Privacy Advisory

This Supplemental Environmental Assessment (SEA) is provided for public comment in accordance with the National Environmental Policy Act (NEPA) (Title 42 of the United States Code [USC] 4321–4347), as amended by the Fiscal Responsibility Act of 2023 (Public Law 118-5); the Department of the Air Force (DAF) Environmental Impact Analysis Process (EIAP) implementing regulations (32 Code of Federal Regulations [CFR] Part 989), to the extent that they are consistent with NEPA as revised by the Fiscal Responsibility Act; Air Force Instruction (AFI) 32-1015, *Integrated Installation Planning*; Federal Aviation Administration (FAA) Order 1050.1F, *Environmental Impacts: Policies and Procedures*; and Executive Order 14154, *Unleashing American Energy*.

The EIAP provides an opportunity for public input on DAF decision making, allows the public to offer input on alternative ways for the DAF to accomplish what it is proposing, and solicits comments 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 SEA. As required by law, comments provided will be addressed in the SEA 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 SEA or associated documents. Private addresses will be compiled to develop a mailing list for those requesting copies of SEA; however, only the names of the individuals making comments and specific comments will be disclosed. Personal home addresses and phone numbers will not be published in the SEA.

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FINAL DRAFT

Supplemental Environmental Assessment
for the
Reconstitution and Enhancement of Space Launch Complex 20
Multi-User Launch Operations
Cape Canaveral Space Force Station
Florida

Prepared for

Space Florida

and

Space Launch Delta (SLD) 45

Cape Canaveral Space Force Station (CCSFS), Florida

May 2025

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACAM	Air Conformity Applicability Model
ACHP	Advisory Council on Historic Preservation
AFI	Air Force Instruction
AIRFA	American Indian Religious Freedom Act
AL2O3	alumina
ARPA	Archaeological Resources Protection Act
BA	Biological Assessment
BC	black carbon
BO	Biological Opinion
BRRC	Blue Ridge Research and Consulting, LLC
BRL	Banana River Lagoon
CAA	Clean Air Act
CCS	Cape Canaveral Spaceport
CCAFS	Cape Canaveral Air Force Station
CCSFS	Cape Canaveral Space Force Station
CDNL	C-Weighted Day-Night Level
CFR	Code of Federal Regulations
Clx	chlorine species
CNS	Canaveral National Seashore
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CRA	Cultural Resource Assessment
CRM	Cultural Resource Manager
CSEL	C-Weighted Sound Exposure Level
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAFMAN	Department of the Air Force Manual
DAF	Department of the Air Force
dB	decibel
dBA	A-weighted decibels
DNL	Day-Night Average Sound Level
DoD	US Department of Defense
DOT	US Department of Transportation
EA	Environmental Assessment
ECS	Environmental Conditioning System
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ER	Eastern Range
ERP	Environmental Resource Permit
ESA	Endangered Species Act

FAA	Federal Aviation Administration
F.A.C.	Florida Administrative Code
FCMP	Florida Coastal Management Plan
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FNAI	Florida Natural Areas Inventory
FONPA	Finding of No Practicable Alternative
FONSI	Finding of No Significant Impact
ft	feet/foot
ft^2	square feet/foot
FWC	Florida Fish and Wildlife Conservation Commission
g/L	grams per liter
gal	gallon(s)
GHG	Greenhouse Gas
ha	hectare
HAP	Hazardous Air Pollutant
HCP	High Concentration Plume
HD	Hazard Division
HIF	Horizontal Integration Facility
HTPB	hydroxyl-terminated polybutadiene
Hz	hertz
IBD	Inhabited Building Distance
IM	interim measure
INRMP	Integrated Natural Resources Management Plan
IRL	Indian River Lagoon
kg	kilogram(s)
kL	kiloliter(s)
km	kilometer(s)
KSC	Kennedy Space Center
L	liter(s)
LAeq	Level Equivalent A-Weighted Sound Level
lb	pound
lbf	pound force
lb/gal	pounds per gallon
LCH4	liquid methane
LCP	Low Concentration Plume
LED	light-emitting diode
LEO	Low Earth Orbit
LMP	Light Management Plan
LMU	Land Management Unit
LNG	liquid natural gas
LOA	Letter of Agreement
LOX	liquid oxygen

LSOL	Launch Site Operator License
m	meter(s)
m^2	square meter(s)
MBTA	Migratory Bird Treaty Act
MINWR	Merritt Island National Wildlife Refuge
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAGPRA	Native American Graves Protection and Repatriation Act
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NOx	nitrous oxide
NO_2	nitrogen dioxide
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
O_3	Ozone
ODC	ozone-depleting chemical
OLS	Orbital Launch Site
OSHA	Occupational Safety and Health Administration
Pb	lead
PM	Particulate matter
$PM_{2.5}$	particulate matter 2.5 micrometers or less in diameter
PM_{10}	particulate matter 10 micrometers or less in diameter
ppb	parts per billion
ppm	parts per million
psf	pounds per square foot
PSFB	Patrick Space Force Base
QD	Quantity Distance
RCRA	Resource Conservation and Recovery Act
RMP	Risk Management Program
ROAA	Record of Air Analysis
ROI	Region of Influence
RP-1	Rocket Propellant 1
RP-X	next generation propellant
RPA	Real Property Agreement

SAS	surficial aquifer system
SDI	Space Data Integrator
SEA	Supplemental Environmental Assessment
SEBM	Southeastern beach mouse
SEL	Sound Exposure Level
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Officer
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SLD 45	Space Launch Delta 45
SLSL	Space and Life Sciences Laboratory
SMS	stormwater management system
SOLAR	Space Operations Launch and Recovery
SO_2	sulfur dioxide
SPCCP	Spill Prevention, Control, and Countermeasures Plan
SR	State Road
SSCM	Space Systems Command Manual
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
SWSA	US Navy Strategic Weapons Systems Ashore
T&E	Threatened and Endangered
TCP	Traditional Cultural Property
THPO	Tribal Historic Preservation Officer
TM	Technical Memorandum
$\mu g/m^3$	micrograms per cubic meter
ULA	United Launch Alliance
US	United States
USACE	US Army Corps of Engineers
USC	United States Code
USCG	US Coast Guard
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USSF	US Space Force
VOC	Volatile Organic Compound
WMO	World Meteorological Organization
WSDOT	Washington State Department of Transportation

1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

On October 28, 2020, a Finding of No Significant Impact (FONSI) was signed for the Real Property Agreement (RPA) by the US Air Force (now US Space Force [USSF]) to grant Space Florida the use of 220 acres (89 hectares [ha]) at Space Launch Complex 20 (SLC-20) for multi-user launch capability purposes (Space Florida 2020). Following this RPA, 33 acres (13 ha) of the total 220 acres (89 ha) was allocated by Space Florida to Firefly Aerospace, Inc. on a dedicated basis to include the existing launch site infrastructure. As part of that action, the existing SLC-20 facilities would be refurbished and enhanced to support small- and medium-lift launch vehicles that would be tested and operated from SLC-20A (e.g., Firefly's Alpha launch vehicle) and SLC-20B (small- to medium lift launch vehicles [e.g., Firefly's Beta launch vehicle]), with vehicle stages that would be transported from Exploration Park to SLC-20. Although the original intent of the 2020 Proposed Action was to establish a multi-user launch capability at SLC-20, only Firefly was committed as a potential launch provider at that time. Since other commercial launch providers could not be predicted with any fidelity, environmental analysis of infrastructure requirements and launch operations was limited to Firefly launch and operational requirements using those requirements as upper environmental impact limit scenarios for SLC-20A and SLC-20B.

Since the October 2020 FONSI, the commercial space market has continued to grow; as a result, Space Florida has identified the need to plan, design, and construct an additional small-lift vehicle launch complex at the north end of SLC-20, herein referred to as SLC-20C, to support launch operations from multiple commercial launch operators. Unlike SLC-20A and SLC-20B, SLC-20C would be strictly limited to small-lift launch vehicles. Similar to the previously analyzed launch vehicles for SLC-20A and SLC-20B, small-lift launch vehicles from SLC-20C would not have recoverable stages.

As a result of the above progression in the marketplace, this document supplements the *2020 Environmental Assessment (EA) for the Reconstitution and Enhancement of Space Launch Complex (SLC) 20 Multi-User Launch Operations at Cape Canaveral Air Force Station (CCAFS)*, hereinafter referred to as the "2020 EA" (Space Florida 2020). Since that document was completed, CCAFS has been renamed the Cape Canaveral Space Force Station (CCSFS) in December 2020, by USSF.

Also, subsequent to the finalization of the 2020 EA and issuance of the above-noted FONSI, Space Florida became the SLC-20 Real Property Licensee. Thus, this Supplemental Environmental Assessment (SEA) assesses the potential environmental impacts associated with the construction of the proposed new SLC-20C, expansion of SLC-20A to accommodate common-use infrastructure to support launches at SLC-20A and SLC-20C, transportation of vehicle stages from Exploration Park and off-site payload processing facilities (e.g., Astrotech), and operation of small, vertical-lift launch vehicles at SLC-20C.

This SEA was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (Title 42 of the United States Code [USC] 4321–4347), as amended by the Fiscal Responsibility Act of 2023 (Public Law 118-5); the Department of the Air Force (DAF) Environmental Impact Analysis Process implementing regulations (32 Code of Federal Regulations [CFR] Part 989), to the extent that they are consistent with NEPA as revised by the Fiscal Responsibility Act; Air Force

Instruction (AFI) 32-1015, *Integrated Installation Planning*; Federal Aviation Administration (FAA) Order 1050.1F, *Environmental Impacts: Policies and Procedures*; and Executive Order 14154, *Unleashing American Energy*.

1.2 Location and Background

CCSFS occupies approximately 15,800 acres (6,394 ha) of land on Florida's Cape Canaveral barrier island (Figure 1-1 and Figure 1-2).

The Cape Canaveral barrier island is on the east coast of Brevard County, Florida, approximately 155 miles (249 kilometers [km]) south of Jacksonville, 210 miles (338 km) north of Miami, and 60 miles (97 km) east of Orlando. The island is 4.5 miles (7 km) wide at its widest point. CCSFS has 81 miles (130 km) of paved roads connecting various launch-support facilities with the centralized Industrial Area. The north boundary of CCSFS adjoins the Kennedy Space Center (KSC) boundary on the Merritt Island barrier island. As defined in Florida Statute Section 313.304, the Space Florida Spaceport territory includes areas within KSC and CCSFS; this territory is referred to as the Cape Canaveral Spaceport (CCS).

The Banana River separates CCSFS from KSC to the west. Port Canaveral adjoins CCSFS to the south. The CCSFS east boundary is the Atlantic Ocean. The base is accessible primarily from State Road (SR) 528 to the south and from KSC to the west and north.

SLC-20 is in the northeast portion of CCSFS, accessible off ICBM Road (Figure 1-2). Most of the area is covered in relatively dense live oak/saw palmetto with scattered herbaceous wetlands. The proposed location is set back from the dune line to the east, and proposed infrastructure has been located and designed to avoid wetland impacts to the extent possible.

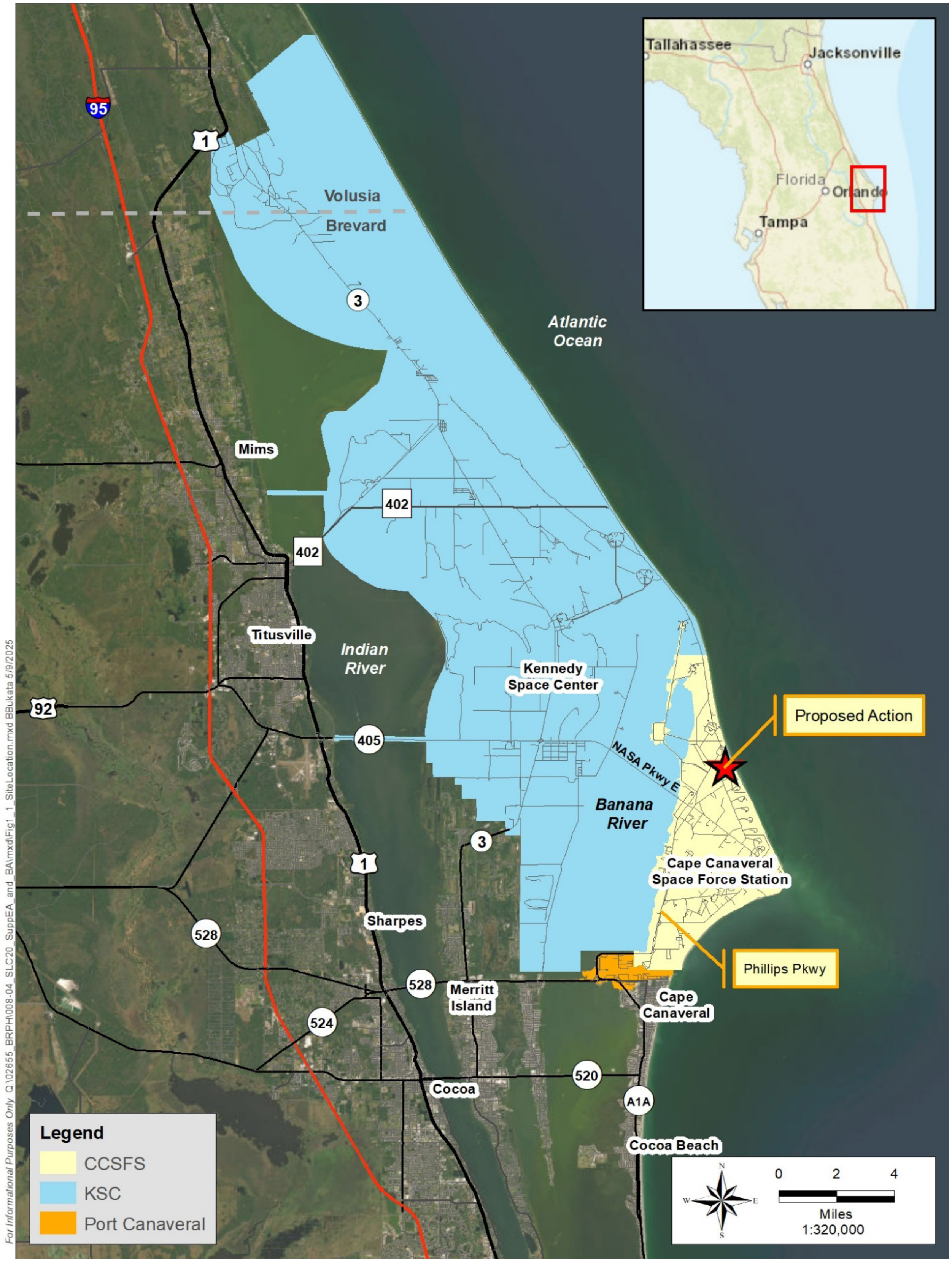
1.3 Purpose of and Need for the Action

Section 1.3 of the 2020 EA identifies the purpose of that Proposed Action, which was to provide multiple launch pads for commercial users in support of Space Florida's CCS Master Plan in accordance with Florida Statutes Section 331. Space Florida must meet current and future commercial, national, and state space transportation requirements through expansion and modernization of space transportation facilities within its Spaceport territories. The territories include but are not limited to areas within CCSFS. The purpose of this Proposed Action is to expand and modernize space transportation facilities to support the rapid acceleration of small launch providers to assemble, process, test, and launch vehicles to meet the demand for lower-cost access to space.

The demand for launching small-lift launch vehicles by commercial users is growing. Therefore, the need for the Proposed Action is for Space Florida to match that growth within their current SLC-20 leased boundary to provide an additional launch pad, available to multiple users, whose use is strictly dedicated to small, vertical-lift launch vehicles.

US policy is to ensure that the US has the capabilities necessary to launch and insert necessary national security payloads into space (10 USC Section 2273, *Policy regarding assured access to space: national security payloads*). The Proposed Action is needed to retain US space capabilities by increasing launch capability and facilitating the need for National Security Space Launch Assured Access to Space.

1



2 **Figure 1-1. CCSFS Location Map**

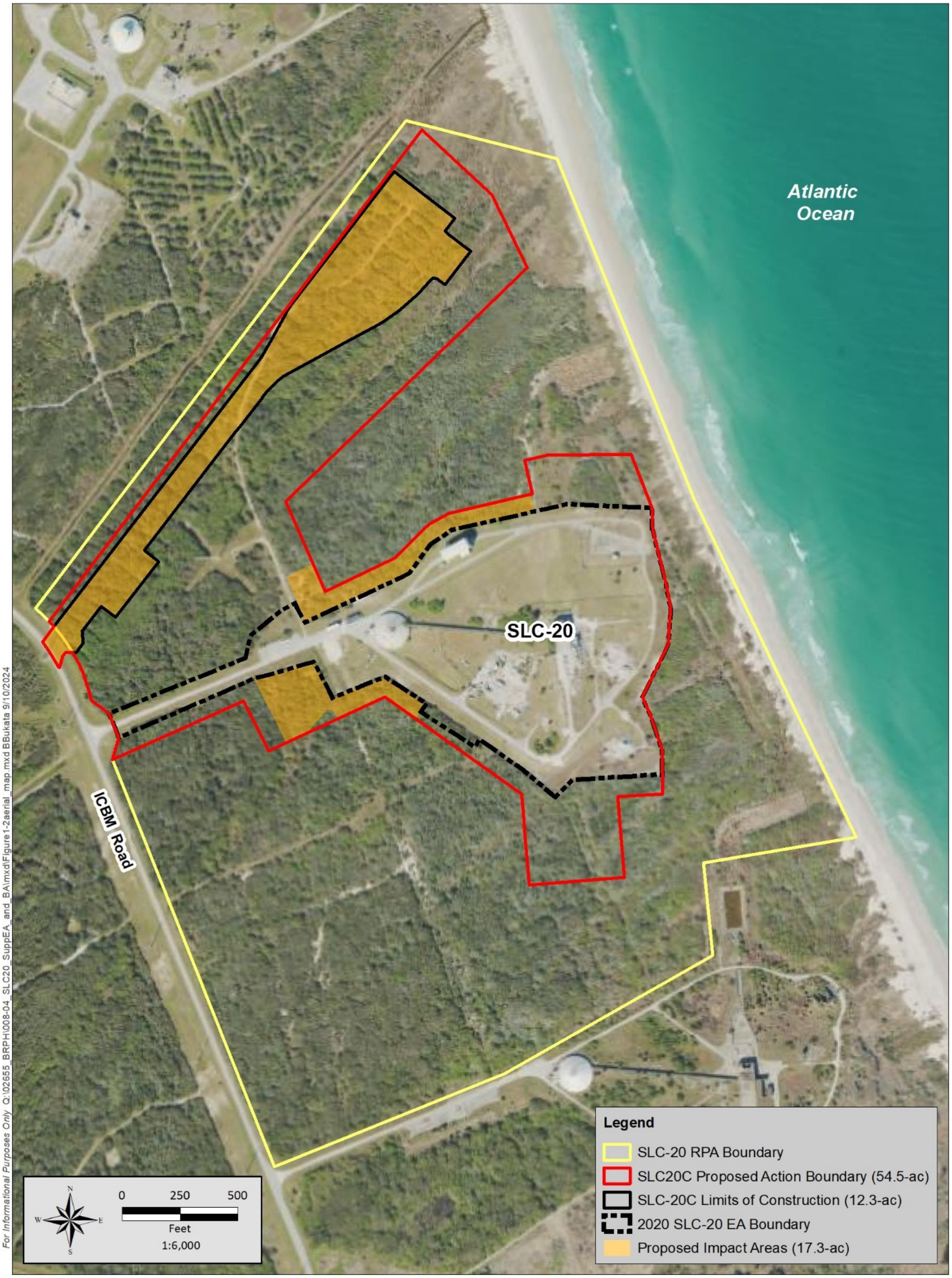


Figure 1-2. Aerial Location Map

The Proposed Action fulfills the US Congress's grant of authority to the Secretary of Defense, pursuant to 10 USC Section 2276(a), *Commercial space launch cooperation*, that the Secretary of Defense is permitted to act to:

- Maximize the use of the capacity of the space transportation infrastructure of the US Department of Defense (DoD) by the private sector in the United States.
- Maximize the effectiveness and efficiency of the space transportation infrastructure of the DoD.
- Reduce the cost of services provided by the DoD related to space transportation infrastructure at launch support facilities and space recovery support facilities.
- Encourage commercial space activities by enabling investment by covered entities in the space transportation infrastructure of the DoD.
- Foster cooperation between the DoD and covered entities.

1.4 Lead and Cooperating Agencies

1.4.1 Lead Agency

The DAF is the lead federal agency, and Space Launch Delta 45 (SLD 45) is the proponent for the Proposed Action. As the lead federal agency, DAF is responsible for analyzing the potential environmental impacts of the Proposed Action. This SEA was prepared by Space Florida, who is the Proposed Action requester and obtained the RPA for SLC-20.

1.4.2 Cooperating Agencies

1.4.2.1 FAA

The FAA expects to receive a Launch Site Operator License (LSOL) application from Space Florida in the foreseeable future to operate a commercial space launch site at SLC-20. The FAA also expects to receive operator license applications from prospective commercial users to conduct launch operations at SLC-20. Therefore, the FAA's future proposed actions of issuing an LSOL to Space Florida and launch licenses to prospective commercial users are considered part of the Proposed Action analyzed in this SEA.

The FAA is a cooperating agency because it licenses commercial space launch operations in the US and approves related airspace closures. If Space Florida applies for an LSOL or if a launch service provider applies for a Vehicle Operator License (VOL) using SLC-20C, FAA may require supplemental environmental documentation based on the review of the specific license application materials.

1.4.2.2 NASA

The National Aeronautics and Space Administration (NASA) is a cooperating agency because of its special expertise and potential need to rely on the analysis contained in this SEA to support its environmental review process as a potential future customer for launching NASA payloads.

1.4.2.3 US Coast Guard

The US Coast Guard (USCG) is a cooperating agency because USCG has regulatory authority over waters subject to jurisdiction of the US pursuant to the Ports and Waterways Safety Act, 46 USC

Section 700, regulatory authority of US- and foreign-flagged vessels as outlined in 46 CFR Parts 33 and 46 and expertise to review and advise SLD 45 on all launch and reentry site evaluation risk assessments with a focus on vessel navigation safety. USCG also supports SLD 45 with early-warning communications to the maritime industry with Notices to Mariners (NOTMARs) as outlined in 33 CFR Part 72. USCG evaluates every launch and reentry activity with potential risk to the maritime transportation system. USCG and USSF have entered into a Memorandum of Agreement to assist with maritime safety and to review space operations that have a maritime nexus; USCG advises USSF on all launch and reentry site evaluations. USCG and FAA maintain a Memorandum of Agreement establishing a process for USCG input into FAA's process for issuing licenses and permits for commercial space launch and reentry activities specific to operations in, on, and immediately adjacent to the navigable waters of the US. This includes matters of public health, safety of property, safe navigation, and national security as they relate to those waters.

1.5 Intergovernmental Coordination/Consultations

Implementation of the Proposed Action involves coordination with several agencies. Compliance with Section 7 of the Endangered Species Act (ESA), in accordance with 50 CFR Part 402, requires consultation with the US Fish and Wildlife Services (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. 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.*) (MSFCMA). FAA is currently consulting with NMFS to incorporate this Proposed Action into an existing programmatic agreement between USSF, FAA, NASA, and NMFS regarding launch operations in the Atlantic Ocean.

In compliance with Section 106 of the National Historic Preservation Act (NHPA), 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 SEA.

According to the requirements of EO 12372, *Intergovernmental Review of Federal Programs*, federal, state, and local agencies with jurisdiction that could be affected by the Proposed Action were notified of the development of this SEA via a letter dated April 10, 2023. Appendix A provides a copy of the scoping letter that the FAA was sent and a list of agencies that received scoping letters.

1.6 Public and Agency Review

Since the Proposed Action occurs within wetlands and/or floodplains, it is subject to the requirements and objectives of EO 11990, *Protection of Wetlands,* and EO 11988, *Floodplain Management,* as amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. Space Florida published an early public notice that the Proposed Action would occur in a wetland/floodplain on

September 28, 2023, in *Florida Today* and *The Hometown News Brevard* (Beaches and North Brevard Editions); the notice was also provided on the SLD 45 Environmental Programs website (https://www.patrick.spaceforce.mil/Resources/Environmental-Information/).

This SEA includes a determination of whether the Proposed Action would result in a significant floodplain encroachment, confirm no practicable alternatives exist to the Proposed Action in wetlands, and ensure all practicable measures to minimize harm to wetlands resulting from the Proposed Action are incorporated.

In accordance with 32 CFR Section 989.15, a Notice of Availability (NOA) of the Draft SEA was published on MONTH DAY, 2025, in *The Florida Today* and *The Hometown News Brevard* newspapers (Appendix B), and the Draft SEA was posted on the SLD 45 Environmental Programs website (https://www.patrick.spaceforce.mil/Resources/Environmental-Information/) for a 30-day review/comment period. In addition, NOA emails were sent to agencies and tribal governments, and XXXX responses were received and addressed in the final SEA (Appendix C). Public comments were accepted through __________, 2025, and XXXX public and agency comments were received and incorporated into the Final SEA (Appendix D). The Florida Clearinghouse review was completed on __________, 2025 (Appendix E).

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2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

The 2020 EA focused on the RPA to license 220 acres (89 ha) of land to include SLC-20 and all facilities contained thereon from USSF to Space Florida and to develop a multi-user launch capability that includes refurbishing and enhancing existing launch pad SLC-20A, operating small-lift vehicles from SLC-20A, operating small-to-medium-lift vehicles from SLC-20B by commercial users such as Firefly under an agreement with Space Florida, and transporting vehicle stages from Exploration Park to SLC-20. Since the 2020 EA was finalized, Space Florida obtained the RPA for SLC-20, is considering pursuing a LSOL, and has developed a business case for another commercial launch operator to launch small-lift vehicles from SLC-20C. Thus, Space Florida identified the need to plan, design, and construct an additional multi-user launch pad, SLC-20C, to support launch operations to include transporting vehicle stages from Exploration Park and off-site payload-processing facilities (e.g., Astrotech) and operating small-lift launch vehicles only at SLC-20C. In addition to constructing SLC-20C, an approximate 5-acre (2-ha) development area within the Proposed Action would be used for non-launch/engineering testing-related processing, storage, or operational-related program needs. The Proposed Action includes changes to SLC-20A and SLC-20B footprints to accommodate future expansion if needed. No additional vertical structures are being proposed as part of these footprint changes.

To develop envelope criteria by which to analyze the potential upper limit of environmental impacts, Space Florida conducted market research whereby they evaluated 14 small-class launch vehicles with the potential to operate from proposed SLC-20C using publicly available information. These launch vehicles included the Rocket Lab (Electron), Astra (Rocket 3.3), Firefly Alpha, Relativity Space (Terran 1), ABL Space (RS 1), Phantom Space (Laguna), Phantom Space (Daytona), BluShift (Red Dwarf), Vaya (Dauntless), Space X (Falcon 1), Minotaur (I), Athena 1, Taurus, and Athena 2 (Appendix F). The evaluation had the following objectives:

- Define representative small-lift launch vehicles.
- Identify combinations and maximum quantities of propellant options.
- Define launch-vehicle parameters (height, mass, diameter, and thrust).
- Define concepts of operations and operational needs.
- Define envelope launch trajectories.
- Consider explosive siting requirements.

The recommended envelope criteria were determined based on the data collected and formed the basis of the Proposed Action and are further described in the sections below.

2.1.1 Proposed Location

The SLC-20 RPA boundary is approximately 220 acres (89 ha). The initial SLC-20A and SLC-20B boundary, as defined in the 2020 EA, was approximately 33 acres (13 ha) and included 14 facilities. The proposed new SLC-20C would be within the 220-acre (89-ha) RPA boundary. As Figure 2-1 for this SEA shows, the Proposed Action boundary includes an area totaling 54.5 acres

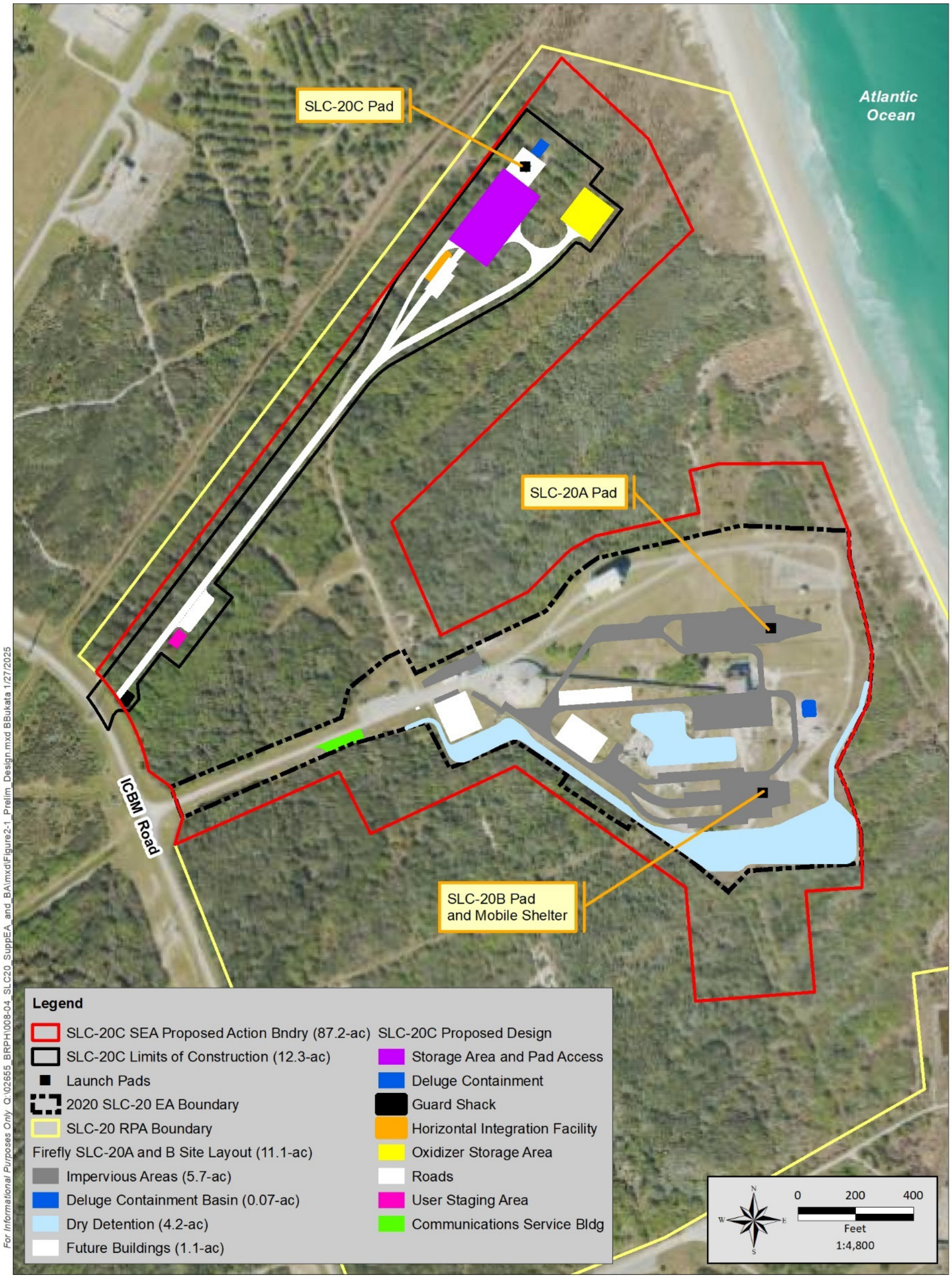

Figure 2-1. SLC-20 Conceptual Site Plan

(22.1 ha), of which site development would occur on 17.3 acres (7 ha). Of the total 17.3 acres (7 ha) of site development, SLC-20C would be constructed on 12.3 acres (5 ha) and the remaining 5 acres (2 ha) would be used for non-launch/engineer testing-related processing, storage, or operational-related program needs. As a result, the SLC-20A, SLC-20B, and SLC-20C Proposed Action totals 87.2 acres (35.3 ha) within the RPA boundary (Figure 2-1).

Since the USFWS consultation associated with the 2020 EA was completed, the site design for SLC-20A and SLC-20B has resulted in a reduction of new impervious areas by 2.7 acres (1.1 ha) (6.8 acres [2.8 ha] versus 9.5 acres [3.8 ha]) as stated in the 2020 EA (Table 2-1).

Table 2-1. SLC-20 Impervious Acreage Summaries

2020 EA New Impervious Acres (Hectares)	SLC-20C Impervious Acres (Hectares)	2024 SLC-20A and SLC-20B Revised New Impervious Acres (Hectares)
9.5 (3.8)	5.3 (2.1)	6.8 (2.8)
Total=	**12.1 (4.9)**	

2.1.2 Infrastructure

Some small-lift launch vehicle systems are expected to use mobile infrastructure, and others would require dedicated launch infrastructure. To accommodate small-lift launch vehicle systems that require dedicated launch infrastructure, common-use infrastructure that could be used by a variety of launch providers would be constructed. The expected infrastructure at SLC-20C includes:

- Raised launch pad area and access roads.
- Horizontal Integration Facility (HIF), with a footprint of 20,000 square feet (ft^2) (1,858.1 square meters [m^2]) (100 ft [30.5 m] wide by 200 ft [61.0 m] long).
- Concrete pads for propellant storage tanks (oxidizers/fuels).
- Lightning protection system.
- Pad lighting.
- Power, data, communications, and basic pad water systems.
- Pad deluge collection/containment basin.

Vehicle-specific dedicated mobile infrastructure, to include temporary propellant storage and loading systems, flame deflectors, sound suppression systems, temporary umbilical towers, and mobile service structures, would be supplied in the future by a vehicle operator to SLD 45 for approval and to FAA as part of their licensing review process. Design and permitting for the pad surface, access road, and limited utilities are expected to complete in late 2025 with construction occurring in 2026 or 2027.

2.1.3 Launch Vehicles

In the 2020 EA, Firefly proposed launching Alpha, a small-lift class launch vehicle, from SLC-20A and Beta, a small- to medium-lift class launch vehicle, from SLC-20B. Table 2-2 lists the general specifications for the launch vehicles that would operate from SLC-20A, SLC-20B, and SLC-20C (using an envelope concept approach to establish an upper limit of potential environmental impacts).

Table 2-2. Specification Summary for Launch Vehicles at SLC-20

Specification	2020 EA		SLC-20C Vehicle Envelope
	SLC-20A Firefly Alpha	SLC-20B Firefly Beta	
Length (ft)	95 ft (29 m)	140 ft (43 m)	120 ft (36.6 m)
Diameter (ft)	6 ft (2 m)	10 ft (3.1 m)	13 ft (4.0 m)
Stages	2	2	2
Recoverable First Stage	No; expected to incinerate and/or break up upon reentry and be expended into the Atlantic Ocean		No; expected to incinerate and/or break up upon reentry and be expended into the Atlantic Ocean
Parachute Required?	No	No	No
Maximum Thrust (lbf)	164,000	620,000	400,000
Total Wet Mass	120,000 lb (54,000 kg)	470,000 lb (214,000 kg)	300,000 lb (136,077.7 kg)
Low-Earth Orbit (LEO) Payload	2,205 lb (1,000 kg)	12,787 lb (5,800 kg)	4,398 lb (1,995.0 kg)
Maximum Launches per Year	24		24
Propellant Combinations	LOX/RP-1	LOX/RP-1/LCH4	LOX/RP-1; LOX/RP-X; LOX/LNG; Solid (HTPB)
Maximum Liquid Propellant for Each Fuel Type	109,000 lb (49,442 kg) of LOX/RP-1;	435,000 lb (197,312 kg) of LOX/RP-1; 419,000 lb (190,055 kg) of LOX/RP-a & LOX/LCH4; 402,000 lb (182,344 kg) of LOX/LCH4	225,000 lb (102,058.2 kg) of LOX/RP-1; 45,000 lb (20,411.7 kg) of LOX/RP-X; 45,000 lb (20,411.7 kg) of LOX/LNG
Maximum Solid Propellant Option	Not Applicable	Not Applicable	245,000 lb (111,130.1 kg) of HTPB
Launch Trajectory (Range of Launch Azimuths)	40 degrees to the northeast and 110 degrees to the southeast (aligned with standard Eastern Range [ER] launch sector)		40 degrees to the northeast and 110 degrees to the southeast (aligned with standard ER launch sector)

Notes: ft = feet; HTPB = hydroxyl-terminated polybutadiene; kg = kilogram; kN = kilonewtons; lb = pounds; lbf = pound-force; LCH4 = liquid methane; LOX = liquid oxygen; m = meter; RP-1 = Rocket Propellant 1; RP-X = next generation propellant (Exxsol D40, similar to mineral spirits).

As part of the FAA licensing process, all launch operators must prepare and submit a preliminary flight data package consisting of launch trajectories, overflight analysis, potential debris corridor, and reliability factor for the vehicle. The preliminary flight data package must be submitted before any launch activity.

Although the flight termination and thrust termination systems would be determined by the preliminary flight safety analysis for the vehicle, all flight termination and thrust termination system would be ER approved before any launch activities are authorized by SLD 45. Some flight termination systems incorporate a small amount of ordnance. If ordnance is to be used, vehicle operators would be required to have an agreement in place with SLD 45 to allow ordnance to be stored at the SLD 45 Ordnance Storage Area and delivered on a real-time basis to the launch complex during vehicle integration to avoid the need for long-term storage of this type of hazardous material on site.

Payload plans for launch vehicles would also need to be submitted and approved before launch activity. Plans may include maximum payload weights, dimensions, propellants used, loading procedures, etc. The maximum allowable payload consistent with the FAA classification of a small-class launch vehicle is 4,400 lb to 100 nautical miles (nm) of orbit (low Earth orbit [LEO]). If a payload incorporates small amounts of hazardous propellants, such as hypergolic or pressurized gases, they would be stored in a certified facility near the payload-processing facility and any residual propellants after loading would be returned to the facility immediately. Payload propellant volumes would vary, and an explosive siting analysis would be required once payload types and quantities are identified. For siting the SLC-20C pad, the payload propellant quantities are assumed to be negligible relative to the explosive siting requirements for the launch vehicle. Propellant mixtures of LOX/LCH4 must be sited at 100-percent TNT equivalency, which will impact SLC-20C from SLC-20A and SLC-20B. For example, the Firefly Beta Variant Vehicle will potentially have a 3,741-foot (1.1-km) explosives arc that encumbers all of SLC-20C.

Table 2-3 and Table 2-4 list the estimated maximum potential propellant quantities for on-site storage at SLC-20.

Table 2-3. Maximum Potential Propellant Quantities at SLC-20A and SLC-20B

Launch Vehicle	2020 EA		Max Quantity
	Storage Type	Propellant Type	
Firefly Alpha	Oxidizer Storage	LOX	180,000 lb (81,647 kg)
	Fuel Storage	RP-1	83,000 lb (37,648 kg)
	Combined Vehicle	LOX/RP-1	109,000 lb (49,442 kg)
Firefly Beta	Oxidizer Storage	LOX	570,000 lb (258,548 kg)
	Variant 1 Fuel Storage	RP- 1	170,000 lb (77,111 kg)
	Variant 1 Combined Vehicle	LOX/RP-1	435,000 lb (197,312 kg)
	Variant 2 Fuel Storage	RP-1 (Stage 1)	126,000 lb (57,153 kg)
	Variant 2 Fuel Storage	LCH4 (Stage 2)	36,000 lb (16,329 kg)
	Variant 2 Combined Vehicle	LOX/RP-1 & LOX/LCH4 (Stage 2)	419,000 lb (190,055 kg)
	Variant 3 Fuel Storage	LCH4	170,000 lb (77,111 kg)
	Variant 3 Combined Vehicle	LOX/LCH4	402,000 lb (182,344 kg)

Notes: kg = kilogram; lb = pounds; LCH4 = liquid methane; LOX = liquid oxygen; RP-1 = Rocket Propellant 1.

Table 2-4. Estimated Maximum On-Site Propellant Storage Volumes at SLC-20C*

Propellant Type	Density (lb/gal) (g/L)	Maximum 1 Mission Quantity (gal [kL])	Maximum 2 Mission Quantity (gal [kL])	Proposed Maximum Storage (gal [kL])
LOX	9.5 (1,138.3)	17,500 (66.2)	35,000 (132.4)	50,000 (18.9)
LNG	3.5 (419.4)	5,000 (18.9)	10,000 (3.8)	15,000 (56.8)
RP-1	6.8 (814.8)	10,000 (3.8)	20,000 (75.7)	25,000 (94.6)
RP-X	6.4 (766.9) (est.)	2,000 (7.6)	4,000 (15.1)	5,000 (18.9)

Notes: * = Estimates based on providing storage capacity in support of two launches; g/L = grams per liter; gal = gallon; kL = kiloliter; lb/gal = pounds per gallon.

2.1.4 Launch Site Operations and Fate of Launched Stages

Table 2-5 summarizes the launch site operations included in the 2020 EA and compares those operations to the newly proposed construction and operational activities included in this SEA. Refer to the appropriate section of the 2020 EA for more detailed information on each operation.

Following a launch from the SLC-20 complex for any launch vehicle, the expendable first stage is expected to incinerate and/or break up upon reentry and, due to their relatively small physical size, be widely dispersed and expended in small pieces into the Atlantic Ocean. No stage recovery is proposed.

The specifics of trajectory and mission plans for SLC-20A, SLC-20B, and SLC-20C are not presently known or defined, so the Atlantic Ocean Action Area (where debris from expended launch vehicle components could fall) uses the Stoke Nova vehicle for potential debris field purposes only. Using this medium-class two-stage liquid-fueled launch vehicle provides a conservative debris field envelope of 777 miles (1,250 km) for SLC-20 operations because the Stoke Nova vehicle is 30-percent heavier than the vehicles proposed at SLC-20 (Figure 2-2). This falls within the Action Area of the NMFS Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment where launch and reentry activities are expected. FAA and NMFS are currently in consultation for an update to this programmatic concurrence letter. All launch operations would continue to comply with the necessary notification requirements, including issuance of a Notice to Airmen (NOTAM) and a NOTMAR, consistent with current procedures. A NOTAM provides notice of unexpected or temporary changes to components of, or hazards in, the National Airspace System (FAA Order JO 7930.2T, *Notice to Airmen*). A NOTMAR provides notice of temporary changes in conditions or hazards in navigable waterways. ER operations, which include proposed launches from SLC-20C, currently follow the procedures stated in a Letter of Agreement (LOA) dated December 29, 2023, between the 45th Space Wing (now SLD 45) and FAA. The LOA establishes responsibilities and describes procedures for ER operations within airspace common to the following areas of jurisdiction: Miami Center, Jacksonville Center, New York Center, San Juan Center Radar Approach Control, Central Florida Terminal Radar Approach Control, Space Florida Launch and Landing Facility, Fleet Area Control and Surveillance Facility Jacksonville, Air Traffic Organization Space Operations, Central Altitude Reservation Function, and Air Traffic Control System Command Center. The LOA defines responsibilities and procedures applicable to operations that require use of Restricted Areas, Warning Areas, Air Traffic-Controlled Assigned Airspace, and/or altitude reservations within ER airspace. The Proposed Action would continue to adhere to any future changes to the ER operations and/or LOA requirements. Additionally, to meet FAA licensing requirements, the commercial operator is responsible for entering into an agreement with USCG through a Letter of Intent pursuant to 14 CFR 450.147 to establish its safe launch responsibilities between the parties, including NOTAMs.

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Table 2-5. Summary of Launch Site Operations

Operation	2020 EA Section	2020 EA Summary	Proposed Action
Launch Vehicle Stage Manufacturing	2.1.3 and 2.1.6	• Exploration Park.	• Exploration Park or off site (e.g., Astrotech).
Launch Vehicle Stage Storage	2.1.3	• Existing HIF until new HIF is constructed.	• Same as described in 2020 EA.
Launch Vehicle Stage and Encapsulated Payload Mating	2.1.3	• Transport Erector Launcher. • HIF (cargo and satellite missions).	• Same as described in 2020 EA.
Payload Preparation	2.1.3	• Conducted in parallel with most launch vehicle preparations. • Include payload checkout, spacecraft propellant loading, as required, and payload encapsulation in the fairings. • Would occur at the existing HIF; however, will transfer to new HIF when constructed.	• Same as described in 2020 EA.
On-site Propellant Stored	2.1.3	• LOX and RP-1 would be trucked in and stored on site. • Nitrogen (gaseous and liquid) is stored on site.	• Same as described in 2020 EA, but RP-X would also be stored. • Quantity stored at SLC-20C is based on supporting two launches.
Dry and Wet Rehearsals	2.1.3	• Two dry rehearsals per launch preparation. • Wet dress rehearsals, as needed.	• Two dry rehearsals per launch preparation. • One wet dress rehearsal per launch.
Static Fire Tests	2.1.3	• Engine is ignited and run for up to 5 seconds. • May be discontinued as program matures.	• Engine is ignited and run for up to 10 seconds. • One test per launch initially and one test for each new vehicle. • May be discontinued as program matures.
Two-stage Acceptance Testing	2.1.3	• Stage 1 would occur with four Reaver engines for 30 seconds. • Stage 2 would occur with one lighting engine for 60 seconds. • Occur up to twice per month.	• Two acceptance testing operations per launch preparation.
Launch Campaign Support	2.1.3	• Would last 2 to 4 weeks initially. • 20–25 launch-provider employees with a peak of 35 personnel not including payload support personnel for approximately 1 week. • Ground support consists of up to three trucks.	• Duration and employee support are the same as described in 2020 EA. • Ground support consists of up to four trucks.

Table 2-5. Summary of Launch Site Operations

Operation	2020 EA Section	2020 EA Summary	Proposed Action
Day-to-Day Operations (Excluding Launch Campaigns)	2.1.3	• 20–25 employees using personal vehicles.	• Duration and employee support are same as described in 2020 EA. • Ground support consists of up to four trucks.
Notifications and Closures	2.1.3	• Compliant with notification requirements and consistent with current procedures stated in the May 1, 2020, LOA between SLD 45 and FAA. • Temporary closures of existing airspace and navigable waters.	• Same as described in 2020 EA.
Launch Vehicle Program Safety Plan	2.1.3	• Compliant with applicable regulations and ER approved.	• Same as described in 2020 EA.
Launch Cadence	2.1.5	• 24 total annual launches at SLC-20A and SLC-20B; however, a maximum of 18 of those launches are assumed to consist of Beta vehicles from SLC-20B. • 70 percent of launches would occur during daytime hours (7:00 AM to 10:00 PM) ,and 30 percent of the launches would occur during nighttime hours (10:00 PM to 7:00 AM). • 4–8 hours of lighting are required for nighttime launches (up to 60 hours per year).	• 24 total annual launches at SLC-20A and SLC-20B and up to 24 total annual launches at SLC-20C (18 liquid vehicle launches and six solid vehicle launches). • 70 percent of launches would occur during daytime hours (7:00 AM to 10:00 PM), and 30 percent of the launches would occur during nighttime hours (10:00 PM to 7:00 AM). • 4–8 hours of lighting are required for nighttime launches (up to 60 hours per year).
Construction Timeline	Status Update	• The RPA is completed. • Construction at SLC-20A and SLC-20B is expected to begin and end in calendar year 2026. • Launch operations are expected to begin in 2027.	• Permitting is expected to be completed in 2025 with construction completed by late 2026. • Launch operations are expected to begin in 2027 or 2028.

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Figure 2-2. Estimated Debris Field and Launch Trajectory Map

The Proposed Action does not include altering the dimensions (shape and altitude) of the airspace. All launch operations would be of short duration and would comply with the necessary notification requirements, issuing NOTAMs, as defined in agreements required for an FAA-issued launch license. Providing advance notice via NOTAMs and identifying Aircraft Hazard Areas will assist general aviation pilots in scheduling around any temporary disruption of flight activities in the proposed operations area. NOTAMs provide notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System. FAA issues a NOTAM at least 24 hours before a launch or reentry activity in the airspace to notify pilots and other interested parties of temporary conditions.

A specific safety plan would be developed for the Launch Vehicle Program to ensure that launch operations comply with applicable regulations, including but not limited to the following:

- Space Systems Command Manual 91-710, Volume 3, *Range Safety User Requirements Manual – Launch Vehicles, Payloads, and Ground Support Systems Requirements*.
- DoD, *Defense Explosives Safety Regulation 6055.09*.
- 32 CFR, Part 117, *National Industrial Security Program Operating Manual*.
- AFI 32-1023, *Designing and Constructing Military Construction Projects.*
- Air Force Occupational Safety and Health Standards (for DoD missions only).
- National Fire Protection Association, National Fire Codes.
- American National Standards Institute.
- Occupational Safety and Health Administration (OSHA).

Users would be required to provide information regarding flight termination systems, which must be compliant with Space Systems Command Manual (SSCM) 91-710 and ER approved. Additionally, as part of the licensing evaluation process, FAA conducts a policy review, payload review, financial determination, and safety review. Space Florida would complete a Flight Safety Analysis as part of their LSOL application, which would include an Expected Casualty calculation and Operational Restrictions; FAA would evaluate this analysis as part of the safety review to ensure that the results meet 14 CFR Part 420 regulations. Launch site operators would also complete the Flight Safety Analysis and define specific trajectories as part of their LSOL. All approved trajectories are based on specific launch vehicle performance and characteristics and would satisfy 14 CFR Part 420 and 14 CFR Part 450 regulations.

2.1.5 Launch Trajectory

Launch vehicle trajectories would be specific to each particular mission based on customer needs. All launches are expected to be conducted to the east over the Atlantic Ocean between the standard ER azimuths of 40 degrees northeast and 110 degrees southeast (Figure 2-2).

2.1.6 Frequency of Launches

As summarized in Table 2-5, up to 24 launches would occur from SLC-20A and SLC-20B and up to 24 small-lift vehicle launches would occur from SLC-20C; therefore, up to 48 launches would occur at SLC-20. Annual launches from SLC-20B would consist of a maximum of 18 launches and the remainder of the launches from SLC-20A. Launches at SLC-20C would consist of up to 18 liquid-propellant small-lift launch vehicles and six solid-propellant small-lift vehicle launches. The annual cadence for SLC-20C is considered a conservative estimate since historical launch cadences are typically less at initial operation and slowly increase over a 5-year period as the user's launch program progresses. For planning purposes, launches would likely range from four to six launches in the first year, six to 10 launches the second year, 10 to 14 launches the third year, 14 to 20 launches the fourth year, and 20 to 24 launches the fifth year.

To assess noise-related impacts in this SEA, the analysis conservatively assumes all 18 liquid-propellant vehicle launches have 225,000 lb (102,058.2 kg) of LOX/RP-1 and all six solid-propellant vehicle launches have 245,000 lb (111,130 kg) of HTPB. This assumption yields the maximum noise exposure and air emissions expected from launching up to 24 small-lift vehicles because it represents the maximum propellant. Seventy percent of the launches are expected to occur during daylight hours and 30 percent of the launches are expected to occur during nighttime hours, subject to change by tenant or user. If the day/night split changes significantly, this will be evaluated again at a future date when the tenant's program is more mature. For this SEA, nighttime is defined as any event occurring after 10:00 PM and before 7:00 AM.

2.1.7 Vehicle Assembly and Transportation

Minimal vehicle assembly or processing on the launch pad of the small launch vehicles would occur. Rather, most of the vehicle assembly would occur at Exploration Park or off site. Most launch vehicle stages and payloads would arrive at SLC-20 via standard tractor-trailer (no longer than 80 ft [24 m]). Oversized load movements are coordinated through CCSFS Spaceport Integration Office. The roads at CCSFS were designed to Florida Department of Transportation (FDOT) standards. Specifically, this standard is to support an HS-20 truck with an axle load of 32,000 lb (14,515 kg) for the rear axles. Launch providers would conform to HS-20 FDOT specifications. These specifications permit a maximum axle loading of 8,000 lb (3,628 kg) on the cab axle and 32,000 lb (14,515 kg) on the rear axles, for an overall maximum weight of 80,000 lb (36,287 kg). Figure 2-3 illustrates the planned transportation route.

2.2 Selection Standards

NEPA regulations mandate the consideration of reasonable alternatives for the Proposed Action. *Reasonable alternatives* are those that also could be used to meet the purpose of and need for the Proposed Action. According to the requirements of 32 CFR Part 989.8, selection standards are used to identify alternatives for meeting the purpose and need for the Air Force action. Section 2.2 of the 2020 EA describes the selection standards and alternatives that were considered in the original EA; the screening criteria are included below in their entirety:

- Safety – Location that provides the maximum safety to the public and workers while ensuring maximum operational performance.
- Multi-user capability – Ability to handle and launch small- to medium-lift class launch vehicles with multi-user expansion capability to maximize the utility of the launch complex in the future.

