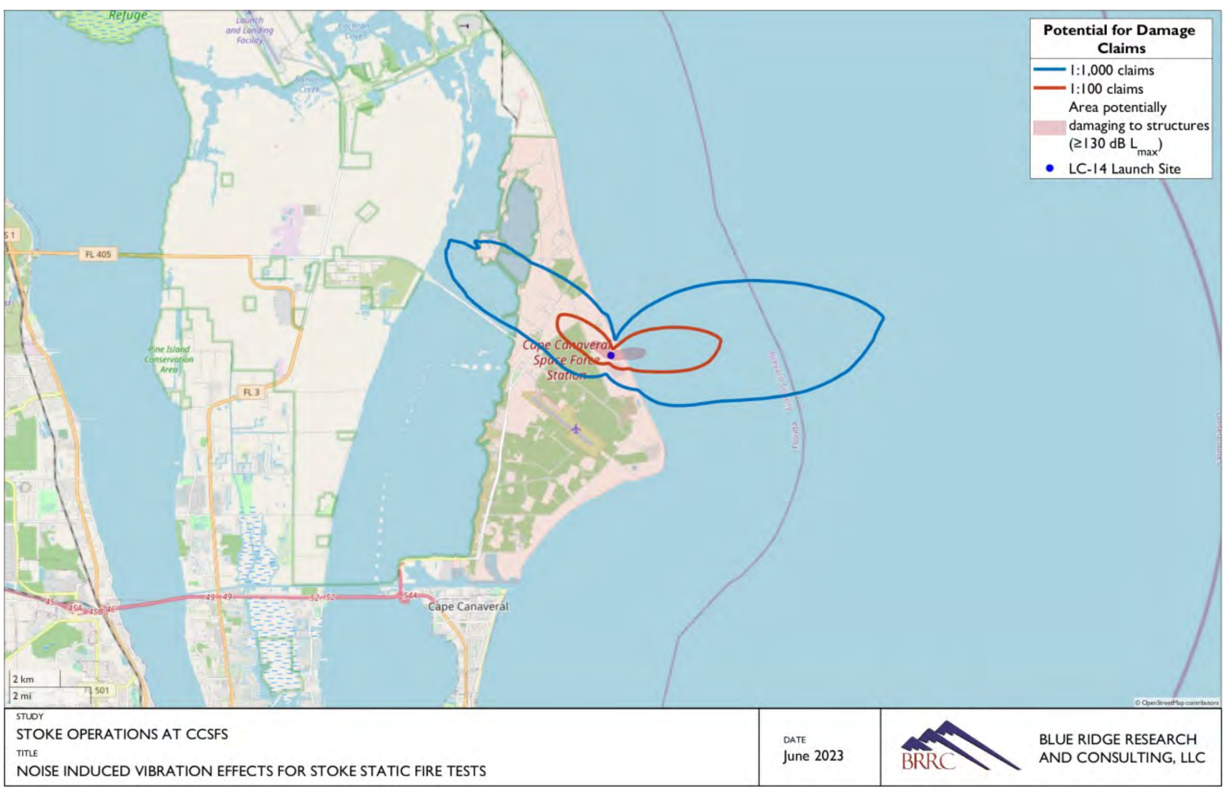

Figure 14. Potential for damage claims contours for static fire tests.

4.2 Sonic Boom Results

Sonic booms generated by Stoke launch operations from LC-14 were modeled using PCBoom 6.7b (see Appendix C.2). The modeled peak overpressure levels of sonic booms from Stoke launch operations are described in Section 5.1. The potential sonic boom impacts from Stoke launch operations are negligible as the sonic booms for these events are entirely over water and thus, will not affect any people or structures.

4.2.1 Sonic Boom Peak Overpressure Levels

The location and intensity of the sonic boom footprint produced by Stoke launch operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. Figure 15 presents the Stoke launch sonic boom contours modeled for a nominal due-east launch azimuth. A summary of the modeled results is detailed below.

The modeled sonic boom begins approximately 49 miles downrange of LC-14 with a narrow, forward-facing crescent shaped focus boom region. The maximum modeled peak overpressures occur within this focus boom region. Figure 15 presents peak overpressure contours up to 4 psf, although higher peak overpressure levels up to 6 psf are modeled to occur over smaller areas along the focus line. The focus boom region is generated when the vehicle continuously accelerates and pitches downward as it ascends. As the vehicle continues to ascend, the sonic boom levels decrease, and the crescent shape becomes slightly longer and wider.

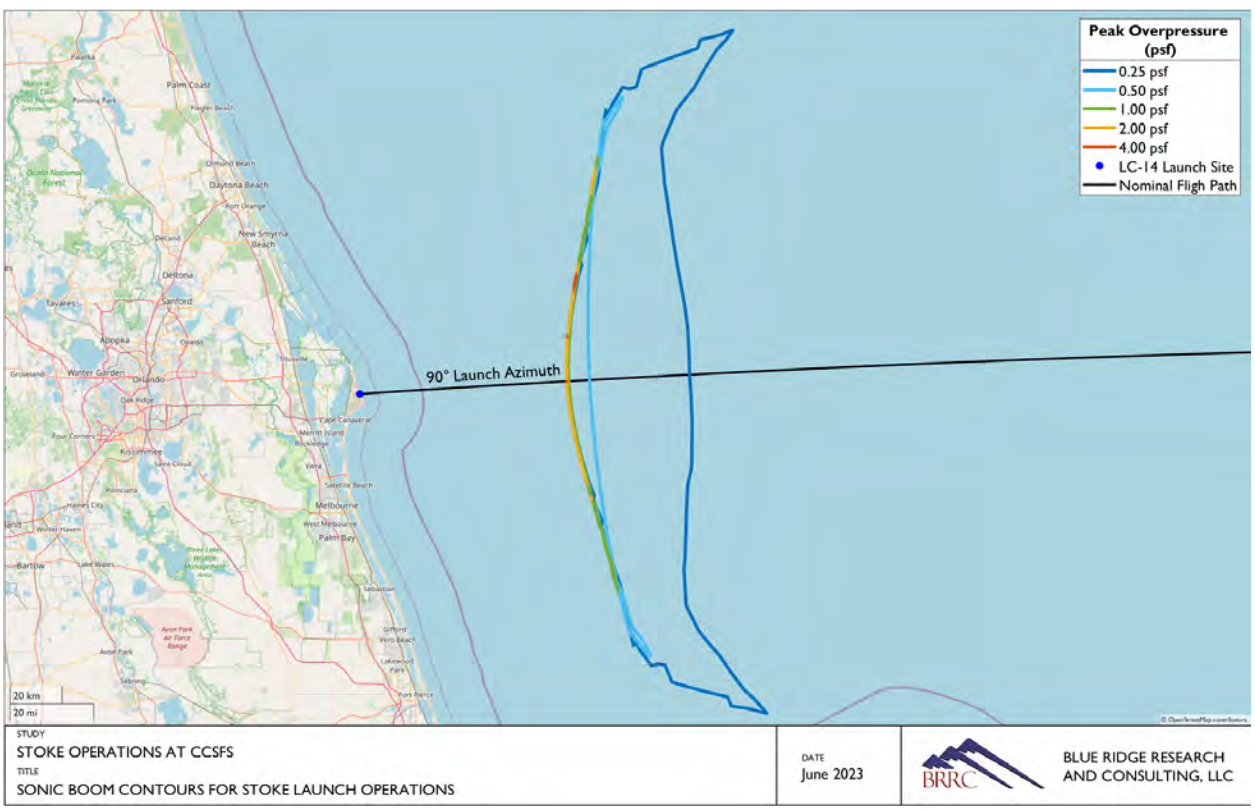

Figure 15. Sonic boom peak overpressure contours for a nominal due-east launch azimuth.

Figure 16 illustrates the sonic boom contours at the extents of the launch azimuth range (35° to 120°) and shows the area potentially exposed to peak overpressures greater than 0.25 psf from this range of launch azimuths. Sonic booms with peak overpressures greater than 0.25 psf from Stoke launch operations are modeled to occur entirely over the Atlantic Ocean.

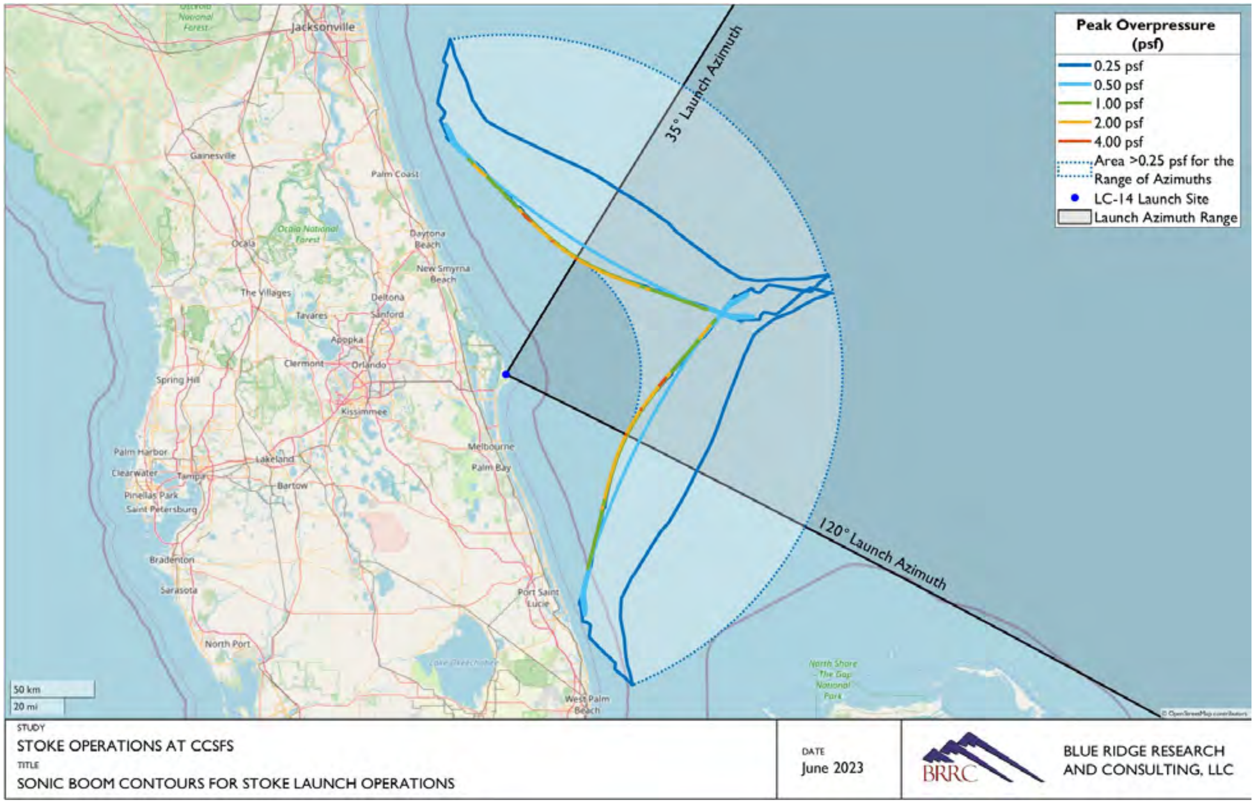

Figure 16. Sonic boom peak overpressure contours for Stoke launch operations over the azimuth range (35° - 120°).

5 SUMMARY

This report documents the noise and sonic boom study performed to support Stoke's environmental review of their launch and static operations at CCSFS LC-14. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

Propulsion Noise Results

The discussion of potential propulsion noise impacts from Stoke operations at LC-14 is summarized for the launch and static fire operations.

- **Annoyance:** The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts resulting from the propulsion noise generated by Stoke operations at LC-14. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundary of CCSFS, and, thus, no residences are impacted.
- **Hearing Conservation:** An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The entire land area encompassed by the 115 dBA Stoke noise contours is within CCSFS boundaries. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a Stoke launch or static fire operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.
- **Structural Damage:** The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [3]. The 120 dB and 111 dB contours do not encompass any land outside of CCSFS and KSC boundaries.

Sonic Boom Results

The potential sonic boom impacts from Stoke launch operations are negligible as the sonic booms are modeled to be entirely over water and thus, will not affect any people or structures.

APPENDIX A BASICS OF SOUND

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [48].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [49].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50 \text{ dB} + 50 \text{ dB} = 53 \text{ dB, and } 70 \text{ dB} + 70 \text{ dB} = 73 \text{ dB.}$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0 \text{ dB} + 60.0 \text{ dB} = 60.4 \text{ dB.}$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [48]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [50].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak overpressure. The peak overpressure is normally described in units of pounds per square foot (psf). The amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [51].

Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 17, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound.

Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and they can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds. Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.

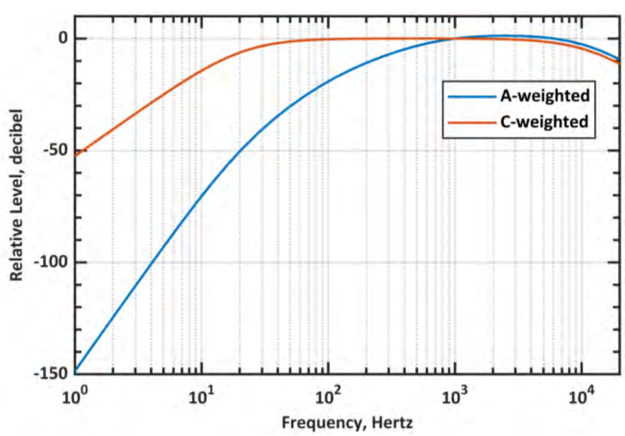

Figure 17. Frequency adjustments for A-weighting and C-weighting. [52]

Duration

The third principal physical characteristic involved in the measurement and human perception of sound is duration, which is the length of time the sound can be detected. Sound sources can vary from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second. A variety of noise metrics have been developed to describe noise over different time periods (See Appendix B).

Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sound sources [53] is shown in Figure 18. Some sources, like the air conditioners and lawn mower, are continuous sounds whose levels are constant for a given duration. Some sources, like the ambulance siren and motorcycle, are the maximum sound during an intermittent event like a vehicle pass-by. Other sources like "urban daytime" and "urban nighttime" (not shown in Figure 18) are averages over extended periods [54]. Per the United States Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [55].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 19. For example, thunder overpressure resulting from lightning strikes at a distance of one kilometer (0.6 miles) is estimated to be near two psf, which is equivalent to 134 dB [56].

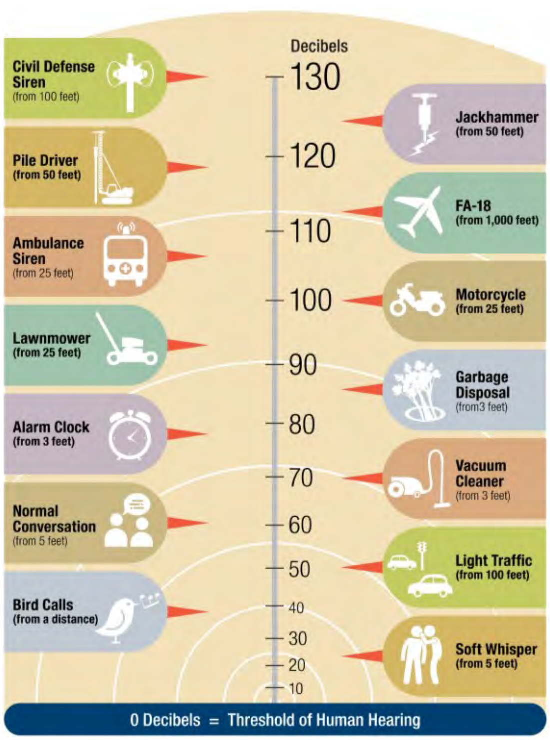

Figure 18. Typical A-weighted levels of common sounds. [57]

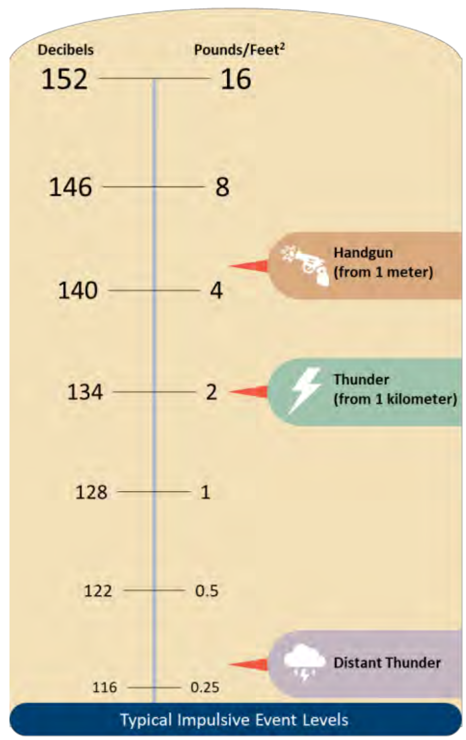

Figure 19. Typical impulsive event levels. [56]

APPENDIX B NOISE METRICS

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

Maximum Sound Level

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

Sound Exposure Level

Sound exposure level (SEL) is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event. For sounds that typically last more than one second, the SEL is usually greater than the L_{max} because a single event takes seconds and the maximum sound level (L_{max}) occurs instantaneously. A-weighted sound exposure level is abbreviated as ASEL.

Day-Night Average Sound Level and Community Noise Equivalent Level

Day-Night Average Sound Level (DNL) is a cumulative metric that accounts for the SEL of all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events. Legislation in the state of California uses the Community Noise Equivalent Level (CNEL), a variant of the DNL. In addition to the 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period, the CNEL includes a ~4.8 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 10:00 PM) to account for decreased community noise during this period. DNL and CNEL do not represent a level heard at any given time but represent long term exposure to noise.

Peak Overpressure

For impulsive sounds, the true instantaneous peak sound pressure level (L_{pk}), which lasts for only a fraction of a second, is important in determining impacts. The peak overpressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

APPENDIX C MODELING METHODS

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section C.1 and C.2, respectively.

C.1 Propulsion Noise Modeling

Rocket propulsion systems, such as solid-propellant motors and liquid-propellant engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

RUMBLE 4.1, the Rocket Propulsion Noise and Emissions Simulation Model, developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 20 and are described in the following subsections.

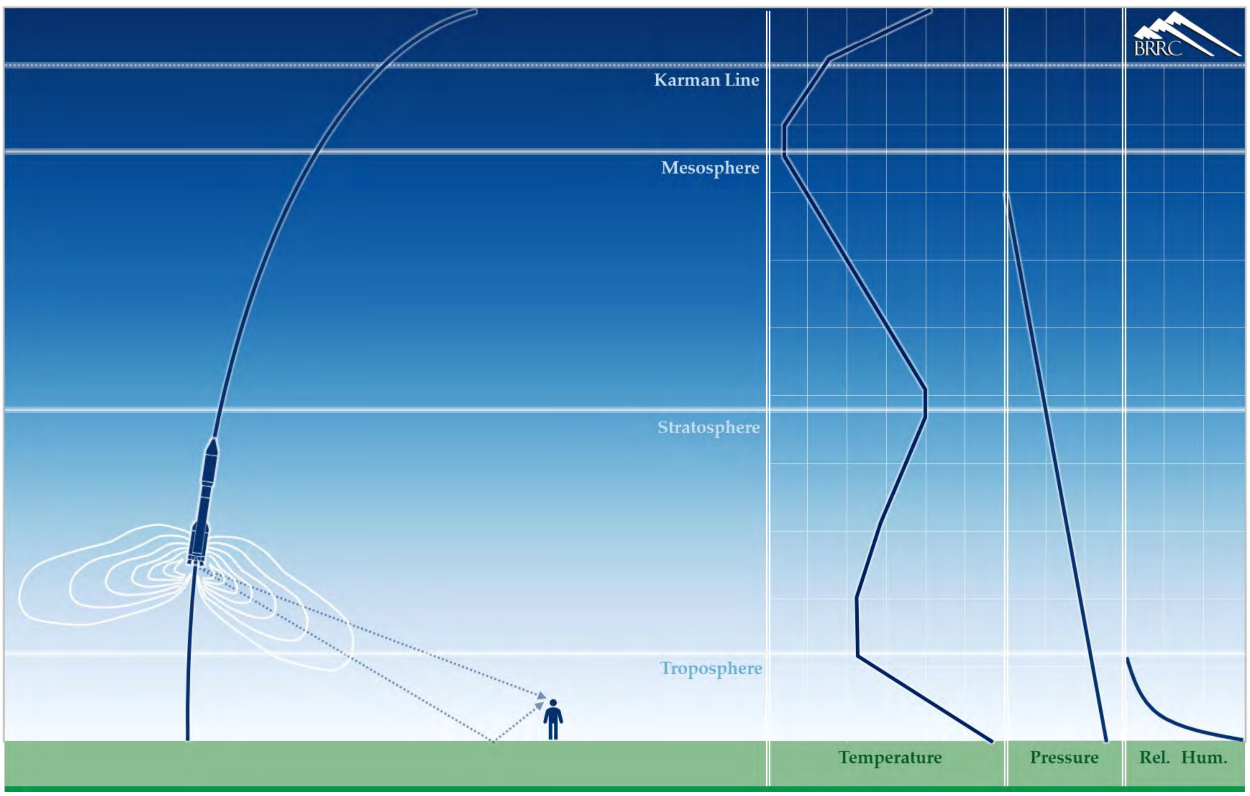

Figure 20. Conceptual overview of rocket noise prediction model methodology.

C.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [14] is utilized for the source characterization. The DSM-1 model determines the vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [15]. The acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [16]. Typical acoustic efficiency values range from 0.2% to 1.0% [14]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [14]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [17-20]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining the directivity of rockets [21]. These directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the NASA DI [22] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver and is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases.

C.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The rocket propulsion noise model components are calculated based on the specific geometry between source (vehicle trajectory point) to receiver (grid point). The position of the vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [23-26] were used to create a composite atmospheric profile for altitudes up to 66 miles. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [27] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [28, 29]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [30-36], but the standard acoustical metrics are not strongly influenced by nonlinear effects [37, 38]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 20. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [39, 40] when estimating the received noise. The model assumes a five-foot receiver height and a variable ground impedance to account for grass (soft) or water (hard) ground surfaces. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [39, 41].

C.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output. If a range of launch azimuths is being considered, the received noise represents the highest metric level generated from any launch azimuth within that range. For example, the noise metric level at a single receiver is modeled for every possible launch azimuth within the specified range, and the maximum of the range of levels is stored for the single receiver. This process is repeated for each receiver in the defined grid, and noise metric contours are developed from the grid of receivers.

C.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section C.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section C.2.2.

C.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter "N," so a sonic boom pressure wave is usually called an "N-wave." An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 21 shows the generation and evolution of a sonic boom N-wave under the vehicle.

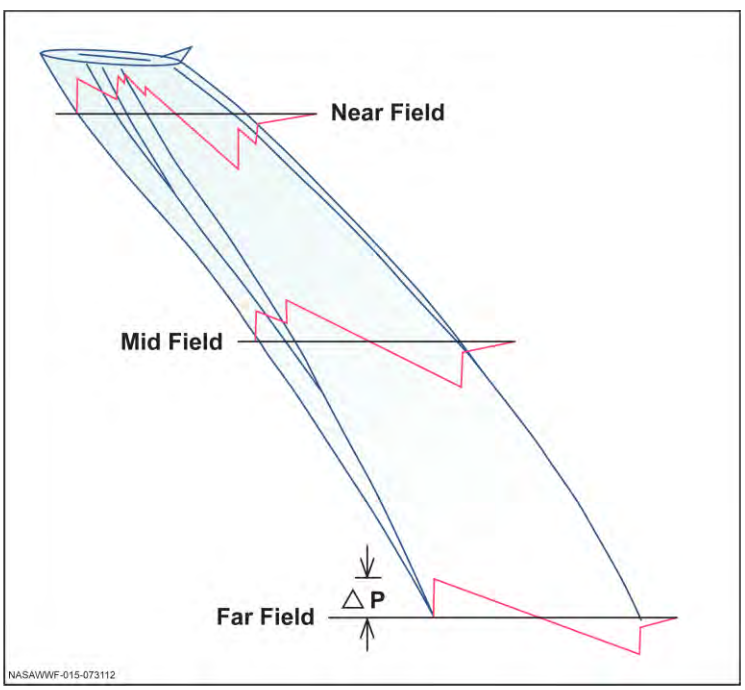

Figure 21. Sonic boom generation and evolution to N-wave. [42]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 22 shows the sonic boom wave cone generated by a vehicle in steady (non-accelerating) level supersonic flight. The wave cone extends toward the ground and is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing levels as the lateral distance increases to the cut-off edge of the "carpet."

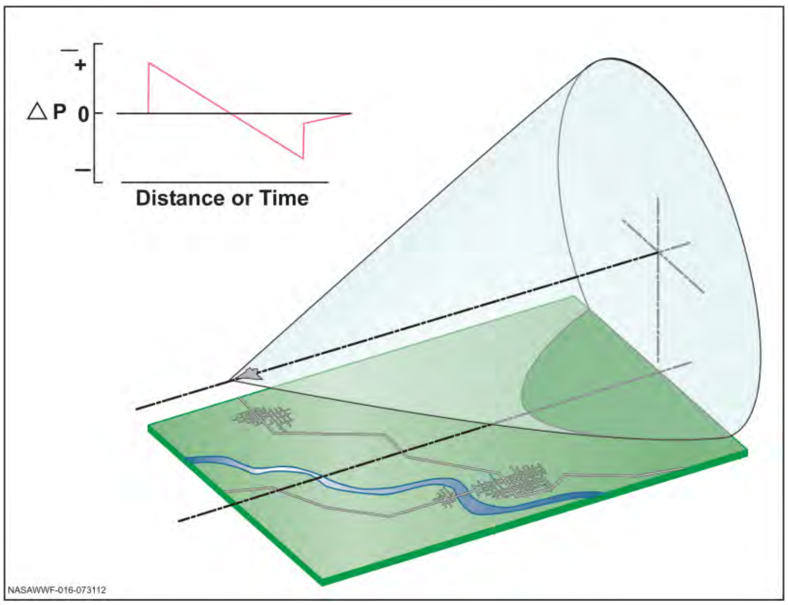

Figure 22. Sonic boom carpet for a vehicle in steady flight. [43]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [44]. Both perspectives are shown in Figure 23. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [44]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an "isopemp." The isopemp is forward-facing [as shown in Figure 23] and falls a distance ahead of the vehicle called the "forward throw." At each new point in the trajectory, a new ray cone is generated, resulting in a new isopemp that strikes the ground. These isopemps are generated throughout the trajectory, sweeping out an area called the "boom footprint."

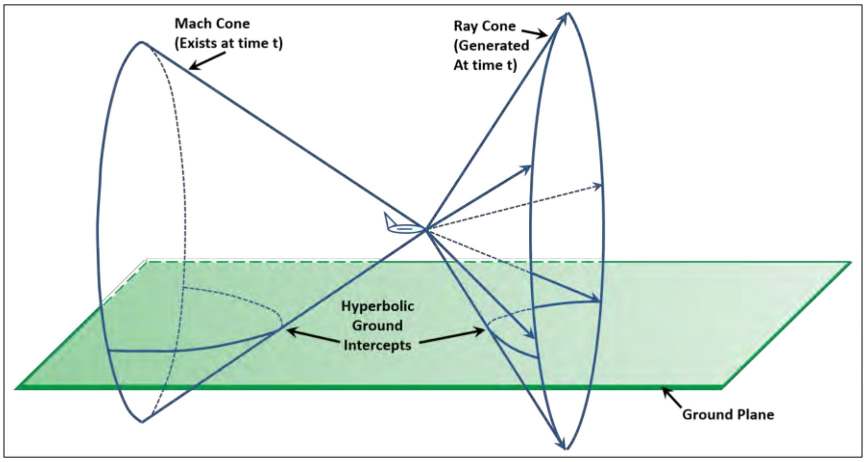

Figure 23. Mach cone vs ray cone viewpoints.

Figure 22 and Figure 23 may give the impression that the boom footprint is generally associated with rays generated from the bottom of a vehicle. This is the case for vehicles at moderate climb and dive angles, or in level flight as shown in Figure 23. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 24, rays from that part of its trajectory will not reach the ground. This is important for vertical launches, where the ascent stage of a launch vehicle typically begins at a steep angle. In these cases, sonic booms are not expected to reach the ground unless refracted back downwards by gradients in the atmosphere. Conversely, if a vehicle is in a sufficiently steep dive, such as in the right image of Figure 24, the entire ray cone may intersect the ground, resulting in an elliptical or even circular isopemp. This is of importance for space flight reentry analysis, where descent may be nearly vertical.

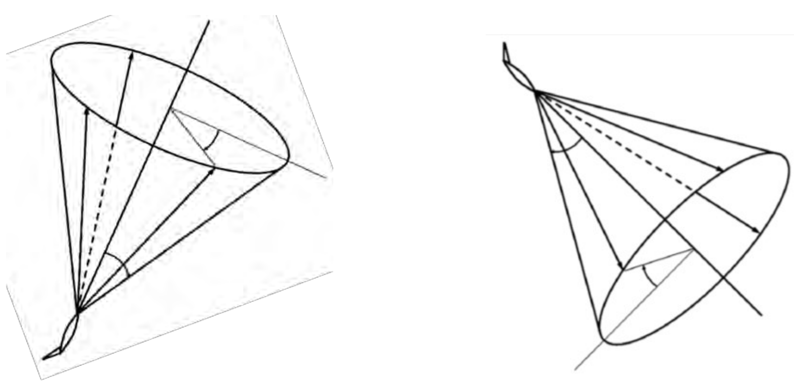

Figure 24. Ray cone in climbing (left) and diving (right) flight.

C.2.2 PCBoom

The single-event prediction model, PCBoom 6.7b [45-47], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, BRRC uses a custom version of PCBoom 6.7b that implements proper plume physics.

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through a site-specific atmospheric profile [26].

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Appendix E. Rocket Emissions Study

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Blue Ridge Research and Consulting, LLC

BRRC Report 23-11 (Final)

Emissions Study for Stoke Operations at CCSFS LC-14

5 June 2023

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Contract Number:
PO-1003221

BRRC
BLUE RIDGE
RESEARCH AND CONSULTING

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1 INTRODUCTION

This report documents the emissions study performed as part of Stoke's efforts on the Environmental Assessment (EA) for their proposed operations at Cape Canaveral Space Force Station (CCSFS) Launch Complex 14 (LC-14). The first stage of Stoke's launch vehicle (Figure 1) is powered by seven liquid natural gas (LNG) and liquid oxygen (LOX) engines with a combined mass flow rate of 1,026 kilograms per second. Stoke's proposed operations at LC-14 include 18 annual easterly launch operations and 18 pre-launch static fire tests.

Figure 1. Conceptual rendering of the Stoke launch vehicle in flight. (Image Credit: Stoke)

This emissions study describes the mass of pollutants generated on an annual basis by Stoke operations at LC-14. The emissions inventories were computed using BRRC's Rocket Noise and Emissions Simulation Model (RUMBLE) Version 4.1 [1]. RUMBLE's emissions modeling methods were developed under the Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP) Project 02-85 and are summarized in Appendix A. For a more detailed description of RUMBLE's formulations, see the TRB ACRP Web-Only Document 51: Commercial Space Vehicle Emissions Modeling [2], published by the National Academies Press. In accordance with the Federal Aviation Administration (FAA) regulations [3], the emissions inventory results provide a quantitative, project-specific indication of the magnitude of the proposed operations' potential air quality impact.

The following sections of this report are outlined below.

- Section 2 describes the proposed Stoke operations;
- Section 3 presents the emissions modeling results; and
- Appendix A describes the general methodology of the emissions modeling.

2 STOKE OPERATIONS

Stoke plans to conduct up to 18 launch operations per year from LC-14. Prior to each launch, Stoke will conduct a pre-launch static fire test with a duration up to 175 seconds. Table 1 presents the modeled annual static fire and launch operations. Table 2 presents the engine modeling data for a nominal configuration of the Stoke launch vehicle. The first stage of Stoke's launch vehicle (Figure 1) is powered by seven liquid natural gas (LNG) and liquid oxygen (LOX) engines with a combined mass flow rate of 1,026 kilograms per second. Note, the emissions modeling of the launch operations uses the time varying mass flow rate profile from the Stoke provided trajectory. Stage separation occurs above the mesosphere; thus the emissions modeling is focused on the first stage of Stoke's launch operations.

Table 1. Proposed Stoke operations at LC-14.

Event	Description	Annual Operations
Static Fire	175 second static fire	18
Launch	Launch from LC-14	18

Table 2. Modeling parameters for the Stoke launch vehicle.

Engine	Propellant	Mass Flow Rate
S1 (Qty. 7)	Liquid Oxygen (LOX) + Liquid Natural Gas (LNG)	146.5 kg/s per engine (1,026 kg/s total)

3 RESULTS

The emissions results are presented in the form of emissions inventories, which enumerate the masses of the various pollutants emitted as a result of the proposed operations. In accordance with FAA guidance [3-5] and the Clean Air Act, the emissions inventories present the relevant criteria air pollutants, hazardous air pollutants (HAPs), and greenhouse gases that could be emitted in each atmospheric layer from the proposed Stoke operations at LC-14. The pollutant masses emitted for these pollutants are presented in metric tons (10^3 kg) per atmospheric layer: troposphere below the mixing height (3,000 feet), troposphere above the mixing height, stratosphere, and mesosphere.

Table 3 presents the duration, propellant burned, and pollutant mass emitted per event in each layer (up to the mesosphere) for each operation type (i.e., static fire and launch). The amount of each pollutant emitted into each atmospheric layer is directly related to the amount of propellant burned in each layer. While the pollutants emitted by static fire tests are confined to the troposphere below 3,000 feet, the launch operations emit pollutants in all layers.

Carbon dioxide (CO_2) and water vapor (H_2O) are the pollutants emitted in the greatest quantities because they are the products of complete combustion between oxygen and the rocket propellant. However, the combustion process in a rocket engine/motor is typically incomplete. Carbon monoxide (CO) and a small amount of black carbon (BC) are emitted due to incomplete combustion inside the rocket engine. BC, commonly known as soot, is the only significant source of particulate matter (PM) emitted by liquid rocket engines. Furthermore, nitrogen oxides (NO_x) are emitted due to afterburning between the extremely high-temperature exhaust plume and nitrogen from the surrounding air. No alumina (Al_2O_3) or chlorine species (Cl_x) are emitted because the propellant does not include aluminum or chlorine compounds. Sulfur dioxide (SO_2) emissions are negligible because sulfur impurities occur in extremely low concentrations in rocket propellants. Additionally, volatile organic compounds (VOCs) are not typically emitted by launch vehicles. Thus, SO_2 and VOCs are not included in the emissions inventories presented below.

The total pollutant mass exceeds the propellant mass because the heated plume reacts with the surrounding air, which adds the mass of molecules from the surrounding air to the pollutants. The amount of each pollutant emitted also varies with altitude due to altitude-dependent chemical processes. At low altitudes, CO is nearly completely oxidized to CO_2 by reactions with oxygen molecules from the surrounding air. However, the rate of oxidation decreases at higher altitudes because fewer oxygen molecules are present in the lower-density air. Thus, the amount of CO increases as altitude increases. Similarly, BC is nearly completely oxidized to CO and CO_2 at low altitudes, but the amount of BC also increases at higher altitudes due to decreasing oxidation. Conversely, since NO_x is formed by afterburning between the high-temperature exhaust plume and nitrogen from the surrounding air, NO_x production decreases with altitude because fewer nitrogen molecules are present in the lower-density air.

Table 3. Duration, propellant burn, and pollutant mass per event for each operation type.

	Duration seconds	Propellant metric tons	Pollutant Mass, metric tons				
			CO_2	H_2O	CO	NO_x	BC
Static Fire							
Troposphere Below 3,000 feet	175	180	109	90	0.24	5.9	0.036
Troposphere Above 3,000 feet	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--
Total	175	180	109	90	0.24	5.9	0.036
Launch							
Troposphere Below 3,000 feet	20	20	12	10	0.028	0.62	0.0041
Troposphere Above 3,000 feet	41	42	25	21	0.077	0.52	0.0083
Stratosphere	64	66	39	33	0.73	0.023	0.11
Mesosphere	32	33	15	16	3.1	<0.01	0.16
Total	157	161	92	80	3.9	1.2	0.28

Table 4 presents the duration, propellant burned, and pollutant mass emitted per year in each atmospheric layer by multiplying the estimates presented in Table 3 by the estimated annual launches for each operation type: 18 static fire test and 18 launch operations.

Table 4. Duration, propellant burn, and pollutant mass per year for each operation type.

	Duration seconds	Propellant metric tons	Annual Pollutant Mass, metric tons				
			CO_2	H_2O	CO	NO_x	BC
Static Fire							
Troposphere Below 3,000 feet	3,150	3,232	1,963	1,615	4.4	106	0.65
Troposphere Above 3,000 feet	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--
Total	3,150	3,232	1,963	1,615	4.4	106	0.65
Launch							
Troposphere Below 3,000 feet	358	367	223	184	0.51	11	0.073
Troposphere Above 3,000 feet	730	749	455	374	1.4	9.4	0.15
Stratosphere	1,160	1,190	705	594	13	0.42	1.9
Mesosphere	572	587	270	293	56	<0.01	2.9
Total	2,820	2,893	1,652	1,446	71	21	5.1

Table 5 and Figure 2 present a summary of the pollutant mass emitted per year in each atmospheric layer from Stoke operations at LC-14 by summing the estimates presented in Table 4 across all static fire tests and launch operations.

Table 5. Annual pollutant mass in metric tons emitted by 18 static fire tests and 18 launches.

	Annual Pollutant Mass, metric tons				
Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC
Troposphere Below 3,000 feet	2,186	1,798	4.9	118	0.72
Troposphere Above 3,000 feet	455	374	1.4	9.4	0.15
Stratosphere	705	594	13	0.42	1.9
Mesosphere	270	293	56	< 0.01	2.9
Total	3,616	3,060	75	127	5.7

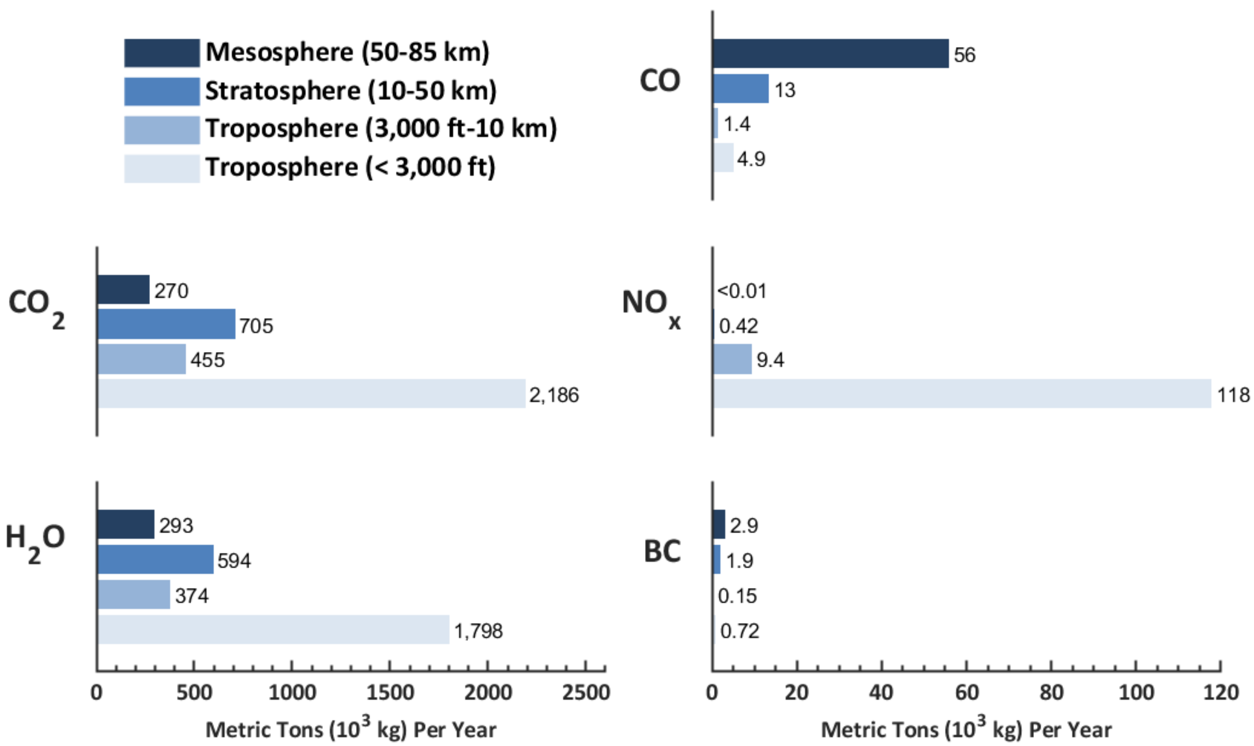

Figure 2. Annual pollutant mass in metric tons emitted by 18 static fire tests and 18 launches.

APPENDIX A EMISSIONS MODELING

RUMBLE 4.1, the Launch Vehicle Noise and Emissions Simulation Model developed by Blue Ridge Research and Consulting, LLC (BRRC), was the model used to predict the emissions associated with the proposed operations. Development of the RUMBLE emissions model was funded by FAA under Airport Cooperative Research Program (ACRP) Project 02-85 [2], administered by the Transportation Research Board (TRB), a unit of the National Academies of Sciences, Engineering, and Medicine. The RUMBLE emissions modeling methodology was developed to produce accurate emissions estimates relevant to environmental analysis of commercial space operations. The model is applicable to inflight and static operations of vertical and horizontal launch vehicles.

A.1 Emissions Background

Launch vehicle propulsion systems, such as liquid-propellant rocket engines and solid rocket motors, produce emissions through a series of chemical reactions, as shown in Figure 3. First, combustion occurs between the fuel and oxidizer inside the rocket engine. Next, the combustion products expand and accelerate through the nozzle, where additional chemical reactions may occur. Finally, the chemical species in the high-temperature exhaust plume may continue to react with each other and the surrounding air in a process called afterburning.

The combustion products present at the nozzle exit plane are called the *primary emissions* of the rocket engine. The products formed by afterburning and other reactions in the high-temperature exhaust plume are referred to as *secondary emissions*. The chemical species emitted into the atmosphere after the rocket has passed by and the exhaust plume has cooled to the ambient temperature include contributions from both the primary and secondary emissions. RUMBLE is designed to estimate these *final emissions* since they are the chemical species that the vehicle ultimately emits into the atmosphere.

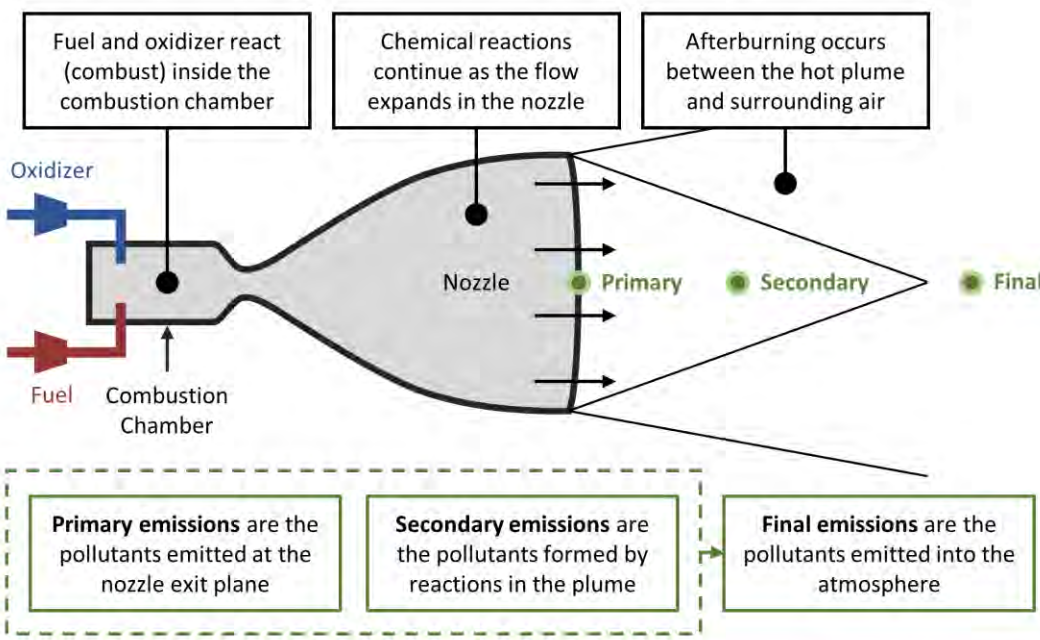

Figure 3. Diagram of the chemical processes in a rocket engine that produce the primary, secondary, and final emissions.

A.2 Emissions Modeling Methodology

The RUMBLE emissions model calculates the mass of each pollutant emitted by commercial space operations. The calculations are first performed at the most detailed level (i.e. individual trajectory segment), and the results are aggregated to produce the propellant burn report and emissions inventory.

First, the propellant mass burned by a single engine during an individual trajectory segment is calculated by

$$\begin{bmatrix}\text{Propellant}\\ \text{Mass}\end{bmatrix} = \begin{bmatrix}\text{Propellant}\\ \text{Mass Flow Rate}\end{bmatrix} \times \begin{bmatrix}\text{Segment}\\ \text{Duration}\end{bmatrix}$$

where the duration of the trajectory segment is the time between successive points in the trajectory.

Next, the mass of each pollutant emitted by a single engine during an individual trajectory segment is calculated by

$$\begin{bmatrix}\text{Pollutant}\\ \text{Mass}\end{bmatrix} = \begin{bmatrix}\text{Emissions}\\ \text{Index}\end{bmatrix} \times \begin{bmatrix}\text{Propellant}\\ \text{Mass}\end{bmatrix}$$

The emissions indices are the factors that relate the amount of propellant burned to the amount of each pollutant emitted by the engine. Emissions indices are discussed in more detail in Section A.3.

The main output of the RUMBLE emissions model is the emissions inventory. The emissions inventory enumerates the masses of the various pollutants emitted as a result of commercial space operations. RUMBLE aggregates the detailed pollutant mass calculations over the number of engines, trajectory segments, and operations to compute the total amount of each pollutant emitted. In accordance with FAA guidelines, RUMBLE reports the emissions inventory in the troposphere below and above the mixing height (3,000 feet), the stratosphere, and the mesosphere.

A.3 Emissions Indices

RUMBLE uses emissions indices to estimate the total amounts of the various pollutants emitted by space vehicles. Emissions indices are the factors that relate the amount of propellant burned to the amount of each pollutant emitted by a rocket engine. The emissions index for a specific pollutant reports the outcome of the complex series of chemical reactions that occur within the rocket engine and exhaust plume as a single number.

Primary Emissions Indices

The primary emissions are the chemical species present at the nozzle exit plane due to processes that occur inside the rocket engine. The primary emissions indices were predicted using the computer program Chemical Equilibrium with Applications (CEA) [4, 5]. CEA was developed at the NASA Glenn Research Center for the purpose of calculating the chemical equilibrium composition and thermodynamic properties of any chemical system.

A key application of CEA is the prediction of theoretical rocket engine performance and emissions. To predict rocket engine emissions, CEA requires the propellant (fuel and oxidizer) species, mixture ratio, combustion chamber pressure, and nozzle area ratio as input parameters.

Using these vehicle-specific input parameters, CEA performs calculations at several locations inside the rocket engine, including the combustion chamber, throat, and nozzle exit plane. The results at each location include the chemical composition, which is reported in terms of mole fractions or mass fractions of the combustion products. The mass fractions at the nozzle exit plane are directly proportional to the primary emissions indices.

Final Emissions Indices

However, the primary emissions indices at the nozzle exit plane are not the final emissions indices used in the emissions model. The chemical species in the high-temperature exhaust plume outside the rocket engine may continue to react with each other and with the surrounding air to produce secondary emissions. These secondary emissions modify and add to the final pollutant species that the rocket ultimately emits into the atmosphere. The formation of secondary emissions in the exhaust plume is a complex process involving finite-rate chemical kinetics, non-isentropic shocks and expansion waves, and turbulent dispersion. Prior studies have shown that the formation of secondary emissions depends most strongly on the chemical composition of the rocket exhaust plume and the altitude. Estimates for the secondary emissions from commercial space vehicles were developed under ACRP Project 02-85 [2]. RUMBLE implements these estimates to calculate the final emissions indices based on the primary emissions indices computed by CEA and the altitude from the nominal trajectory.

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Appendix F. ACAM

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Table F-1
Emissions by Activity Type

	CO (tons/yr)	NO_X (tons/yr)	SO_X (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	VOC (tons/yr)	CO_2 (metric tons/yr)	CH_4 (metric tons/yr)	N_2O (metric tons/yr)	CO_2e (metric tons/yr)
Construction Activities (total)	**16.08**	**12.37**	**0.03**	**35.22**	**0.49**	**2.18**	**0.00**	**0.00**	**0.00**	**0.00**
2024 (peak year)	*11.72*	*9.12*	*0.02*	*31.59*	*0.36*	*1.11*	-	-	-	-
2025	4.36	3.25	7.0E-03	3.62	0.13	1.07	-	-	-	-
Operational Activities (steady state total)	**6.17**	**72.26**	**1.47E-03**	**0.46**	**0.46**	**0.16**	**2,985**	**1.70**	**0.01**	**3,030**
Launch and Static Fire	2.95	71.87	0.00	0.44	0.44	0.00	2,000	0.04	3.9E-03	2,002
Non-road Equipment	1.0E-02	0.04	7.6E-05	1.8E-03	1.7E-03	1.7E-03	27	1.1E-03	2.2E-04	27
Flares	2.39	0.14	-	-	-	-	219	1.65	3.98E-04	261
Paint / Solvent Usage	-	-	-	-	-	0.10	-	-	-	-
Heating	0.15	0.18	1.1E-03	1.4E-02	1.4E-02	1.0E-02	218	4.1E-03	4.1E-03	220
Delivery Vehicles (local)	4.8E-03	7.0E-03	1.1E-05	1.5E-04	1.4E-04	3.3E-04	-	-	-	-
Delivery Vehicles (local and national)	-	-	-	-	-	-	101	1.6E-03	2.8E-04	101
Employee Commutes	0.66	2.4E-02	2.9E-04	6.3E-04	5.5E-04	4.8E-02	57	2.5E-03	9.3E-04	57
Power Usage	-	-	-	-	-	-	362	-	-	362

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform a net change in emissions analysis to assess the potential air quality impact/s associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, *Environmental Compliance and Pollution Prevention*; the *Environmental Impact Analysis Process* (EIAP, 32 CFR 989); the *General Conformity Rule* (GCR, 40 CFR 93 Subpart B); and the *USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide*. This report provides a summary of the ACAM analysis.

Report generated with ACAM version: 5.0.23a

a. Action Location:
Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: Reactivation of Space Launch Complex-14 at Cape Canaveral Space Force Station, Florida

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2024

e. Action Description:

The Proposed Action is to reactivate SLC-14 to support Stoke's launch program, which includes the construction of new facilities, improvements to existing infrastructure, ground support operations, and launch operations.

f. Point of Contact:
Name: Michelle York
Title: Contractor
Organization: Jacobs Engineering
Email: michelle.york@jacobs.com
Phone Number: 360-931-8672

2. Air Impact Analysis: Based on the attainment status at the action location, the requirements of the GCR are:

____ applicable
__X__ not applicable

Total reasonably foreseeable net direct and indirect emissions associated with the action were estimated through ACAM on a calendar-year basis for the start of the action through achieving "steady state" (hsba.e., no net gain/loss in emission stabilized and the action is fully implemented) emissions. The ACAM analysis uses the latest and most accurate emission estimation techniques available; all algorithms, emission factors, and methodologies used are described in detail in the *USAF Air Emissions Guide for Air Force Stationary Sources*, the *USAF Air Emissions Guide for Air Force Mobile Sources*, and the *USAF Air Emissions Guide for Air Force Transitory Sources*.

"Insignificance Indicators" were used in the analysis to provide an indication of the significance of the proposed Action's potential impacts to local air quality. The insignificance indicators are trivial (de minimis) rate thresholds that have been demonstrated to have little to no impact to air quality. These insignificance indicators are the 250 ton/yr Prevention of Significant Deterioration (PSD) major source threshold and 25 ton/yr for lead for actions occurring in areas that are "Attainment" (hsba.e., not exceeding any National Ambient Air Quality Standard (NAAQS)). These indicators do not define a significant impact; however, they do provide a threshold to identify actions that are insignificant. Any action with net emissions below the insignificance indicators for all criteria pollutants is considered so insignificant that the action will not cause or contribute to an exceedance on one or more NAAQS. For further detail on insignificance indicators, refer to *Level II, Air Quality Quantitative Assessment, Insignificance Indicators*.

The action's net emissions for every year through achieving steady state were compared against the Insignificance Indicators and are summarized below.

Analysis Summary:

2024

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	1.110	250	No
NOx	9.119	250	No
CO	11.719	250	No
SOx	0.018	250	No
PM 10	31.593	250	No
PM 2.5	0.361	250	No
Pb	0.000	25	No
NH3	0.024	250	No

2025

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	1.144	250	No
NOx	3.384	250	No
CO	4.795	250	No
SOx	0.008	250	No
PM 10	3.633	250	No
PM 2.5	0.136	250	No
Pb	0.000	25	No
NH3	0.013	250	No

2026 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.155	250	No
NOx	0.206	250	No
CO	0.810	250	No
SOx	0.001	250	No
PM 10	0.014	250	No
PM 2.5	0.014	250	No
Pb	0.000	25	No
NH3	0.007	250	No

None of the estimated annual net emissions associated with this action are above the insignificance indicators; therefore, the action will not cause or contribute to an exceedance of one or more NAAQSs and will have an insignificant impact on air quality. No further air assessment is needed.

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

Michelle York, Contractor	Jan 17 2024
Name, Title	**Date**

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

1. General Information

- Action Location

Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Action Title: Reactivation of Space Launch Complex-14 at Cape Canaveral Space Force Station, Florida

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2024

- Action Purpose and Need:

The purpose of the Proposed Action is to deploy a medium-class space transportation system in direct support of the U.S. Commercial Space Launch Competitiveness Act of 2015 (Public Law 114–90, November 25, 2015) and the USSF's Launch Pad Allocation Strategy (LPAS) (USSF 2022). The Proposed Action is needed to develop a more cost-competitive commercial space launch system to advance U.S. space launch capability, provide redundancy, and ensure the U.S. remains a leader in space launch technology. In so doing, the Proposed Action allows for the continued fulfillment of the National Space Policy (85 Federal Register 81755, 2020) to actively promote the purchase and use of U.S. commercial space goods and services and reduce space transportation costs. The Proposed Action would contribute to meeting the goals of the National Space Transportation Policy (Executive Office of the President, November 21, 2013) and DoD policy pursuant to DoD Directive 3230.3, "DoD Support for Commercial Space Launch Activities" (October 14, 1986).

USSF's federal action would be the leaseholder or license holder for the real property (SLC-14) where the Proposed Action would occur and would be responsible for approving the construction or site modifications. If, after the public's review of the EA, the USSF determines that the Proposed Action would not individually or cumulatively result in significant impacts on the human or natural environments, the USSF would issue a final Finding of No Significant Impact (FONSI).

- Action Description:

The Proposed Action is to reactivate SLC-14 to support Stoke's launch program, which includes the construction of new facilities, improvements to existing infrastructure, ground support operations, and launch operations.

- Point of Contact

Name: Michelle York
Title: Contractor
Organization: Jacobs Engineering
Email: michelle.york@jacobs.com
Phone Number: 360-931-8672

Report generated with ACAM version: 5.0.23a

- Activity List:

	Activity Type	Activity Title
2.	Construction / Demolition	Launch Mount / Pad - Ramp
3.	Construction / Demolition	Launch Mount / Pad - Fixed Interface
4.	Construction / Demolition	Launch Mount / Pad - ECS Building
5.	Heating	ECS Building Heating
6.	Construction / Demolition	Launch Mount / Pad - Deluge Water Tower & System
7.	Construction / Demolition	Tank Farm
8.	Construction / Demolition	Engineering Support Facility - Office Space

9.	Heating	Engineering Support Facility - Office Space
10.	Construction / Demolition	Launch Vehicle Processing - Maintenance Hangar
11.	Heating	Launch Vehicle Processing - Maintenance Hangar
12.	Construction / Demolition	Launch Vehicle Processing - Payload Processing
13.	Heating	Launch Vehicle Processing - Payload Processing
14.	Construction / Demolition	Launch Vehicle Processing - Overflow Storage Building
15.	Construction / Demolition	Asphalt Roadway and Parking Lot
16.	Construction / Demolition	Launch Mount / Pad - Lightning Protection Towers
17.	Construction / Demolition	Pumphouse & All Utilities
18.	Construction / Demolition	Guard Shack
19.	Personnel	Employee Commutes
20.	Degreaser	IPA Use for Payload Processing

Emission factors and air emission estimating methods come from the United States Air Force's Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and Air Emissions Guide for Air Force Transitory Sources.

2. Construction / Demolition

2.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Mount / Pad - Ramp

- Activity Description:
Launch Mount / Pad - Ramp

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 3
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.195182
SO_x	0.003204
NO_x	1.535219
CO	1.974617

Pollutant	Total Emissions (TONs)
PM 10	0.185079
PM 2.5	0.056274
Pb	0.000000
NH_3	0.004284

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.012874
N_2O	0.005331

Pollutant	Total Emissions (TONs)
CO_2	329.674409
CO_2e	331.584114

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)

Pollutant	Total Emissions (TONs)

CH_4	0.012874
N_2O	0.005331

CO_2	329.674409
CO_2e	331.584114

2.1 Demolition Phase

2.1.1 Demolition Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 2
Number of Days: 21

2.1.2 Demolition Phase Assumptions

- General Demolition Information
Area of Building to be demolished (ft^2): 29500
Height of Building to be demolished (ft): 20

- Default Settings Used: Yes

- Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Concrete/Industrial Saws Composite	1	8
Rubber Tired Dozers Composite	1	1
Tractors/Loaders/Backhoes Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.1.3 Demolition Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Concrete/Industrial Saws Composite [HP: 33] [LF: 0.73]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.46984	0.00743	3.74409	4.38122	0.11720	0.10782

Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.40864	0.00491	4.01022	3.25251	0.17852	0.16424
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Concrete/Industrial Saws Composite [HP: 33] [LF: 0.73]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02332	0.00466	574.90465	576.87758
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.20301	534.02939
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

2.1.4 Demolition Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (0.00042 * BA * BH) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
0.00042: Emission Factor (lb/ft^3)
BA: Area of Building to be demolished (ft^2)
BH: Height of Building to be demolished (ft)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment

WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = BA * BH * (1 / 27) * 0.25 * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building being demolish (ft^2)
BH: Height of Building being demolish (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
0.25: Volume reduction factor (material reduced by 75% to account for air space)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.2 Building Construction Phase

2.2.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 3
Start Year: 2024

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Phase Duration
Number of Month: 12
Number of Days: 0

2.2.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 29500
Height of Building (ft): 20
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	6
Forklifts Composite	2	6
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

2.2.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5

Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.54567	0.00793	4.37292	2.88066	0.17997	0.16558
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.53415	0.00735	3.78255	4.55763	0.13078	0.12031

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.03976	528.84843
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02305	0.00461	568.31451	570.26482
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02150	0.00430	529.93313	531.75173
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02305	0.00461	568.28951	570.23973

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

2.2.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)

NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3. Construction / Demolition

3.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Mount / Pad - Fixed Interface

- Activity Description:
Launch Mount / Pad - Fixed Interface

- Activity Start Date
Start Month: 3
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 3
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.066003
SO_x	0.001279
NO_x	0.578972
CO	0.794385

Pollutant	Total Emissions (TONs)
PM 10	0.026440
PM 2.5	0.024321
Pb	0.000000
NH_3	0.001513

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.005838
N_2O	0.001413

Pollutant	Total Emissions (TONs)
CO_2	144.407888
CO_2e	144.974721

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.005838
N_2O	0.001413

Pollutant	Total Emissions (TONs)
CO_2	144.407888
CO_2e	144.974721

3.1 Building Construction Phase

3.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 3

Start Quarter: 3
Start Year: 2024

- Phase Duration
Number of Month: 12
Number of Days: 0

3.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 5400
Height of Building (ft): 10
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

3.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5

Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.03976	528.84843
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

3.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4. Construction / Demolition

4.1 General Information & Timeline Assumptions

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Mount / Pad - ECS Building

- Activity Description:
Launch Mount / Pad - ECS Building

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.209030
SO_x	0.001810
NO_x	0.822844
CO	1.119830

Pollutant	Total Emissions (TONs)
PM 10	0.037308
PM 2.5	0.034317
Pb	0.000000
NH_3	0.002428

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008268
N_2O	0.002745

Pollutant	Total Emissions (TONs)
CO_2	208.304587
CO_2e	209.328818

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008268
N_2O	0.002745

Pollutant	Total Emissions (TONs)
CO_2	208.304587
CO_2e	209.328818

4.1 Building Construction Phase

4.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 16
Number of Days: 24

4.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 10000
Height of Building (ft): 35

Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

4.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

4.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)

2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4.2 Architectural Coatings Phase

4.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 4
Start Year: 2025

- Phase Duration
Number of Month: 1
Number of Days: 4

4.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Total Square Footage (ft^2): 10000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

4.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

5. Heating

5.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: ECS Building Heating

- Activity Description:
ECS Building Heating

- Activity Start Date
Start Month: 5
Start Year: 2025

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.001820
SO_x	0.000199
NO_x	0.033095
CO	0.027800

Pollutant	Emissions Per Year (TONs)
PM 10	0.002515
PM 2.5	0.002515
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.000748
N_2O	0.000748

Pollutant	Emissions Per Year (TONs)
CO_2	39.720574
CO_2e	39.761612

5.2 Heating Assumptions

- Heating
Heating Calculation Type: Heat Energy Requirement Method

- Heat Energy Requirement Method
Area of floorspace to be heated (ft^2): 10000

Type of fuel: Natural Gas
Type of boiler/furnace: Commercial/Institutional (0.3 - 9.9 MMBtu/hr)
Heat Value (MMBtu/ft^3): 0.00105
Energy Intensity (MMBtu/ft^2): 0.0695

- Default Settings Used: Yes

- Boiler/Furnace Usage
Operating Time Per Year (hours): 900 (default)

5.3 Heating Emission Factor(s)

- Heating Criteria Pollutant Emission Factors (lb/1000000 scf)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
5.5	0.6	100	84	7.6	7.6		

- Heating Greenhouse Gasses Pollutant Emission Factors (lb/1000000 scf)

CH_4	N_2O	CO_2	CO_2e
2.26	2.26	120019	120143

5.4 Heating Formula(s)

- Heating Fuel Consumption ft^3 per Year

FC_{HER}= HA * EI / HV / 1000000

FC_{HER}: Fuel Consumption for Heat Energy Requirement Method
HA: Area of floorspace to be heated (ft^2)
EI: Energy Intensity Requirement (MMBtu/ft^2)
HV: Heat Value (MMBTU/ft^3)
1000000: Conversion Factor

- Heating Emissions per Year

HE_{POL}= FC * EF_{POL} / 2000

HE_{POL}: Heating Emission Emissions (TONs)
FC: Fuel Consumption
EF_{POL}: Emission Factor for Pollutant
2000: Conversion Factor pounds to tons

6. Construction / Demolition

6.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Mount / Pad - Deluge Water Tower & System

- Activity Description:
Launch Mount / Pad - Deluge Water Tower & System

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Start Date
Start Month: 6
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 5
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.066791
SO_x	0.001303
NO_x	0.593835
CO	0.804062