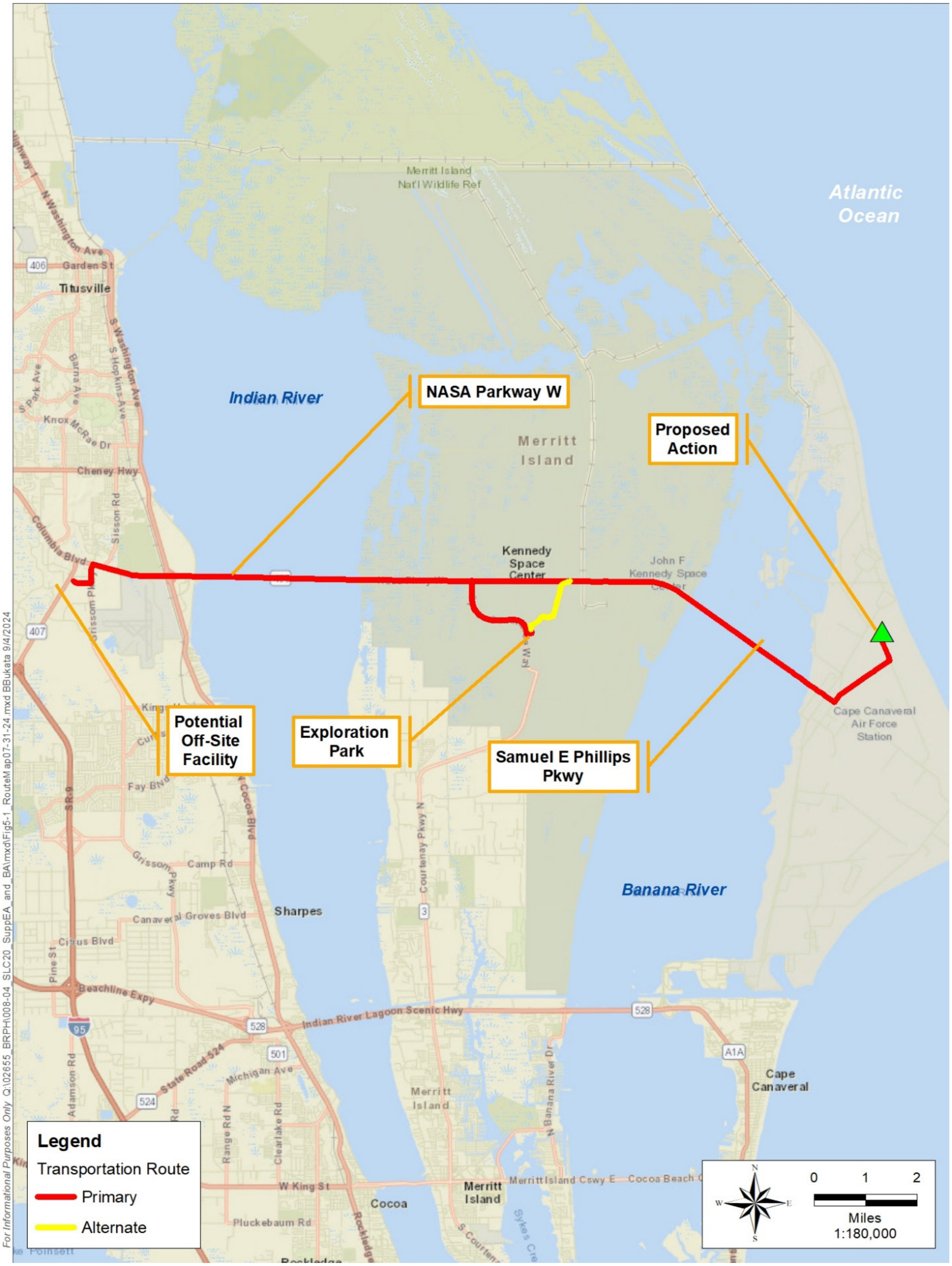

Figure 2-3. Planned Transportation Route

- Geographic location – An existing launch complex in Florida that complies with Space Florida's statutory mandate of providing commercial space services within the territory of Florida.
- Operational flexibility – Avoids and/or minimizes impacts to the following: launch-scheduling conflicts; known cultural resources where reconstruction would be prohibited; excessively contaminated soils and/or groundwater whose cleanup is cost prohibitive; known critical habitat for the North Atlantic right whale (*Eubalaena glacialis*), West Indian manatee (*Trichechus manatus*), and loggerhead sea turtle (*Caretta caretta*); proximal distance to Exploration Park; and populated areas.
- Availability – A launch complex that is available, requires relatively limited reconstruction to be put into service, and is not currently planned for use by others.
- Long-term operational cost – Controlling long-term operational costs associated with local wages, utility rates, logistical costs, real estate occupancy costs, construction costs, taxes, insurance, etc.
- Schedule – Ability to complete construction-related tasks in support of the 2020 Alpha vehicle-type launches.
- Workforce availability – Ability to acquire skilled workers from regional workforce supply.
- Ability to handle and launch small- to medium-lift class launch vehicles.
- Compatibility with CCS Master Plan for launches intended for small- to medium-lift capacity.

For this SEA, the above-summarized criteria are adopted, and the following additional screening criteria were identified for the Proposed Action:

- Operate within Space Florida's current SLC-20 leased boundary.
- Employ common infrastructure (e.g., water, sewer, power, and communications utilities), range assets, operations support, and airspace.
- Maintain proximity to vehicle-assembly locations.
- Meet the growing demand for launching small-lift vertical-launch vehicles from commercial launch operators in a timely manner.

2.3 Alternatives Considered but Eliminated from Further Analysis

Other launch sites outside Florida, within Florida, and within CCSFS were considered in the 2020 EA. A summary is provided herein for reference; however, for this SEA additional screening criteria were identified to include operating within Space Florida's current SLC-20 leased boundary.

As noted in the 2020 EA, Space Florida has a statutory constraint to provide service within Florida and the unique requirements to access orbital launch range assets; therefore, launch sites outside Florida were eliminated from further analysis.

Other launch sites within Florida, in accordance with the statutory constraints of Space Florida's charter, were considered in the 2020 EA, but none of the sites met the screening criteria. Cecil Field and the Titusville-Cocoa Airport Authority could support commercial aerospace activities; however, these locations do not have the capability to support vertical-launch vehicles without overflight of inhabited areas. Therefore, these two locations did not meet the selection criteria for safety, operational flexibility, availability, ability to handle small-lift class vertical-launch vehicles, or compatibility with the CCS Master Plan.

Space Florida has a Real Property License and LSOL for SLC-46. SLC-46 is a multi-use vertical-launch facility on the easternmost end of CCSFS east-southeast of the Skid Strip. Although Space Florida operates this launch complex for commercial purposes, it is a shared-use facility with the US Navy; therefore, DoD missions have priority for its use, which impacts use by commercial customers. Therefore, SLC-46 does not meet the selection criteria for multi-user capability, operational flexibility, and availability.

Different site configurations or locations within SLC-20 were not considered due to known environmentally sensitive areas (known groundwater plume associated with the SLC-34 Installation Restoration Site, critical habitat, and wetlands) and safety hazard zones that would restrict operational flexibility and result in increased long-term operational costs.

Other alternative launch sites within CCSFS would require that Space Florida obtain an additional Real Property License for those locations, which does not meet the selection criteria for operating a launch pad within Space Florida's current leased boundary.

2.4 Alternatives Carried Forward for Analysis

This SEA considers the No Action Alternative and the Proposed Action Alternative.

2.4.1 Proposed Action

Under the Proposed Action, Space Florida would implement the Proposed Action as described in Section 2.1. Specific to the construction projects listed in Section 2.1.2, the SLC-20B deluge containment and new HIF would be considered shared infrastructure with SLC-20C under the Proposed Action.

Since Space Florida is the current SLC-20 Real Property Licensee, expanding the Proposed Action to include constructing the SLC-20C launch pad within its currently leased boundary would enable Space Florida to make use of common infrastructure (e.g., water, sewer, power, communications utilities), range assets, operations support, and airspace; remain close to vehicle assembly locations; and meet the growing demand for launching small-lift launch vehicles from commercial launch operators in a timely manner. Furthermore, the Proposed Action meets all the selection criteria.

Permitting for the Proposed Action is expected to be completed in 2025 with construction occurring as early as late 2025 and ending in 2026, with launch operations beginning in 2027. The direct and indirect effects from construction and launch operational activities at SLC-20A, SLC-20B, and SLC-20C are assessed in Chapter 3 of this SEA.

2.4.2 No Action Alternative

Under the No Action Alternative, Space Florida would not construct an additional launch pad at the north end of SLC-20 and transport vehicles stages from Exploration Park and off-site payload processing facilities (e.g., Astrotech) or operate small-lift launch vehicles at SLC-20C. The No Action Alternative is the environmentally preferable alternative. Under the No Action Alternative, the Proposed Action as documented in the signed October 28, 2020, FONSI would be implemented. To date, the RPA is completed and construction at SLC-20A and SLC-20B is expected to begin in calendar year 2026 with launch operations beginning in 2027 or 2028. Table 2-6 summarizes the estimated construction activities scheduled to occur in 2026.

Table 2-6. Construction Included in the No Action Alternative

New Facility	Existing Site
SLC-20A Firefly Alpha Pad	Fac 15540, Launch Pad A
SLC-20A Firefly Alpha Launch Equipment	Fac 15541, Equipment Building Pad A
SLC-20A Deluge Containment	New Construction Near Former Fac 15540 and Fac 15541
SLC-20A Firefly Alpha Environmental Conditioning System (ECS)	New Construction
RP-1 and Gaseous Nitrogen Storage	Fac 15500AD, Fuel Holding Area
Ordnance Storage	New Construction Near Former Fac 15640, Launch Pad B
LOX, Liquid Nitrogen, and Gaseous Helium	Fac 15608, Power Center; Fac 15609, Control Center; and Fac 15531, Retaining Wall (Former Oxidizer Holding Area)
Generators	New Construction Near Fac 18800, Blockhouse
Launch Communication Equipment and Pad Office	New Construction Near Fac 18800, Blockhouse
Support Shop	Fac 18806, Payload Assembly Building
Pad Security	Fac 18803, Guard House
Non-Hazardous Payload Process Facility	Fac 18705, Warehouse
HIF	
Complex Support Building/Office	New Construction
SLC-20B Deluge Containment	Fac 15500B, Launch Stand and Ramp
SLC-20B Firefly Beta Pad	
SLC-20B Firefly Beta ECS	
SLC-20B Firefly Beta Launch Equipment	
New HIF/Hazardous Payload Processing Facility	New Construction
Water Pump House	New Construction
Customer Support Building/Office	New Construction

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3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This section describes the current conditions of the environmental resources, either man-made or natural, that could potentially be affected by the implementation of the Proposed Action.

Consistent with 40 CFR Sections 1500.2 and 1500.4 and 32 CFR Section 989.14, EAs should be concise, match the magnitude of the proposal, and support a determination of whether to prepare a FONSI or an Environmental Impact Statement (EIS). The 2020 EA considered 15 broad environmental resource areas, as well as additional resources required to be assessed in accordance with FAA Order 1050.1F (i.e., natural resources and energy supply, farmlands, and children's environmental health and safety risks).

The Proposed Action described in the 2020 EA has been expanded to include the proposed construction of a new SLC-20C, expansion of SLC-20A to accommodate common-use infrastructure to support launches at SLC-20A and SLC-20C, transportation of vehicle stages from Exploration Park and off-site payload processing facilities (e.g., Astrotech), and operation of small, vertical-lift launch vehicles at SLC-20C.

Since the Proposed Action boundary analyzed in this SEA is within the RPA boundary analyzed in the 2020 EA, the following resources were considered but not analyzed in this SEA because the resource considered would not be affected or no change would occur from what was analyzed in the 2020 EA: land use and coastal resources; hazardous materials, hazardous waste, and solid waste; geology and soils; utilities; socioeconomic resources; natural resources and energy supply; wild and scenic rivers; visual effects, light emissions, and visual resources/character; children's environmental health and safety risks; and farmlands. In reaching this determination, consideration of short- and long-term effects, beneficial and adverse significant effects that would warrant the preparation of an EIS, significant effects on public health and safety, and significant effects that would violate laws protecting the environment were considered.

Resources not analyzed further in this SEA are discussed below. Resources carried forward for analysis in this SEA include noise (Section 3.1), biological resources (Section 3.2), cultural resources (Section 3.3), air quality and climate change (Section 3.4), transportation (Section 3.5), water resources (Section 3.6), health and safety (Section 3.7), Section 4(f) properties (Section 3.8), and airspace and marine transportation management (Section 3.9).

Land Use and Coastal Resources: Land Use and Coastal Resources, to include compliance with the Florida Coastal Zone Management Act (CZMA), were analyzed in the 2020 EA; refer to Sections 3.1 and 4.1 in the 2020 EA for the affected environment and environmental consequences, respectively. In general, the region of influence (ROI) for this resource category includes land in the immediate vicinity of the Proposed Action as well as lands at and surrounding CCSFS. Similar to the 2020 EA, the Proposed Action would be consistent with the land use of the area. SLC-20 is within the Launch Operations Area Boundary, and the space complex is within the Gateway Planning District – Leased Properties (USSF 2022a).

Coordination with KSC, FAA, the Merritt Island National Wildlife Refuge (MINWR), the Florida Department of Environmental Protection (FDEP), and the Florida Coastal Management Plan (FCMP) member agencies would be conducted, as required, at the time of permitting in compliance with the Florida CZMA. The Florida State Clearinghouse is the primary contact for receipt of consistency evaluations from federal agencies, and these evaluations are conducted in conjunction with wetland resource and environmental resource permits (ERPs) issued by FDEP or St. Johns River Water Management District (SJRWMD).

Consistent with the analysis included in the 2020 EA, the construction and increase in launch cadence would remain consistent with existing land use at SLC-20, would not result in a change to land use or be incompatible with adjacent land use, and would not alter the existing character of the area. Therefore, negligible impacts would occur and, as such, these resources were considered but not analyzed in this SEA.

Hazardous Materials, Hazardous Waste, and Solid Waste: Hazardous Materials, Hazardous Waste (to include space vehicle processing hazardous waste production), and Solid Waste were analyzed in the 2020 EA; refer to Sections 3.7 and 4.7 in the 2020 EA for the affected environment and environmental consequences, respectively. The ROI for this resource category includes areas within and around SLC-20. As discussed in Section 4.7 of the 2020 EA, if contaminated soils are determined to be present during construction activities, all construction debris, root balls, etc., determined to contain contaminated soils above regulatory thresholds would be retained on site or would be handled and disposed of in accordance with the requirements established by the Resource Conservation and Recovery Act (RCRA) and OSHA and transported in accordance with FDOT regulations for shipping hazardous substances. No contaminated soils, hazardous waste, or solid waste have been documented at SLC-20C since it is undisturbed natural area; however, the expanded areas of SLC-20A and SLC-20B are within Solid Waste Management Unit (SWMU) C043, which has associated land use controls for soil contamination. Before construction, coordination with SLD 45 would occur to ensure compliance with the land use controls. Before approval for construction activities and use by any launch operator at SLC-20, the contractor(s) performing this work would be required to prepare a Hazardous Waste Management Plan for approval by SLD 45, which would minimize the generation of hazardous waste from the construction activities and, separately, from launch operator-related actions.

Furthermore, all applicable federal, state, and local rules and regulations would continue to be followed during construction and launch operations for the proper storage, handling, and usage of hazardous materials by Space Florida's tenant(s) launch program. This includes regulations and protocols for storing and disposing of hazardous materials and wastes and the generation and disposal of hazardous waste. Any accidental discharges or unauthorized releases would continue to be managed in accordance with the Hazardous Materials Emergency Response Plan. Additionally, although an increase in waste is expected with the increased launch activities, the amount of solid waste generated would be handled under existing collection and disposal operations. Space Florida's tenant(s) would develop a Pollution Prevention Management Plan, in coordination with CCSFS pollution prevention plans and goals, and comply with all federal, state, and local regulations. Space Florida's tenant(s) would track the usage of all Environmental Planning and Community Right-to-Know Act-listed chemicals and report emissions to the responsible government organization at CCSFS.

Consistent with the analysis included in the 2020 EA, any impact to hazardous materials, hazardous waste, and solid waste is expected to remain negligible; therefore, this resource was considered but not analyzed in this SEA.

Geology and Soils: Geology and Soils were analyzed in the 2020 EA; refer to Sections 3.9 and 4.9 in the 2020 EA for the affected environment and environmental consequences, respectively. The ROI for this resource includes areas within and around the Proposed Action. As discussed in Section 4.9.1 of the 2020 EA, no unique geologic features of exceptional interest or mineral resources occur in the ROI and contaminated sediments have been removed as documented in a 2019 Environmental Baseline Survey (GEAR 2019). Additionally, launch operations would not affect geology or soils in the ROI.

The Proposed Action would disturb up to approximately 17.3 acres for construction of SLC-20C and additional future infrastructure. None of the Proposed Action contains unique geologic features or mineral resources, and disturbance would only occur to the upper few feet of existing soil to remove unsuitable soil during site development. Clean fill would be used for the SLC-20C site construction. As a result, no adverse impacts to Geology and Soils are expected from the construction or operation of the Proposed Action; therefore, this resource was considered but not analyzed in this SEA.

Utilities: Utilities were analyzed in the 2020 EA; refer to Sections 3.11 and 4.11 in the 2020 EA for the affected environment and environmental consequences, respectively. As described in Section 3.11 of the 2020 EA, the ROI for this resource comprises all utility systems, including water (potable and fire protection), wastewater (collection and treatment), electrical supply, and solid waste, and their supplier and distribution systems. As discussed in Section 4.11 of the 2020 EA, each utility capability was evaluated on the basis of the ability to provide service to CCSFS and to the individual operational launch sites such as SLC-20. Attributes considered include processing, distribution/storage capacities, and related factors such as average daily consumption and projected peak demand. Historical and projected utility uses were determined from past records of purveyors, regulatory compliance reports, and the application of generally accepted average growth rates.

Consistent with the analysis included in the 2020 EA and because of the small additional combined utility usage required by SLC-20A, SLC-20B, and SLC-20C construction and launch operations, impacts to utilities are expected to remain negligible as a result of the implementation of the Proposed Action; therefore, this resource was considered but not analyzed in this SEA.

Socioeconomic Resources: Socioeconomic Resources were analyzed in the 2020 EA; refer to Sections 3.13 and 4.13 in the 2020 EA for the affected environment and environmental consequences, respectively. The ROI for this resource includes all of Brevard County. As described in the 2020 EA, local, short-term, minor beneficial impacts to socioeconomics are expected from construction activities; however, no large-scale migration to the area is expected since the construction labor and materials would be procured locally, and the regional area would likely absorb the temporary increase in the demand for jobs and materials. Following construction, some permanent jobs associated with day-to-day support would remain; however, this small number of permanent jobs would not significantly affect the local housing market or local economy.

Any socioeconomic impacts that occur because of delays or re-routing the overflight of commercial aircraft due to SLC-20 launch operations would be similar to those experienced with delays or re-routing aircraft for other reasons such as inclement weather, runway closures, natural disasters, or military exercises. The expected impacts from aircraft delays or re-routing might include additional commercial airline operating costs for increased flight distances and times resulting from re-routing aircraft and increased passenger costs including time lost from delayed flights, missed connections, and flight cancelations. Specific to delays, FAA reported that in 2022, 143 aircraft were delayed an average of 32 minutes as a result of commercial space operations, representing 0.04 percent of total minutes of delays that year (GAO 2024). Specific to airspace closures for launches, in April 2023, FAA revised the zone of restricted airspace around and offshore for launches from CCSFS and KSC to reduce impacts to aircraft traveling on easterly to southerly trajectories (FAA 2023, Fox Weather 2023). As a result of the revised restricted airspace, it was reported that no flights were rerouted for 10 of the 12 launches that occurred from April to June 2023 (Fox Weather 2023). Furthermore, the Space Data Integrator (SDI) is an operational protype that FAA would use to enable improved situational awareness and airspace management decision-making; specifically, the SDI would allow FAA to track the actual-versus-planned trajectory of launch and reentry operations, the status of mission events, and the display of Aircraft Hazard Areas to reduce the closed airspace necessary (FAA 2024a).

Any socioeconomic impacts that would occur from implementing the Proposed Action due to maritime closures on boating or fishing activities would be similar to those experienced with restricting vessels from entering temporary safety zones within the USCG District Seven area of responsibility offshore of Cape Canaveral. However, the Proposed Action would not recover its first stage or use a parachute. To provide mariners and the shipping industry access to real-time, geospatial information about space launches and reentries to navigate safely in areas affected by space operations, the USCG Navigation Center announced on December 13, 2023, the release of the Space Operations Launch and Recovery (SOLAR) geospatial visualization tool (USCG 2023). SOLAR would provide mariners and the shipping industry access to information on launch security zones within the Warning Areas and Hazard Areas specific to space launch operations so they can plan their own operations accordingly. Furthermore, recent NEPA analyses (CCSFS 2024b; CCSFS 2024c) have not identified any significant effects to maritime activities.

The Proposed Action would result in less than significant socioeconomic impacts; therefore, this resource was considered but not analyzed in this SEA.

Natural Resources and Energy Supply: The Proposed Action would not require the use of scarce or unusual materials and would not measurably increase demand on local supplies of energy or natural resources. The Proposed Action would not have a measurable effect on natural resources, such as water, asphalt, aggregate, or wood. Therefore, this resource was considered but not analyzed in this SEA.

Wild and Scenic Rivers: No rivers protected under the Wild and Scenic Rivers Act exist within the ROI. Therefore, this resource was considered but not analyzed in this SEA.

Visual Effects, Light Emissions, and Visual Resources/Visual Character: The Proposed Action would not change the existing or planned use of CCSFS. All construction and launch operations would occur from SLC-20 on CCSFS property. The additional 48 annual contrails for all three launch pads that could result from implementing the Proposed Action would be considered negligible since it is consistent with the land use of the area. Construction and launch operations would not differ visually from those activities already occurring at CCSFS. Therefore, this resource was considered but not analyzed in this SEA.

Children's Environmental Health and Safety Risks: EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, as amended by EO 13229 and EO 13296, directs federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. 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, water used for recreational purposes, and soils. The Proposed Action would not affect nor disproportionately affect children within the ROI nor result in any health or safety risk that would disproportionately affect children. Furthermore, with respect to responsibilities as to who controls the exposure of construction and operational health and safety risks to children and the general public, CCSFS controls public access to CCSFS, USCG issues NOTMARs to mariners, and FAA would issue NOTAMs to airmen. Since children are not expected to be present around the construction site or launch site during operations, no potential for significant impacts exists; therefore, this resource was considered but not analyzed in this SEA.

Farmlands: No farmland is present within the Proposed Action; therefore, this resource was considered but not analyzed in this SEA.

In compliance with NEPA, DAF, and FAA guidelines, the discussion of the affected environment focuses only on those resource areas potentially subject to impacts. In addition, the level of detail used in describing a resource category is commensurate with the expected level of potential impact to that respective resource. The following resources are included for analysis in this document:

- Noise
- Biological resources
- Cultural resources
- Air quality and Climate Change
- Water resources
- Health and safety
- Section 4(f) properties
- Airspace and Marine Transportation Management

3.1 Noise

3.1.1 Regulatory Setting

This section describes the potential impacts from noise generated by construction and launch operations at SLC-20A, SLC-20B, and SLC-20C. The ROI for noise includes the area around SLC-20C, CCSFS, KSC, and the closest populated areas, which are Cape Canaveral and Cocoa Beach to the south and Merritt Island to the west and southwest.

Aside from OSHA regulations to protect workers, primary responsibility for controlling noise is with state and local governments (USEPA 2024d). Brevard County Code of Ordinances, Chapter 46, Article IV, Section 46-133, requires construction activities be performed between 7:00 am to 8:00 pm Monday through Saturday. Additionally, Brevard County Code of Ordinances, Chapter 46, Article IV, Section 46-131, identifies the maximum permissible sound levels from construction when measured at the closest residential, commercial, institutional, or industrial property line (Table 3-1).

Table 3-1. Maximum Permissible Sound Levels by Land Use and Time Period

Land Use	Time Period	Maximum Allowable Sound Pressure Level (dBA)
Residential	7:00 am to 10:00 pm	60
	10:01 pm to 6:59 am	55
Commercial or Institutional	7:00 am to 10:00 pm	65
	10:01 pm to 6:59 am	55
Industrial	7:00 am to 10:00 pm	75
	10:01 pm to 6:59 am	65

Note: dBA = A-weighted decibels.
Source: Brevard County Code of Ordinances, Chapter 46, Article IV, Section 46-131.

For launch facility and equipment noise emissions, the provisions of the Noise Control Act of 1972 (42 USC Sections 4901–4918) apply. This Act amended the Control and Abatement of Aircraft Noise Sonic Boom Act of 1968 (49 USC Section 44715) to add consideration of the protection of public health and welfare and added USEPA to the rulemaking process for aircraft noise and sonic boom standards. FAA issued the Aviation Noise Abatement Policy in 1976; since the issuance of this Policy, FAA has used the Day-Night Average Sound Level (DNL) 65 A-weighted decibels (dBA) as the basis for its noise goal of reducing the number of people exposed to significant aircraft noise. This level does not represent a noise standard; rather, it is a basis to set appropriate standards that should also factor in local considerations and issues.

3.1.2 Affected Environment

3.1.2.1 General Description

Refer to Section 3.2 in the 2020 EA or a general description of noise. Table 3-2 provides common sound level descriptors.

Table 3-2. Noise Descriptions and Definitions

Description	Definition
A-Weighted Sound Level	The momentary magnitude of sound weighted to approximate the human ear's frequency and sensitivity. A-weighted sound levels typically measure between 20 Hz and 20 kilohertz.
Level Equivalent A-Weighted Sound Level (LAeq)	An A-weighted sound level that is "equivalent" to an actual time-varying sound level.
Day-Night Average Sound Level (DNL)	An A-weighted equivalent sound level averaged over a 24-hour period with a 10-dB "penalty" added to nighttime sounds. DNL has been adopted by federal agencies as the standard for measuring environmental noise.
C-Weighted Sound Level	Measures sound levels in dB, with no significant adjustment to the noise level over most of the audible frequency range except for a slight de-emphasis of the signal below 160 Hz and above 1,600 Hz. It is used as a descriptor of low-frequency noise sources, such as blast noise and sonic booms.

Table 3-2. Noise Descriptions and Definitions

Description	Definition
C-Weighted Day-Night Level (CDNL)	The C-weighted sound level averaged over a 24-hour period; with a 10-dB penalty added to nighttime sounds. CDNL is similar to DNL, except that C-weighting is used rather than A-weighting.
C-Weighted Sound Exposure Level (CSEL)	C-weighted SEL. The same as SEL except that the measurement is in C-weighting rather than A-weighting.
LA_{max}	LA_{max} is the A-weighted, maximum sound level. (Maximum is not *peak*.)
L_{max}	L_{max} is the maximum unweighted sound level.
Peak Overpressure	A measure of change in air pressure and often measured in units of pounds per square foot (psf). Peak overpressure is often used to measure the magnitude of sonic booms, particularly with respect to evaluating the potential for structural damage.
Sound Exposure Level (SEL)	A-weighted SEL. The total sound energy in a sound event if that event could be compressed into 1 second. SEL converts the total sound energy in a given noise event with a given duration into a 1-second equivalent and therefore allows direct comparison between sounds with varying magnitudes and durations.

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 supplemental noise metrics is recommended (A-Weighted Sound Level, Unweighted Sound Pressure Level, A-Weighted Sound Exposure Level, Percent Allowable Daily Noise Dose). Section 3 of the Blue Ridge Research and Consulting, LLC (BRRC) *Noise Study for Small-Class Launch Vehicle Operations* (2023) in Appendix G provides additional information.

3.1.2.2 Ambient Noise Levels

The ROI for noise includes the area around SLC-20C, CCSFS, KSC, and the closest populated areas, which are Cape Canaveral and Cocoa Beach to the south and Merritt Island to the west and southwest. Noise levels around industrial facilities at CCSFS and KSC are comparable to those of an urban industrial area, reaching levels of 60 to 80 dBA. The aircraft landing facilities and CCSFS Skid Strip are additional on-site sources of noise.

Other less frequent but more intense sources of noise are launches from CCSFS and KSC. The largest portion of the total acoustic energy produced by a launch vehicle is usually contained in the low-frequency end of the spectrum. Launch vehicles also generate sonic booms, which are shock waves that result from the displacement of air in supersonic flights.

Merritt Island, Cocoa Beach, and Cape Canaveral are more than 7 miles (11.3 km) from CCSFS and KSC. The distance between CCSFS, KSC, and adjacent communities reduces the noise effects experienced in residential areas. Typical sound levels in these areas are usually low with higher levels occurring in industrial areas near Port Canaveral or along transportation corridors. Residential areas and resorts along the beach would be expected to have low overall noise levels, normally about 45 to 55 dBA. Infrequent aircraft fly-overs and rocket launches from CCSFS and KSC would be expected to increase noise levels for short periods.

Table 3-3 lists typical noise levels generated by common outdoor and indoor activities and possible human effects.

Table 3-3. Common Noise Levels and Possible Human Responses

Noise	Noise Level (dBA)	Possible Human Response
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Thunderclap	130	Painfully loud
Auto horn	120	Maximum vocal effort
Rock concert	110	Extremely loud
Garbage truck	100	Very loud
Firecrackers	100	Very loud
Heavy truck (50 feet)	90	Very annoying with hearing damage after 8 hours of exposure
City traffic	90	Very annoying with hearing damage after 8 hours of exposure
Hair dryer	80	Annoying
Business office	70	Telephone use is difficult
Freeway traffic	70	Telephone use is difficult
Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room	40	Quiet
Bedroom	40	Quiet
Quiet office	40	Quiet
Library/soft whisper	30	Very quiet
Broadcasting studio	20	Very quiet
Threshold of hearing	0	Hearing begins

Source: Washington State Department of Transportation (WSDOT) 2020.

3.1.2.3 Launch Operations-Related Noise Description and Considerations

Launch operations-related noise refers to noise generated from activities such as actual launches and temporary noise during maintenance or refurbishment activities and ongoing noise generated from worker traffic to and from the selected site. The highest recorded noise levels at KSC were produced by Space Shuttle launches, which could exceed 160 dBA. Actual launch activities are the major source of all operational noise. Three distinct noise events are associated with the launch and ascent of a launch vehicle: (1) on-pad engine noise, (2) in-flight engine noise, and (3) sonic booms. Operation-related noise from the actual launches is summarized below.

On-Pad Noise

On-pad engine noise occurs when engines are firing but the vehicle is still on the pad. The engine exhaust is diverted horizontally by a flame deflector or flame duct. Noise levels in the immediate vicinity of the launch vehicle and within the launch complex are high. Since the sound source is at or near ground level, propagation from the launch vehicle to off-site locations is along the ground, leading to substantial attenuation over distance due to the interaction with the ground and atmospheric conditions. Consequently, on-pad noise levels are typically much lower than inflight noise levels, where the vehicle is airborne, and sound propagates more freely.

In-Flight Engine Noise

In-flight noise occurs when the vehicle is in the air, clear of the launch pad, and the engine exhaust plume is in line with the vehicle. In the early part of the flight, when the vehicle's motion is primarily vertical, noise contours are somewhat uniform (circular), particularly for the higher levels near the center. The outer noise contours tend to be somewhat distorted. These noise contours can be stretched out in the launch direction or broadened across the launch direction, depending on specific details of the launch. Because the contours are approximately circular, summarizing noise by giving the sound levels at a few distances from the launch site is often adequate. The in-flight sound source is also well above the ground; therefore, less attenuation of the sound occurs as it propagates to large distances.

The emitted acoustic power from a rocket engine and the frequency spectrum of the noise can be calculated from the number of engines, their size and thrust, and their flow characteristics. Normally, the largest portion of the total acoustic energy is contained in the low-frequency end of the spectrum (1 to 100 Hz).

Sonic Booms

Sonic booms occur when vehicles reach supersonic speeds. A sonic boom is the shock wave resulting from the displacement of air in supersonic flight. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second. The intensity of a sonic boom 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, and measured in psf.

In many cases, an ascending launch vehicle’s orientation at Mach 1 (speed of sound) is nearly vertical, and therefore the sonic boom ray cone would not impinge on the Earth’s surface and would not be heard. Conversely, a descending launch vehicle’s orientation often would cause a sonic boom to impinge on the Earth’s surface and be heard.

3.1.3 Environmental Consequences

Noise impact criteria are based on land use compatibility guidelines and on factors related to the duration and magnitude of noise level changes. Although hearing impairment and structure damage are considerations, they are unlikely consequences outside the immediate vicinity of the launch point, making annoyance effects the primary consideration for most noise impact assessments on humans. Noise impacts on wildlife are discussed in Section 3.2.3.

In accordance with FAA Order 1050.1F, significant noise impacts would occur if the Proposed Action would increase noise by DNL 1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level or that would be exposed at or above the DNL 65 dB level due to a DNL 1.5-dB or greater increase, when compared to the No Action Alternative for the same timeframe. Typically, noise-sensitive areas include residential, educational, health, religious structures and sites, parks or recreational areas (including areas with wilderness characteristics), wildlife refuges, and cultural and historical sites.

In general, the threshold for well-maintained building damage due to sonic booms is 2 psf, below which damage is unlikely. For project-related overpressures at 1 psf, the probability of a window-breaking range is low.

3.1.3.1 Proposed Action

The Proposed Action includes noise generated by construction and launch operations at SLC-20A, SLC-20B, and SLC-20C.

Clearing and Construction-Related Noise

The two most common types of noise are point source and line source. Point source noise is typically associated with a stationary source, such as most construction activities. Examples include jackhammers, excavators, or a single traveling vehicle. The standard reduction for point source noise is 6 dB per doubling of the distance from the source. Line source noise is generated from moving objects such as highway traffic. The standard reduction for line source noise is 3 dB per doubling of the distance (WSDOT 2020). Table 3-4 lists example noise reduction over distance from a 95-dBA source when the site is considered generally flat and hard such as concrete or hard-packed soil.

Table 3-4. Example Noise Reduction Over Distance From a 95-dBA Source

Distance from Source (feet [meters])	Point Source (dBA)	Line Source (dBA)
50 (15.2)	95	95
100 (30.5)	89	92
200 (61.0)	83	89
400 (121.9)	77	86
800 (243.8)	71	83
1,600 (487.7)	65	80
3,200 (975.4)	59	77
6,400 (1,950.7)	53	74

Source: WSDOT 2020.

Additionally, dense vegetation can reduce noise levels by as much as 5 dB per 100 feet (30.5 m) of vegetation, up to a maximum reduction of 10 dB over 200 feet (61.0 m) (WSDOT 2020).

Typical construction equipment that would be used during construction include milling machines, excavators, bulldozers, graders, asphalt pavers, material transfer vehicles, compactors/rollers, water trucks, dump trucks, forklifts, scrapers, trenchers, line-up trucks, and pickup trucks. In general, this equipment would range in noise levels of 72 to 93 dB at 50 feet (15.2 m) from its source (WSDOT 2020). The construction-related sound is expected to attenuate below County ordinance requirements before leaving the site boundary, resulting in less than significant impacts. Additionally, no residential areas or other sensitive receptors are in the construction noise ROI, all work would be performed during normal business hours, and the contractor would employ industry-standard best management practices to ensure that all equipment is operated in accordance with the manufacturer's specifications and equipped with noise-reducing equipment in proper working condition. Furthermore, pursuant to 29 CFR Part 1917, worker protection against the effects of noise exposure would be required.

Temporary minor to moderate adverse effects, and therefore not significant, are expected from construction-related noise impacts from implementation of the Proposed Action.

Operations and Launch Vehicle-Related Noise

A 2019 technical report, *Noise Study for Firefly's Cape Canaveral Orbital Launch Site Environmental Assessment* (BRRC 2019), was developed to assess launch and sonic boom noise as a result of the proposed activities at SLC-20A and SLC-20B and analyzed up to 28 total annual launches and 76 static fire tests. Refer to Section 4.2.1 of the 2020 EA for a discussion of impacts. A 2023 technical report, *Noise Study for Small Class Launch Vehicle Operations at SLC-20C*, was also prepared to assess launch and sonic boom noise as a result of launch operations at SLC-20C that analyzed up to 24 total launches annually and 18 static fire tests (BRRC 2023). The potential impacts at SLC-20C from propulsion noise and sonic booms were evaluated on a single-event and cumulative basis in relation to hearing conservation, structural damage, and human annoyance. Appendix H contains the FAA approval letter for the noise modeling methodology, Appendix G contains the report, and the results are summarized below. BRRC developed and used their Launch Vehicle Noise and Emissions Simulation Model (RUMBLE) noise model to predict the noise associated with the proposed small-class launch vehicle operations. Based on the above-cited noise studies and analyses, launch and sonic boom noise from the Proposed Action are not expected to be significant.

An upper limit noise level of LA_{max} 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. LA_{max} can be used to identify potential locations where hearing protection should be considered for launch operations. LA_{max} is the maximum A-weighted sound pressure level recorded over the period stated and is often used as a measure of the most obtrusive facet of the noise, even though it may only occur for a very short time.

A single small-class launch vehicle event may generate levels at or above LA_{max} 115 dBA within 0.57 mile (0.9 km) of the launch site. The 115-dBA contours associated with the launch and static fire events are entirely within the boundaries of CCSFS (Figure 3-1).

The potential for structural damage claims were assessed by analyzing the 111- and 120-dB L_{max} contours generated by small-class launch vehicle events. 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 (Guest and Slone 1972). For the small-class launch vehicle event, the modeled 120- and 111-dB L_{max} contours are limited to radii of 0.57 and 1.6 miles (0.9 and 2.6 km) from the launch site, respectively. The entire land area encompassed by the 111-dB noise contours resulting from the small-class launch vehicle or static fire events lies within the CCSFS and KSC boundaries.

For impulsive noise events such as sonic booms, noise impacts to human annoyance and health and safety are not expected due to the low magnitude and frequency of these events. The potential exists for structural damage to glass, plaster, roofs, and ceilings for well-maintained structures for overpressure levels greater than 2 psf. Sonic booms resulting from small-class launch vehicle operations are predicted to occur over the Atlantic Ocean for all proposed launch azimuths between 40 degrees and 110 degrees. Modeled (using PCBoom) sonic boom overpressure levels between 2 and 7.4 psf are directed east over the Atlantic Ocean in the direction of the launch azimuth, making them inaudible on the mainland. Accordingly, noise impacts with respect to human annoyance, health and safety, or structural damage are not

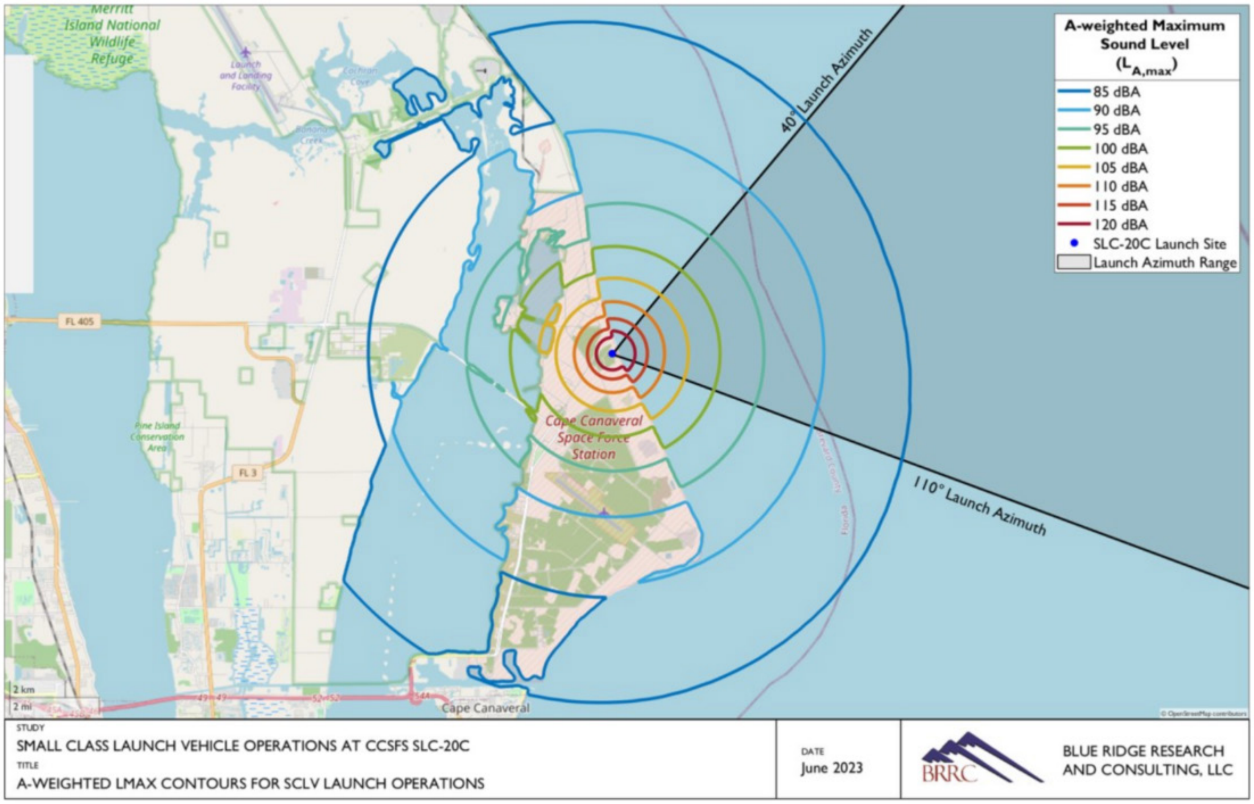


Figure 3-1. Noise Contours

expected to result from the sonic booms produced by small-class launch vehicle operations. Therefore, no significant impacts are expected as a result of sonic booms produced by small-class launch vehicle operations.

As identified in the 2023 BRRC technical report, the launch propulsion noise depicted by the DNL 65- and 60-dBA contours extend approximately 1.2 and 1.8 miles (1.9 and 2.9 km) from the launch site, respectively. This area does not encompass land outside the boundaries of CCSFS and KSC; therefore, no significant impacts to residences would occur from propulsion noise (Figure 3-2).

Airspace closures associated with launches could result in temporarily grounded aircraft at affected airports and re-routing of enroute flights on established alternate flight paths. As noted previously, FAA reported in 2022 that 143 aircraft were delayed an average of 32 minutes as a result of commercial space operations, representing 0.04 percent of total minutes of delays that year (GAO 2024). To reduce impacts to aircraft traveling on easterly to southerly trajectories, FAA revised the zone of restricted airspace around and offshore for launches from CCSFS and KSC in April 2023; this has had a beneficial impact of preventing flight reroutes (FAA 2023, Fox Weather 2023). Additionally, use of the SDI would further reduce the closed airspace necessary (FAA 2024a). However, if aircraft were grounded, noise levels at the airport could temporarily increase as the planes are idle. Also, depending on the altitude at which aircraft approach an airport, temporary increases in noise levels could occur in communities around the airports.

However, aircraft would travel on existing routes and flight paths that are used daily to account for weather and other temporary restrictions. As stated previously, re-routing associated with launch-related closures represents a small fraction of the total amount of re-routing that occurs

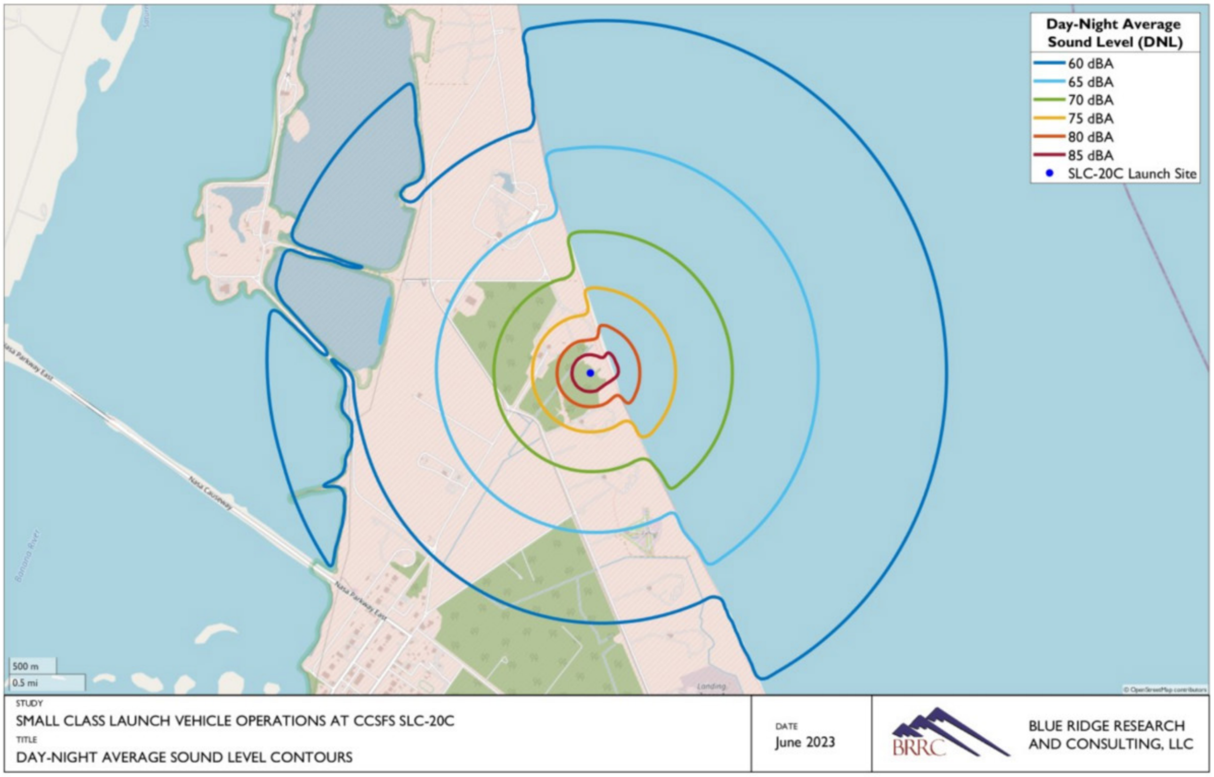


Figure 3-2. DNL Contours

for 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 day-night average sound levels at the affected airports and surrounding areas. Therefore, airspace closures due to launches are not expected to result in significant noise impacts. Advancements in airspace management are expected to further reduce the number of aircraft that would contribute to noise at the affected airports and surrounding areas.

Section 4.2.1 in the 2020 EA stated that minor adverse impacts would occur from noise generated by Firefly Alpha and Beta launch operations. The addition of launch operations at SLC-20C would not change those findings. Accordingly, minor adverse impacts, and therefore not significant impacts, from noise generated by small-class launch vehicle operations are expected.

3.1.3.2 No Action Alternative

The noise report included as Appendix B of the 2020 EA models the predicted sonic booms generated to be directed easterly out over the Atlantic Ocean for SLC-20A and SLC-20B launches, and the 65 and 60 A-weighted decibel contours to be encompassed within CCSFS and KSC boundaries. Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.2.1 of the 2020 EA are hereby incorporated by reference.

3.2 Biological Resources

This section describes the vegetation and wildlife species that occur or could potentially occur within the ROI. For biological resources, the ROI includes the Proposed Action and areas within the proposed RPA boundary that could be affected by construction activities and launch operations. Biological resources include native plants and animals and the habitats in which they exist. Sensitive and protected biological resources include plant and animal species that are threatened or endangered (T&E) and candidate species as listed by USFWS.

SLD 45 is committed to the long-term management of all-natural areas on its installations as directed by AFI 32-7064, *Integrated Natural Resources Management*. Long-term management objectives are identified in the SLD 45 Integrated Natural Resources Management Plan (INRMP)(USSF 2022b), which also contains management plans for scrub-jay and sea turtles.

The following sections were derived from several sources, including the SLD 45 INRMP (USSF 2022b) and a recently completed BA for the site (Appendix I). In response to this BA, USFWS prepared a Biological Opinion (BO) (Appendix J).

3.2.1 Regulatory Setting

3.2.1.1 Federal Regulations

Endangered Species Act (ESA). The ESA provides for the conservation of ecosystems upon which T&E species of fish, wildlife, and plants depend, through federal action and by encouraging the establishment of state programs. 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 USFWS and/or the National Oceanic and Atmospheric Administration (NOAA) NMFS.

Marine Mammal Protection Act (MMPA). The MMPA protects mammals including cetaceans (whales, dolphins, and porpoises) and other marine mammals in US waters. USFWS and NMFS share responsibility for implementing MMPA.

Migratory Bird Treaty Act (MBTA). Under this Act, it is unlawful to take, kill, or possess migratory birds. EO 13186, signed in 2001, requires federal agencies to protect migratory birds and their habitats. This requires that if nests may be impacted, the nest must be empty of eggs or young before relocation or removal.

Bald and Golden Eagle Protection Act. This Act prohibits the taking or possession of, and commerce in, bald and golden eagles.

Marine Wildlife and EFH. The MSFCMA 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.”

Section 3.2.2 describes habitats that could be affected by the Proposed Action. Section 3.2.3 describes non-listed wildlife species that could be affected by the Proposed Action, Section 3.2.4 analyzes marine species and habitats under the jurisdiction of NMFS that could be affected, and Section 3.2.5 analyzes listed wildlife species under the jurisdiction of USFWS that could be affected by the Proposed Action.

3.2.2 Vegetation

3.2.2.1 Affected Environment

Table 3-5 summarizes the land cover that occurs on CCSFS (USAF 2018a). Many of these natural communities are high quality despite the communities being fragmented by mission-related construction and clearing activities. These communities range from scrub to mangrove swamps. The dominant native vegetation communities on CCSFS consist of maritime hammock, coastal strand, and live oak/palmetto. Eight state-listed plant species have been documented on CCSFS based on field surveys, but none of these eight species were documented within the boundaries of the Proposed Action. No federally listed plant species have been documented on CCSFS based on field surveys.

Table 3-5. Summary of Land Cover on CCSFS

Natural Vegetation Community	
Name	**Acreage (hectares)**
Beach Dune (acreage not available)	Not Available
Coastal Grassland	Included in Coast Strand Acreage
Coastal Strand	1,728 (699.30)
Basin Marsh	75 (30.35
Coastal Interdunal Swale	142 (57.47)
Maritime Hammock	2,291 (927.13)
Live Oak/Saw Palmetto Hammock	1,237 (500.60)
Live Oak/Saw Palmetto Shrubland	1,477 (597.72)
Xeric Hammock	556 (225.01)
Scrub	1,083 (438.27)
Hydric Hammock	9 (3.64)
Mangrove or Exotics	901 (364.62)

Land cover within the Proposed Action comprises two upland and one wetland vegetation communities (Figure 3-3). Each community is described below.

Uplands. Two upland habitats are found within the Proposed Action boundary: Maintained Grasses and Xeric Hammock. Maintained Grasses comprise 2.8 acres (1.1 ha) and contain herbaceous or sandy areas that have been maintained inconsistently, were portions of the legacy SLC-20 operational areas, or serve as unimproved access roads (Figure 3-3 and Table 3-6). Vegetated areas in this community are dominated by a diversity of native and exotic species such as ragweed (*Ambrosia artemisiifolia*), beggars tick (*Bidens alba*), frogfruit (*Phyla nodiflora*), muhly grass (*Muhlenbergia capillaris*), Bermuda grass (*Cynodon dactylon*), bahia grass (*Paspalum notatum*), alamo vine (*Merremia dissecta*), mother of thousands (*Kalanchoe daigremontiana*), sunflower (*Helianthus debilis*), lantana (*Lantana sp.*), century plant (*Agave americana*), prickly pear cactus (*Opuntia humifusa*), morning glory (*Ipomea* sp.), partridge pea (*Chamaecrista fasciculata*), and winged loosestrife (*Lythrum alatum*).