Pollutant	Total Emissions (TONs)
PM 10	0.026804
PM 2.5	0.024656
Pb	0.000000
NH_3	0.001876

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.005954
N_2O	0.002311

Pollutant	Total Emissions (TONs)
CO_2	151.705770
CO_2e	152.542886

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.005954
N_2O	0.002311

Pollutant	Total Emissions (TONs)
CO_2	151.705770
CO_2e	152.542886

6.1 Building Construction Phase

6.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 12
Number of Days: 0

6.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 1500
Height of Building (ft): 250
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4

Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

6.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679

LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

6.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

7. Construction / Demolition

7.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Tank Farm

- Activity Description:
Tank Farm

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.264539
SO_x	0.004315

Pollutant	Total Emissions (TONs)
PM 10	0.082175
PM 2.5	0.075586

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NO_x	2.043919
CO	2.626341

Pb	0.000000
NH_3	0.004778

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.017231
N_2O	0.004782

Pollutant	Total Emissions (TONs)
CO_2	429.316308
CO_2e	431.171558

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.017231
N_2O	0.004782

Pollutant	Total Emissions (TONs)
CO_2	429.316308
CO_2e	431.171558

7.1 Building Construction Phase

7.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 17
Number of Days: 29

7.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 47800
Height of Building (ft): 8
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	6
Forklifts Composite	2	6
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

7.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54567	0.00793	4.37292	2.88066	0.17997	0.16558
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53415	0.00735	3.78255	4.55763	0.13078	0.12031

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.31451	570.26482
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.28951	570.23973

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644

HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

7.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)

1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

8. Construction / Demolition

8.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Engineering Support Facility - Office Space

- Activity Description:
Engineering Support Facility - Office Space

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)	Pollutant	Total Emissions (TONs)

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

VOC	0.208907
SO_x	0.001806
NO_x	0.820529
CO	1.118323

PM 10	0.037252
PM 2.5	0.034265
Pb	0.000000
NH_3	0.002371

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008250
N_2O	0.002605

Pollutant	Total Emissions (TONs)
CO_2	207.167846
CO_2e	208.149976

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008250
N_2O	0.002605

Pollutant	Total Emissions (TONs)
CO_2	207.167846
CO_2e	208.149976

8.1 Building Construction Phase

8.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 16
Number of Days: 24

8.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 10000
Height of Building (ft): 30
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

8.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271

LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

8.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

8.2 Architectural Coatings Phase

8.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 4
Start Year: 2025

- Phase Duration
Number of Month: 1
Number of Days: 4

8.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 10000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

8.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644

HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

8.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase

$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

9. Heating

9.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Engineering Support Facility - Office Space

- Activity Description:
Engineering Support Facility - Office Space

- Activity Start Date
Start Month: 5
Start Year: 2025

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.001820
SO_x	0.000199
NO_x	0.033095
CO	0.027800

Pollutant	Emissions Per Year (TONs)
PM 10	0.002515
PM 2.5	0.002515
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.000748
N_2O	0.000748

Pollutant	Emissions Per Year (TONs)
CO_2	39.720574
CO_2e	39.761612

9.2 Heating Assumptions

- Heating
Heating Calculation Type: Heat Energy Requirement Method

- Heat Energy Requirement Method
Area of floorspace to be heated (ft^2): 10000
Type of fuel: Natural Gas
Type of boiler/furnace: Commercial/Institutional (0.3 - 9.9 MMBtu/hr)
Heat Value (MMBtu/ft^3): 0.00105
Energy Intensity (MMBtu/ft^2): 0.0695

- Default Settings Used: Yes

- Boiler/Furnace Usage
Operating Time Per Year (hours): 900 (default)

9.3 Heating Emission Factor(s)

- Heating Criteria Pollutant Emission Factors (lb/1000000 scf)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
5.5	0.6	100	84	7.6	7.6		

- Heating Greenhouse Gasses Pollutant Emission Factors (lb/1000000 scf)

CH_4	N_2O	CO_2	CO_2e
2.26	2.26	120019	120143

9.4 Heating Formula(s)

- Heating Fuel Consumption ft^3 per Year

FC_{HER}= HA * EI / HV / 1000000

FC_{HER}: Fuel Consumption for Heat Energy Requirement Method
HA: Area of floorspace to be heated (ft^2)
EI: Energy Intensity Requirement (MMBtu/ft^2)
HV: Heat Value (MMBTU/ft^3)
1000000: Conversion Factor

- Heating Emissions per Year

HE_{POL}= FC * EF_{POL} / 2000

HE_{POL}: Heating Emission Emissions (TONs)
FC: Fuel Consumption
EF_{POL}: Emission Factor for Pollutant
2000: Conversion Factor pounds to tons

10. Construction / Demolition

10.1 General Information & Timeline Assumptions

- Activity Location

County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Vehicle Processing - Maintenance Hangar

- Activity Description:

Launch Vehicle Processing - Maintenance Hangar

- Activity Start Date

Start Month: 1
Start Month: 2024

- Activity End Date

Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.601869
SO_x	0.004237
NO_x	2.033679
CO	2.535625

Pollutant	Total Emissions (TONs)
PM 10	0.079841
PM 2.5	0.073440
Pb	0.000000
NH_3	0.007460

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.017070
N_2O	0.011860

Pollutant	Total Emissions (TONs)
CO_2	461.540607
CO_2e	465.500422

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.017070
N_2O	0.011860

Pollutant	Total Emissions (TONs)
CO_2	461.540607
CO_2e	465.500422

10.1 Building Construction Phase

10.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 16
Number of Days: 24

10.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 30000
Height of Building (ft): 100
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	6
Forklifts Composite	2	6
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips

Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

10.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54567	0.00793	4.37292	2.88066	0.17997	0.16558
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53415	0.00735	3.78255	4.55763	0.13078	0.12031

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.31451	570.26482
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.28951	570.23973

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e

LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

10.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds

EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

10.2 Architectural Coatings Phase

10.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 4
Start Year: 2025

- Phase Duration
Number of Month: 1
Number of Days: 4

10.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 30000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

10.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

10.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase

VMT_{WT} = (1 * WT * PA) / 800

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

11. Heating

11.1 General Information & Timeline Assumptions

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Vehicle Processing - Maintenance Hangar

- Activity Description:
Launch Vehicle Processing - Maintenance Hangar

- Activity Start Date
Start Month: 5
Start Year: 2025

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.005091
SO_x	0.000555
NO_x	0.092571
CO	0.077760

Pollutant	Emissions Per Year (TONs)
PM 10	0.007035
PM 2.5	0.007035
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.002092
N_2O	0.002092

Pollutant	Emissions Per Year (TONs)
CO_2	111.103303
CO_2e	111.218091

11.2 Heating Assumptions

- Heating
Heating Calculation Type: Heat Energy Requirement Method

- Heat Energy Requirement Method
Area of floorspace to be heated (ft^2): 30000
Type of fuel: Natural Gas
Type of boiler/furnace: Commercial/Institutional (0.3 - 9.9 MMBtu/hr)
Heat Value (MMBtu/ft^3): 0.00105
Energy Intensity (MMBtu/ft^2): 0.0648

- Default Settings Used: Yes

- Boiler/Furnace Usage
Operating Time Per Year (hours): 900 (default)

11.3 Heating Emission Factor(s)

- Heating Criteria Pollutant Emission Factors (lb/1000000 scf)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
5.5	0.6	100	84	7.6	7.6		

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Heating Greenhouse Gasses Pollutant Emission Factors (lb/1000000 scf)

CH_4	N_2O	CO_2	CO_2e
2.26	2.26	120019	120143

11.4 Heating Formula(s)

- Heating Fuel Consumption ft^3 per Year

FC_{HER}= HA * EI / HV / 1000000

FC_{HER}: Fuel Consumption for Heat Energy Requirement Method
HA: Area of floorspace to be heated (ft^2)
EI: Energy Intensity Requirement (MMBtu/ft^2)
HV: Heat Value (MMBTU/ft^3)
1000000: Conversion Factor

- Heating Emissions per Year

HE_{POL}= FC * EF_{POL} / 2000

HE_{POL}: Heating Emission Emissions (TONs)
FC: Fuel Consumption
EF_{POL}: Emission Factor for Pollutant
2000: Conversion Factor pounds to tons

12. Construction / Demolition

12.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Vehicle Processing - Payload Processing

- Activity Description:
Launch Vehicle Processing - Payload Processing

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.175090
SO_x	0.001837
NO_x	0.839050
CO	1.130381

Pollutant	Total Emissions (TONs)
PM 10	0.037705
PM 2.5	0.034683
Pb	0.000000
NH_3	0.002824

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008395
N_2O	0.003723

Pollutant	Total Emissions (TONs)
CO_2	216.261780
CO_2e	217.580711

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.008395
N_2O	0.003723

Pollutant	Total Emissions (TONs)
CO_2	216.261780
CO_2e	217.580711

12.1 Building Construction Phase

12.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 16
Number of Days: 24

12.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 7000
Height of Building (ft): 100
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC

POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips

Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

12.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

12.1.4 Building Construction Phase Formula(s)

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

12.2 Architectural Coatings Phase

12.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 4
Start Year: 2025

- Phase Duration
Number of Month: 1
Number of Days: 4

12.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 7000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

12.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

12.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

13. Heating

13.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Vehicle Processing - Payload Processing

- Activity Description:

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Launch Vehicle Processing - Payload Processing

- Activity Start Date
Start Month: 5
Start Year: 2025

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.001274
SO_x	0.000139
NO_x	0.023167
CO	0.019460

Pollutant	Emissions Per Year (TONs)
PM 10	0.001761
PM 2.5	0.001761
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.000524
N_2O	0.000524

Pollutant	Emissions Per Year (TONs)
CO_2	27.804402
CO_2e	27.833128

13.2 Heating Assumptions

- Heating
Heating Calculation Type: Heat Energy Requirement Method

- Heat Energy Requirement Method
Area of floorspace to be heated (ft^2): 7000
Type of fuel: Natural Gas
Type of boiler/furnace: Commercial/Institutional (0.3 - 9.9 MMBtu/hr)
Heat Value (MMBtu/ft^3): 0.00105
Energy Intensity (MMBtu/ft^2): 0.0695

- Default Settings Used: Yes

- Boiler/Furnace Usage
Operating Time Per Year (hours): 900 (default)

13.3 Heating Emission Factor(s)

- Heating Criteria Pollutant Emission Factors (lb/1000000 scf)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
5.5	0.6	100	84	7.6	7.6		

- Heating Greenhouse Gasses Pollutant Emission Factors (lb/1000000 scf)

CH_4	N_2O	CO_2	CO_2e
2.26	2.26	120019	120143

13.4 Heating Formula(s)

- Heating Fuel Consumption ft^3 per Year
FC_{HER}= HA * EI / HV / 1000000

FC_{HER}: Fuel Consumption for Heat Energy Requirement Method
HA: Area of floorspace to be heated (ft^2)
EI: Energy Intensity Requirement ($MMBtu/ft^2$)
HV: Heat Value ($MMBTU/ft^3$)
1000000: Conversion Factor

- Heating Emissions per Year
$HE_{POL} = FC * EF_{POL} / 2000$

HE_{POL}: Heating Emission Emissions (TONs)
FC: Fuel Consumption
EF_{POL}: Emission Factor for Pollutant
2000: Conversion Factor pounds to tons

14. Construction / Demolition

14.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Vehicle Processing - Overflow Storage Building

- Activity Description:
Launch Vehicle Processing - Overflow Storage Building

- Activity Start Date
Start Month: 3
Start Month: 2025

- Activity End Date
Indefinite: False
End Month: 4
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.010465
SO_x	0.000218
NO_x	0.091532
CO	0.132655

Pollutant	Total Emissions (TONs)
PM 10	0.003888
PM 2.5	0.003577
Pb	0.000000
NH_3	0.000319

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000991
N_2O	0.000421

Pollutant	Total Emissions (TONs)
CO_2	25.504478
CO_2e	25.654553

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000991
N_2O	0.000421

Pollutant	Total Emissions (TONs)
CO_2	25.504478
CO_2e	25.654553

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14.1 Building Construction Phase

14.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2025

- Phase Duration
Number of Month: 2
Number of Days: 0

14.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 2500
Height of Building (ft): 30
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

14.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.20113	0.00487	1.94968	1.66287	0.07909	0.07277
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.26944	0.00487	2.55142	3.59881	0.13498	0.12418
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19600	0.00489	2.00960	3.48168	0.07738	0.07119

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.58451	529.39505
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.10822	528.91712
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.86270	531.68105

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30440	0.00175	0.13290	4.77199	0.00371	0.00328	0.05325
LDGT	0.26083	0.00216	0.17973	4.20900	0.00418	0.00370	0.04444
HDGV	0.98518	0.00481	0.66400	11.99902	0.02092	0.01850	0.09582
LDDV	0.08914	0.00133	0.14951	6.42748	0.00351	0.00323	0.01693
LDDT	0.20580	0.00152	0.47872	6.07454	0.00570	0.00525	0.01788
HDDV	0.12304	0.00426	2.47202	1.65242	0.05496	0.05057	0.06504
MC	3.22233	0.00193	0.54715	12.64378	0.02290	0.02026	0.05135

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01506	0.00514	346.03787	347.94148
LDGT	0.01548	0.00747	427.58921	430.19622
HDGV	0.05923	0.02786	951.90377	961.66618
LDDV	0.04271	0.00073	395.50643	396.79223
LDDT	0.03143	0.00108	447.56743	448.67639
HDDV	0.01995	0.16036	1266.81748	1315.09331
MC	0.11395	0.00333	391.06501	394.90588

14.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower

LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds

EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

15. Construction / Demolition

15.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Asphalt Roadway and Parking Lot

- Activity Description:
Asphalt Roadway and Parking Lot

- Activity Start Date
Start Month: 7
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 3
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.151917
SO_x	0.002007
NO_x	1.253942
CO	1.500314

Pollutant	Total Emissions (TONs)
PM 10	17.192976
PM 2.5	0.054875
Pb	0.000000
NH_3	0.002128

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.009078
N_2O	0.003134

Pollutant	Total Emissions (TONs)
CO_2	229.623871
CO_2e	230.784327

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.009078
N_2O	0.003134

Pollutant	Total Emissions (TONs)
CO_2	229.623871
CO_2e	230.784327

15.1 Site Grading Phase

15.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 7
Start Quarter: 1
Start Year: 2024

- Phase Duration

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Number of Month: 4
Number of Days: 15

15.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 383200
Amount of Material to be Hauled On-Site (yd^3): 3548
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

15.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.41507	0.00542	3.50127	4.19664	0.11916	0.10962
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.36076	0.00489	3.17634	3.40450	0.17539	0.16136
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34346	0.00488	3.24084	3.56285	0.20853	0.19184
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.40864	0.00491	4.01022	3.25251	0.17852	0.16424
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						

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	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02382	0.00476	587.31685	589.33237
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02151	0.00430	530.17041	531.98982
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02144	0.00429	528.45375	530.26726
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.20301	534.02939
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

15.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

15.2 Paving Phase

15.2.1 Paving Phase Timeline Assumptions

- Phase Start Date

Start Month: 11
Start Quarter: 2
Start Year: 2024

- Phase Duration
Number of Month: 4
Number of Days: 14

15.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 383200

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

15.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24765	0.00486	2.70778	3.42266	0.14436	0.13282
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.22632	0.00488	2.40974	3.44725	0.10918	0.10044
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.61835	0.00541	3.81402	4.19473	0.19185	0.17650

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02135	0.00427	526.33172	528.13796
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	N_2O	CO_2	CO_2e

Emission Factors	0.02142	0.00428	528.11469	529.92704
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02380	0.00476	586.79790	588.81164

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

15.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

16. Construction / Demolition

16.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Mount / Pad - Lightning Protection Towers

- Activity Description:
Launch Mount / Pad - Lightning Protection Towers

- Activity Start Date
Start Month: 3
Start Month: 2024

- Activity End Date
Indefinite: False

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

End Month: 11
End Month: 2024

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.064898
SO_x	0.000928
NO_x	0.423928
CO	0.572373

Pollutant	Total Emissions (TONs)
PM 10	0.019028
PM 2.5	0.017502
Pb	0.000000
NH_3	0.001471

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.004246
N_2O	0.001941

Pollutant	Total Emissions (TONs)
CO_2	109.659852
CO_2e	110.344291

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.004246
N_2O	0.001941

Pollutant	Total Emissions (TONs)
CO_2	109.659852
CO_2e	110.344291

16.1 Building Construction Phase

16.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 8
Number of Days: 14

16.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 1500
Height of Building (ft): 250
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

16.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21025	0.00487	2.13057	1.68023	0.08573	0.07887
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29170	0.00487	2.75083	3.61458	0.15732	0.14473
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.53174	529.34210
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.03976	528.84843
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

16.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)

0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

16.2 Architectural Coatings Phase

16.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 11
Start Quarter: 2
Start Year: 2024

- Phase Duration
Number of Month: 0
Number of Days: 17

16.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 1500
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

16.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

16.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase

VMT_{WT} = (1 * WT * PA) / 800

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

17. Construction / Demolition

17.1 General Information & Timeline Assumptions

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Pumphouse & All Utilities

- Activity Description:
Pumphouse & All Utilities

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.143591
SO_x	0.002075
NO_x	1.208065
CO	1.591692

Pollutant	Total Emissions (TONs)
PM 10	17.482076
PM 2.5	0.048976
Pb	0.000000
NH_3	0.002443

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.009458
N_2O	0.002495

Pollutant	Total Emissions (TONs)
CO_2	235.182758
CO_2e	236.162405

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.009458
N_2O	0.002495

Pollutant	Total Emissions (TONs)
CO_2	235.182758
CO_2e	236.162405

17.1 Site Grading Phase

17.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 3
Number of Days: 0

17.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 116800
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

17.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.36076	0.00489	3.17634	3.40450	0.17539	0.16136
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34346	0.00488	3.24084	3.56285	0.20853	0.19184
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.40864	0.00491	4.01022	3.25251	0.17852	0.16424
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02151	0.00430	530.17041	531.98982
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02144	0.00429	528.45375	530.26726
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.20301	534.02939

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Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

17.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)

(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

17.2 Trenching/Excavating Phase

17.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 4
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 12
Number of Days: 0

17.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 116800
Amount of Material to be Hauled On-Site (yd^3): 2163
Amount of Material to be Hauled Off-Site (yd^3): 0

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipmen Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

17.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.41507	0.00542	3.50127	4.19664	0.11916	0.10962
Other General Industrial Equipmen Composite [HP: 35] [LF: 0.34]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54521	0.00542	3.85582	4.77621	0.16518	0.15196
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02382	0.00476	587.31685	589.33237
Other General Industrial Equipmen Composite [HP: 35] [LF: 0.34]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02386	0.00477	588.15144	590.16982
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

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- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346
LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

17.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

17.3 Building Construction Phase

17.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 4
Start Quarter: 1
Start Year: 2025

- Phase Duration
Number of Month: 3
Number of Days: 0

17.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 1200
Height of Building (ft): 25
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

17.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.20113	0.00487	1.94968	1.66287	0.07909	0.07277
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.26944	0.00487	2.55142	3.59881	0.13498	0.12418
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19600	0.00489	2.00960	3.48168	0.07738	0.07119

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.58451	529.39505
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.10822	528.91712
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.86270	531.68105

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31287	0.00178	0.15174	4.94075	0.00384	0.00340	0.05485
LDGT	0.27556	0.00220	0.20340	4.45877	0.00436	0.00385	0.04644
HDGV	1.00405	0.00480	0.72186	12.67463	0.02085	0.01845	0.09731
LDDV	0.08501	0.00134	0.14279	6.03046	0.00324	0.00298	0.01679
LDDT	0.20078	0.00154	0.47191	5.96927	0.00587	0.00540	0.01813
HDDV	0.13925	0.00434	2.62491	1.70896	0.06430	0.05916	0.06420
MC	3.23022	0.00193	0.54883	12.80710	0.02290	0.02026	0.05095

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01600	0.00544	352.50072	354.51700
LDGT	0.01669	0.00796	436.10061	438.88415
HDGV	0.06154	0.02903	949.67357	959.84346

LDDV	0.04146	0.00073	397.80789	399.06271
LDDT	0.03182	0.00108	454.67599	455.79460
HDDV	0.02052	0.15850	1288.82285	1336.55551
MC	0.11576	0.00333	390.93995	394.82642

17.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

18. Construction / Demolition

18.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Guard Shack

- Activity Description:
Guard Shack

- Activity Start Date
Start Month: 3
Start Month: 2025

- Activity End Date
Indefinite: False
End Month: 5
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.016742
SO_x	0.000298
NO_x	0.124050
CO	0.182666

Pollutant	Total Emissions (TONs)
PM 10	0.005345
PM 2.5	0.004916
Pb	0.000000
NH_3	0.000349

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.001353
N_2O	0.000348

Pollutant	Total Emissions (TONs)
CO_2	33.702062
CO_2e	33.839404

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- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.001353
N_2O	0.000348

Pollutant	Total Emissions (TONs)
CO_2	33.702062
CO_2e	33.839404

18.1 Building Construction Phase

18.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2025

- Phase Duration
Number of Month: 2
Number of Days: 24

18.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 200
Height of Building (ft): 100
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

18.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.20113	0.00487	1.94968	1.66287	0.07909	0.07277
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.26944	0.00487	2.55142	3.59881	0.13498	0.12418
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19600	0.00489	2.00960	3.48168	0.07738	0.07119

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.58451	529.39505
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.10822	528.91712
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.86270	531.68105

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30440	0.00175	0.13290	4.77199	0.00371	0.00328	0.05325
LDGT	0.26083	0.00216	0.17973	4.20900	0.00418	0.00370	0.04444
HDGV	0.98518	0.00481	0.66400	11.99902	0.02092	0.01850	0.09582
LDDV	0.08914	0.00133	0.14951	6.42748	0.00351	0.00323	0.01693
LDDT	0.20580	0.00152	0.47872	6.07454	0.00570	0.00525	0.01788
HDDV	0.12304	0.00426	2.47202	1.65242	0.05496	0.05057	0.06504
MC	3.22233	0.00193	0.54715	12.64378	0.02290	0.02026	0.05135

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01506	0.00514	346.03787	347.94148
LDGT	0.01548	0.00747	427.58921	430.19622
HDGV	0.05923	0.02786	951.90377	961.66618
LDDV	0.04271	0.00073	395.50643	396.79223
LDDT	0.03143	0.00108	447.56743	448.67639
HDDV	0.01995	0.16036	1266.81748	1315.09331
MC	0.11395	0.00333	391.06501	394.90588

18.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment

WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase

VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

18.2 Architectural Coatings Phase

18.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 4
Start Year: 2025

- Phase Duration
Number of Month: 0
Number of Days: 6

18.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 200
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

18.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30440	0.00175	0.13290	4.77199	0.00371	0.00328	0.05325
LDGT	0.26083	0.00216	0.17973	4.20900	0.00418	0.00370	0.04444
HDGV	0.98518	0.00481	0.66400	11.99902	0.02092	0.01850	0.09582
LDDV	0.08914	0.00133	0.14951	6.42748	0.00351	0.00323	0.01693
LDDT	0.20580	0.00152	0.47872	6.07454	0.00570	0.00525	0.01788
HDDV	0.12304	0.00426	2.47202	1.65242	0.05496	0.05057	0.06504
MC	3.22233	0.00193	0.54715	12.64378	0.02290	0.02026	0.05135

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01506	0.00514	346.03787	347.94148
LDGT	0.01548	0.00747	427.58921	430.19622

HDGV	0.05923	0.02786	951.90377	961.66618
LDDV	0.04271	0.00073	395.50643	396.79223
LDDT	0.03143	0.00108	447.56743	448.67639
HDDV	0.01995	0.16036	1266.81748	1315.09331
MC	0.11395	0.00333	391.06501	394.90588

18.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

19. Personnel

19.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Employee Commutes

- Activity Description:
Employee Commutes

- Activity Start Date
Start Month: 7
Start Year: 2025

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.047770
SO_x	0.000287
NO_x	0.024324
CO	0.657154

Pollutant	Emissions Per Year (TONs)
PM 10	0.000625
PM 2.5	0.000553
Pb	0.000000
NH_3	0.006854

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.002470
N_2O	0.000932

Pollutant	Emissions Per Year (TONs)
CO_2	56.800135
CO_2e	57.138803

19.2 Personnel Assumptions

- Number of Personnel
Active Duty Personnel: 0
Civilian Personnel: 0
Support Contractor Personnel: 25
Air National Guard (ANG) Personnel: 0
Reserve Personnel: 0

- Default Settings Used: Yes

- Average Personnel Round Trip Commute (mile): 20 (default)

- Personnel Work Schedule
Active Duty Personnel: 5 Days Per Week (default)
Civilian Personnel: 5 Days Per Week (default)
Support Contractor Personnel: 5 Days Per Week (default)
Air National Guard (ANG) Personnel: 4 Days Per Week (default)
Reserve Personnel: 4 Days Per Month (default)

19.3 Personnel On Road Vehicle Mixture

- On Road Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	37.55	60.32	0	0.03	0.2	0	1.9
GOVs	54.49	37.73	4.67	0	0	3.11	0

19.4 Personnel Emission Factor(s)

- On Road Vehicle Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30440	0.00175	0.13290	4.77199	0.00371	0.00328	0.05325
LDGT	0.26083	0.00216	0.17973	4.20900	0.00418	0.00370	0.04444
HDGV	0.98518	0.00481	0.66400	11.99902	0.02092	0.01850	0.09582
LDDV	0.08914	0.00133	0.14951	6.42748	0.00351	0.00323	0.01693
LDDT	0.20580	0.00152	0.47872	6.07454	0.00570	0.00525	0.01788

HDDV	0.12304	0.00426	2.47202	1.65242	0.05496	0.05057	0.06504
MC	3.22233	0.00193	0.54715	12.64378	0.02290	0.02026	0.05135

- On Road Vehicle Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01506	0.00514	346.03787	347.94148
LDGT	0.01548	0.00747	427.58921	430.19622
HDGV	0.05923	0.02786	951.90377	961.66618
LDDV	0.04271	0.00073	395.50643	396.79223
LDDT	0.03143	0.00108	447.56743	448.67639
HDDV	0.01995	0.16036	1266.81748	1315.09331
MC	0.11395	0.00333	391.06501	394.90588

19.5 Personnel Formula(s)

- Personnel Vehicle Miles Travel for Work Days per Year

$VMT_P = NP * WD * AC$

VMT_P: Personnel Vehicle Miles Travel (miles/year)
NP: Number of Personnel
WD: Work Days per Year
AC: Average Commute (miles)

- Total Vehicle Miles Travel per Year

$VMT_{Total} = VMT_{AD} + VMT_C + VMT_{SC} + VMT_{ANG} + VMT_{AFRC}$

VMT_{Total}: Total Vehicle Miles Travel (miles)
VMT_{AD}: Active Duty Personnel Vehicle Miles Travel (miles)
VMT_C: Civilian Personnel Vehicle Miles Travel (miles)
VMT_{SC}: Support Contractor Personnel Vehicle Miles Travel (miles)
VMT_{ANG}: Air National Guard Personnel Vehicle Miles Travel (miles)
VMT_{AFRC}: Reserve Personnel Vehicle Miles Travel (miles)

- Vehicle Emissions per Year

$V_{POL} = (VMT_{Total} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{Total}: Total Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Personnel On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

20. Degreaser

20.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Title: IPA Use for Payload Processing

- Activity Description:
IPA Use for Payload Processing

- Activity Start Date
Start Month: 7
Start Year: 2025

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.097695
SO_x	0.000000
NO_x	0.000000
CO	0.000000

Pollutant	Emissions Per Year (TONs)
PM 10	0.000000
PM 2.5	0.000000
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.000000
N_2O	0.000000

Pollutant	Emissions Per Year (TONs)
CO_2	0.000000
CO_2e	0.000000

20.2 Degreaser Assumptions

- Degreaser
Net solvent usage (total less recycle) (gallons/year): 30

- Default Settings Used: No

- Degreaser Consumption
Solvent used: Isoproypl Alcohol CAS #67-63-0
Specific gravity of solvent: 0.78
Solvent VOC content (%): 100
Efficiency of control device (%): 0

20.3 Degreaser Formula(s)

- Degreaser Emissions per Year
DE_{VOC}= (VOC / 100) * NS * SG * 8.35 * (1 - (CD / 100)) / 2000

DE_{VOC}: Degreaser VOC Emissions (TONs per Year)
VOC: Solvent VOC content (%)
(VOC / 100): Conversion Factor percent to decimal
NS: Net solvent usage (total less recycle) (gallons/year)
SG: Specific gravity of solvent
8.35: Conversion Factor the density of water
CD: Efficiency of control device (%)
(1 - (CD / 100)): Conversion Factor percent to decimal (Not effected by control device)
2000: Conversion Factor pounds to tons

AIR CONFORMITY APPLICABILITY MODEL REPORT
GREENHOUSE GAS (GHG) EMISSIONS

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform an analysis to estimate GHG emissions and assess the theoretical Social Cost of Greenhouse Gases (SC GHG) associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, Environmental Compliance and Pollution Prevention; the Environmental Impact Analysis Process (EIAP, 32 CFR 989); and the USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide. This report provides a summary of GHG emissions and SC GHG analysis.

Report generated with ACAM version: 5.0.23a

a. Action Location:
Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: Reactivation of Space Launch Complex-14 at Cape Canaveral Space Force Station, Florida

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2024

e. Action Description:

The Proposed Action is to reactivate SLC-14 to support Stoke's launch program, which includes the construction of new facilities, improvements to existing infrastructure, ground support operations, and launch operations.

f. Point of Contact:

Name: Michelle York
Title: Contractor
Organization: Jacobs Engineering
Email: michelle.york@jacobs.com
Phone Number: 360-931-8672

2. Analysis: Total combined direct and indirect GHG emissions associated with the action were estimated through ACAM on a calendar-year basis from the action start through the expected life cycle of the action. The life cycle for Air Force actions with "steady state" emissions (SS, net gain/loss in emission stabilized and the action is fully implemented) is assumed to be 10 years beyond the SS emissions year or 20 years beyond SS emissions year for aircraft operations related actions.

GHG Emissions Analysis Summary:

GHGs produced by fossil-fuel combustion are primarily carbon dioxide (CO2), methane (CH4), and nitrous oxide (NO2). These three GHGs represent more than 97 percent of all U.S. GHG emissions. Emissions of GHGs are typically quantified and regulated in units of CO2 equivalents (CO2e). The CO2e takes into account the global warming potential (GWP) of each GHG. The GWP is the measure of a particular GHG's ability to absorb solar radiation as well as its residence time within the atmosphere. The GWP allows comparison of global warming impacts between different gases; the higher the GWP, the more that gas contributes to climate change in comparison to CO2. All GHG emissions estimates were derived from various emission sources using the methods, algorithms, emission factors, and GWPs from the most current Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and/or Air Emissions Guide for Air Force Transitory Sources.

AIR CONFORMITY APPLICABILITY MODEL REPORT
GREENHOUSE GAS (GHG) EMISSIONS

The Air Force has adopted the Prevention of Significant Deterioration (PSD) threshold for GHG of 75,000 ton per year (ton/yr) of CO2e (or 68,039 metric ton per year, mton/yr) as an indicator or "threshold of insignificance" for NEPA air quality impacts in all areas. This indicator does not define a significant impact; however, it provides a threshold to identify actions that are insignificant (de minimis, too trivial or minor to merit consideration). Actions with a net change in GHG (CO2e) emissions below the insignificance indicator (threshold) are considered too insignificant on a global scale to warrant any further analysis. Note that actions with a net change in GHG (CO2e) emissions above the insignificance indicator (threshold) are only considered potentially significant and require further assessment to determine if the action poses a significant impact. For further detail on insignificance indicators see Level II, Air Quality Quantitative Assessment, Insignificance Indicators (April 2023).

The following table summarizes the action-related GHG emissions on a calendar-year basis through the projected life cycle of the action.

Action-Related Annual GHG Emissions (mton/yr)						
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**	**Threshold**	**Exceedance**
2024	1,829	0.07166333	0.02837265	1,839	68,039	No
2025	853	0.03083214	0.01364405	857	68,039	No
2026 [SS Year]	250	0.00597068	0.00457532	250	68,039	No
2027	250	0.00597068	0.00457532	250	68,039	No
2028	250	0.00597068	0.00457532	250	68,039	No
2029	250	0.00597068	0.00457532	250	68,039	No
2030	250	0.00597068	0.00457532	250	68,039	No
2031	250	0.00597068	0.00457532	250	68,039	No
2032	250	0.00597068	0.00457532	250	68,039	No
2033	250	0.00597068	0.00457532	250	68,039	No
2034	250	0.00597068	0.00457532	250	68,039	No
2035	250	0.00597068	0.00457532	250	68,039	No
2036	250	0.00597068	0.00457532	250	68,039	No

The following U.S. and State's GHG emissions estimates (next two tables) are based on a five-year average (2016 through 2020) of individual state-reported GHG emissions (Reference: State Climate Summaries 2022, NOAA National Centers for Environmental Information, National Oceanic and Atmospheric Administration. https://statesummaries.ncics.org/downloads/).

State's Annual GHG Emissions (mton/yr)				
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**
2024	227,404,647	552,428	58,049	228,015,124
2025	227,404,647	552,428	58,049	228,015,124
2026 [SS Year]	227,404,647	552,428	58,049	228,015,124
2027	227,404,647	552,428	58,049	228,015,124
2028	227,404,647	552,428	58,049	228,015,124
2029	227,404,647	552,428	58,049	228,015,124
2030	227,404,647	552,428	58,049	228,015,124
2031	227,404,647	552,428	58,049	228,015,124
2032	227,404,647	552,428	58,049	228,015,124
2033	227,404,647	552,428	58,049	228,015,124
2034	227,404,647	552,428	58,049	228,015,124
2035	227,404,647	552,428	58,049	228,015,124
2036	227,404,647	552,428	58,049	228,015,124

U.S. Annual GHG Emissions (mton/yr)				
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**
2024	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2025	5,136,454,179	25,626,912	1,500,708	5,163,581,798

2026 [SS Year]	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2027	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2028	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2029	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2030	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2031	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2032	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2033	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2034	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2035	5,136,454,179	25,626,912	1,500,708	5,163,581,798
2036	5,136,454,179	25,626,912	1,500,708	5,163,581,798

GHG Relative Significance Assessment:

A Relative Significance Assessment uses the rule of reason and the concept of proportionality along with the consideration of the affected area (yGba.e., global, national, and regional) and the degree (intensity) of the proposed action's effects. The Relative Significance Assessment provides real-world context and allows for a reasoned choice against alternatives through a relative comparison analysis. The analysis weighs each alternative's annual net change in GHG emissions proportionally against (or relative to) global, national, and regional emissions.

The action's surroundings, circumstances, environment, and background (context associated with an action) provide the setting for evaluating the GHG intensity (impact significance). From an air quality perspective, context of an action is the local area's ambient air quality relative to meeting the NAAQSs, expressed as attainment, nonattainment, or maintenance areas (this designation is considered the attainment status). GHGs are non-hazardous to health at normal ambient concentrations and, at a cumulative global scale, action-related GHG emissions can only potentially cause warming of the climatic system. Therefore, the action-related GHGs generally have an insignificant impact to local air quality.

However, the affected area (context) of GHG/climate change is global. Therefore, the intensity or degree of the proposed action's GHG/climate change effects are gauged through the quantity of GHG associated with the action as compared to a baseline of the state, U.S., and global GHG inventories. Each action (or alternative) has significance, based on their annual net change in GHG emissions, in relation to or proportionally to the global, national, and regional annual GHG emissions.

To provide real-world context to the GHG and climate change effects on a global scale, an action's net change in GHG emissions is compared relative to the state (where action will occur) and U.S. annual emissions. The following table provides a relative comparison of an action's net change in GHG emissions vs. state and U.S. projected GHG emissions for the same time period.

Total GHG Relative Significance (mton)					
		CO2	**CH4**	**N2O**	**CO2e**
2024-2036	State Total	2,956,260,412	7,181,560	754,635	2,964,196,607
2024-2036	U.S. Total	66,773,904,327	333,149,852	19,509,199	67,126,563,378
2024-2036	Action	5,427	0.168173	0.092345	5,447
Percent of State Totals		0.00018359%	0.00000234%	0.00001224%	0.00018377%
Percent of U.S. Totals		0.00000813%	0.00000005%	0.00000047%	0.00000812%

From a global context, the action's total GHG percentage of total global GHG for the same time period is: 0.00000109%.*

* Global value based on the U.S. emits 13.4% of all global GHG annual emissions (2018 Emissions Data, Center for Climate and Energy Solutions, accessed 7-6-2023, https://www.c2es.org/content/international-emissions).

AIR CONFORMITY APPLICABILITY MODEL REPORT
GREENHOUSE GAS (GHG) EMISSIONS

Climate Change Assessment (as SC GHG):

On a global scale, the potential climate change effects of an action are indirectly addressed and put into context through providing the theoretical SC GHG associated with an action. The SC GHG is an administrative and theoretical tool intended to provide additional context to a GHG's potential impacts through approximating the long-term monetary damage that may result from GHG emissions affect on climate change. It is important to note that the SC GHG is a monetary quantification, in 2020 U.S. dollars, of the theoretical economic damages that could result from emitting GHGs into the atmosphere.

The SC GHG estimates are derived using the methodology and discount factors in the "Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990," released by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG SC GHGs) in February 2021.

The speciated IWG Annual SC GHG Emission associated with an action (or alternative) are first estimated as annual unit cost (cost per metric ton, $/mton). Results of the annual IWG Annual SC GHG Emission Assessments are tabulated in the IWG Annual SC GHG Cost per Metric Ton Table below:

IWG SC GHG Discount Factor: 2.5%

IWG Annual SC GHG Cost per Metric Ton ($/mton [In 2020 $])			
YEAR	**CO2**	**CH4**	**N2O**
2024	$82.00	$2,200.00	$29,000.00
2025	$83.00	$2,200.00	$30,000.00
2026 [SS Year]	$84.00	$2,300.00	$30,000.00
2027	$86.00	$2,300.00	$31,000.00
2028	$87.00	$2,400.00	$32,000.00
2029	$88.00	$2,500.00	$32,000.00
2030	$89.00	$2,500.00	$33,000.00
2031	$91.00	$2,600.00	$33,000.00
2032	$92.00	$2,600.00	$34,000.00
2033	$94.00	$2,700.00	$35,000.00
2034	$95.00	$2,800.00	$35,000.00
2035	$96.00	$2,800.00	$36,000.00
2036	$98.00	$2,900.00	$36,000.00

Action-related SC GHG were estimated by calendar-year for the projected action's lifecycle. Annual estimates were found by multiplying the annual emission for a given year by the corresponding IWG Annual SC GHG Emission value (see table above).

Action-Related Annual SC GHG ($K/yr [In 2020 $])				
YEAR	**CO2**	**CH4**	**N2O**	**GHG**
2024	$149.99	$0.16	$0.82	$150.97
2025	$70.76	$0.07	$0.41	$71.24
2026 [SS Year]	$20.97	$0.01	$0.14	$21.12
2027	$21.47	$0.01	$0.14	$21.62
2028	$21.72	$0.01	$0.15	$21.88
2029	$21.97	$0.01	$0.15	$22.13
2030	$22.22	$0.01	$0.15	$22.38
2031	$22.71	$0.02	$0.15	$22.88
2032	$22.96	$0.02	$0.16	$23.14
2033	$23.46	$0.02	$0.16	$23.64

2034	$23.71	$0.02	$0.16	$23.89
2035	$23.96	$0.02	$0.16	$24.14
2036	$24.46	$0.02	$0.16	$24.64

The following two tables summarize the U.S. and State's Annual SC GHG by calendar-year. The U.S. and State's Annual SC GHG are in 2020 dollars and were estimated by each year for the projected action lifecycle. Annual SC GHG estimates were found by multiplying the U.S. and State's annual five-year average GHG emissions for a given year by the corresponding IWG Annual SC GHG Cost per Metric Ton value.

State's Annual SC GHG ($K/yr [In 2020 $])				
YEAR	**CO2**	**CH4**	**N2O**	**GHG**
2024	$18,647,181.06	$1,215,340.97	$1,683,417.08	$21,545,939.11
2025	$18,874,585.70	$1,215,340.97	$1,741,465.95	$21,831,392.62
2026 [SS Year]	$19,101,990.35	$1,270,583.74	$1,741,465.95	$22,114,040.04
2027	$19,556,799.65	$1,270,583.74	$1,799,514.81	$22,626,898.20
2028	$19,784,204.29	$1,325,826.51	$1,857,563.68	$22,967,594.48
2029	$20,011,608.94	$1,381,069.28	$1,857,563.68	$23,250,241.90
2030	$20,239,013.59	$1,381,069.28	$1,915,612.54	$23,535,695.41
2031	$20,693,822.88	$1,436,312.06	$1,915,612.54	$24,045,747.48
2032	$20,921,227.53	$1,436,312.06	$1,973,661.41	$24,331,200.99
2033	$21,376,036.82	$1,491,554.83	$2,031,710.27	$24,899,301.92
2034	$21,603,441.47	$1,546,797.60	$2,031,710.27	$25,181,949.34
2035	$21,830,846.12	$1,546,797.60	$2,089,759.14	$25,467,402.85
2036	$22,285,655.41	$1,602,040.37	$2,089,759.14	$25,977,454.92

U.S. Annual SC GHG ($K/yr [In 2020 $])				
YEAR	**CO2**	**CH4**	**N2O**	**GHG**
2024	$421,189,242.68	$56,379,205.70	$43,520,521.44	$521,088,969.82
2025	$426,325,696.86	$56,379,205.70	$45,021,229.08	$527,726,131.63
2026 [SS Year]	$431,462,151.04	$58,941,896.86	$45,021,229.08	$535,425,276.98
2027	$441,735,059.39	$58,941,896.86	$46,521,936.72	$547,198,892.97
2028	$446,871,513.57	$61,504,588.03	$48,022,644.35	$556,398,745.96
2029	$452,007,967.75	$64,067,279.20	$48,022,644.35	$564,097,891.30
2030	$457,144,421.93	$64,067,279.20	$49,523,351.99	$570,735,053.12
2031	$467,417,330.29	$66,629,970.37	$49,523,351.99	$583,570,652.65
2032	$472,553,784.47	$66,629,970.37	$51,024,059.62	$590,207,814.46
2033	$482,826,692.83	$69,192,661.54	$52,524,767.26	$604,544,121.62
2034	$487,963,147.01	$71,755,352.70	$52,524,767.26	$612,243,266.97
2035	$493,099,601.18	$71,755,352.70	$54,025,474.90	$618,880,428.78
2036	$503,372,509.54	$74,318,043.87	$54,025,474.90	$631,716,028.31

Relative Comparison of SC GHG:

To provide additional real-world context to the potential climate change impact associate with an action, a Relative Comparison of SC GHG Assessment is also performed. While the SC GHG estimates capture an indirect approximation of global climate damages, the Relative Comparison of SC GHG Assessment provides a better perspective from a regional and global scale.

The Relative Comparison of SC GHG Assessment uses the rule of reason and the concept of proportionality along with the consideration of the affected area (yGba.e., global, national, and regional) and the SC GHG as the degree (intensity) of the proposed action's effects. The Relative Comparison Assessment provides real-world context and allows for a reasoned choice among alternatives through a relative contrast analysis which weighs each alternative's SC GHG proportionally against (or relative to) existing global, national, and regional SC GHG. The below table provides a relative comparison between an action's SC GHG vs. state and U.S. projected SC GHG for the same time period:

Total SC-GHG ($K [In 2020 $])					
		CO2	CH4	N2O	GHG
2024-2036	State Total	$264,926,413.80	$18,119,629.01	$24,728,816.46	$307,774,859.27
2024-2036	U.S. Total	$5,983,969,118.54	$840,562,703.10	$639,301,452.94	$7,463,833,274.58
2024-2036	Action	$470.36	$0.40	$2.91	$473.67
Percent of State Totals		0.00017754%	0.00000218%	0.00001177%	0.00015390%
Percent of U.S. Totals		0.00000786%	0.00000005%	0.00000046%	0.00000635%

From a global context, the action's total SC GHG percentage of total global SC GHG for the same time period is: 0.00000085%.*

* Global value based on the U.S. emits 13.4% of all global GHG annual emissions (2018 Emissions Data, Center for Climate and Energy Solutions, accessed 7-6-2023, https://www.c2es.org/content/international-emissions).

Michelle York, Contractor | Jan 17 2024

Name, Title | **Date**

Appendix G. Noise Study

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

Blue Ridge Research and Consulting, LLC

BRRC Report 23-10 (Final)

Noise Study for Stoke Operations at CCSFS LC-14

5 June 2023

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ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in the report:

ASEL	A-weighted Sound Exposure Level
BRRC	Blue Ridge Research and Consulting, LLC
CCSFS	Cape Canaveral Space Force Station
CDNL	C-weighted Day-Night Average Sound Level
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
DI	Directivity Indices
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DSM-1	Distributed Source Method 1
EA	Environmental Assessment
FAA	Federal Aviation Administration
ft	Foot/Feet
Hz	Hertz
KSC	Kennedy Space Center
LC-14	Launch Complex 14
lbf	Pound Force
lbs	Pound Mass
$L_{A,max}$	Maximum A-weighted Sound Level in Decibels
L_{max}	Maximum Unweighted Sound Level in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Rocket Propulsion Noise and Emissions Simulation Model
SEL	Sound Exposure Level
S.L.	Sea Level

1 INTRODUCTION

This report documents the noise study performed as part of Stoke Space's efforts on the Environmental Assessment (EA) for their proposed operations at Cape Canaveral Space Force Station (CCSFS) Launch Complex 14 (LC-14). The first stage of Stoke's launch vehicle (Figure 1) is powered by seven liquid natural gas (LNG) and liquid oxygen (LOX) engines which generate a combined thrust of 700,000 lbf. Stoke's proposed operations at LC-14 include 18 annual easterly launch operations and 18 pre-launch static fire tests.

Figure 1. Conceptual rendering of the Stoke launch vehicle in flight. (Image Credit: Stoke)

This noise study describes the environmental noise associated with the proposed Stoke operations. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage. The following sections of this report are outlined below.

- Section 2 defines the proposed Stoke operations.
- Section 3 reviews the noise metrics and effects discussed throughout this report.
- Section 4 presents the propulsion noise and sonic boom modeling results.
- Section 5 summarizes the notable findings of this noise study.
- Appendix A gives an overview of the basics of sound.
- Appendix B provides definitions of the noise metrics discussed throughout this report.
- Appendix C describes the propulsion noise and sonic boom modeling methods.

2 STOKE OPERATIONS

Stoke plans to launch from LC-14 on an easterly launch azimuth within the Eastern Range's allowable range of azimuths, approximately 35° to 120° as shown in Figure 2. The Stoke launch trajectory will be unique to the vehicle configuration, mission, and environmental conditions. Stoke provided a nominal launch trajectory for the noise and sonic boom modeling.

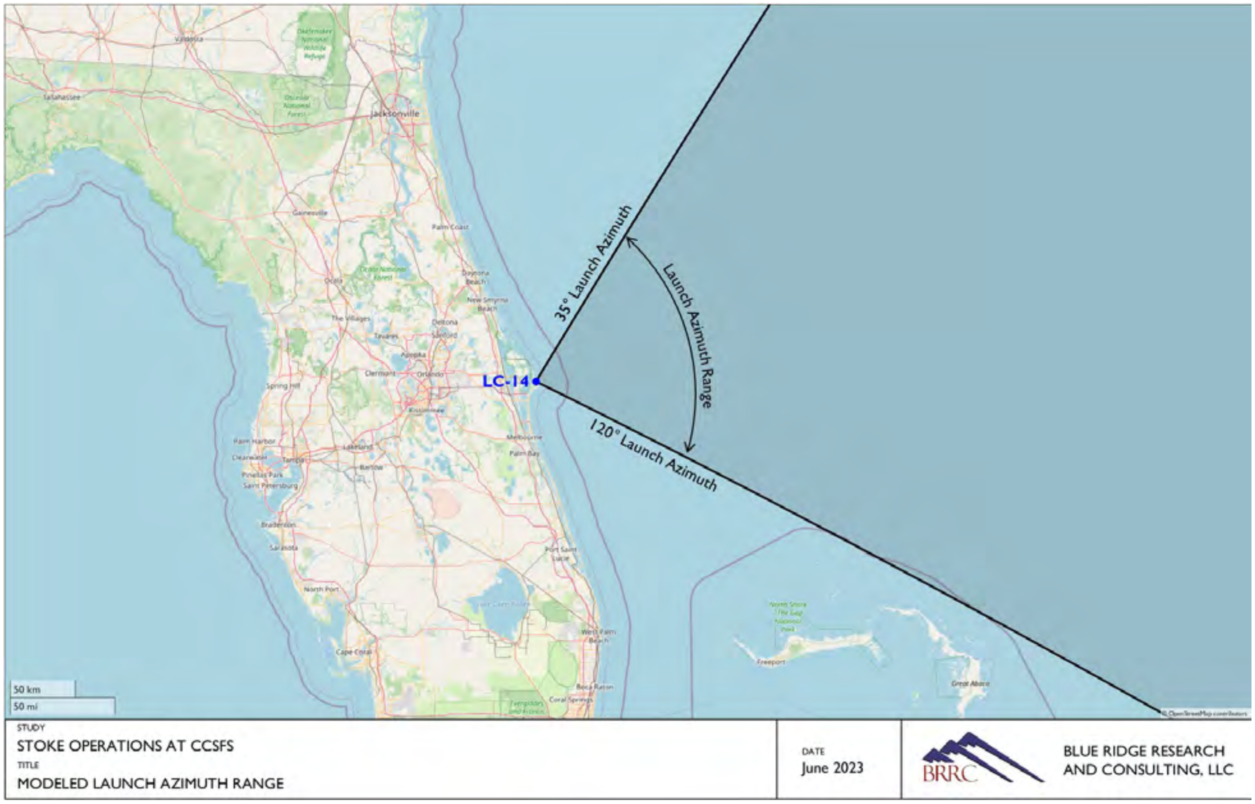

Figure 2. Range of Stoke launch azimuths from LC-14.

Table 1 presents the proposed Stoke operations at CCSFS. Stoke plans to conduct up to 18 launch operations from LC-14 per year. Prior to each launch, Stoke will conduct a pre-launch static fire test with a duration up to 175 seconds. Table 1 also presents the distribution of the Stoke operations between acoustic day (0700 to 2200) and acoustic night (2200 – 0700). The acoustic time of day distribution is used to account for increased sensitivity to noise at night when computing the Day-Night Average Sound Level (DNL) metric, which applies an additional 10 dB adjustment to events during the acoustical nighttime period.

Table 1. Proposed Stoke operations at LC-14.

		Annual Operations		
Event	Description	Daytime 0700 – 2200	Nighttime 2200 – 0700	Total
Static Fire	175 second static fire	18	0	18
Launch	Launch from LC-14	10	8	18

Table 2 presents the vehicle and engine modeling data for a nominal configuration of the Stoke launch vehicle. The first stage of Stoke's launch vehicle (Figure 3) is powered by seven LNG/LOX engines which generate a combined thrust of 700,000 lbf at the surface of the earth (i.e. sea level). The vehicle's weight and thrust vary with altitude, thus the noise and sonic boom modeling of the launch operations use the time varying weight and thrust profiles provided in the trajectory. The thrust profile increases with altitude, from 700,000 lbf at sea level to a maximum thrust of approximately 780,000 lbf at altitude.

Table 2. Vehicle and engine modeling parameters for a nominal configuration of the Stoke launch vehicle.

Modeling Parameters	Values
Manufacturer	Stoke
Length	132 ft
Diameter	12 ft
Gross Weight	500,000 lbs
1st Stage Thrust (Max S.L)	700,000 lbf (100,000 lbf x Qty. 7 LNG/LOX engines)

Figure 3. Conceptual rendering of the Stoke launch vehicle (Image Credit: Stoke)

3 NOISE METRICS AND EFFECTS

A variety of acoustic metrics can be used to describe how noise from commercial space operations affects communities and the environment. Metrics can describe the effect of an individual operation (single event) or the cumulative noise of multiple events over a long time. An overview of the basics of sound and definitions of the noise metrics discussed throughout this report are provided in Appendix A and Appendix B, respectively. Additionally, a comprehensive listing of acoustical terminology and definitions is available in the American National Standards Institute's (ANSI) "Acoustical Terminology" standard (ANSI S1.1-2013).

The Day Night Average Sound Level (DNL) is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities [1]. Despite the differences between aviation and commercial space vehicle noise, DNL is the required metric to quantify cumulative exposure to noise from commercial space transportation activities, too. However, the DNL metric may not fully describe the noise experienced during a commercial space noise event, and the use of supplemental noise metrics is recommended.

The metrics and effects relevant to propulsion noise and sonic booms from commercial space operations are presented in Sections 3.1 and 3.2, respectively. The noise effects described in the following sections are associated with the effects on people and structures.

3.1 Propulsion Noise Metrics and Effects

Table 3 presents metrics and associated effects relevant to the analysis of propulsion noise from commercial space operations. The associated effects referenced in Table 3 are discussed in more detail in Sections 3.1.1 through 3.1.3. For more detailed definitions of the metrics, beyond the descriptions provided in Table 3, see Appendix B.

In addition to the FAA's primary noise metric, DNL, Table 3 provides supplemental metrics that are used to evaluate potential impacts to people and structures. The maximum sound level metrics are particularly useful in improving the public's understanding of exceptionally loud commercial space event(s). Maximum sound level metrics are used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures. Additionally, A-weighted Sound Exposure Level (SEL), and Percent Allowable Daily Noise Dose are used to describe the potential noise impact from rocket operations.

Table 3. Metrics for propulsion noise analysis.

Metric	Description	Effect	Level
Day-Night Average Sound Level (DNL)	A cumulative (A-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.1.1)	65 dBA Ref. [1]
Maximum A-weighted Sound Level ($L_{A,max}$)	A single-event metric that describes the highest A-weighted sound level during an event in which the sound changes with time. (Appendix B)	Hearing Impairment (Section 3.1.2)	115 dBA Ref. [2]
Maximum Unweighted Sound Pressure Level (L_{max})	A single-event metric that describes the highest unweighted sound pressure level during an event in which the sound changes with time. (Appendix B)	Vibration on Structures (Section 3.1.3)	111 dB and 120 dB Ref. [3]
A-weighted Sound Exposure Level (SEL)	A single-event metric that accounts for the noise level and duration of the event, referenced to a standard duration of one second. (Appendix B)	--	--
Percent Allowable Daily Noise Dose	A single-event metric that describes the sound exposure normalized to an 8-hour working day, expressed as a percentage of the allowable daily noise dose. (Appendix B)	Hearing Impairment (Section 3.1.2)	--

3.1.1 Annoyance

DNL is based on long-term cumulative noise exposure and has been found to correlate with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [4, 5]. Noise studies used in the development of the DNL metric did not include rockets, which can have significant low-frequency noise energy and are historically irregularly occurring events. Thus, the suitability of DNL for rocket noise events is uncertain [6]. Additionally, the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [1]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance.

DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities. Exhibit 4-1 of FAA Order 1050.1F [1] defines the FAA's significance threshold for noise. An action is considered significant if it would increase noise in a noise-sensitive area by DNL 1.5 dBA or more and the resulting noise exposure level is at least DNL 65 dBA. For example, an increase from DNL 65.5 dBA to 67 dBA is considered a significant impact, as is an increase from DNL 63.5 dBA to 65 dBA.

3.1.2 Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. These guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [2], National Institute for Occupational Safety and Health (NIOSH) [7], and the Department of Defense (DoD) Occupational Hearing Conservation Program [8]. 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 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. $L_{A,max}$ can be used to identify potential locations where hearing protection should be considered for rocket operations.

In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). Although the daily noise dose metric was established to protect workers against NIHL, the results can also help contextualize the noise exposure in the community. The level of exposure is typically calculated in terms of a daily noise dose, which is a function of the sound exposure normalized to an 8-hour workday. For example, a person will reach 100% of their daily noise dose after 15 minutes of exposure to 115 dBA. A person will also reach 100% of their daily noise dose after 8 hours of exposure to 90 dBA.

3.1.3 Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element.

A National Aeronautics and Space Administration (NASA) technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The conclusions were based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB (unweighted) and one in 1,000 households exposed to 111 dB (unweighted).

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the rocket engine remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [3] damage claim criteria represent the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

3.2 Sonic Boom Metrics and Effects

Table 4 presents metrics and associated effects relevant to the analysis of sonic booms from commercial space operations. The associated effects referenced in Table 4 are discussed in more detail in Sections 3.2.1 through 3.2.4. For more detailed metric definitions beyond the descriptions provided in Table 4, see Appendix B.

In addition to the FAA's primary noise metric for sonic booms, C-weighted DNL (CDNL), Table 4 provides supplemental metrics that can be used to evaluate potential impacts to people, and structures. The peak overpressure is particularly useful in improving the public's understanding of the impulsive sonic boom event(s). The peak overpressure is used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures.

Table 4. Metrics for sonic boom analysis.

Metric	Description	Effect	Level
C-weighted Day-Night Average Sound Level (CDNL)	A cumulative (C-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.2.1)	60 dBC [9]
Peak Overpressure	A single-event metric that describes the highest instantaneous sound pressure level, characterized for sonic booms by the front shock wave. (Appendix B)	Physiological Effects (Section 3.2.2)	
		Hearing Impairment (Section 3.2.3)	140 dB (4 psf) [7]
		Vibration on Structures (Section 3.2.4)	2 psf [10, 11]

3.2.1 Annoyance

Similar to propulsion noise (see Section 3.1.1), DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to sonic booms. However, for impulsive noise sources with significant low frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [12]. In terms of percentage of people who are highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [9].

3.2.2 Physiological Effects

The unexpected, loud impulsive noise of sonic booms tends to cause a startle effect in people. However, when people are exposed to impulsive noises with similar characteristics on a regular basis, they tend to become conditioned to the stimulus and no longer display the startle reaction. The physiological effects of single sonic booms on humans [13] can be grouped as presented in Table 5.

Table 5. Physiological effects of a single sonic booms on humans. [13]

Overpressure	Behavioral effects
< 0.3 psf	Orienting, but no startle response; eyeblink response in 10% of subjects; no arm/hand movement.
0.6–2.3 psf	Mixed pattern of orienting/startle responses; eyeblink in about half of subjects; arm/hand movements in about a fourth of subjects, but not gross bodily movements.
2.7–6.5 psf	Predominant pattern of startle responses; eyeblink response in 90 percent of subjects; arm/hand movements in more than 50 percent of subjects with gross body flexion in about a fourth of subjects.

3.2.3 Noise-Induced Hearing Impairment

Multiple U.S. government agencies provide guidelines on permissible noise exposure limits for impulsive noise such as sonic booms. NIOSH [7] and OSHA [2] state that impulsive or impact noise levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom peak overpressure level of approximately 4 psf.

3.2.4 Noise-Induced Vibration Effects on Structures

The potential for damage from sonic booms is generally confined to brittle objects, such as glass, plaster, roofs, and bric-a-brac. Table 6 provides a summary of potential damage to conventional structures at various overpressures. Additionally, Table 6 describes example impulsive events for each level range. A large degree of variability exists in damage types and amounts, and much of the potential for damage depends on the sonic boom overpressure and the pre-existing condition of a structure. Generally, the potential for damage to well-maintained structures from sonic boom overpressures less than 2 psf is unlikely [10, 11]. The probability of the potential for damage to well-maintained structures by overpressures less than 4 psf is low (see Table 6) and increases for levels greater than 4 psf. Ground motion resulting from sonic boom is rare and is considerably below structural damage thresholds accepted by the United States Bureau of Mines and other agencies.

Table 6. Possible damage to structures from sonic booms. [10]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf *piledriver at construction site*	Glass	Extension of existing cracks; potential for failure for glass panes in bad repair; failure potential for existing good glass panes is less than 1 out of 10,000 at 2 psf.
	Ceiling Plaster	Fine cracks; extension of existing cracks; mostly from fragile areas.
	Wall Plaster	Fine cracks; extension of existing cracks (less than in ceilings); over doorframes; between some plasterboards; mostly fragile areas.
	Roof	Older roofs may have slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole; New and modern roofs are rarely affected.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
2 – 4 psf *cap gun/ firecracker near ear*	Glass	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
	Ceiling Plaster	Estimated rate of cracking ranges from less than 1 out of 5,000 (2 psf) to 1 out of 625 (4 psf).
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 10,000 (2 psf) to 1 out of 1,000 (4 psf).
	Roof	Potential for nail-peg failure if eroded.
	Bric-a-brac	Increased risk of tipping or falling objects.
4 – 10 psf *handgun at shooter's ear*	Glass	Regular failures within a large population of well-installed glass (1 out 50 (10 psf) to 500 (4 psf)); Failure potential in industrial and greenhouses glass panes.
	Ceiling Plaster	Estimated rate of cracking ranges from 1 out of 625 (4 psf) to 1 out of 10 (10 psf). Potential for partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 1,000 (4 psf) to 1 out of 50 (10 psf). Measurable movement of inside ("party") walls at 10 psf.
	Roof	Regular failures within a large population of nominally good slate, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Bric-a-brac	Increased risk of tipping of falling objects

Table 6. Possible damage to structures from sonic booms. [10] (continued)

Nominal level	Damage Type	Item Affected
> 10 psf *fireworks display from viewing stand*	Glass	Some good glass will fail regularly (great than 1 out of 10) to sonic booms and at an increase rate when the wavefront is normal to the glass panel. Glass with existing faults could shatter and fly. Large window frames move.
	Ceiling Plaster	Plasterboards displaced by nail popping.
	Wall Plaster	Most plaster affected. Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Roof	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; rarely domestic chimneys dislodged if not in good condition.
	Bric-a-brac	Some nominally secure items can fall, e.g., large pictures, especially if fixed to party walls.

4 STOKE NOISE AND SONIC BOOM MODELING RESULTS

The following section presents the propulsion noise and sonic boom modeling results with respect to the potential environmental impacts associated with Stoke operations at CCSFS.

4.1 Propulsion Noise Results

Rocket propulsion noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Propulsion noise generated by Stoke operations from LC-14 was modeled using RUMBLE 4.1, BRRC's Rocket Noise and Emissions Model (see Appendix C.1).

The propulsion noise results are presented in the form of noise contours, where a noise contour is a line drawn on a map that connects points of equal noise level. The noise contours are overlaid on map tiles from OpenStreetMap which contain helpful orienting features such as places, roads and boundaries, including the state and international water boundaries (shown parallel to the coastline). The single-event noise contour maps are presented for each event type, where the launch noise contours represent the maximum sound levels over the range of launch azimuths between 35° and 120°. The noise contours extend further over water than over land because water surfaces reflect more sound energy than land. Thus, the sound levels over water are elevated relative to the sound levels over land at comparable distances.

The noise levels are presented in Section 4.1.1 to provide additional context regarding the intensity of the sound and its duration. The noise effects are discussed in Section 4.1.2 with respect to annoyance, hearing conservation, and structural damage.

4.1.1 Propulsion Noise Levels

The modeled noise levels generated by Stoke operations at CCSFS are presented for three noise metrics: Unweighted Maximum Sound Level, A-weighted Maximum Sound Level, and A-weighted Sound Exposure Level. Although the maximum sound level provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard. Thus, A-weighted SEL contours are provided in addition to the $L_{A,max}$ contours, as SEL represents both the intensity of a sound and its duration. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. The A-weighted SEL is also used in the calculation of DNL.