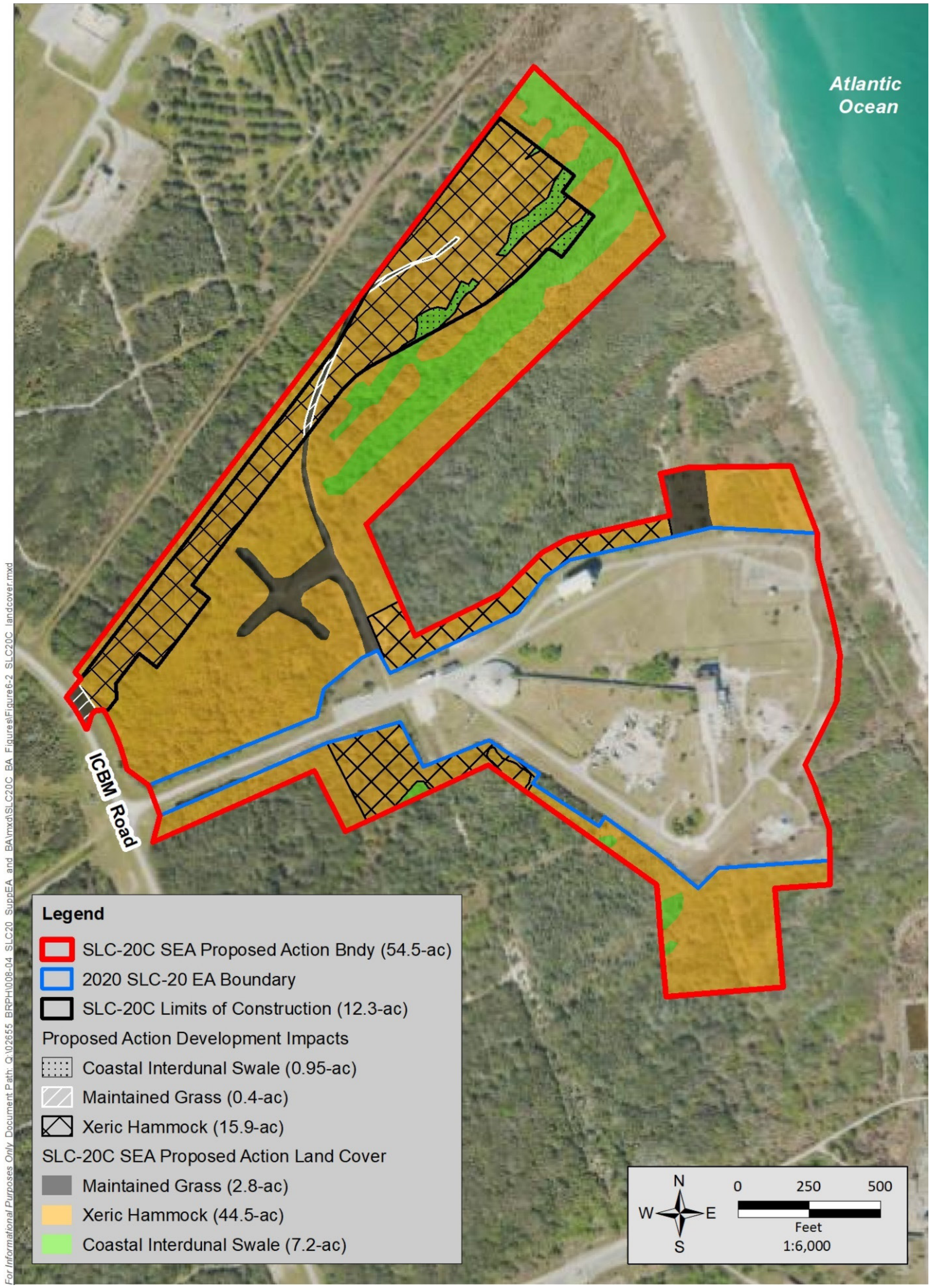


Figure 3-3. Existing Land Cover Map

Table 3-6. Land Cover Summary

Proposed Action	Land Cover (acres [hectares])			TOTAL
	Maintained Grass	Xeric Hammock	Coastal Interdunal Swale	
SLC-20 2020 EA	32.4 (13.1)	0.3 (0.1)	0.0	32.7 (13.2)
SLC-20C Proposed Action				
SLC-20C Site Development (Proposed Impacts)	0.4 (0.16)	15.9 (6.4)	0.95 (0.38)	17.3 (6.9)
Remaining Unaffected Area	2.4 (0.97)	28.6 (11.6)	6.2 (2.8)	37.2 (15.3)
SLC-20C Subtotal	2.8 (1.1)	44.5 (18.0)	7.2 (3.1)	54.5 (22.2)
TOTAL	**35.2 (14.2)**	**44.8 (18.1)**	**7.2 (3.1)**	**87.2 (35.3)**

The second upland community, Xeric Hammock, is found throughout the Proposed Action and comprises approximately 44.8 acres (18.1 ha) (Figure 3-3). This area is dominated by live oak (*Quercus virginiana*), cabbage palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), greenbriar (*Smilax* sp.), and grapevine (*Vitis rotundifolia*).

Wetlands. The wetlands within the Proposed Action are characterized as Coastal Interdunal Swale and are found throughout the northeast and south portions of the site (Figure 3-3). This community comprises 7.2 acres (3.1 ha) and is dominated by sand cordgrass (*Spartina bakerii*), saw palmetto, groundsel tree (*Baccharis halimifolia*), wax myrtle (*Myrica cerifera*), solidago (*Solidago* sp.), yaupon holly (*Ilex vomitoria*), spurred butterfly pea (*Centrosema virginianum*), sea-oxeye-daisy (*Borrichia arborescens*), marsh elder (*Iva frutescens*), and glasswort (*Salicornia maritima*) (Table 3-6).

3.2.2.2 Environmental Consequences

Proposed Action

Construction. Construction of the Proposed Action would result in the loss of an additional 15.9 acres (6.4 ha) of Xeric Hammock and 0.4 acre (0.16 ha) of Maintained Grass, which are required in the near term for constructing the SLC-20C launch facility (Table 3-6). Section 3.6.3.3 discusses the impacts to the 0.95 acre (0.38 ha) of Coastal Interdunal Swale wetlands.

Due to the loss of the native upland vegetation communities for construction, minor adverse impacts, and therefore not significant impacts, to vegetation are expected as a result of the Proposed Action.

Operation. Some scorching of vegetation could occur as a result of launches, but scorching would be minimized by the use of a flame diverter and deflector at each pad. The diverter would direct the flame to the east and the deflector would deflect the heat plume upward at an approximately 5-degree angle (Figure 3-4). Scorched vegetation would regrow, and the vegetation within the Proposed Action is a fire-dependent community and accustomed to fire. As a result, negligible adverse impacts, and therefore not significant impacts, to vegetation are expected as a result of the Proposed Action.

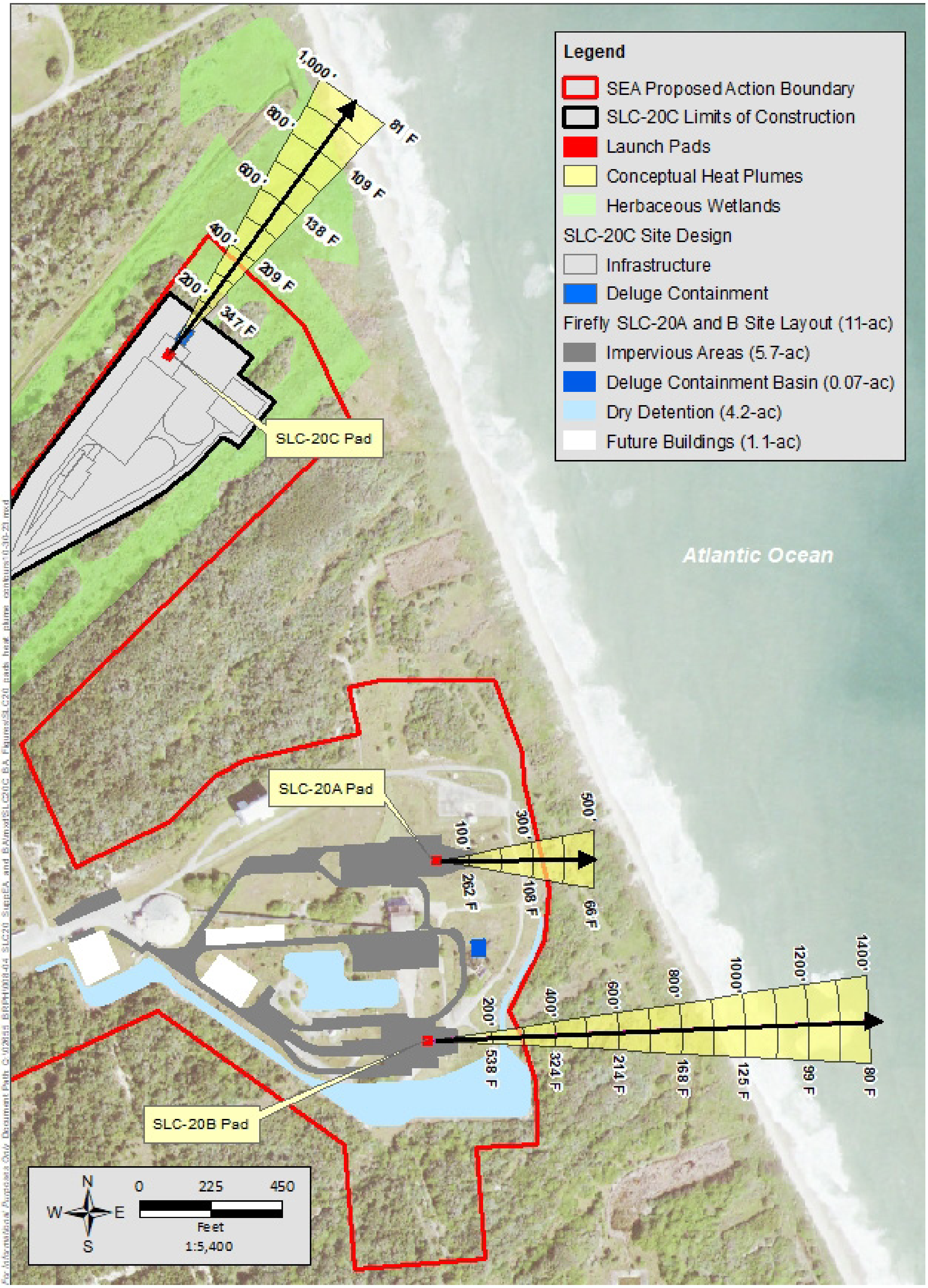


Figure 3-4. Heat Plume Location Map

No Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.3.1 of the 2020 EA are hereby incorporated by reference.

3.2.3 Wildlife

3.2.3.1 Affected Environment

CCSFS is on a barrier island that supports many plants, animals, and natural communities. Barrier islands along the Atlantic coast are especially important to nesting sea turtles and populations of small mammals and as foraging and roosting habitat for a variety of resident and migratory birds. Specifically, more than 25 mammalian species, more than 50 amphibian and reptile species, and more than 200 bird species are known to occur on or in the vicinity of CCSFS.

The coastal scrub and associated woodlands provide habitat for a wide range of wildlife including raccoon (*Procyon lotor*), long-tailed weasel (*Mustela frenata peninsulae*), round-tailed muskrat (*Neofiber alleni*), southeastern beach mouse (SEBM) (*Peromyscus polionotus niveiventris)*, migratory birds, and mammals such as the white-tailed deer (*Odocoileus virginianus cariacou*), armadillo (*Dasypodidae*), bobcat (*Lynx rufus rufus*), and feral hog (*Equus caballus*). Numerous marine mammals populate the coastal and lagoon waters including bottlenose dolphin (*Tursiops truncatus*), spotted dolphin (*Stenella*), and manatee (*Trichechus manatus*), which is protected.

Amphibians documented on CCSFS include the spade-foot toads (*Bufo marinus*), eastern narrow-mouth toads (*Gastrophryne carolinensis*), southern leopard frogs (*Rana sphenocephala*), Florida gopher frog (*Rana capito aesopus*), and green and squirrel tree frogs (*Rana clamitans melanota*). Reptiles observed include the American alligator (*Alligator mississippiensis*), Florida box turtle (*Terrapene baurii*), gopher tortoise (*Gopherus polyphemus*), Florida softshell turtle (*apalone ferox*), green anole (*Anolis carolinensis*), eastern six-lined racerunner (*Cnemidophorus sexlineatus sexlineatus*), broad-headed skink (*Eumeces laticeps*), southern ringneck snake (*Diadophis punctatus punctatus*), everglades racer (*Coluber constrictor palidicola*), eastern coachwhip (*Masticophis flagellum flagellum*), eastern diamondback rattlesnake (*Crotalus adamanteus*), and pine snake (*Pituophis melanoleucus*).

The seagrass beds in the north Indian River Lagoon (IRL) system provide important nursery areas, shelter, and foraging habitat for a wide variety of fish and invertebrates, manatees, and green sea turtles. The inland rivers and lagoons provide habitat for marine worms, mollusks, and crustaceans. The Mosquito Lagoon is an important shrimp nursery area. The beaches and off-shore area are inhabited by five species of marine turtles.

Several saltwater fish species can be found within Indian and Banana River systems including the bay anchovy (*Engraulis nanus*), great pipefish (*Syngnathus acus*), goby (*Cheiracanthium gobi*), silver perch (*Bairdiella chrysoura*), lined sole (*Achirus lineatus*), spotted sea trout (*Cynoscion*), and oyster toadfish (*Opsanus tau*). The small freshwater habitats found on CCSFS contain bluegill (*Lepomis macrochirus*), garfish (*Belone belone*), Florida largemouth bass (*Micropterus floridanus*), killifishes (*Floridichthys carpio*), sailfin molly (*Poecilia latipinna*), and top minnow (*Phoxinum Phoxinus*) (USAF 1998).

3.2.3.2 Environmental Consequences

Construction of the Proposed Action would impact approximately 17.3 acres (7 ha) of habitat, 0.95 acre (0.4 ha), of which is herbaceous wetlands and the remainder predominately dense xeric hammock (Table 3-6). This wetland community is common at CCSFS, and thus vast acreages of similar habitat are available for species to utilize that would remain adjacent to the construction area and throughout CCSFS. The loss of 0.95 acre (0.4 ha) is not expected to cause measurable population losses or shifts in species movements that result in population changes. The gopher tortoise, a state-listed species, would be captured and relocated in accordance with SLD 45 guidelines where conflicts with site development occur at SLC-20A, SLC-20B, and SLC-20C. As a result, negligible impacts (not significant) to wildlife species are expected as a result of construction of the Proposed Action.

Operation of the Proposed Action could result in mortality of terrestrial species in the vicinity from vehicle strikes due to increased traffic during launch days and from launch heat plume. However, this increase in mortality is expected to be negligible (not significant). Operational noise impacts to wildlife are not expected to result in mortality or changes in populations at CCSFS. Heat plumes resulting from launches could adversely affect wading bird species that are foraging in adjacent wetlands at the time of launch, but this is very unlikely. As a result, the construction and operation of the Proposed Action is expected to have negligible and no significant impacts to wildlife species.

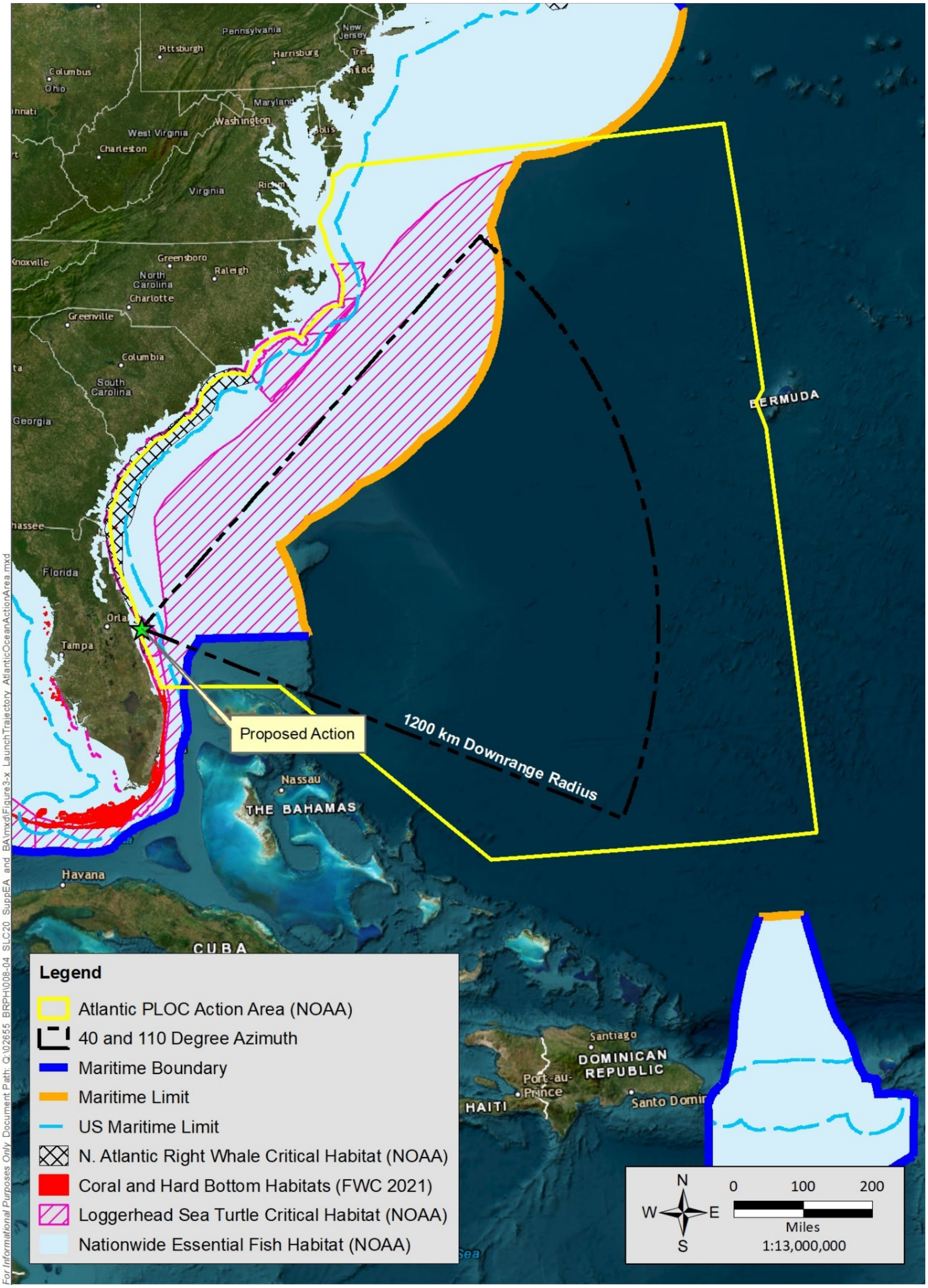
3.2.4 Marine Life and Essential Fish Habitat

3.2.4.1 Affected Environment

Section 305(b)(2) of the MSFCMA, as amended, requires interagency coordination to further the conservation of federally managed fisheries and each federal agency that may adversely affect EFH to consult with the NMFS and identify the EFH. The MSFCMA defines EFH as *those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity*. Coral and hardbottom habitats are designated *Habitat Areas of Particular Concern* under the EFH provisions of the MSFCMA. EFH for coastal migratory pelagic species includes sandy shoals and offshore bars, all coastal inlets, designated nursery habitats, and high-profile rocky bottom and barrier island ocean-side waters. This extends from the surf to 200 miles (321.9 km) offshore along the coastline. Areas inshore of the 100-ft (0.03-km) contour, estuarine emergent vegetated wetlands, tidal creeks, estuarine scrub/shrub, oyster reefs and shell banks, unconsolidated bottom (soft sediments), artificial reefs, coral reefs, and live/hard bottom habitats are EFH for specific life stages of estuarine-dependent and near shore snapper-grouper species.

NMFS OPR-2025-XXXXX (2025) identified an Atlantic Ocean Action Area for 18 ESA species under NMFS management (Figure 3-5).

The following species could occur in this Atlantic Ocean Action Area: 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 (*Trichechus manatus*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), Atlantic sturgeon (*Acipenser oxyrinchus*; south Atlantic distinct population segment), giant manta



1
2 **Figure 3-5. Proposed Action Launch Azimuth and ROI for SLC-20A, SLC-20B, or SLC-20C Launch Vehicles**

rays (*Manta birostris*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), shortnose sturgeon (*Acipenser brevirostrum*), and smalltooth sawfish (*Pristis pectinata*). In addition, 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 (Figure 3-5). Detailed species and habitat descriptions can be found in the NMFS OPR-2025-XXXXX (2025).

3.2.4.2 Environmental Consequences

Construction of the Proposed Action would not result in adverse impacts to marine life and EFH. Operation of the Proposed Action could affect marine life and EFH as a result of sonic booms and the return of vehicle components as they reenter the atmosphere and land in the Atlantic Ocean (Figure 3-6, Figure 3-7, and Figure 3-8). The specifics of the trajectory and mission plan for SLC-20A, SLC-20B, or SLC-20C are not presently defined; therefore, an ROI was developed to cover a variety of mission types launched from SLC-20A, SLC-20B, or SLC-20C. Figure 3-5 shows that launches are expected to be conducted toward the east over the Atlantic Ocean between the standard ER azimuths of 40 degrees northeast and 110 degrees southeast. The Proposed Action does not include booster recovery or escape modules. Vehicle stages are expected to break up due to aerodynamic and aerothermal loading during reentry. The SLC-20A, SLC-20B, and SLC-20C vehicles are lighter than the Stoke Nova vehicle. Accordingly, we expect with high probability that the significantly lighter SLC-20A, SLC-20B, and SLC-20C vehicles means that the vehicle stages would deplete propellant sooner than the Stoke Nova and return to Earth sooner, thereby needing a smaller ROI. Therefore, the debris fields of SLC-20A, SLC-20B, and SLC-20C vehicles would be assumed with relatively high confidence to be contained within the Stoke Nova ROI, and use of the Stoke Nova ROI (1,200 km downrange) would provide a conservative envelope for the SEA. However, each launch vehicle operator would need to complete a Part 450 review with FAA, at which time a detailed debris field analysis would be completed using known vehicle specifications. The Part 450 review would require analysis with the actual vehicle component materials and other data to confirm that the ROI assumed in NMFS OPR-2025-XXXXX (2025) remains valid. If the resulting debris field/component fate ROI is not consistent with this request, then FAA would require the operator to reconsult with NMFS to resolve this issue.

Based on the findings of NMFS OPR-2021-02908 (2025) and inclusion of SLC-20A, SLC-20B, and SLC-20C operations at CCSFS, the Proposed Action is expected to have negligible adverse impacts (and therefore not significant) to marine ESA-listed species and designated critical habitat within NMFS' jurisdiction.

3.2.5 Threatened and Endangered Species

3.2.5.1 Affected Environment

CCSFS contains habitat that is utilized by a large number of federally and state-listed species. The Florida Natural Areas Inventory (FNAI) conducted a comprehensive biological survey of CCSFS for SLD 45. This 2-year survey was completed in December 1997 to document rare, threatened, and endangered flora and fauna, migratory birds, and outstanding natural communities. Survey efforts at CCSFS since that time (Gulledge et al. 2009; Reyier et al. 2011; Oddy et al. 2012; Fleming and Greenwade 2007; Hankla 2008) have identified additional federally and state-listed sensitive

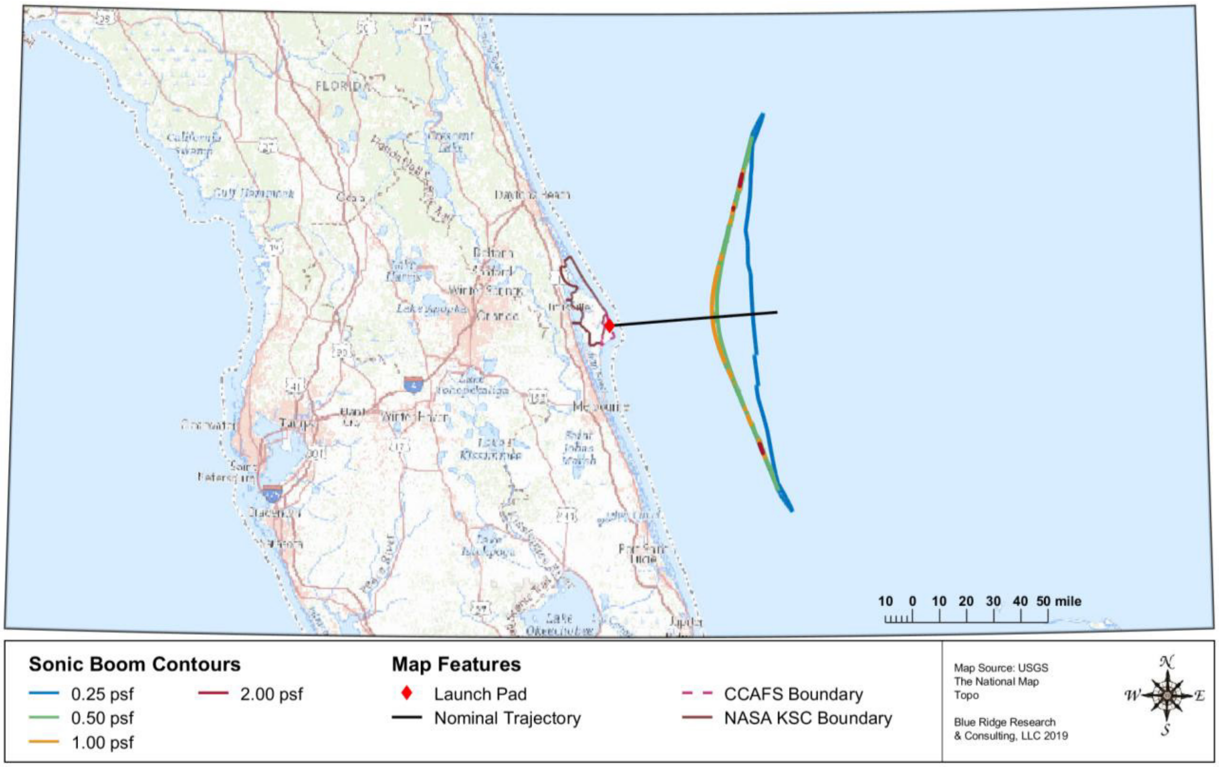


Figure 3-6. Sonic Boom Peak Overpressure Contours for a Nominal Alpha Launch from SLC-20A

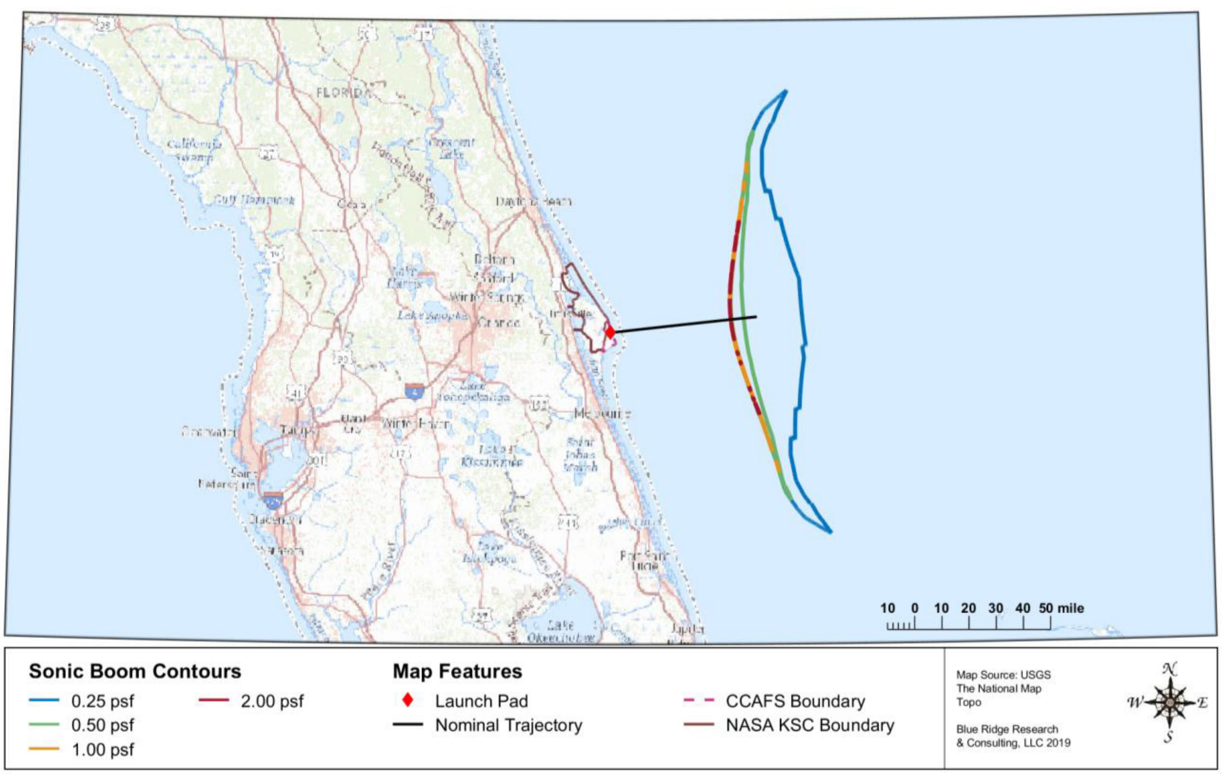


Figure 3-7. Sonic Boom Peak Overpressure Contours for a Nominal Beta Launch from SLC-20B

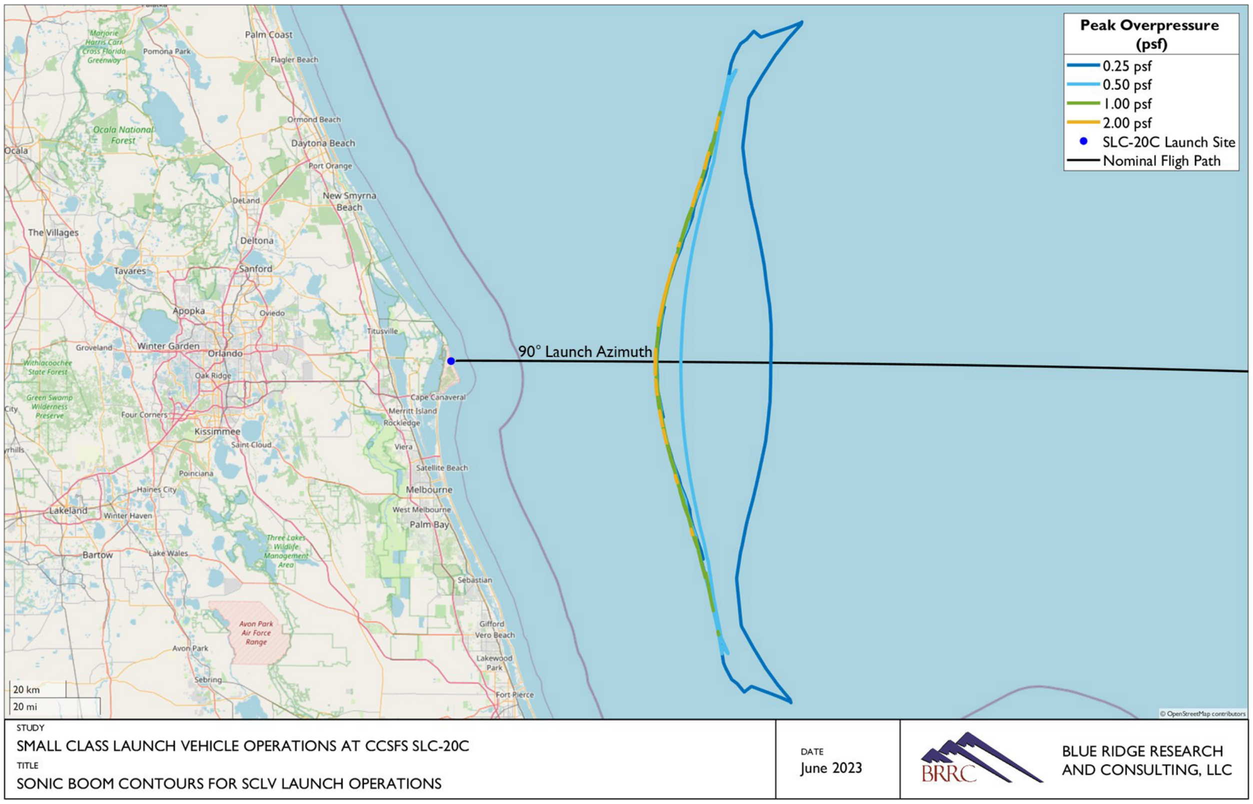


Figure 3-8. Sonic Boom Peak Overpressure Contours for a Nominal Due-East Launch Azimuth

species occurring at the installation. Federally or state-listed species occurring within CCSFS include five fish, nine reptiles, 15 birds, four mammals, and 11 plants. No federally designated critical land habitat under Section 4 of the ESA is mapped on the installation. The USFWS has jurisdiction for those species that occur on land as well as sea turtles for their nesting activities. The NMFS has jurisdiction over listed species and EFH that occur in the ocean.

Table 3-7 presents listed wildlife species that are known to occur at CCSFS. USSF (2022b) provides a list of federal and state regulatory requirements (addressing vegetation and wildlife that may be present on CCSFS) and a more detailed description of protected species present at CCSFS. No federally listed plant species occur on CCSFS.

Table 3-7. Protected Species Known to Occur at CCSFS

Common Name	*Scientific Name*	Status	
		Federal	State
Atlantic Sturgeon*	*Acipenser oxyrinchus*	E	
Oceanic Whitetip Shark*	*Carcharinus longimanus*	T	
Nassau Grouper	*Epinephalus striatus*	T	
Giant Manta Ray*	*Manta birostris*	T	
Smalltooth Sawfish*	*Pristis pectinata*	E	
Amphibians			
None listed			
Reptiles			
American Alligator	*Alligator mississippiensis*	T(S/A)	
Loggerhead Sea Turtle	*Caretta caretta*	T	
Green Sea Turtle	*Chelonia mydas*	T	
Leatherback Sea Turtle	*Dermochelys coriacea*	E	
Eastern Indigo Snake	*Drymarchon couperi*	T	
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	
Gopher Tortoise	*Gopherus polyphemus*		T
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	
Florida Pine Snake	*Pituophis melanoleucus mugitus*		T
Birds			
Florida Scrub-Jay	*Aphelocoma coerulescens*	T	
Red Knot	*Calidris canutus rufa*	T	
Audubon's Crested Caracara	*Caracara cheriway*	T	
Piping Plover	*Charadrius melodus*	T	
Snowy Plover	*Charadrius nivosus*		T
Little Blue Heron	*Egretta caerulea*		T
Reddish Egret	*Egretta rufescens*		T
Tricolored Heron	*Egretta tricolor*		T
Southeastern American Kestrel	*Falco sparverius paulus*		T
American Oystercatcher	*Haematopus palliatus*		T
Wood Stork	*Mycteria americana*	T	
Roseate Spoonbill	*Platalea ajaja*		T
Black Skimmer	*Rynchops niger*		T
Roseate Tern	Sterna dougallii	T	
Least Tern	*Sternula antillarum*		T
Black-Capped Petrel	*Pterodroma hasitata*	E	
Bald Eagle**	*Haliaeetus leucocephalus*		
Mammals			
North Atlantic Right Whale*	*Eubalaena glacialis*	E	
Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	T	
West Indian Manatee	*Trichechus manatus*	T	
Tri-colored Bat	*Perimyotis subflavus*	C	
Insects			
Monarch Butterfly	*Danaus plexippus*	C	

Table 3-7. Protected Species Known to Occur at CCSFS

Common Name	*Scientific Name*	Status	
		Federal	State
Plants			
Sea-Lavender	*Argusia gnaphalodes*		E
Curtiss's Milkweed	*Asclepias curtissii*		E
Sand Dune Spurge	*Chamaesyce cumulicola*		E
Satin-Leaf	*Chyrsophyllum oliviforme*		T
Coastal Vervain	*Glandularia maritima*		E
Pineland Florida Lantana	*Lantana depressa var. floridana*		E
Simpson's Stopper	*Myrcianthes fragrans*		T
Shell Mound Prickly-Pear Cactus	*Opuntia stricta*		T
Beach-Star	*Remirea maritima*		E
Inkberry	*Scaevola plumieri*		T

Notes:
* Species does not occur on SLD 45 properties but occurs in water adjacent to SLD 45 properties.
** Species not listed but protected by Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act:
C = Candidate species.
E = Endangered species.
S/A = Species listed due to similarity of appearance to American crocodile.
T = Threatened species.

3.2.5.2 Environmental Consequences

Proposed Action

The Proposed Action is a 54.5-acre (22.1-ha) area within which SLC-20C would be constructed and operated. Thirteen of the federally listed wildlife species under the jurisdiction of USFWS have been documented within the Proposed Action or could be affected by the Proposed Action. Analysis in the BA determined that construction and operation of the Proposed Action may affect, is likely to adversely affect sea turtles, Florida scrub-jay, and SEBM. As a result, construction and operation of the Proposed Action is expected to have minor adverse, but not significant, impacts to listed wildlife species under USFWS jurisdiction. Table 3-8 summarizes the effects on listed wildlife species. For more specifics on analysis of listed wildlife species, the BA in Appendix I provides life history information, analysis of direct and indirect impacts, and proposed mitigation measures for the 13 listed wildlife species.

No Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Sections 4.3.2 and 4.3.3 of the 2020 EA are hereby incorporated by reference.

Table 3-8. Potential Impacts, Findings, and Compensation for Federal- and State-Protected Wildlife Species that Occur or Have Potential to Occur within the Proposed Action (Area defined as direct or indirect impact by construction or operations.)

Common Name Scientific Name	USFWS Status[1]	Occurrence	Potential Impacts	Section 7 Finding	Compensation and/or Conservation Measures
Monarch Butterfly *Danaus plexippus*	C	Potential	Loss of Habitat; Heat/Scorching; Road Vehicle Strikes	May Affect, Not Likely to Adversely Affect (MANLAA)	N/A
American Alligator *Alligator mississippiensis*	T (S/A)	Potential	Loss of Habitat; Disruption due to Noise	MANLAA	N/A
Eastern Indigo Snake *Drymarchon corais couperi*	T	Potential	Loss of Habitat; Crushing by Construction Equipment or Road Vehicle Strikes; Disruption due to Noise	May Affect, is Likely to Adversely Affect (MALAA)	Continued habitat restoration at CCSFS. The following Conservation Measures would be implemented: (1) SLD 45 Indigo Snake Protection/Education Plan (2) Excavation of all gopher tortoise burrows on site (3) Any indigos snakes encountered during clearing or gopher tortoise relocation efforts would be allowed to safely move out of the project area before activities are resumed.
Marine Turtles: Leatherback (*Dermocheyls coriacea*) Green (*Chelona mydas)* Loggerhead (*Caretta caretta*) Kemps Ridley (*Lepidochelys kempii*) Hawksbill (*Eretmochelys imbricata*)	 E T T E E	Documented	Disruption and Disorientation due to Light; Disruption due to Noise	MALAA	Implement Exterior Lighting Management Plans.
Piping Plover *Charadrius melodus*	T	Potential	Disruption due to Noise	MANLAA	None Provided
Red Knot *Calidris canutus*	T	Potential	Disruption due to Noise	MANLAA	None Provided
Audubon's Crested Caracara *Polyborus plancus audubonii*	T	Potential	Loss and Disruption of Foraging Habitat; Disruption due to Noise; Heat/Scorching	MANLAA	The following Conservation Measures will be implemented: (1) Monitoring for Audubon's crested caracara before construction activities begin. (2) Inspecting all trees and cabbage palms for nests before removal.
American Wood Stork *Mycteria americana*	T	Potential	Loss and Disruption of Foraging Habitat; Disruption due to Noise; Heat/Scorching	MANLAA	Impacts to wetlands would be mitigated in accordance with state and federal wetland regulations.
Florida Scrub-Jay *Aphelocoma coerulescens*	T	Potential	Habitat Loss; Disruption due to Noise; Road Vehicle Strikes	MALAA	(1) 31.8 acres (15.9 acres at 2:1 mitigation) of Habitat Restoration on CCSFS for impacts associated with SLC-20C site development. (2) Change in SLD 45 operational controls to ensure burn days and continued habitat restoration on CCSFS. (3) Conduct nesting surveys if clearing is proposed to occur March through June 30. (4) Establish buffers around active nests and avoid disturbance until chicks have fledged.
Black-Capped Petrel *Pterodroma hasitata*	E	Potential	Disruption due to Noise; Collision with Orbital Debris	MANLAA	None Provided
West Indian Manatee *Trichechus manatus*	T	Potential	Disruption due to Noise	MANLAA	N/A
Southeastern Beach Mouse *Peromyscus polionotus niveiventris*	T	Documented	Disruption due to Noise; Habitat Loss; Heat/Scorching; Lighting; Crushing by Construction Equipment; Road Vehicle Strikes	MALAA	0.4 acre (1:1 mitigation) of habitat restoration on CCSFS.
Tricolored Bat *Perimyotis subflavus*	C	Documented	Habitat Loss, Disruption due to Noise; Heat/Scorching	MANLAA	Avoid tree clearing May through July 15 to minimize impacts during bat maternity season; avoid tree clearing when ambient daytime temperatures are 45 degrees F or below.

[1] Species not listed but protected by Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act:
C = Candidate species.
E = Endangered species.
S/A = Species listed due to similarity of appearance to American crocodile.
T = Threatened species.

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3.3 Cultural Resources

3.3.1 Regulatory Setting

Historical and cultural resources include prehistoric and historic sites, man-made structures, buildings, and remnants of legacy launch vehicle districts, artifacts, or any other physical evidence of human activity considered important to a culture or community for scientific, traditional, religious, or any other reasons. The ROI for the historical and cultural resources for the Proposed Action includes areas within and around the Proposed Action.

An extensive array of federal and state laws requires analyses of possible effects to cultural resources during the planning, design, and construction on federal lands and elsewhere. These laws and regulations prescribe the responsibilities and coordination between the federal agency where the Proposed Action would occur and stakeholder agencies having review and comment authority over the Proposed Action. These agencies include the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers (THPOs), and Advisory Council on Historic Preservation (ACHP). Specific laws pertaining to the treatment of cultural resources are Sections 106 and 110 of the National Historic Preservation Act (NHPA), Archaeological Resources Protection Act (ARPA), American Indian Religious Freedom Act (AIRFA), and Native American Graves Protection and Repatriation Act (NAGPRA). AFMAN 32-7003, *Environmental Conservation*, provides guidance and procedures for cultural and natural resources programs.

Only those cultural resources that are determined to be significant or potentially significant under the regulations cited are subject to protection from adverse impacts from a Proposed Action. To be considered significant, a cultural resource must meet one or more of the criteria established by the NPS that would make the resource eligible for inclusion in the National Register of Historic Places (NRHP). The phrase *eligible for inclusion* includes all properties that meet the NRHP listing criteria, which are specified in the Department of the Interior regulations cited in 36 CFR Part 60.4 and NRHP Bulletin 15. Any property considered prehistoric, historic, or considered to be traditionally significant are collectively referred to as *historic properties*. Archaeological sites, mounds, burial sites, ceremonial areas, caves, plant habitat, and gathering areas, including any sites that would have religious or heritage significance, are traditional resources that could be considered significant traditional cultural properties (TCPs) that are subject to the same regulations as other historic properties and are therefore afforded the same protection.

3.3.2 Affected Environment

Research suggests that Florida experienced its first human occupation as early as 15,000 years ago. Cape Canaveral has a long record of human occupation, which is reflected by the presence of numerous prehistoric and historic sites that are part of the area's rich archaeological heritage. Human occupation at Cape Canaveral spans from the first Native Americans approximately 5,000 years ago (Doran et al. 2014). Precontact inhabitance in the vicinity of CCSFS includes the following periods: Archaic Period; Mt. Taylor Period; Orange Period; Transitional Period; Malabar I, IIA, and IIB Periods; and Protohistoric or Seminole Period. Historical occupations include First Spanish (1513 to 1763), British (1763 to 1783), Second Spanish (1783 to 1821), American Territorial (1821 to 1842), Early Statehood (1842 to 1861), Civil War (1861 to 1865), Reconstruction and Late Nineteenth Century (1865 to 1899), and Twentieth Century (1900+).

By 1948, CCSFS was firmly established as a launch site for USAF (45 SW 2015). An extensive history of CCSFS space operations can be found in works by USAF and Pan American World Airways, Inc. (1974) and Cleary (1994). This land has had numerous names under government ownership including Cape Canaveral (1950 to 1963), Cape Kennedy (1963 to 1974), Cape Canaveral (1974 to 1994), Cape Canaveral Air Force Station (1994 to 2020), and CCSFS (2020 to present).

During a site visit to CCSFS in 2011, the Seminole Tribe of Florida and Seminole Nation of Oklahoma verbally stated that they have no TCPs on CCSFS (SLD 45 Cultural Resource Manager [CRM], personal communication to W. Puckett, September 2019). SLD 45 ICRMP confirms that no TCPs are present at CCSFS (45 SW 2015).

3.3.3 Environmental Consequences

In June 2019, the SLD 45 CRM performed a Phase I cultural resource assessment (CRA) for the RPA area, which includes the SLC-20 and SLC-20C Proposed Action. Besides the SLC-20 Blockhouse (Facility 18800; 8BR3155), no other historic properties, historical or archaeological, were found during the 2019 CRA. Approximately 545 ft (166 m) north of the Proposed Action lies SLC-34, an NRHP-eligible historic district resource group with contributing and individual NRHP-eligible structures; approximately 1,975 ft (602 m) south of the Proposed Action lies SLC-19, an NRHP-eligible historic district resource group with contributing and individual NRHP-eligible structures, including the SLC-19 Air Vent and Escape Tunnel (8BR4181) that lies just outside the district boundary. SLC-34 and SLC-19 are also National Historic Landmarks (NHLs). Directly bordering to the west of the Proposed Action lies ICBM Road, an NRHP-eligible linear resource group. No TCPs are present at CCSFS (45 SW 2015).

3.3.3.1 Proposed Action

A Technical Memorandum (TM) was prepared that summarized the findings regarding the SLC-20 cultural resource value and determined whether any of the facilities or cultural resources within the RPA area may be considered eligible for listing in the NRHP. On September 12, 2019, the SHPO concurred with the findings of the CRM that the Proposed Action reuse of the SLC-20 would not result in an adverse effect to its facilities and cultural resources. Appendix K contains a copy of the SHPO's 2019 concurrence letter and the SLC-20 TM, including a 2020 concurrence letter to the Florida State Clearinghouse that was received and included in the 2020 EA. The reuse of the Blockhouse that would otherwise stay abandoned is considered to have a beneficial impact.

Regarding Tribal cultural resources at SLC-20 and noted previously, no TCPs are present at CCSFS (45 SW 2015). Therefore, no TCPs are expected to be adversely affected by the Proposed Action.

North and south of SLC-20 and the SLC-20C Proposed Action are NRHP-eligible complexes and structures, and construction and utilization of the new facilities may incur indirect effects on the property through vibration and noise. According to FAA Section 106 guidance, "Although the regulations do not define the term indirect effect, the criteria of adverse effects cover reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative" (FAA 2015). According to the *Noise Study for Small Class Launch Vehicle Operations at SLC-20C*, a single small-class launch vehicle event may generate levels at or above LA_{max} 115 dBA within 0.57 mile (0.9 km) of the launch site (BRRC 2023). The SLC-34 and

SLC-19 Historic Districts are within this radius of the proposed new launch pad. In analyzing structural damage claims from private households, one household in 100 incurred a structural damage claim from noise and vibration exposed to 120 dB, although the number was one household in a 1,000 for vibration levels of 111 dB (Space Florida 2020). These figures are for residential households not built to withstand noise and vibration at that level; however, NASA designed the facilities at SLC-34 and SLC-19 precisely to withstand space-related noise and vibrations from launch vehicles. Noise and vibration would not likely incur an immediate adverse effect; however, as the facilities age and the concrete deteriorates from rain and moisture, noise and vibration from the new launch pad may increase as a factor in facility deterioration for SLC-34 and SLC-19. Monitoring for deterioration should already be captured as part of the SLD 45 CRM's annual inspection of historic properties (45 SW 2015). These structures would not likely be adversely impacted by the Proposed Action. As a result, no adverse impacts during construction to cultural resources and negligible adverse to beneficial impacts from operational activities are expected from implementing the Proposed Action. Therefore, none of the impacts would be significant. In accordance with applicable laws and regulations, the SLD 45 Cultural Resources Manager initiated consultation with appropriate agencies and interested parties. Appendix K of this SEA includes the Section 106 agency correspondence letters.

3.3.3.2 No Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.4.1 of the 2020 EA are hereby incorporated by reference.

3.4 Air Quality and Climate Change

3.4.1 Regulatory Setting

3.4.1.1 Ambient Air Quality Standards

Air quality at CCSFS is regulated under Federal Clean Air Act (CAA) regulations (40 CFR Parts 50 through 99) and Florida Administrative Code (F.A.C.) Chapters 62-200 through 62-299. USEPA, under the authority of the CAA, as amended, has established nationwide air quality standards known as the National Ambient Air Quality Standards (NAAQS). The NAAQS represents the maximum allowable atmospheric concentrations of health-based criteria and are referred to as *criteria pollutants*. These criteria pollutants include carbon monoxide (CO), lead (Pb), NO_2, O_3, sulfur dioxide (SO_2), particulate matter (PM) 10 micrometers or less in diameter (PM_{10}), and $PM_{2.5}$. The NAAQS are further broken down into two categories – the National Primary Standards and National Secondary Standards. The Primary NAAQS provide public health protection for the health of *sensitive* populations such as the elderly, children, and persons with asthma. The Secondary NAAQS provide general public welfare protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Table 3-9 lists the NAAQS.

Table 3-9. Federal National Ambient Air Quality Standards

Pollutant	Average Time	Federal Primary NAAQS	Federal Secondary NAAQS
CO	8-hour	9 ppm	N/A
	1-hour	35 ppm	N/A
Pb	Rolling 3-month Average	0.15 μg/m^3	0.15 μg/m^3
NO_2	1-hour	100 ppb	N/A

Table 3-9. Federal National Ambient Air Quality Standards

Pollutant	Average Time	Federal Primary NAAQS	Federal Secondary NAAQS
	Annual	53 ppb	53 ppb
O_3	8-hour	0.07 ppm	0.07 ppm
$PM_{2.5}$	Annual	9 μg/m³	15 μg/m³
	24-hour	35 μg/m³	35 μg/m³
PM_{10}	24-hour	150 μg/m³	150 μg/m³
SO_2	1-hour	75 ppb	N/A
	3-hour	N/A	0.5 ppm

Notes: N/A = not applicable; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide; μg/m³ = micrograms per cubic meter (of air).

Source: USEPA 2024c.

3.4.1.2 General Conformity

Florida has a state-wide network of air-quality monitoring. The focus of this network is the management of air quality throughout the state with an emphasis on areas where ambient air quality standards are at risk of being violated and areas where the ambient standards are being met but are at risk due to potential growth in the populations of those areas or industrial growth. Regional air quality in Florida is assessed at the county level; Brevard County is designated as *in attainment* with the NAAQS. The term *in attainment* refers to areas with concentrations of criteria pollutants that are below the levels established by the NAAQS. If the concentration of one or more criteria pollutant in an area exceeds the levels established by NAAQS, the area may be classified as a *non-attainment* area. Since Brevard County is in attainment for all regulated criteria pollutants, no conformity determination is required for the Proposed Action.

3.4.1.3 Greenhouse Gas Emissions

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere. The main GHGs include carbon dioxide (CO_2), methane, and nitrous oxide, and fluorinated gases (USEPA 2024e); however, CO_2 is the primary GHG emitted through human activities such as the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation and accounted for 80 percent of all US GHG emissions in 2022 (USEPA 2024e). The DAF *GHG and Climate Change Assessment Guide* identifies 75,000 tons per year, or 68,039 metric tons per year, as an indicator or threshold of insignificance for air quality impacts in all areas under NEPA (Air Force Civil Engineer Center 2023b). This indicator does not define a significant impact, but identified actions that are insignificant. The DAF considers proposed actions with a net change in GHG (carbon dioxide equivalent [CO_2e]) emissions below 75,000 tons per year, or 68,039 metric tons per year, as being too insignificant to warrant further consideration. Actions with a net change in GHG emissions above 75,000 tons per year, or 68,039 metric tons per year, are considered only potentially significant and require further assessment to determine if the action poses a significant impact.