A-weighted Maximum Sound Level ($L_{A,max}$)

The modeled A-weighted maximum sound level ($L_{A,max}$) contours are presented for Stoke launch and static fire operations in Figure 4 and Figure 5, respectively.

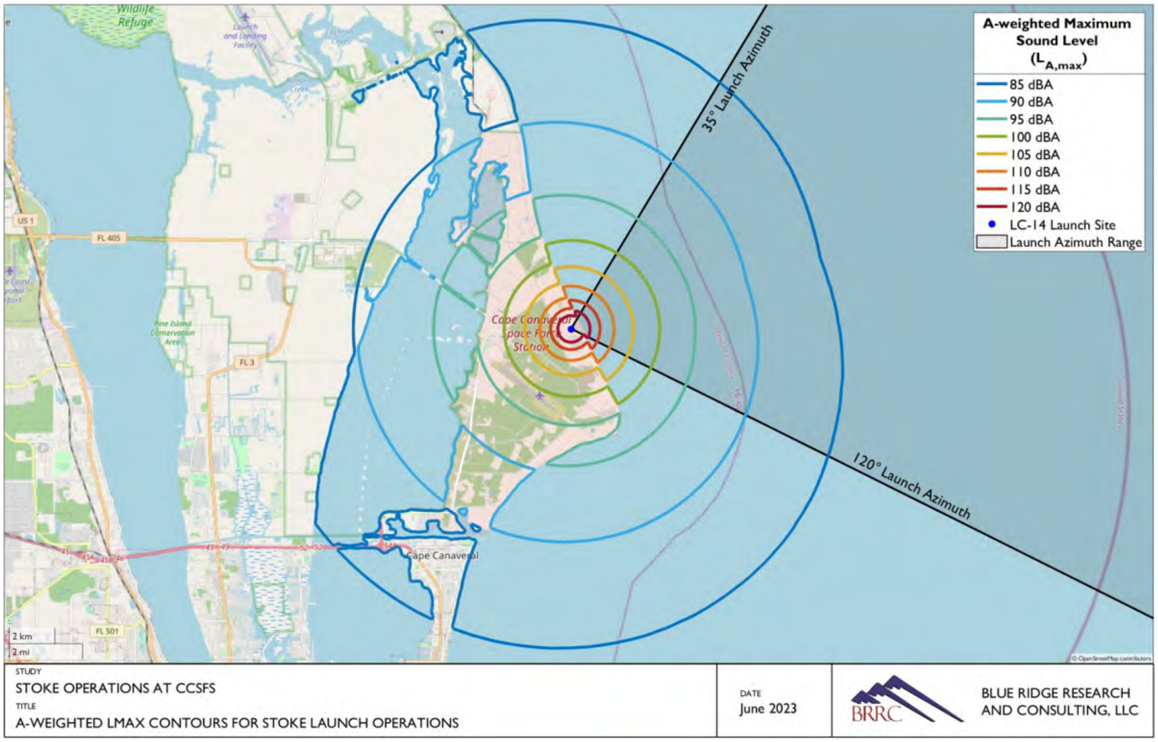

Figure 4. $L_{A,max}$ contours for Stoke launch operations over the azimuth range (35° - 120°).

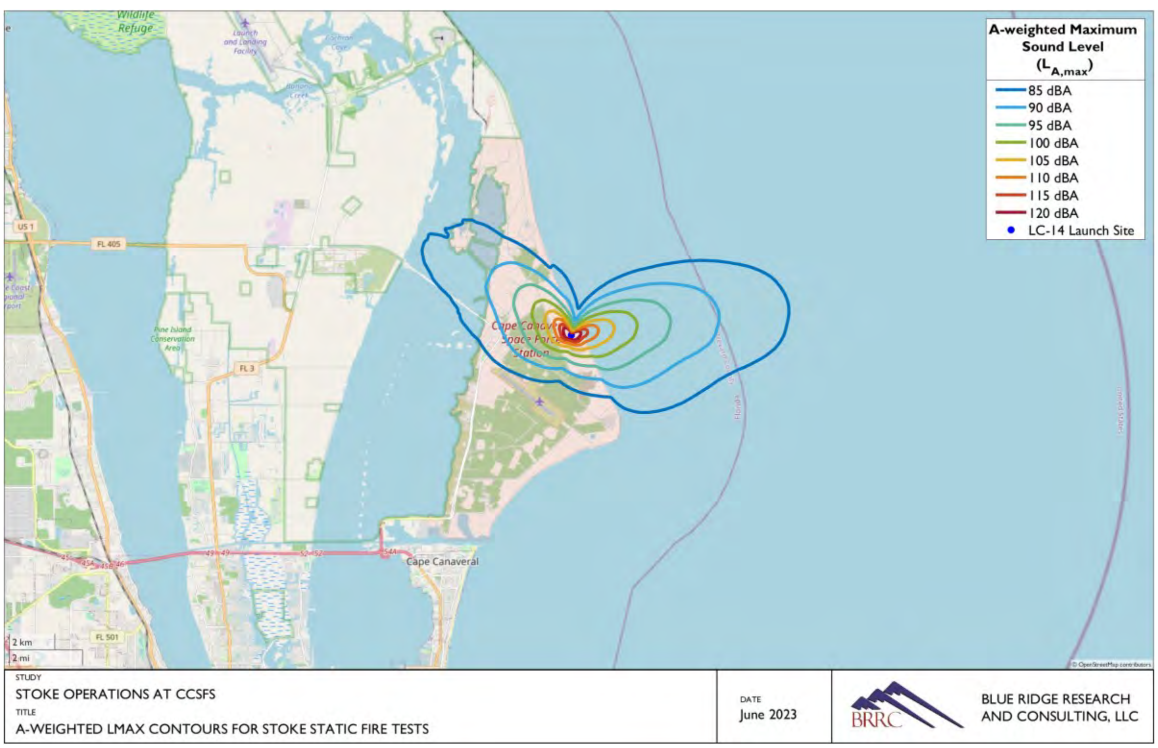

Figure 5. $L_{A,max}$ contours for Stoke static fire tests.

Unweighted Maximum Sound Level

The modeled unweighted maximum sound level contours (L_{max}) contours for Stoke launch and static fire operations are presented in Figure 6 and Figure 7, respectively.

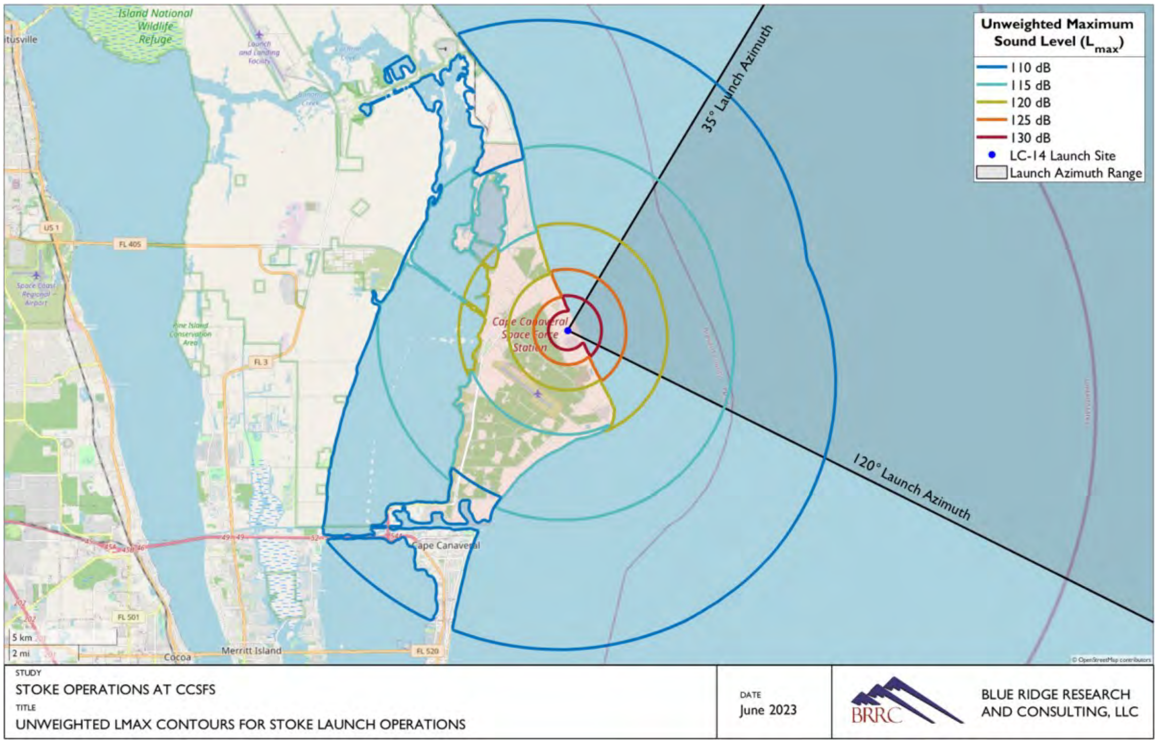

Figure 6. L_{max} contours for Stoke launch operations over the azimuth range (35° - 120°).

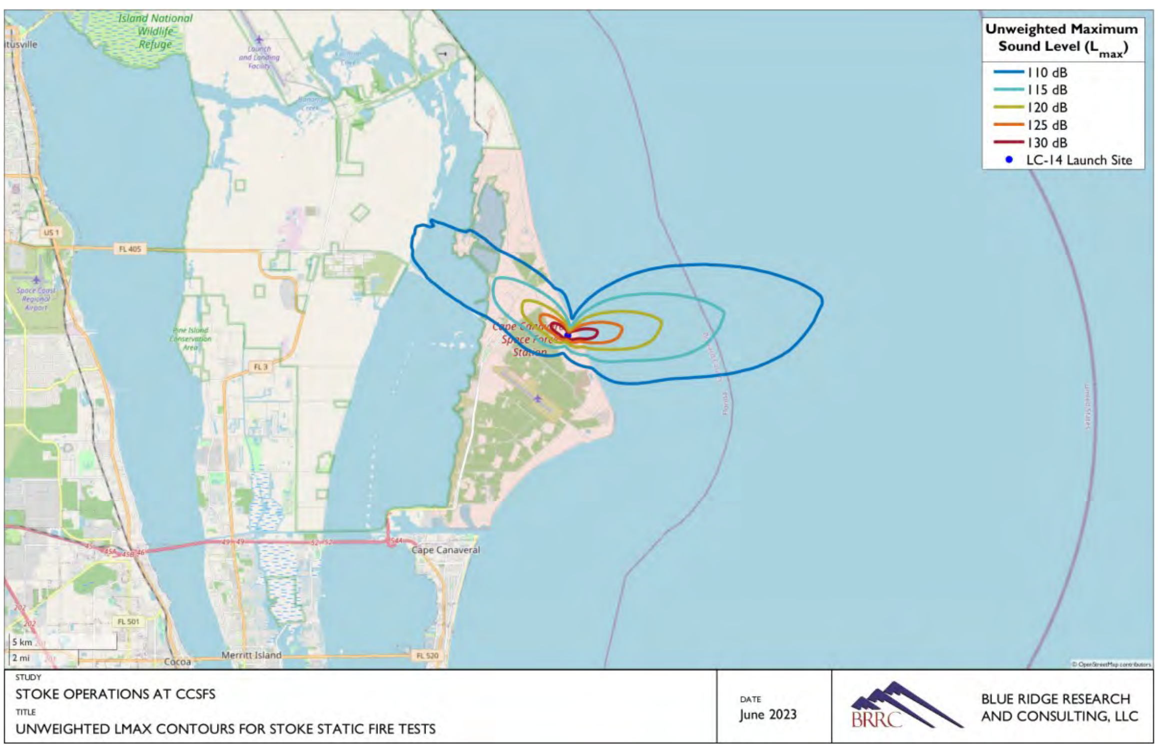

Figure 7. L_{max} contours for Stoke static fire tests.

A-weighted Sound Exposure Level

The modeled A-weighted sound exposure level (SEL) contours are presented for Stoke launch and static fire operations in Figure 8 and Figure 9, respectively.

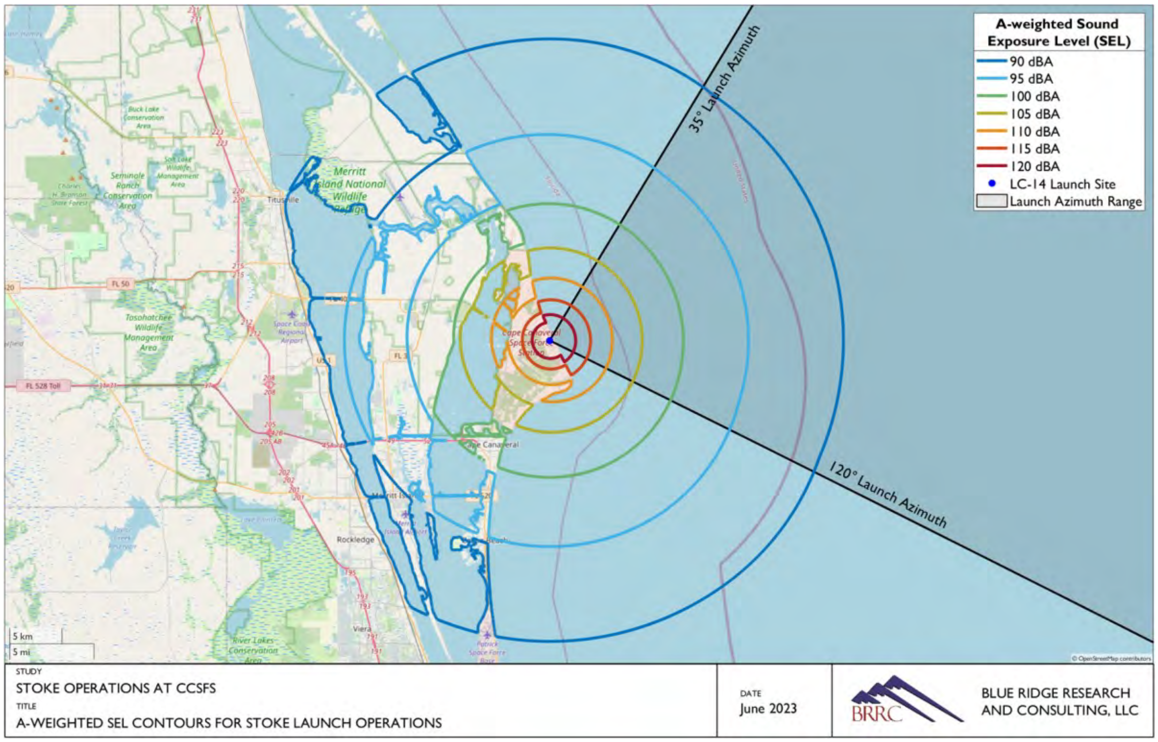

Figure 8. SEL contours for Stoke launch operations over the azimuth range (35° - 120°).

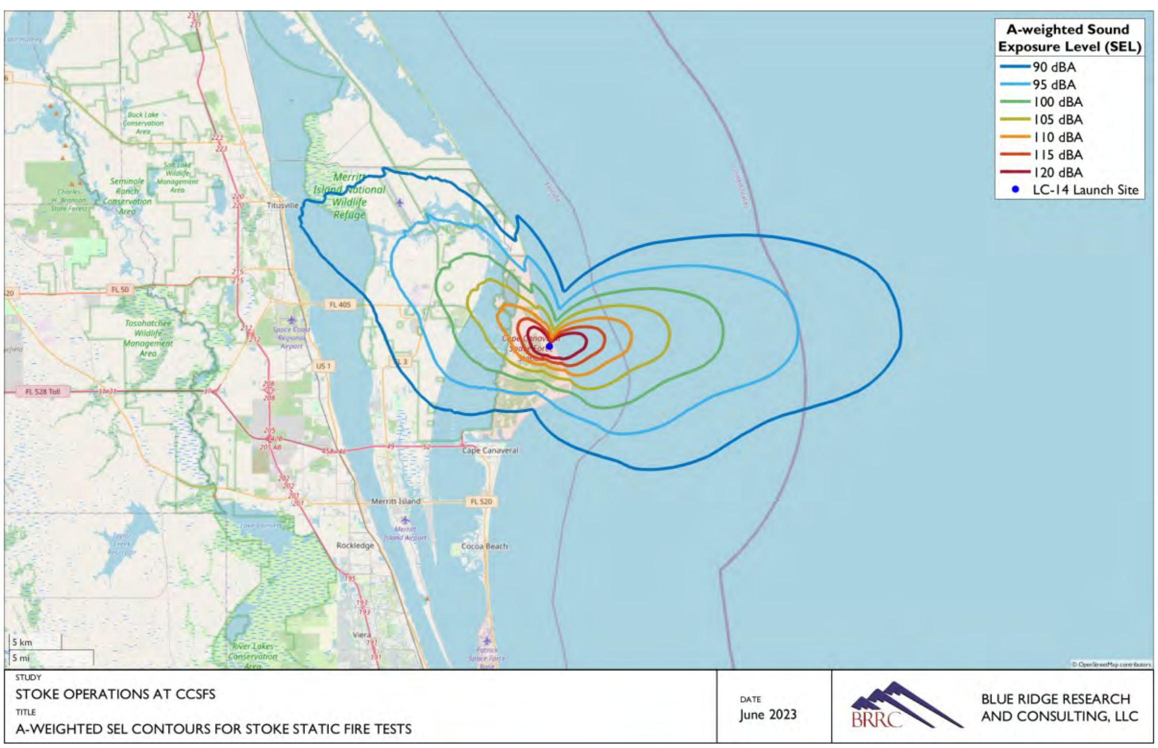

Figure 9. SEL contours for Stoke static fire tests (175 seconds).

4.1.2 Propulsion Noise Effects

The modeled noise generated by Stoke operations at LC-14 is presented with respect to three noise effects: annoyance, hearing conservation, and structural damage.

Annoyance

The potential for long-term community annoyance is assessed using DNL for propulsion noise. DNL accounts for the A-weighted SEL of all noise events in an average annual day; and accounts for increased sensitivity during the acoustical nighttime period. The DNL contours from 60 dBA to 85 dBA are presented in Figure 10 for the proposed Stoke operations at LC-14: 18 launch operations and 18 static fire tests.

DNL contours representing the no action alternative at CCSFS are unavailable, thus, an alternative technique is used to identify the potential for significant noise impacts. The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts, as 60 dBA is the smallest level that could increase noise by DNL 1.5 dBA or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dBA noise exposure level, or that will be exposed at or above this level due to the increase. The DNL 65 and 60 dBA contours do not encompass any land area outside of CCSFS boundaries, and thus no residences are impacted.

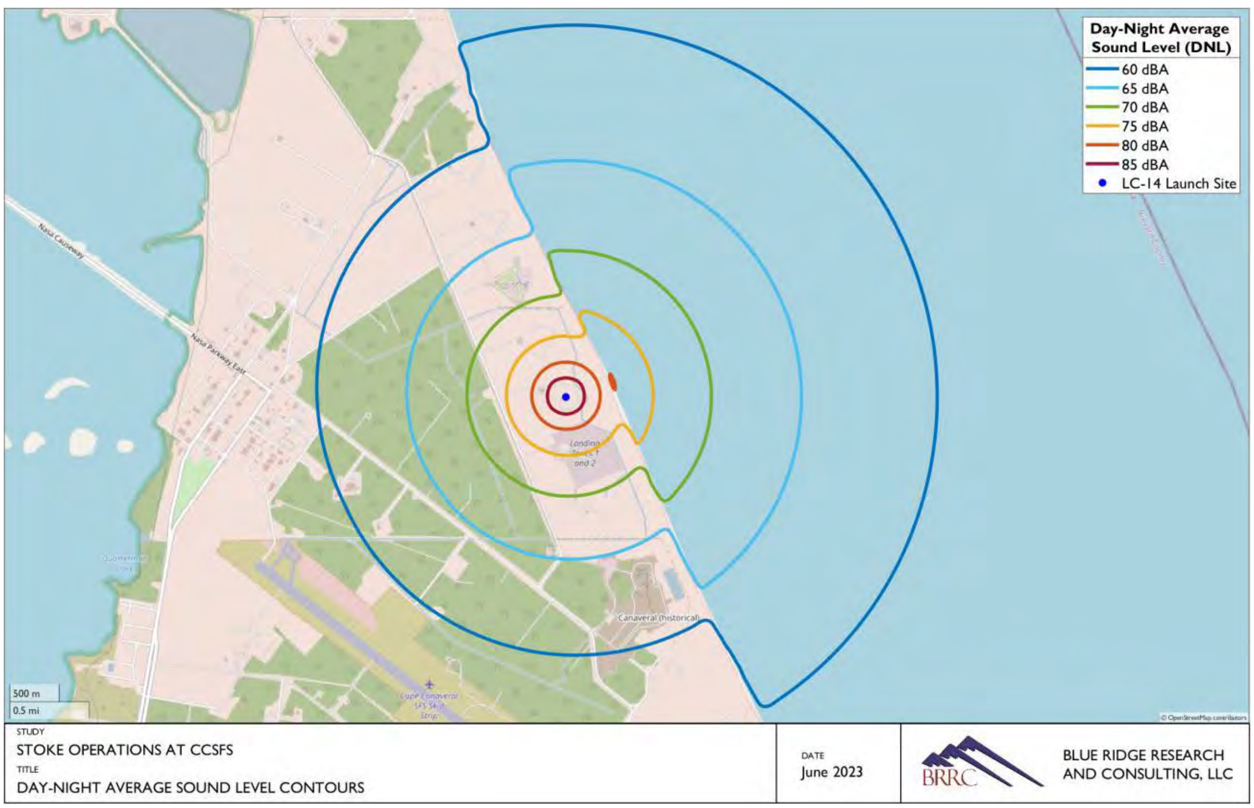

Figure 10. DNL contours for Stoke operations at LC-14.

Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. The most conservative upper noise level limit is the OSHA standard, which specifies that exposure to continuous steady-state noise is limited to a maximum of 115 dBA. The $L_{A,max}$ 115 dBA contour can be used to identify potential locations where hearing protection should be considered for rocket operations. In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). The modeled allowable daily noise dose contours and the $L_{A,max}$ 115 dBA contour associated with Stoke launch and static fire operations at LC-14 are presented in Figure 11 and Figure 12, respectively.

The modeled Stoke launch operations generate levels on land that are at or above an $L_{A,max}$ of 115 dBA within 0.56 miles of LC-14. The modeled Stoke static fire noise contours are more directive than the launch noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located on land along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.4 miles of LC-14 for static fire tests. Note, the levels produced by static fire tests will remain constant over the duration of the event, whereas the levels produced by launch operations will decrease as the rocket moves further away from the receptor. The entire land area encompassed by the 115 dBA noise contours is within the boundaries of CCSFS. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a single Stoke operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

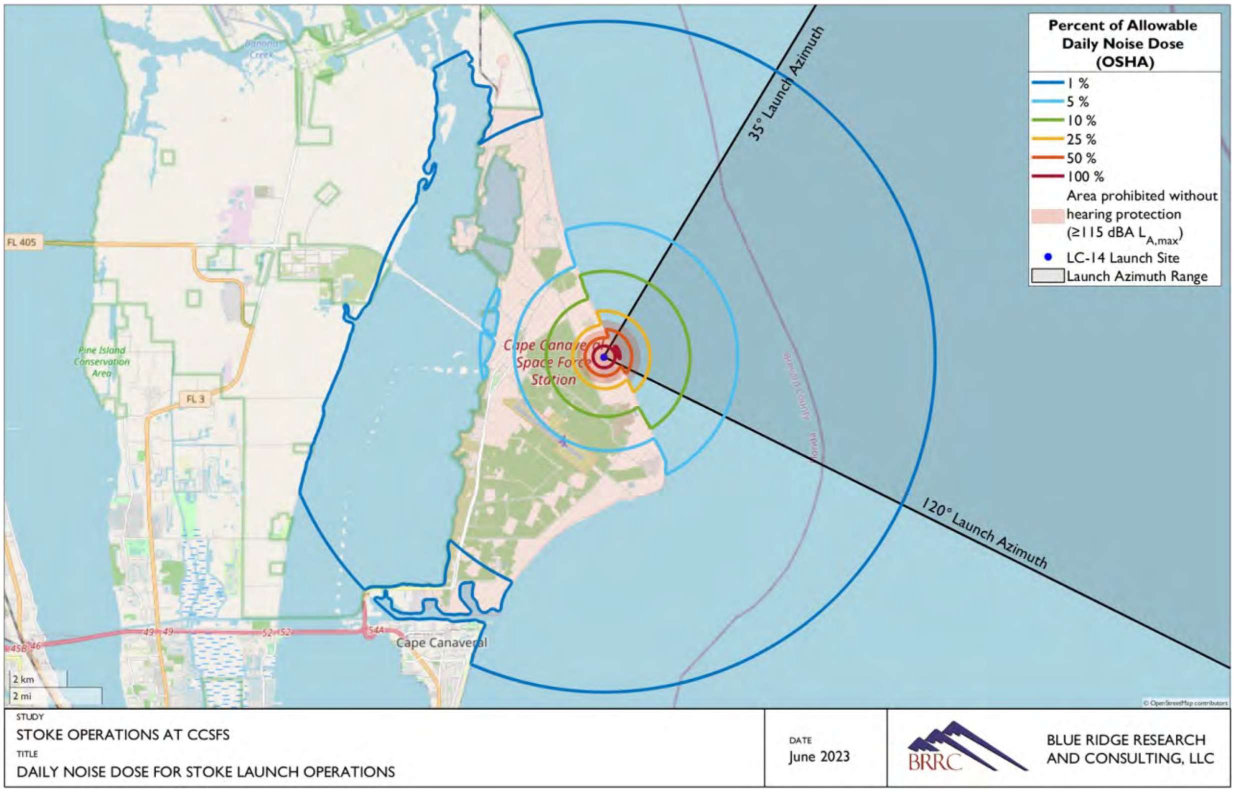

Figure 11. Allowable daily noise dose contours for Stoke launch operations over the azimuth range (35° - 120°).

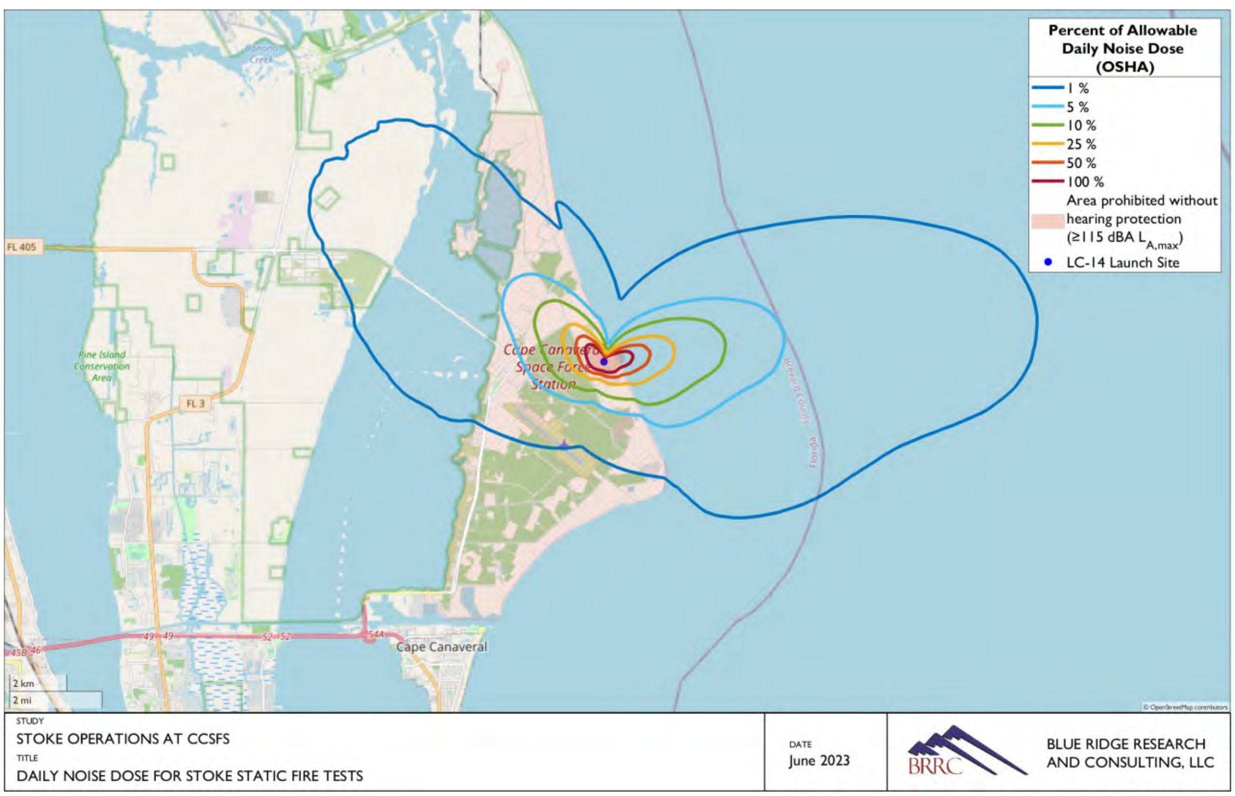

Figure 12. Allowable daily noise dose contours for Stoke static fire tests.

Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element. A NASA technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB and one in 1,000 households exposed to 111 dB. L_{max} values of 120 dB and 111 dB are used in this report as conservative thresholds for potential risk of structural damage claims. The contours associated with 1:1,000 damage claims (111 dB) and 1:100 damage claims (120 dB) for Stoke launch and static fire operations are presented in Figure 13 and Figure 14, respectively. Both the 1:1,000 and 1:100 damage claims contours do not encompass any land area outside of CCSFS and Kennedy Space Center (KSC) boundaries.

The L_{max} value of 130 dB is used to further assess potential impacts to structures based on a report from the National Research Council which states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. The 130 dB L_{max} contours do not include any land area outside of CCSFS boundaries.

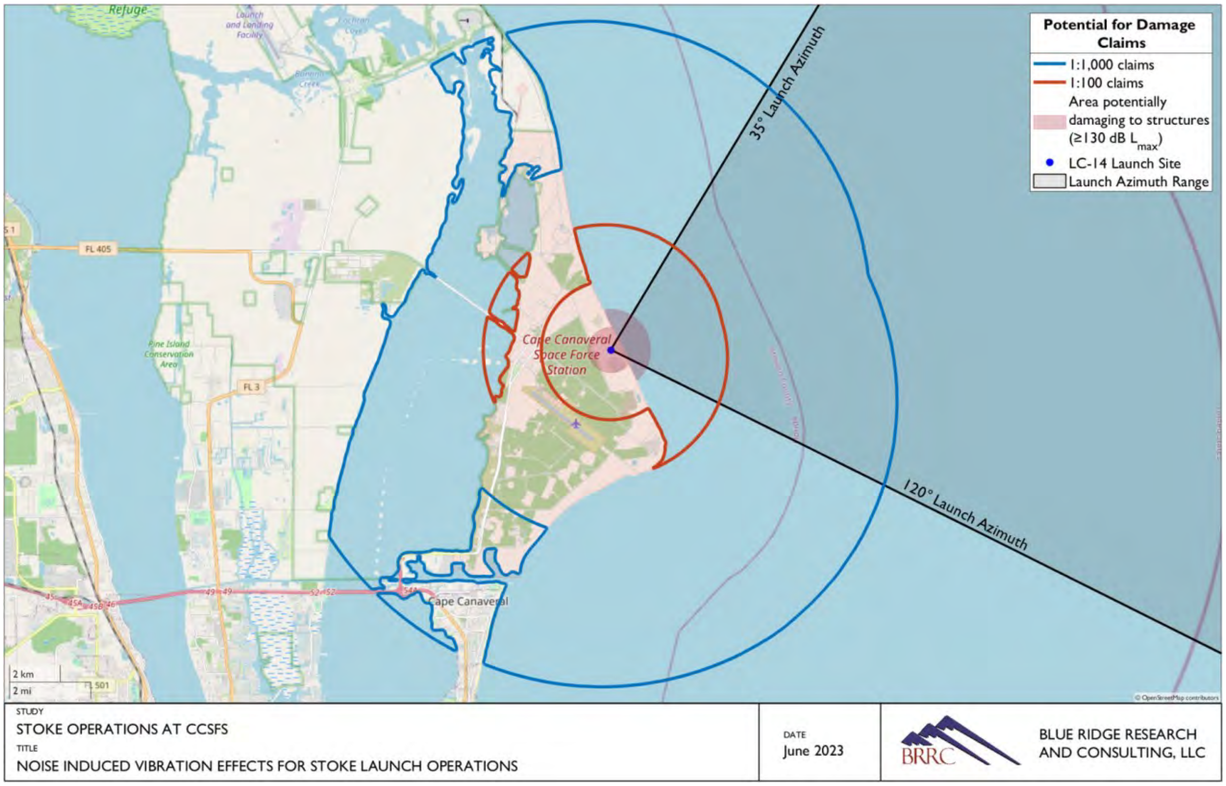

Figure 13. Potential for damage claims contours for Stoke launch operations over the azimuth range (35° - 120°).