3.4.1.4 Climate Change

Climate change involves significant changes in average conditions such as temperature, precipitation, wind patterns, and other aspects of climate that occur over decades or longer as a primary result of releasing excess GHGs into the atmosphere (USEPA 2024f). On November 9, 2021, the FAA published the US Aviation Climate Action Plan, which describes a whole-of-government approach to put the aviation sector on a path toward achieving net-zero emissions by 2050 (FAA 2021).

3.4.2 Affected Environment

CCSFS holds a non-Title V General Permit (0090005-020-AG) that expires on June 2, 2027. Table 3-10 summarizes air emissions for 2012 through 2016 for CCSFS of actual tons per year of the NAAQS-regulated criteria pollutants and total hazardous air pollutants (HAPs). This represents the most recent publicly available information.

Table 3-10. History of Actual Annual Emissions (Tons per Year) at CCSFS

Pollutant	Year				
	2016	2015	2014	2013	2012
CO	11.66	10.75	9.83	10.95	19.47
Pb	0.000033	—	—	—	—
NO_2	42.21	36.28	33.56	35.79	73.58
$PM_{2.5}$	3.00	2.59	2.66	2.63	5.20
PM_{10}	2.76	2.31	2.21	2.29	5.03
HAPs	0.02	0.03	0.03	0.03	0.15
VOCs	3.35	2.86	2.69	2.84	6.22

Note: — = not detected.

Source: FDEP 2024a.

Within Brevard County, air quality data are available for two locations. The Freedom 7 Elementary School in Cocoa Beach (Location 1), approximately 14 miles (22.5 km) from SLC-20, monitors for O_3. The 400 West Florida Avenue site in Melbourne (Location 2), approximately 31 miles (49.9 km) from SLC-20, monitors for O_3, PM_{10}, and $PM_{2.5}$ (FDEP 2024b). Table 3-11 summarizes the highest air emissions data for these two locations.

Table 3-11. History of Highest Readings for Select Emissions in Two Brevard County Locations

Pollutant	Year				
	2024***	2023	2022	2021	2020
Location 1 – O_3*	62 ppb	65 ppb	64 ppb	60 ppb	64 ppb
Location 2 – O_3*	61 ppb	63 ppb	63 ppb	62 ppb	63 ppb
Location 2 – $PM_{2.5}$**	18.0 $\mu g/m^3$	47.1 $\mu g/m^3$	22.5 $\mu g/m^3$	27.0 $\mu g/m^3$	27.6 $\mu g/m^3$
Location 2 – PM_{10}**	57.7 $\mu g/m^3$	75.1 $\mu g/m^3$	72.9 $\mu g/m^3$	73.3 $\mu g/m^3$	93.7 $\mu g/m^3$

Notes: * maximum 8-hour average; ** daily average; ***data reported through August 29, 2024.

Source: FDEP 2024b.

With respect to ozone-depleting chemicals (ODCs), CCSFS strictly prohibits using ODCs.

3.4.3 Environmental Consequences

The ROI for air quality includes all of CCSFS and Brevard County; however, the ROI for climate impacts is global. Specific to air-quality impacts analyzed are those that occur at altitudes of 3,000 ft (914 m) or less, where the NAAQS would be applicable. USEPA has accepted this height as the nominal height of the atmospheric mixing layer for assessing contributions from launch emissions to ground-level ambient-air quality under the CAA (USEPA 1992). In terms of determining significance, in accordance with the DAF's Level II, Air Quality Quantitative Assessment, Insignificant Indicators, air emissions from construction that exceed 250 tons per year for O_3, CO, SO_2, NO_2, PM_{10}, and $PM_{2.5}$ would be considered a significant impact. Additionally, Pb emissions that exceed 25 tons per year or GHG emissions (measured in CO_2e) that exceed 75,000 tons per year would also be considered a significant impact (Air Force Civil Engineer Center 2023a).

Air emissions from the Proposed Action would result from construction at SLC-20A, SLC-20B, and SLC-20C, transportation of vehicle stages from Exploration Park and off-site payload processing facilities, and operation of small-lift launch vehicles at SLC-20C. No permanent generators or boilers would be used and no permanent change to the number of on-site personnel would occur. All staff would be temporary and associated with a launch.

3.4.3.1 Proposed Action

Construction

In addition to the SLC-20A and SLC-20B construction projects listed in Table 2-6 that were analyzed in the 2020 EA, to accommodate the small-lift launch-vehicle systems proposed at SLC-20C that require dedicated launch infrastructure, common-use infrastructure would be constructed as discussed in Section 2.1.2.

Any requisite vehicle-specific dedicated mobile infrastructure, to include fixed-propellant storage and loading systems, flame deflectors, sound-suppression systems, fixed umbilical towers, and mobile service structures, would be supplied in the future by a vehicle operator.

Construction-related impacts to air quality would occur from minor, temporary increases in PM due to facility renovations, limited demolition, clearing, grading, movement of construction vehicles, and short-term generator use. Fossil-fueled vehicles and equipment would release CO_2, CO, NOx, and hydrocarbons into the ambient air during the approximately 12 months of construction. Construction and demolition emissions were estimated using the Air Conformity Applicability Model (ACAM) Version 5.0.23a. The ACAM Summary Report and ACAM Detail Report are included in Appendix L and summarized in Table 3-12.

Table 3-12. Maximum Annual Construction Emissions Estimates for the Proposed Action (Tons/Year)

Year	VOC	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$	Pb
2026	0.990	11.800	12.431	0.047	16.390	0.326	0.00
DAF Insignificance Indicators	250	250	250	250	250	250	25

Notes: VOC = volatile organic compound; Insignificance Indicators provide an indication of the significance of the proposed action's potential impacts to local air quality and are based on the 250 tons/year Prevention of Significance Deterioration major source threshold.

Table 3-13 summarizes the ACAM results for the GHGs from the proposed construction.

Table 3-13. GHG Emissions for the Proposed Action

Year	Estimated Annual Air Emissions of GHGs (metric tons/year)			
	CO_2	CH_4	N_20	CO_2e
2026	4,527	0.094	0.469	4,670
DAF Threshold of Insignificance	—	—	—	68,039

Notes: — = no threshold identified; Threshold of Insignificance is based on the Prevention of Significance Deterioration that the Air Force has adopted for NEPA air quality impacts in all areas.

The construction and demolition activities associated with the Proposed Action would not exceed the level of significance thresholds. Therefore, the Proposed Action would have no significant impact to air quality and GHG emissions or climate change.

Operations

Airspace closures associated with launches would result in additional aircraft emissions primarily from aircraft being re-routed and subsequently expending additional fuel. However, emissions from aircraft being re-routed would occur above 3,000 ft (914 m) (the mixing layer) where NAAQS would not be applicable; therefore, no impact to air quality would occur from aircraft re-routing from airspace closures.

With regard to departure delays, FAA reported in 2022 that 143 aircraft were delayed an average of 32 minutes as a result of commercial space operations, representing 0.04 percent of total minutes of delays that year (GAO 2024). Additionally, using the SDI would further reduce the closed airspace necessary and minimize departure delays (FAA 2024a). Worst case, airspace-related impacts could increase up to a maximum of 48 times per year; however, since Brevard County is in attainment for all criteria pollutants, only a negligible amount of emissions would be generated from any aircraft departure delays associated with launches at CCSFS. Therefore, any air emissions increase from departure delays are not expected to result in an exceedance of a NAAQS for any criteria pollutant. Emissions from aircraft being re-routed would occur above 3,000 ft (914 m) (the mixing layer) and would not affect ambient air quality. Therefore, airspace closures associated with launches are not expected to result in significant air quality impacts.

Daily operations and prelaunch activities, such as ground support operations and refueling operations, are expected to generate PM, VOCs, NOx, SOx, HAPs, CO_2, and CO from a variety of sources including on-site traffic, mobile equipment emissions, surface-coating applications, ground-support equipment, occasional maintenance painting of on-site structures, *de minimis* fugitive emissions from liquid fuels storage and transfer, and diesel fuel use. The relatively small emissions associated with ground support operations or refueling operations would have negligible (not significant) impacts on air quality, especially since Brevard County is in attainment for all criteria pollutants.

After final systems checkout, a mission rehearsal would typically be performed without propellants on board (dry rehearsal) and a mission rehearsal with propellants loaded on the vehicle (wet rehearsal) to verify full launch readiness. Two dress rehearsals are typical in the launch-preparation schedule to allow for team training and coordination of activities between the launch vehicle crew and CCSFS. For this SEA, a wet rehearsal before every launch is assumed. No NAAQS exceedances during operations are expected, and no significant impacts to existing air emissions at CCSFS would occur from implementing the Proposed Action.

Small-Lift Launch Vehicles

The small-lift launch vehicles are considered mobile sources and are not subject to air-permitting requirements. Launches at SLC-20C would consist of up to 18 liquid propellant (LOX/RP-1) vehicles and six solid propellant (HTPB) vehicle launches. The primary emission products from these propellants include CO_2, CO, water vapor, and small amounts of NO_x and PM. Nearly all the emitted CO oxidizes rapidly to CO_2 during afterburn in the exhaust plume, which would then be dispersed in the atmosphere and have no impact on air quality. Other propellant combinations proposed at SLC-20C would produce less impactful emissions, and therefore a worst-case scenario of 18 LOX/RP-1 and six HTPB operations was used in the emissions analysis performed by BRRC.

The expected maximum annual cadence (48 total launches) at SLC-20 is considered a conservative estimate since historical launch cadences are typically less at initial operation and slowly increase over a 5-year period as the user's launch program progresses. For planning purposes, launches are expected to increase gradually over the course of 5 years with a maximum of 48 launches in the fifth year. For assessing air quality impacts, the first year is expected to begin in 2027. Additionally, up to one static fire test per launch is expected initially and one test for each new vehicle. Each static fire would last for up to 10 seconds.

Additionally, under the Proposed Action, the maximum propellant scenario involved the following two vehicles using the following modeling parameters:

- Liquid Vehicle: LOX/RP-1 small class launch vehicle with a mass flow rate of 572 kilograms per second (kg/s).
- Solid Vehicle: HTPB small class launch vehicle with a mass flow rate of 616 kg/s.

As discussed in Section 4.5.1.3 of the 2020 EA, the SpaceX Falcon and Falcon Heavy Program was used as an envelope concept for the air emissions analysis. The analysis is hereby incorporated by reference. Air emission calculations at SLC-20C were computed using BRRC's RUMBLE, Version 4.1, using an envelope approach to establish an upper limit of potential environmental impacts from the Proposed Action for air quality. The envelope concept was applied since the proposed engines to be used at SLC-20C are currently evolving and, although the basic outline of a project may be known during a NEPA analysis, its details often have not been finalized. The envelope concept facilitates the environmental analysis process by providing a threshold below which, if not exceeded under a worst-case scenario for the Proposed Action due to previous NEPA analysis of similar engines, further in-depth NEPA analysis is not needed.

Under the Proposed Action, the maximum propellant scenario involving LOX/RP-1 would have a maximum propellant quantity of 225,000 lb (102,060 kg). The maximum propellant scenario involving HTPB would have a propellant quantity of 245,000 lb (111,130 kg).

Table 3-14 presents the individual emissions from a liquid-fueled static fire.

Table 3-14. Liquid-Fueled Static Fire Emissions Per Event and Annually (Metric Tons)

CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
4.8	1.9	0.01	0.19	0.0057	—	—

Notes: AL_2O_3 = alumina; BC = black carbon, Clx = chlorine species; H_20 = water; NOx = nitrogen oxides; PM = particulate matter. Annual quantities are in parentheses.

Source: Blue Ridge Research and Consulting, LLC (2023).

Table 3-15 presents the individual launch vehicle emissions from a liquid-fueled launch.

Table 3-15. Liquid-Fueled (LOX/RP-1) Launch Emissions Per Event (Metric Tons)

CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
71.2	30.4	2.9	0.77	0.69	—	—

Source: Blue Ridge Research and Consulting, LLC (2023).

Table 3-16 presents the individual launch vehicle emissions from a solid-fueled launch.

Table 3-16. Solid-Fueled (HTPB) Launch Emissions Per Event (Metric Tons)

CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
34.2	30.7	1.3	0.8	0.8	35.4	20.7

Source: Blue Ridge Research and Consulting, LLC (2023).

Table 3-17 presents the maximum annual emissions from the Proposed Action (i.e., 18 annual static fires, 18 liquid-fueled vehicle launches, and six solid-fueled vehicle launches).

Table 3-17. Maximum Annual Emissions (Metric Tons)

CO2	H_2O	CO	NO_x	BC	Al2O3	Cl_x
1,573.20	765.60	60.18	22.08	17.32	212.40	124.20

Source: Blue Ridge Research and Consulting, LLC (2023).

Since the environmental impacts of space vehicle emissions vary depending on the atmospheric layer where they are emitted, FAA guidelines state that environmental documents for commercial space vehicle operations should report emissions inventories by atmospheric layer. As such, Table 3-18 presents the annual pollutant mass emitted by proposed SLC-20C operations by atmospheric layer.

Table 3-18. Annual Pollutant Mass Emitted by Proposed SLC-20C Operations (Metric Tons)

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
Troposphere (below 3,000 feet)	337	150	0.70	14	0.45	33	20
Troposphere (above 3,000 feet)	443	205	1.2	7.9	0.62	58	35
Stratosphere	608	287	10	0.32	6.7	82	49
Mesosphere	193	124	48	<0.01	9.3	35	21
Total	1,581	766	59.9	22.2	17.1	208	125

Source: Blue Ridge Research and Consulting, LLC (2023).

As shown in the tables above, CO_2 and water vapor are the pollutants emitted in the greatest quantities from complete combustion between oxygen and the rocket propellant. Other pollutants, such as CO and BC, are emitted by liquid rocket engines, and AL_20_3 and BC are emitted by solid rocket motors. In addition to the air emission estimates summarized above, launch vehicles would accelerate rapidly, and the high temperatures of the exhaust products would cause their air emissions to rise quickly and disperse with the prevailing winds.

Consistent with other previously approved NEPA documents for launch operations from larger launch vehicles with similar or greater launch cadences, any increases in GHGs caused by operations are not expected to result in significant climate-related impacts.

SLC-20 is in Brevard County, which is in attainment with the NAAQS. Air emissions from launch activities would rise above 3,000 ft (914 m) quickly, and the high temperatures of the exhaust products would cause the air emissions to rise and disperse with the prevailing winds. As a result, launch operation at SLC-20C, when combined with the operation of up to 24 small- to medium-lift launch vehicles at SLC-20A and SLC-20B, would result in minor adverse impacts, and therefore not significant, to air quality.

Appendix M provides the BRRC Emissions Study for Small Class Launch Vehicle Operations at SLC-20C.

3.4.3.2 No-Action Alternative

Construction

Under the No Action Alternative, the Proposed Action would not be implemented; however, construction and launch operations would proceed at SLC-20A and SLC-20B as described in the 2020 EA. The ACAM Summary Report and ACAM Detail Report are included in Appendix L. Table 3-19 and Table 3-20 provide the construction emission estimates and the GHG emissions.

Table 3-19. Maximum Annual Construction Emissions Estimates for the No Action Alternative (Tons/Year)

Year	VOC	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$	Pb
2026	0.748	7.314	9.095	0.039	2.661	0.232	0.0
DAF Insignificance Indicators	250	250	250	350	250	250	25

Notes: VOC = volatile organic compound; Insignificance Indicators provide an indication of the significance of the proposed action's potential impacts to local air quality and are based on the 250 tons/year Prevention of Significance Deterioration major source threshold.

Table 3-20. GHG Emissions for the No Action Alternative

Year	Estimated Annual Air Emissions of GHGs (metric tons/year)			
	CO_2	CH_4	N_20	CO_2e
2026	2,498	0.060	0.217	2,565
DAF Threshold of Insignificance	—	—	—	68,039

Notes: — = no threshold identified; Threshold of Insignificance is based on the Prevention of Significance Deterioration that the Air Force has adopted for NEPA air quality impacts in all areas.

The construction and demolition activities associated with the No Action Alternative would not exceed the significance thresholds. Therefore, the No Action Alternative would have no significant impact on air quality and GHG emissions or climate change.

Operations

Under the No Action Alternative, launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Sections 4.5.1 and 4.6.1 of the 2020 EA are hereby incorporated by reference.

3.5 Transportation

A transportation network provides access to CCSFS. The ROI focuses on the roadways on CCSFS reaching SLC-20 and the regional area immediately surrounding CCSFS. Regionally, the CCSFS area can be accessed from Daytona Beach to the north via US Highway 1 or Interstate 95, from Orlando approximately 50 miles to the west via SR 528, and from Miami approximately 187 miles to the south via US Highway 1 or Interstate 95.

Locally, the majority of the employees and other related support services providers for CCSFS reside within the unincorporated areas of north and central Brevard County and in the cities of Titusville, Cape Canaveral, Cocoa, Cocoa Beach, and Rockledge, which are all within 20 miles of the CCSFS south Gate 1. The key roads providing access to CCSFS from the local communities include SR A1A, SR 520, SR 528, SR 401, SR 3, and SR 405. Kennedy Parkway W, Beach Road, and SR 528 connect CCSFS with KSC, the inner barrier islands, and the mainland. SR 3 is a north-south highway on the south side of KSC that becomes Kennedy Parkway once on KSC property. Access roads include:

- North access into CCSFS through Gate 4 and Gate 6 at KSC from SR 3.
- Beach Road provides access to Gate 4 and Gate 6 from the west. Beach Road becomes SR 401 as it approaches CCSFS and subsequently turns into Samuel C. Phillips Parkway.
- South access into CCSFS occurs through Gate 1. Gate 1 is accessed by SR 401 via SR A1A, SR 520, and SR 528.
- West access onto CCSFS is provided by Kennedy Parkway W and SR 405.
- SR 3 is a north-south highway on the south side of KSC that provides access to Gate 2.
- SR 405 is a four-lane road providing access to CCSFS from the west. It becomes NASA Parkway after entering KSC at Gate 3, just before crossing the IRL. After continuing through KSC, SR 405 crosses the Banana River, entering CCSFS and intersecting SR 401 (Samuel C. Phillips Parkway).

SLC-20 is on the east side of ICBM Road, south of the intersection of ICBM Road and Samuel C. Phillips Parkway.

Available data indicate that the roads and supporting structures (culverts, bridges, pavement) were constructed to meet FDOT standards. The condition of roadways within CCSFS were most recently assessed in 2013 (AMEC 2013). At the time of the assessment, most road pavement conditions were indexed as good or fair. However, a section of Samuel C. Phillips Parkway (Section ID 01A) was assigned an index condition of poor. This section extends from approximately SLC-41 north to the turnoff to KSC Pad 39A; however, SLC-41 is approximately 5 miles (8 km) away and is not part of the planned transportation route as shown in Figure 2-3. The transportation study indicated that although conditions of most culverts that may be transited appeared to be in good condition, some older culverts may require replacement because their conditions cannot be deterministically calculated due to age and condition. Roadways on KSC property from Space Commerce Way to Cape Road also appear to be in good or fair condition. However, pavement rehabilitation programs are on-going within KSC, and the condition would vary over time.

3.5.1 Affected Environment

Sections 3.10 and 4.10 in the 2020 EA provide the affected environment and environmental consequences, respectively, for SLC-20A and SLC-B. The ROI for this resource includes regional and local roadways described above that provide access to CCSFS and SLC-20 that could be affected by the construction and operation of the Proposed Action activities.

3.5.2 Environmental Consequences

3.5.2.1 Proposed Action

Construction

Appendix L provides the detailed ACAM Report, which includes assumptions associated with the average miles per round trip for equipment per day by construction phase. Construction of the Proposed Action would result in a negligible increase in traffic resulting from construction contractors coming onto CCSFS from various directions to construct SLC-20C. The increase in daily trips as a result of this construction is estimated to be negligible due to the small size of the construction project and the lack of buildings or other infrastructure that require several months of construction. As a result, no significant impacts on transportation are expected as a result of the construction of the Proposed Action.

Operation

As discussed in Section 2-11, most of the vehicle assembly would occur at Exploration Park or off site. The CCSFS roads were designed to FDOT specifications to accommodate an HS-20 traffic loading. Launch providers using SLC-20C would be using a standard tractor trailer and would stay within FDOT maximum weights for an HS-20 vehicle loading (eight kips on front axles, 32 kips for rear axles), for a maximum allowable weight of 80,000 lb. Since the existing transport routes expected to be used were designed to FDOT design standards, no adverse impacts are expected as transport loads are expected to stay within legal limits.

Launch providers using SLC-20C would likely rely on a standard tractor trailer with an extension for a maximum length of 80 ft for rocket transport due to the use of SLC-20C by small-launch class vehicles only. This is comparable to (and slightly smaller than) the overall length of an AASHTO WB-96 or WB-114 vehicle. These vehicles require a minimum 21- and 17-ft (6.4- and 5.8-m) inside turning radius measured from the inside wheel and a 50- and 60-ft (18.3-m) turning radius measured from the outside wheel, respectively. These inside radii at the four main intersections on CCSFS are greater than the minimum required inside radii for the comparable AASHTO vehicles. Regardless, launch providers would continue to coordinate transportation planning through the appropriate SLD 45 and NASA KSC channels, including Cape Support and the KSC Planning Office and Construction of Facilities office, to minimize transportation operational impacts to SLD 45 and KSC.

Each transported load would require a slower than posted speed, and in some areas counterflow traffic would need to be blocked and/or re-routed. To reduce any slow-paced traffic effects, vehicle transport would be scheduled in *off-hours* and would avoid peak-flow periods, generally from 6:00 to 9:00 AM and from 3:30 to 5:30 PM. Shipment of these components to CCSFS and the launch support staff trips required would occur no more than 48 times a year for all SLC-20A, SLC-20B, and SLC-20C launches. A slight but negligible, thus not significant, traffic volume increase for Proposed Action launches would be expected.

Space Florida tenant(s) would coordinate transportation planning through the appropriate 45 SW and NASA KSC channels, including Cape Support and the KSC Center Planning Office and Construction of Facilities office to minimize transportation operational impacts. Up to 48 cumulative launches would result in localized road closures and disrupted traffic patterns. This amount of road closures would impact local traffic patterns for contractors and CCSFS staff. As a result of these closures, minor adverse impacts, and therefore not significant, to transportation are expected as a result of the operation of the Proposed Action.

3.5.2.2 No-Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.10.1 of the 2020 EA are hereby incorporated by reference.

3.6 Water Resources

3.6.1 Regulatory Setting

Water resources of CCSFS and within the Proposed Action include surface waters, groundwater, floodplain, and wetlands. The federal Clean Water Act (CWA) provides the basic structure for regulating the discharge of pollutants from point sources to Waters of the United States, as implemented by USEPA through pollution-control programs such as the National Pollutant Discharge Elimination System (NPDES) and industry standards set for wastewater. Permitting through the US Army Corps of Engineers (USACE) is required where waters are regulated under Section 404 of the CWA (33 USC 1344). USACE has jurisdiction over Section 10 of the Rivers and Harbor Act for navigable waters and interstate commerce. The CWA sets the requirements for water- quality standards in all surface water and regulates the discharge of pollutants through NPDES permits, including stormwater, stormwater construction, and wastewater construction and operation permits. SJRWMD regulates and issues stormwater construction and operation permits. FDEP regulates NPDES stormwater construction permits for land- disturbing activities greater than 1 acre (0.4 ha). FDEP also has authority to regulate wastewater, surface water, and groundwater discharges and issue permits for the construction of new potable water force mains, wastewater force and gravity mains, and lift stations. The coordination with all regulatory agencies is done in cooperation with SLD 45.

Wetlands are protected under Section 404, Waters of the United States, the CWA via USACE, as well as by the State of Florida via the state water management districts (WMDs) and FDEP. EO 11990 requires avoidance, to the extent possible, of the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever a practicable alternative exists. In addition, US Department of Transportation (DOT) Order 5660.1A (*Preservation of the Nation's Wetlands*) sets forth guidelines for the planning, construction, and operation of transportation facilities that ensure the protection and enhancement of wetlands to the fullest extent possible. Any proposed primary or secondary wetland impacts as a result of the Proposed Action would require a federal Dredge and Fill Permit and an Environmental Resource Permit from the USACE and SJRWMD, respectively.

3.6.2 Affected Environment

3.6.2.1 Surface Waters

Water resources include surface waters, groundwater, wetlands, and floodplains and their physical, chemical, and biological characteristics. CCSFS is within the IRL watershed within the Cape Canaveral sub-basin (Hydrologic Unit Code [HUC] 03080202). Specifically, CCSFS is within the Banana River subwatershed (HUC 030802020201) and is bordered by the Banana River to the west and the Atlantic Ocean to the east (Figure 3-9). The Banana River Lagoon (BRL) has been designated a Class III surface water, a designation under the CWA that intends for a level of water quality suitable for recreation and the production of fish and wildlife communities. In 1990, the IRL system was also designated as an Estuary of National Significance under USEPA's National Estuary Program.

As Figure 3-9 shows, no surface waters occur within the Proposed Action boundary.

Figure 3-9. Surface Water Location Map

3.6.2.2 Groundwater

The surficial and the Floridan aquifer systems underlie CCSFS. The surficial aquifer system (SAS), which generally consists of sand and marl, is unconfined and approximately 70-ft (21.3-m) thick. The SAS is recharged by infiltration of precipitation through the thin vadose zone. Assuming negligible runoff, the amount of recharge is approximately equal to the amount of precipitation minus the amount returned to the atmosphere through evaporation and transpiration (NASA 2013). Overall, SAS groundwater flow direction within the Proposed Action is predominantly to the south and southwest under a relatively flat hydraulic gradient. Depth to the SAS varies but is approximately 3.3 ft (1 m) (GEAR 2019).

KSC has documented SAS contamination with chlorinated compounds (predominately trichloroethene and vinyl chloride) at the north end of the Proposed Action boundary and portions of the proposed SLC-20C facility. The areas in the Proposed Action boundary are primarily low-concentration plumes that are a result of contamination that occurred at SLC-34 (Figure 3-10). "Hot spots" depicted in Figure 3-10 are areas within a high concentration plume that have contaminant concentrations 10 times that of the HCP. KSC has been actively remediating and monitoring SLC-34 contamination areas with a hydraulic containment system since 2010 and documenting conditions in annual performance monitoring reports.

The Floridan aquifer is the primary source of potable water in central Florida and contains water under artesian conditions. It is confined by the clays, sands, and limestones of the overlying Hawthorn Formation, which is approximately 80- to 120-ft (24.4- to 36.6-m) thick. Water enters the Floridan aquifer near the center of the Florida peninsula and moves laterally toward both coasts. In the vicinity of CCSFS, groundwater in the Floridan aquifer flows northeast.

3.6.2.3 Wetlands

Wetlands are defined in Department of the Air Force Manual (DAFMAN) 32-1067, *Water and Fuel Systems,* as those areas, "that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in seasonally saturated soil conditions." Wetlands include swamps, marshes, bogs, sloughs, mud flats, and natural or manmade ponds. Wetlands are some of the most biologically productive of all habitats. Over 1,100 acres of wetlands have been mapped on CCSFS and are characterized as basin marsh, coastal interdunal swales, and mangrove (Gulledge et al. 2009).

USACE and SJRWMD jurisdictional coastal interdunal swale wetlands comprise 7.2 acres (2.9 ha) within the Proposed Action boundary (Figure 3-3).

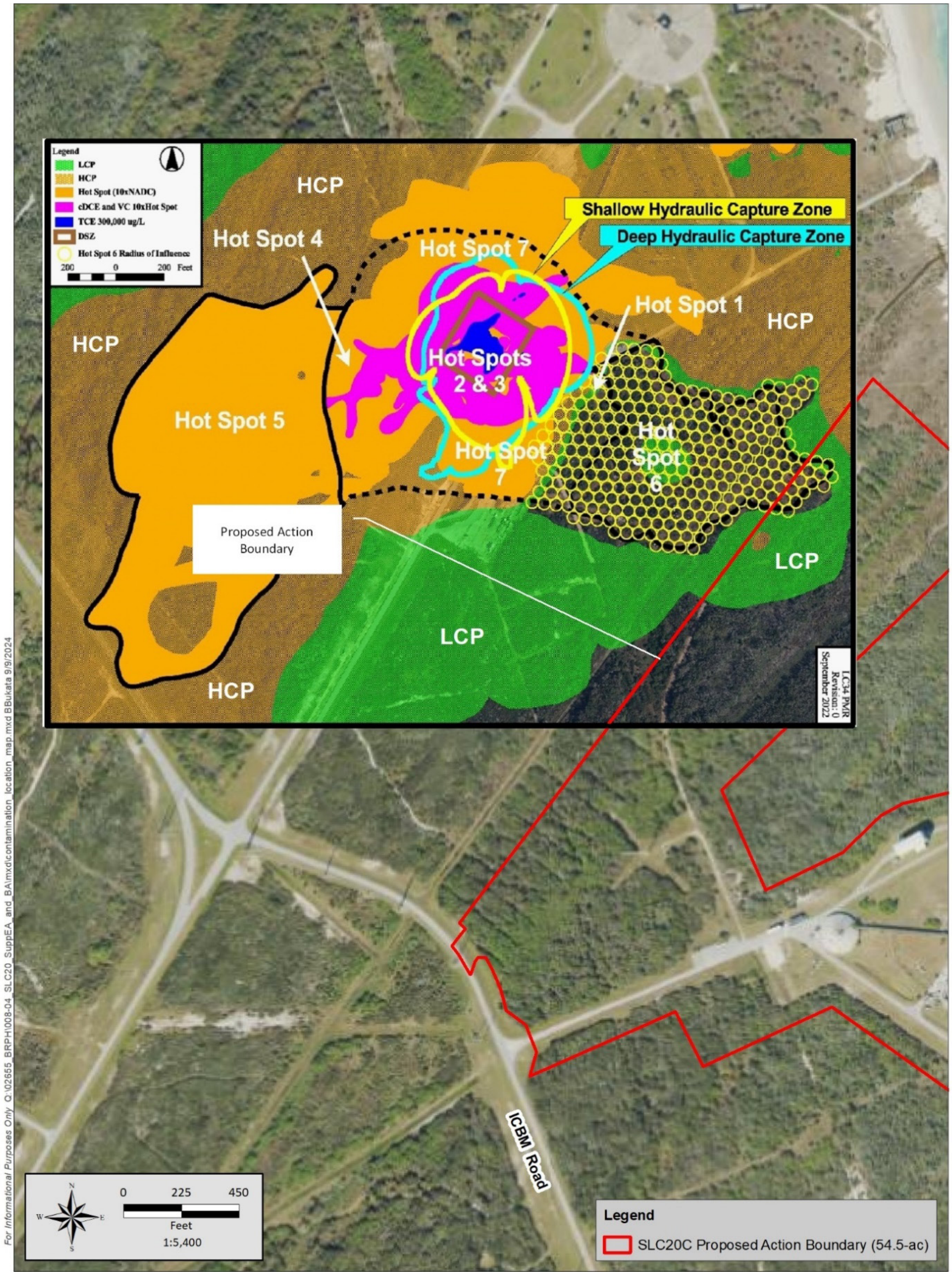

Figure 3-10. Contamination Plumes from SLC-34 (NASA 2022)

(LCP = Low Concentration Plume; HCP = High Concentration Plume; TCE = Trichloroethene; DSZ = DNAPL Source Zone; cDCE and VC 10xNADC) = cis-1,2-dichloroethene and vinyl chloride 10xNatural Attenuation Default Concentration)

3.6.2.4 Floodplains

Floodplains are low-land and relatively flat areas adjoining inland and coastal waters and other flood-prone areas such as offshore islands. These flood hazard areas are identified on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) and are referred to as a Special Flood Hazard Area (SFHA). SFHAs are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs are labeled as 'Zones,' several of which are east of, but not within, the Proposed Action:

- Zone AE – The base floodplain where base flood elevations are provided. AE Zones are now used on new-format FIRMs instead of A1 through A30 Zones.
- Zone AO – River or stream flood hazard areas and areas with a 1 percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 ft (0.3 to 0.9 m). These areas have a 26-percent chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
- Zone VE – Coastal areas with a 1 percent or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26-percent chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
- Zone X – Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level.

DOT implemented EO 11988 through policies and procedures documented in DOT Order 5650.2, *Floodplain Management and Protection*. DOT Order 5650.2 defines the natural and beneficial values provided by floodplains to include "natural moderation of floods, water quality maintenance, groundwater recharge, fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, and forestry."

No floodplains occurred in the 2020 EA Proposed Action. However, FEMA completed and published a floodplain map revision to the region in 2021. Based on this revision, approximately 53.4 (21.6 ha) of the 54.5 acres (22 ha) Proposed Action is floodplain. In addition, 29.4 acres (11.9 ha) of floodplain now occur in the 2020 EA Proposed Action boundary for a total of 83.9 acres (33.9 ha) (Figure 3-11). These floodplains are defined by FEMA as *Coastal Floodplains* and thus potential floods occur primarily due to coastal storm surge rather than rainfall.

3.6.3 Environmental Consequences

Specific to this SEA, a project may have a significant impact on water resources if it substantially affects a significant water body, such as an ocean, stream, lake, wetland, or bay; causes substantial flooding or exposes people to reasonably foreseeable hydrologic hazards such as flooding; substantially affects surface or groundwater quality or quantity; or exceeds the existing potable water or wastewater system capacities for CCSFS.

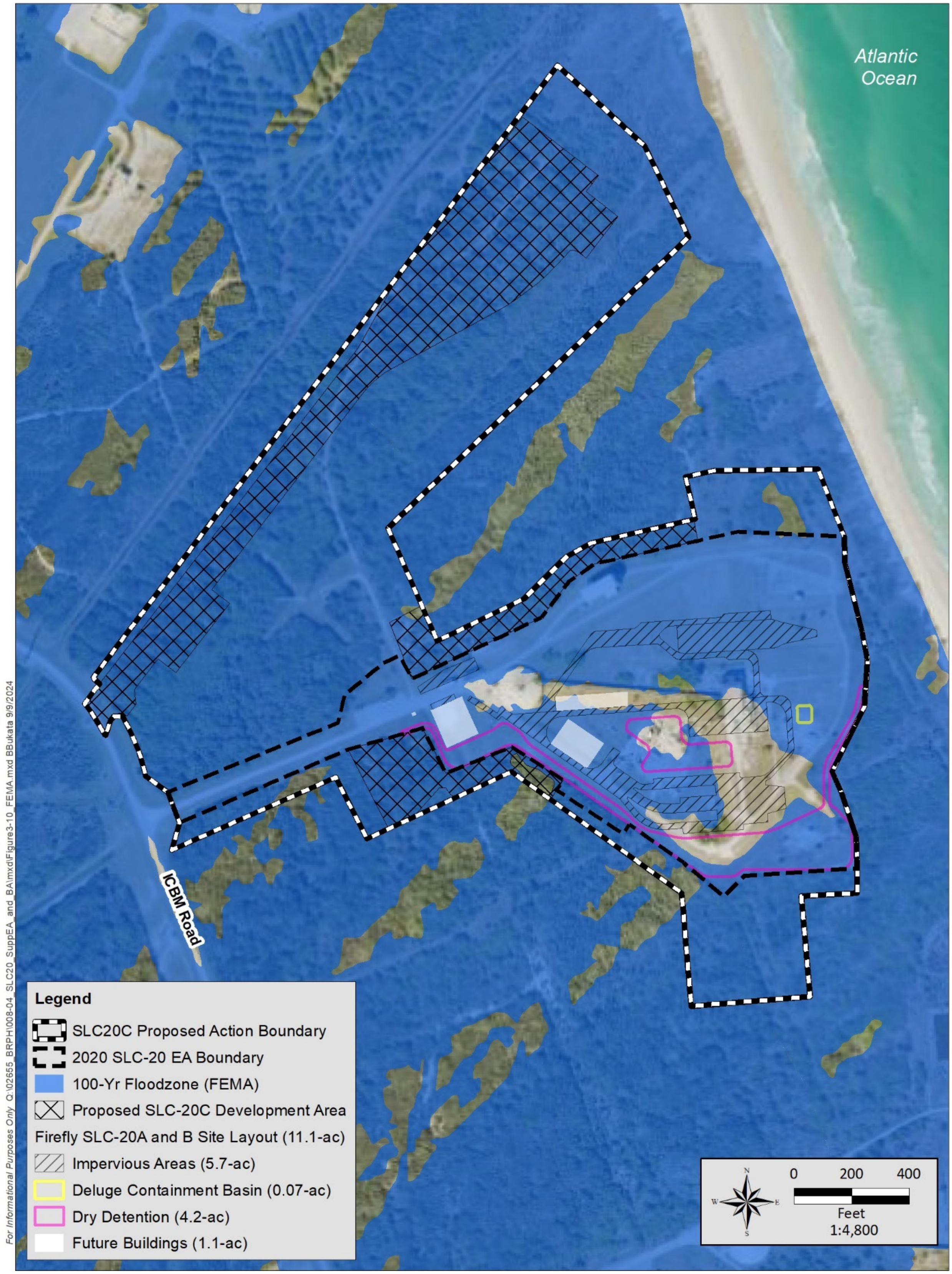

Figure 3-11. Floodplain Map

This section presents the potential effects to surface water and groundwater (including hydrology and water quality), wetlands, and floodplains resulting from implementing the Proposed Action and the No Action Alternative. FAA has determined that impacts would be considered significant if the Proposed Action resulted in any of the effects described below.

Surface Water and Groundwater

- Exceed water quality standards established by federal, state, local, and tribal regulatory agencies.
- Contaminate public drinking water supply such that public health may be adversely affected.

Wetlands

- Adversely affect a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers.
- Substantially alter the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected.
- Substantially reduce 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 affect the maintenance of natural systems supporting wildlife and fish habitat economically important timber, food, or fiber resources of the affected or surrounding wetlands.
- Promote the development of secondary activities or services that would cause the circumstances listed above to occur.
- Be inconsistent with applicable state wetland strategies.

Floodplains

- Cause notable adverse impacts on natural and beneficial floodplain values as defined in Paragraph 4.k of DOT Order 5650.2, *Floodplain Management and Protection.*

3.6.3.1 Surface Waters

Proposed Action

Construction. No direct impacts to surface waters would occur as a result of construction of the Proposed Action. The Proposed Action site plan design would require an ERP from SJRWMD with the SLD 45 as co-applicant before construction can commence. A stormwater management system would be required to treat stormwater runoff from new, proposed impervious surface construction at the launch site (Table 2-1). Low-impact development design features would be incorporated where feasible to minimize site runoff and increase treatment. In addition, a Stormwater Pollution Prevention Plan (SWPPP) would be required to address sedimentation and erosion to protect water quality before, during, and after construction. Since the disturbed area is greater than 1 acre, an NPDES Stormwater Construction General Permit would be required by FDEP. A SWPPP is a requirement under the Construction General Permit and would be implemented to address sedimentation and erosion and to protect water quality before, during, and after construction. These permit review and issuance processes ensure that the design complies with current and applicable stormwater and wastewater regulations and is protective of wetlands and surface waters. As a result, construction of the Proposed Action is expected to result in negligible adverse impacts on surface water quality at surrounding areas and therefore not significant.

Operation. The engine-testing and launch operations associated with the Proposed Action are not expected to have any effect on the IRL and BRL due to distance. Although the proposed launch vehicle transportation route passes over the IRL and BRL, no impacts are expected as a result of this activity.

Under the Proposed Action, launch deluge wastewater generated by engine-testing and launch operations would be contained in new, separate deluge (impermeable concrete) basins. Collected water would be tested and then released to the stormwater retention basins or may be reused and pumped back to the storage tank. Any discharge to the ground surface would require an FDEP Industrial Wastewater permit and potentially coordination with the SJRWMD in conjunction with SLD 45. Space Florida would continue discussions with FDEP and pursue all required permitting for stormwater discharges associated with industrial activity. With an approximate deluge basin capacity of 10,000 gallons, inadvertent discharge of deluge wastewater from the basin is highly unlikely before testing and controlled discharge to stormwater retention basins.

Stormwater generated from impervious surfaces would be treated in the stormwater management system in accordance with SJRWMD regulations before it is discharged off site (Table 2-1). Stormwater would primarily be treated in the on-site treatment basins, will infiltrate, and would rarely discharge off site. In addition to the site occurring within an impaired basin, the site may be designed to discharge to the Banana River, which is included in 62-302.700(9), F.A.C. as Outstanding Florida Water. In addition, a Spill Prevention, Controls, and Countermeasure Plan (SPCCP) would be implemented by each tenant. As a result, operation of the Proposed Action is expected to result in negligible adverse impacts on surface water quality at surrounding areas and therefore not significant.

No Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.8.1 of the 2020 EA are hereby incorporated by reference.

3.6.3.2 Groundwater

Proposed Action

Construction and Operation. The Proposed Action would not use groundwater from underlying aquifers at the site for any purpose during construction or operation. Potable, deluge, or water for other uses would be supplied by the existing CCSFS water distribution system.

Groundwater contamination with chlorinated compounds (predominately trichloroethene and vinyl chloride) has been documented by KSC at the north end of the Proposed Action boundary and portions of the proposed SLC-20C facility. The areas in the Proposed Action boundary are primarily LCPs that are a result of contamination that occurred at SLC-34 (Figure 3-10).

A long-term remediation and monitoring plan is managed by KSC to ensure degradation of contaminants. During construction, if dewatering is required, a dewatering management plan would be required from submission and approval by KSC, SLD 45, AF IRP, and FDEP. Additionally, monitoring and sparge wells are present within the general area. Any wells damaged or destroyed would be replaced by the contractor. Coordination with SLD 45 and KSC would be required to address means and methods that minimize plume movement and potential for soil contamination.

Groundwater contamination could occur during construction or operations of SLC-20C if petroleum products or other hazardous liquids are spilled in significant quantities. An SPCCP would be prepared by each tenant and approved by SLD 45 during the launch license application process that outlines spill management and would address prevention of groundwater contamination. In addition, the potential for accidental releases or spills would be minimized by tenant adherence to provider safety and operating procedures outlined in the SPCCP.

Due to the lack of use of groundwater for the Proposed Action and the prevention and spill response plans that would be in place to avoid and minimize spill potential, construction and operation of the Proposed Action would have negligible adverse impact*s* on groundwater resources and therefore not significant.

No Action Alternative.

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.8.1 of the 2020 EA are hereby incorporated by reference.

3.6.3.3 Wetlands

Proposed Action

Construction. The Proposed Action boundary contains USACE and SJRWMD jurisdictional wetlands. Construction of the SLC-20C complex under the Proposed Action would impact 0.95 acre (3.8 ha) of herbaceous wetlands as a result of filling (Figure 3-3). USACE and SJRWMD also assess secondary impacts to the remaining wetlands by quantifying acreage within 100 ft of the proposed impacts. A total of 3.63 acres (1.5 ha) of secondary impacts are expected to occur.

Several SLC-20C design iterations were completed to avoid and minimize wetland impacts. However, inhabited building distance (IBD) arcs required that SLC-20C be located at the north end of the RPA and no other practicable alternative location could be used. More specifically, the north/south footprint of the facility was compressed to the greatest extent possible as well as the eastern limits of construction to avoid and minimize wetland impacts. Exhibit 4-1 of FAA Order 1050.1F provides the FAA’s significance threshold for wetlands which are analyzed below:

1. *Adversely affect a wetland’s function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers;* Wetland impacts are not to wetlands that are associated with municipal water supplies as the municipal water supply serving CCSFS is taken from a deep Floridan aquifer on the mainland in Cocoa, Florida.
2. *Substantially alter the hydrology needed to sustain the affected wetland system’s values and functions or those of a wetland to which it is connected*; The wetland hydrology is driven by

the elevation of the surficial aquifer and rainfall. The proposed wetland fill is along the wetland margins and would not negatively affect the remaining wetlands hydrology, values, or functions.

3. *Substantially reduce 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)*; The proposed impact area is a small portion of a much larger wetland that runs north/south and also along the north side of the Proposed Action. Public health, safety, or welfare would not be affected as the impact occurs on CCSFS, which is a secured area and the Proposed Action is very isolated from facilities inhabited by CCSFS and contractors.

4. *Adversely affect the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands*; Additionally, the proposed wetland impacts are a tiny fraction of the wetland acreage that occurs at CCSFS.

5. *Promote development of secondary activities or services that would cause the circumstances listed above to occur;* Construction of the Proposed Action would not result in, promote, or foster secondary activities that could cause a reduction in function of the remaining wetlands.

6. *Be inconsistent with applicable state wetland strategies*; Wetland impacts would be mitigated in accordance with USACE and SJRWMD regulations and would ensure that no net loss of wetland function occurs.

Primary and secondary wetland impacts as a result of filling and secondary impacts to adjacent remaining wetland would be mitigated by the use of excess functional gain generated from the construction of three mitigation sites at KSC. As a result, construction of the Proposed Action would result in negligible adverse impacts, therefore not significant, on wetlands.

Operation. No impacts to wetlands would occur during the operation of the Proposed Action.

No Action Alternative

Under the No Action Alternative, the construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.8.1 of the 2020 EA are hereby incorporated by reference.

3.6.3.4 Floodplains

Proposed Action

Construction. Most of the land east and west of ICBM Road is within a 100-year floodplain as a result of major FEMA floodplain map revisions that were published in January 2021. The Proposed Action would result in the filling of up to 17.1 acres (6.9 ha) of floodplains for the construction of the SLC-20C and approximately 4.7 acres (1.9 ha) for SLC-20 A and B infrastructure for a total of 21.8 acres (8.8 ha). No mitigation is proposed for the filling of floodplains as these floodplains are the result of coastal surge and these events flood a large portion of the CCSFS. In the event of a flood or storm event, tenants would implement flood-control measures that could include locating water-sensitive equipment, supplies, chemicals, etc., above flood level and moving hazardous waste outside of the floodplain when substantial storms are imminent. The implementation of these measures would reduce the likelihood that a flood or storm event might result in loss of life, injury to persons, or damage to property or otherwise would be considered a “critical action” as defined in EO 11988, *Floodplain Management*. The construction activities would also be required to comply with EO 11988, *Floodplain Management*, through the procedures identified in DOT Order 5650.2. To determine if construction activities associated with the Proposed Action would result in a significant floodplain encroachment according to DOT Order 5650.2, each of the three scenarios are addressed below:

The action would have a considerable probability of loss of human life: Construction of the Proposed Action would not result in considerable probability of loss of human life. The proposed facilities are not designed nor would they be constructed for human habitation or as a human dwelling. The proposed modifications would not prohibit people from entering or exiting the areas should a flood event occur. Furthermore, no private property occurs near the Proposed Action or on CCSFS.

The action would likely have substantial, encroachment-associated costs or damage, including interrupting aircraft service or loss of a vital transportation facility (e.g., flooding of a runway or taxiway, important navigational aid out of service due to flooding, etc.): The Proposed Action is located within a large contiguous coastal floodplain that spans thousands of acres. The proposed expansions would result in the filling of 22 acres of floodplain. Filling this relatively small area (less than 1 percent of the contiguous area) would not result in new areas being subject to 100-year floods, nor would it exacerbate or make adjacent areas more prone to floods.

The action would cause a notable adverse impact on natural and beneficial floodplain values: Per DOT Order 5650.2, natural and beneficial floodplain values include, but are not limited to, natural moderation of floods, water quality maintenance, groundwater recharge, fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, and forestry. Based on the analysis in this SEA, the FAA has determined that the proposed expansion would not result in notable adverse impacts to the natural and beneficial floodplain values because the Proposed Action would not result in significant impacts to any of the environmental impact categories that encompass these characteristics, as follows:

- A small loss of flood storage capacity would occur. Some minor benefits resulting from the filtering capacity of the floodplain would be lost due to the proposed construction. The portion of the floodplain removed from performing a filtering function is a small percentage of the overall floodplain, and stormwater facilities constructed as part of the Proposed Action would restore some of this capacity.
- Operations would not restrict public access to recreational areas within the floodplain as the Proposed Action occurs within the confines of the CCSFS.

As a result, construction of the Proposed Action is expected to result in minor adverse impacts, yet not significant, on floodplains.

Operation. No impacts to floodplains would occur during the operation of the Proposed Action.

No Action Alternative

Under the No Action Alternative, construction and launch operations would occur at SLC-20A and SLC-20B and result in 4.7 acres (1.9 ha) of floodplain impacts. As a result, minor but not significant adverse impacts to floodplains would occur.

3.7 Health and Safety

3.7.1 Regulatory Setting

Health and safety issues are managed at CCSFS by organizations that review the planning, construction, pre-flight processing, and launch-day operations. The objective of range safety is to ensure that the general public, launch-area personnel, surrounding launch complexes and personnel, and areas of overflight are compliant with USAF requirements, adhere to Space Systems Command Manual 91-710, *Range Safety User Requirements Manual – Launch Vehicles, Payloads, and Ground Support Systems Requirements*, and all public laws.

Space Systems Command Manual 91-710 is the document that implements AFI 91-202, *The US Air Force Mishap Prevention Program*, and is consistent with DoD Directive (DoDD) 3100.10, *Space Policy*, DoDD 3230.3, *DoD Support for Commercial Space Launch Activities*, AFPD 91-2, *Safety Programs*, and the *Memorandum of Agreement between the Department of the Air Force and the Federal Aviation Administration for Launch and Reentry Activity on Department of the Air Force Ranges and Installations*.

3.7.2 Affected Environment

Operational health and safety concerns are primarily focused on the areas in and around CCSFS that could be affected by launch vehicles, equipment, and materials transported to and from the launch complex, payload processing, and launch operations. As noted above, range safety organizations review, approve, monitor, and impose safety holds, when necessary, on all pre-launch and launch operations in accordance with Space Systems Command Manual 91-710.

Any hazardous materials, including liquid fuels, that must be transported to the launch complex, must be compliant with FDOT regulations regarding interstate shipment of those materials governed by 49 CFR Parts 100 through 199.

Explosive safety quantity-distance criteria and regulations established by DoD and USAF Explosive Safety Standards are used to establish safe distances from launch complexes and associated support facilities to non-related facilities and roadways. Explosive safety quantity distance criteria would be used to establish safe distances from all on-site facilities and adjoining roadways.

CCSFS access is controlled through manned guard stations and fencing, necessitating access badges for entry by all employees and visitors.

3.7.3 Environmental Consequences

Any commercial space firm that enters into an RPA with Space Florida is responsible for protecting worker health and safety in accordance with OSHA regulations (29 CFR Part 1926, *Safety and Health Regulations For Construction*). Specific to this SEA, a health and safety impact would be considered significant if an action created a substantial or potential hazard to on-site personnel or the general public.

3.7.3.1 Proposed Action

Construction

On-site facilities would be reviewed for potential hazards at a future date, and Space Florida tenant(s) would work with SLD 45 to ensure safety compliance. A project-specific health and safety plan would be developed by the tenant(s) and approved by SLD 45 before any construction activity is initiated. In general, health and safety plans identify potential health and safety hazards, fall protection associated with cranes or platforms, electrical hazards, mechanized equipment, and hand and power tools risks; define fire and rescue protection and prevention including water safety; outline safety inspections; establish safety equipment requirements such as personal protective equipment, lighting, signs, and barricades; designate materials containment including handling, storage, use, and disposal processes; and provide necessary training and communication to ensure the safety of construction workers, working personnel, and visitors. In addition, all construction activities would be conducted in accordance with OSHA regulations and the SLD 45 safety program. Therefore, implementing the Proposed Action would have no significant adverse impacts on health and safety.

Operations

Space Systems Command Instruction 91-701, *The Space Systems Command Launch and Range Safety Program,* and Space Systems Command Manual 91-710, Volume 3, *Range Safety User Requirements Manual – Launch Vehicles, Payloads, and Ground Support Systems Requirements* provide common requirements for all vehicle classes to ensure operations are conducted safely. The Proposed Action launch providers would be compliant with these publications, which specify that all facilities, including launch complexes, used to store, handle, or process ordnance or propellants, shall be properly sited and approved in accordance with DoD quantity distance criteria and explosive safety standards specified in Defense Explosives Safety Regulation 6055.09_AFMAN 91-201 Explosives Safety Standards. Commercial operators are required to submit documentation before use, to include an Operations Safety Plan, Danger Area Information Plan, and Facility Emergency Operating Plan.

The SLD 45 Safety Office would review, approve, and monitor all pre-launch and launch operations conducted at SLC-20 under the Proposed Action and would impose safety holds if necessary. The intent of a safety hold is to ensure that *there are no hazards that are exposed to the public, launch base, launch area, launch complex and range assets greater than those considered to be acceptable by military regulations, state requirements, or public law*. These references include but are not limited to 42 USC, Chapter 116, *Emergency Planning and Community Right to Know*; 29 CFR Part 1910.119, *Process Safety Management of Highly Hazardous Chemicals*; 40 CFR Part 355, *Emergency Planning and Notification*; 40 CFR Part 68, Subpart G, *Risk Management Plan*; and EO 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*.

The SLC-20A, SLC-20B, and SLC-20C commercial small-lift launch user(s) would be required to coordinate their planned launch schedule with the SLD 45 Safety Office to ensure that FAA is properly notified to allow air traffic control hazard avoidance and coordinate with the USCG for timely notification of ship traffic potentially at risk due to overflight scenarios.

All launches must comply with established government safety requirements and cannot jeopardize public safety or property per 14 CFR 450, DAFI 91-202, and SSCM 91-710. The probability of a launch mishap substantially affecting a member of public or their property must be extremely unlikely for a mission to be authorized for launch.

Safe distance areas are developed for each mission to address the risks associated with a potential launch mishap. The safe distances could not extend into local communities per DAF and FAA regulations. Because no safety distance areas are beyond the CCSFS boundary, there would be no terrestrial closure areas for the public.

Structure heights of the Proposed Action lightning protection system would be designed to avoid impacts on airfield (Skid Strip [KXMR]) operations.

A common safety practice is to establish restricted-access hazard arcs around the facilities where potentially dangerous explosive materials are present. The purpose of defining these safety arcs, known as an Explosive Quantity-Distance Safety Arc, is to separate the hazardous procedures from other nearby operations and from the general public. For example, before a launch vehicle is erected on a launch pad, a hazard arc is calculated based on the potential hazards of that vehicle (e.g., the types and quantities of propellant onboard, rocket reliability, flight trajectory, and types of debris expected if the flight were terminated) and is activated around the launch pad. Operational controls (e.g., evacuation areas, temporary road closures) are established within and at the perimeter of the hazard arc to minimize the potential hazards associated with the operations of the launch range. All payload processing and launch facilities used to store, handle, or process ordnance items or propellants must have an Explosive Quantity-Distance Site Plan. Table 3-21 provides the maximum quantity distance safety arcs for SLC-20A, SLC-20B, and SLC-20C. Section 4.12.1 of the 2020 EA is hereby incorporated for information and analysis specific to SLC-20A and SLC-20B. For SLC-20C, the arcs are based on the maximum amount of explosive material used. For this SEA, the HIF is assumed to not be used for explosive operations.

Table 3-21. Maximum Explosive Siting Considerations for SLC-20C

Launch Vehicle	Propellant Mass (lb [kg])	HD	NEW (lb [kg])	IBD (ft [m])
Max LOX/RP-1	225,000 (102,058)	1.1	45,000 (20,412)	1,423 (434)
Max LOX/RP-X	45,000 (20,412)	1.1		
Max LOX/LNG	45,000 (20,412)	1.1		
Max HTPB	245,000 (111,130)	1.3	245,000	403 (123)

Before constructing infrastructure, SLD 45 would need to prepare a DoD Explosives Safety Board-approved explosive site plan for the facility. The IBD represents the distance needed between an explosive location and a building that could be occupied by people. Two operational IBDs would be established at SLC-20C in support of the Proposed Action. The first IBD would be a distance of 1,250 ft (381.0 m) for small-lift launch vehicles with a Net Explosive Weight (NEW) less than or equal to 30,000 lb (13,608 kg). The first IBD would support approximately 75 percent of the small-class vehicles that are proposed to be launched at SLC-20C without impacting operations at SLC-20A or SLC-20B. The second IBD would be 1,423 ft (433.7 m) for small-lift launch vehicles with a NEW up to 45,000 lb (20,412 kg). The second IBD would provide additional flexibility for the site without restricting adjacent operations at SLC-20A or SLC-20B during on-pad wet dress rehearsals at SLC-20C.

Current DoD guidance treats unique propellant combinations (such as LOX/RP-X and LOX/LNG) as 100-percent NEW of hazard division (HD) 1.1. For this SEA, RP-X is also known as Exxsol D40 and is similar to mineral spirits. As listed in Table 3-21, the proposed IBD for SLC-20C is approximately 1,423 ft (433.7 m). As a result, a maximum NEW of 45,000 lb (20,412 kg) of HD 1.1 and 245,000 lb (111,130 kg) of HD1.3 is proposed for SLC-20C.

All payload and launch programs that use toxic materials must have a Toxic Release Contingency Plan for facilities that use those materials. A Toxic Hazard Assessment must also be prepared by the tenant user(s) and approved by SLD 45 for each facility that proposes the use of toxic propellants. The Toxic Hazard Assessment identifies the safety areas to be controlled during the storage, handling, and transfer of the toxic propellants. In addition, FAA would conduct a safety review of operations as part of their license application review process.

Hazardous materials such as propellant, ordnance, chemicals, and booster/payload components are transported in accordance with FDOT regulations for inter-/intra-state shipment of hazardous substances (49 CFR Parts 100 through 199). Hazardous materials such as propellant are transported in specially designed containers to reduce the potential of a mishap should an accident occur. Rocket engine testing or the operation and launch of small-lift launch vehicles would comply with all applicable federal, state, and local safety regulations for storage, use, and transfer of hazardous materials.

Flight-related risks for each type of launch vehicle at CCSFS are distinct. The SLD 45 Safety Office coordinates all operations, including those proposed from SLC-20, with FAA, the USCG, and other organizations as required to clear potential hazard areas. As discussed in Section 2.1.4, all launch operations would continue to comply with the necessary notification requirements, including issuance of a NOTAM and NOTMAR at least 24 hours before a launch operation occurs.

Additionally, the SLD 45 Safety Office regularly distributes electronic notices of launch-related hazard areas that include local watermen, marinas, and marine transportation companies. Risk criteria have been established by CCSFS to protect the public, mission-essential and critical-operations personnel, and property from risks associated with operations that occur within CCSFS. These criteria are consistent with the National Range Commanders Council guidelines.

A trajectory analysis would be completed before each flight to define the flight safety limits for the small-lift launch vehicles scheduled to launch from SLC-20C and coordinated with SLD 45 Range Safety for approval. The Proposed Action includes launch vehicles with Flight Termination Systems or Thrust Termination Systems that control the termination by destruction of the vehicle if the flight is deemed erratic or crosses the established self-destruct boundary. Flight termination boundaries are designed to protect the public and personnel by ensuring that vehicle destruction occurs within a predetermined safety zone. Users would be required to provide information regarding flight termination systems that comply with Space Systems Command Manual 91-710 and are ER approved.

As a safety measure regarding lightning, the SLC-20A, SLC-20B, and SLC-20C launch complexes would be designed to include a lightning-protection system. The actual maximum height of the lightning-protection system would be below the Skid Strip’s height limitations of 350 to 400 ft

(107 to 122 m) to ensure that no impacts to the safety requirements for that airfield would occur.

Therefore, no significant impact to human health and safety would be expected from the implementation of the Proposed Action.

3.7.3.2 No Action Alternative

Under the No Action Alternative, construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.12.1 of the 2020 EA are hereby incorporated by reference.

3.8 Section 4(f) Properties

3.8.1 Regulatory Setting

Section 4(f) of the DOT Act of 1966 (49 USC Section 303 and 23 USC Section 138) applies only to DOT and is limited to projects that receive funding from or require approval by an agency of the DOT. Under this law, DOT agencies cannot approve a project that would use land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless (1) there is no feasible and prudent avoidance alternative to the use of the land and the action includes all possible planning to minimize harm to the property resulting in such use or (2) the Federal Highway Administration determines that the use of the property would have a *de minimis* impact. Two Section 4(f) properties are within the KSC boundaries, MINWR and most of the Canaveral National Seashore (CNS).

3.8.2 Affected Environment

No designated Section 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCSFS. MINWR and CNS are north and northwest of CCSFS. MINWR was established as an overlay of KSC; the lands and waters of KSC are primarily to serve the space program and secondarily to serve as a wildlife refuge or park (USFWS 2023). MINWR is co-located with KSC and all areas not directly used for NASA operations are managed by MINWR/USFWS and by NPS for the CNS. The combined 135,225 acres (54,724 ha) comprising MINWR (128,570 acres [52,031 ha]) and CNS (6,655 acres [2,693 ha]) are outside the NASA KSC daily operations area, but NASA retains ownership of those lands and retains the operational control for temporary closures for launch- and landing-related activities. USFWS and NPS exercise control over their respective environmental management programs, habitat management, and recreational use for MINWR and CNS. The nearest public park south of SLC-20, Jetty Park, is approximately 5 miles (8 km) south of SLC-20 in the City of Cape Canaveral. Other public parks within an approximate 15-mile (24.1-km) radius of SLC-20 include Kelly Park, KARS Park, Kings Park, and Manatee Cove Park.

3.8.3 Environmental Consequences

3.8.3.1 Proposed Action

Construction

No designated Section 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of the Proposed Action or CCSFS. As a result, the construction of the Proposed Action would have no impacts on Section 4(f) properties.

Operation

Section 4(f) properties within an approximately 15-mile (24.1-km) radius of SLC-20 would experience temporary operation-related noise as a result of launches. The increased noise level would only last a few minutes and would occur up to 48 times per year; however, this is considered a conservative estimate since historical launch cadences are typically less at initial operation and slowly increase over a 5-year period as the user's launch program progresses. For planning purposes, launches are expected to increase gradually over the course of 5 years with a maximum of 48 launches in the fifth year.

All pre-launch operations and effects would occur within or very close to the boundaries of the SLC-20A, SLC-20B, or SLC-20C. Launch vehicles would be launched from one of the three pads at SLC-20 and accelerate over the Atlantic Ocean and away from Section 4(f) lands. In accordance with Section 4(f), FAA would not approve any program or project that requires the use of a Section 4(f) property unless no feasible or prudent alternative exists for the use of such land and the program or project includes all possible planning measures to minimize any harm related to such use. Section 4(f) defines three conditions that constitute *use*: "permanent incorporation (outright acquisition), temporary occupancy, or constructive use." Constructive use occurs when the project's impacts to the 4(f) property are so serious that the activities, features, and attributes of the 4(f) property are substantially impaired.

The above-referenced Section 4(f) properties have experienced operational launch noise from CCSFS and adjacent KSC for decades; yet, through the close cooperative planning and coordination between those agencies and USFWS and NPS, a balance of spaceflight operations and protection of natural resources within those Section 4(f) properties has been and continues to be achieved (NASA 2013). Therefore, FAA has determined the Proposed Action would not substantially diminish the use of the protected activities, features, or attributes of any of the Section 4(f) properties identified and would not result in substantial impairment of the properties. The Proposed Action would not result in a constructive use of these Section 4(f) properties and would not invoke Section 4(f) of the DOT Act. Therefore, the Proposed Action would have no significant impacts on Section 4(f) properties.

No Action Alternative

Under the No Action Alternative, construction and launch operations would occur at SLC-20A and SLC-20B; therefore, the analysis and conclusions presented in Section 4.15.1 of the 2020 EA are hereby incorporated by reference.

3.9 Airspace and Marine Transportation Management

3.9.1 Regulatory Setting

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

The USCG Marine Transportation Systems Directorate is responsible for developing and implementing policies and procedures that facilitate commerce, improve safety and efficiency, and inspire dialogue with ports and waterway users with the goal of making waterways as safe, efficient, and commercially viable as possible (USCG 2022).

3.9.2 Affected Environment

The ROI includes the airspace and water areas within the Proposed Action as shown in Figure 3-8. This figure shows the entire range of launch azimuth areas for the Proposed Action where airspace and water areas could be potentially affected by management activities to those entities. Individual launches would have management footprints smaller than the entire area shown and be defined on a case-by-case basis for each launch.

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

3.9.3.1 Proposed Action

Construction

The construction at SLC-20 would have no impact on airspace management or marine transportation management.

Operation

As part of launch operations at SLC-20A, SLC-20B, and SLC-20C, temporary closures of existing airspace and navigable waterways would occur up to 48 times per year. However, no changes to airspace dimensions would occur. Advanced notice via NOTAMs and NOTMARs would allow general aviation pilots and mariners to expect temporary disruptions to flight and marine activities during launch operations. In addition, the use of SDI and SOLAR would also minimize impacts to pilots and mariners. Launch operations would be scheduled in advance, would be short in duration, and would not include recovering the first stage. Therefore, no significant impacts to airspace and marine transportation management would occur from implementing the Proposed Action.

No-Action Alternative

Under the No Action Alternative, the construction and launch operations at SLC-20A and SLC-20B would proceed as described in the 2020 EA. However, for the reasons described for the Proposed Action, implementing the No Action Alternative would have no effect on airspace and marine transportation management during construction and no significant impacts on airspace and marine transportation during launch operations.

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4.0 CUMULATIVE EFFECTS

4.1 Definition of Cumulative Effects

The cumulative effects analysis follows the requirements of NEPA. For the purposes of this document, cumulative impacts are defined as follows:

> *Effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from actions with individually minor but collectively significant effects taking place over a period of time.*

Cumulative effects are most likely to arise when a relationship or synergism exists between a Proposed Action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or near the Proposed Action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative effects, the analysis needs to address the following three fundamental questions:

1. Does a relationship exist such that impacts to affected resource areas by the Proposed Action might interact with the impacts to resources of past, present, or reasonably foreseeable actions?
2. If so, what would the combined impact be?
3. Are there any potential significant impacts not identified when the Proposed Action is considered alone?

4.2 Cumulative Activities

The overall geographic scope of analysis consists of CCSFS and the immediately surrounding area. The timeframe for the analysis must include the past, present, and future. For most resource areas, the period within the last 5 years marks the past temporal boundary for the cumulative impacts analysis. The future temporal boundary includes the life of the Proposed Action (i.e., 2026 through 2031) and other reasonably foreseeable actions within the overall timeframe. The temporal boundary for the present is defined by actions in detailed planning, under construction, or that have been recently initiated. Since the potential effects to resources carried forward in the cumulative impacts analysis may require several years to recover following the end of the LSOL, the future temporal boundary is bound by activities that can be reasonably foreseen, as well as the standard FAA license duration, which is approximately 5 years.

4.2.1 Past, Present, and Reasonably Foreseeable Actions

4.2.1.1 CCSFS Launch Activities

Table 4-1 summarizes the current commercial licensed operators at CCSFS. Most launches that occurred in 2022, 2023, and 2024 were from SpaceX. Table 4-2 provides the past and future predicted vehicle launches at CCSFS based on currently available NEPA documentation.

Table 4-1. Current Commercial Licensed Operators at CCSFS

License Number	Operator	Vehicle	Launch Pad	License Expiration Date
RLO 20-007 (Rev 5)	SpaceX	Dragon 2	Atlantic Ocean/Gulf of Mexico Reentry	March 10, 2026
VOL 23-127	Relativity Space	Terran 1	SLC-16	February 21, 2028
VOL 22-124 (Rev 2)	Astra	Astra Rocket v3.3	SLC-46	January 4, 2027
LLO 01-059 (Rev 3)	Orbital	Pegasus	Skid Strip	March 17, 2026
LLO 17-099 (Rev 2)	Orbital	Minotaur IV	SLC-46	March 9, 2026
LLO 18-105 (Rev 18)	SpaceX	Falcon 9	SLC-40	March 9, 2026
LLO 18-113 (Rev 5)	ULA	Atlas V	SLC-41	March 9, 2026
LLO 23-128	ULA	Vulcan Centaur	SLC-41	March 9, 2026

Source: FAA 2024b.

Table 4-2. Past and Future Predicted Vehicle Launches at CCSFS

Document	Launch Provider	Launch Pad	Project Status	Annual Launches from CCSFS
Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station	SpaceX	SLC-40	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	SLC-20	Under Construction	24
Environmental Assessment for the United Launch Alliance Vulcan Centaur Program Space Launch Complex 41 at Cape Canaveral Air Force Station	ULA	SLC-41	Active	20
Environmental Assessment for Blue Origin Orbital Launch Site at Cape Canaveral Air Force Station, Florida	Blue Origin	SLC-11	Under Construction	12
Environmental Assessment for Space Florida Launch Site Operator License at Launch Complex- 46	Space Florida	SLC-46	Active	24
Supplemental Environmental Assessment for the Relativity Space Terran R Launch Program at Cape Canaveral Space Force Station, Florida	Relativity	SLC-16	Under Construction	24
Draft Environmental Assessment for Stoke's Nova Launch Program at Cape Canaveral Space Force Station	Stoke Space Technology	SLC-14	Proposed	10
Total Approved Launch Cadence Approved Under NEPA				**164**

Sources: CCSFS 2024a, FAA 2008, FAA 2020b, FAA 2024b, USAF 2016, USSF 2024a, and USSF 2024b.

Table 4-3 lists the past and reasonably foreseeable licensed vehicle launches at CCSFS and KSC.

Table 4-3. Past and Future Predicted Licensed Launches at CCSFS and KSC

Year	Total Number of Licensed Launches
Past Totals	
2018	20
2019	15
2020	31
2021	31
2022	57
2023	72
2024	93
Subtotal	***319***
Future Predictions	
2025	135
2026	165
2027	120
2028	115
Subtotal	***535***

Source: CCSFS 2024a.

4.2.1.2 Other Past, Present, and Reasonably Foreseeable Actions

Table 4-4 presents past, present, and reasonably foreseeable actions in the geographic area and their potential for cumulative effects.

4.3 Assessment of Cumulative Impacts by Resource

The analytical methodology presented in Chapter 3, which was used to determine potential impacts to the various resources analyzed in this SEA, was also used to determine cumulative impacts. The ROI is resource dependent as follows:

- Noise: CCSFS and surrounding areas.
- Biological Resources: SLC-20 and surrounding areas.
- Cultural Resources: SLC-20 and surrounding areas.
- Air Quality: CCSFS and Brevard County.
- Transportation: Regional and local roadways.
- Water Resources: SLC-20 and surrounding areas.
- Health and Safety: CCSFS and surrounding areas.
- Section 4(f) Properties: SLC-20 and surrounding areas.
- Airspace and Marine Transportation Management: airspace and water areas within the Proposed Action.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
International Space Research Park	The Proposed Action consisted of developing the International Space Research Park over 20 to 25 years on approximately 345 acres (140 ha). The development would occur over six phases on 25 parcels with the goal of providing a site to enable commercial, research and development, and academic organizations from public and private sectors. In the 2004 EIS for this project, the number of employees working at the International Space Research Park was estimated to grow to as many as 10,350 employees in 2020. The EIS was released in June 2004. Impacts to land use, air quality, ambient noise, geology and soils, hydrology and water quality, biological resources, socio-economics, and cultural resources were assessed. Presently, Blue Origin occupies this area.	Past	Potential for Cumulative Effects: No potential for overlap exists with construction activities as this facility is built and operational.
Exploration Park Phase 1	The Proposed Action consisted of constructing eight buildings and associated parking to support education, technology and innovation development, industrial application, and space industry support services on a 60-acre (24.3-hectare) site. At build-out, the footprint was estimated to total 315,000 ft^2 (0.03 km^2) in facilities and 768,030 ft^2 (0.07 km^2) of roads, parking lots, sidewalks, and other related infrastructure. The development would accommodate up to 800 permanent employees. A Final EA was published in December 2008. Impacts to facilities and infrastructure, air quality, biological resources, threatened and endangered species, cultural resources, geology and soils, noise, surface water quality, groundwater quality, socioeconomics, and land use were assessed. No significant impacts were identified. Presently, Airbus US Space & Defense, formerly known as Airbus OneWeb Satellites, occupies one building and uses it as the final assembly line for small satellites.	Past	Potential for Cumulative Effects: No potential exists for overlap with construction activities since this building has been constructed. However, an Airbus US Facility Expansion Project is proposed, which would be analyzed in detail by KSC as a separate project.
Space and Life Sciences Laboratory (SLSL)	The SLSL, built in 2003, is a 104,000-ft^2 (0.01-km^2) world-class laboratory supporting biological and life sciences research.	Past	Potential for Cumulative Effects: No potential for overlap exists with construction activities as this facility is built and operational.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Brevard County Capital Improvement Plan for Fiscal Year 2023–2024 through 2027–2028	Brevard County uses the Capital Improvement Plan planning process to identify, quantify, and assess its capital improvement need over a 5-year time period. A variety of capital projects that cost $35,000 or more and have a 5-year or longer expected service life is proposed. Projects associated with the Merritt Island Redevelopment Agency Program are close to CCSFS. These projects include a 3+ acre (1.2 ha) amphitheater project, improvements to Borman Drive, North 520 stormwater management, Fortenberry Road stormwater pipe extension, Merritt Island riverwalk, improvements on South Courtenay Parkway between Fortenberry Road and Cone Road, transit shelter improvements, Veterans Park improvements, and safety improvements to Courtenay Parkway (SR 3), SR 520, and SR 528. The capital improvements projects span FY 2023–2024 through FY 2027–2028.	Present	Potential for Cumulative Effects: The potential for construction overlap with some projects exists, which could result in cumulative impacts to noise, air quality, and GHGs. From an operations perspective, Merritt Island could be exposed to noise and sonic booms from the Proposed Action. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.
Canaveral Port Authority 30-Year Strategic Vision Plan (2017–2047)	The 30-year strategic plan outlines Port Canaveral's potential for the following major businesses: cruise, cargo, fishing, parks and recreation, marine recreation, commercial development, and commercial space. The goals of the master plan are to be a great partner to the citizens and users of the Port by providing services and opportunities to the private sector, to be a great neighbor by creating developments that are compatible with the adjoining communities, and to serve the needs of the maritime community by providing the infrastructure needed to facilitate the movement of goods and services. Specific to the commercial space industry, the Port's plan provides $78 million for additional phases to accommodate growth needs. The plan provides for a dedicated area to transfer rockets and equipment to nearby commercial space facilities and berth spaces for marine vessels transporting space mission components.	Present	Potential for Cumulative Effects: The potential for construction overlap with some projects exists, which could result in cumulative impacts to noise, air quality, and GHGs. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.
City of Cocoa Beach 2025 Comprehensive Plan	As documented in the 2025 Comprehensive Plan, the City will continue its contractual arrangement with Patrick Air Force Base (now Space Force Base [SFB]) to treat wastewater and return reclaimed water for use at the golf course and housing area irrigation; investigate potential improvements to transportation facilities that connect Port Canaveral and PSFB with residential, commercial, and tourist uses within Cocoa Beach; and continue to coordinate with sanitary sewer customers.	Present	Potential for Cumulative Effects: The potential for construction overlap with some projects exists, which could result in cumulative impacts to noise, air quality, and GHGs.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Space Florida Launch Site Operator License at Launch Complex-46	Under the Proposed Action, FAA would issue a launch site operator license for LC-46 at CCSFS to Space Florida. The LSOL would allow Space Florida to offer the site for launches of solid- and liquid-propellant launch vehicles by commercial launch vehicle operators. Under the Proposed Action, up to 24 annual launches could occur. Potential impacts to air quality, biological resources, water resources, noise, compatible land use, socioeconomic resources, hazardous materials, solid waste, and pollution were assessed. No significant impacts were identified. Space Florida's LSOL for LC-46 expires on July 1, 2025; however, it can be renewed.	Present	Potential for Cumulative Effects: No potential for overlapping with construction activities exists since impacts would be limited to operations only. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.
Launch Operator Licenses for the Evolved Expendable Launch Vehicle (EELV) Program Atlas V and Delta IV	Under the Proposed Action, the FAA would issue, renew, or modify Launch Operator Licenses for launch vehicles covered under the Evolved Expendable Launch Vehicle Program, which includes Atlas V and Delta IV vehicles from Cape Canaveral Air Force Station (now CCSFS) and Vandenberg Air Force Base (now Vandenberg Space Force Base). The Record of Decision incorporated by reference the associated 1998 Final EIS and 2000 Supplemental EIS. No significant impacts would occur to air quality, biological resources, cultural resources, geology and soils, land use and Section 4(f) properties, noise, water resources, hazardous materials, pollution prevention, solid waste, socioeconomics, and children's environmental health and safety.	Present	Potential for Cumulative Effects: No potential for overlapping with construction activities exists since impacts would be limited to operations only. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station	Under the Proposed Action, FAA would modify the existing SpaceX licenses or issue new launch licenses to SpaceX to continue conducting Falcon launch operations at KSC and CCSFS and to issue new reentry licenses to SpaceX for Dragon reentry operations. Under the Proposed Action, a maximum of 70 launches would occur in 2024 and 70 launches would occur in 2025 from LC-39A and LC-40. Of that, each year 20 launches (half Falcon Heavy and half Falcon 9) would occur from LC-39A, and 50 launches (all Falcon 9) would occur from LC-40. Following a launch, SpaceX would recover and reuse the payload fairings, as well as conducting boost-back and landing of first stage boosters. Impacts to air quality; biological resources; climate; coastal resources; Section 4(f) properties; hazardous materials, solid waste, and pollution prevention; historical, architectural, archeological, and cultural resources; land use; natural resources and energy supply; noise and noise-compatible land use, socioeconomics, visual effects, and water resources. No significant impacts were identified.	Present	Potential for Cumulative Effects: No potential for overlapping with construction activities exists since impacts would be limited to operations only. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.
Widening of Space Commerce Way	FDOT funded a $22.9-million project to widen 2.7 miles (4.3 km) of Space Commerce Way between NASA Parkway West to Kennedy Parkway South from two lanes to four lanes. This project will support future growth and economic vitality by allowing the transportation of oversized space-industry vehicles to launch sites, as well as public and commercial traffic between the mainland near Titusville and North Merritt Island (and other barrier islands in that vicinity). The project will also provide visitors with access to the KSC Visitor Center and support the manufacturing and research workforce in the Space Commerce District. During the widening effort, intermittent lane closures on Space Commerce Way will occur; however, signage will be erected to alert drivers of detours. No closure to side streets, residences, and business will occur. The project began in July 2023 and is expected to be completed by spring 2025.	Present	Potential for Cumulative Effects: This construction project and its impacts to relevant resource areas would be complete before the Proposed Action would commence.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Exploration Park North (Astronaut Training Facility)	The Proposed Action is for NASA to execute an RPA with Space Florida for Exploration Park North, which would allow construction and operation of an Astronaut Training Facility on a 66-acre (27-ha) development area that would be accessed via a road connected to New Space Drive. The facility would include astronaut training facilities, astronaut accommodations, and auxiliary support facilities for future commercial astronauts and other customers. The facility would be within the Space Commerce District and could accommodate up to 50 permanent staff and 30 astronaut trainees at any one time. Additionally, a public restaurant and café could accommodate upward of 180 people. No specific construction and operational dates are available. A Final EA was released in August 2021. Impacts to transportation, utilities, air quality, biological resources, threatened and endangered species, cultural resources, geology and soils, noise, surface water quality, groundwater quality, and socioeconomics were assessed. No significant effects were identified.	Present	Potential for Cumulative Effects: Exploration Park North is in the northeast portion of the Space Commerce District (approximately 7.5 miles [12.1 km] from SLC-20). The timeline is unknown, but construction and operations overlap would likely occur. Cumulative impacts from construction and operations could occur to noise, air quality, and GHGs.
Blue Origin Orbital Launch Site (OLS) at Cape Canaveral Air Force Station	The Proposed Action would allow the construction and operation of an OLS at LC-11 and LC-36. The commercial facility would contain infrastructure to test rocket engines, integrate launch vehicles, and conduct launches of liquid fueled, heavy-lift class orbital vehicles. Up to 12 launches would be conducted per year beginning in 2018, with 10 during daytime hours and two at nighttime. Approximately 8.3 acres (3.4 ha) of primary wetlands are estimated to be impacted; these impacts would be mitigated by creating and enhancing approximately 53 acres (21.4 ha) of wetlands at Blue Origin's manufacturing facility parcel in Brevard County. USFWS issued a BO on May 27, 2016, that the action would not likely jeopardize the continued existence of any federally listed species, and no critical habitat would be affected. Potential impacts to land use/visual resources (which includes coastal resources), noise, biological resources, cultural resources, air quality, climate, hazardous materials/hazardous waste (which includes solid waste and pollution prevention), orbital debris, water resources, geology and soils, transportation, utilities, health and safety, socioeconomics, and Section 4(f) properties were assessed. No significant impacts would occur.	Present	Potential for Cumulative Effects: Because the construction is completed, no potential for overlap with construction activities exists. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
United Launch Alliance Vulcan Centaur Program Operations and Launch at CCSFS	The Proposed Action would allow implementation of the Vulcan Centaur Program at CCAFS (now CCSFS). Once fully operational, United Launch Alliance would phase out its Atlas V and Delta IV programs. Vulcan vehicle components would be shipped from Alabama and received at the CCSFS Wharf and then transferred via truck to the Atlas Spaceflight Operations Center. United Launch Alliance does not intend to recover any vehicle components and plans to launch 20 vehicles per year by 2027 from SLC-41. To accommodate United Launch Alliance's new vehicle, modification at SLC-41 would occur, including constructing a new Mobile Launcher Platform, upgrading the existing crane, and modifying the launch facilities at SLC-41. The EA analyzed potential impacts to land use, visual resources, noise, biological resources, historical and cultural resources, air quality, climate, orbital and de-orbiting debris, hazardous materials and solid and hazardous waste, water resources, geology and soils, transportation, utilities, health and safety, socioeconomics, and Section 4(f) properties. No impacts to floodplains or wetlands would occur, and no significant impacts would occur to other resources analyzed.	Present	Potential for Cumulative Effects: SLC-41 is approximately 5.1 miles (8.2 km) from SLC-20. Because construction is completed, no cumulative impacts are expected from construction. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.
Eastern Range Planning and Infrastructure Development at Cape Canaveral Space Force Station	The Proposed Action would improve, modernize, and expand the infrastructure at CCSFS as described in the CCSFS District Development Plan. The Proposed Action would include site preparation activities (e.g., vegetation clearing, grubbing, and grading), facility construction and demolition, and transportation and utility improvements. Based on conceptual planning, the Proposed Action is expected to result in approximately 740 acres (300 ha) of ground disturbance throughout the installation and would impact up to 20 acres (8.1 ha) of wetlands, 1 acre (0.4 ha) of surface waters, and 240 acres (97.1 ha) of the 100-year floodplain. With the implementation of approved mitigation and conservation measures, USFWS determined the action would not adversely affect federally listed species. Potential impacts to air quality and climate; water resources; noise; soils and geological resources; historical and cultural resources; biological resources; land use and visual/coastal zone resources; infrastructure (transportation and utilities); health and safety; hazardous materials and wastes; socioeconomics; and airspace were assessed. No significant impacts would result. Construction started in January 2024 and is expected through 2030 with steady state reached in 2031.	Present	Potential for Cumulative Effects: Cumulative impacts would occur during construction overlap in 2026. In addition, based on conceptual planning, the Proposed Action is expected to result in approximately 740 acres (299.5 ha) of ground disturbance throughout the installation and would impact up to 20 acres (8.1 ha) of wetlands, 1 acre (0.4 ha) of surface waters, and 240 acres (97.1 ha) of the 100-year floodplain. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Relativity Terran R Launch Program at SLC-16	The Terran R Program would supersede the Terran 1 Program and deliver payloads up to 73,855 lb (33,500 kg) max to Low Earth Orbit or 51,810 lb (23,500 kg) under a reusable configuration. Following LC-16 modifications, the first Terran R launch is scheduled for 2026 with an expected future maximum launch rate of 24 launches per year. Expected modifications include a launch pad and flume, HIF, Environmental Control System Facility, instrumentation bay, tech workshop, office, lightning protection towers, two flare stacks, vehicle lighting, liquefied natural gas and liquified oxygen storage tanks, and roadway infrastructure. The Proposed Action would impact approximately 1.6 acres (0.6 ha) of wetlands and 33.01 acres (13.4 ha) of potential southeastern beach mouse habitat. The loss of these habitats was mitigated. Potential impacts to air quality and climate, water resources, noise, soils and geological resources, historical and cultural resources, biological resources, land use and visual/coastal zone resources, infrastructure (transportation and utilities), health and safety, hazardous materials and wastes, socioeconomics, Section 4(f) properties, and airspace were assessed. No significant impacts would result.	Present	Potential for Cumulative Effects: Because the construction is expected to be completed before the Proposed Action occurs, no potential for overlap with construction activities exists. However, the Terrain R action would result in impacts of approximately 1.6 acres (0.6 ha) of wetlands along the north portion of SLC-16; the wetlands impact is carried forward in the cumulative impacts analysis. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Project Comet (Project Kuiper) at the Space Florida Launch and Landing Facility	Project Comet, also known as Project Kuiper, would consist of a new payload process facility at Space Florida's Launch and Landing Facility northeast of the Space Commerce District. The new facility would be two stories high with additional mechanical mezzanines. The gross floor area will be approximately 102,854 ft^2 (9,555.4 m^2) with a footprint of approximately 81,610 ft^2 (7,581.8 m^2). Approximately 71 parking spaces would be available for this location. The primary use of the building would be processing payloads for the commercial space program. The total on-site development area is 31.6 acres (12.8 ha). Along with the construction of the payload processing facility, additional support facilities would be constructed within the proposed development area to include an in-transit storage facility, a badging security office, and an office building. The facility would have a perimeter fence and new dry retention ponds in the area. During construction, a construction compound would be used to include a material laydown area, no more than 10 independent construction office trailers (not to exceed 1,350 ft^2 [125.4 m^2] each), and a staging/stockpile area. The construction compound would be surrounded by a 6-ft (1.8-m) tall temporary chain link fence. The new facility is expected to be completed and operational by 2025. A Draft EA was released in January 2021 for the development of this area. Impacts to fish and wildlife; plants; floodplains; historical, architectural, archeological, and cultural resources; water quality; and wetlands were assessed. No significant effects were identified.	Future	Potential for Cumulative Effects: Because the construction is expected to be completed before the Proposed Action occurs, no potential for overlap with construction activities exists. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
SpaceX Roberts Road North Expansion	The approximately 100-acre (40.5-hectare) parcel of land north of the existing Roberts Road Operations Area would be used for developing additional office space and industrial facilities in support of vehicle and payload processing, fabrication, storage, manufacturing, and shipping and receiving. SpaceX would construct facilities, not to exceed 1.5 million ft^2 (0.14 km^2) with a maximum facility height of 400 ft (122 m). Upgraded utilities would include new underground electrical feeder lines, fiber communication connectivity, water, and wastewater. Internal site roads would provide access and connectivity to facilities within the area. The September 2023 SEA evaluated potential environment effects from expanding Roberts Road Operations Area, upgrading utilities, and widening Saturn Causeway approximately 8 ft (2.4 m) from the VAB to Phillips Parkway to support vehicle transport to and from launch facilities. Resources analyzed in the SEA included land use/visual resources, coastal zone, habitats and vegetation, wildlife protected species, cultural resources, air quality, climate, surface waters, floodplains, groundwater, geology and soils, transportation, utilities, and hazardous materials and waste. No significant effects were noted. Construction development is expected to last 2 to 3 years.	Present	Potential for Cumulative Effects: The SpaceX Roberts Road North Expansion project area is currently under construction. Construction overlap is not likely to occur and thus cumulative impacts to noise, air quality, and GHGs are not anticipated.
Stoke's Nova Launch Program at SLC-14	The purpose of the Proposed Action was to execute an RPA and reactivate SLC-14 in support of Stoke's launch program, which includes demolishing existing structures, constructing new facilities, and improving the existing infrastructure, ground support operations, and launch operations. Under the Proposed Action, two launches would occur during the first year of operation in 2025 and then increase to 10 launches per year for the subsequent 2 years. Up to 50 percent of the launches could occur at night. Resources analyzed included biological resources, cultural resources, air quality and climate change, noise, hazardous materials, solid waste, hazardous waste, water resources, geology and soils, infrastructure, health and safety, land use, visual resources, coastal resources, socioeconomics, children's environmental health and safety risks, and airspace and marine transportation management. No significant impacts would occur.	Present	Potential for Cumulative Effects: No overlap in construction would occur because Stoke's Nova Launch Program-related construction is expected to be completed by 2025. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
SpaceX Falcon 9 Operations at SLC-40	The purpose of the Proposed Action is to provide greater mission capability to the DOD, NASA, and commercial customers by increasing Falcon 9's flight opportunities. Under the Proposed Action, there would be an increase in the Falcon 9 annual launch cadence from 50 to 120 launches per year at SLC-40 on CCSFS, an increase in Falcon 9 first stage and fairing recovery activities, and the construction and operation of a landing zone at SLC-40. Up to 34 booster landings annually would relocate from Landing Zone 1/Landing Zone 2 (also known as SLC-13) to the new landing zone at SLC-40. Resources analyzed in the March 2025 Draft EA included air quality, climate, noise and noise-compatible land use, cultural resources, water resources, biological resources, coastal resources, land use, and socioeconomics. No significant impacts would occur; however, potential minor adverse impacts to air quality, climate, sound (airborne), cultural resources, water resources, biological resources, coastal resources, land use, and socioeconomics were noted. The public comment period ended on May 15, 2025.	Present	Potential for Cumulative Effects: SLC-40 is approximately 3.6 miles (5.8 km) from SLC-20. Because construction is completed, no cumulative impacts are expected from construction. Cumulative impacts from construction and operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, transportation, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
2023–2024 Development Projects, Blue Origin Orbital Launch Site (OLS) Manufacturing Complex	Blue Origin is proposing to develop four vacant areas totaling 100.04 acres (40.5 ha) in the OLS Manufacturing Complex, construct a parking lot, and erect a temporary storage building. The projects would provide for the infrastructure needs of existing and near future facilities for the manufacture of the Blue Origin OLS space flight hardware and launch vehicle components. The six projects include the following: 1. North Campus Early Site Development (Tier One North Campus, Area 3, 8.6 acres [3.5 ha]) – Provide clearing, stripping, earthwork, and storm drainage improvements to prepare the area for new facilities construction. No specific facilities or buildings details are currently available for this plan. 2. North Campus Early Site Development (Tier Two North Campus, Area 2, 27.6 acres [11.2 ha]) – Provide clearing, stripping, earthwork, and storm drainage improvements to prepare the area for new facilities construction. No specific facilities or buildings details are currently available for this plan. 3. Deep South Early Site Development (Tier One South Campus, 33.7 acres [13.6 ha]) – Provide clearing, stripping, earthwork, and storm drainage improvements to prepare the area for new facilities construction. No specific facilities or buildings layout and design details are currently available for this plan. 4. Deep South Early Site Development (Tier Two South Campus, 26.1 acres [10.6 ha]) – Provide clearing, stripping, earthwork, and storm drainage improvements to prepare the area for new facilities construction. No specific facilities or buildings layout and design details are currently available for this plan. 5. North Campus Parking Lot Improvement (Tier One North Campus, Area 4, 3.6 acres [1.5 ha]) – Develop a satellite automobile parking lot to serve existing facilities. Project includes site preparation, asphalt pavements, curbs, sidewalks and site lighting. No specific facilities or buildings layout and design details are currently available for this plan. 6. South Campus Temporary Storage Structure (South Campus Improvements totaling 17,220 ft^2 (1,599.8 m^2) – Construct a fabric-covered storage structure for 18 months of operation. The tent structure would be erected in the auto parking lot of the future Chemical Processing Facility. The structure would be removed before the operation of the Chemical Processing Facility building begins. The structure would be an enclosed, conditioned space and equipped with fire-protection mechanisms to meet Florida Building Code and Florida Fire Code requirements.	Future	Potential for Cumulative Effects: The Blue Origin OLS Manufacturing Complex is near the central portion of the Space Commerce District approximately 7.5 miles (12.1 km) from SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Blue Origin Exploration Park Campus Updates	Blue Origin is proposing to add several new facilities to the Orbital Launch Site (OLS) Manufacturing Complex in Exploration Park. The planned facilities include the following: • North Campus, Building E SCF (NASA ID# M6-1161) – 4,000 ft^2 (371.6 m^2) single-story building with a height of 25 ft (7.6 m). • North Campus, Hazardous Processing Area – Five structures with a maximum height of 90 feet (27.4 m) for hydrostatic and pneumatic test procedures of vehicle components and sub-assemblies. • North Campus, Building O Parking Garage – Enclosed five-story, pre-cast concrete structure with 2,300 parking spaces. The footprint would be 310 ft (94.5 m) by 435 ft (132.6 m) by 75 ft (22.9 m) high. • North Campus, Reservoir Road Widening – Expand roadway to accommodate large vehicle movements. • South Campus, Building H Lunar Production Facility – 204,700 ft^2 (19,017.3 m^2) two-story building with a height of 140 feet (42.7 m). • South Campus, Revised Building M Maintenance Support Facility – 101,250 ft^2 (9,406.4 m^2) single-story building with a height of 50 ft (15.2 m). • South Campus, Office Trailer Additions – Four temporary, 2,500 ft^2 (232.3 m^2) modular units, each with a height of 15 ft (5.6 m). A 30-ft (9.1-m) separation would be between each modular unit. The facilities would be within the Space Commerce District.	Future	Potential for Cumulative Effects: The Blue Origin OLS Manufacturing Complex is near the central portion of the Space Commerce District approximately 7.5 miles (12.1 km) from SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs.
15-Year Development Plan for the KSC Visitor Complex and Launch Complex 39 Viewing Gantry	The Proposed Action was to implement a 15-year Development Plan to attract additional visitors and immerse them in a uniquely themed, enhanced interactive environment of NASA's past and future. As part of the action, construction would occur over a 15-year period on 15 parcels totaling 312.1 acres (126.3 ha). The construction would support a projected growth of full-time staff and visitors from the existing 1.7 million in 2024 to a projected 3.3 million in 2038. A Draft Programmatic EA was released in August 2024. Impacts to land use and visual resources, transportation, utilities, air quality, biological resources, cultural resources, water resources, noise, and socioeconomics were assessed. No significant impacts were identified.	Future	Potential for Cumulative Effects: The KSC VC is approximately 7.5 miles (12.1 km) west of SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs. Cumulative impacts from operations are expected to be beneficial as the Visitor Center provides the public the opportunity to witness launches.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
Airbus US Facility Expansion Project	The development consists of Site Improvements of ±5.7 acres (2.3 ha) for the building expansion within the Space Commerce District. The work includes the following four elements: 1. Site Demolition – Remove existing parking, landscape, site lighting, etc., within and around the general footprint of the building expansion. 2. Site Preparation – Prepare ±5.7 acres (2.3 ha) of existing land for development. The work includes earthwork, grading and drainage improvements, erosion and sedimentation control, and stormwater management facilities. 3. Site Improvements – Improve ±5.7 acres (2.3 ha) of the prepared land for support of the building expansion. Improvements consist of water distribution, electrical power distribution, communications, stormwater management systems, pavements, drives, aprons, parking, sidewalks, landscaping, and site lighting. 4. Building Construction – The design of the building is in the beginning stage, requiring further input from the owner and end user. Further design elements would be provided in future submittals.	Future	Potential for Cumulative Effects: The Airbus US Facility Expansion project area is in the northeast portion of the Space Commerce District approximately 7.5 miles (12.1 km) from SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs.
SpaceX Starship-Super Heavy Operations at SLC-37	As part of the Proposed Action, SpaceX would redevelop SLC-37 at CCSFS to support Starship-Super Heavy operations, analyzing up to 76 launches and 152 landings (76 for each stage) annually. The public scoping period ended on March 22, 2024 with the draft EIS expected in summer 2025.	Future	Potential for Cumulative Effects: SLC-37 is approximately 7.5 miles (12.1 km) west of SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs. Cumulative impacts from operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Table 4-4. Past, Present, and Reasonably Foreseeable Action and Relevance to Proposed Action

Project	Project Summary	Time	Relevance
SpaceX Starship-Super Heavy Project at KSC SLC-39A	SpaceX proposes to construct launch, landing, and other associated infrastructure at and near SLC-39A to support Starship-Super Heavy operations, analyzing up to 44 launches and 88 landings (44 for each stage) annually. The public scoping period ended on June 24, 2024, with the draft EIS expected in summer 2025.	Future	Potential for Cumulative Effects: SLC-39A is approximately 7.5 miles (12.1 km) west of SLC-20. The timeline for construction is unknown, but construction overlap would likely occur, which could result in cumulative impacts to noise, air quality, and GHGs. Cumulative impacts form operations could occur. Resources carried forward for cumulative impacts analysis include noise, biological resources, cultural resources, air quality, water resources, health and safety, Section 4(f) properties, and airspace and marine transportation management.

Sources: Brevard County 2024, Canaveral Port Authority 2019, City of Cocoa Beach 2015, DAF 2025, FAA 2008, FAA 2011, FAA 2020b, FAA 2025a, FAA 2025b, FDOT 2023a, FDOT 2023b, NASA 2004, NASA 2008, NASA 2021, NASA 2022, NASA 2023, NASA 2024a, NASA 2024b, Space Florida 2024, USAF 2016, USAF 2019, USSF 2023, USSF 2024a, and USSF 2024b.

4.3.1 Noise

The construction-related projects in Table 4-4 that are carried forward into the cumulative impacts analysis, when combined with the Proposed Action, would result in a cumulative increase in noise. Typical construction equipment that would be used during the construction phases under the Proposed Action and other nearby construction includes milling machines, excavators, bulldozers, graders, asphalt pavers, material transfer vehicles, compactors/rollers, water trucks, dump trucks, forklifts, scrapers, trenchers, line-up trucks, and pickup trucks. In general, this equipment would range in noise levels from 72 to 93 dB at 50 feet (15.2 m) from its source (WSDOT 2020). The sound is expected to attenuate below Brevard County ordinance requirements before leaving the CCSFS site boundary. Additionally, all work is expected to be performed during normal business hours, and the contractor would be required to ensure that all equipment is operated in accordance with the manufacturer's specifications and equipped with noise-reducing equipment in proper condition.

Operationally, up to 164 launches could occur per year (Table 4-2) at CCSFS and up to 535 launches are predicted to occur at CCSFS between 2025 and 2028 (Table 4-3). Additionally, launches involving first-stage returns would generate noise and sonic booms. The Proposed Action would contribute to noise associated with up to 24 more additional launches per year (Table 4-2 includes the 24 launches documented in the 2020 EA). During these periods, a short-term increase in the noise level received in the community would occur, similar to other launches; however, the noise and sonic booms are consistent with the current conditions at CCSFS and KSC. Furthermore, two simultaneous launches in the ROI would never occur so launches would be separated in time, and the additional 24 launches annually from the Proposed Action would not significantly add to the noise generated from launch activities.

Considering past, present, and foreseeable actions, significant noise impacts are possible. However, the additional 24 annual launches from the Proposed Action would not substantially increase noise beyond what is already approved under NEPA, as the envelope criteria for the launch vehicles remain within the small to medium-class rockets (see Table 4-2).

4.3.2 Biological Resources

Other past, present, and future development projects have/will impact habitats and vegetation. Impacts to wetlands and protected species' habitat would be mitigated as required. All projects will require an ERP from SJRWMD and a Federal Dredge and Fill 404 Permit from USACE. These permits require mitigation compensation for unavoidable wetland loss. Additionally, all projects with potential impacts to protected species will require consultation with USFWS. This will result in required mitigation to offset any adverse impacts.

Biological resource mitigation actions discussed in Section 3.2.3 of this SEA, the BA (Appendix I), and the USFWS BO (Appendix J) would be accomplished to minimize the effects on threatened and endangered species due to the Proposed Action. The Proposed Action would result in clearing of 15.9 acres (6.5 ha) of Xeric Hammock habitat. This habitat would result in a reduction of scrub habitat acreage for future restoration. Space Florida would conduct 31.8 acres (15.9 ha) of habitat restoration at a location to be determined in consultation with USFWS as mitigation for direct impacts to Florida scrub-jay and SEBM.

Specific to prescribed burning, prescribed burning on CCSFS is required to meet listed species habitat management requirements and to reduce wildfire risk. SLD 45 typically needs between 6 and 8 days of burning to meet its annual goal of 500 acres (202.3 ha) of prescribed fire to manage habitat for listed species, including the SEBM and Florida scrub-jay. Since SLC-20 launch providers are responsible for protecting their spacecraft, flight hardware, and other critical systems from smoke, smoke restriction cannot be placed on their CCSFS facilities, equipment, or real property assets. Launches associated with the Proposed Action would not preclude a prescribed burn under suitable weather conditions. To minimize constraints on prescribed burning in the surrounding area and not put undue stress on SLD 45 Prescribed Burn Program, SLC-20 operators would coordinate with SLD 45 to deconflict operations for SLD 45 to continue to implement prescribed burning, which provides long-term positive benefits to the Florida scrub-jay.

In the event of a mishap down range over the open ocean, the expected impacts to wildlife would not be significant given the relatively low density of species within the surface waters of these open ocean areas.

When considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute a noticeable incremental impact on biological resources.

The overall cumulative effect when combined with other past, present, and reasonably foreseeable future actions on biological resources are considered minor and not significant given permitting requirements and scrub-jay/SEBM and sea turtle mitigation measures.

4.3.3 Cultural Resources

No adverse impacts to cultural resources would result from the implementation of the Proposed Action. Therefore, no potential for cumulative impacts exists when considered with other past, present, and reasonably foreseeable actions.

4.3.4 Air Quality and Climate Change

In terms of short-term cumulative impacts, the construction-related projects proposed under the Proposed Action and other regional projects listed in Table 4-4 could produce short-term additive amounts of emissions if they are concurrent. As stated in Section 3.4.3, the construction-related emissions resulting from implementing of the Proposed Action would not exceed the significance thresholds. Additionally, implementing best management practices, such as inspecting and maintaining equipment, turning off idling vehicles and equipment, using new equipment when practicable, and employing methods to reduce the generation of dust, would minimize air quality impacts during construction. Furthermore, since Brevard County is in an attainment area for all pollutants, criteria pollutant emissions related to construction activities would not result in a violation or risk Brevard County’s attainment status.

In terms of long-term cumulative impacts from launch operations, up to 164 launches could occur per year (Table 4-2) at CCSFS and up to 535 launches are predicted to occur at CCSFS between 2025 and 2028 (Table 4-3). The Proposed Action would contribute air quality impacts associated with up to 24 more additional launches per year (Table 4-2 includes the 24 launches documented in the 2020 EA). All these launches would generate air emissions. However, the air emissions associated with the Proposed Action and other present and reasonably foreseeable projects are expected to be temporary, especially considering the launch vehicles would accelerate rapidly and the high temperatures would cause the air emissions to rise and disperse with the prevailing winds.

GHG emissions during both construction and operation activities are expected to be negligible, but any emission of GHGs represents an incremental increase in global GHG concentrations. According to the World Meteorological Organization (WMO), rocket launches have a small effect (much less than 0.1 percent) on total stratospheric ozone (WMO 2022). Overall, future cumulative impacts depend on rocket design, launch vehicle sizes, launch rates, spaceport locations, and fuel types. Gaps remain in understanding rocket emissions and their combined chemical, radiative, and dynamical impacts on the global stratosphere and in projections of launch rates. Additionally, the potential cumulative impacts associated with reentering space debris are also not well understood (WMO 2022). Although some level of cumulative impact associated with space industry emissions is likely, more research is needed to determine whether the impacts are significant.

When considered with other past, present, and foreseeable future actions and using best available information, the Proposed Action would have no significant impact on air quality, GHG emissions, or climate change.

4.3.5 Transportation

In terms of short-term cumulative impacts, the construction-related projects proposed under the Proposed Action and other regional projects listed in Table 4-4 could produce short-term increases in the number of vehicles on regional and local roadways. As Section 3.5.2 states, the construction-related trips resulting from implementing the Proposed Action would be negligible due to the scope and duration of the construction activities.

Regarding long-term cumulative impacts from launch operations, most of the vehicle assembly would occur at Exploration Park or off site, and the existing transport routes were designed to FDOT standards. To reduce any slow-paced traffic effects during the no more than 48 launches per year, vehicle transport would be scheduled during off-hours to avoid peak-flow periods.

When considered with other past, present, and foreseeable future actions and using the best available information, the Proposed Action would have no significant impact on transportation.

4.3.6 Water Resources

Other past, present, and future development projects have/will impact water resources. For example, the Blue Origin Orbital Launch Site was estimated to impact 8.3 acres (3.4 ha) of primary wetlands; the ER Planning and Infrastructure Development was estimated to impact up to 20 acres (8.1 ha) of wetlands, 1 acre (0.4 ha) of surface waters, and 240 acres (97.1 ha) of the 100-year floodplain; and the Relativity Terran R Launch Program was estimated to impact approximately 1.6 acres (0.6 ha) of wetlands. The Proposed Action would result in the permanent filling of up to 0.95 acre (0.4 ha) of wetlands and up to 21.8 acres (8.8 ha) of floodplain would be filled.