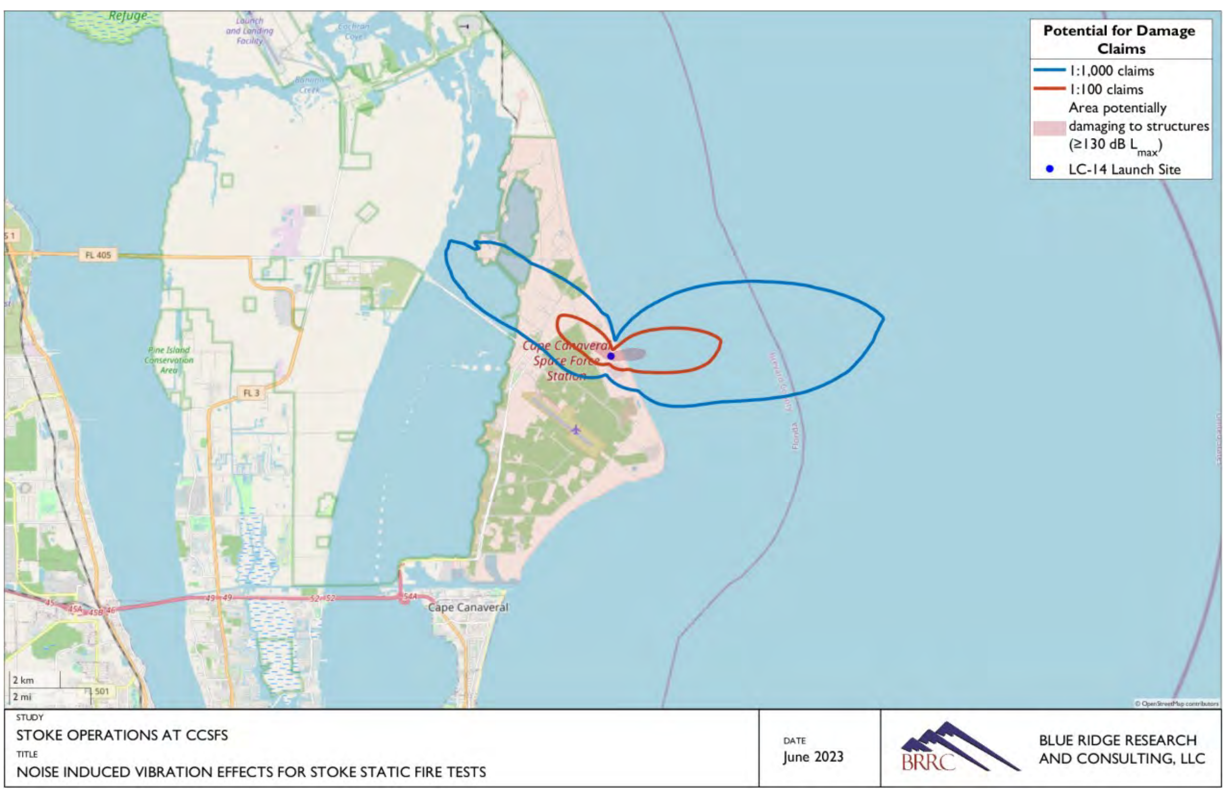

Figure 14. Potential for damage claims contours for static fire tests.

4.2 Sonic Boom Results

Sonic booms generated by Stoke launch operations from LC-14 were modeled using PCBoom 6.7b (see Appendix C.2). The modeled peak overpressure levels of sonic booms from Stoke launch operations are described in Section 5.1. The potential sonic boom impacts from Stoke launch operations are negligible as the sonic booms for these events are entirely over water and thus, will not affect any people or structures.

4.2.1 Sonic Boom Peak Overpressure Levels

The location and intensity of the sonic boom footprint produced by Stoke launch operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. Figure 15 presents the Stoke launch sonic boom contours modeled for a nominal due-east launch azimuth. A summary of the modeled results is detailed below.

The modeled sonic boom begins approximately 49 miles downrange of LC-14 with a narrow, forward-facing crescent shaped focus boom region. The maximum modeled peak overpressures occur within this focus boom region. Figure 15 presents peak overpressure contours up to 4 psf, although higher peak overpressure levels up to 6 psf are modeled to occur over smaller areas along the focus line. The focus boom region is generated when the vehicle continuously accelerates and pitches downward as it ascends. As the vehicle continues to ascend, the sonic boom levels decrease, and the crescent shape becomes slightly longer and wider.

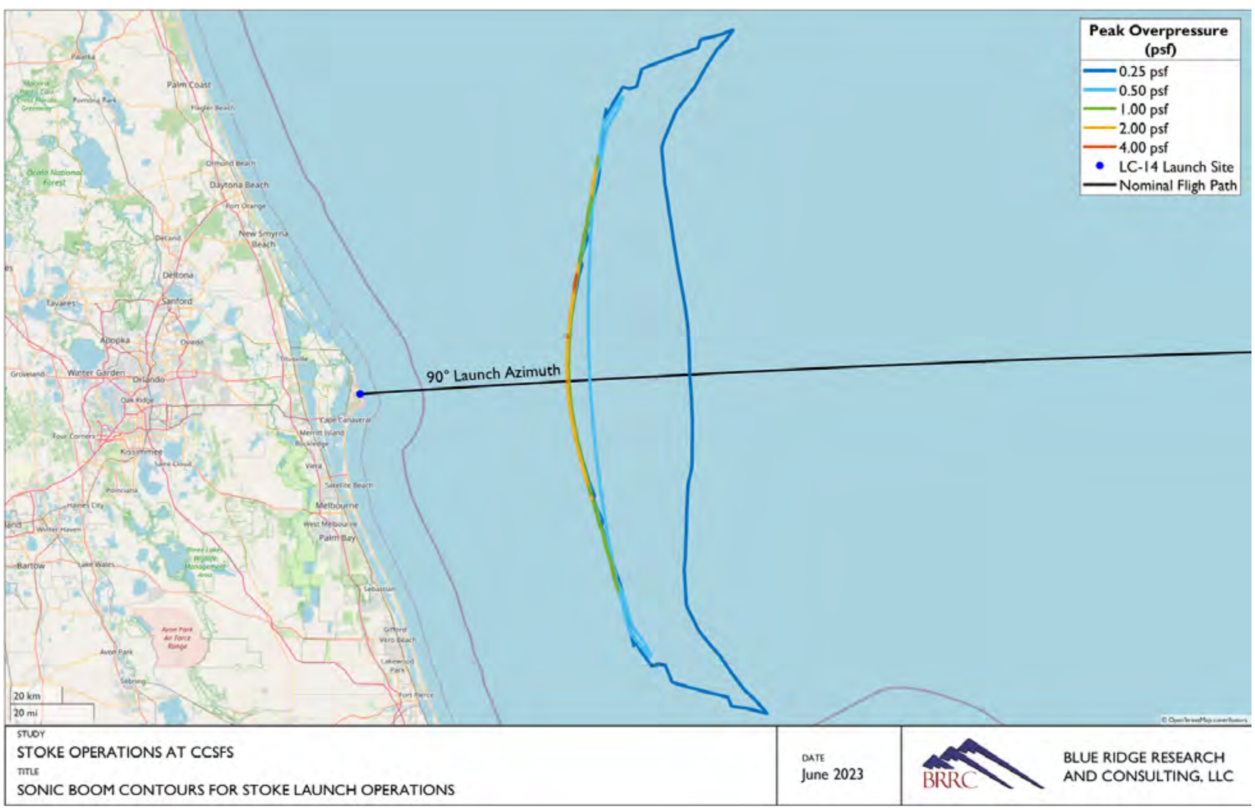

Figure 15. Sonic boom peak overpressure contours for a nominal due-east launch azimuth.

Figure 16 illustrates the sonic boom contours at the extents of the launch azimuth range (35° to 120°) and shows the area potentially exposed to peak overpressures greater than 0.25 psf from this range of launch azimuths. Sonic booms with peak overpressures greater than 0.25 psf from Stoke launch operations are modeled to occur entirely over the Atlantic Ocean.

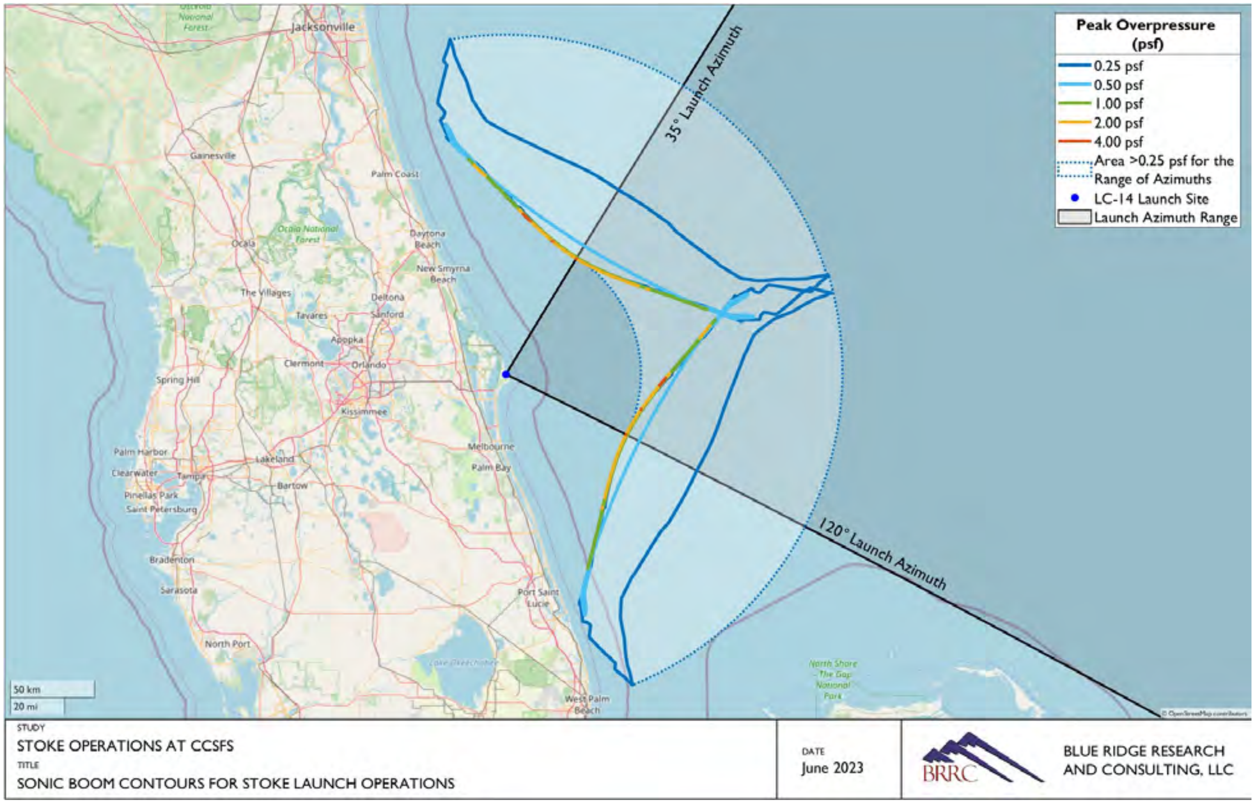

Figure 16. Sonic boom peak overpressure contours for Stoke launch operations over the azimuth range (35° - 120°).

5 SUMMARY

This report documents the noise and sonic boom study performed to support Stoke's environmental review of their launch and static operations at CCSFS LC-14. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

Propulsion Noise Results

The discussion of potential propulsion noise impacts from Stoke operations at LC-14 is summarized for the launch and static fire operations.

- **Annoyance:** The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts resulting from the propulsion noise generated by Stoke operations at LC-14. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundary of CCSFS, and, thus, no residences are impacted.
- **Hearing Conservation:** An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The entire land area encompassed by the 115 dBA Stoke noise contours is within CCSFS boundaries. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a Stoke launch or static fire operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.
- **Structural Damage:** The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [3]. The 120 dB and 111 dB contours do not encompass any land outside of CCSFS and KSC boundaries.

Sonic Boom Results

The potential sonic boom impacts from Stoke launch operations are negligible as the sonic booms are modeled to be entirely over water and thus, will not affect any people or structures.

APPENDIX A BASICS OF SOUND

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [48].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [49].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50 \text{ dB} + 50 \text{ dB} = 53 \text{ dB, and } 70 \text{ dB} + 70 \text{ dB} = 73 \text{ dB.}$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0 \text{ dB} + 60.0 \text{ dB} = 60.4 \text{ dB.}$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [48]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [50].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak overpressure. The peak overpressure is normally described in units of pounds per square foot (psf). The amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [51].

Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 17, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound.

Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and they can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds. Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.

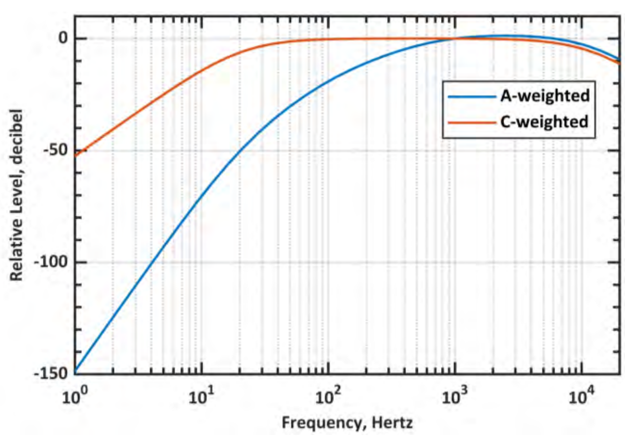

Figure 17. Frequency adjustments for A-weighting and C-weighting. [52]

Duration

The third principal physical characteristic involved in the measurement and human perception of sound is duration, which is the length of time the sound can be detected. Sound sources can vary from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second. A variety of noise metrics have been developed to describe noise over different time periods (See Appendix B).

Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sound sources [53] is shown in Figure 18. Some sources, like the air conditioners and lawn mower, are continuous sounds whose levels are constant for a given duration. Some sources, like the ambulance siren and motorcycle, are the maximum sound during an intermittent event like a vehicle pass-by. Other sources like "urban daytime" and "urban nighttime" (not shown in Figure 18) are averages over extended periods [54]. Per the United States Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [55].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 19. For example, thunder overpressure resulting from lightning strikes at a distance of one kilometer (0.6 miles) is estimated to be near two psf, which is equivalent to 134 dB [56].

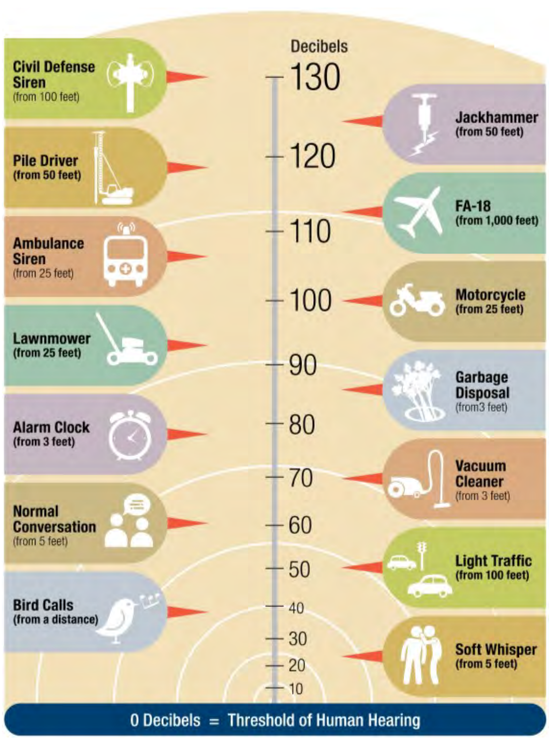

Figure 18. Typical A-weighted levels of common sounds. [57]

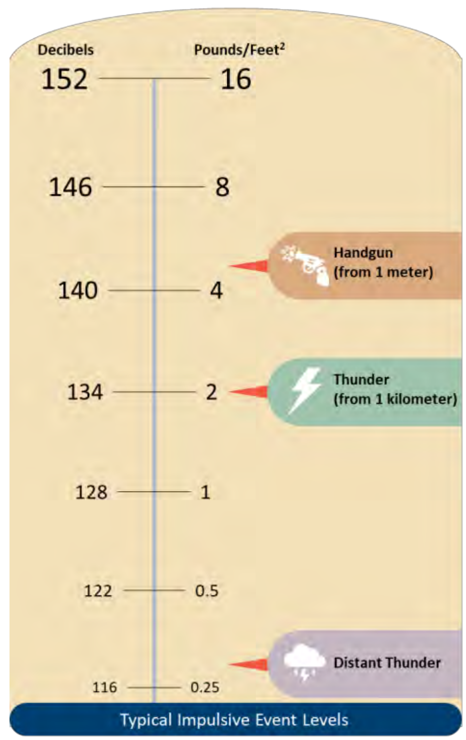

Figure 19. Typical impulsive event levels. [56]

APPENDIX B NOISE METRICS

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

Maximum Sound Level

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

Sound Exposure Level

Sound exposure level (SEL) is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event. For sounds that typically last more than one second, the SEL is usually greater than the L_{max} because a single event takes seconds and the maximum sound level (L_{max}) occurs instantaneously. A-weighted sound exposure level is abbreviated as ASEL.

Day-Night Average Sound Level and Community Noise Equivalent Level

Day-Night Average Sound Level (DNL) is a cumulative metric that accounts for the SEL of all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events. Legislation in the state of California uses the Community Noise Equivalent Level (CNEL), a variant of the DNL. In addition to the 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period, the CNEL includes a ~4.8 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 10:00 PM) to account for decreased community noise during this period. DNL and CNEL do not represent a level heard at any given time but represent long term exposure to noise.

Peak Overpressure

For impulsive sounds, the true instantaneous peak sound pressure level (L_{pk}), which lasts for only a fraction of a second, is important in determining impacts. The peak overpressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

APPENDIX C MODELING METHODS

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section C.1 and C.2, respectively.

C.1 Propulsion Noise Modeling

Rocket propulsion systems, such as solid-propellant motors and liquid-propellant engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

RUMBLE 4.1, the Rocket Propulsion Noise and Emissions Simulation Model, developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 20 and are described in the following subsections.

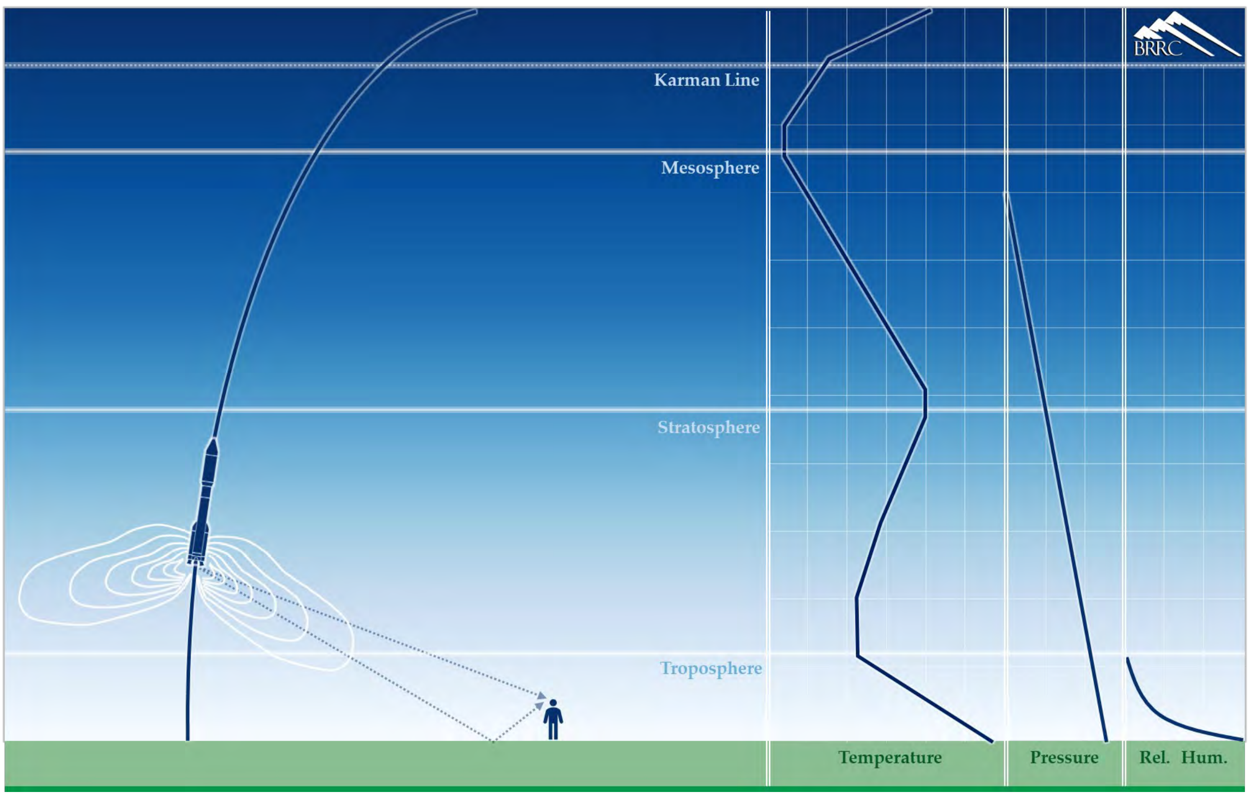

Figure 20. Conceptual overview of rocket noise prediction model methodology.

C.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [14] is utilized for the source characterization. The DSM-1 model determines the vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [15]. The acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [16]. Typical acoustic efficiency values range from 0.2% to 1.0% [14]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [14]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [17-20]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining the directivity of rockets [21]. These directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the NASA DI [22] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver and is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases.

C.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The rocket propulsion noise model components are calculated based on the specific geometry between source (vehicle trajectory point) to receiver (grid point). The position of the vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [23-26] were used to create a composite atmospheric profile for altitudes up to 66 miles. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [27] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [28, 29]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [30-36], but the standard acoustical metrics are not strongly influenced by nonlinear effects [37, 38]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 20. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [39, 40] when estimating the received noise. The model assumes a five-foot receiver height and a variable ground impedance to account for grass (soft) or water (hard) ground surfaces. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [39, 41].

C.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output. If a range of launch azimuths is being considered, the received noise represents the highest metric level generated from any launch azimuth within that range. For example, the noise metric level at a single receiver is modeled for every possible launch azimuth within the specified range, and the maximum of the range of levels is stored for the single receiver. This process is repeated for each receiver in the defined grid, and noise metric contours are developed from the grid of receivers.

C.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section C.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section C.2.2.

C.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter “N,” so a sonic boom pressure wave is usually called an “N-wave.” An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 21 shows the generation and evolution of a sonic boom N-wave under the vehicle.

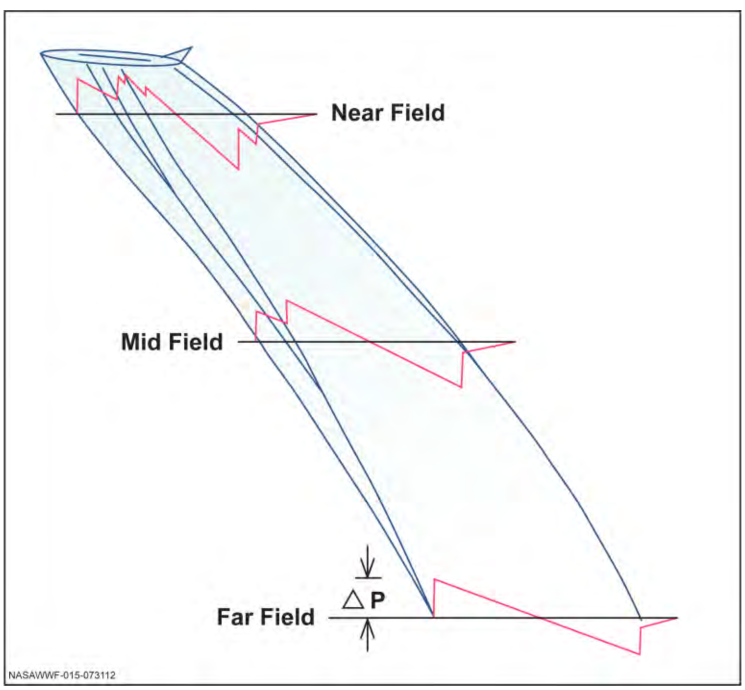

Figure 21. Sonic boom generation and evolution to N-wave. [42]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 22 shows the sonic boom wave cone generated by a vehicle in steady (non-accelerating) level supersonic flight. The wave cone extends toward the ground and is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing levels as the lateral distance increases to the cut-off edge of the "carpet."

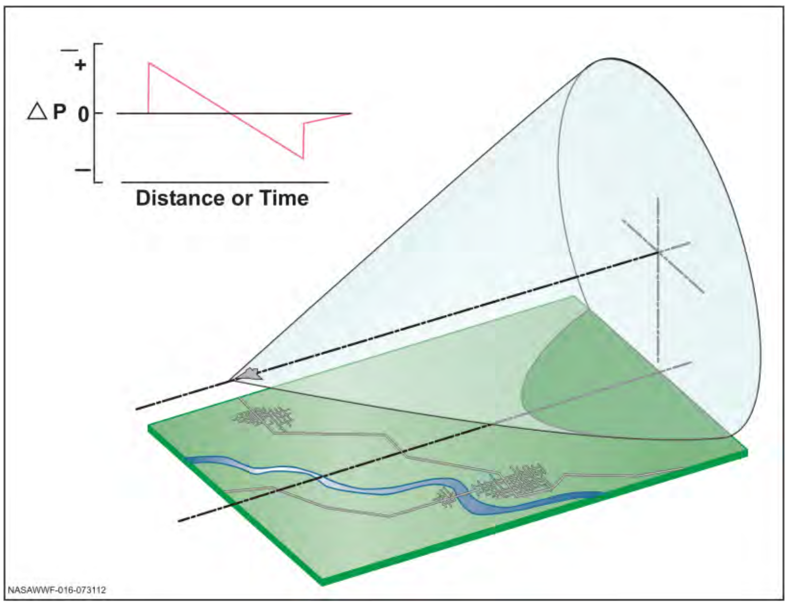

Figure 22. Sonic boom carpet for a vehicle in steady flight. [43]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [44]. Both perspectives are shown in Figure 23. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [44]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an "isopemp." The isopemp is forward-facing [as shown in Figure 23] and falls a distance ahead of the vehicle called the "forward throw." At each new point in the trajectory, a new ray cone is generated, resulting in a new isopemp that strikes the ground. These isopemps are generated throughout the trajectory, sweeping out an area called the "boom footprint."

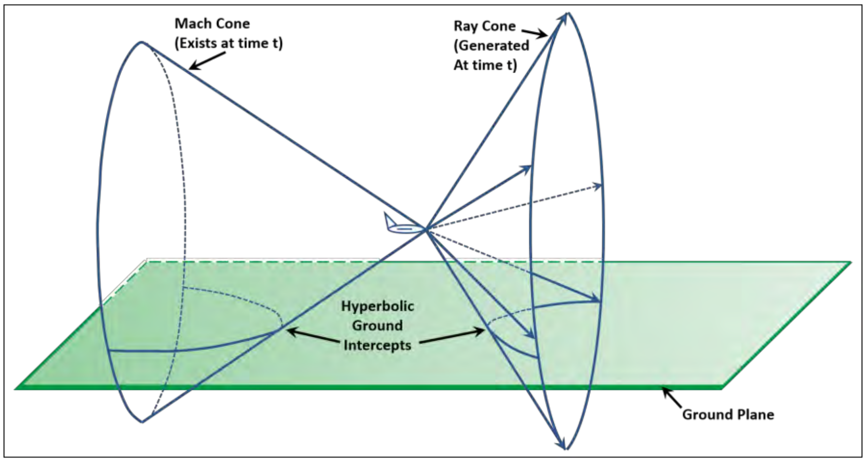

Figure 23. Mach cone vs ray cone viewpoints.

Figure 22 and Figure 23 may give the impression that the boom footprint is generally associated with rays generated from the bottom of a vehicle. This is the case for vehicles at moderate climb and dive angles, or in level flight as shown in Figure 23. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 24, rays from that part of its trajectory will not reach the ground. This is important for vertical launches, where the ascent stage of a launch vehicle typically begins at a steep angle. In these cases, sonic booms are not expected to reach the ground unless refracted back downwards by gradients in the atmosphere. Conversely, if a vehicle is in a sufficiently steep dive, such as in the right image of Figure 24, the entire ray cone may intersect the ground, resulting in an elliptical or even circular isopemp. This is of importance for space flight reentry analysis, where descent may be nearly vertical.

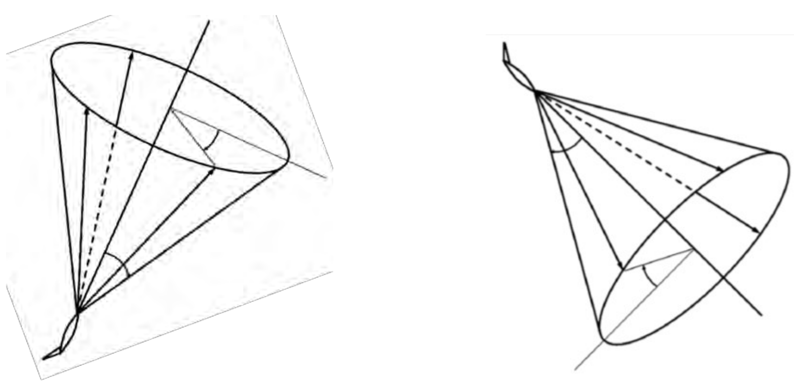

Figure 24. Ray cone in climbing (left) and diving (right) flight.

C.2.2 PCBoom

The single-event prediction model, PCBoom 6.7b [45-47], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, BRRC uses a custom version of PCBoom 6.7b that implements proper plume physics.

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through a site-specific atmospheric profile [26].

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Appendix H. Atlantic Ocean Nautical Charts

[Note: If you need help accessing this document, please contact Ms. Taylor Janise at taylor.janise.1@spaceforce.mil.]