Before any work within wetlands and surface waters, a CWA Section 404 permit and a State of Florida ERP would be obtained. Regulatory agency-approved compensatory mitigation of impacted wetlands would be provided by purchasing mitigation credits from a nearby mitigation bank and/or wetland restoration efforts, as required by the permit conditions. As discussed in Section 2.2, based on the reasonable alternative screening factors and meeting the purpose and need for the Proposed Action, only the Proposed Action was considered to be reasonable. Therefore, no practicable alternative exists to completely avoid ,or otherwise not affect, wetlands. Practicable measures to avoid and/or minimize harm to wetlands would be implemented during the design process to reduce wetland effects where feasible. The effects to wetlands would be small and mitigated during permitting. Cumulative loss of wetlands would reduce the ability of the land to absorb stormwater. However, to minimize cumulative impacts, pad water collection ponds would be constructed to serve as a stormwater management system (SMS).

Although the Proposed Action would involve constructing impervious surfaces within the 100-year floodplain, the Proposed Action provides for the fewest adverse effects to floodplains while meeting the purpose and need of the Proposed Action (Table 2-1).

Constructing new impervious surfaces associated with the proposed SLC-20C, common use infrastructure at SLC-20A and SLC-20B, and roads would require an SJRWMD permit that would require an SMS to treat and store stormwater based on the proposed site development (Table 2-1). This SMS would store and treat stormwater generated from site improvements to pre-development quality and would be operated and maintained by Space Florida or the tenant. The SMS would store and filter much of the suspended solids out of the water percolating into the ground, and biological and chemical processes in the SMS would reduce the contaminants found in runoff and minimize pollutants that infiltrate into the water table. Stormwater would infiltrate into the surficial aquifer and would not be discharged to downstream surface waters. When considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute a noticeable incremental impact on water resources. As a result, the overall cumulative effect, when combined with other past, present, and reasonably foreseeable future actions on water resources, is not significant.

4.3.7 Health and Safety

Similar to all other launch and hazardous operations at CCSFS and KSC, the Proposed Action must account for public safety distances and may require periodic road closures. Road closures are not expected to be required for engine test periods. Similar to other launch vehicle providers at CCSFS and KSC who periodically close roads to ensure public safety, Space Florida would implement engineering design controls to limit impacts of payload processing so that road closures would be avoided. Coordination would be developed to minimize impact when considered in context with other CCSFS clients. The Proposed Action does not require transportation mitigation measures beyond that of similar launch activities that occur at CCSFS or KSC.

Space Florida tenant(s) will follow the existing rigorous launch safety certification process and will be required to gain a launch license from FAA, both of which would require a detailed public safety risk assessment to ensure that safety impacts to the public meet all applicable standards. Public clear distances to be implemented on launch days would be limited to CCSFS. Over time, this impact is expected to be no greater than current launch operations at CCSFS. The Proposed Action would not result in a substantial increase in potential impacts to health and safety of the public.

When considered with other past, present, and foreseeable future actions, the Proposed Action does not significantly impact health and safety.

4.3.8 Section 4(f) Properties

No designated Section 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of the Proposed Action or CCSFS. MINWR and CNS within KSC boundaries are considered Section 4(f) properties and are north of CCSFS. The nearest public park to the south of CCSFS, Jetty Park, is about 5 miles (8 km) south of SLC-20 in the City of Cape Canaveral. Other public parks within an approximate 15-mile (24.1-km) radius of the Proposed Action include Kelly Park, KARS Park, Kings Park, and Manatee Cove Park.

The construction associated with the Proposed Action would have no effect on Section 4(f) properties. Section 4(f) properties within an approximately 15-mile (24.1-km) radius of SLC-20 would experience temporary operation-related noise as a result of launches. All pre-launch operations and effects would occur within or very close to the boundaries of SLC-20A, SLC-20B, or SLC-20C. Launch vehicles would be launched from SLC-20 and accelerate over the Atlantic Ocean and away from Section 4(f) lands. The increased noise level would only last a few minutes in the vicinity of SLC and would occur up to 48 times a year.

As previously discussed, MINWR was established as an overlay of KSC and the primary purpose of the lands and waters of KSC is to support the space program. Since KSC and CCSFS have historically been associated with operational launch noise, KSC, CCSFS, USFWS, and NPS continue to work together to balance space flight operations and protection of natural resources within Section 4(f) properties. Although a cumulative increase in operational launch noise would occur, launches would accelerate over the Atlantic Ocean and away from Section 4(f) properties resulting in only a temporary exposure to noise. As a result, the Proposed Action, when combined with other past, present, and reasonably foreseeable launches at CCSFS, would not substantially diminish use of the protected activities, features, or attributes of any of the Section 4(f) properties identified and would not result in substantial impairment of the properties. Therefore, the Proposed Action would not be considered a constructive use of these Section 4(f) properties, would not invoke Section 4(f) of the DOT Act, and would not result in significant cumulative impacts to Section 4(f) properties.

4.3.9 Airspace and Marine Transportation Management

The construction at SLC-20 would have no effect on airspace management or marine transportation management; therefore, no potential for cumulative impacts for this resource category exists.

Operationally, up to 164 launches could occur per year (Table 4-2) at CCSFS and up to 535 launches are predicted to occur at CCSFS between 2025 and 2028 (Table 4-3). The Proposed Action would contribute to noise associated with up to 24 more additional launches per year (Table 4-3 includes the 24 launches documented in the 2020 EA). All these launches would require temporary closures of existing airspace and navigable waterways. However, advanced notice via NOTAMs and NOTMARs would allow general aviation pilots and mariners to anticipate temporary disruptions to flight and marine activities during launch operations. In addition, the use of SDI and SOLAR would also minimize impacts to pilots and mariners. Launch operations would be scheduled in advance, short in duration, and would not include recovering the first stage. Therefore, the overall cumulative effect, when combined with other past, present, and reasonably foreseeable future actions on airspace management and marine transportation management would not be significant.

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6.0 LIST OF PREPARERS

Table 6-1 lists the individuals who provided details, data, or analyses and who prepared this document.

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Appendix A

Representative Scoping Letter and Scoping Letter Mailing List

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FINAL DRAFT

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

April 10, 2023

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

Stacy Zee, Manager
Operations Support Branch
Office of Commercial Space Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591
Stacey.zee@faa.gov

Dear Ms. Zee,

The United States Space Force (USSF) is preparing a Supplemental Environmental Assessment (SEA) to evaluate potential environmental impacts associated with the construction and operation of a new launch pad in the northern end of the Space Launch Complex 20 (SLC-20) boundary to support small-lift vehicles, as well as the construction of common use infrastructure at the existing SLC-20 central pad, and the transportation of vehicles stages from Exploration Park and offsite payload processing facilities. A location map (Figure 1) is attached for your reference. This SEA is a supplement to the October 2020 *Environmental Assessment (EA) for the Reconstitution and Enhancement of SLC-20 Multi-User Launch Operations at Cape Canaveral Space Force Station (CCSFS)*. The purpose of the Proposed Action is to provide multiple launch pads for commercial users in support of Space Florida's Cape Canaveral Spaceport Master Plan in accordance with Florida Statutes Section 331. Space Florida must meet current and future commercial, national, and state space transportation requirements through expansion and modernization of space transportation facilities within its Spaceport territories. The territories include, but are not limited to, areas within CCSFS. The Proposed Action is needed because there is a growing demand for launching small-lift launch vehicles by commercial users; therefore, the Proposed Action will provide Space Florida the ability to grow within their current SLC-20 leased boundary to meet that need.

The SEA 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 will also be examined when combined with past, present, and future (reasonably foreseeable) actions.

USSF is the lead federal agency and is preparing this SEA in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (Title 42 of the United States Code 4321–4347), the Council on Environmental Quality regulations for implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500–1508), United States Air Force (USAF) Environmental Impact Analysis Process (EIAP) (32 CFR Part 989), and Federal Aviation Administration (FAA) Order 1050.1F, Environmental Impacts: Policies and Procedures. The purpose of a NEPA analysis is to ensure full disclosure and consideration of environmental information in federal agency decision making. Due to jurisdiction and special expertise related to the Proposed Action, the National Aeronautics and Space Administration (NASA), FAA, and United States Coast Guard (USCG) are cooperating agencies in the development of the SEA.

As part of the USAF EIAP, we request your input on the Proposed Action and assistance in identying 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 taylor.janise.1@spaceforce.mil or via mail at Taylor Janise, 45 CES/CEIE, 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 within 30 days of receipt of this letter. Thank you in advance for your assistance in this effort.

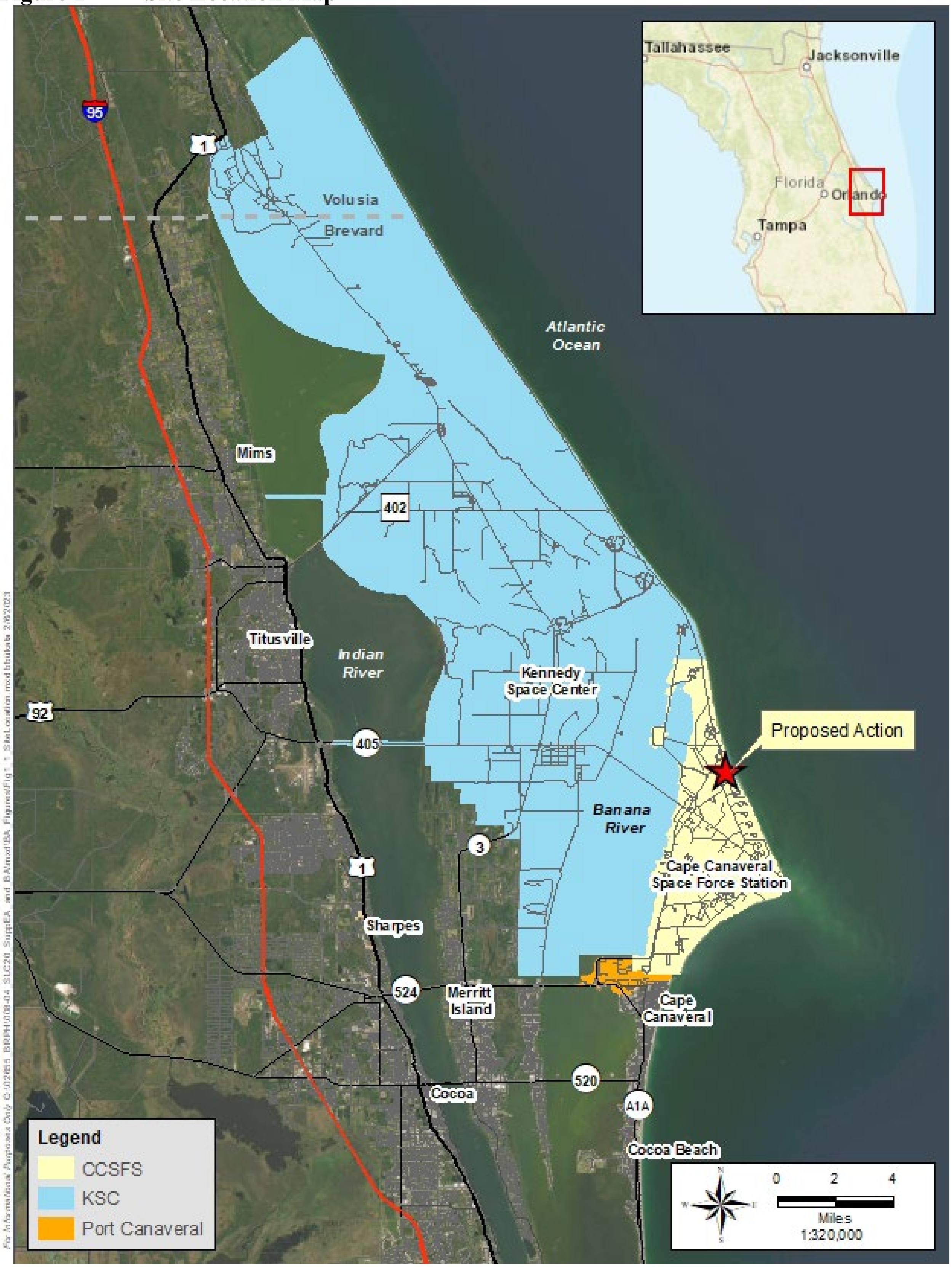
Sincerely,

MICHAEL BLAYLOCK, NH-03, DAF
Chief, Environmental Conservation

Attachment:
Figure 1. Location Map

FINAL DRAFT

Figure 1 Site Location Map



FINAL DRAFT

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City of Titusville	Consulting Agency	Larese	Scott	City Manager	321-567-3702	virginia.blacylock@titusville.com	PO Box 2806	Titusville	FL	32781
City of Cape Canaveral	Consulting Agency	Morley	Todd	City Manager	321-205-4122	citymanager@cityofcapecanaveral.org	100 Polk Ave.	Cape Canaveral	FL	32920
East Central Florida Regional Planning Council	Consulting Agency	McCue, AICP	Tara	Executive Director	407-245-0300	tara@ecfrpc.org	455 N. Garland Ave., Fourth Floor	Orlando	FL	32801
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FDEP Florida State Clearinghouse	Consulting Agency	Stahl	Chris	Clearinghouse Coordinator	850-717-9076	Chris.Stahl@dep.state.fl.us	2600 Blair Stone Road, MS 47	Tallahassee	FL	32399
Florida Department of Transportation	Consulting Agency	Tyler	John	District 5 Secretary	386-943-5477	john.tyler@dot.state.fl.us	719 South Woodland Boulevard	DeLand	FL	32720
					COURTESY COPY:	Sarah.VanGundy@dot.state.fl.us; Jesse.Blouin@dot.state.fl.us; William.Walsh@dot.state.fl.us; Kellie.Smith@dot.state.fl.us				
Florida Division of Historical Resources	Consulting Agency	Slade, Lotane	Alissa	State Historic Preservation Officer and Director of Historical Resources	850-245-6300	alissa.lotane@DOS.MyFlorida.Com	Bureau of Historic Preservation R.A. Gray Building 500 South Bronough Street	Tallahassee	FL	32399-2590
	COURTESY COPY:	Chase	Kelly	Compliance Review	850.245.6342	kelly.chase@dos.myflorida.com	Bureau of Historic Preservation R.A. Gray Building 500 South Bronough Street	Tallahassee	FL	32399-2590
Merritt Island National Wildlife Refuge	Consulting Agency	Penn	Tom	Refuge Manager	321-861-0667	tom_penn@fws.gov; MerrittIsland@fws.gov	PO Box 2683	Titusville	FL	32781
	COURTESY COPY:	Keith	Ramos	Project Leader	207-436-0000	keith_ramos@fws.gov				
NASA KSC	Cooperating Agency	Thorpe	David	Master Planner	321-867-2530	david.b.thorpe@nasa.gov		NASA Kennedy Space Center	FL	
	COURTESY COPY:	Dankert	Don	Environmental Planning Lead	321-861-1196	donald.j.dankert@nasa.gov				
National Parks Service Canaveral National Seashore	Consulting Agency	Kneifl	Kristen	Chief of Resource Management	321-267-1110 x14	kristen_kneifl@nps.gov	Canaveral National Seashore 212 S. Washington Ave.	Titusville	FL	32796
	COURTESY COPY:	Waldbuesser	Cinda	Superintendent	321-504-8833	Cinda_Waldbuesser@nps.gov	Canaveral National Seashore 212 S. Washington Ave.	Titusville	FL	32796
		West	Ben	Regional NEPA Office		Ben_West@nps.gov				
National Marine Fisheries Service Habitat Conservation Division Essential Fish Habitat	Consulting Agency	Wilber	Pace	Branch Chief		pace.wilber@noaa.gov	Southeast Regional Office, Habitat Conservation Division, 263 13th Avenue South	St. Petersburg	FL	33701-5505
	COURTESY COPY:	Wunderlich	Mary	Protected Resources Division ESA Section 7 Coordinator	727-209-5985	Mary.Wunderlich@noaa.gov	Southeast Regional Office, Protected Resources Division, 263 13th Avenue South	St. Petersburg	FL	33701-5505
Space Coast Transportation Planning Organization (TPO)	Consulting Agency	Kraum	Sarah	Senior Transportation Planner	321-690-6890	sarah.kraum@brevardfl.gov	2725 Judge Fran Jamieson Way; Building B; Room 105 MS #82	Melbourne	FL	32940
Space Florida	Consulting Agency	Szabo, PE	Steve	Director of Planning and Development	321-730-5301 x107	sszabo@spaceflorida.gov	505 Odyssey Way, Suite 300	Exploration Park	FL	32953
	COURTESY COPY:	Eggert	Pete	Vice President, Environmental Health and Safety	321-266-9020	PEggert@spaceflorida.gov				
St. Johns River Water Management District	Consulting Agency	Prather	Jeff	Division Director, Regulatory Services	321-676-6609	jprather@sjrwmd.com	525 Community College Parkway, SE	Palm Bay	FL	32909
US Space Force SLD 45	Lead Federal Agency	Blaylock	Michael	Chief, Environmental Conservation	321-853-0964	michael.blaylock.4@spaceforce.mil	1224 Juniper Street, MS 9125	Patrick Space Force Base	FL	32925
US Army Corps of Engineers	Consulting Agency	Palmer	John	Section Chief	321-504-3771 x12					
US Fish and Wildlife Service, Florida Ecological Services Office	Regulatory Agency				904-731-3195	FW4FLESRegs@fws.gov				
	COURTESY COPY:	Meyers	Brendan	Regulatory Biologist		brendan_myers@fws.gov				
US Coast Guard	Cooperating Agency	Springer	Laura			Laura.M.Springer@uscg.mil				
	COURTESY COPY:	Smith	Urdley			Urdley.N.Smith@uscg.mil				
		Chong	Creighton			Creighton.C.Chong@uscg.mil				
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US Navy	Cooperating Agency	Mack	Jamiyo	Strategic Systems Programs Environmental Program Manager		Jamiyo.Mack@ssp.navy.mil				
	COURTESY COPY:	Fedinatz	Kimberly	Associate Counsel Strategic Systems Programs		Kimberly.Fedinatz@SSP.NAVY.MIL				
		Kobischen	Jenna			jenna.d.kobischen.civ@us.navy.mil				
		Clayton	Adonna	NEPA Planner NAVFAC SE, NAS Jacksonville		adonna.n.clayton.civ@us.navy.mil				
		Smith	Robert	Navy Region Southeast Planning and Conservation Branch Chief	904-542-6313 301-904-1525	robert.j.smith1384.civ@us.navy.mil				
		Kalin	Robert	U.S. Fleet Forces Environmental Team USFF Operations/Environmental Program Coordinator SAIC Contractor Support	904-534-6723	robert.e.kalin.ctr@us.navy.mil				
		Crispen	Carol	NOTU		Carol.Crispen@SSP.NAVY.MIL				
		Beck	Dr. Sidney	NOTU Chief Engineer	321-853-1200	Sidney.Beck@ssp.navy.mil				
Tribes										
Miccosukee Tribe of Indians of Florida	Tribes	Donaldson	Kevin	Environmental Specialist	305-223-8380 x2246	kevind@miccosukeetribe.com	Tamiami Station, PO Box 440021	Miami	FL	33144
Seminole Nation of Oklahoma	Tribes	Yahola	Ben	THPO	405-257-7200	Davidleefrank@gmail.com	P.O. Box 1498	Wewoka	OK	74884
Seminole Tribe of Florida	Tribes	Backhouse, PhD	Paul	Senior Director, THPO	863-983-6549 x12244	paulbackhouse@semtribe.com	30290 Josie Billie Highway, PMB 1004	Clewiston	FL	33440
Seminole Tribe of Florida	Tribes	Cancel	Juan	Deputy THPO	863-983-6549 x12245	juancancel@semtribe.com;	30290 Josie Billie Highway, PMB 1004	Clewiston	FL	33440
Seminole Tribe of Florida	Tribes	Simon	Danielle	Compliance Review Supervisor	863-983-6549	daniellesimon@semtribe.com				
Seminole Tribe of Florida	Tribes			THPO Compliance	863-983-6549	thpocompliance@semtribe.com				
Seminole Tribe of Florida	Tribes	Osceola	Tina	THPO Compliance	863-983-6549	TinaOsceola@semtribe.com				

Appendix B

Notice of Availability

(To be Included at a Future Date)

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Appendix C

Notice of Availability Emails

(To be Included at a Future Date)

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Appendix D

SEA Public Comments

(To be Included at a Future Date)

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Appendix E

Florida Clearinghouse Correspondence

(To be Included at a Future Date)

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Appendix F

SLC-20 North Vehicle Enveloping Recommendations Technical Memorandum

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Kimley»Horn

Technical Memorandum

To:	Priyanka Valletta, PE Project Manager BRPH
From:	Brian Gulliver Project Manager Kimley-Horn
Date:	5/11/2022
Subject:	LC-20 North Vehicle Enveloping Recommendations – Rev 1

<u>**Executive Summary**</u>

Kimley-Horn conducted an evaluation of small class launch vehicles with potential to operate from a proposed Launch Complex 20 North (LC-20 North). The goal of the evaluation was to identify enveloping criteria to support the environmental review for proposed launch site developments at LC-20 North. The potential small launch vehicles evaluated are provided in Table 1. The following recommended envelope criteria were determined based on data collected from each candidate:

- While most vehicles identified utilize Liquid Oxygen (LOX) and Kerosene (RP-1) propulsion systems, Kimley-Horn recommends the following propellant combinations be evaluated:
  - LOX / RP-1
  - LOX / RP-X
  - LOX / Liquified Natural Gas (LNG)
  - Solid-fueled (HTPB)
- Kimley-Horn recommends the following propellants and quantities be considered for storage on site:
  - LOX: 50,000 gallons
  - LNG: 15,000 gallons
  - RP-1: 25,000 gallons
  - RP-X: 5,000 gallons
- Kimley-Horn recommends that an Explosive Site Plan be developed with two operational Inhabited Building Distance (IBD) values. The first should be 1,250 ft which allows approximately 75% of the small class vehicles evaluated to be supported at LC-20 North without impacting adjacent operations at LC-20 Central. The second is and IBD of 1,423 ft which provides the additional ability to support small class launch vehicles with a Net Explosive Weight (NEW) up to 45,000 lbs and provides additional flexibility for the site without restricting adjacent operations at the LC-20 Central HIF during on-pad wet dress rehearsals at LC-20 North.

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- Many of the potential small class launch vehicle systems utilize mobile infrastructure and need minimal pad infrastructure.
- Some small class launch vehicles analyzed require permanent launch pad and support infrastructure.
- Kimley-Horn recommends the maximum vehicle envelope includes the following parameters:
    - Max. Height: 120 ft
    - Max. Diameter: 13 ft
    - Max. Gross Liftoff Weight: 300,000
- Kimley-Horn recommends the following permanent infrastructure be provided:
    - Elevated launch pad and transportation route
    - Horizontal integration facility (HIF)
    - Concrete pads for propellant storage tanks (oxidizers / fuels)
    - Lightning protection system
    - Access roads
    - Pad lighting
    - Power, data, communications, basic pad water system
    - Pad water collection ponds
- Optional recommended infrastructure includes:
    - Sound suppression and deluge water
- While some launch vehicles systems may desire launch azimuths that extend outside the standard Eastern Range launch sector, Kimley-Horn recommends aligning the proposed launch azimuths from LC-20 North with current launch azimuths for the Eastern Range.
- Some potential users are proposing launch rates between once per month and once per week. Kimley-Horn recommends that a weekly launch cadence up to 52 launches per year be considered with a distribution of 46 liquid propellant vehicle launches and 6 solid propellant vehicle launches per year.
- Kimley-Horn recommends that the following vehicles be used to develop an environmental envelope for liquid and solid propellant launch vehicles in accordance with the number of anticipated annual launches for each.
    - Liquid Propellants
        - Max LOX/RP-1 Vehicle with 225,000 lbs of propellant
        - Max LOX/RP-X Vehicle with 45,000 lbs of propellant
        - Max LOX/LNG Vehicle with 45,000 lbs of propellant
    - Solid Propellants
        - Athena 2 with approximately 245,000 lbs of HTPB

1. Evaluation Process

Kimley-Horn was tasked with conducting initial market research to characterize envelope criteria for potential small class launch vehicles capable of operating from a new proposed launch site at Launch Complex 20 North (LC-20 North). Most of the market research was conducted using data from public domain sources.

Market research conducted included:

- Identification of operational small class launch vehicles;
- Identification of developmental small class launch vehicles;
- Identification of historical small class launch vehicles;
- Launch vehicle parameters (height, mass, diameter);
- Launch vehicle propellant combinations;
- Explosive siting considerations;
- Permanent infrastructure requirements; and
- Launch azimuth envelope.

2. Identification of Small Class Launch Vehicles

Kimley-Horn evaluated 15 small class launch vehicles (see Table 1) and categorized them by program status; Active, In Development, and Historical. A hypothetical vehicle was also included to provide maximum enveloping small class vehicle parameters. Of the 15 vehicles, two (2) vehicles were identified as "Active", and eight (8) as "In Development". Historical data from five (5) vehicles that are no longer actively launching has also been included.

Table 1. Potential Small Class Launch Vehicles (Approximate)

Launch Vehicle	Program Status	Height (ft)	Diameter (ft)	GLOW (lb)
Rocket Lab (Electron)	Active	56	4	27,600
Astra (Rocket 3.3)	Active	44.4	4.3	26,745
Firefly (Alpha)	In Development	95	6	119,000
Relativity Space (Terran 1)	In Development	115.4	7.5	90,000
ABL Space (RS 1)	In Development	88	6	94,500
Phantom Space (Laguna)	In Development	67.3	6.6	111,000
Phantom Space (Daytona)	In Development	61.4	4.1	41,000
BluShift (Red Dwarf)	In Development	78	3.3	10,000
Vaya (Dauntless)	In Development	115	8	260,000
Space X (Falcon 1)	Historical	70	5.6	62,000
Minotaur(I)	Historical	63	5.3	79,800
Athena 1	Historical	65	7.8	152,500
Taurus	Historical	89	7.8	161,000
Athena 2	Historical	95	7.8	272,600

3. Launch Vehicle Propellant Combinations

Most of the small class launch vehicles evaluated use liquid propellants, with some using solid propellants and two using a solid/liquid hybrid propellant combination. Vehicle propellants combinations are listed in Table 2 and Table 3. Only the liquid and solid propellant combinations were caried forward due to limited information being available on the proprietary hybrid rocket motors for two of the systems.

4. Explosive Siting Considerations

Using the vehicle Gross Liftoff Weights (GLOW) and the guidance in DESR 6055.09, Edition 1, an approximate Net Explosive Weight (NEW) was calculated for each vehicle. The estimated NEW was used to estimate an Inhabited Building Distance (IBD), a Public Traffic Route Distance (PTRD), and Intraline Distance (ILD) for each vehicle. Launch vehicles with a NEW less than or equal to 30,000 lbs requires a IBD of 1,250 ft and a PTRD of 750 ft, which accounts for approximately 75% of the liquid vehicles analyzed in this study, which are retained in Table 2.

Based on conversations with Space Launch Delta 45, guidance was provided that DoD currently treats unique propellant combinations (such as LOX/RP-X, LOX/LNG, and Hybrids) as 100% NEW of HD 1.1. This approach generates much larger safety distances for some propellant combination than an equivalent propellant weight of LOX/RP-1. For the purposes of this study RP-X is also known as Exxsol D40. Four launch systems, shown in Table 3, were excluded for further consideration due to their unique propellant combinations or large IBD. Prior to construction of infrastructure at LC-20 North, Space Launch Delta will need to prepare a DDESB approved explosive site plan for the facility.

Table 2. Launch Point – Explosive Siting Considerations (Estimated)

Launch Vehicle	Propellant type	NEW Equivalence	HD	NEW[1,2] (lbs)	IBD (ft)	PTRD (ft)	ILD (ft)
Rocket Lab (Electron)	LOX / RP-1	20%	1.1	5,000	1,250	750	308
Phantom Space (Daytona)	LOX / RP-1	20%	1.1	7,000	1,250	750	344
Space X (Falcon 1)	LOX / RP-1	20%	1.1	11,000	1,250	750	400
ABL Space (RS 1)	LOX / RP-1	20%	1.1	17,000	1,250	750	463
Phantom Space (Laguna)	LOX / RP-1	20%	1.1	20,000	1,250	750	489
Firefly (Alpha)	LOX / RP-1	20%	1.1	21,000	1,250	750	497
Astra (Rocket 3.3)	LOX / RP-X	100%	1.1	24,000	1,250	750	519
Minotaur I	Solid	100%	1.3	72,000	270	270	182
Athena 1	Solid	100%	1.3	137,000	333	333	227
Taurus	Solid	100%	1.3	145,000	339	339	232
Athena 2	Solid	100%	1.3	245,000	403	403	281

[1] NEW values are approximate.
[2] Solid propellant NEW is estimated as 90% of vehicle GLOW based off public data.

Table 3. Explosive Siting Considerations for Excluded Launch Systems

Launch Vehicle	Propellant type	HD	NEW[1] (lbs)	IBD (ft)	PTRD (ft)	ILD (ft)
BluShift (Red Dwarf)	Hybrid (Solid/N2O)	1.1	9,000	1,250	750	374
Relativity Space (Terran 1)	LOX / LNG	1.1	81,000	1,731	1,038	779
Vaya (Dauntless)	Solid / C3H6 / LOX	1.1	234,000	3,033	1,820	1,109
[1] NEW values are approximate.						

Based on a preliminary planning study conducted by BRPH for LC-20, it has been estimated that a proposed launch point could be located approximately 1,425 ft from the LC-20 Central HIF therefore a maximum NEW of 45,000 lbs of HD 1.1 and 245,000 lbs of HD 1.3 is proposed for LC-20 North (see Table 4). This represents maximum propellant quantities and combinations for fueled vehicles at the LC-20 North pad to be included in the environmental analysis. Users that exceed these maximums will need to submit specific propellant requirements for separate environmental and explosive siting analysis.

Table 4. Launch Point – Max Explosive Siting Considerations for LC-20 North (Estimated)

Launch Vehicle	Propellant Mass (lbs)	HD	NEW[1] (lbs)	IBD (ft)	PTRD (ft)	ILD (ft)
Max LOX / RP-1	225,000	1.1	45,000	1,423	854	640
Max LOX / RP-X	45,000	1.1				
Max LOX / LNG	45,000	1.1				
Max Solid (Athena 2)	245,000	1.3	245,000	403	403	281
[1] Solid propellant NEW is estimated as 90% of vehicle GLOW based off public data.						

Table 5 provides propellant volume estimates based on maximum propellant weights from the maximum vehicles listed in Table 4. A proposed maximum storage quantity was calculated to support two (2) missions of the vehicles and includes a percent of margin to be retained in the tanks. While the storage quantities were calculated based on the maximum used by two flights of a larger vehicle, even more missions could be supported for smaller vehicles that use lower quantities of propellants.

Table 5: Estimated Propellant Volumes

Propellant Type	Density (lb/gal)	Max 1 Mission Qty (gal)	Max 2 Mission Qty (gal)	Proposed Max Storage Qty (gal)[1]
LOX	9.5	17,500	35,000	50,000
LNG	3.5	5,000	10,000	15,000
RP-1	6.8	10,000	20,000	25,000
RP-X	6.4 (est.)	2,000	4,000	5,000
[1] ~30% margin for Cryogenic Propellants, ~10% margin for other liquid propellants				

Table 6: Propellant Storage – Explosive Siting Considerations

Propellant Type	Proposed Max Storage Qty (gal)	Max Allowable (gal)	IBD (ft)	PTRD (ft)	ILD[1] (ft)
LOX	50,000	Unlimited	100	100	100
LNG	12,000	70,000	25	25	25
RP-1	25,000	100,000	25	25	25
RP-X[2]	5,000	100,000	25	25	25

[1] Unprotected ILD.
[2] Storage of RP-X is assumed to be treated similarly to RP-1 and other Kerosene's.

5. Infrastructure Considerations

As depicted in Table 2 approximately 75% of the vehicles have an IBD of 1,250 ft or less, while Vaya Dauntless has an IBD greater than 3,000 ft. To minimize operational impacts to adjacent pads, a future launch point location should be placed a minimum of 1,423 ft from the HIF at the LC-20 Central pad.

Kimley-Horn recommends that a hypothetical vehicle with a maximum height of 120 ft, maximum diameter of 13 ft, and maximum weight of 300,000 lbs be utilized for planning purposes. Infrastructure and vehicle transport requirements should be based on this envelope. Some systems evaluated utilize mobile infrastructure and other require dedicated launch infrastructure. Table 7 provides assumed launch infrastructure requirements for the range of launch systems evaluated. The assumptions are based on publicly available information and is approximate. Actual vehicle / program requirements may be different.

Table 7: Permanent Infrastructure Expectations (Assumed)

	Permanent Infrastructure						
Launch Vehicle	Integration Approach	Integration Orientation	Propellant Storage	Launch Mount	Umbilical Tower	Flame Deflector	Mobile Service Tower
Rocket Lab (Electron)	ITL	Horizontal	Fixed	Mobile	Mobile	Custom	No
Astra (Rocket 3.3)	ITL	Horizontal	Mobile	Mobile	Mobile	None	No
Phantom Space (Daytona)	ITL	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Space X (Falcon 1)	ITL	Horizontal	Fixed	Mobile	Fixed	Unknown	No
ABL Space (RS 1)	ITL	Horizontal	Mobile	Mobile	Mobile	Mobile	No
Phantom Space (Laguna)	ITL	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Firefly (Alpha)	ITL	Horizontal	Fixed	Mobile	Mobile	Fixed	No
Minotaur I	BOP	Vertical	None	Fixed	Mobile	Fixed	Yes
Athena 1	BOP	Vertical	None	Fixed	Fixed	Fixed	Yes
Taurus	BOP	Vertical	None	Fixed	Mobile	None	No
Athena 2	BOP	Vertical	None	Fixed	Fixed	Fixed	Yes

All vehicles will require lightning protection pursuant to 14 CFR § 420.71.

Kimley-Horn recommends that the following shared-use infrastructure be provided as most programs can benefit from some shared common use infrastructure at LC-20.

- Elevated launch pad and transportation route
- Horizontal Integration Facility (HIF)
  - 2 High Bays with connected office space
  - Planning footprint 100 ft wide x 200 ft long.
  - Actual building footprint may be smaller based on design
- Concrete pads for propellant storage tanks (oxidizers / fuels)
- Lightning protection system
- Access roads
- Pad lighting
- Power, data, communications, basic pad water system
- Pad water collection ponds

It is recommended that vehicle specific dedicated infrastructure, such as fixed propellant storage and loading systems, flame deflectors, sound suppression systems, fixed umbilical towers, and mobile service structures be supplied by a vehicle operator at a later time.

Operational Launch Rate

Some potential users are proposing launch rates between once per month and once per week. Kimley-Horn recommends that a weekly launch cadence up to 52 launches (46 liquid and 6 solid propellant) per year be considered from an impact analysis standpoint. It is anticipated the launch cadence will ramp up over a period of 5 years before reaching a weekly tempo.

Envelope Criteria for Noise

For the operational launch rate described above, Kimley-Horn recommends that the following vehicles be used for noise analysis.

Liquid Propellant Vehicle: Max LOX/RP-1 Vehicle with 225,000 lbs of propellant.
Solid Propellant Vehicle: Athena 2 with ~245,000 lbs of HTPB

Envelope Criteria for Air Quality

For the operational launch rate described above, Kimley-Horn recommends that the following vehicles be used for air quality analysis. For the liquid vehicles, all three configurations should be analyzed to determine the worst-case scenario.

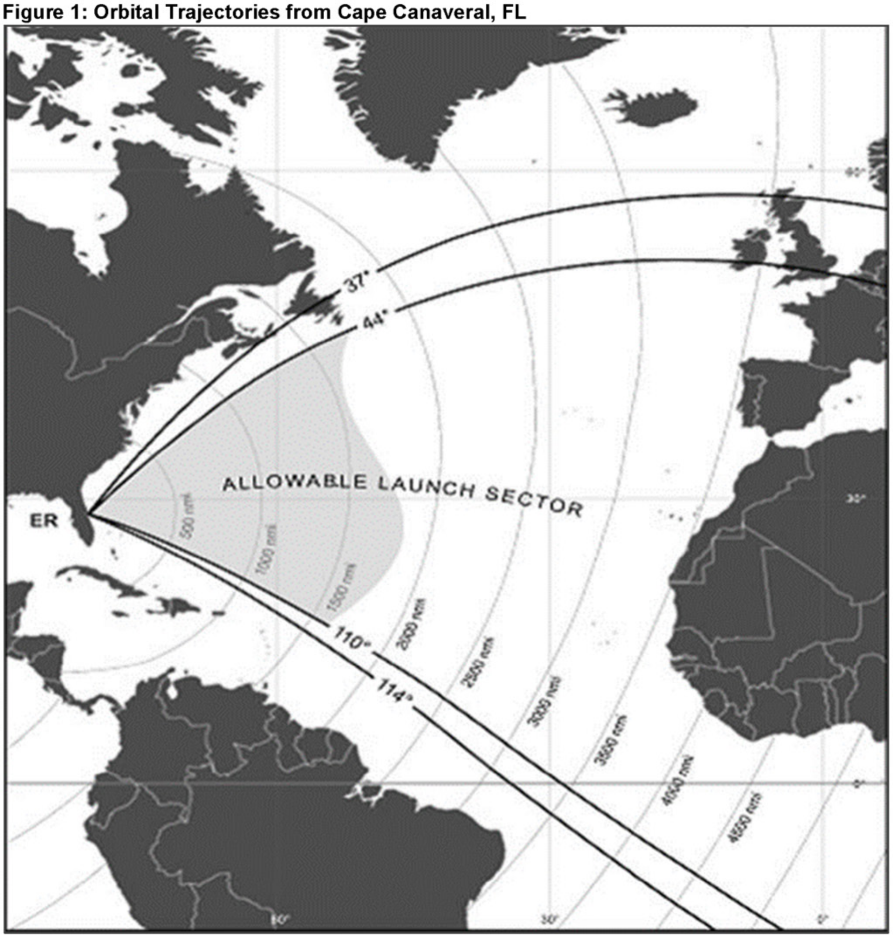
Liquid Propellant Vehicles:
- Max LOX / RP-1 Vehicle with 225,000 lbs of propellant.
- Max LOX / RP-X Vehicle with 45,000 lbs of propellant.
- Max LOX / LNG Vehicle with 45,000 lbs of propellant.

Solid Propellant Vehicle: Athena 2 with ~245,000 lbs of HTPB

Launch Trajectories from LC-20 North

Launch trajectories from LC-20 North would be limited by the range for which undue hazard to populated areas is minimized for spaceflight originating from Cape Canaveral, Florida. Standard limitations for this area identify allowable launch azimuths from 44 degrees to 110 degrees. The launch azimuths are depicted below in Figure 1 and align with what is identified for the eastern range in the AFSPCMAN 91- 710 Volume 1, *Range Safety User Requirements Manual, Air Force Space Command Range Safety Policies and Procedures.*

Figure 1: Orbital Trajectories from Cape Canaveral, FL



Source: AFSPCMAN 91- 710 Volume 1, November 2016

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Appendix G

BRRC Noise Study for Small-Class Launch Vehicle Operations at SLC-20C

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FINAL DRAFT

Blue Ridge Research and Consulting, LLC

BRRC Report 23-12 (Final)

Noise Study for Small Class Launch Vehicle Operations at SLC-20C

5 June 2023 (Rev 2, 13 February 2025)

Prepared for:
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Prepared by:
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Michael James, M.S.

Contract Number:
IPO-005

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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
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
SLC-20C	Space Launch Complex 20C

1 INTRODUCTION

This report documents the noise study performed as part of Kimley-Horn's efforts on the Environmental Assessment (EA) for proposed small class launch vehicle (SCLV) operations at Cape Canaveral Space Force Station (CCSFS) Space Launch Complex 20C (SLC-20C). Figure 1 shows the locations of the SLC-20C launch site at CCSFS. Space Florida plans to support 24 liquid- and/or solid-fueled SCLV launch operations per year with a maximum sea level thrust of approximately 410,000 lbf.

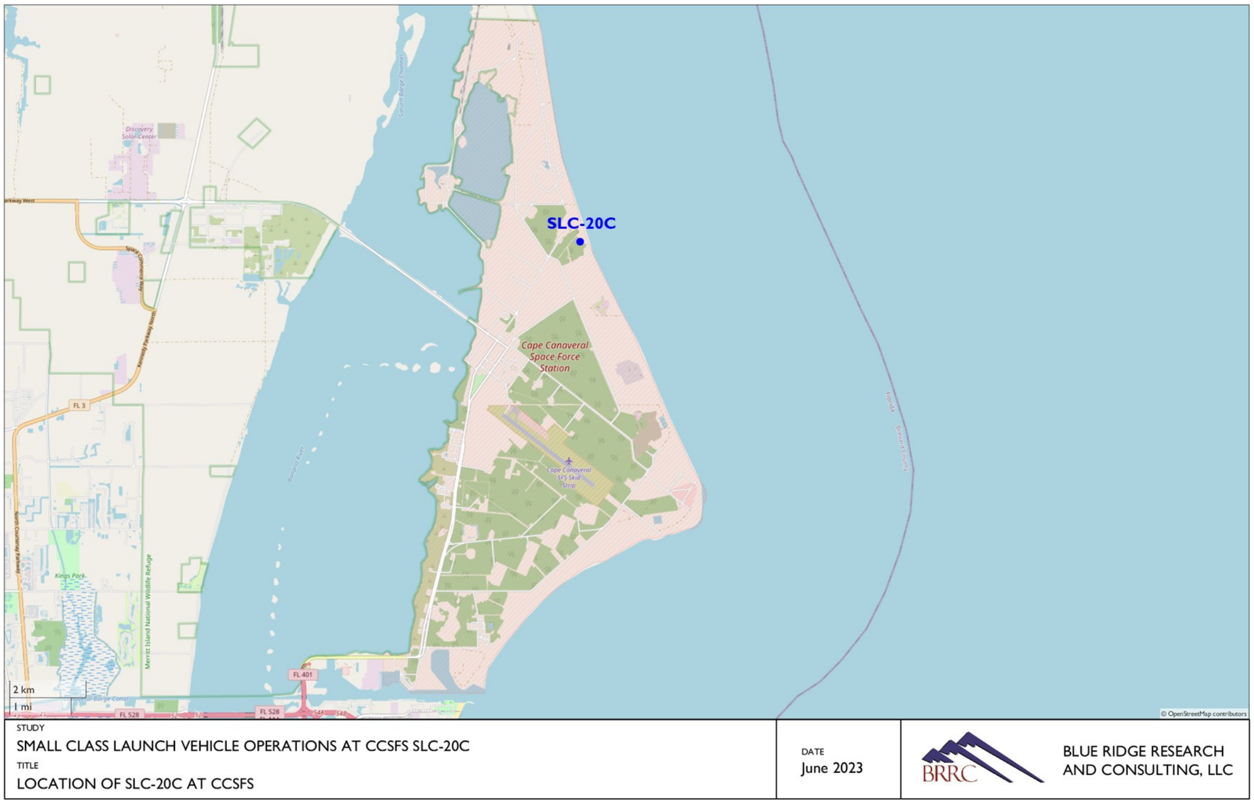

Figure 1. Location of the SLC-20C launch site at CCSFS.

This noise study describes the environmental noise associated with the proposed SCLV 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 SCLV 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 SLC-20C OPERATIONS

Launch from SLC-20C will operate on an easterly launch azimuth within the Eastern Range's allowable range of azimuths, approximately 40° to 110° as shown in Figure 2. The launch trajectory will be unique to the vehicle configuration, mission, and environmental conditions. A representative SCLV launch trajectory was used for the noise and sonic boom modeling.

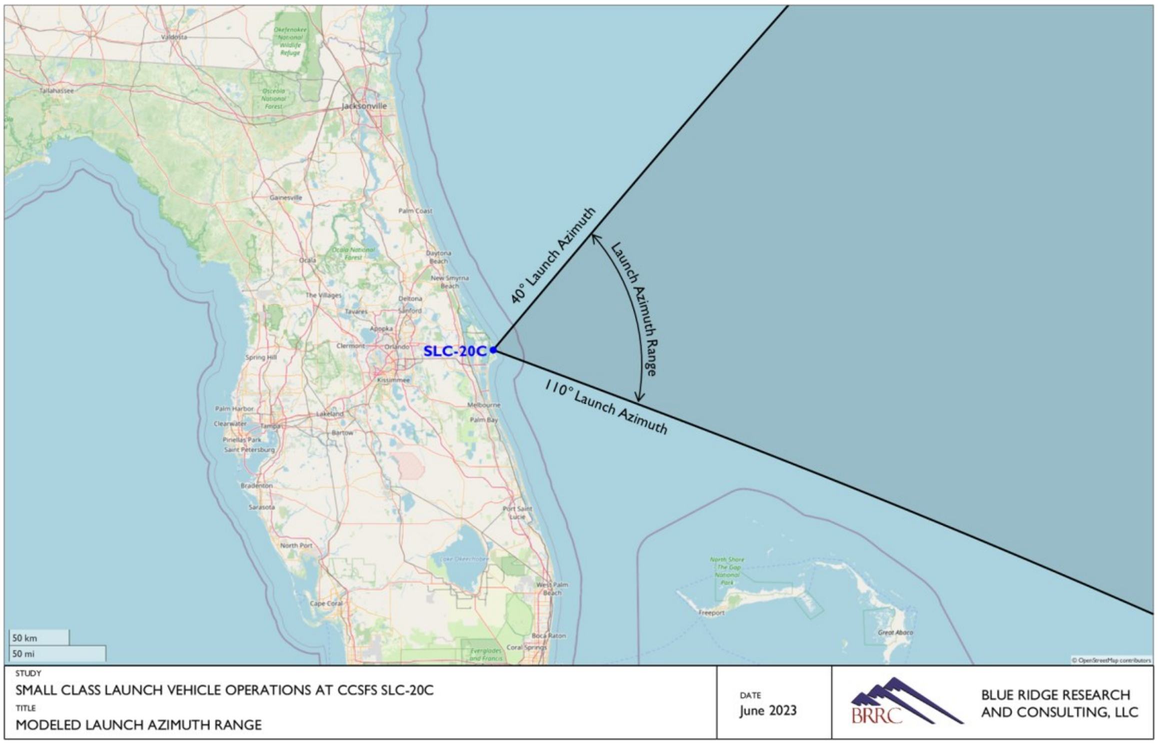

Figure 2. Range of launch azimuths from SLC-20C.

Table 1 presents the proposed SCLV operations at CCSFS SCL-20C. Space Florida plans to support up to 24 launch operations from SLC-20C per year. Prior to each liquid-fueled launch, a pre-launch static fire test could occur with a duration of approximately 10 seconds. Table 1 also presents the distribution of the SCLV 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 SCLV operations at SLC-20C.

		Annual Operations		
Event	Description	Daytime 0700 – 2200	Nighttime 2200 – 0700	Total
Static Fire	10 second static fire	18	0	18
Launch	Launch from SLC-20C	17	7	24

Space Florida plans to provide SLC-20C launch opportunities to both liquid-fueled and solid-fueled SCLV. A representative SCLV was selected to model the envelope thrust of the proposed SCLV's. Table 2 presents the vehicle and engine modeling data for the representative SCLV. The noise and sonic boom modeling of the launch operations use the time varying weight and thrust profiles provided in the trajectory. A maximum thrust of approximately 505,000 lbf is reached during launch.

Table 2. Vehicle and engine modeling parameters for a representative SCLV.

Modeling Parameters	Values
Length	120 ft
Diameter	13 ft
Gross Weight	300,000 lbs
Propellant	LOX/RP-1
Thrust (S.L.)	410,000 lbf

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
Yearly 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 and regulations 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. $L_{A,max}$ 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
Yearly 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 and regulations 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 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 SCLV operations at SLC-20C.

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 SCLV operations from SLC-20C 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 40° and 110°. 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 SCLV operations at SLC-20C 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 SCLV launch and static fire operations in Figure 3 and Figure 4, respectively.

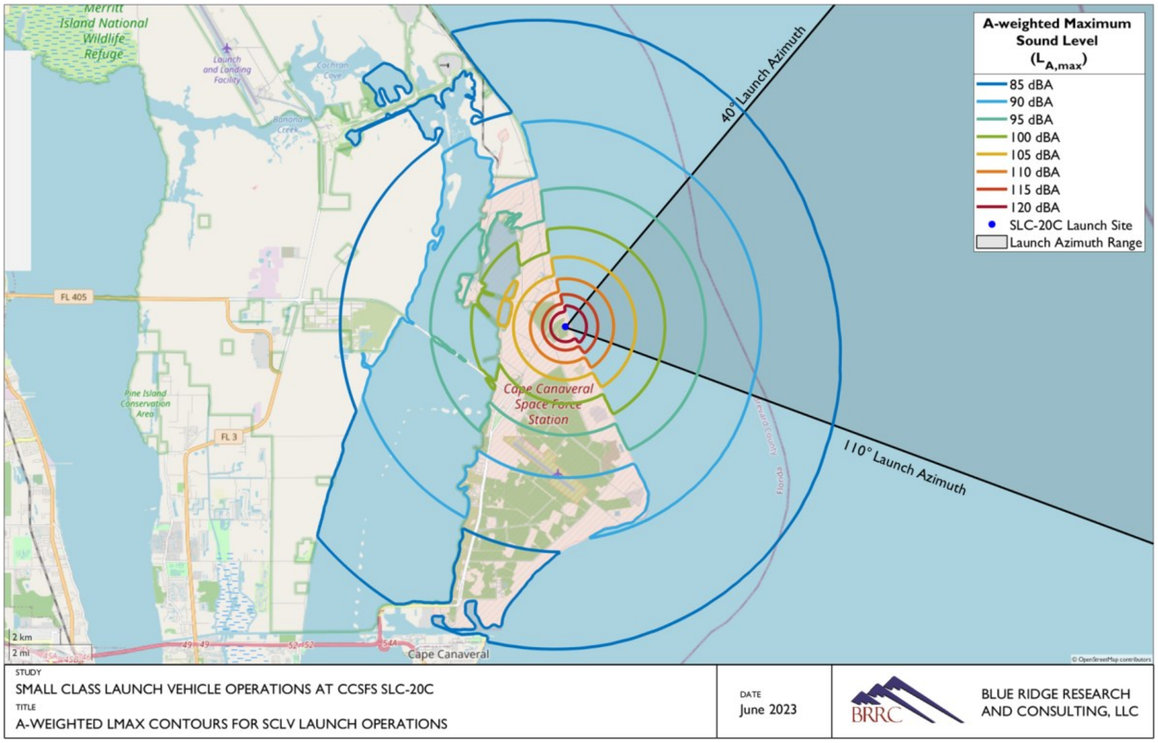

Figure 3. $L_{A,max}$ contours for SCLV launch operations over the azimuth range (40° - 110°).

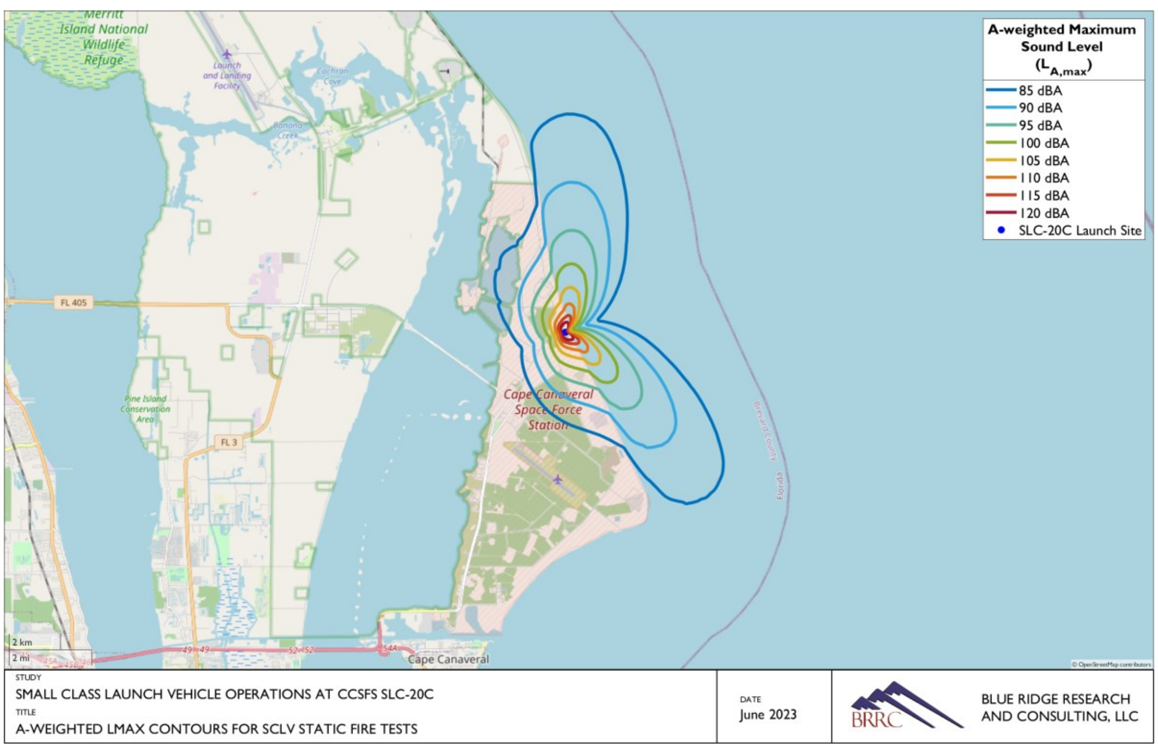

Figure 4. $L_{A,max}$ contours for SCLV static fire tests.

Unweighted Maximum Sound Level

The modeled unweighted maximum sound level contours (L_{max}) contours for SCLV launch and static fire operations are presented in Figure 5 and Figure 6, respectively.

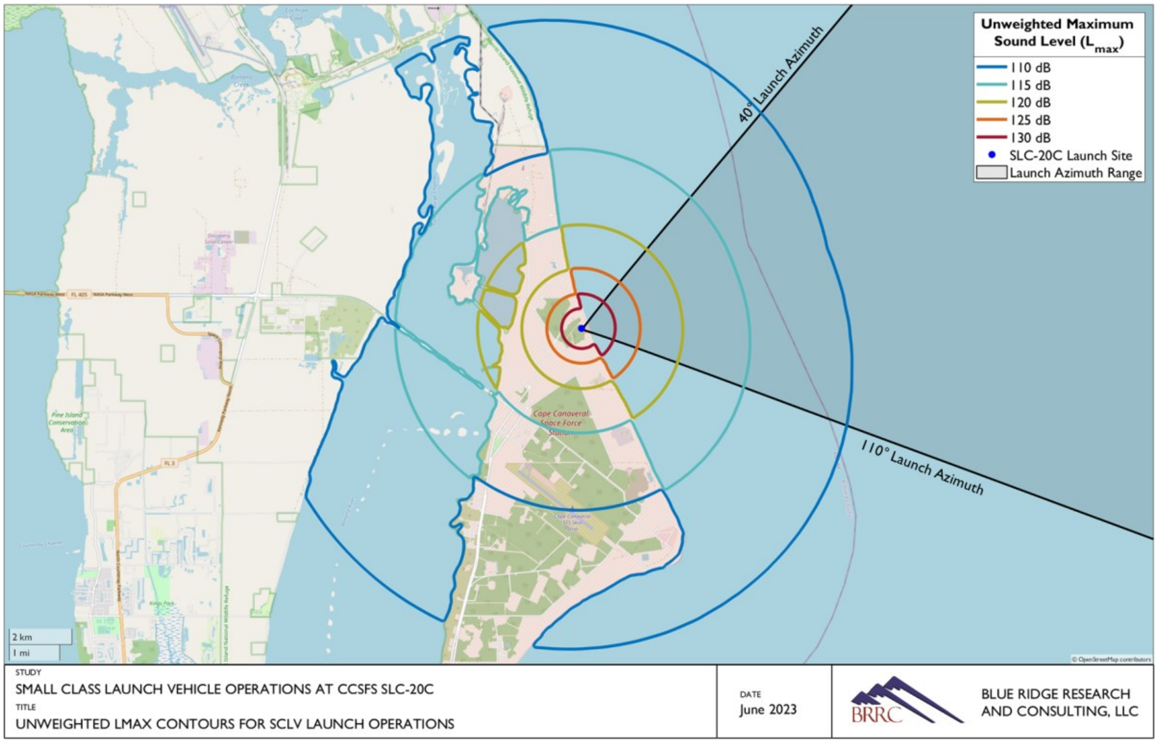

Figure 5. L_{max} contours for SCLV launch operations over the azimuth range (40° - 110°).

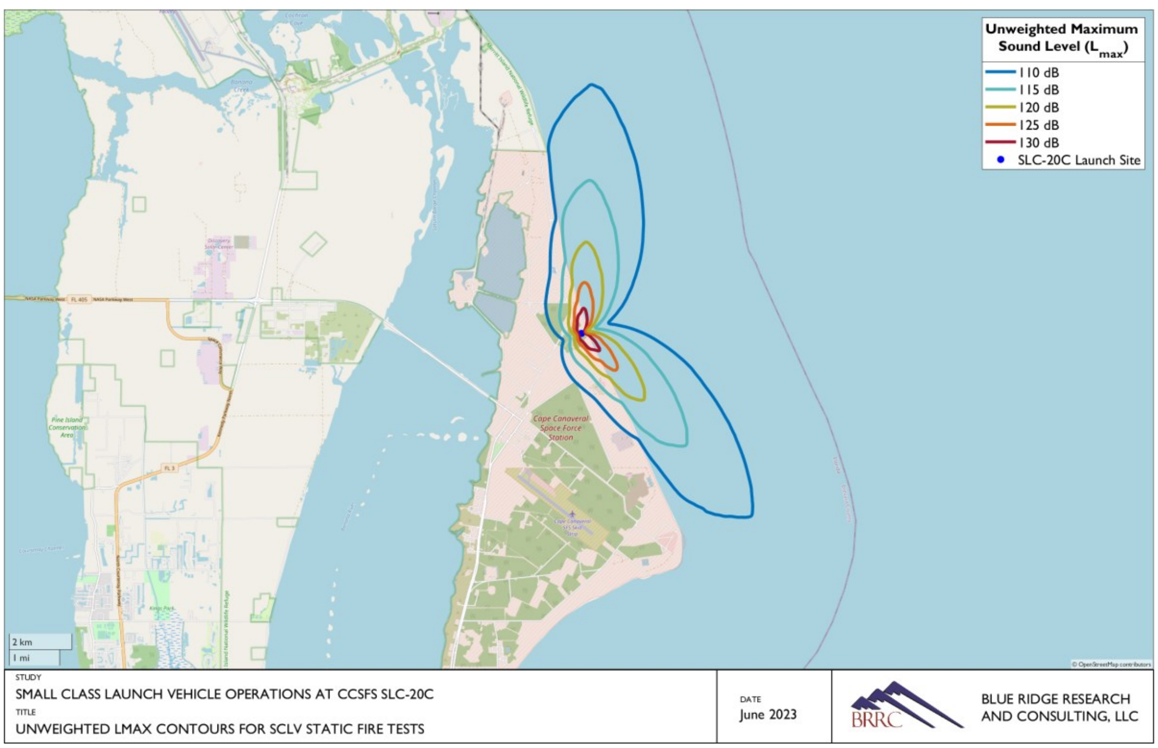

Figure 6. L_{max} contours for SCLV static fire tests.

A-weighted Sound Exposure Level

The modeled A-weighted sound exposure level (SEL) contours are presented for SCLV launch and static fire operations in Figure 7 and Figure 8, respectively.

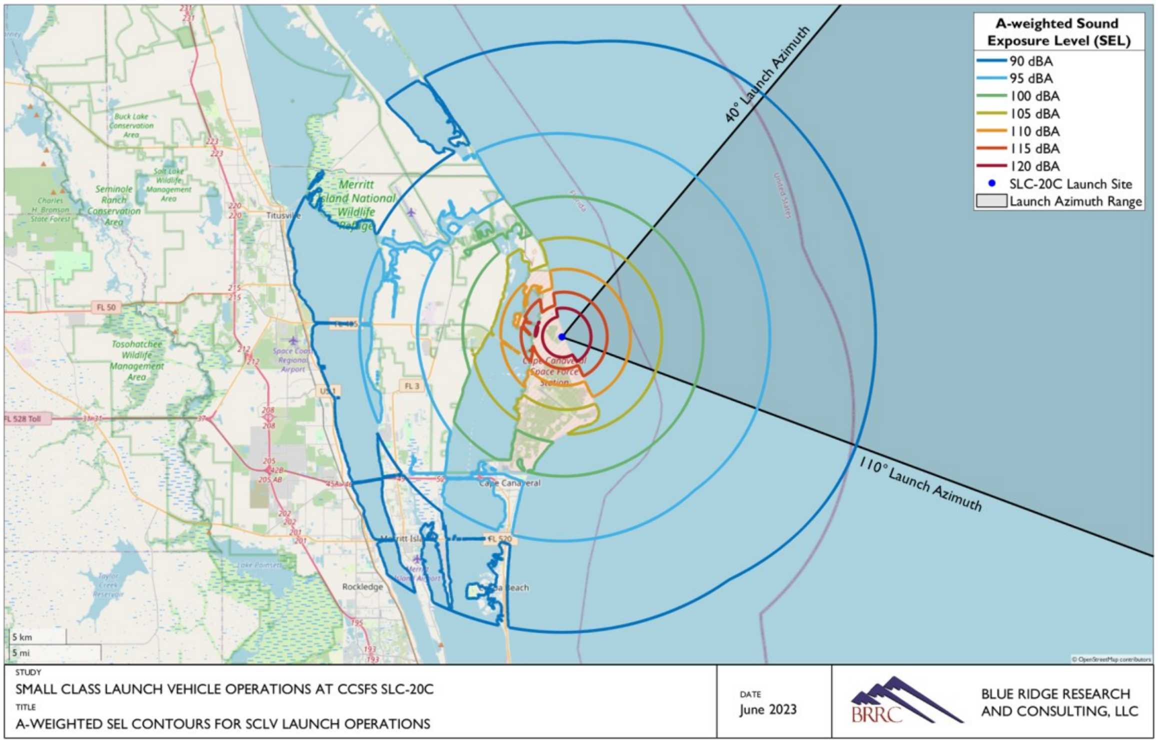

Figure 7. SEL contours for SCLV launch operations over the azimuth range (40° - 110°).

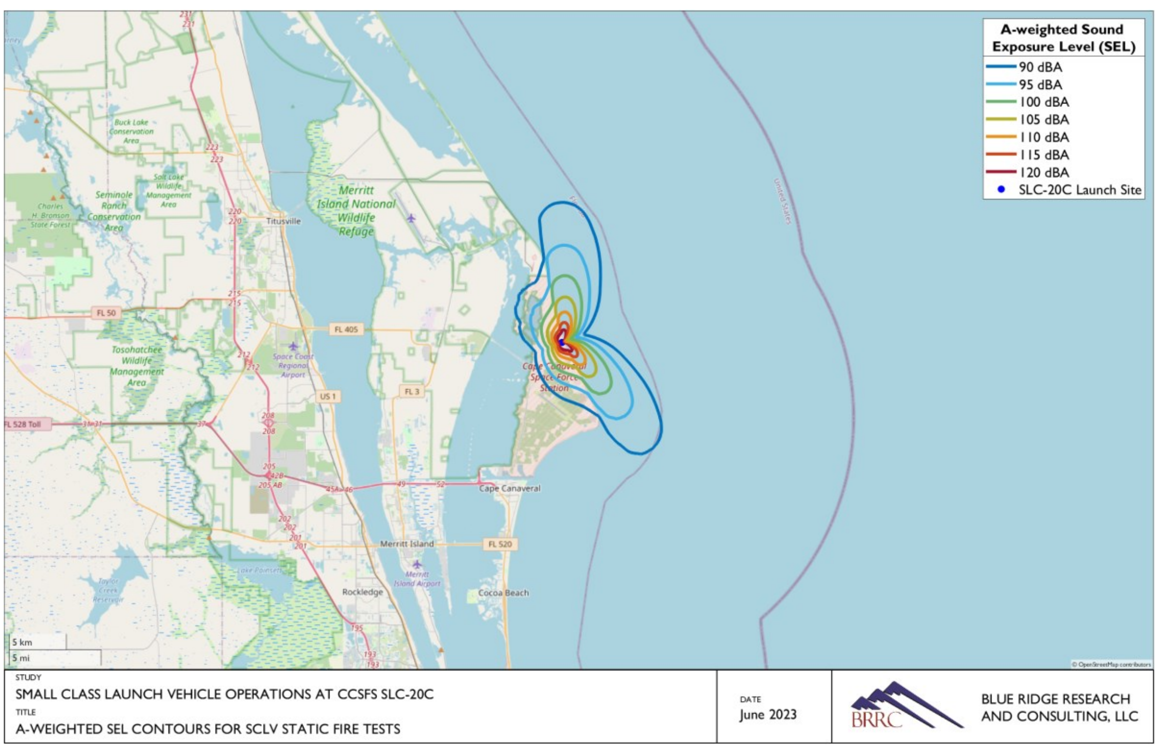

Figure 8. SEL contours for SCLV static fire tests.

4.1.2 Propulsion Noise Effects

The modeled noise generated by SCLV operations at SLC-20C 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 9 for the proposed SCLV operations at SLC-20C: 24 launch operations and 18 static fire tests.

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. 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. For example, if a noise sensitive area had a no action alternative DNL of 63.5 dBA, adding DNL 60 dBA would increase the cumulative noise by DNL 1.5 dBA to DNL 65 dBA (i.e., 63.5 dBA + 60 dBA = 65 dBA). The DNL 65 and 60 dBA contours do not encompass any land area outside of CCSFS boundaries, and thus no residences are impacted.

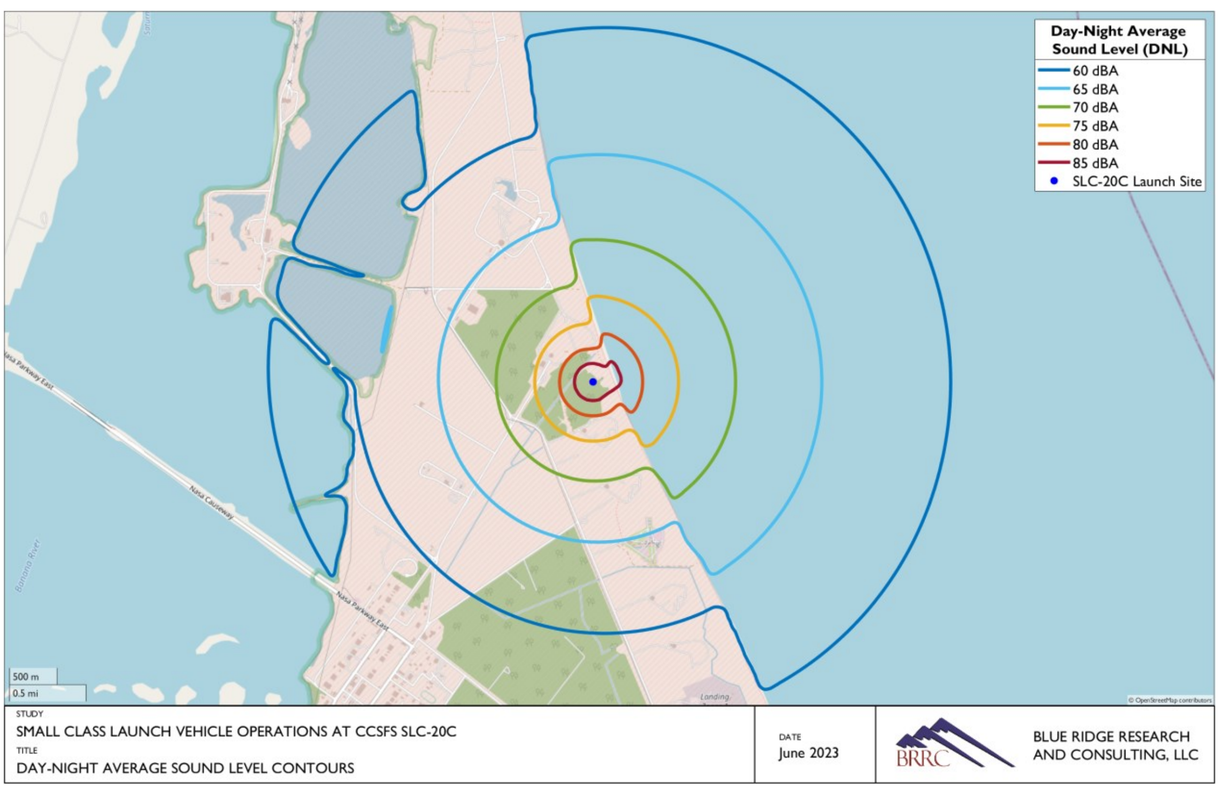

Figure 9. DNL contours for SCLV operations at SLC-20C.

Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines and regulations 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 SCLV launch and static fire operations at SLC-20C are presented in Figure 10 and Figure 11, respectively.

The modeled SCLV launch operations generate levels on land that are at or above an $L_{A,max}$ of 115 dBA within 0.57 miles of SLC-20C. The modeled SCLV 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 0.37 miles of SLC-20C 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 SCLV operation at SLC-20C. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

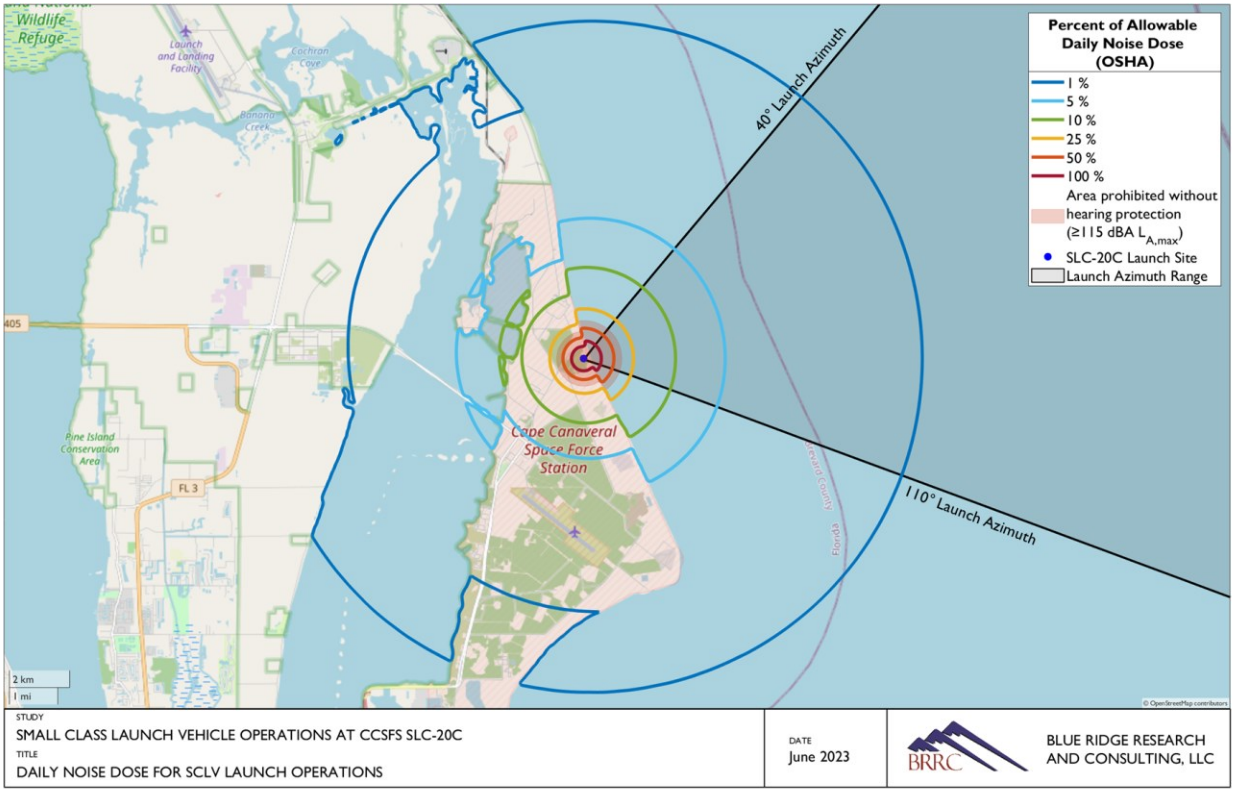

Figure 10. Allowable daily noise dose contours for SCLV launch operations over the azimuth range (40° - 110°).

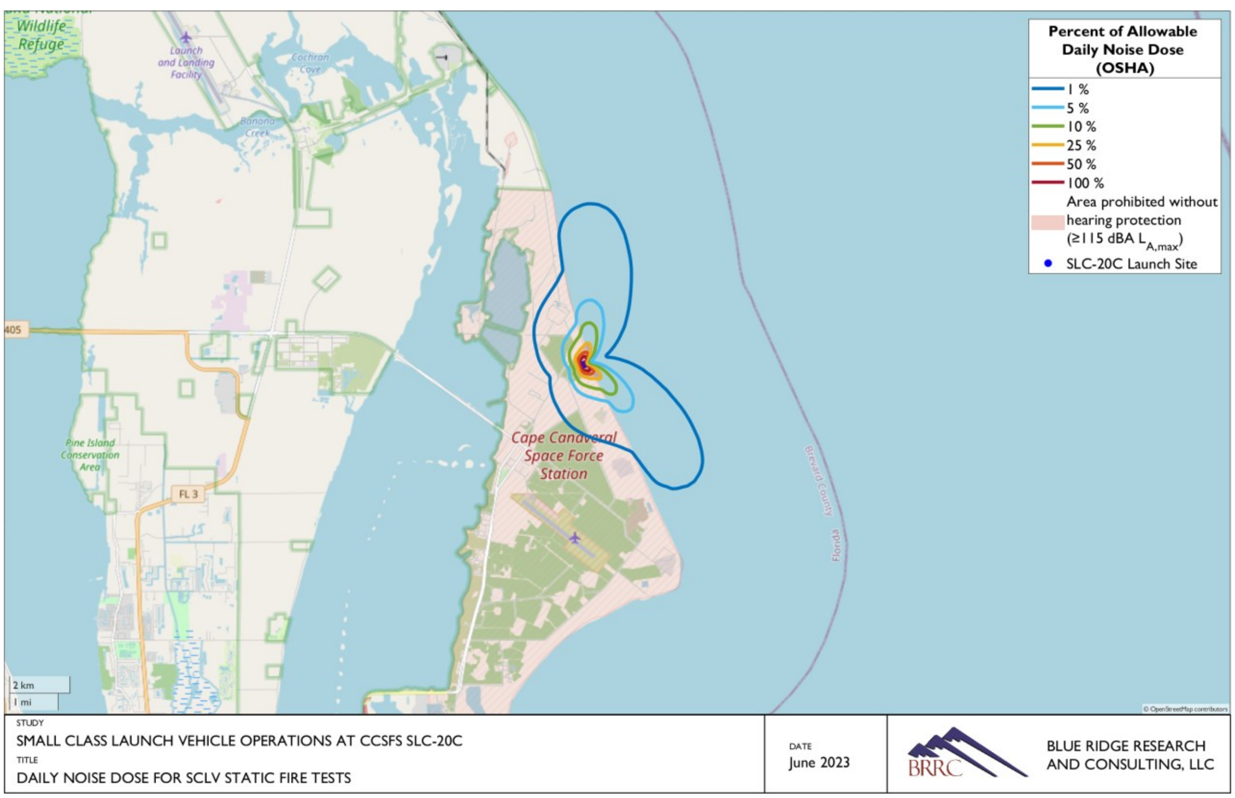

Figure 11. Allowable daily noise dose contours for SCLV static fire tests.

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 SCLV launch and static fire operations are presented in Figure 12 and Figure 13, 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.

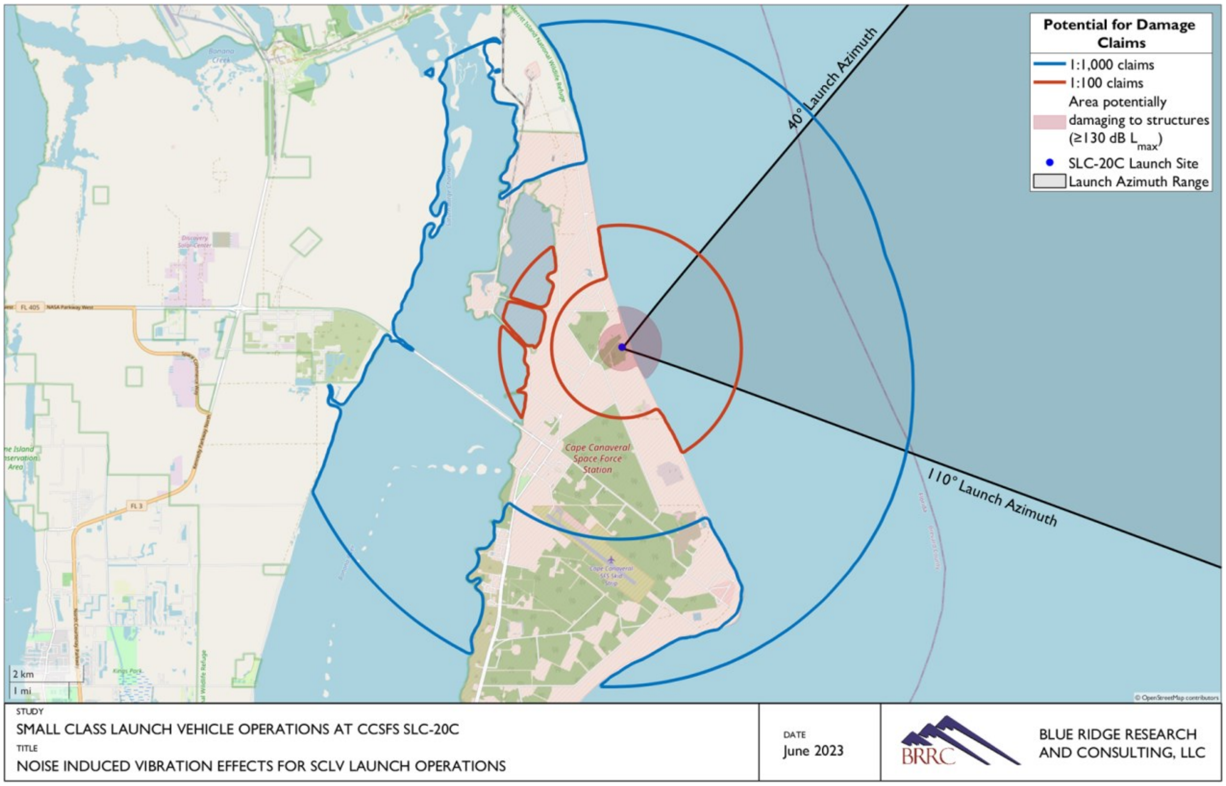

Figure 12. Potential for damage claims contours for SCLV launch operations over the azimuth range (40° - 110°).

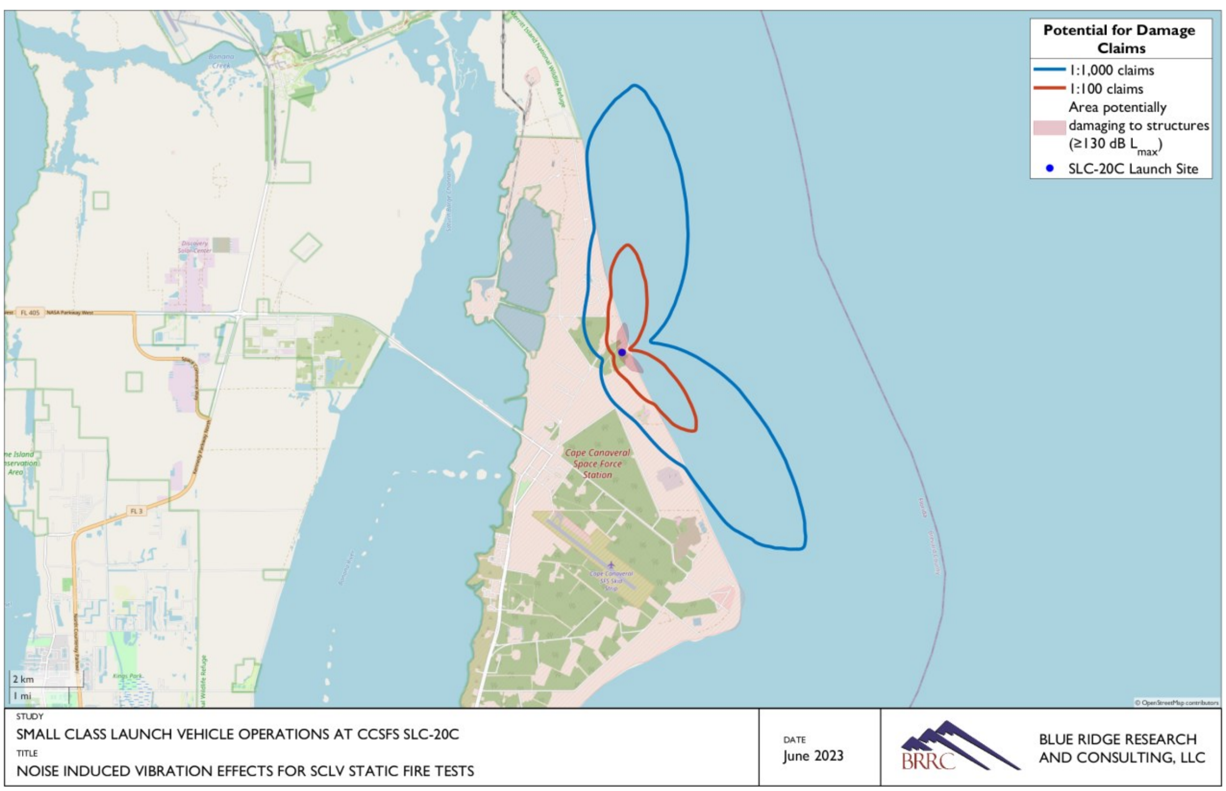

Figure 13. Potential for damage claims contours for SCLV static fire tests.

4.2 Sonic Boom Results

Sonic booms generated by SCLV launch operations from SLC-20C were modeled using PCBoom 6.7b (see Appendix C.2). The modeled peak overpressure levels of sonic booms from SCLV launch operations are described in Section 5.1. The potential sonic boom impacts from SCLV 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 SCLV launch operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. Figure 14 presents the SCLV 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 44 miles downrange of SLC-20C with a narrow, forward-facing crescent shaped focus boom region. The maximum modeled peak overpressures occur within this focus boom region. Figure 14 presents peak overpressure contours up to 2 psf, although higher peak overpressure levels up to 3.5 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.

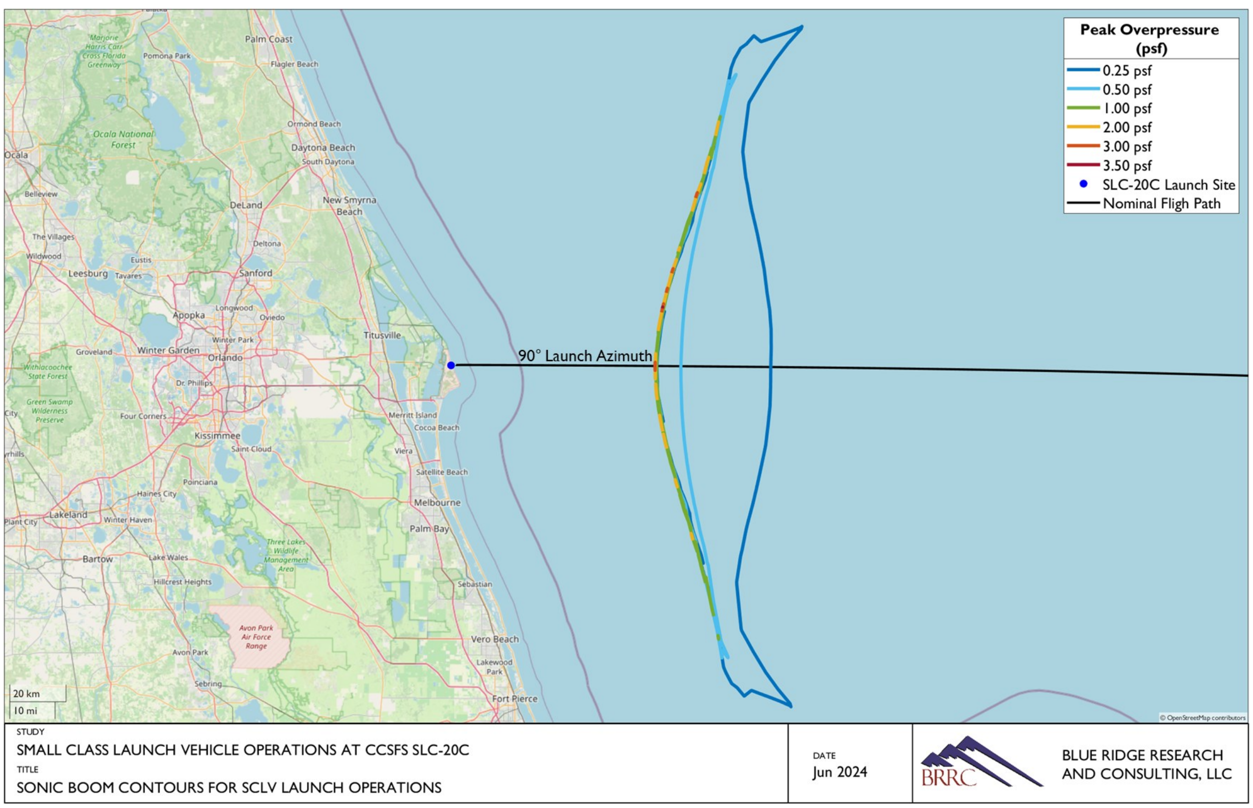

Figure 14. Sonic boom peak overpressure contours for a nominal due-east launch azimuth.

Figure 15 illustrates the sonic boom contours at the extents of the launch azimuth range (40° to 110°) 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 SCLV launch operations are modeled to occur entirely over the Atlantic Ocean.

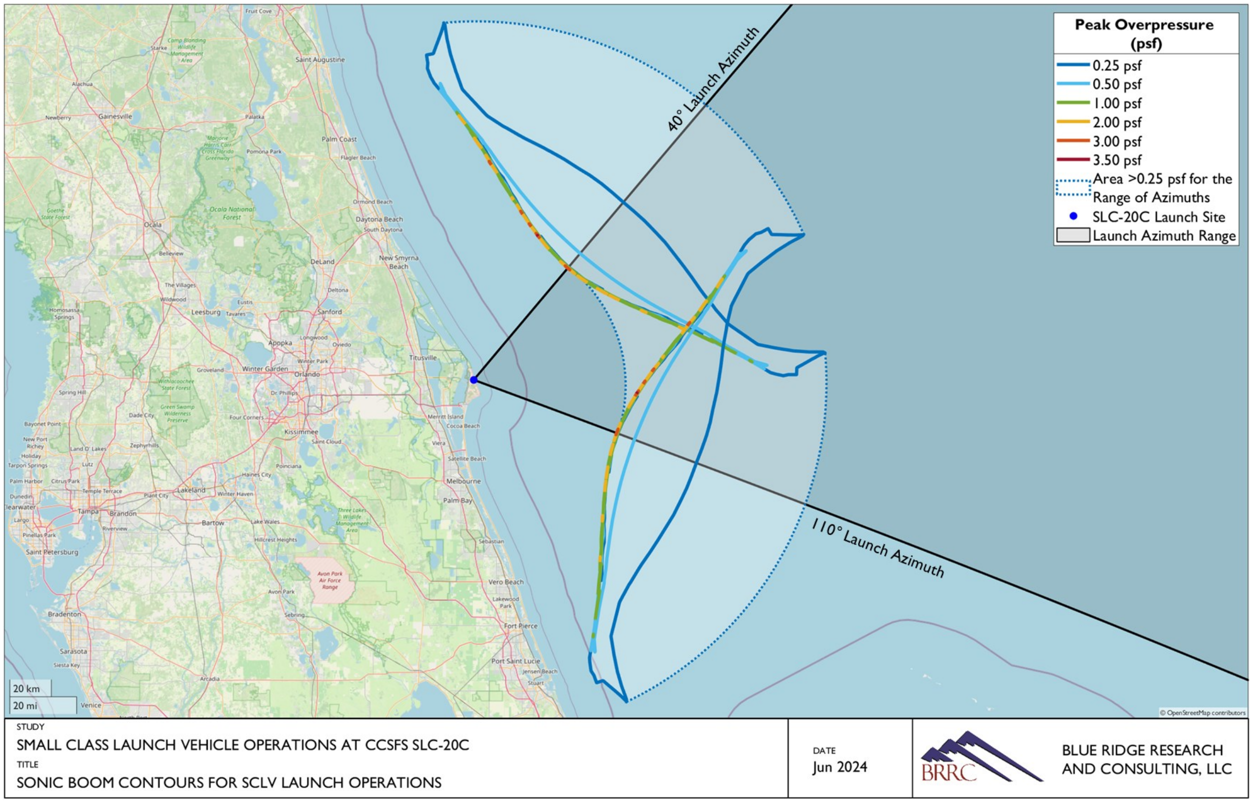

Figure 15. Sonic boom peak overpressure contours for SCLV launch operations over the azimuth range (40° - 110°).

5 SUMMARY

This report documents the noise and sonic boom study performed to support Kimley-Horn's environmental review of SCLV launch and static operations at CCSFS SLC-20C. 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 SCLV operations at SLC-20C 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 SCLV operations at SLC-20C. 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 SCLV SLC-20C 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 SCLV SLC-20C 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 SCLV 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 16, 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.

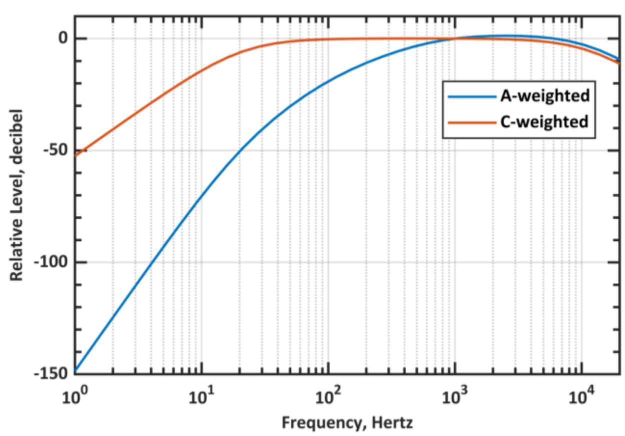

Figure 16. Frequency adjustments for A-weighting and C-weighting. [52]

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 17. 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 17) 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 18. 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].

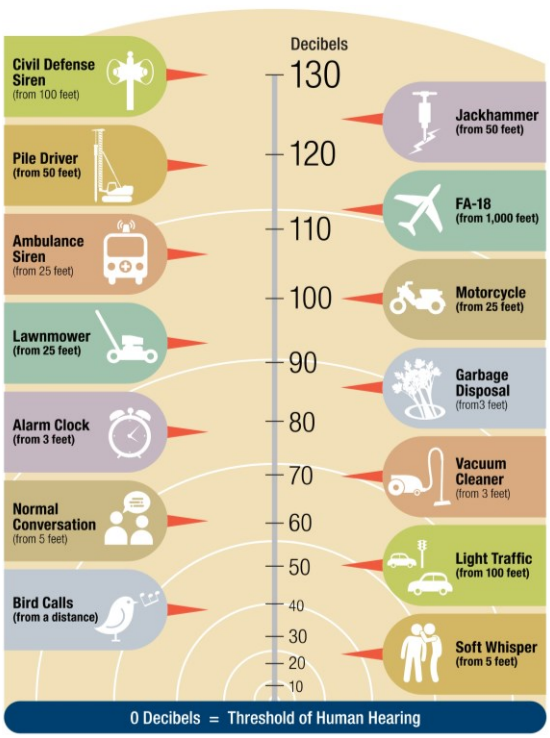

Figure 17. Typical A-weighted levels of common sounds. [57]

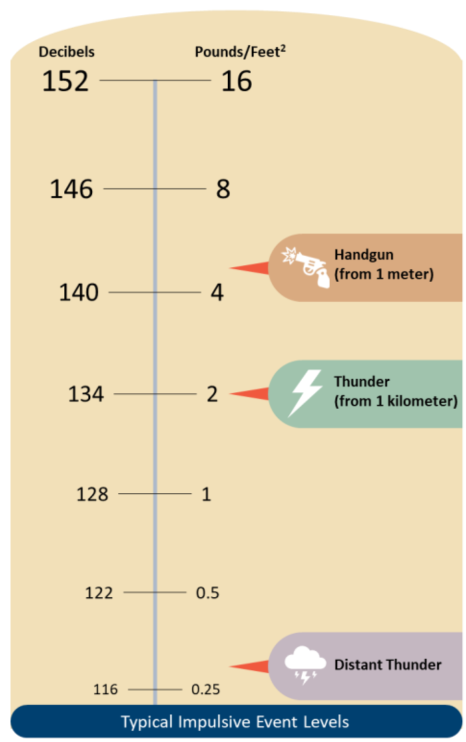

Figure 18. Typical impulsive event levels. [56]

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 19 and are described in the following subsections.

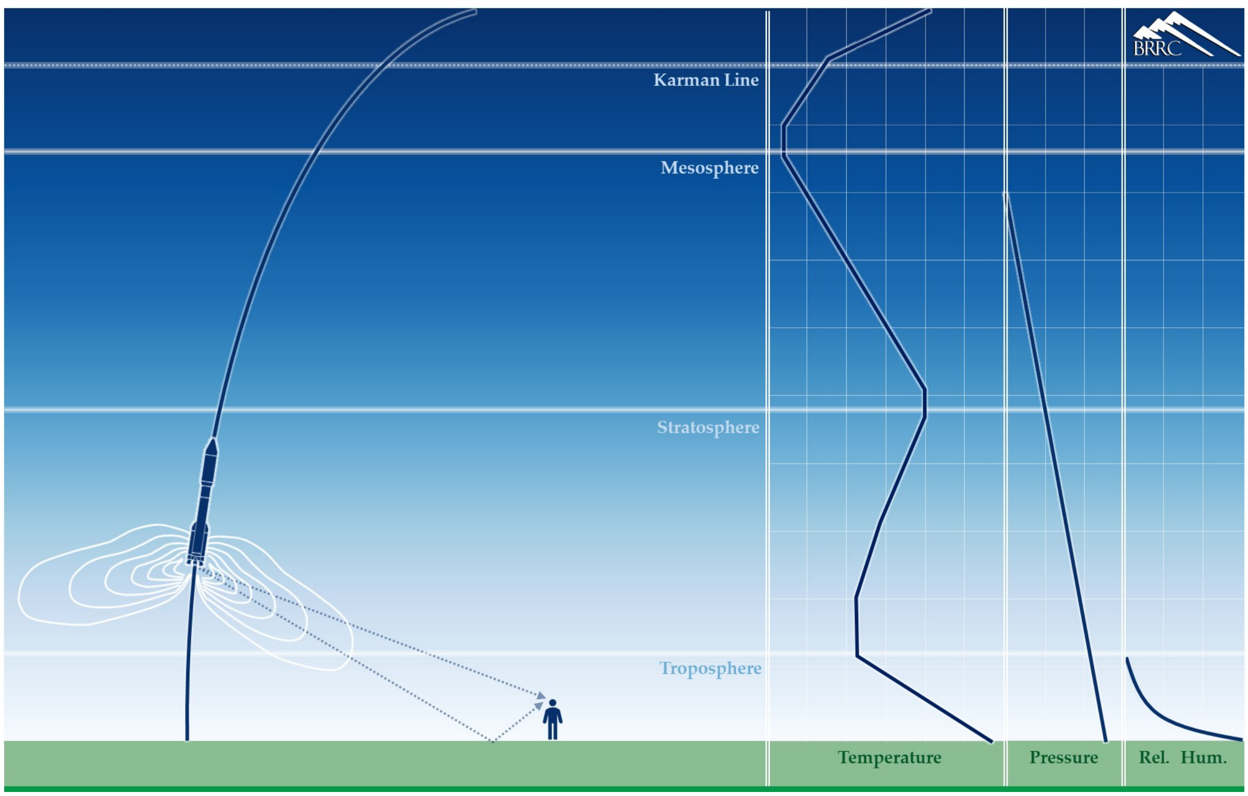

Figure 19. Conceptual overview of rocket noise prediction model methodology.

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 19. 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 20 shows the generation and evolution of a sonic boom N-wave under the vehicle.

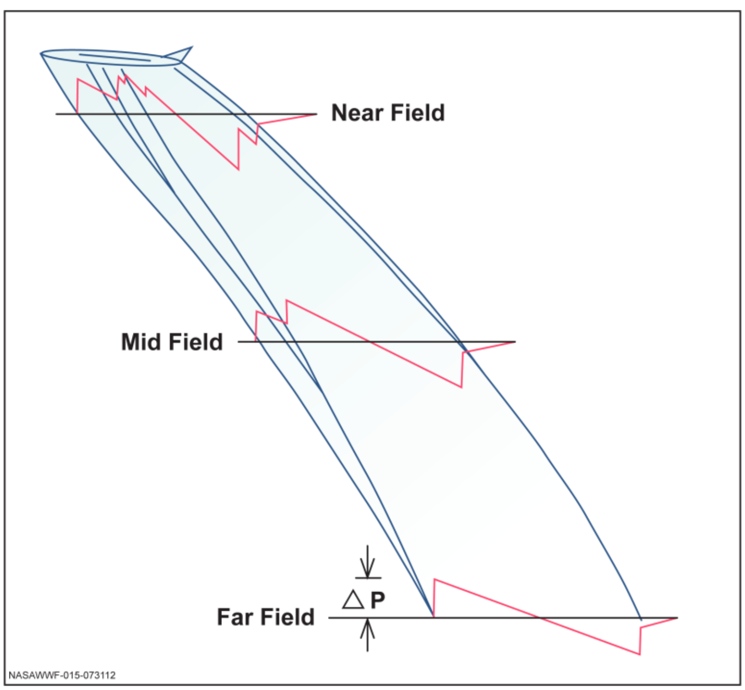

Figure 20. Sonic boom generation and evolution to N-wave. [42]

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 21 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."

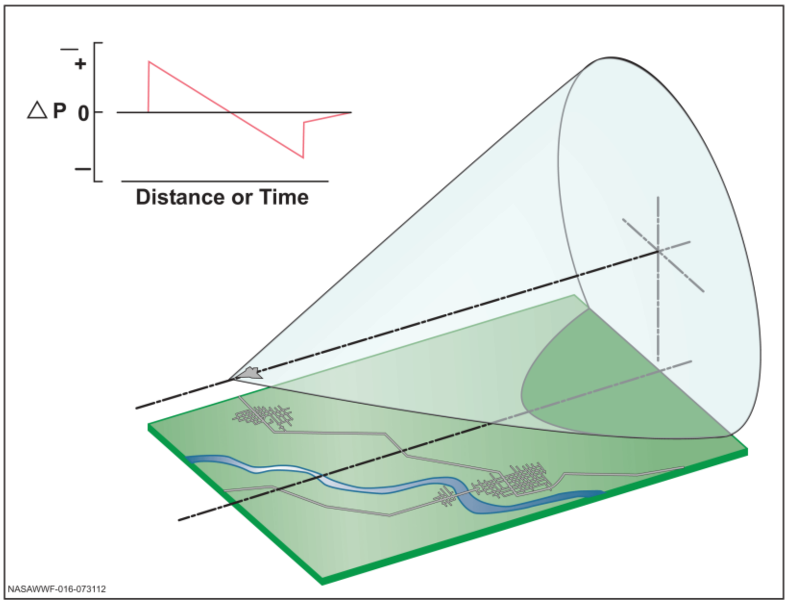

Figure 21. Sonic boom carpet for a vehicle in steady flight. [43]

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 22. 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 22] 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."

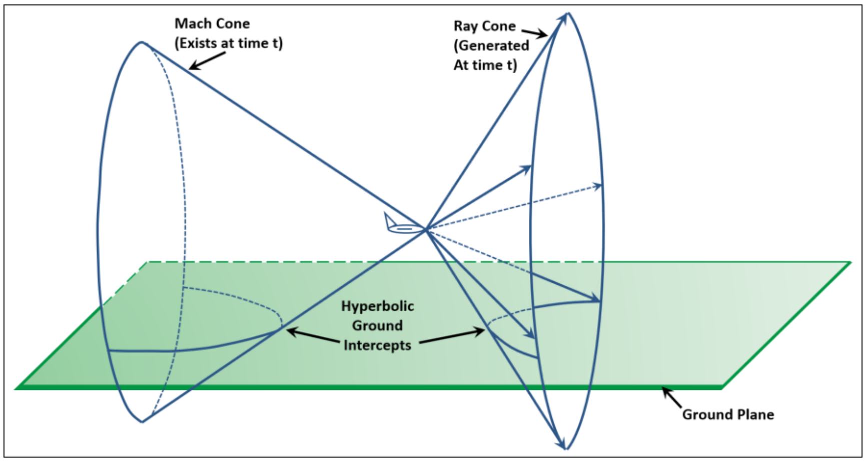

Figure 22. Mach cone vs ray cone viewpoints.

Figure 21 and Figure 22 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 22. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 23, 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 23, 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.

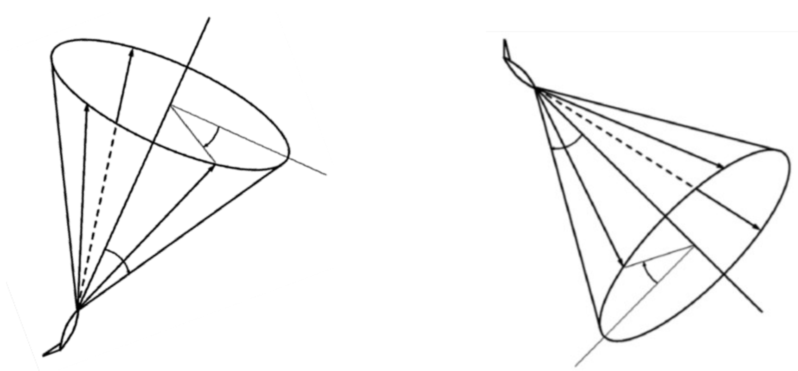

Figure 23. Ray cone in climbing (left) and diving (right) flight.

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

FAA Noise Modeling Methodology Approval

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Federal Aviation Administration

Memorandum

Date: August 20, 2024

Digitally signed by DAVID ALAN SENZIG
Date: 2024.08.20 13:50:13 -04'00'

From: David Senzig, Manager (A), Noise Div, Office of Environment & Energy (AEE)

To: Andrew Leske, Office of Commercial Space Transportation (AST)

Subject: Noise Modeling Methodology for Supplemental Environmental Assessment evaluating small class launch vehicle operations at Cape Canaveral Space Force Station Space Launch Complex 20C - Approved

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling methodology to be used in the proposed Supplemental Environmental Assessment (SEA) evaluating small class launch vehicle (SCLV) operations at Cape Canaveral Space Force Station (CCSFS) Space Launch Complex 20C (SLC-20C).

As the FAA does not currently have an approved propulsion noise model for launch vehicles, in accordance with FAA Order 1050.1F, all non-standard noise analysis in support of the noise impact analysis for the National Environmental Policy Act (NEPA) must be approved by AEE. This letter serves as AEE's response to the AST office on behalf of Space Florida on the proposed use of the Rocket Noise and Emissions Simulation Model - RUMBLE (2.0) developed by Blue Ridge Research and Consulting, LLC (BRRC), as requested in the memo entitled " Noise Methodology Approval Request – RUMBLE " prepared on July 30, 2024.

The noise levels generated from commercial space launch vehicle and static firing are predicted using RUMBLE, a fully featured time-simulation noise model. For the sonic boom, Space Florida's may use PCBOOM to model sonic booms from the small class launch vehicles.

The proposed methodology appears to be adequate for modeling propulsion noise and sonic boom from launch vehicles. Therefore, AEE concurs with the methodology proposed for this project. Please understand that this approval is limited to the proposed Supplemental Environmental Assessment and small class launch vehicles. Any additional projects using this or other launch noise methodologies or variations of launch vehicles will require separate approval.