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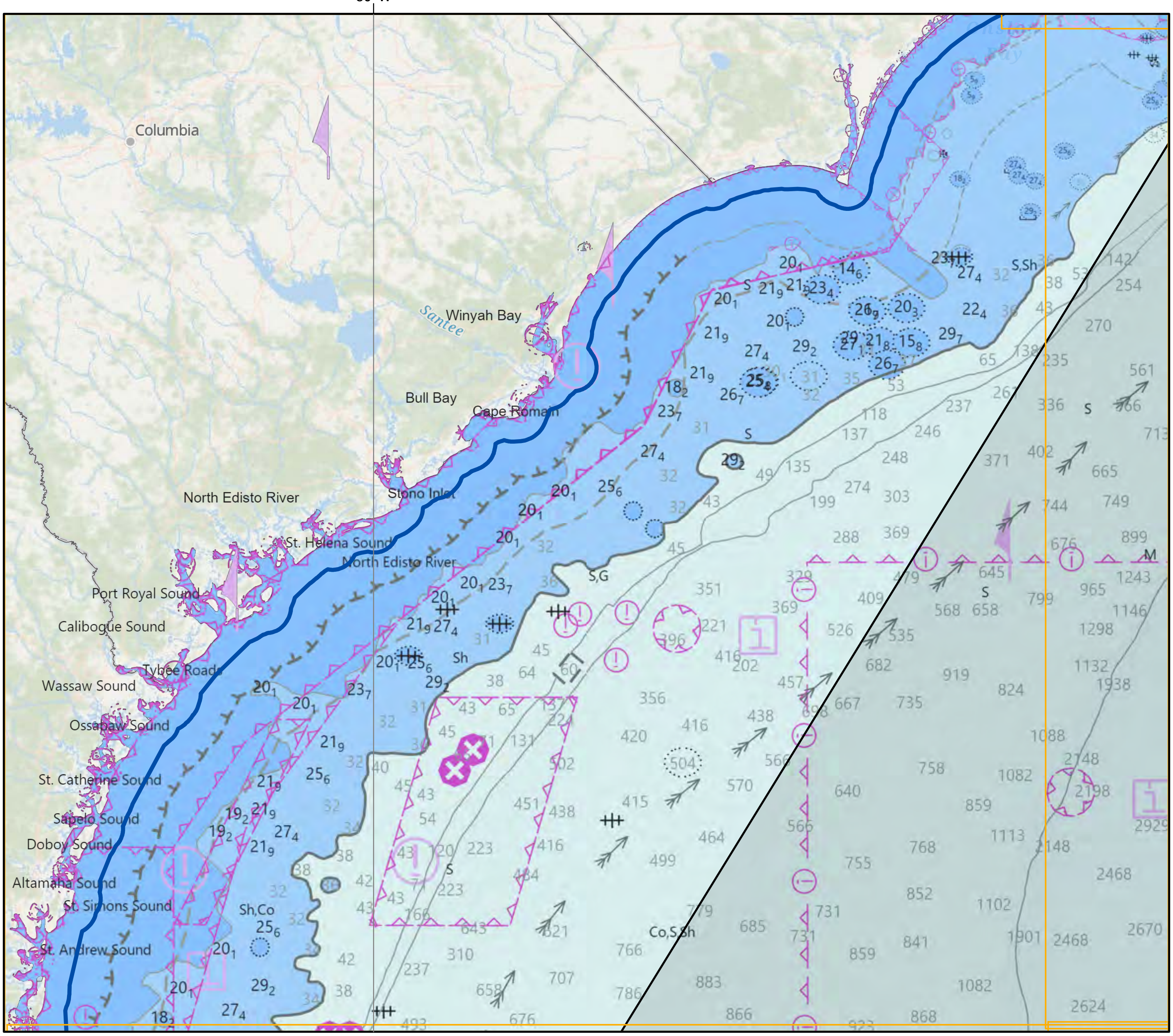

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- Launch Azimuth Range
- Nautical Map Chart Extent

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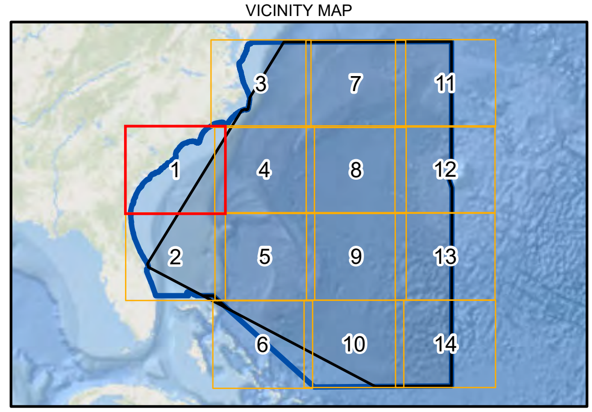

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1 inch = 44 miles

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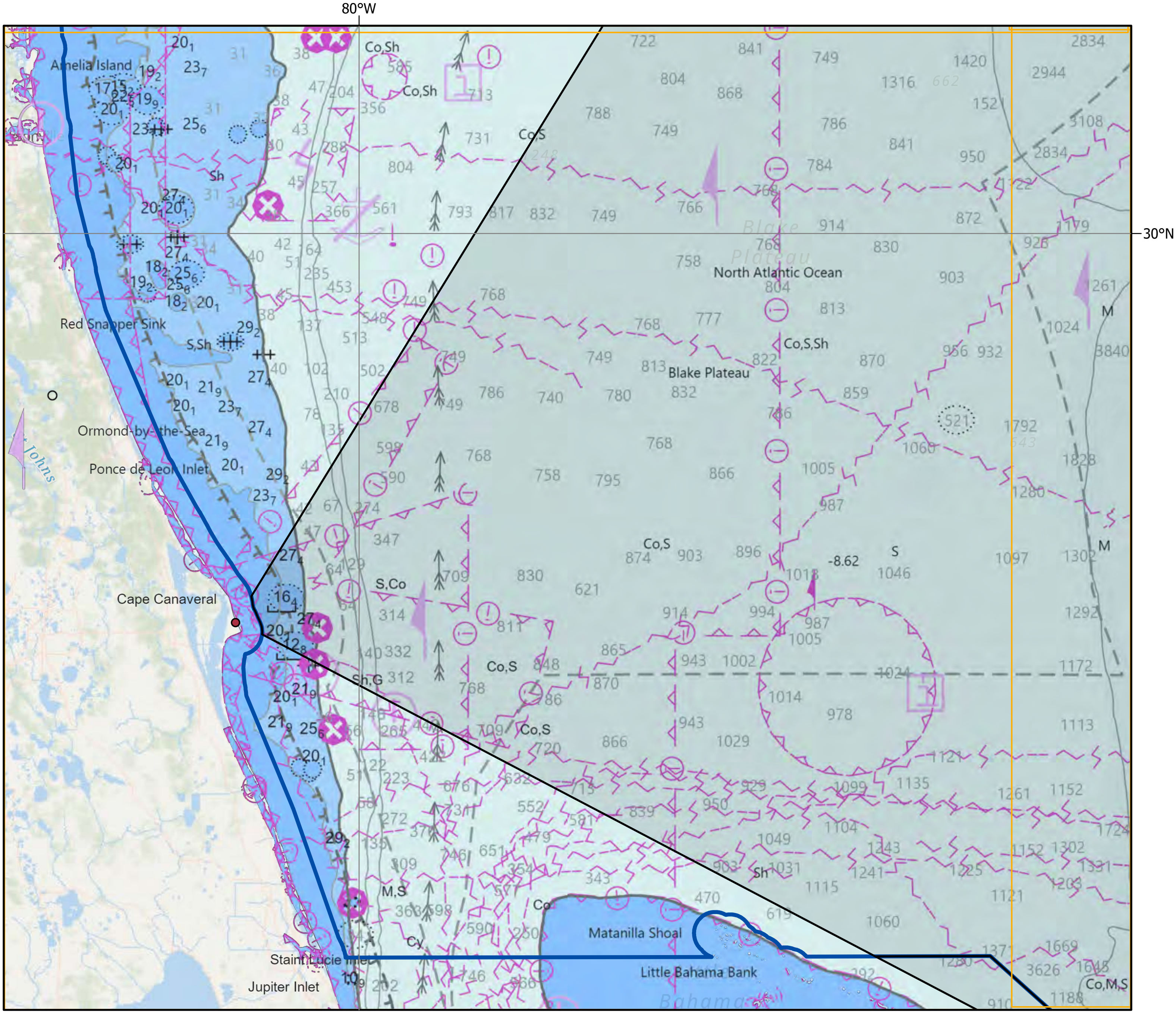

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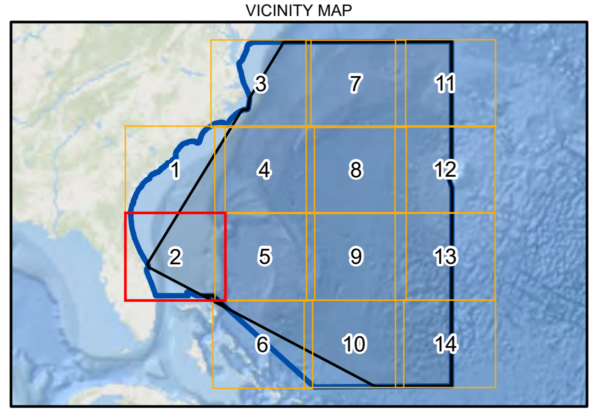

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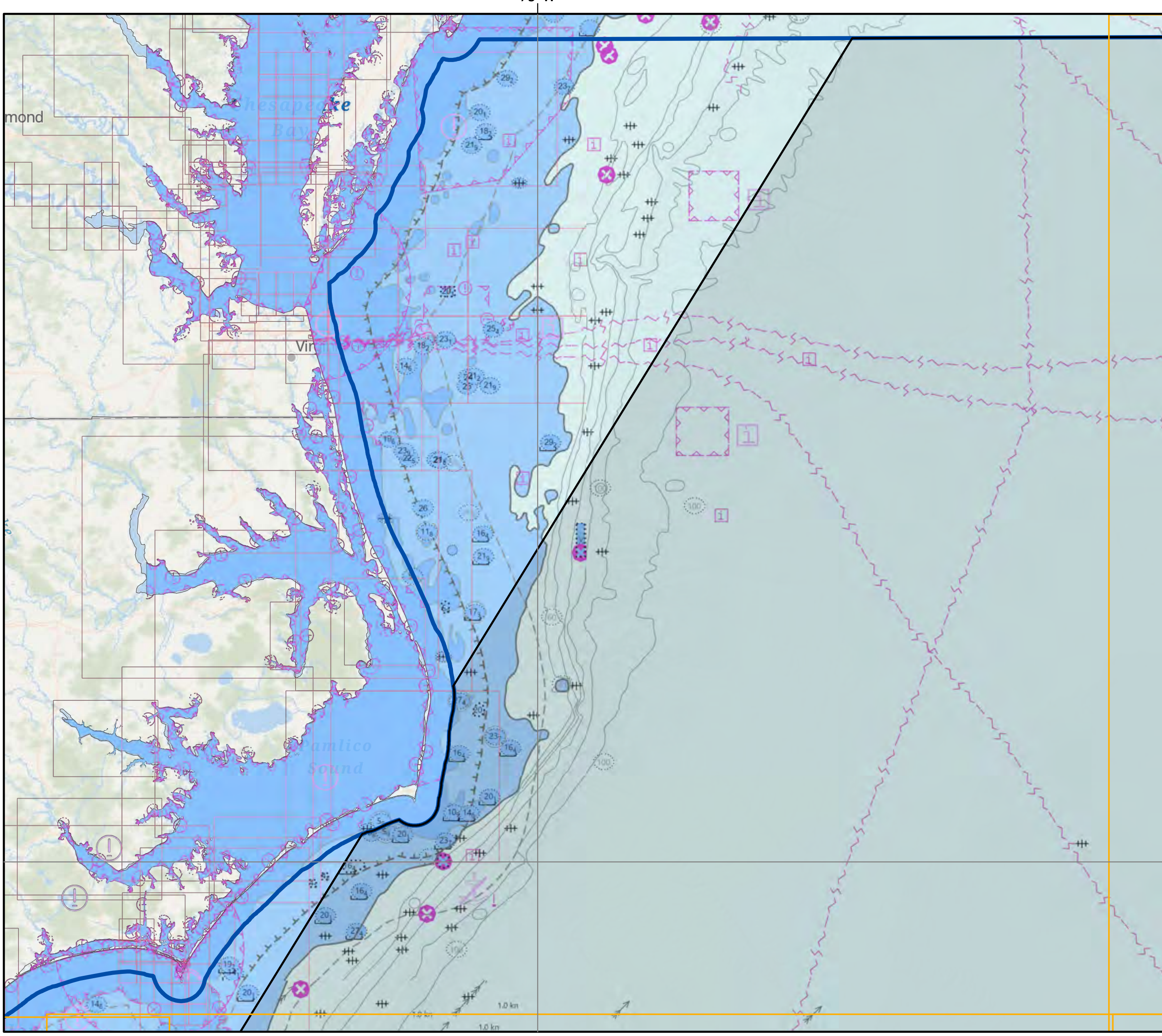

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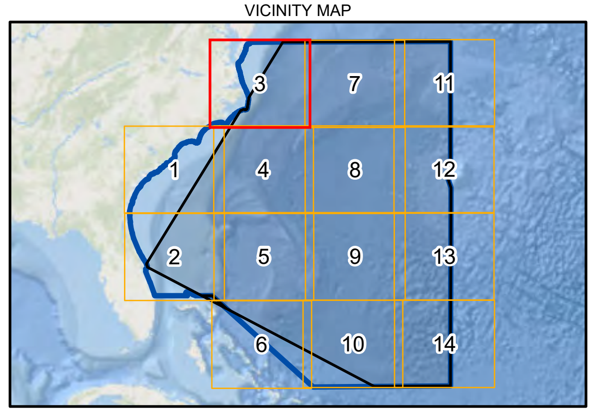

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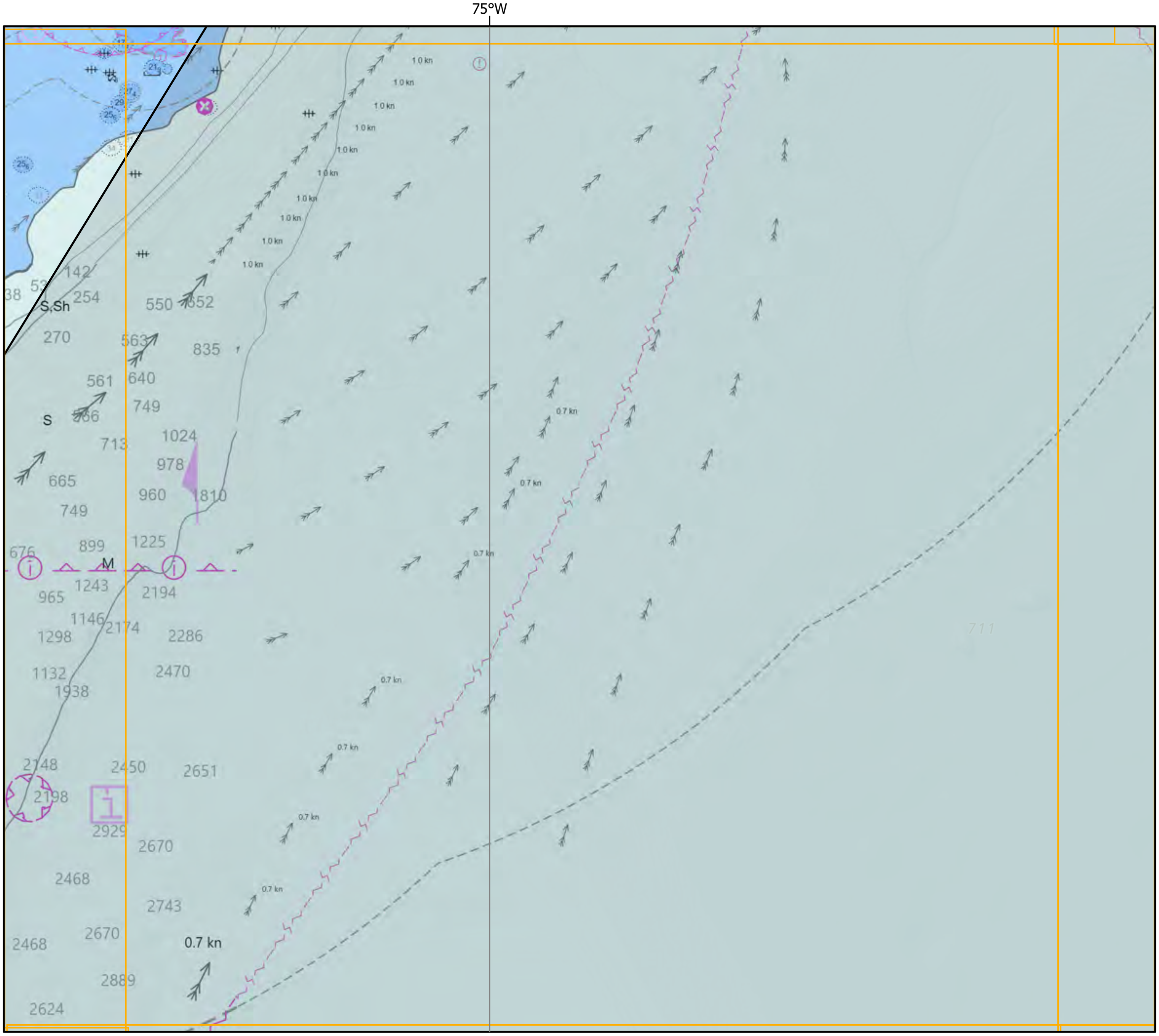

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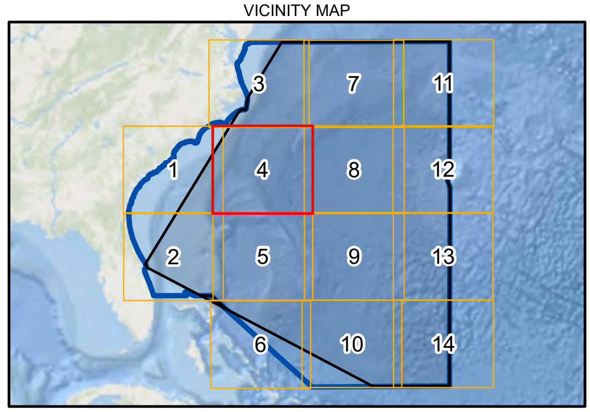

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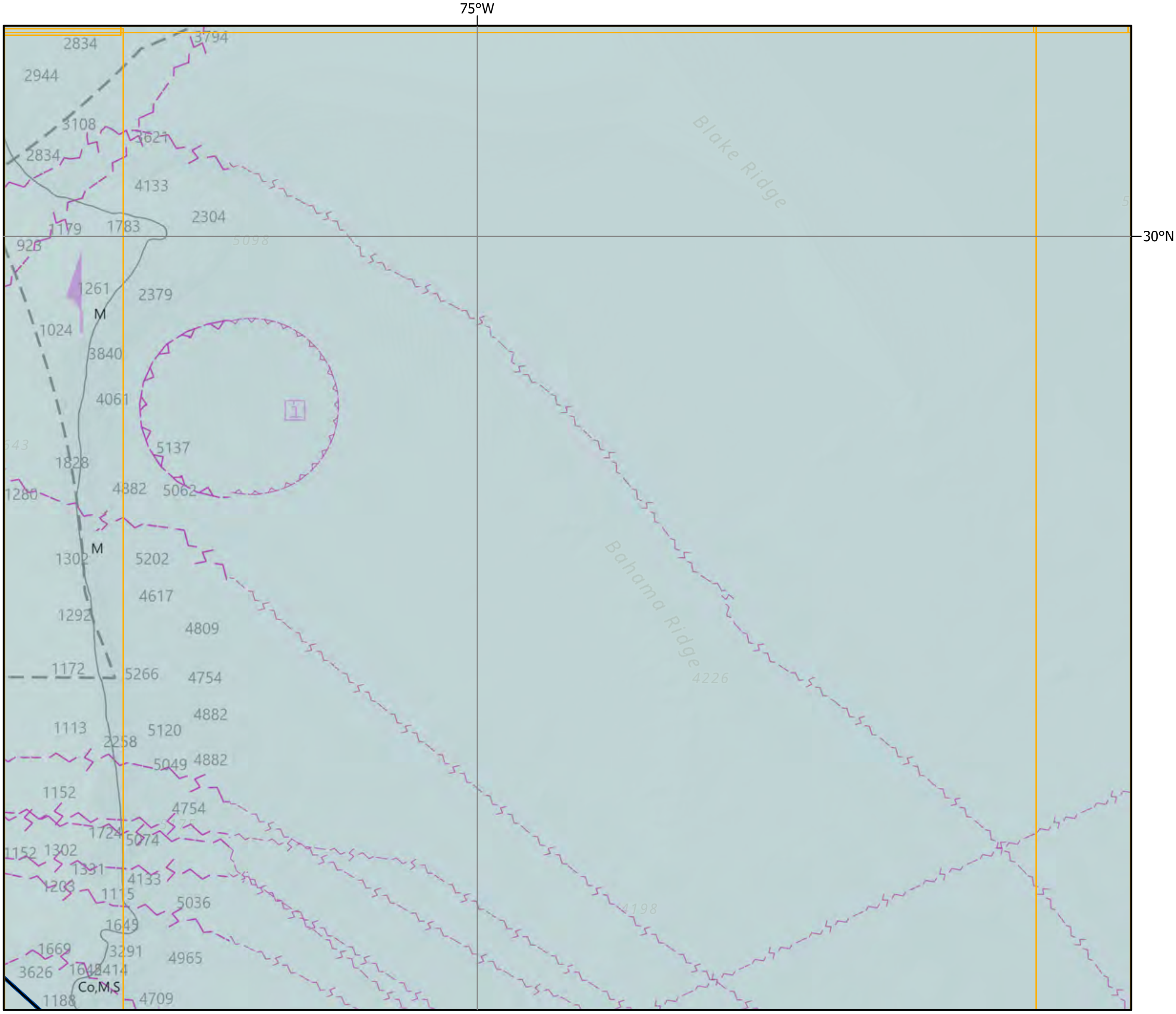

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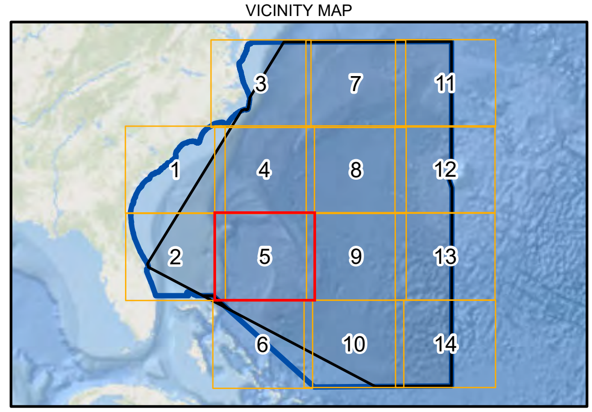

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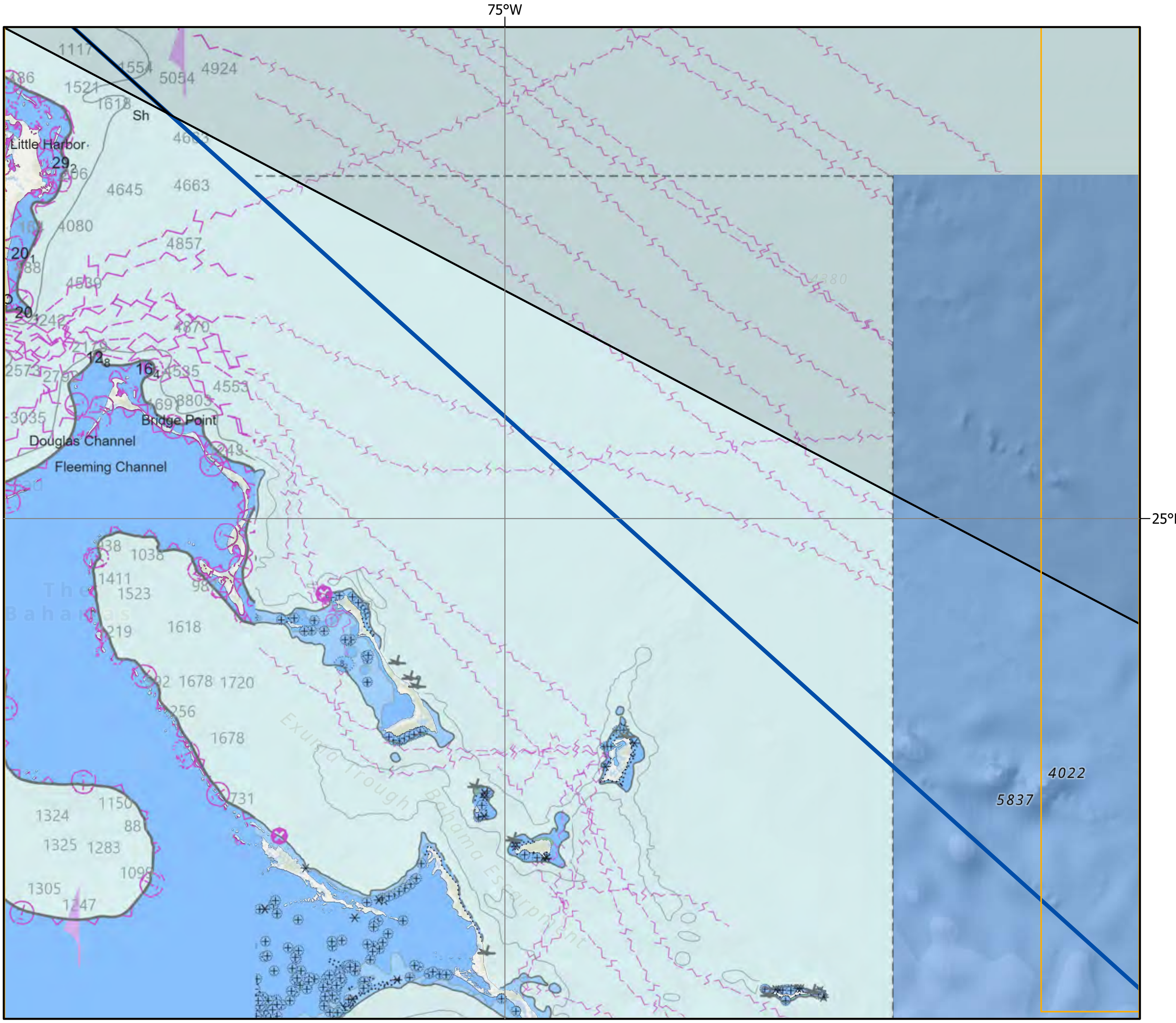

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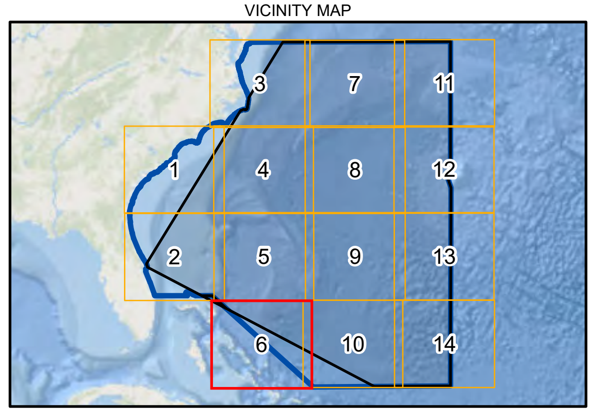

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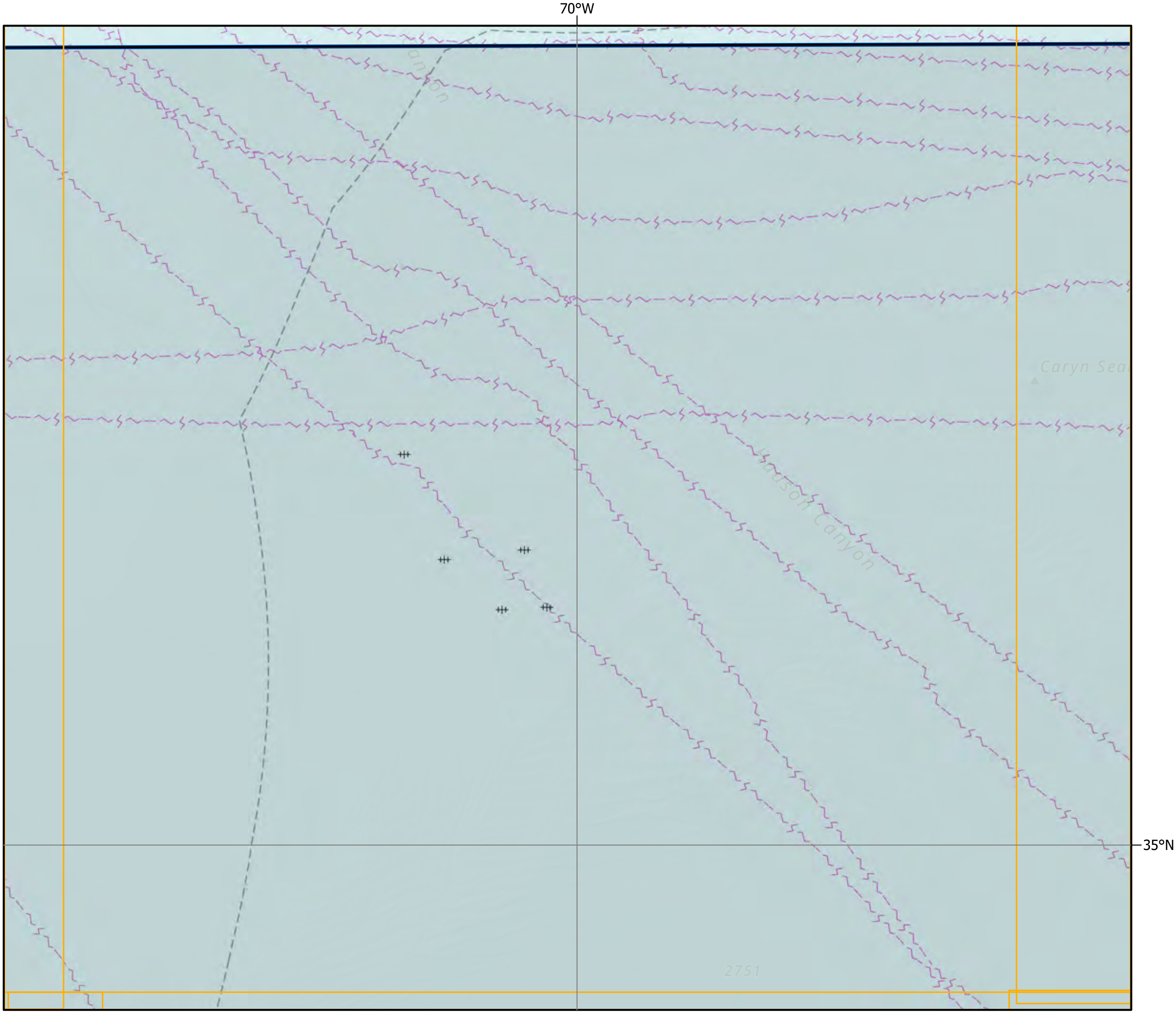

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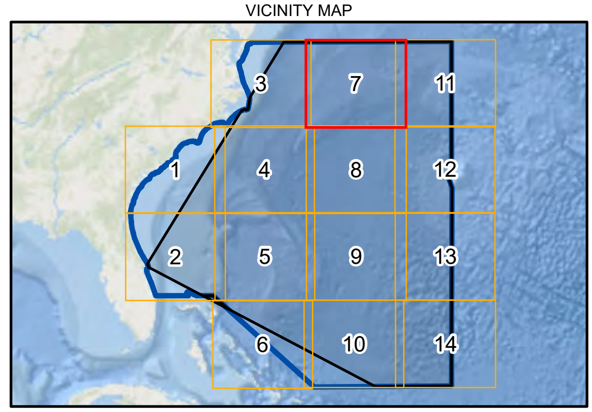