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Appendix I
Biological Assessment
(To be Included at a Future Date)

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Appendix J
Biological Opinion
(To be Included at a Future Date)

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Appendix K

State Historic Preservation Office and Florida State Clearinghouse Correspondence

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FINAL DRAFT

FLORIDA DEPARTMENT of STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

Mr. Michael A. Blaylock
Chief, Environmental Conservation
45 CES/CEIE
1224 Jupiter Street, MS-9125
Patrick AFB, FL 32925-3343

September 12, 2019

RE: DHR Project File No.: 2019-5045
Proposed Reuse of Launch Complex 20 (LC-20)
Cape Canaveral Air Force Station, Brevard County, Florida

Mr. Blaylock:

Our office received and reviewed the above referenced project in accordance with Section 106 and Section 110 of the *National Historic Preservation Act of 1966*, for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places*.

A review of our files indicates that this office has previously determined that Facility 18800 - LC-20 Blockhouse (8BR3155 appears to meet the criteria for listing on the *National Register*. However, based on the information provided, this office concurs with your determination that the proposed undertaking will have no adverse effect on the historic character of the blockhouse or other historic resources.

If you have any questions, please contact Scott Edwards, Historic Preservationist, by electronic mail *scott.edwards@dos.myflorida.com*, or at 850.245.6333 or 800.847.7278.

Sincerely,

Jason Aldridge
For

Timothy A. Parsons, Ph.D.
Director, Division of Historical Resources
and State Historic Preservation Officer

FINAL DRAFT

FLORIDA DEPARTMENT *of* STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

Chris Stahl
Florida State Clearinghouse
Florida Department of Environmental Protection
2600 Blair Stone Road, M.S. 47
Tallahassee, FL 32399-2400

June 9, 2020

RE: DHR Project File No.: 2020-3034
Project: SAI# FL202005128941C
Department of Defense – Department of the Air Force
Environmental Assessment for the Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations
Cape Canaveral Air Force Station, Brevard County

Mr. Stahl:

The Florida State Historic Preservation Officer reviewed the referenced project for possible effects on historic properties listed, or eligible for listing, on the National Register of Historic Places. The review was conducted in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations in 36 CFR Part 800: Protection of Historic Properties.

We have reviewed Sections 3.4, 4.4 and 5.3.4 of the referenced document which deal with Cultural Resources. The 45th Space Wing Cultural Resources Manager evaluated the areas that would be affected by the Proposed Action, and no historical or cultural resource issues were found within the Proposed Action boundaries or surrounding areas with the exception of Facility 18800 - LC-20 Blockhouse (8BR3155).

The Blockhouse was previously determined by this office to appear to meet the criteria for listing in the *National Register*. The Proposed Action proposes to use the facility as it was originally intended and to maintain the exterior similar to its original construction.

Therefore, based on the information provided, it is the opinion of this office that the document has adequately addressed cultural resources and it is our opinion that proposed undertakings will have no adverse effect on the historic character of the blockhouse or other historic resources.

Division of Historical Resources
R.A. Gray Building • 500 South Bronough Street• Tallahassee, Florida 32399
850.245.6300 • 850.245.6436 (Fax) • FLHeritage.com

FINAL DRAFT

If you have any questions, please contact Scott Edwards, Historic Preservationist, by electronic mail scott.edwards@dos.myflorida.com, or at 850.245.6333 or 800.847.7278.

Sincerely,

Jason Aldridge
For

Timothy A. Parsons, Ph.D.
Director, Division of Historical Resources
and State Historic Preservation Officer

FINAL DRAFT

FLORIDA DEPARTMENT *of* STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

Mr. Michael A. Blaylock
Chief, Environmental Conservation - 45 CES/CEIE
1224 Jupiter Street, MS-9125
Patrick AFB, FL 32925-3343

October 7, 2020

RE: DHR Project File No.: 2019-5045-B
Proposed Reuse of Launch Complex 20 (LC-20)
Cape Canaveral Air Force Station, Brevard County, Florida

Mr. Blaylock:

In our September 12, 2019 letter, we noted that Facility 18800 - LC-20 Blockhouse (8BR3155) appears to meet the criteria for listing on the *National Register*. This office concurred with your finding that the proposed undertaking would have no adverse effect on the historic character of the blockhouse or other historic resources. The finding of *No Adverse Effect* was for the following undertakings as described in Section 3.1 of your submittal:

- Lease of LC-16 by a non-Federal entity
- Repair/upgrade existing roads and pads
- Construction of new fences around the complex
- Demolition of non-essential facilities
- Reuse of existing launch pad including future launches
- Reuse of the Facility 13122 (8BR2322) as a launch building
- Repair and upgrade Facility 13122(8BR2322) (c.f. pressure wash and paint exterior, repair damaged concrete, repair/replace doors, repair periscopes, etc.) while maintaining the integrity
- Upgrade utilities

If you have any questions, please contact Scott Edwards, Historic Preservationist, by electronic mail *scott.edwards@dos.myflorida.com*, or at 850.245.6333 or 800.847.7278.

Sincerely,

Jason Aldridge
For

Timothy A. Parsons, Ph.D.
Director, Division of Historical Resources
and State Historic Preservation Officer

FINAL DRAFT

TECHNICAL MEMO

Phase I Cultural Resources Assessment Survey Near Launch Complex 20, Cape Canaveral Air Force Station, Brevard County, Florida

Prepared for:

45th Space Wing

Cape Canaveral Air Force Station

1224 Jupiter Street

Patrick Air Force Base, FL 32925

Prepared by:

University of South Florida Libraries

Digital Heritage and Humanities Center

4202 East Fowler Avenue LIB 122

Tampa, FL 33620

www.lib.usf.edu/dhhc/

Jaime A. Rogers, M.A.
Project Archaeologist

Lori D. Collins, Ph.D.
Co-Principal Investigator

Travis F. Doering, Ph.D.
Co-Principal Investigator

June 2019

INTRODUCTION

The University of South Florida's Digital Heritage and Humanities Center (DHHC) is conducting ongoing cultural resource assessment surveys (CRAS) of multiple land management units (LMUs) along ICBM road on Cape Canaveral Air Force Station (CCAFS). These projects were performed to comply with Section 110(a)(2)(D) of the National Historic Preservation Act (NHPA). The current technical memo describes our methods and results within LMUs 15 and 18, north and south of Launch Complex 20 (LC-20), respectively (**Figure 1**). LMUs 15 and 18 are part of different ongoing DHHC projects. LMU 15 is under the LMU 13-17 project, which fieldwork is completed for and report writing is underway. LMU 18 is under the ICBM project, which fieldwork is currently underway. Shovel testing is complete in both LMUs.

METHODS

Because this was a Section 110 project, our survey method focused on testing a site probability model created in ArcGIS Pro, rather than overlying an arbitrary shovel test grid on an Area of Potential Effect (APE) as is more common with Section 106 projects. The suitability model generated zones of high, medium, and low site probability, which were tested at 25m, 50m, and 100m intervals, respectively. Several Basic Information Guides (BIGs) from the 50s, 60s, 70s, 90s, and 00s were georeferenced and compared with field findings. Additionally, 2019 FMSF GIS data and previous surveys were reviewed.

RESULTS

A total of 119 shovel tests were excavated within LMU 15. All were negative for cultural material (**Figure 2**). Of the 119 shovel tests, 47 were noted as being disturbed or possibly disturbed. Soil drainage was also recorded, 76 were noted as being well-drained, 30 were medium, and 13 were poorly drained. The poorly drained shovel tests were concentrated in the northeast portion of the LMU.

Generally speaking, the majority of profiles in the south and central areas showed evidence of disturbance. Fill was often observed on the surface in these areas. The shovel tests along the dune ridges, while elevated, showed no evidence of cultural material. Those to the west were not disturbed but were also sterile and within very dense vegetation. The central portion of this LMU had very dense vegetation, but given the low elevation and disturbed surroundings, we do not think there is much probability of encountering sites within the untested area. Clay inclusions or sandy clay strata were noted in a few shovel tests, but there is no spatial pattern between them. Minimal shell inclusions were relatively common throughout most of the LMU. The majority of the tests noted as being disturbed also had small rock inclusions as well. The location of the disturbed tests often aligns with clearings in the historic aerials, although some tests are outside of the apparent disturbance zones.

A total of four Air Force facilities were encountered within LMU 15 (**Figure 3**). Two are identified as a Weather Tower 006 (F. 22101) and associated equipment building (F. 22100) (**Figure 4**). These were constructed in 1990 in the same location as historic structures that served the same function (F. 15523A and F. 15523B). The remnants of the historic facilities were not encountered. Given the year the new weather tower was constructed, the two facilities will not be recorded.

The other two structures are currently unidentified. The first is a small fenced-in area with metal and wood remains (**Figure 5**). When BIGs are georeferenced, the remnants are within 20m of F. 15530, but this facility number designates a contaminated liquids pond. The next closest facility is 90m away and is a Theodolite Building (15521A); however, the structural information provided on the BIGs do not align with the structural remains encountered. It is likely that this facility was short lived during the 80s, given our gap of BIGs during this time. However, there is also a possibility that this structure is pre-Air Force. Regardless, this structure remains unidentified. However, given its small size and deteriorating condition, the DHHC would more than likely recommend the structure ineligible for listing on NRHP.

Lastly, another unidentified structure is present 75m east of Weather Tower 006 (**Figures 6 and 7**). This facility remains unlabeled on BIGs, except for the general area being described as Thrust Block and Valve Pit on the 1966 BIG. Additional maps and documents are currently being reviewed to try and confirm the identity of this structure.

A total of 96 shovel tests were excavated within LMU 18. All were negative for cultural material (**see Figure 2**). Only eight were described as being disturbed. The majority of the disturbed tests are in the southern portion of the LMU boundary. The vast majority of soil was described as being well-drained, some medium-drained, and none were described as being poorly drained. Stratigraphy described in LMU 18 is very similar to those outlined in LMU 15 above.

A total of three Air Force structures were encountered in LMU 18 (**see Figure 3**). In the southern portion of LMU 18, the DHHC encountered a small vented structure with a tunnel attached (**Figure 8**). After a review of an Engineering report done by AMRO (Eley et al. 1962), we have preliminarily identified the structure as an escape tunnel (**Figure 9**). Eley et al. (1962:51) depict a typical launch complex layout. Although their example uses LC-15 and LC-16, the layout for LC-19 should be the same or very similar. **Figure 9** indicates an Air Vent and Escape Tunnel leading northwest from the Blockhouse in the same location as the structure observed by the DHHC. Therefore, the DHHC likely encountered the terminus of the escape tunnel for LC-19 and will be recorded as a structure within the Resource Group associated with LC-19 (8BR216).

The second structure is currently unidentified. It consists of a metal hatched door overlying a few pumps that are currently inundated (**Figure 10**). When georeferenced with BIGs, the closest facilities are storage buildings and an electric substation. We do not currently have a preliminary identification for this structure but considering its size and presumed limited function, we would likely not recommend this eligible for NRHP.

The third structure encountered in LMU 18 is the same type of structure encountered in LMU 15 and has the same location in relation to the respective launch complex (LC-19) (**Figure 11**). Therefore, the structure has been temporarily called a Thrust Block and Valve Pit until a positive identification can be confirmed.

CONCLUSIONS

Fieldwork around LC-20 has been completed, but the identification of Air Force structures within LMUs 15 and 18 is ongoing. In total, five historic structures were encountered. Two are preliminarily identified as Thrust Block and Valve Pit structures associated with LC-19 and LC-20. One is preliminarily identified as an Air Vent and Escape Tunnel associated with LC-19. The remaining two are currently unidentified. The DHHC will continue to review historic maps and documents to try and determine the temporality and function of all of the structures mentioned in this memo. No evidence of prehistoric habitation was encountered in either LMU.

APPENDIX A: FIGURES

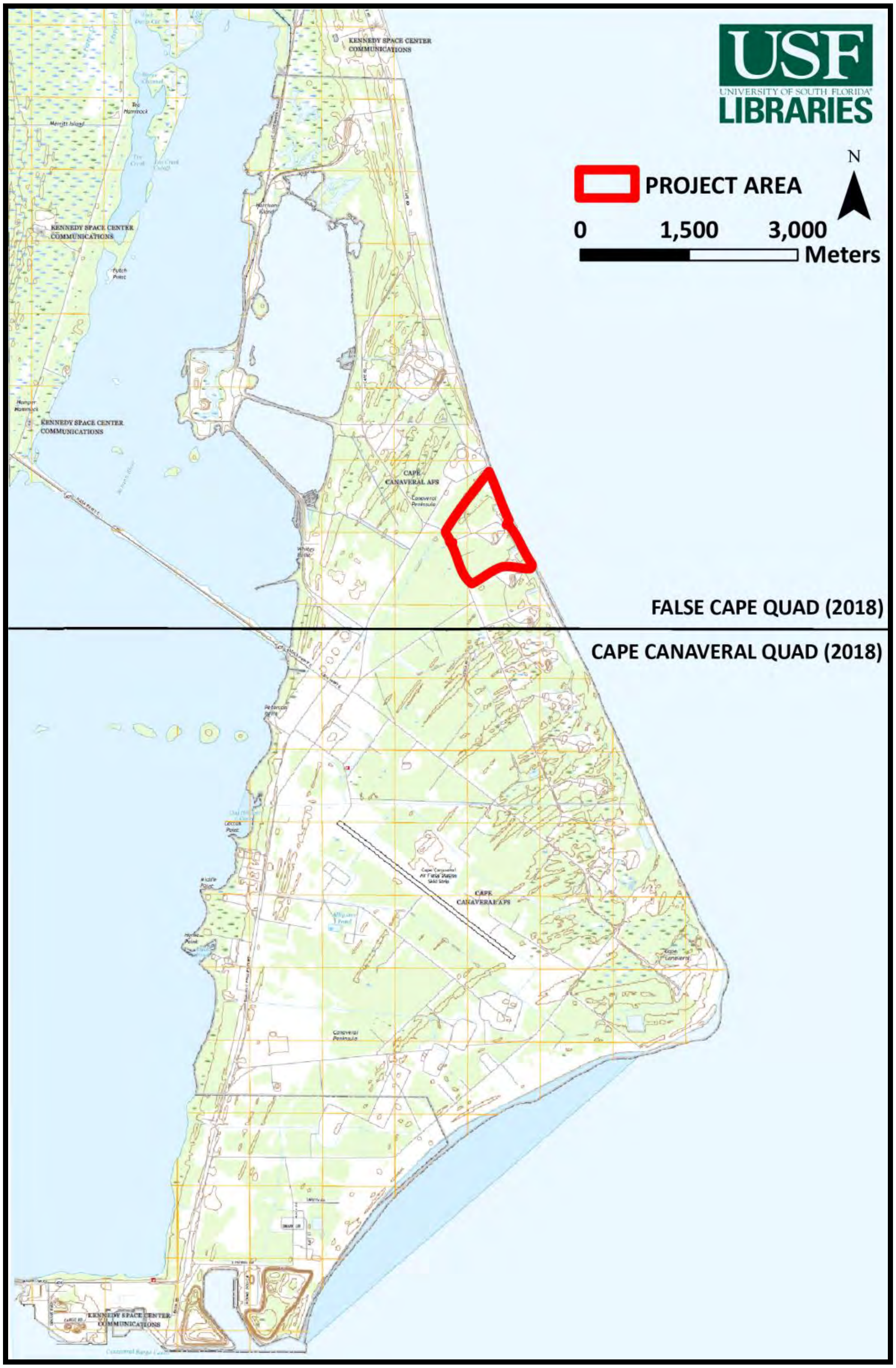

Figure 1. Project area (red) discussed in this memo (LMUs 15 and 18 on CCAFS).

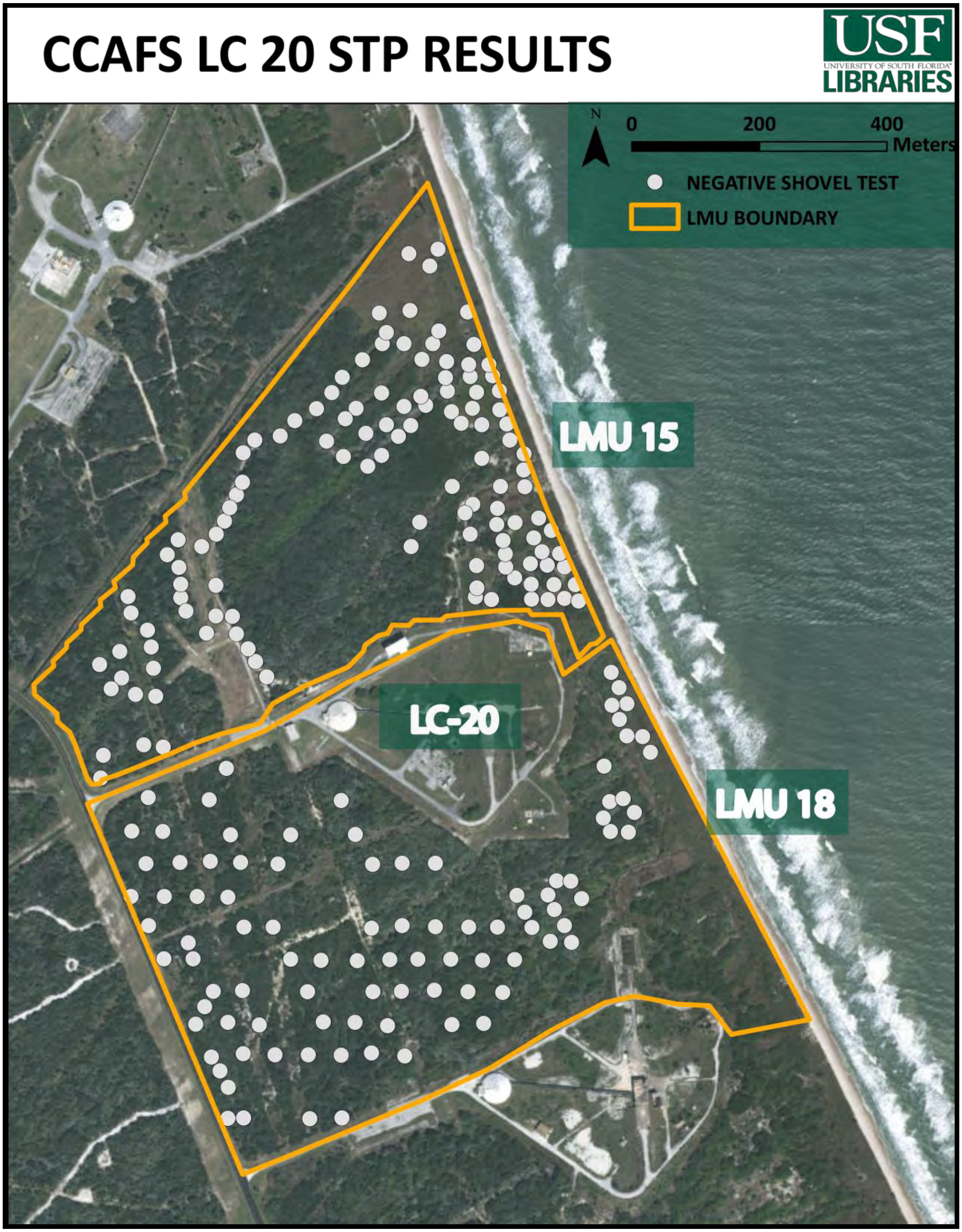

Figure 2. STP results for LMUs 15 and 18.

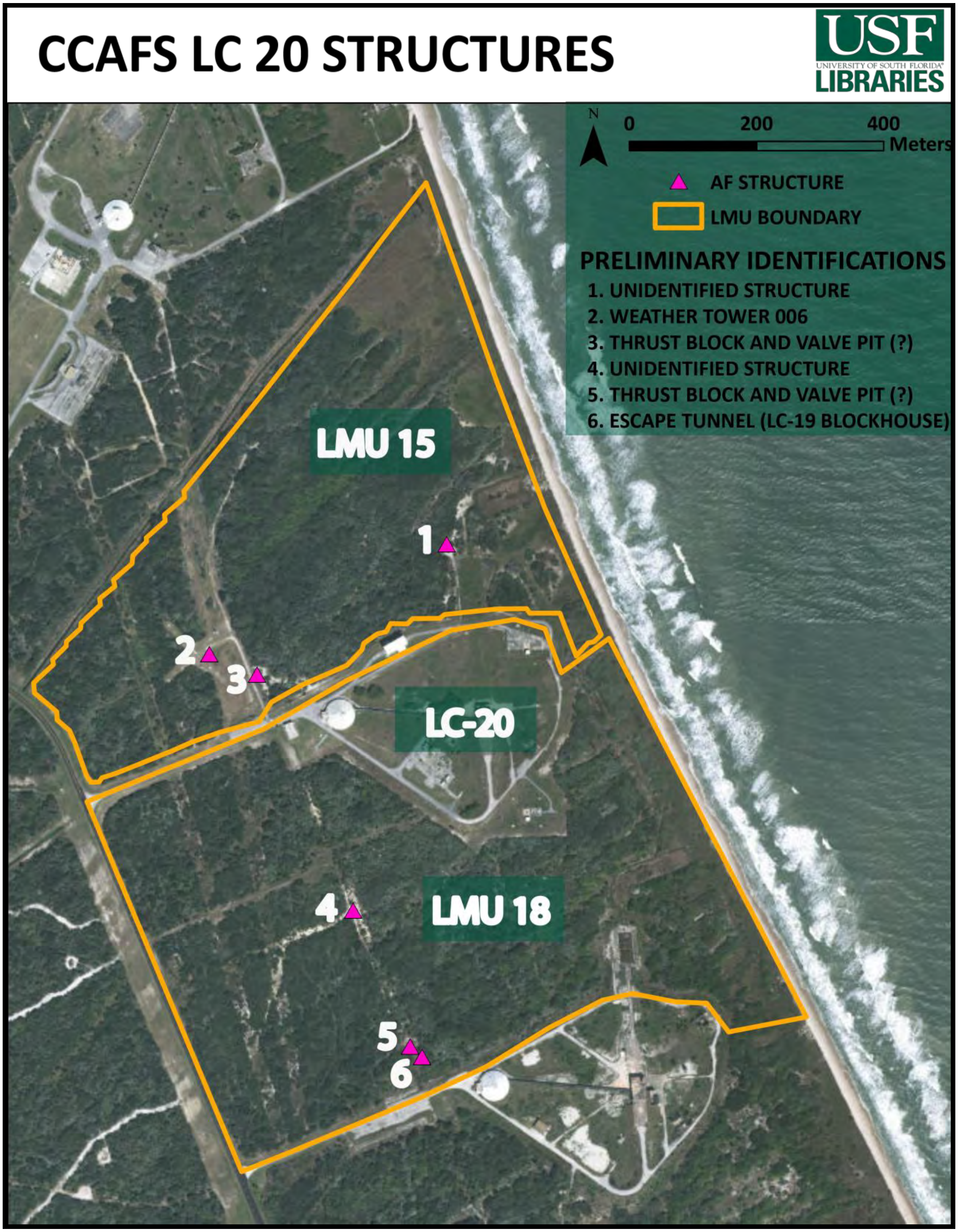

Figure 3. Structures located within LMUs 15 and 18.

Figure 4. Weather Tower 006 (F. 22101) in the southeast portion of LMU 15 - view facing W.

Figure 5. Unidentified structure (wood and metal remains) in LMU 15 - view facing E.

Figure 6. Backside of structure preliminarily identified as a Thrust Block and Valve Pit – view facing W.

Figure 7. View of water pump on structure preliminarily identified as a Thrust Block and Valve Pit - view facing S.

Figure 8. Vented structure attached to a tunnel located in LMU 18 - view facing S.

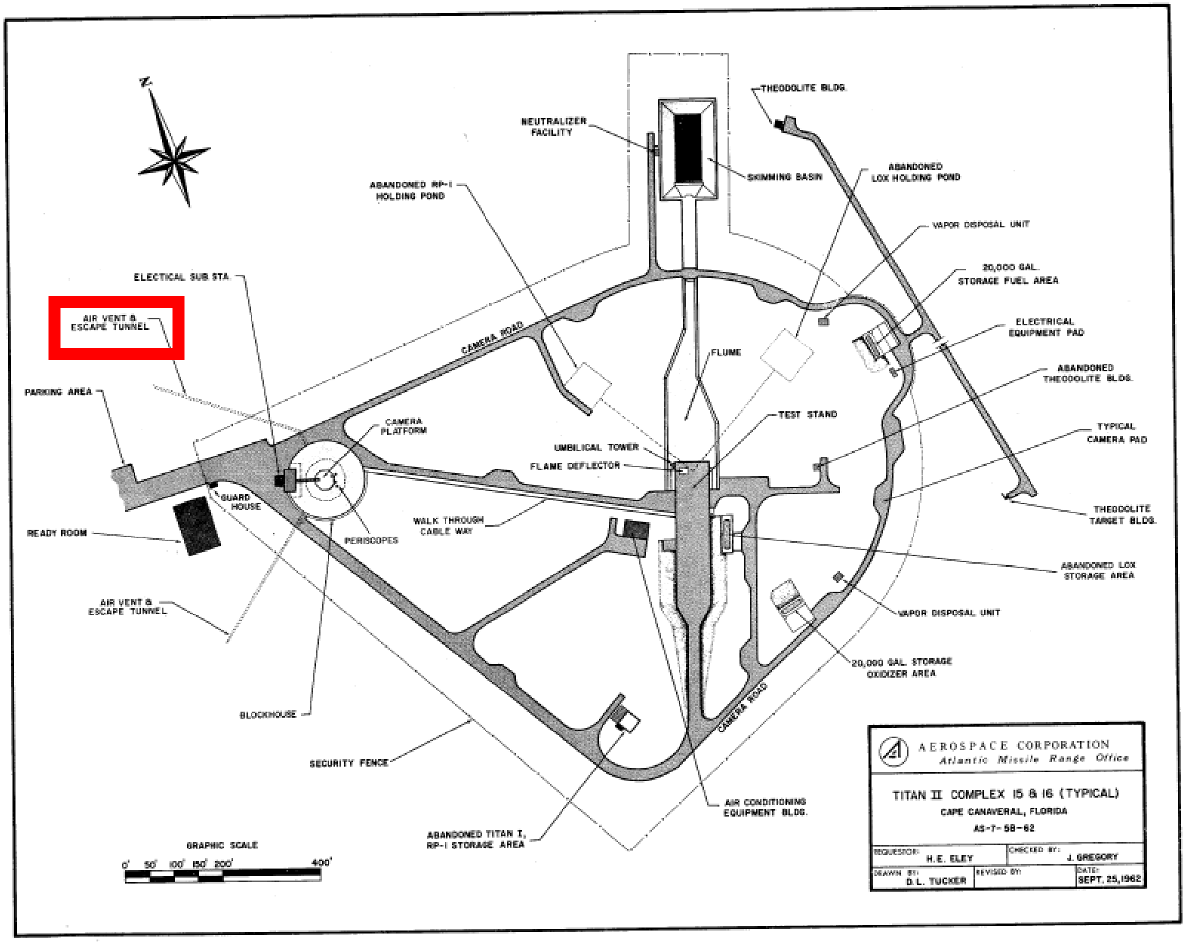

Figure 9. AMRO Engineering Staff (1962:51) LC 15/16 Plan View. Escape tunnel highlighted in red (Figure II.26).

Figure 10. Unidentified structure in LMU 18.

Figure 11. Similar structure to the one found in LMU 15. Preliminarily identified as a Thrust Block and Valve Pit - view facing N.

WORK CITED

Eley, H. E., T. J. Bryan, Jack L. Gregory, R. L. Thibault, and J. W. Tolbert
1962 The AMRO Handbook Volume VI: Atlantic Missile Range Launch Facilities. Prepared by the AMRO Engineering Staff. Aerospace Corporation. Report No. ATM-63. On File with Pan American World Airways Inc. Master Planning.

Appendix L

Air Conformity Applicability Model Report and Record of Air Analysis

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FINAL DRAFT

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: SLC-20 SEA -Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2026

- Action Purpose and Need:
Proposed Action is to build our SLC-20A, SLC-20B, and SLC-20C. No Action Alternative would be to only build or reconstitue SLC A and B only.

- Action Description:
Proposed Action is to build our SLC-20A, SLC-20B, and SLC-20C.

- Point of Contact
Name: LEESA N GERALD
Title: SENIOR AIR QUALITY SCIENTIST
Organization: ONEIDA LG2
Email: LNGERALD@OESCGROUP.COM
Phone Number: 904-363-1686

Report generated with ACAM version: 5.0.23a

- Activity List:

Activity Type		Activity Title
2.	Construction / Demolition	PROPOSED ACTION: SLC-20A, SLC-20B, and SLC-20C
3.	Emergency Generator	PROPOSED ACTION: SLC-20A, SLC-20B, and SLC-20C

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: PROPOSED ACTION: SLC-20A, SLC-20B, and SLC-20C

- Activity Description:
CONSTRUCT SLC-20A, SLC-20B, and SLC-20C

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Start Date
Start Month: 1
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.961330
SO_x	0.022791
NO_x	11.683616
CO	12.353081

Pollutant	Total Emissions (TONs)
PM 10	16.364694
PM 2.5	0.300507
Pb	0.000000
NH_3	0.230868

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.103295
N_2O	0.516889

Pollutant	Total Emissions (TONs)
CO_2	4978.078683
CO_2e	5134.656056

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.103295
N_2O	0.516889

Pollutant	Total Emissions (TONs)
CO_2	4978.078683
CO_2e	5134.656056

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 12
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 134349
Amount of Material to be Hauled On-Site (yd^3): 42000
Amount of Material to be Hauled Off-Site (yd^3): 4976

- 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

2.1.3 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	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- 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	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
LDDV	0.08708	0.00132	0.14749	6.56557	0.00364	0.00335	0.01705
LDDT	0.15078	0.00150	0.41118	5.60763	0.00583	0.00536	0.01751
HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

2.1.4 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

2.2 Building Construction Phase

2.2.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- 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): 158600
Height of Building (ft): 200
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 7

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Construction Exhaust

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): 110

- 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): 110

- 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): 110

- 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)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.46472	0.00735	3.57020	4.49314	0.09550	0.08786

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.29068	570.24091

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
LDDV	0.08708	0.00132	0.14749	6.56557	0.00364	0.00335	0.01705
LDDT	0.15078	0.00150	0.41118	5.60763	0.00583	0.00536	0.01751
HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

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

2.3 Paving Phase

2.3.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 12
Number of Days: 0

2.3.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 44029

- 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
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- 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

2.3.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025

Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02313	0.00463	570.16326	572.11992
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
LDDV	0.08708	0.00132	0.14749	6.56557	0.00364	0.00335	0.01705
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HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

2.3.4 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)

3. Emergency Generator

3.1 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: PROPOSED ACTION: SLC-20A, SLC-20B, and SLC-20C

- Activity Description:
PROPOSED ACTION TO BUILD SLC- 20A, 20B, AND 20C

- Activity Start Date
Start Month: 1
Start Year: 2026

- Activity End Date
Indefinite: No
End Month: 12
End Year: 2026

- Activity Emissions of Criteria Pollutants:

Pollutant	Total Emissions (TONs)
VOC	0.028249
SO_x	0.023794
NO_x	0.116438
CO	0.077760

Pollutant	Total Emissions (TONs)
PM 10	0.025414
PM 2.5	0.025414
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.000469
N_2O	0.000094

Pollutant	Total Emissions (TONs)
CO_2	11.643750
CO_2e	13.466250

3.2 Emergency Generator Assumptions

- Emergency Generator
Type of Fuel used in Emergency Generator: Diesel
Number of Emergency Generators: 5

- Default Settings Used: No

- Emergency Generators Consumption

Emergency Generator's Horsepower: 135
Average Operating Hours Per Year (hours): 30

3.3 Emergency Generator Emission Factor(s)

- Emergency Generators Criteria Pollutant Emission Factor (lb/hp-hr)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
0.00279	0.00235	0.0115	0.00768	0.00251	0.00251		

- Emergency Generators Greenhouse Gasses Pollutant Emission Factor (lb/hp-hr)

CH_4	N_2O	CO_2	CO_2e
0.000046297	0.000009259	1.15	1.33

3.4 Emergency Generator Formula(s)

- Emergency Generator Emissions per Year

AE_{POL}= (NGEN * HP * OT * EF_{POL}) / 2000

AE_{POL}: Activity Emissions (TONs per Year)
NGEN: Number of Emergency Generators
HP: Emergency Generator's Horsepower (hp)
OT: Average Operating Hours Per Year (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hp-hr)

FINAL DRAFT

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: SLC-20 SEA -Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2026

e. Action Description:

Proposed Action is to build our SLC-20A, SLC-20B, and SLC-20C.

f. Point of Contact:
Name: LEESA N GERALD
Title: SENIOR AIR QUALITY SCIENTIST
Organization: ONEIDA LG2
Email: LNGERALD@OESCGROUP.COM
Phone Number: 904-363-1686

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:

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.990	250	No
NOx	11.800	250	No
CO	12.431	250	No
SOx	0.047	250	No
PM 10	16.390	250	No
PM 2.5	0.326	250	No
Pb	0.000	25	No
NH3	0.231	250	No

2027 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.000	250	No
NOx	0.000	250	No
CO	0.000	250	No
SOx	0.000	250	No
PM 10	0.000	250	No
PM 2.5	0.000	250	No
Pb	0.000	25	No
NH3	0.000	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.

LEESA N GERALD, SENIOR AIR QUALITY SCIENTIST | Sep 14 2024

Name, Title | **Date**

FINAL DRAFT

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: SLC-20 SEA -Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2026

- Action Purpose and Need:
Proposed Action is to build our SLC-20A, SLC-20B, and SLC-20C. No Action Alternative would be to only build or reconstitue SLC A and B only.

- Action Description:
. No Action Alternative would be to only build or reconstitue SLC A and B only.

- Point of Contact
Name: LEESA N GERALD
Title: SENIOR AIR QUALITY SCIENTIST
Organization: ONEIDA LG2
Email: LNGERALD@OESCGROUP.COM
Phone Number: 904-363-1686

Report generated with ACAM version: 5.0.23a

- Activity List:

	Activity Type	Activity Title
2.	Construction / Demolition	NO ACTION ALTERNATIVE TO CONSTRUCT SLC-20A AND SLC-20B ONLY
3.	Emergency Generator	ALTERNATIVE ACTION

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: NO ACTION ALTERNATIVE TO CONSTRUCT SLC-20A AND SLC-20B ONLY

- Activity Description:
CONSTRUCT SLC-20A AND SLC-20B

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Activity Start Date
Start Month: 1
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.720057
SO_x	0.014713
NO_x	7.198011
CO	9.017214

Pollutant	Total Emissions (TONs)
PM 10	2.636052
PM 2.5	0.206626
Pb	0.000000
NH_3	0.117992

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.065930
N_2O	0.238839

Pollutant	Total Emissions (TONs)
CO_2	2741.481826
CO_2e	2814.285212

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.065930
N_2O	0.238839

Pollutant	Total Emissions (TONs)
CO_2	2741.481826
CO_2e	2814.285212

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 12
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 20200
Amount of Material to be Hauled On-Site (yd^3): 38000
Amount of Material to be Hauled Off-Site (yd^3): 20200

- 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	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	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

2.1.3 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	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- 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	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
LDDV	0.08708	0.00132	0.14749	6.56557	0.00364	0.00335	0.01705
LDDT	0.15078	0.00150	0.41118	5.60763	0.00583	0.00536	0.01751
HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

2.1.4 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

2.2 Building Construction Phase

2.2.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- 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): 69700
Height of Building (ft): 200
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 7

- Construction Exhaust

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): 110

- 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): 110

- 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): 110

- 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)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.46472	0.00735	3.57020	4.49314	0.09550	0.08786

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.29068	570.24091

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
LDDV	0.08708	0.00132	0.14749	6.56557	0.00364	0.00335	0.01705
LDDT	0.15078	0.00150	0.41118	5.60763	0.00583	0.00536	0.01751
HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

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

2.3 Paving Phase

2.3.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 12
Number of Days: 0

2.3.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 44029

- 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
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- 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

2.3.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025
Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872

Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02313	0.00463	570.16326	572.11992
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26860	0.00172	0.11494	4.59156	0.00364	0.00322	0.05129
LDGT	0.22958	0.00212	0.14451	3.87645	0.00408	0.00361	0.04304
HDGV	0.88395	0.00483	0.59039	11.06281	0.01969	0.01741	0.09480
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HDDV	0.10944	0.00419	2.34024	1.60034	0.04742	0.04363	0.06571
MC	3.20770	0.00193	0.54558	12.49470	0.02291	0.02026	0.05171

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01351	0.00495	340.96759	342.77490
LDGT	0.01304	0.00715	419.83935	422.29139
HDGV	0.05499	0.02808	955.36623	965.09057
LDDV	0.04285	0.00073	393.05215	394.34113
LDDT	0.03067	0.00109	441.62237	442.71351
HDDV	0.01948	0.16187	1248.10200	1296.81517
MC	0.11230	0.00331	391.17366	394.96854

2.3.4 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)

3. Emergency Generator

3.1 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: ALTERNATIVE ACTION

- Activity Description:
CONSTRUCT A AND B ONLY

- Activity Start Date
Start Month: 1
Start Year: 2026

- Activity End Date
Indefinite: No
End Month: 12
End Year: 2026

- Activity Emissions of Criteria Pollutants:

Pollutant	Total Emissions (TONs)
VOC	0.028249
SO_x	0.023794
NO_x	0.116438
CO	0.077760

Pollutant	Total Emissions (TONs)
PM 10	0.025414
PM 2.5	0.025414
Pb	0.000000
NH_3	0.000000

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.000469
N_2O	0.000094

Pollutant	Total Emissions (TONs)
CO_2	11.643750
CO_2e	13.466250

3.2 Emergency Generator Assumptions

- Emergency Generator
Type of Fuel used in Emergency Generator: Diesel
Number of Emergency Generators: 5

- Default Settings Used: No

- Emergency Generators Consumption
Emergency Generator's Horsepower: 135
Average Operating Hours Per Year (hours): 30

3.3 Emergency Generator Emission Factor(s)

- Emergency Generators Criteria Pollutant Emission Factor (lb/hp-hr)

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3
0.00279	0.00235	0.0115	0.00768	0.00251	0.00251		

- Emergency Generators Greenhouse Gasses Pollutant Emission Factor (lb/hp-hr)

CH_4	N_2O	CO_2	CO_2e
0.000046297	0.000009259	1.15	1.33

3.4 Emergency Generator Formula(s)

- Emergency Generator Emissions per Year

AE_{POL}= (NGEN * HP * OT * EF_{POL}) / 2000

AE_{POL}: Activity Emissions (TONs per Year)
NGEN: Number of Emergency Generators
HP: Emergency Generator's Horsepower (hp)
OT: Average Operating Hours Per Year (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hp-hr)

FINAL DRAFT

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: SLC-20 SEA -Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2026

e. Action Description:

- No Action Alternative would be to only build or reconstitue SLC A and B only.

f. Point of Contact:
Name: LEESA N GERALD
Title: SENIOR AIR QUALITY SCIENTIST
Organization: ONEIDA LG2
Email: LNGERALD@OESCGROUP.COM
Phone Number: 904-363-1686

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:

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.748	250	No
NOx	7.314	250	No
CO	9.095	250	No
SOx	0.039	250	No
PM 10	2.661	250	No
PM 2.5	0.232	250	No
Pb	0.000	25	No
NH3	0.118	250	No

2027 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.000	250	No
NOx	0.000	250	No
CO	0.000	250	No
SOx	0.000	250	No
PM 10	0.000	250	No
PM 2.5	0.000	250	No
Pb	0.000	25	No
NH3	0.000	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.

LEESA N GERALD, SENIOR AIR QUALITY SCIENTIST Sep 14 2024

Name, Title **Date**

Appendix M

BRRC Emissions Study for Small-Class Launch Vehicle Operations at SLC-20C

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FINAL DRAFT

Blue Ridge Research and Consulting, LLC

BRRC Report 23-13 (Final)

Emissions Study for Small Class Launch Vehicle Operations at CCSFS SLC-20C

5 June 2023

Prepared for:
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Michael James, M.S.

Contract Number:
IPO-005

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1 INTRODUCTION

This report documents the emissions study performed as part of Kimley-Horn's efforts on the Environmental Assessment (EA) for proposed small class launch vehicle (SCLV) operations at Cape Canaveral Space Force Station (CCSFS) Space Launch Complex 20C (SLC-20C). Space Florida plans to support 24 SCLV launch operations per year. The proposed launch operations are split between liquid-fueled SCLV's (18) and solid-fueled SCLV's (6). This emissions study describes the mass of pollutants generated on an annual basis by SCLV operations at SLC-20C.

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 SCLV operations;
- Section 3 presents the emissions modeling results; and
- Appendix A describes the general methodology of the emissions modeling.

2 SLC-20C OPERATIONS

Space Florida plans to provide SLC-20C launch opportunities to both liquid-fueled and solid-fueled SCLV's. Table 1 presents the proposed annual SCLV operations which includes 18 liquid-fueled static fire tests with a run-time up to 10 seconds, 18 liquid-fueled launch operations, and 6 solid-fueled launch operations. Table 2 presents the engine/motor data used to model the emissions for representative liquid-fueled and solid fueled SCLVs. A single representative SCLV launch trajectory was used for the emissions modeling.

Table 1. Proposed SCLV operations at SLC-20C.

Vehicle	Event	Description	Annual Operations
Liquid-fueled SCLV	Static Fire	10 second static fire	18
	Launch	Launch from SLC-20C	18
Solid-fueled SCLV	Launch	Launch from SLC-20C	6

Table 2. Engine modeling parameters for the representative SCLV's.

Vehicle	Propellant	Mass Flow Rate
Liquid-fueled SCLV	LOX/RP-1	572 kg/s
Solid-fueled SCLV	HTPB	616 kg/s

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 SCLV operations at SLC-20C. 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 for each propellant/operation type (i.e., liquid-fueled static fire, liquid-fueled launch, solid-fueled 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/motor. BC, commonly known as soot, is the only significant source of particulate matter (PM) emitted by liquid rocket engines. The PM emitted by solid rocket motors include alumina (Al_2O_3) in addition to BC. Solid rocket motors also include chlorine-containing compounds. Thus, unlike liquid engines, solid motors emit chlorine species (hereafter referred to as Cl_x) which include hydrogen chloride (HCl) and atomic and diatomic chlorine (Cl and Cl_2). Furthermore, nitrogen oxides (NO_x) are emitted due to afterburning between the extremely high-temperature exhaust plume and nitrogen from the surrounding air. 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 <u>per event</u> in each layer for each propellant/operation type.

	Duration	Propellant	Pollutant Mass, metric tons						
	seconds	metric tons	CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
Liquid-fueled Static Fire									
Troposphere Below 3,000 feet	10	5.7	4.8	1.9	0.010	0.19	0.0057	--	--
Troposphere Above 3,000 feet	--	--	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--	--	--
Total	10	5.7	4.8	1.9	0.010	0.19	0.0057	--	--
Liquid-fueled Launch									
Troposphere Below 3,000 feet	25	14	12	4.8	0.026	0.44	0.014	--	--
Troposphere Above 3,000 feet	44	25	21	8.5	0.061	0.32	0.025	--	--
Stratosphere	62	35	29	12	0.50	0.013	0.27	--	--
Mesosphere	27	15	9.2	5.1	2.3	<0.01	0.38	--	--
Total	157	90	72	30	2.9	0.77	0.69	--	--
Solid-fueled Launch									
Troposphere Below 3,000 feet	25	15	5.7	4.9	0.010	0.47	0.015	5.5	3.3
Troposphere Above 3,000 feet	44	27	10	8.6	0.023	0.35	0.027	10	5.8
Stratosphere	62	38	14	12	0.19	0.015	0.30	14	8.1
Mesosphere	27	16	4.5	5.2	1.1	<0.01	0.41	5.9	3.5
Total	157	97	34	31	1.3	0.8	0.7	35	21

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 propellant/operation type: 18 liquid-fueled static fire tests, 18 liquid-fueled launch operations, and 6 solid-fueled launch operations.

Table 4. Duration, propellant burn, and pollutant mass per year in each layer for each propellant/operation type.

	Duration seconds	Propellant metric tons	Annual Pollutant Mass, metric tons						
			CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
Liquid-fueled Static Fire (18/year)									
Troposphere Below 3,000 feet	180	103	87	35	0.18	3.4	0.10	--	--
Troposphere Above 3,000 feet	--	--	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--	--	--
Total	180	103	87	35	0.18	3.4	0.10	--	--
Liquid-fueled Launch (18/year)									
Troposphere Below 3,000 feet	446	256	216	86	0.46	7.8	0.26	--	--
Troposphere Above 3,000 feet	792	453	382	153	1.1	5.8	0.45	--	--
Stratosphere	1,110	636	524	215	9.0	0.23	4.9	--	--
Mesosphere	477	273	166	92	42	< 0.1	6.8	--	--
Total	2,826	1,618	1,287	547	52	14	12	--	--
Solid-fueled Launch (6/year)									
Troposphere Below 3,000 feet	149	92	34	29	0.058	2.8	0.09	33	20
Troposphere Above 3,000 feet	264	163	61	52	0.14	2.1	0.16	58	35
Stratosphere	370	228	84	73	1.1	0.089	1.8	82	49
Mesosphere	159	98	27	31	6.4	< 0.1	2.5	35	21
Total	942	581	207	185	7.7	5.0	4.5	208	124

Table 5 and Figure 1 present a summary of the pollutant mass emitted per year in each atmospheric layer from SCLV operations at SLC-20C by summing the estimates presented in Table 4 across all propellant/operation types.

Table 5. Annual pollutant mass emitted by proposed SLC-20C operations.

	Annual Pollutant Mass, metric tons						
Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	Al_2O_3	Cl_x
Troposphere Below 3,000 feet	337	150	0.70	14	0.45	33	20
Troposphere Above 3,000 feet	443	205	1.2	7.9	0.62	58	35
Stratosphere	608	287	10	0.32	6.7	82	49
Mesosphere	193	124	48	<0.01	9.3	35	21
Total	1,581	766	60.02	22.2	17.08	208	124

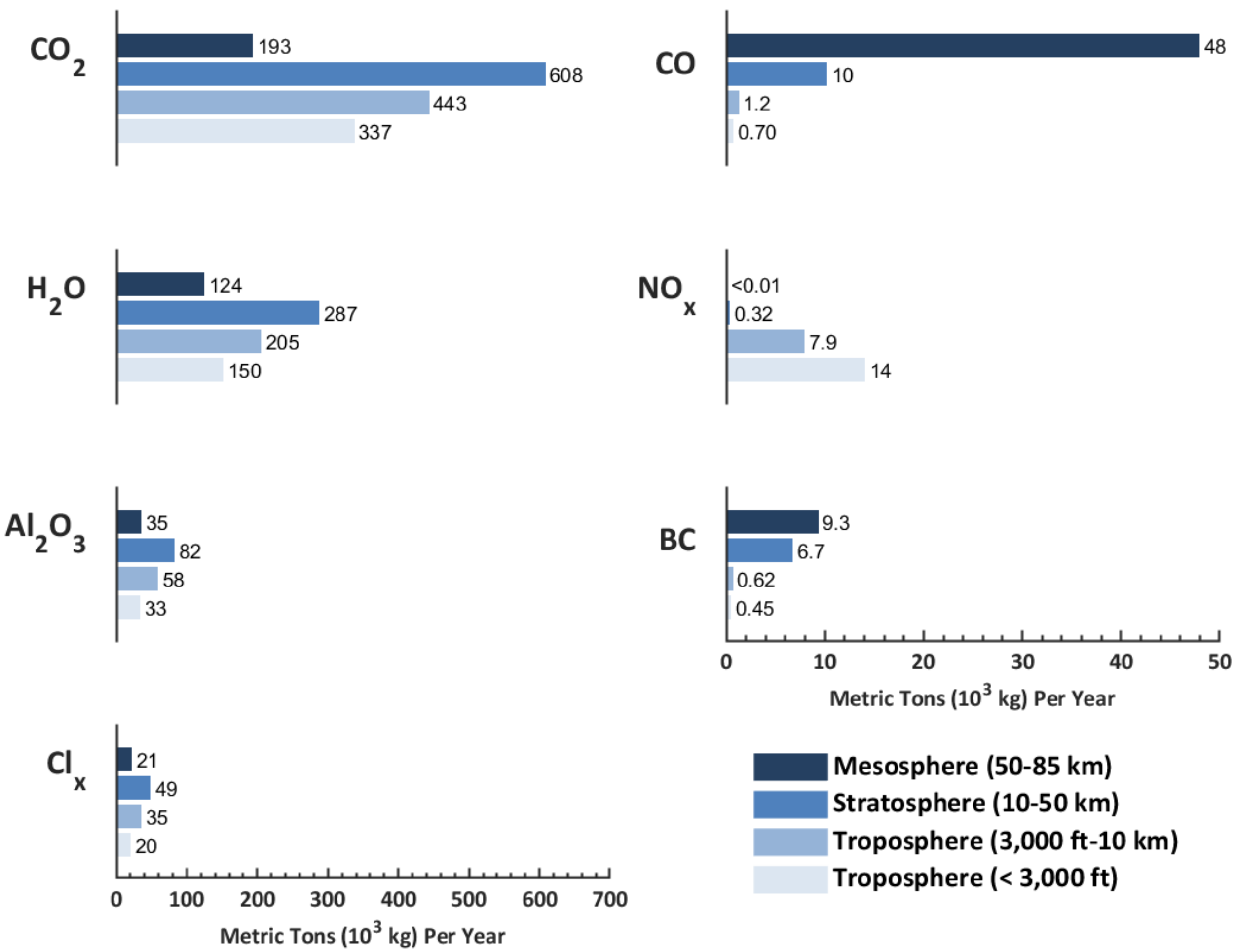

Figure 1. Annual pollutant mass emitted by the proposed SCLV operations at SLC-20C.

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 2. 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.

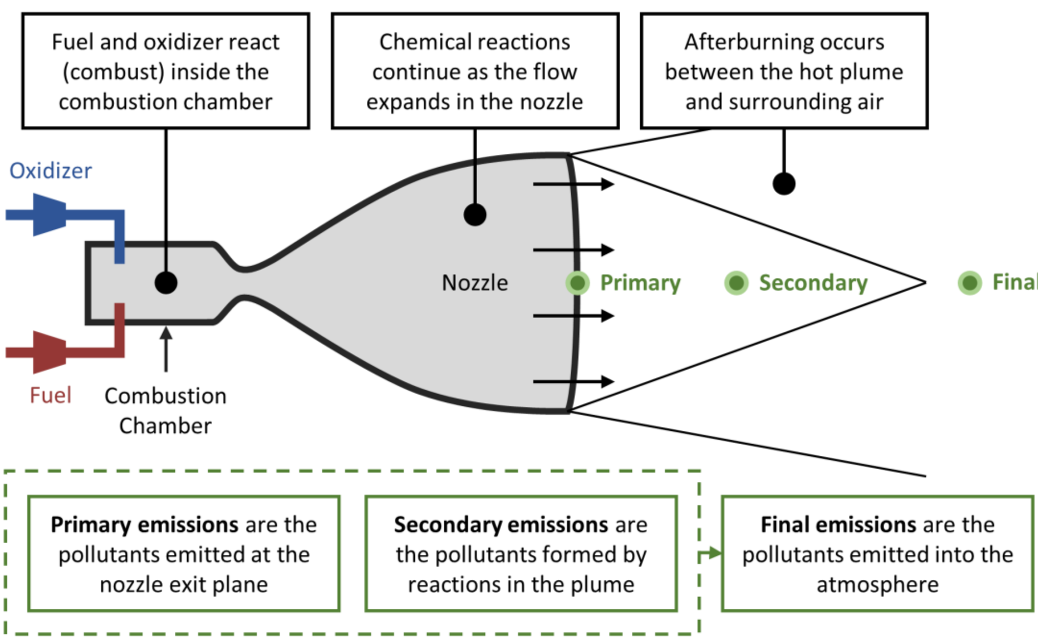

Figure 2. Diagram of the chemical processes in a rocket engine that produce the primary, secondary, and final emissions.

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) [6, 7]. 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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[1] M. M. James, A. R. Salton, M. F. Calton, and S. V. Lympany, "RUMBLE Version 3.0 User Guide," Blue Ridge Research and Consulting, LLC, Asheville, North Carolina, 2020.

[2] M. M. James, S. V. Lympany, A. R. Salton, M. F. Calton, R. C. Miake-Lye, and R. L. Wayson, "Commercial Space Vehicle Emissions Modeling," National Academies of Sciences, Engineering, and Medicine, Washington, DC, 978-0-309-46888-6, 2021.

[3] "FAA Order 1050.1F Desk Reference Version 2," Federal Aviation Administration, 2020.

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