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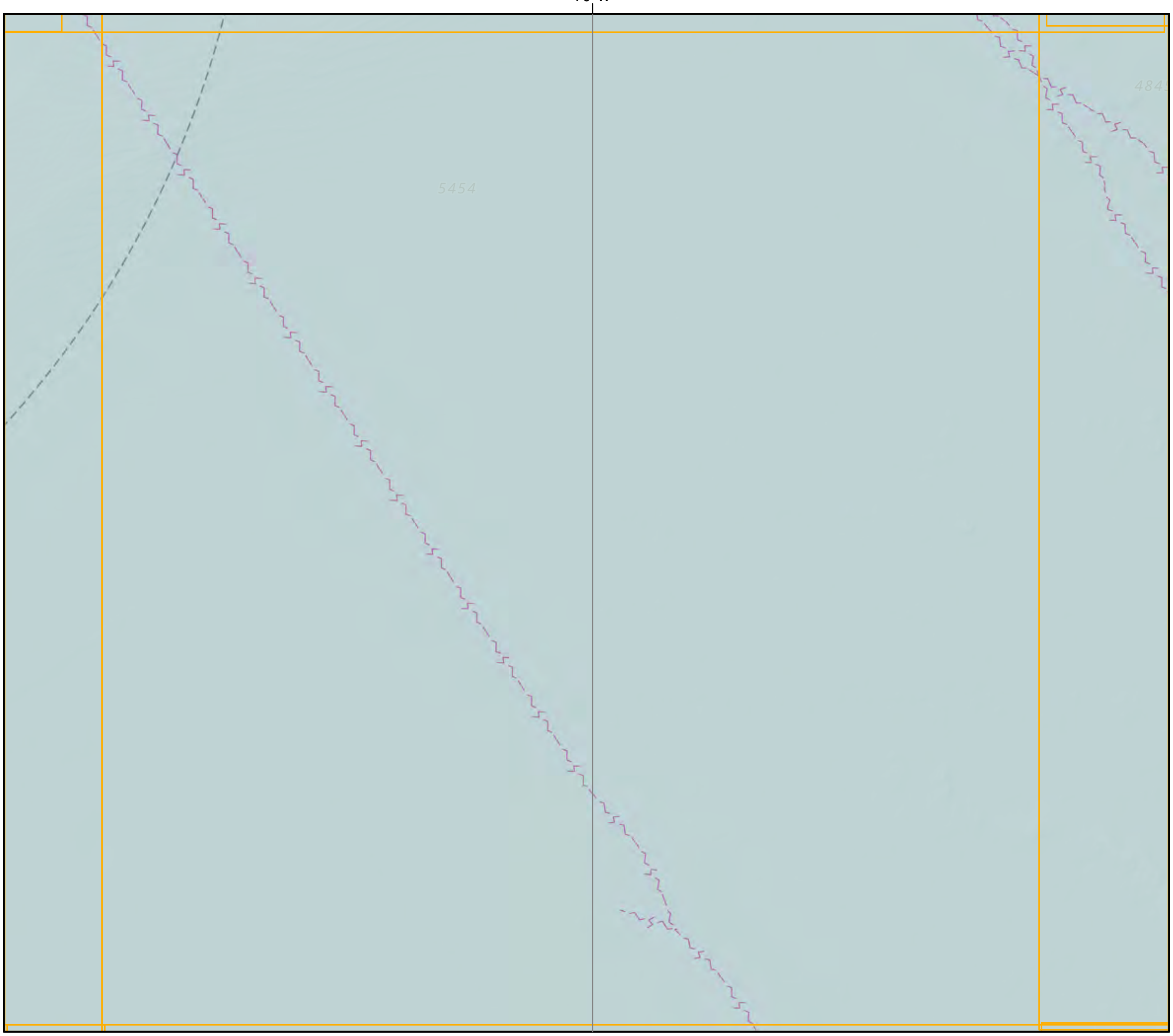

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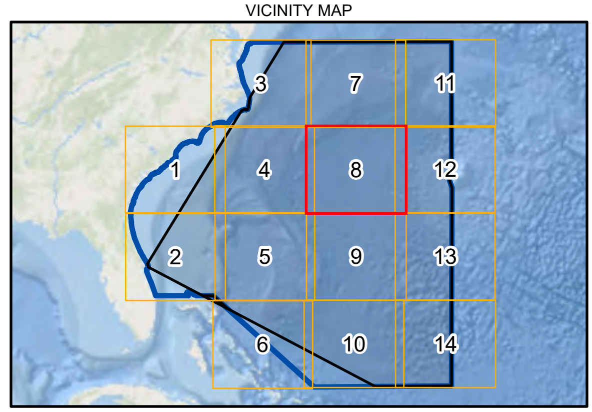

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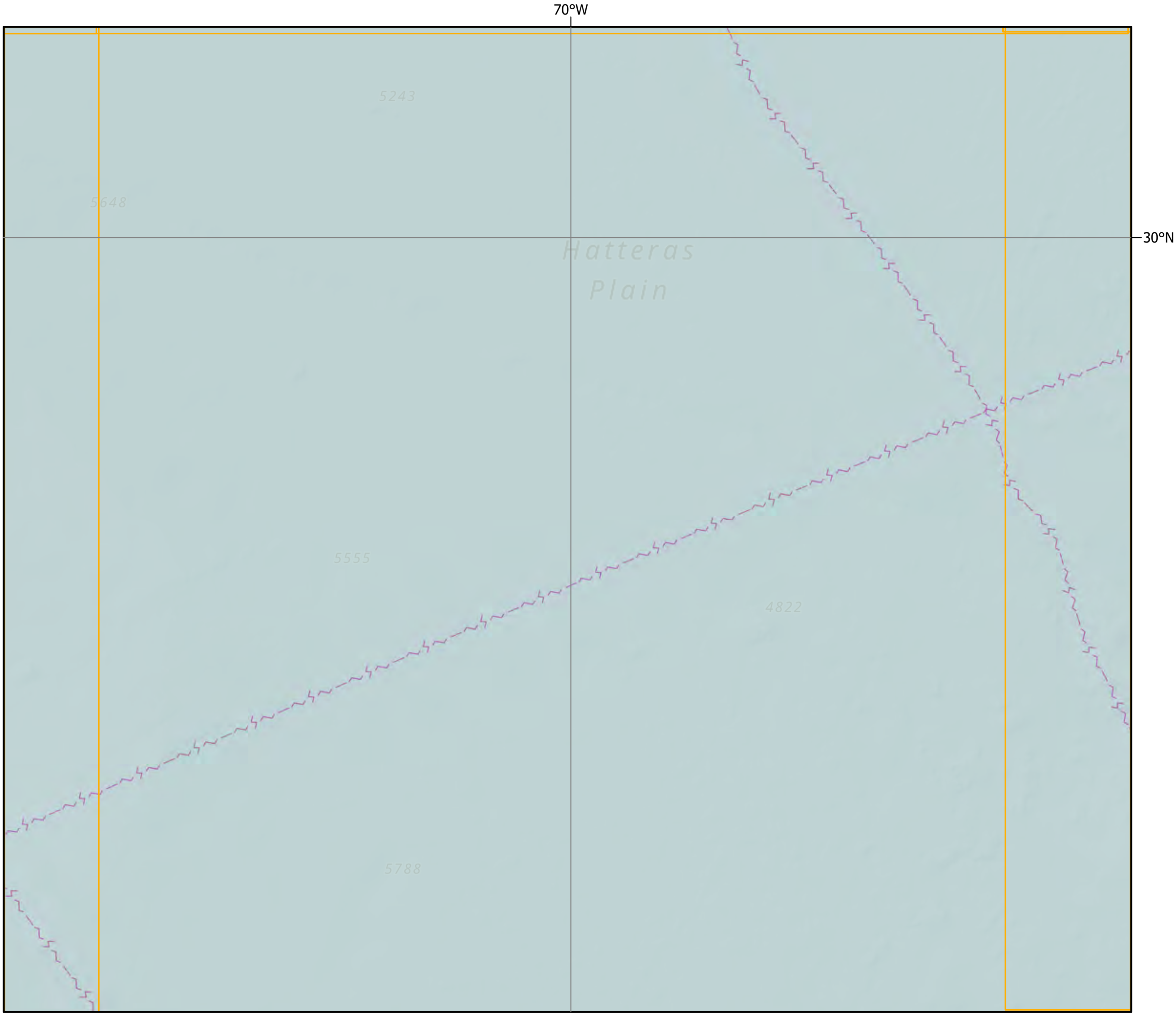

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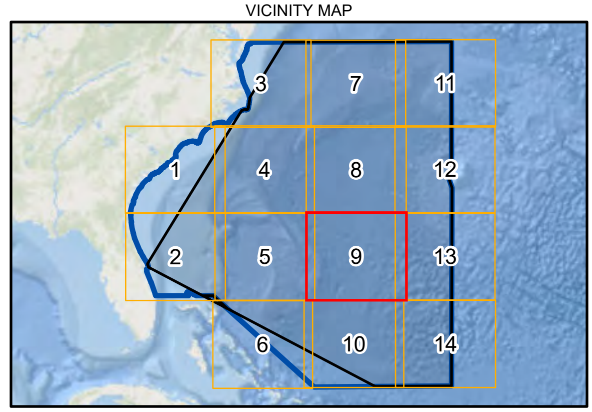

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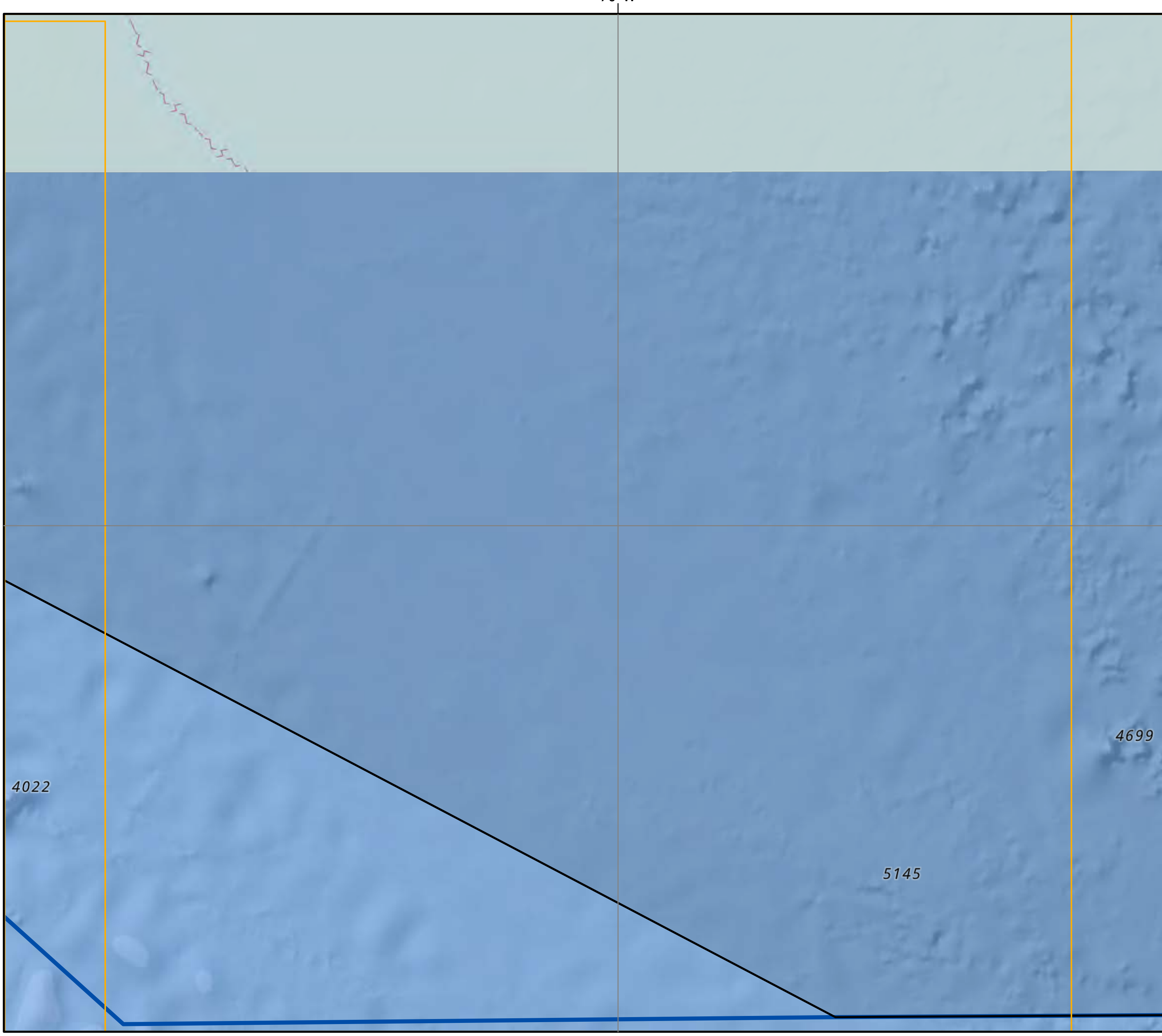

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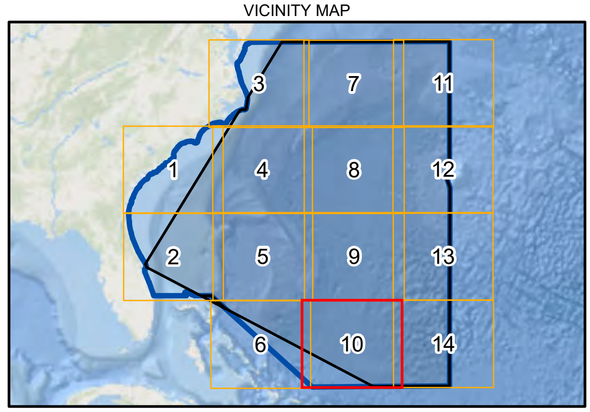

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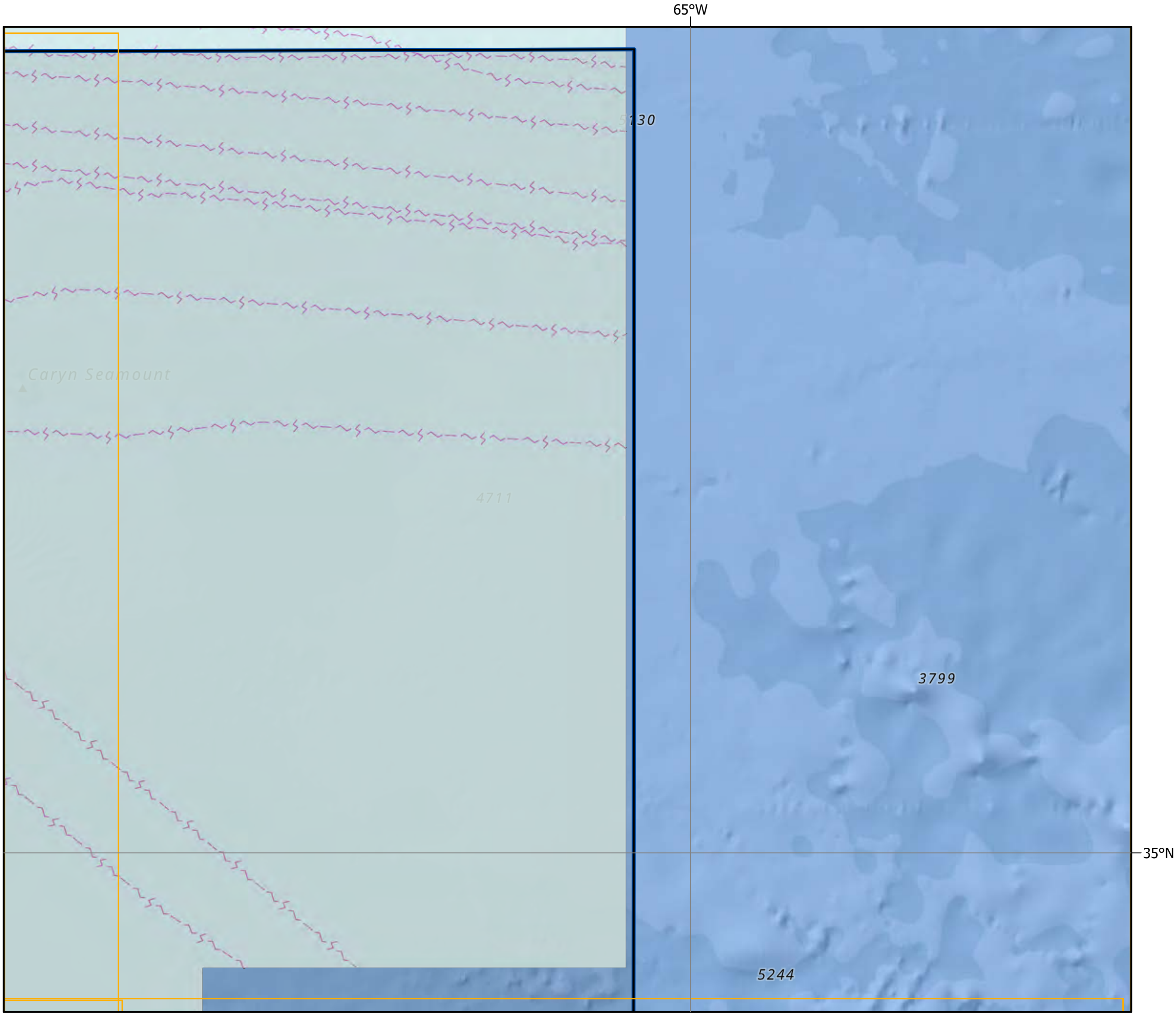

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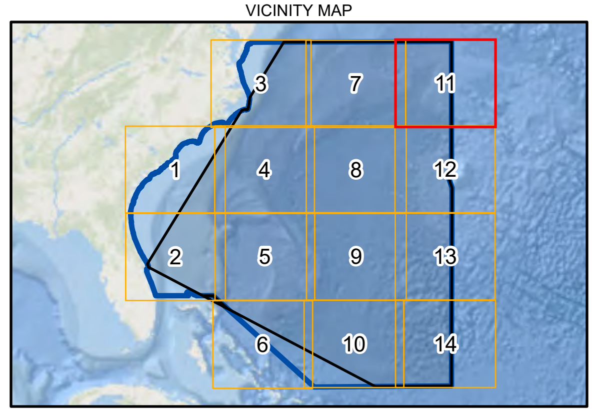

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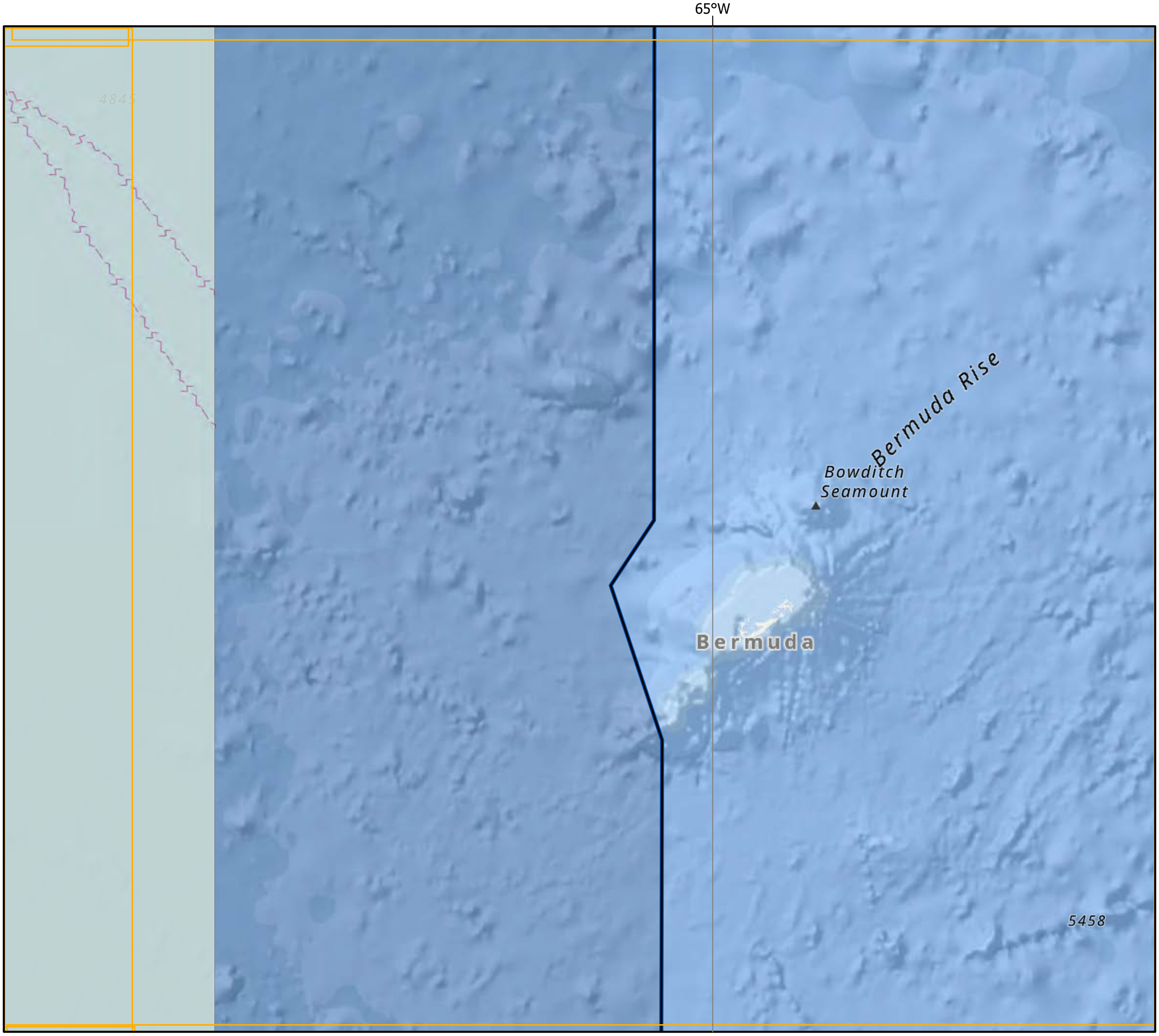

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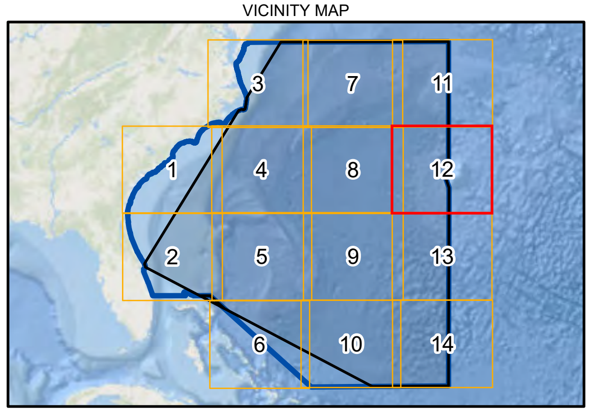

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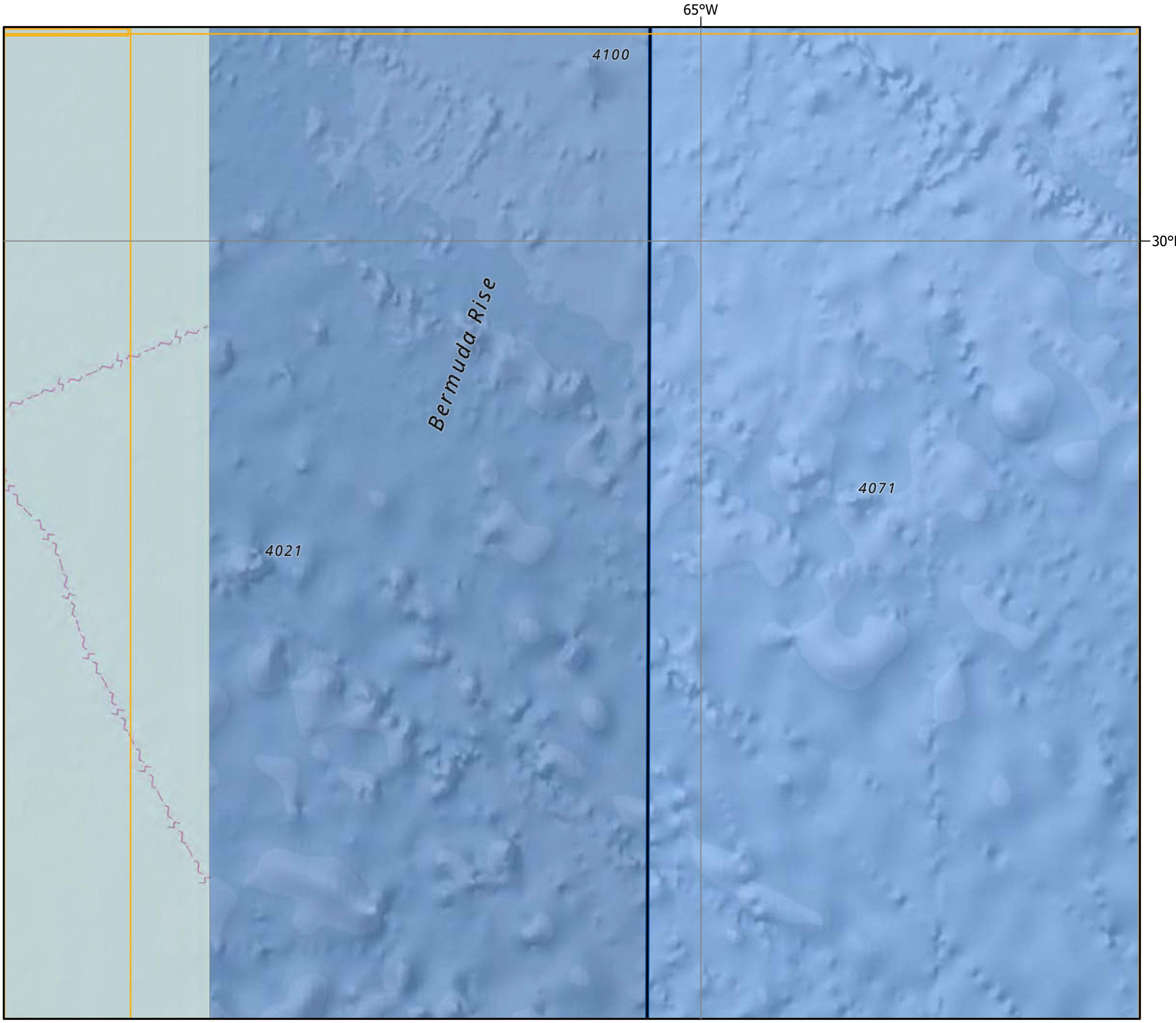

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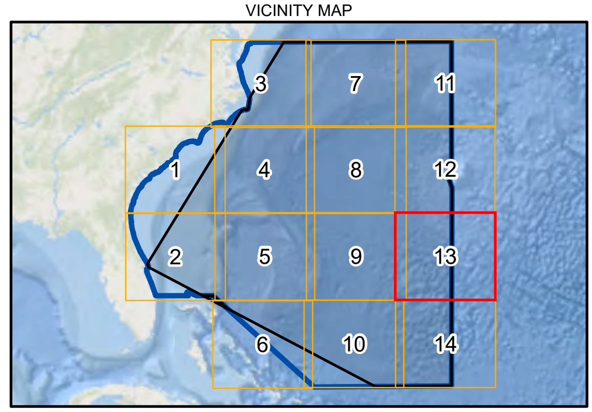

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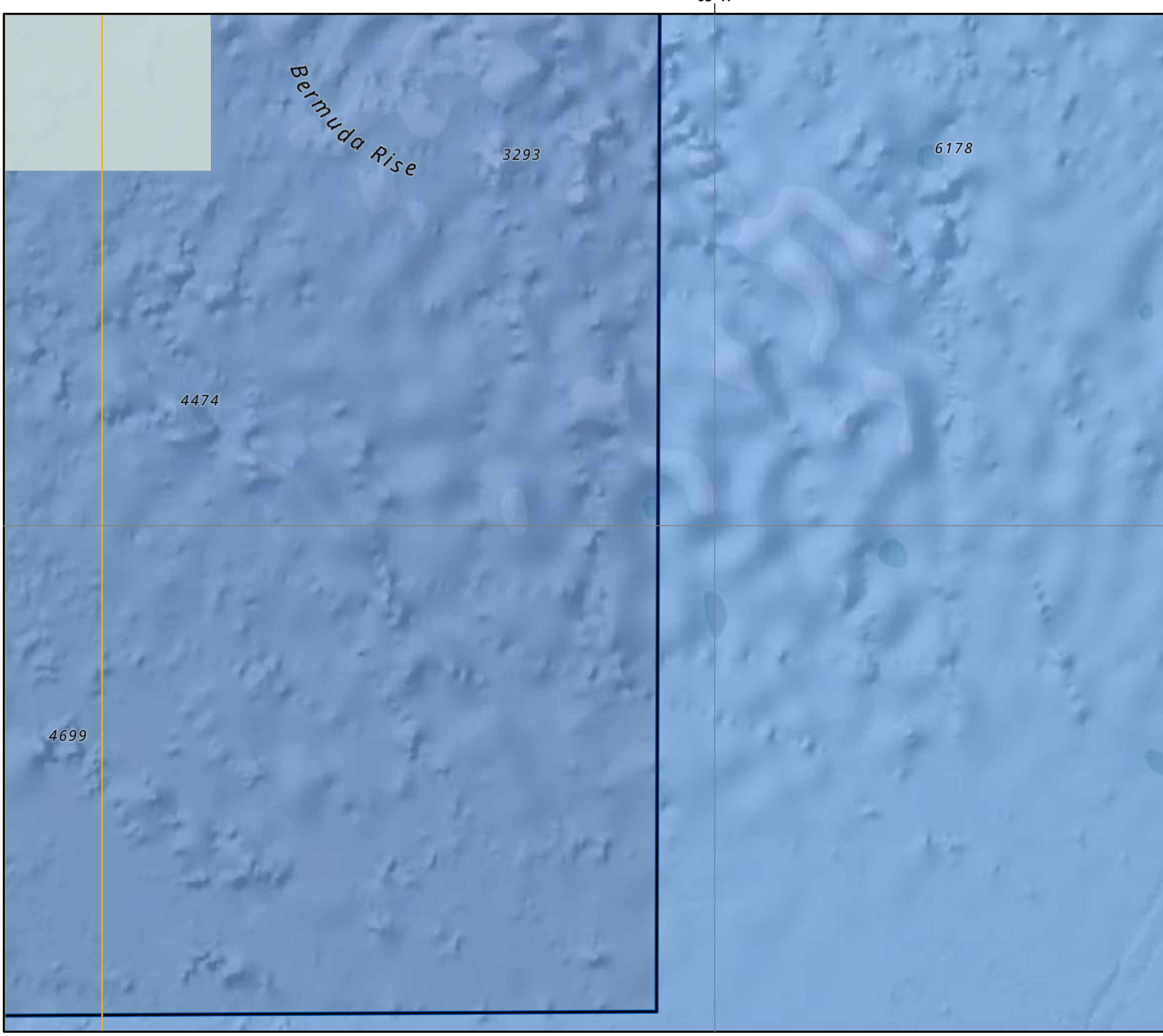

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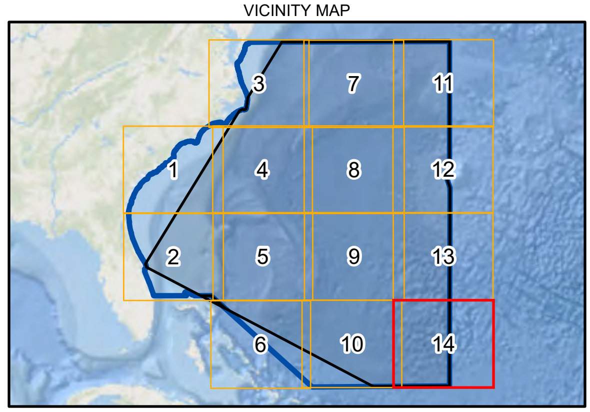

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0 44 88 132 176 Miles

1:2,787,840

1 inch = 44 miles

N

Service Layer Credits: World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS; World Ocean Base: Esri, GEBCO, Garmin, NaturalVue; MCS/ENCOnline/MapServer/exts/ MaritimeChartService: